MSc Thesis

Assessing the Transfer of Knowledge and Valorisation Performance of Public-Private Partnerships: Cross-Sectional Study at the Centre for Bio Systems Genomics

Management Studies Group

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Management Summary

Project Context

This research project emerged in answer to the growing attention for the assessment of knowledge transfer and the effectiveness of public-private collaboration; in fact, very few studies empirically measure the tangible benefits of such collaborations. Building upon the theoretical streams of innovation management and absorptive capacity, a conceptual model was developed (**Figure 2.3(1)** and **Figure 2.5(2)**) to enable empirical testing of knowledge valorisation and measuring the financial, innovative and scientific effect on the private partners engaging in private-public research collaboration. The main objective of this study is to gain a better insight in the knowledge transfer process and the valorisation performance of public-private research partnerships. In order to investigate the factors contributing to successful knowledge transfer and valorisation, a study was carried out at the Centre for Bio Systems Genomics (CBSG). CBSG is a public-private partnership in plant genomics involving universities, research institutes, (inter)national companies and branch organizations active in plant breeding (**Chapter 3**).

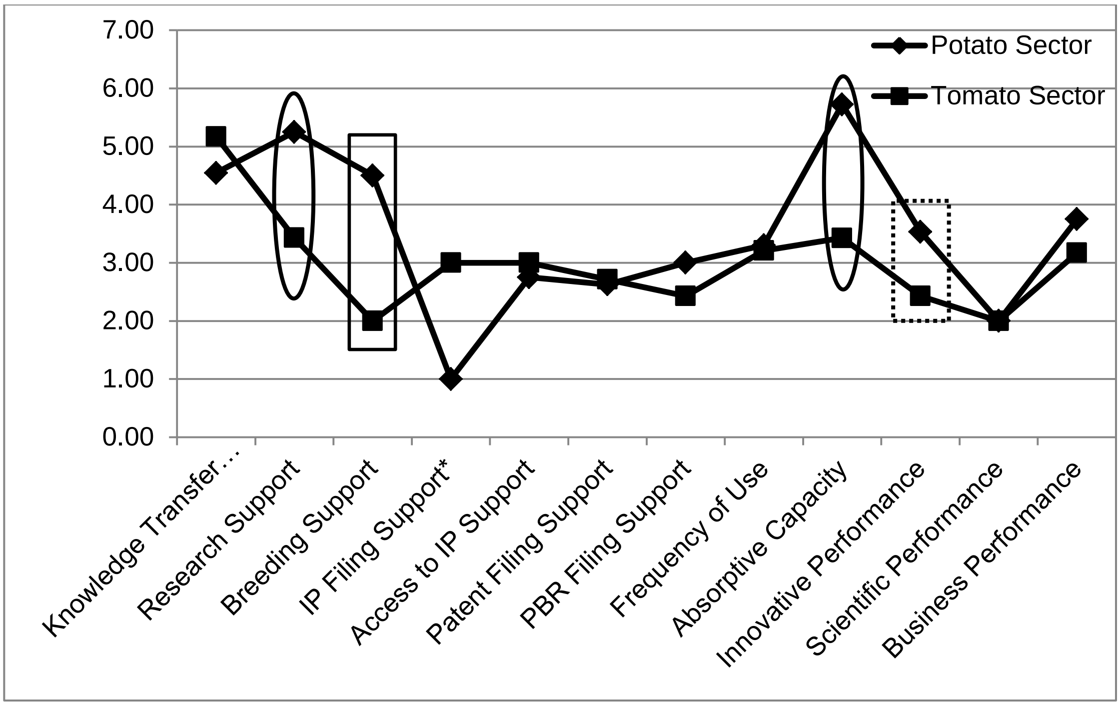
Research Strategy

The CBSG Valorisation Questionnaire was developed and administered to fifteen participants part of the CBSG, eight potato and seven tomato companies. Ten heads of the research and development department and five breeding directors answered this questionnaire. A knowledge valorisation model was created based on the theoretical concepts used to build the questionnaire. To test this valorisation model empirically, the concepts from the questionnaire were split into research variables that were operationalized by providing definitions and variables to produce measurable items. Based on the raw data retrieved from the questionnaires and financial and intellectual property figures, a choice for the analysis was made. Eight propositions (**Chapter 4, §4.3**) were tested by analysing the results using Pearson's bivariate correlations for the performance indicators (**Chapter 5, §5.6**) and Spearman's bivariate correlations for the valorisation factors (**Chapter 5, §5.4**) as well as the association between valorisation factors and performance indicators (**Chapter 5, §5.7**).

Results and Conclusions

First, a reliability analysis of the factors was conducted with the data available from the CBSG Valorisation Questionnaire (**Chapter 5, §5.3**) together with a baseline description of the respondents financial and intellectual property figures (**Chapter 5, §5.5**). We will start presenting the results for the valorisation factors for potato and tomato companies separately, followed by the valorisation performance indicators and finally with the results obtained from the association of both and the elaboration of a final valorisation model.

Valorisation Factors



Rectangle = very significant difference p < 0.01
Circle = significant difference p < 0.05
Dashed rectangle = marginal significant difference p < 0.1
*No significant difference could be found in the IP Filing Support due to unreliable data

The Figure above demonstrates the median average and significant values of the ranking given by both tomato and potato companies to the different factors of the valorisation model. The most important findings were (1) Knowledge Transfer Support is in average, the most important valorisation factor. Both tomato and potato companies showed great interest in receiving support from the CBSG in the following knowledge transfer activities: website, intranet, contact with CBSG researchers, enhanced interaction with companies and access to external sources of information. (2) Potato companies are significantly more interested in receiving research and breeding support from the CBSG, due to the technological lag in molecular breeding they suffer from when compared to tomato companies. (3) The absorptive capacity of potato companies is significantly higher than the one of tomato companies due to the long innovation life cycles of potatoes, which has caused potato companies to focus their research in areas not related to CBSG. Hence, CBSG infrastructure provides the required capital to conduct research in the core technology areas of CBSG. The opposite happens with tomato companies, which have been carrying out research in CBSG-related areas since 1990 and are now interesting in conducting research that is more complex. Absorptive capacity refers to the extent to which CBSG enables companies to test and implement new genetic markers. (4) Potato companies showed a significant higher innovative performance that tomato companies, such difference in innovative performance could be explained due to position taken by CBSG to projects carried out by both potato and tomato companies. CBSG is conducting applied projects together with the potato companies, while with the tomato companies CBSG is performing fundamental projects. Applied research is known for being capable of producing results rather quickly (Fortuin, 2009), which in turn would increase the innovative performance of potato companies in the short-term. Innovative performance refers to the extent to which CBSG enables companies to increase the sales of new products, enter new markets and introduce new products to the market faster than competitors. (5) No significant difference found in the IP Filing Support factor since it proved to be unreliable.

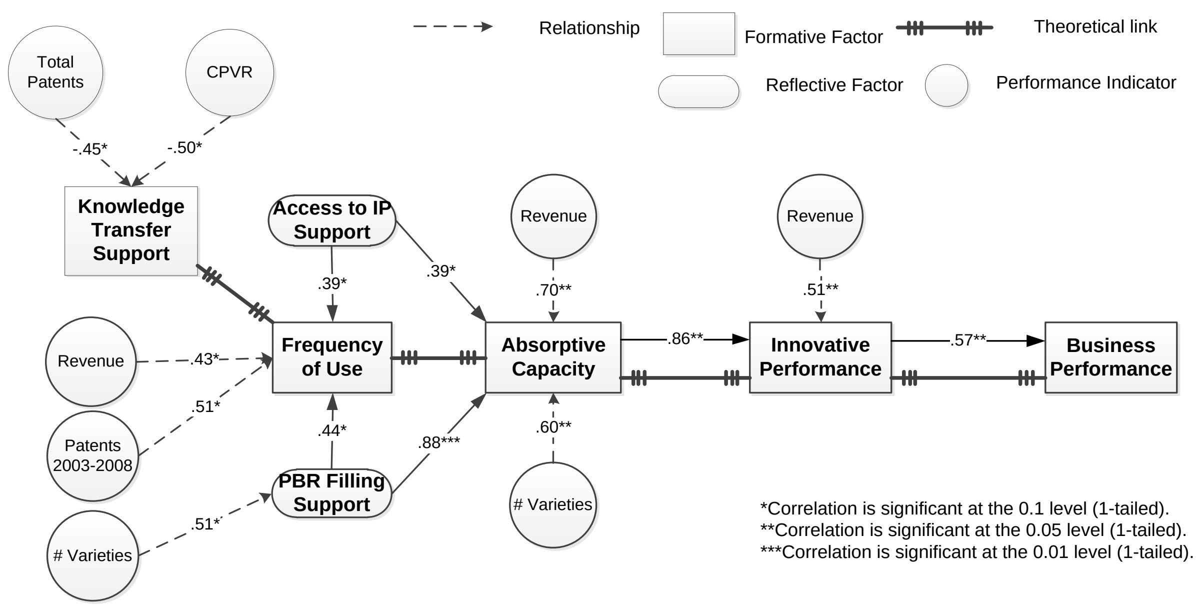
Performance Indicators

Small Dutch tomato companies apply more intensively for Community Plant Variety Rights (CPVR) per Full Time Employees (**Figure 5.6**) as well as Plant Breeder's Rights (PBR) per Euro spent in research and development (**Figure 5.6.2(2)**) than large tomato companies. This finding confirms that (1) the cost of PBR or CPVR applications is less prohibited to small companies and helps them to compete against market leaders and position themselves in the market. (2) Small companies are more innovative and (3) intellectual property permissions encourage the use of PBR and CPVR by bringing independency from suppliers, adapting easily without litigation and preventing potentially useful tools from being left on the shelf (Hope, 2009). We also found that there is a negative relationship between the number of CPVR applications and knowledge transfer support for potato companies (**Table 5.7(1)**). Hence, based on **Table 5.6.1(1)** and **Figure 5.6.1(2)** we can say that potato companies that apply more frequently for CPVR, the smallest and most innovative companies in the market, are in fact the least interested in receiving support from CBSG in knowledge transfer activities. Supporting this is Santoro and Chakrabarti (2002) who found that small firms are prone to collaborate less due to restricted resources in core-related technologies.

There is a significant negative relation between patent applications and the innovative performance of tomato companies. This lack of relationship between the number of patent applications and innovation is caused mainly by high access barriers present in the tomato-breeding sector (Louwaars, 2009). Monsanto is the leading patent applicant, followed by Pioneer-HiBred (**Figure 5.6.4(1)**). **Figure 5.6.4(4)** shows a special analysis performed on the PBR and patent applications of a large tomato company part of the CBSG, where in 2006 changed from a patenting to a PBR strategy. Unfortunately, this phenomenon is the opposite for small tomato companies; the average number of patent applications for CBSG companies is higher than that of non-CBSG participants for the period of 2003-2008 (**Figure 5.6.4(1)** and **Figure 5.6.4(2)**). Hence, it appears to be as if large tomato companies part of the CBSG are trying to become more innovative and make use of more open intellectual property channels such as PBR, while small tomato companies are competing to become the top patent applicants of CBSG-related technology, hopefully not falling in a competence trap (Levinthal and March 1993). Regarding potato companies, one potato company part of the CBSG is the leading applicant for CPVR applications when compared to other European companies (**Figure 5.6.1(2)**) and Frito Lay is the top patent application among potato companies.

Curiously, the top patent applicant among all the potato companies part of the CBSG is a family-owned company. Difference in intellectual property behaviour can occur due to differences in the innovation chain of companies. Tomato companies are large multinationals that are capable of integrating all the steps in the chain, (see **Figure 3.3,** business model E), while potato companies only focus on plant breeding, production of seeds and planting material and marketing and sales (see **Figure 3.3**, business model A or B).

Valorisation Model



After combining both empirical results and theoretical insights regarding knowledge transfer and valorisation performance, several factors (represented by squares and ovals) and indicators (represented by circles) proved to have strong validity while others demonstrated to be unreliable. The Figure above illustrates the final valorisation model, providing an overview of the significant relationships found at the empirical and theoretical level between knowledge transfer factors and valorisation performance indicators. The valorisation model is classified into three different regions: the first region is formed by the knowledge transfer, access to IP and PBR filing Support factors which measure the expectations that companies have regarding the services offered by CBSG in these areas. The second region is formed by frequency of use which measures the frequency in which companies have made use of certain service in terms of daily, weekly or monthly usage. The third final region is formed by the absorptive capacity, innovative and business performance factors which measure the degree in which CBSG enables companies to achieve certain objective in terms of number of tested and implemented markers, new products developed, personnel training, etc. Now, between these three regions, factors can connect between each other in two different ways: empirical which is symbolized by an straight line with an arrow and theoretical which is symbolized with a line with 3 cutting sticks at the beginning and at the end. For example, theory supports the links between knowledge transfer support, frequency of use and absorptive capacity (Lane, Koka et al. 2006, Bosch, Volberda et al. 1999, Szulanski 1996 and Liao, Fei et al. 2007) while a strong empirical support is found between PBR Filing and Absorptive Capacity ($p<0.01$). We just explained the relationships between factors, now to the relationships between valorisation performance indicators and knowledge transfer factors. The nature of these correlations is important because it establishes a connection between real financial and innovative figures such as number of varieties and revenue with the results collected from the CBSG Valorisation Questionnaire. It provides an starting to point for understanding possible instruments, which data can be easily collected, that may be capable of measuring these factors in the long term. Now the main relationships found between valorisation indicators and knowledge transfer factors are: (1) Revenue is a good indicator for absorptive capacity and innovative performance. (2) CPVR applications are a negative indicator of the importance that companies give to activities supporting knowledge transfer. (3) Patent applications and number of varieties are significantly correlated with Frequency of Use and PBR Filing Support.

Recommendations

A set of recommendations have been elaborated for companies, CBSG and future management studies.

- **The companies**

It is imperative for these types of partnerships to enhance the built-in valorisation model by establishing an original agreement in the intellectual property field that not only benefits the companies, but also society, with the intention of maximizing the effects of public investments. We propose that (1) the biological material and plant varieties developed in public labs or with public funds and protected by patent rights should be freely available without licensing restrictions for the development, use and commercialization of new varieties, and (2) CBSG should assess the licensing procedure for publicly developed knowledge and technology derived from public efforts in order to assign and select entities that will benefit society to a greater degree; more specifically, tomato companies 5 and 6 and potato company 5, that are the leading patenting companies.

- **CBSG**

Focusing on applied projects may lead to short-term positive results that improve performance; however, it can limit future benefits due to infrastructure subutilization and hinder long-term innovation. Thus, we suggest that especially potato companies reorient and turn back towards fundamental projects such as decreasing the life cycle of the crop, as well as developing a pioneering research strategy to unify and complement research projects.

Additionally, considering the restricted resources that are to become available in the future for public-private research and development, we recommend to CBSG to utilize resources more precisely. We suggest encouraging Knowledge Transfer Support activities for tomato companies, Research and Breeding Support activities for potato companies and increasing the core-related technology base of potato and (small) tomato companies.

- **Management**

Further research is needed to lend validity to the valorisation model and to confirm our explorative findings. Important future studies in this field would include a complete valorisation model of the relationships between public-private and academic sectors in order to precisely assess valorisation and measure overall performance. We suggest that special attention to be given to patent classification and finding causality through longitudinal analyses. Longitudinal analysis can provide the required tools to create a strong valorisation model for public-private partnerships. We also suggest realizing an in-depth analysis of privately owned companies in order to find the indicators that these companies use to measure their performance. Such a study might lead to the discovery of a performance indicator that could be used for the whole sample, increasing the interpretability and reliability of the results.

Table of Contents

Preface / Acknowledgments

This study represents my thesis research project, which is the final requirement to obtain the Master in Management, Economics and Consumer Studies (MME) at Wageningen University and Research Centre. I am a Dutch-Ecuadorian international agri-business engineer with a born passion for the environment and technology. Therefore, in my research thesis I wanted to combine my background with the knowledge I have learned during the masters to study the efficiency of a public-private partnership in the seed sector. When it comes to valorising knowledge, the performance of such projects and pointing out the key factors, the setting is immensely broad and abstract, especially when the data is the starting point and the project has to be run backwards, from the end to the beginning. Therefore, it was fundamental to concentrate in the initial empirical phase and let myself be guided by the numbers. Fortunately, both distinguished and wild papers supported our intuitive, but practical model.

I want to thank my supervisor at the Management Studies Group, dr. Frances Fortuin for her commitment and steering guidance during this project. I also want to thank prof. S.W.F Omta, my second supervisor head of the Management Studies Group, for his wise advices to handle the inherent uncertainty that comes when doing research and for his sharp feedback that improved the interpretation and understanding of the data analysed. Finally, I also want to thank dr. Gionata Leone, Valorisation Officer at Centre for BioSystems Genomics, dr. Herman van Eck, Assistant Professor in the Plant Breeding Deparment at Wageningen University and all the researchers of CBSG and the participant companies that have shared their time and knowledge during this study. Finally, I would like to thank Bicore and its team for collecting the data and supporting our research.

Reading Guide

The thesis is structured into six parts. The first part provides an overview of CBSG and describes the objective and research questions to be answered in this study (**Chapter 1**). The second part gives a theoretical perspective on innovation and absorptive capacity and presents findings of the desk research as well as it substantiates the creation of a valorisation model (**Chapter 2**). This part begins by introducing the main theories studied: open innovation, open source, knowledge transfer, absorptive capacity, performance measurement and triple helix. The third part examines the study domain by providing a brief summary of the CBSG goals and objectives, the companies involved in this study and the plant-breeding sector in the Netherlands and encapsulates key facts on two vegetables, tomato and potato (**Chapter 3**). **Chapter 4** will further build on the theories studied and a valorisation model will be built with empirical support. This chapter will also state the propositions to be proved empirically as well as the overall research design. **Chapter 5** will cover the empirical part of this study where the data collected will be analysed. **Chapter 6** finishes the thesis with a conclusion, discussion and recommendation for CBSG, companies and future management studies.

A list of references, index, glossary and list of tables, figures and appendices can be found in the back.

Chapter 1

Introduction

The Centre for Bio Systems Genomics (CBSG) is a consortium of major Dutch and international companies and top plant scientists working on potato, tomato, Arabidopsis and Brassica. It is a unique public-private partnership in plant genomics involving universities, research institutes, (inter)national companies and branch organizations active in potato, tomato and Brassica research and exploitation. CBSG was established in 2002 as a Centre for Excellence under the auspices of the Netherlands Genomics Initiative (NGI) with a total research budget of 53 M€. In 2008, CBSG 2012 entered its second 5-year phase with an equivalent budget. CBSG 2012 carries out plant genomics pre-competitive research using the latest state-of-the-art technologies. Pre-competitive research is defined as a "non-competitive area, where collaboration between companies is prelude to a generation of commercially attractive knowledge that will be useful in product development. Its construction as a middle category allows collaboration between private sector partners that are direct competitors in the same market, but also legitimizes government investments in these collaborative networks" (Vroom, 2006). Its limited choice of crops has been made to maintain focus and to cover the species of greatest importance to Dutch Agro-industry. The consortium covers the entire production chain from (pre)breeders to processors in both the food and non-food industries. CBSG 2012 aims to exploit the full potential of a broad range of genomics approaches in order to create new opportunities for sustainable agro-production systems for potato, tomato and Brassica which shall have socio-economic implications for producer, processor and consumer alike, through crop production, enhanced food quality and reduced environmental impact (CBSG 2010).

There is growing attention to the effectiveness of public-private collaboration and on assessing the transfer of knowledge. Since 1980, a large number of changes occurred simultaneously in the plant breeding sector: (1) the onset of biotechnology, (2) policy changes, (3) reorganization of the knowledge system, (4) seed business development and (5) Intellectual Property Rights (IPR) (Dons 2010). The main concern resides in the fact that the validity of such cooperation agreements has been criticized because millions of € have been spent which have led to none or very few tangible benefits.

In response to this phenomenon, several studies on the field of effectiveness of public-private collaboration support our concerns. In a study carried out on 219 federal laboratory-industry partnerships based on Cooperative Research and Development Agreements (CRADA), Bozeman (1995) found that substantial benefits are usually rare and can only be seen in future products and not in the specific projects. Another study carried out by Ham (1998), on the same type of cooperation agreements, concluded that economic assessment in the short term is difficult due to the lack of project-related benefits. A literature survey on the factors that impinge on the generation and performance of industry-university and industry-Federal laboratories cooperation carried out by Geisler (2001), on Inter-sector Technology Cooperation (ITC), derived a new theoretical insight on measuring success factors. He argues that gains to the partners appeared to be mainly in the form of leveraged R&D rather than the actual innovation, and the benefits obtained differed significantly from the projected and expected ones. This lack of benefit tangibility may be explained by a study performed on 83 Spanish Technology Institutes, where a capability failure in absorbing externally generated technology was found (Arnold 2004). The potential determinants of business sector R&D intensity were investigated empirically using a panel of the Organisation for Economic Co-operation and Development countries for the period of 1970 to 2002, with data measured as five-year averages. This empirical paper found that training and human capital are key for innovation (Falk 2006; Bozeman 2000; Bartel and Lichtenberg 1987). Another study, carried out on the data collected by the Spanish Innovation Survey administered by the Spanish Statistical Institute (INE) in 1999, found empirical evidence suggesting that policies that enhance human capital and absorptive capacity could lead to higher levels of public R&D effectiveness (Busom and Fernández-Ribas 2008).

The main objective of this study is to gain a better insight into the knowledge transfer process and valorisation performance of public-private partnerships by conducting an analysis of the empirical data collected from the CBSG Valorisation Questionnaire. This objective requires a dual methodology capable of identifying the strengths of a general valorisation model as well as capturing the differences between tomato and potato breeding partners.

Knowledge valorisation “is the formal transfer of knowledge resulting from basic and applied research in universities and research institutes, as well as from applied research and development in companies, to (other parties in) the commercial sector for economic benefit” (Goorden 2008). Despite increased interest in knowledge valorisation and measuring the impact of public R&D on private partners, very few studies measure empirically the key performance indicators of private-public collaboration and their financial, innovative and scientific impact. Most studies point to the intangibility of benefits and others point to the human capital factors. This is exactly what this study will test with the data gathered from the CBSG Valorisation project. This project is sponsored by the NGI and funded by six ministries, one of which is the Ministry of Agriculture, Nature and Food Quality who is currently incentivizing a policy programme. This programme has an emphasis on valorisation of knowledge generated in publicly funded research activities and a focus on sharing and transferring of demand-driven knowledge. It is called “Knowledge must cycle”, a system in which funds will be granted for public-private partnerships involving at least one private company and one research provider (Wijering 2010). Also part of this valorisation movement, the Ministry of Economic Affairs of the Netherlands is now including valorisation as part of its Innovation Programmes and is creating new tools to enhance knowledge transfer such as the STW (Dutch Science Foundation) Valorisation Grant and “Knowledge Vouchers” (Zonneveld 2010).

To carry out an empirical investigation, however, the objective of the study has to be narrowed down. For this reason, the present study focuses on analysing the companies that are part of the CBSG consortium, excluding both the public and academic sectors, which are needed to develop a complete valorisation model. Fifteen technology-based firms, which are leaders in their respective areas, were included in the study. Twelve of these firms are performing plant-breeding[1] activities, two are processors and one is a technology provider. To measure the performance of the companies involved and the valorisation capabilities they possess, a cross-sectional survey was conducted. This study will be used to address the following research question:

What factors can be used to assess the transfer of knowledge and valorisation performance of public-private partnerships?

Chapter 2 discusses the two main theoretical perspectives used to measure the performance of companies, namely innovation and absorptive capacity. The focus of the innovation perspective is on competency development and the innovation process. Both are tackled using open innovation and open source as models for increasing knowledge mobility, availability of venture capital and product life cycles. A major concern here is the difference in the level of competencies between companies, which is addressed by studying absorptive capacity. Absorptive capacity allows us to investigate the internal ability that companies have to recognize, acquire and apply knowledge in order to enhance their innovative capacity. We argue that innovation theory and absorptive capacity perspectives are complementary to understanding the external environment and the internal fit of companies and, ultimately, to measure performance.

In Chapter 3, the focus is on the internal structure and the external environment of CBSG. The strategy of CBSG is introduced in terms of its mission, vision and objectives, together with the history of the public-private partnership. In this Chapter, we also briefly describe company members of the CBSG as well as their merger and acquisition history. As the CBSG is an R&D consortium, we consider R&D to be a key function in developing new products, processes and services in technology-based firms (Fortuin et al., 2007). Finally, the plant-breeding sector is briefly explained and the differences between companies within the CBSG are described.

[1] Definition at http://www.ers.usda.gov/Briefing/Biotechnology/glossary.htm

In Chapter 4, the research design is discussed. The conceptual model is developed based on the variables from the CBSG Valorisation Questionnaire, supported on similar theoretical models and clarified through operating principles. The instruments, concepts and measures used to calculate the relevant relations and assess the internal and external validity are also described. The research questionnaire used in the cross-sectional study can be found in the Appendix A. We also focus on the sampling methods used to ensure sample representativeness and assert the data analysis methods used.

The cross-sectional study, the empirical results that are discussed in Chapter 5, focuses on answering three research questions:

RQ1. *How is the conceptual model designed and applied in view of the set of theories and indicators?*

RQ2. *Which factors can be used to assess knowledge transfer in CBSG?*

RQ3. *Which indicators can be used to assess performance valorisation in CBSG?*

This chapter reports the results of the data analysis and the empirical study that was designed to assess the factors of knowledge transfer and measure the valorisation performance of the companies part of CBSG. It will be argued that significant valorisation factors can be found in Knowledge Transfer, Research, Breeding, IP Filing, PBR Filing, Access to IP and Patent Filing Support as well as in Frequency of Use, Absorptive Capacity and Innovative, Scientific and Business Performance. While significant performance indicators can be found in Plant Breeders' Rights (PBR), Community Variety Rights (CVR), Plant Variety Protection (PVP), size or patent applications. The companies in the present study belong to either the tomato or potato-breeding sector, but differ in their Intellectual Property (IP) strategy by using patents or PBR and protecting knowledge locally or internationally.

Structured questionnaires were sent to all partners of CBSG, organizations that are among the top 10 tomato seed companies operating in the global market, and the main Dutch potato organizations in the Dutch and European potato market. Participants were selected based on their involvement with CBSG: they were contact persons, project leaders, or CBSG Management Team (MT) members. Within their organizations, the participants fulfil the role of researchers, breeders, R&D managers or directors. It is important to mention that the questionnaire data was collected personally and that of the 16 completed questionnaires, one questionnaire was not relevant because the participants had marked differences from the rest of the group. Financial information regarding the companies involved in the study was collected from annual reports or secondary sources. In Chapter 5, we discuss the results regarding the eight propositions defined in Chapter 4. Finally, in Chapter 6 we derive conclusions based on the results obtained from the assessment of the valorisation model in CBSG.

Chapter 2

Theoretical perspective: innovation and absorptive capacity

The aim of this chapter is to zoom briefly into the research topic from a larger perspective in order to understand the relationship between the concepts used and the present study.

Nowadays, in a global market, competition has become fierce not only locally or regionally but also internationally. Companies, based in developing countries, are penetrating the first world markets with technology developed at site and cost advantages have transformed this into a one sided battle. That is why, organizations based in developed markets, have to change strategy and reorient their efforts towards collaboration. Why collaboration? Simply because this is the only area in which European and American companies may outperform their foreign competitors. Companies based abroad may be more innovative and cost effective but the social and cultural behaviour and specially that top-down approach are preventing them from efficiently reducing technology life cycles. On the other hand and taking the case of Europe, governments have taken the initiative and together with universities and the private sector have begun to form cooperation agreements in order to take the next step into the new knowledge-based economy.

Knowledge is the perfect resource, as it cannot be depleted; it can only be stored, shared or transformed into products or knowledge with higher value. Cooperation agreements among these three driving sectors of the economy cannot only enhance the creation and transfer of knowledge among organisms but also the use of such. Stored knowledge can become active again by distributing it into applied sciences, while the knowledge base can be further increased through fundamental projects. Therefore, by increasing the knowledge capacity of companies, universities and governments are developing innovative competences through public-private partnerships in order to recover the competitive edge.

This chapter presents a critical analysis on the literature available on innovation and absorptive capacity. Considering the extensive amount of studies focused on innovation, this research has focused on alternative business models that can be adopted by the plant-breeding sector like and Open Source (OS). Further, we build on the fact that precompetitive research only focuses on the early stages of the innovation process and that in such arenas where subsidized capital has been used, the open innovation model plays an important role. IP is always a top point in the agenda of cooperative agreements, so we look at patents and PBR in the breeding sector from an OS perspective. The second section of this chapter begins by explaining the foundation of absorptive capacity theory and highlighting several definitions and findings. After introducing the basics, we discuss absorptive capacity in relation to several of the firms' activities, such as knowledge transfer, innovation process and performance. We present a theoretical model, which was influenced by the most relevant authors, and summarize explorative research studies that identify the strengths and weaknesses of measuring absorptive capacity. The last section of this chapter connects absorptive capacity with triple helix theory in a model that aims to clarify the role of absorptive capacity and innovation in public-private partnerships. Absorptive capacity focused more intensively at an internal level; it narrowed the approach by transforming knowledge into a resource, while innovation was externally oriented with public-private partnerships and the environment.

2.1 Innovation

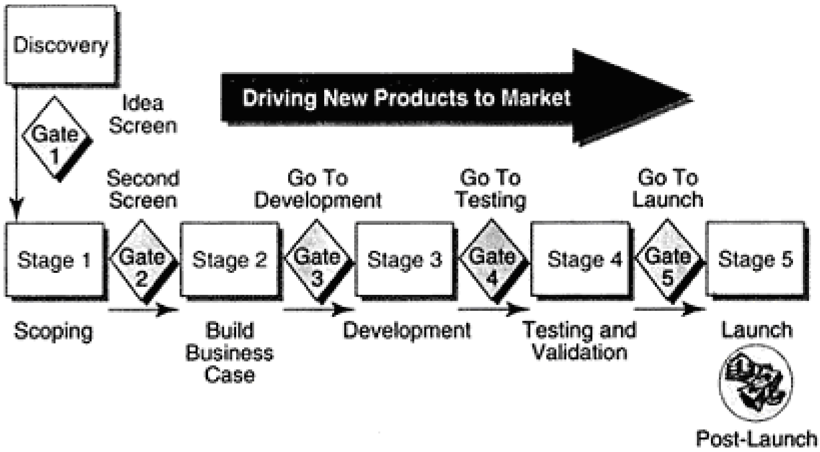
Innovation is defined by Schumpeter (1934) as:

The introduction of a new good – that is one with which consumers are not yet familiar – or of a new quality of a good. 2) The introduction of a new method or production, which need by no means be founded upon a discovery scientifically new, and can also exist in a new way of handling a commodity commercially. 3) The opening of a new market that is a market into which the particular branch of manufacture of the country in question has not previously entered, whether or not this market has existed before. 4) The conquest of a new source of supply of raw materials or half-manufactured goods, again irrespective of whether this source already exists or whether it has first to be created. 5) The carrying out of the new organization of any industry, like the creation of a monopoly position (for example through trustification) or the breaking of a monopoly position.

In definition, according to John et al., (2008) *innovation involves the conversion of new knowledge into a new product, process or service and putting this new product, process or service into use, either via the marketplace or by other processes of delivery*. Applying this definition to the triple helix model, Perkmann and Walsh (2007) in their theoretical review derived that firms' expectations towards industry-government-university interactions are not always innovation-driven but knowledge oriented. They concluded that such a positive attitude towards collaboration and knowledge transfer rather than to products is to be expected in subsidized public research partnerships as opposed to fully privatized R&D. In the breeding sector, publicly funded research is precompetitive, meaning that firms cannot appropriate research results exclusively but instead they are available for all members and sometimes even for external parties. The main goal is not to commercialize new products but to generate knowledge spillovers that may lead to an increased number of projects being funded. Such cooperation platforms serve as expectation catalysers since small firms are in necessity of resources and big firms are in need of innovation.

In the literature presented, it is clear that innovations play a significant role in responding to changing customer demands. It is important to look at the how companies manage innovation and to understand the sources and direction of their technological change. Tidd, Bessant and Pavitt (2005), stated that innovation is so complex, uncertain and risky that it may seem impossible to manage and it requires improvement and changes in the operation of technical and organizational systems (Tidd, Bessant et al. 2005). With these challenges, organizations find the process complicated and decide not to innovate. Thus, key issues in innovation, which range from searching innovative ideas to adopting and sustaining technology, must be addressed to make innovation successful.

Figure 2.1: Stage-Gate Innovation Process



Source: Cooper, 2008

In Cooper's model, there are five stages in the innovation process: the first two stages are considered to be in the "fuzzy" front end of the innovation process, the following two are part of the development process and the last stage is the commercialization process of the product. Each stage allows for information gathering, reducing uncertainties and risks for the next step. Each stage has higher costs than the preceding one, where all departments of the firm are cross-functionally involved. In the course of this research, we will give higher importance to the front-end innovation due to its connection with precompetitive research: discovery idea capture, strategic disruptions in customer's industry, scenario generation, voice of the customer, technology development. The preliminary market, technical, business and financial assessment and recommendations make up Stage 1. The user needs and wants study, competitive analysis, market analysis, detailed technical assessment, concept testing, detailed business and financial analysis and development of the "Business Case" make up Stage 2.

In terms of the direction of technological change, Tidd et al. (2005) mentioned five major technological trajectories: 1) supplier-dominated, 2) scale-intensive, 3) science based, 4) information-intensive, and 5) specialized suppliers. Each trajectory defines the nature and sources of innovation, and specifies implications for technology strategy and innovation management. The direction and type of innovation that companies follow depends on the resources and competencies they have, which greatly influence where R&D will be located and how the management structure will be organized. The following text presents details regarding innovation in the breeding sector. The breeding industry is more product innovation-oriented than process innovation-oriented and is more likely to introduce incremental rather than radical innovation. Therefore, firms in this sector rely on external sources of innovation and engage in the acquisition of intermediate and capital goods more than the average company in other industries. Other external sources of innovation, such as technological scientific information, expertise acquired externally and patents are important for traditional industries (Archibugi et al. 1991). Major internal sources of innovation in breeding companies include R&D, design and tooling up, and patents.

Competencies are the activities and processes through which an organisation deploys its resources effectively (Johnson, Scholes et al. 2008).

Competencies involve processes and routines that are programmed in order to perform activities in different ways. Some of these will be essential to a firm's business development and will be difficult for competitors to copy (Scholten 2006). Examples of competencies that can deliver additional value and increase performance are business alignment, problem solving, innovation management, strategic vision, structure of the organization, etc. (Johnson, Scholes et al. 2008). A firm that has developed an effective problem solving method may use this competence in the long term to adapt to and penetrate dynamic markets quicker and easier than other firms. Regarding the innovation process, companies must be capable of understanding their internal learning curve, the product life cycle and the strategy; linking the appropriate resources and skills with strategy can generate a strong innovative direction and a competitive advantage. Such competencies are unique and can play a decisive role in the development of the firm.

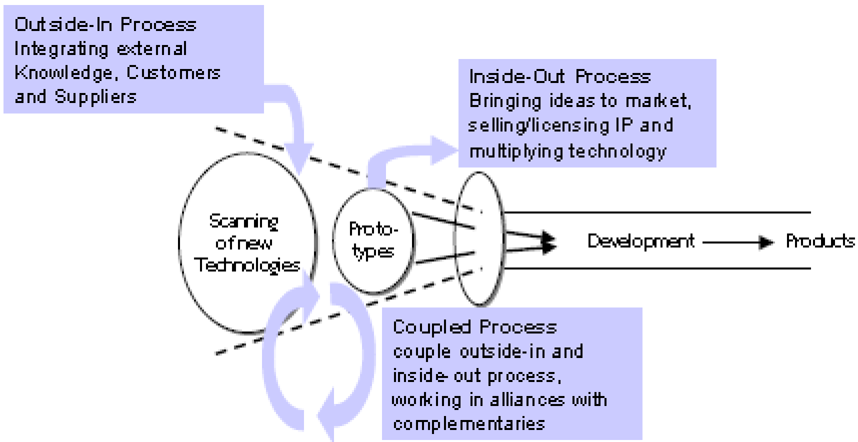
2.1.1 Open innovation

Open Innovation is a recent term coined by Henry Chesbrough, but the movement and idea itself has already been developing for several years, so in the following lines we will briefly explain why innovation is changing from a closed perspective to a more open view. During the last decade, breakthrough innovations have been few compared to those of the 80's and 90's, when new types of energy became available and findings in the genetic and electronic industry made breakthroughs in several industries. Over the last few years, companies have depended on incremental innovations and the acquisition of smaller organizations, which were most frequently responsible for bringing new technologies to market. They also rarely shared ideas during the first stages of the innovation process with other competitors and never during the commercialization stages (Gassmann 2006).

A simple and short explanation for a change in this attitude would be the rising costs of developing technology, the shorter product life cycles (Chesbrough 2007), knowledge mobility and the increasing availability of private venture capital (Chesbrough 2003). According to Piet Schalkwijk (2010), director of IPR of Akzo Nobel N.V., big companies are not a good source of breakthrough innovation. An advantage of Open Innovation is that big players can associate with Small Medium Enterprises (SME) to benefit from each other where access to networks and proximity to knowledge are keys to trigger innovation. Hence, considering that the process of creating and transferring knowledge is a rather cyclical method with constant feedback loops, the linear innovation model of push and pull evolves into an open, networked, assisted model based on industry-university interactions incentivized by the government, capable of efficiently encouraging technology and knowledge transfer through hybrid entities (Etzkowitz and Leydesdorff 2000). Such an interface allows university and firm to connect to external sources of knowledge and academic resources respectively (Etzkowitz 2003). Against this perspective is Cohen et al., (2002), who in a study performed in 1200 R&D laboratories in the manufacturing sector, concluded that the linear innovation model might adapt more practically to the pharmaceutical sector because external sources of knowledge are not as important as in-house R&D for the innovation process.

In a study by Enkel and Gassman (2009), they identified three archetypes of the open innovation process: the outside-in process, the inside-out process and the couple process, which is a combination of both. The outside-in process involves increasing the knowledge capacity of the company through the integration, coordination and motivation of external knowledge sources like suppliers and customers. The inside-out process focuses on using external markets and users to multiply the reach of technology, which consequently, increases its adoption rate. The coupled process is a mix of both outside-in and inside-out process, but whose main characteristic is that companies should cooperate with others in strategic networks. It is important to understand that the orientation of such platforms is toward enabling a flexible innovation strategy that combines both organizational and consumer approaches in order to generate customer acceptance and create industry standards (Gassmann and Enkel 2004).

Figure 2.1.1: Three archetypes of the open innovation process



Source from: Gassman and Enkel, 2004

Open Innovation is a model that frees businesses from an isolated environment, where valuable ideas and knowledge from external sources are welcome to be incorporated (West and Gallagher 2006) and ideas from the inside are capable of leaving the organization. In this model both R&D and the customers have new roles: R&D compiles and organizes the information gathered from internal and external sources and finds ways to generate and capture value from it, while customers become the creators of their own products (Chesbrough 2003). The key challenge is finding the useful knowledge that is available in the environment, which OS seems to have tackled (Chesbrough and Vanhaverbeke 2006).

2.1.2 Open Source and intellectual property in plant breeding

The main power of OS lies in the strength of the appropriability regimes and not in 'free' as it is commonly thought (Pisano and Teece 2007). OS licenses ensure that any user can become a developer and a distributor, consequently limiting companies in their ability to profit from it. There are three key objectives of OS licensing that seek to support innovation and cumulative development by constantly adding value to the technology through co-development and sharing:(1) credible commitment, (2) competition and, optionally, (3) copy left (Hope 2009). Credible commitment indicates the trust that users have in the capacity of the system to enforce the rules. Competition implies that for OS projects to arise, a significant market has to previously exist; a perfect example would be Microsoft versus Linux. Finally, copy left is a type of license that guarantees that further distribution, modifications or other versions of the same program or work remain free of charge.

The benefits of OS are multiple: OS tools are frequently better due to their constant testing; they are usually cheaper and easier to access than private technologies; they bring independency from suppliers; they can be adapted easily without IP litigations; and there is no danger that a potentially useful tool will be left on the shelf (Hope 2009). However, there can also be pitfalls to OS. According to Behlendorf (1999), the developing costs of an OS Model are not necessarily always lower that private ones. Therefore, the analysis of demand is a cornerstone of this model, as it will be the source of development and the reason for decreasing costs. OS has slowly been adopted by businesses to pool resources towards problem solving, as its friendly orientation towards IP removes the threat of anti-trust court cases (Perens 1999).It has also been implemented by others to compete against market leaders and position themselves in the market (Hope 2009). OS and Open Innovation are both characterized by a free-revealing direction that allows collaborative design for all the users (Von Hippel and Von Krogh 2006).

In the scientific community, journals are an incomplete expression of an open system, which have been progressively evolving to an "available for all" policy, with the introduction of the not-yet-so-popular open journals. For knowledge to become available in such areas, the peer reviewers must first filter them. Publishing serves as a strong incentive for scientific staff by providing recognition from an external scientific audience—in the private sector as well as academia. A bibliometric study by Koenig (1983) found that the R&D personnel of top pharmaceutical companies in the US publish as many articles in top journals as leading universities. Apparently, European companies are less publication-driven due to lack of career possibilities, but they still publish a considerable amount of articles in top journals.

Omta (1995) concluded that the motivation of the scientific staff could deeply influence the innovative and industrial performance of the company. Opposing this view is Horrobin (1990), who concluded that, "many scientists-reviewers are against innovation unless it is their innovation. Innovation from others may be a threat because it diminishes the importance of the scientist's own work".

An example where we can clearly link OS with innovation and the breeding sector is PBR. PBR is an OS system adapted for the breeding of new plant varieties in the sector. For a variety to be accepted and protected, it must follow a number of conditions in the DUS criteria: Distinctive, Uniform, Stable and novel. Although PBR may act as patents by restricting other users from reproducing, handling, selling, or storing propagation material, there are fundamental restrictions that distinguish them, such as the farmers' privilege, research exemption and breeder's exemption. The farmer's privilege consists of preserving a certain amount of seeds after harvesting to be used for the next harvest, which is of particular relevance in developing countries. The research exemption stipulates that the breeder of a variety cannot act against third parties that are using the protected variety for experimental uses only. The breeder's exemption allows competitors to use the variety as a base to improve and breed new varieties. Louwaars et al., (2009) in a case study for the Centre for Genetic Resources, found that the role of PBR and patent is not that of encouraging innovation but that of transferring knowledge, for example through the breeder's exemption. High access barriers, which differentiate the breeding industry from sectors such as the chemical and pharmaceutical, where small companies are the source of innovation, cause this lack of relation with innovation. It is important to mention that there are different organisms that are in charge of handling applications of new varieties for PBR. In the U.S., it is the Plant Variety Protection (PVP) Office[2], in the European Union (EU), it is the Community Plant Variety (CPV) Office[3] and in the Netherlands, it is the NAK Tuinbouw[4].

Regarding patents, patent rights availability for plant varieties has been restricted in the Netherlands for a long time, but in the last few years, several revisions have been made that led to changes in regulation. Nowadays, inventions subject to patentability are plant genes and special cases of biological processes and special cases of plant varieties; for a plant variety to be patentable, it must contain inserted genetic material that changes the characteristics of the plant. This inserted genetic material is patentable and therefore obtaining such a variety without the additional genetic material is impossible. Patents provide companies an important source of market power and resource control, preventing competitors from imitating traits (Omta 1995). In a recent study of 80 faculty members connected to an

[2] http://www.ars-grin.gov/cgi-bin/npgs/html/pvplist.pl

[3] http://www.cpvo.europa.eu/main/en

[4] http://www.plantenrassen.nl/

agricultural biology department of four land grant institutions, Lei et al., (2009) concluded that Intellectual Property protection has a negative effect on research. Therefore, in privately funded R&D projects, patents relate to innovative performance. The difference resides in the fact that patent applications are made for finalized products that are going to be commercialized in the market, in order to block competitors. However, in precompetitive research, the aim is to generate public knowledge that in further stages can be transformed into a final product via spill overs. Again, it is important to mention the differences between the United States (US) and the EU patent system. In the decision that the Supreme Court took in the case of Diamond v. Chakrabarty, 447 U.S. 303 in 1980, utility patents may be granted to plants. While in 2001, the decision of J.E.M Ag Supply, Inc. v. Pioneer Hi-Bred International, Inc, 534 U.S. 124, allowed sexually reproduced plants to be eligible for utility patents[5]. European law does not allow the patenting of plant varieties, therefore stimulating the PBR system.

2.2 Absorptive capacity and knowledge

According to Cohen and Levinthal (1990), absorptive capacity is defined as:

The ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends.

The absorptive capacity of an organization, therefore, is dependent on the aggregated capabilities of its human capital learning potential (Lane, Koka et al. 2006) and prior related knowledge (Cohen and Levinthal 1990). Employees with experience in the field of research are more likely to understand and assimilate the knowledge and technology derived from such investigation (Bergh and Lim 2008). Unfortunately, during the last decades, technology has developed at a pace that neither whole organizations nor the brightest of employees can embrace. Absorptive capacity consequently depends on practices within the organization that enable knowledge sharing and transfer not only at the individual level, but at the organizational level as well (Lane, Koka et al. 2006).

Absorptive capacity can be enhanced through inter-organizational relationships, by joining a community and by developing procedures that stimulate knowledge transfer practices and support absorption of complex knowledge or external sources (Bosch, Volberda et al. 1999). Although such techniques do not ensure the flow of knowledge among individuals and firms, it certainly does increase the probability that this will occur (Leonard 1995). A study of 20 major auto companies (nine European, eight Japanese and three American), conducted from 1980 to 1987 by Clark and Fujimoto (1991), revealed a strong

[5] http://en.wikipedia.org/wiki/Plant_Variety_Protection_Act_of_1970

Japanese advantage in lead time and engineering hours. However, an update of this study performed by Ellison et al. (1994) on 19 companies found gains in American and European companies in terms of lead times and productivity, principally due to knowledge transfer activities between these and Japanese companies (Leonard 1995). Szulanski (1996), in an empirical study of eight companies, concluded that absorptive capacity is a bottleneck in the development of knowledge transfer inside the firm.

Knowledge sharing is a key element of the absorptive capacity of a firm (Zahra and George 2002); it is embedded in formal and informal procedures of the organization and its members. A formal mechanism that promotes knowledge exploration and exploitation are information databases such as websites or intranets that are easy to access from inside or outside the firm (Fosfuri and Tribó 2008). In a study done in 769 organizational units of a large, European, multi-unit financial service firm, Jansen et al., (2005) found that social integration systems that augment connectedness are crucial for boosting the absorptive capacity of the firm. The breeding industry is a sector with a high degree of technology and innovative capability. Hence, information, knowledge and skills must travel quickly in order for the firm to keep up to date with the latest trends. A common bottleneck is the out-dating of skills and knowledge of the employees working in this dynamic environment. This is why, in order to build up expertise for the future of this knowledge-based economy, the public sector in the Netherlands is investing a great deal of effort and resources in both infrastructure and training through cooperative agreements with the private sector (Angenent 2010).

Knowledge originates from three different sources: academia, industry and government institutes. In order for this information to be transferred among units and sectors, facilitating instruments must be developed within the triple helix (Etzkowitz and Leydesdorff 2000). Bipolar knowledge exchange is the critical bond that encourages university-firm cooperation (Meyer-Krahmer and Schmoch 1998); in the biotech sector academic-to-firm knowledge streaming is most common (Baba, Shichijo et al. 2009). Newsletters, websites, meetings, conferences and especially channels where open science can be practiced in public spaces are found to be most frequently used by universities and firms, while official channels such as patents and licenses play a limited role in the transfer of knowledge between institutions (Etzkowitz 2003). Building upon the previous point, in a study conducted on 600 academic and industrial researchers belonging to four different sectors, Bekkers and Bodas (2008) found a negative relationship between the number of published patents and the importance given to personal contact. Supporting this is a case study performed on CRADA's (Ham and Mowery, 1997), which found that obtaining IPR for the jointly developed results of the CRADA were not as important as generating supplementary projects that would otherwise be unfeasible. Supplementary projects would be carried out due to higher credibility and due to collaborative participation in projects with competitors. Partners of the triple helix are interested in increasing their knowledge base and develop competencies to manage the R&D

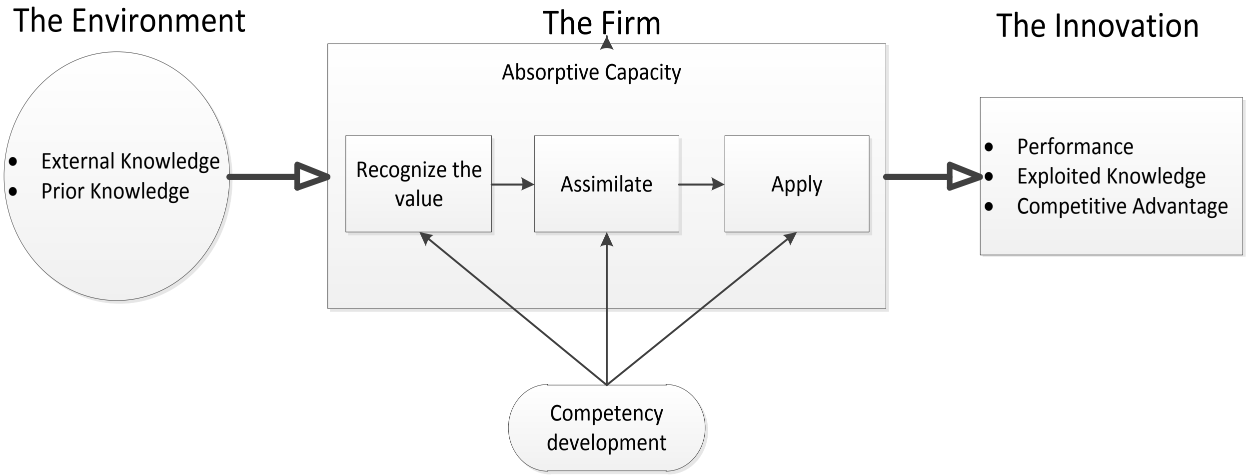
process. Knowledge generated from pre-competitive research must first pass through several innovation stages, which require intensive capital investment before this knowledge reaches the market in shape of a product or new technology.

Aside from public channels, another common source of knowledge is R&D carried by competitors in public laboratories (Cohen, Nelson et al. 2002). It is known that competitors launch parallel R&D studies in their private R&D facilities, based on the knowledge gathered from research performed by competitors in public areas. The central idea is that although conflicts of interest may arise in cooperation between spheres, the new ideas generated via individuals exchanging knowledge will lead to productive cross-fertilization among helices (Etzkowitz 2008). Human capital and training are key drivers of knowledge transfer and innovation (Bozeman 2000; Falk 2006). Cohen et al., (2002) found that public research on industrial R&D has a larger effect on applied than on fundamental science fields. Moreover, Bekkers and Bodas (2008) found a positive relation between working in an applied field and giving high importance to open channels for communication. They also found that a more intensive collaboration was appreciated in application rather than fundamental-oriented fields. Link and Rees (1990) found that small firms are able to transfer knowledge from university to industry more effectively than larger firms are. Conversely, Bekker and Bodas (2008) in a study on 500 researchers and Santoro and Chakrabarti (2002) in a study on 21 research centres found that small firms are prone to collaborate less due to restricted resources in core-related technologies.

2.3 Absorptive capacity and performance

Two types of outputs influenced by absorptive capacity affect firm performance: 1) knowledge products such as scientific publications, technical expertise and organizational developments, and 2) commercial outputs such as products, services and patents (Lane, Koka et al. 2006). Regarding the first type of output, Henderson and Cockburn (1994) found that firms that use publications as a promotion method for scientists are likely to be more productive than competitors and are expected to be positioned near important research centres. Concerning the second kind of output, Tsai (2001) in a study of two multinational firms, found a relationship between absorptive capacity and innovation. In addition, a study performed by Fosfuri and Tribo (2008), based on the Community Innovation Survey (CIS) administered in Spain in 2000 by the Spanish Institute of Statistics, found that the firms' levels of absorptive capacity are influenced by efficient internal information flows, and that in turn these firms obtained larger share of their sales from new or improved products. The differentiation between these two types of outputs does not imply independence because firm value does not increase only via exploiting new knowledge but also by investing in its absorption (Todorova and Durisin 2007). An investment in absorption will enhance the value generation capacity of the firm as it progressively recombines resources to assimilate external knowledge (Clemente et al., 2008). Hence, the firm must devote resources to increase prior related knowledge in order to be capable of capitalizing on R&D efforts realized outside the firm.

Figure 2.3(1): A model of absorptive capacity conceptualizing the recently reviewed theories in three stages: (1) the environment, (2) the firm and (3) the innovation



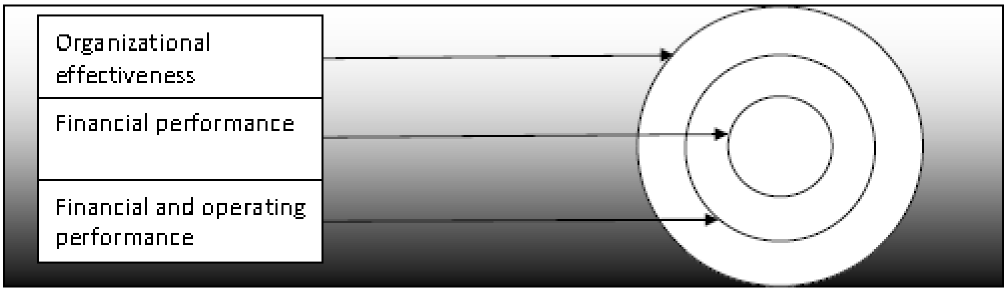
Adapted from Cohen and Levinthal (1990), Zahra and George (2002) and Fosfuri and Tribó (2008)

Cohen and Levinthal (1990) argue that great emphasis should be placed on the role of absorptive capacity and its management in the adoption and diffusion of innovations, since a firm's new products are highly related to the type of prior research that has been carried out in the their laboratories. They suggest that innovations will be adopted sooner if previous efforts have been made to increase the capital linked to that technology. Therefore, isolated efforts embodied as cooperation agreements will not be capable of supplying by themselves the required capabilities to increase performance. Investments in the internal capital of the firm in the form of parallel research or complementary projects must be realized in order to enhance the absorptive capacity of the firm. Once results obtained from precompetitive research pass on to the next stages, the process of transforming public knowledge into a commercial output is very time and capital intensive (Dons 2010). This is why previous investments in the internal absorptive capacity of the firm will lead to a reduction of costs and a decline in development times, further increasing the firm's competitive advantage. A major study of joint ventures found the firms with the highest technological degree were those that had previously performed R&D related to the field in which they were collaborating with partners. They even launched projects similar to those realized in the public environment in order to emulate and learn from their competitors approaches (Harrigan 1985).

Companies must be capable of measuring the performance of public-private projects in order to assess the results obtained from such agreements and evaluate their continuity in these programmes. According to management guru Jim Collins (2005), "business, performance principally means financial results, specifically return on invested capital. For a social organization, on the other hand, performance must be assessed first and foremost relative to the organization's mission, not its financial results*".* A firm's business strategy is dependent on the value creation and performance enhancement to satisfy shareholders, which ensures that both top management and employees will attempt to fulfil shareholders expectations (Jensen and Meckling 1976). According to Neeley et al., (1999) there are two reasons to use performance measures: 1) for the planning and control cycle to provide decision-making entities with feedback, and 2) to direct future assessments in the appropriate direction Performance measures can also be used for behavioural control.

Nowadays, there are extensive approaches to measuring performance, which can lead to confusion (Lewin and Minton 1986). In an effort to reduce this complexity, Figure 2.3(2) provides a scheme summarizing the business performance realm in two different perspectives. The first is financial performance, a simple technique that reveals the level to which the firm has accomplished its economic goals. Financial performance is measured by means of output-based financial indicators, such as sales, growth, profitability (return on investment and return on equity), earnings per share, etc. Considering Collins' (2005) definition, the performance of a firm should be measured not only against its financial goals, but also against its organizational goals. In order to achieve this, a broader perspective on performance, which goes beyond financial outputs, must be taken into consideration. Operational performance makes use of various indicators, such as market-share, new product introduction, product quality, marketing effectiveness, manufacturing value-added and other measures of technological efficiency. "The inclusion of operational performance indicators takes us beyond the "black box" approach that seems to characterize the exclusive use of financial indicators and focuses on those key operational success factors that might lead to financial performance" (Venkatraman and Ramanujam 1986).

Figure 2.3(2): Circumscribing the domain of business performance



Source: Venkatram and Ramanuja (1986)

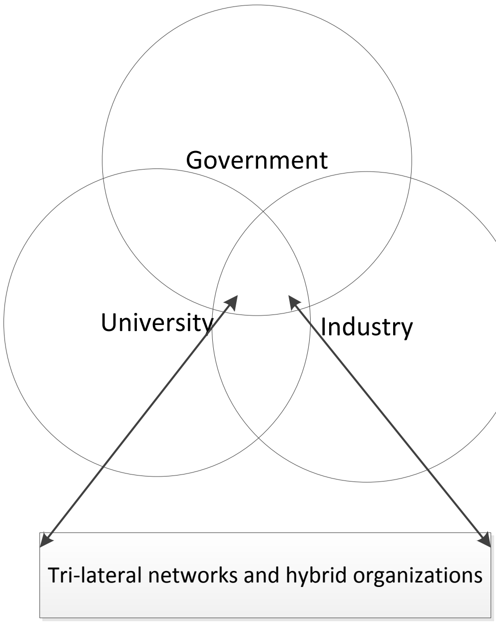
A series of empirical studies has proven the relationship between innovation and firm performance. Soni et al., (1992) in their research performed on the Innovations Database built by Chakrabarti at Drexel University, concluded that innovativeness has a positive effect on performance. Hall and Bagchi-Sen (2001) confirm this relationship in a study done in 74 biotechnology firms in Canada. Geroski et al., (1993) in a study on 721 innovative firms, found that the number of innovations produced by a certain firm had a positive effect on its profitability. Finally, Banbury and Mitchell (1995) in a study done on 11 innovations found that market share is strongly affected by the introduction of new product developments. Therefore, based on the literature, we assume that there is a positive relationship between innovative performance and business performance.

2.4 Absorptive capacity as a factor and weaknesses

Absorptive capacity is an interdependent factor that can mediate between knowledge transfer activities and innovation capability, explicitly creating a positive relationship between the knowledge level of a firm and its innovative performance (Liao, Fei et al. 2007). Therefore, absorptive capacity adds relevance to the knowledge exploration phase, where efficient recognition, assimilation and management of resources will lead to a competitive advantage (Lane, Koka et al. 2006). A study done by Lane and Lubatkin (1998) on 69 alliances in the pharmaceutical and biotechnology field concluded that firms in these sectors must increase their awareness of the environment and enhance their external and internal knowledge structure in order to react promptly to market demands. Enhancement of external knowledge structure may take the form of learning alliances such as cooperative agreements or joint R&D projects. Internal knowledge structure can be improved by advanced Information Technology (IT) systems or social integration processes (Yoffie 1993). Nowadays, open innovation plays an important role in connecting these two streams of external and internal knowledge (see Section 3.2, for more on open innovation). Knowledge exploitation firms that are driven by short-term benefits may fall into a competence trap, preventing them from accurately scouting market trends and changes (Levinthal and March 1993). However, this dependence on external sources of knowledge presents a threat to the firms' absorptive capacity because competencies and the ability to manage them must be created and assimilated in a concurrent environment, increasing the complexity of internally adopting them (Lei and Hitt, 1995).

2.5 Absorptive capacity and triple Helix

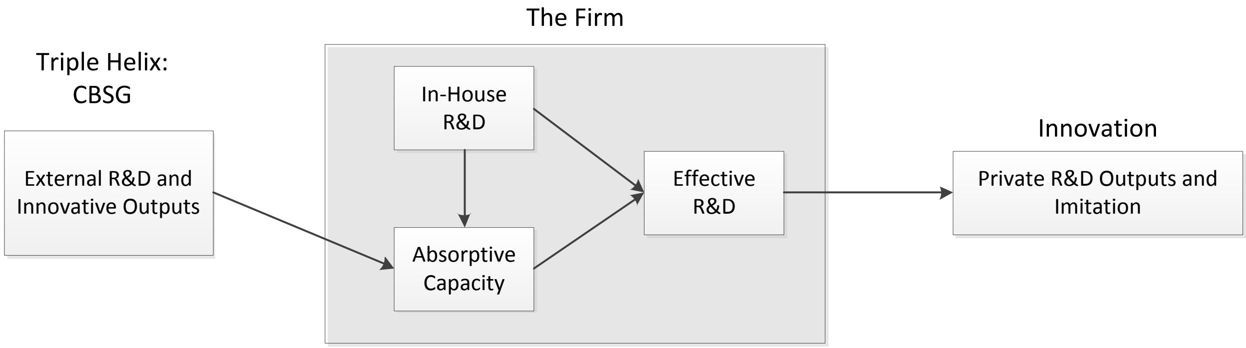
Figure 2.5(1): The triple helix model of University-Industry-Government relations



Source: Etzkowitz and Leydesdorff (2000)

The triple helix model consists of three independent yet interlinking environments: (1) industry, (2) university and (3) government (Leydesdorff and Meyer 2006). The objective of assembling these cornerstones of societal development together is to generate an innovative setting formed of university spin-offs, trilateral initiatives, strategic alliances among organizations and academic research groups (Etzkowitz and Leydesdorff 2000), as well as to reduce risk and share costs among the participants (Busom, 2010). These institutions change collectively to form central hybrid organizations such as technology transfer offices, venture capital firms and incubators which are vital to an ever demanding knowledge-based economy (Etzkowitz, de Mello et al. 2005). The corporation-led model appears to fit most appropriately with our study; in the model the university is seen as a regular source of incremental innovations in the products and processes of firms. Academia and business meet in what is known as a science park: they share R&D facilities and are interlocked in unique R&D cooperation projects (Etzkowitz and Zhou 2007). The relationship between long-term exploratory and fundamental research is evolving into a model in which a firm's exploitation-driven objectives steer basic research with the stimulus of the government (Etzkowitz and Leydesdorff 2000)

Figure 2.5(2): A model of absorptive capacity within the triple helix: (1) the Government-Firm-University alliance R&D projects, (2) the firm's private R&D based on public knowledge (3) the innovation obtained from such process



Adapted from: Scott (2003)

As previously, stated, absorptive capacity is a dependent and cumulative process that combines resources available within and outside the firm. The same concept also applies to R&D cooperation agreements, where the partnership's absorptive capacity will increase as more firms perform public research. For example, a firm may perform a comparative in-house project based on the information extracted from a competitor's R&D effort realized in a public laboratory. A theoretical study conducted by Scott (2003), derived that absorptive capacity can be developed via cooperative agreements instead of in-house R&D, through means of innovative output generated by other firms, spill overs of R&D insights and by finding research partners. In addition, a longitudinal study done on 792 alliances by Mowery (2002), found that the absorptive capacity developed in U.S.-only alliances was higher than those made with European companies. Such difference may occur due to heterogeneity in the political, economic, social and technological environment between American and European firms (Gulati 1995).

2.6 Concluding remarks

In the first section of this chapter, a general understanding of the scope of the study is given by describing the concept of innovation and the innovation process. We argue that enhancing innovation through cooperation is the main driver and firms are expected to make use of the resources provided by the partnership and to fund new projects that may lead to radical innovations. In the second section of this chapter, absorptive capacity was defined and described as an important factor, capable of connecting knowledge transfer and innovative performance. Identifying external sources of knowledge is important for innovation in public-private partnerships, but merely accumulating knowledge will not increase a firm's performance. Firms must develop competencies to be able to valorise knowledge adequately and differentiate from competitors. Open innovation and OS provide organizations with the required set of tools to create a suitable strategic direction. It connects the firm's competencies with available resources in the environment, enhancing the innovation process.

Chapter 3

Study Domain: CBSG

This chapter explains the structure and goals of the Centre for Bio Systems Genomics (CBSG), introducing the reader to the specific domain on which this study is founded. Public-private partnerships are not a newly invented model, but it is recently that interest has developed in measuring its business, societal and scientific benefits. Section 3.1 explores in depth the internal and external structure of CBSG as well as the history behind this public-private R&D consortium. Internal structure refers to the mission, vision, goals and objectives set by the managerial board of CBSG in agreement with the private and public sectors. While the external structure talks about the sectors, in which the CBSG is involved, making a clear distinction between tomato and potato companies. Section 3.2, describes briefly each of the members of the CBSG that took part in our study, with a focus on mergers and acquisitions. In Section 3.3, we introduce the history of the plant-breeding sector, the role it plays in Dutch society and the relevance that R&D has in this knowledge-based environment. In Section 3.3.1, we focus on two representative crops, presenting figures for the tomato and potato industries, and articulating the characteristic differences between them. Finally, Section 3.4 presents the concluding remarks of the chapter.

3.1 CBSG[6]

The Centre for Bio Systems Genomics (CBSG 2007) is a private-public research consortium of biologists and social scientists from 4 Dutch Universities, 15 Dutch and multi-national companies responsible for the majority of the world's potato and fresh tomato seed production and 2 academic groups with international reputations in potato, tomato and Arabidopsis. It was established in 2003 for the long-term enhancement of agricultural crops that have a real impact on Dutch society, with a total contribution of 53 M€ of which 21% was contributed by the companies. The goal is to improve crops in order to reduce the impact of agriculture on the environment and to benefit the natural milieu and the consumer. CBSG 2007 focuses on two main agricultural crops for the Dutch economy: tomato and potato. Research in the potato industry is mainly oriented towards disease resistant traits, while tomato companies focus on improving quality traits.

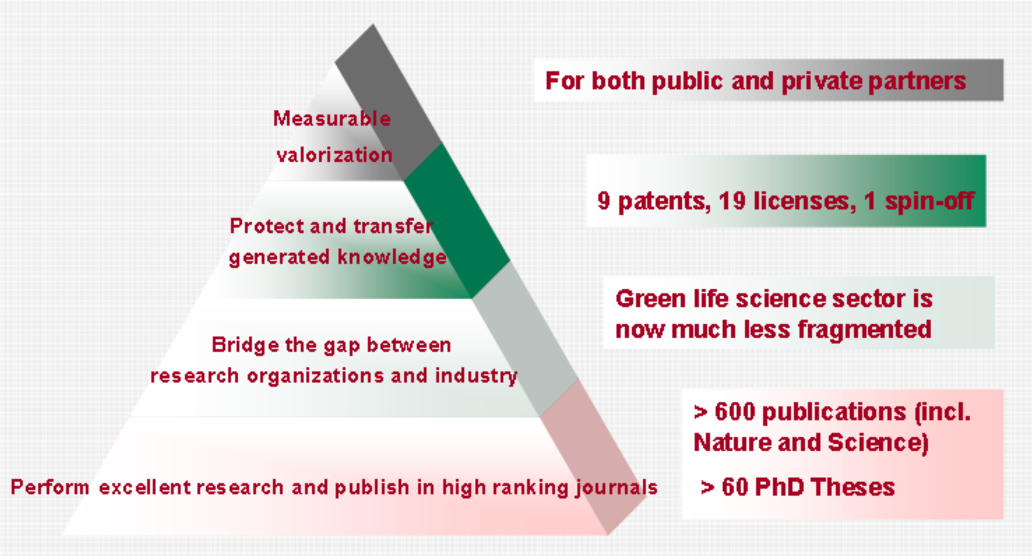
The main strength of CBSG 2007 lies in generating innovative technology platforms by stimulating the interaction of industry-university partners along the chain. In order to achieve this, CBSG 2007 has combined a selection of well-known academic researchers with a fundamental approach, together with top industrial scientists with the best knowledge background in their crop. Such an approach maximizes results in both practical and academic areas by steering research towards a commercial outcome and by enlarging the knowledge pool through scientific publications. The main responsibility of CBSG 2007 is to valorise knowledge by guiding top-quality, focused research programmes dedicated to the translation of scientific results into an applied context, minimizing the gap between research and society. Additional objectives are to provide training, education and effective facility sharing to strengthen the scientific infrastructure of the Netherlands and to encourage the visualization of scientific results through publications in well-known journals. Together, these efforts will increase collaboration between industry and academia, increase the number of products and improve the quality of results, produce top quality papers, patents and licensed technologies and encourage the launch of new radical initiatives.

A full-scale self-assessment of CBSG 2007 activities was performed in 2006, recognising a set of important accomplishments in both the academic and business areas. CBSG 2007 added value by applying innovative technology platforms, interacting efficiently with the industry and openly participating with international institutions. These actions, coupled with highly professional management, have led to spinoff activities worth 120 M€. The only major weakness found in the assessment of CBSG 2007 was the lack of integration and capitalization of bioinformatics activities, which need to be more integrated with the research areas. Figure 8.1 provides an illustration of the quantitative results obtained in the

[6] Leone, G. Centre for Biosystems Genomics CBSG2012. Business Plan 2008-2012. March 2007. Wageningen, the Netherlands.

assessment and their relationship with the established goals. It can appreciated that measuring valorisation is on top, as it is of extreme importance to institute a model that can be used longitudinally, and to establish the indicators that affect the performance of both industry and university.

Figure 3.1: CBSG valorisation goals and outputs



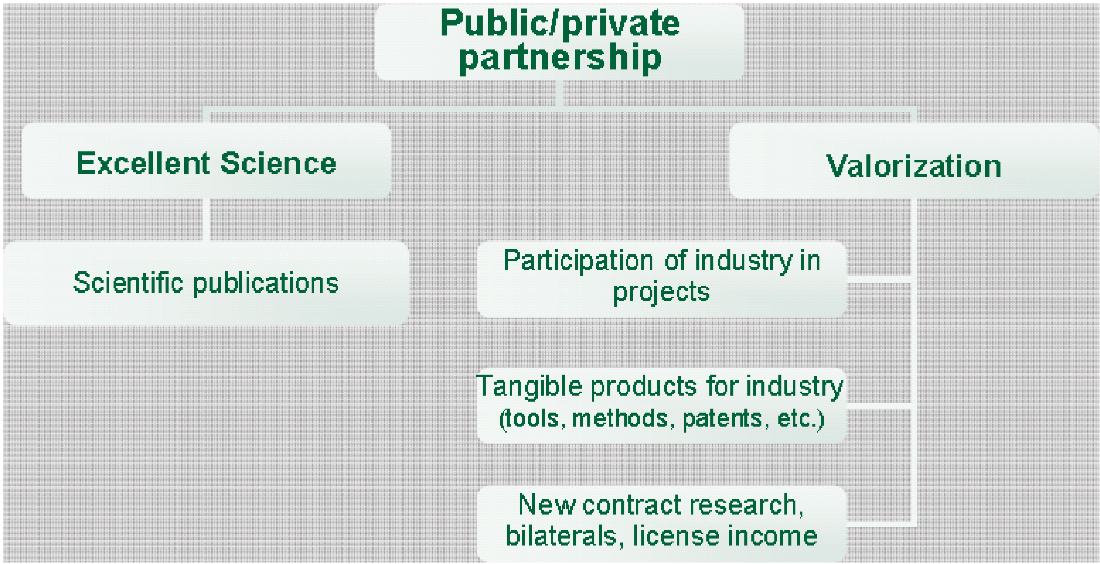
Source: Leone, 2010

In the long term, CBSG will have a direct impact on society in various ways. It will match the evolving needs of growers and consumers by fitting its strategy to their needs. It will enhance the capacity of crops to reduce agrochemical dependence and food shortages, which will lead to a healthier population and greater benefits for farmers. It will encourage entrepreneurial behaviour through knowledge spinoff activities that will provide jobs for local populations. Finally, CBSG industrial and scientific partners will focus on satisfying the consumer by generating open debate on controversial and essential consumer-related topics, and designing effective research programs that match triple helix communication with consumer-driven interaction.

3.1.1 Built-in valorisation

Valorisation can be seen as a combination of value creation and value capture: how the value created is distributed across the contributors. There happen to be multiple models for capturing value available such as contract research, valorisation afterwards and built-in valorisation. Contract research is limited valorisation, with constrained scientific results and benefits often just available for the research sponsor. Valorisation afterwards consists of first packaging research results in IP (often patents) and then marketing and selling them. Built-in valorisation involves agreeing up front in the research program and contracts with the rights in which the research results can be used, together with the related fees; typically fees are limited but all participants contribute to the research costs. Built-in valorisation captures the entire application sector for the results to guarantee more economic benefits. The idea is to bring private parties together with research institutes and agree up front with the rights and fees to use research results as well as sharing of research strategy and costs. High Tech Automotive Systems program HTAS, World Class Maintenance Consortium and the Holst Centre are clear success stories of public-private partnerships implementing the built-in valorisation model (Leone, 2010).

Figure 3.1.1: CBSG valorisation strategy



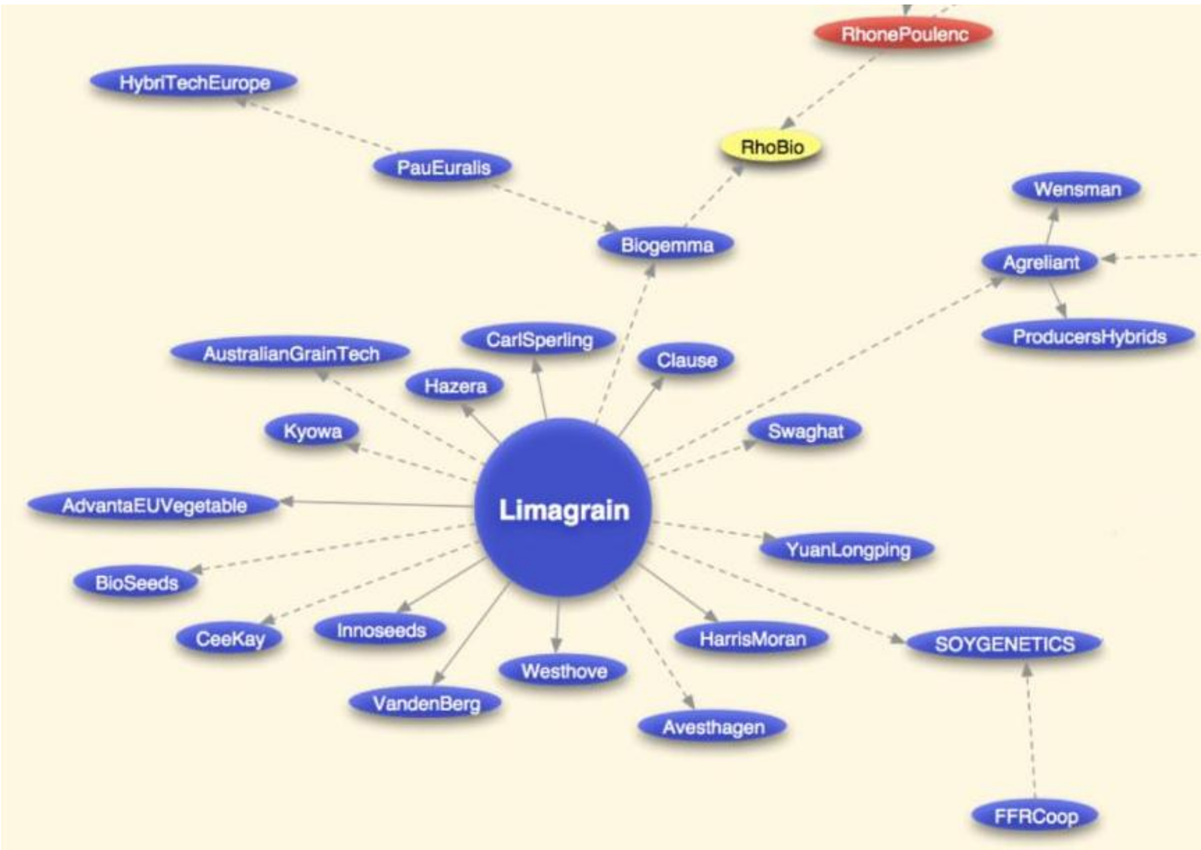
3.2 The companies

This chapter will introduce the companies that formed part of this study and belong to the CBSG research consortia. Seven tomato companies: Vilmorin & Cie, Syngenta, Takii Seeds Co., Rijk Zwaan, De Ruiter Seeds, Enza Zaden and Keygene B.V. as well as eight potato companies: KWS SAAT AG, AVEBE U.A. and daughter company Averis Seeds B.V., C. Meijer, McCain Foods Ltd, Farm Frites, HZPC Holland B.V. and Agrico. The aim is to describe the most important dates and facts such as foundation, mergers, acquisitions, disinvestments, expansion periods, privately or publicly owned, etc. so the reader becomes acquainted with the companies. This will facilitate the interpretation of the conceptual model, the propositions established and the results themselves.

Vilmorin & Cie

It was 1742 when Vilmorin started selling seeds and plants in a small town in France. After a series of family partnerships and generations of adequate management, the company produced the first seed catalogue for farmers and academics around 1856. In 1972 a French farmer, René Hodéé, acquired the company and sold it 3 years later to Groupe Limagrain. Vilmorin-Andrieux became known as Vilmorin S.A. and began specializing on vegetable seeds and trees. Limagrain's subsidiary Vilmorin later turned out to be the fourth largest seed company in the world, after a series of acquisitions. Vilmorin acquired Dutch seed produced Nickerson Seeds Company in 1990 and took over Nickerson-Zwaan's distribution system in France. It was 1993 when the company decided to go public on the Paris Stock Exchange and started to acquire numerous seed and bio companies. These were Clause Semense, Clause Jardin, 12.6% stake of Hazera Genetic in Israel (1998), Kiowa Seeds in Japan (2000), a stake in Keygene in the Netherlands (2001), 55% stake in Hazera (2003) and in 2004 Sperling GmbH from Germany. Finally, in 2007, Vilmorin acquired Anadolu and LPHT located in Turkey and China respectively, and in 2008, bought a small stake in Australian Grain Technologies[7]. Figure 3.2(1) illustrates the networkization of the Limagrain Group and although Vilmorin & Cie cannot be observed, this illustration proves the reason of why Vilmorin & Cie is considered one of the top seed companies in the world

Figure 3.2(1): Networkization of the Limagrain Group.



Source: Howard, 2009

Takii Seed Co.

Mr. Takii founded Takii & Co in 1835, when he started selling seeds for the first time in Kyoto. In 1905, it issued its first seed catalogue and in 1920, it became privately owned to

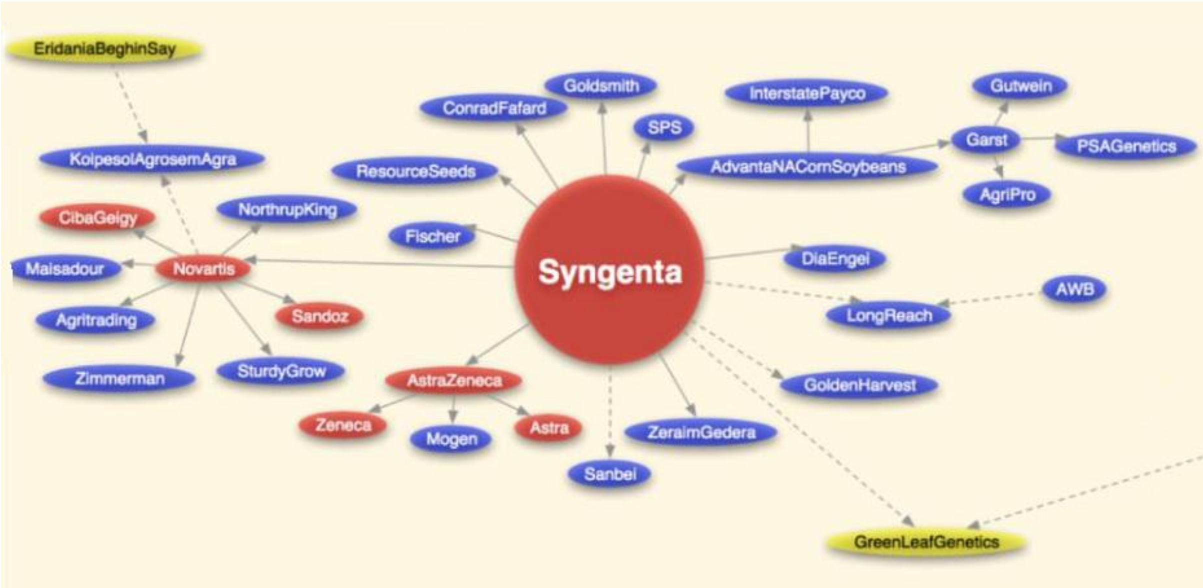
[7] http://en.wikipedia.org/wiki/Vilmorin

later change its name to Takii Seed Co in 1926. During the following years, Takii began doing breeding research and in 1949 they created the first ever F1 cucumber hybrid, later on during the 60's it also developed the first F1 hybrids for onion, broccoli, carrot and cauliflower[8]. In 1982, Takii & Co opened their first subsidiary office in Europe in the Netherlands. During the 80's and 90's Takii opened offices in Chile, Seoul, France and started joint ventures in Thailand, Brazil, Hong Kong and India. Finally, in 2007, they acquired a stake in the Dutch company Bio Seeds B.V. (Dons and Bino, 2008).

Syngenta

Publicly owned Syngenta was formed in 2000 from the merger between Zeneca Agrochemicals and Novartis Agribusiness. The name Novartis originated in 1995 when three companies: Ciba, Sandoz Laboratories and Johann Rudolf Geigy-Gemuseus merged. Syngenta is the world's number 2 biotech company which does not only commercializes field crops, vegetables and flower seeds but also other products like herbicides, fungicides and insecticides (Wikipedia, 2010). Syngenta's seed section name S&G originates from Nanne Groot and Nanne Sluis, the pioneers of the seed business in the Netherlands (NTZ, 1992). During the last decade, Syngenta's has either acquired or formed joint ventures with a great number of companies, as can be appreciated in Figure 3.2(2).

Figure 3.2(2): Networkization of Syngenta



Source: Howard, 2009

8 http://translate.google.co.jp/translate?hl=en&sl=ja&u=http://www.takii.co.jp/&ei=hiPQTKfwNsShOrqd6agF&sa=X&oi=translate&ct=result&resnum=8&ved=0CDUQ7gEwBw&prev=/search%3Fq%3Dtakii%2Bseeds%26hl%3Den

Rijk Zwaan

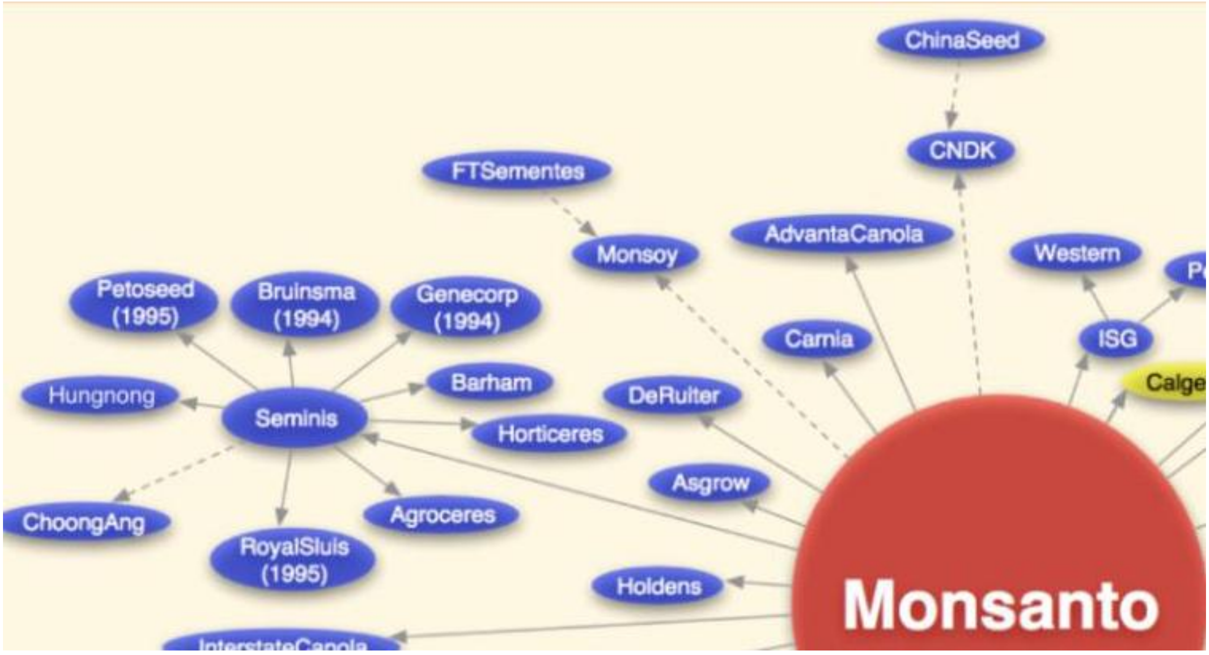
Rijk Zwaan, a family owned company was founded in 1924 in Rotterdam, Netherlands. It all began as a small vegetable seed shop and later became one of the leading companies in the Netherlands and one of the top five largest vegetable breeding companies in the world. The 80's was an important decade for the company since biotechnology started to play a role in seed breeding and because British Petroleum approached the company but fortunately decided to keep its distance. Yet, Cebeco managed to acquire 70% of the shares and later on planned to buy the other 30% from other three main shareholders. This action failed and instead the remaining three shareholders bought the 70% stake that Cebeco had in their hands.[9] This guaranteed Rijk Zwaan independency, which was efficiently channelled in an organic structure, oriented towards the employee, employees own 14% of the shares in the form of share certificates. Rijk Zwaan main goal is to ensure satisfying and rewarding jobs to employees rather than corporate profits, which has positioned them in the top three of a recently performed job satisfaction poll. Rijk Zwaan sells more than 900 varieties around the globe, represented by 25 vegetable crops.[10]

[9] http://www.seedquest.com/forum/k/KrinkelsMonique/oct05.htm
[10] http:// www.rijkzwaan.com

De Ruiter Seeds

Dutch vegetable producer of tomato, cucumber, melon, pepper, aubergine and rootstock was acquired by Monsanto for 546 M€ in 2008. It is one of the top tomato breeding companies in the world and the leading tomato breeder in the Netherlands.[11]

Figure 3.2(3): Networkizatino of Monsanto, including that of De Ruiter Seeds



Source: Howard, 2009

Enza Zaden

It was 1938 when Jacob Mazereeuw founded “De Enkhuizer Zaadwinkel” a seed shop in Enkhuizen, the Netherlands. Later on, in 1959, the company took an important direction by including plant breeding as part of the core business of developing new products. It was not long until constant growth and a strong set of varieties allowed the company to focus internationally. Enza Zaden is recognized as one of the top breeding companies in the world with very entrepreneurial and innovative competences. They are well known for introducing beef tomato in the Netherlands and for owning the tomato Dutch market leader variety Extase. Other vegetables include cucumber, sweet pepper, melon, squash, eggplant, spinach, onion, leek, cauliflower, kohlrabi, etc.[12] Enza Zaden has established subsidiaries in countries like Germany, Italy, Indonesia, China, Turkey, France, USA, Australia, Poland and Tanzania. For an introductory movie from Enza Zaden please follow the link[13]

[11] http://www.linkedin.com/companies/de-ruiter-seeds
[12] http://www.enzazaden.com/AboutUs/org/history/
[13] http://www.enzazaden.com/movie/

Keygene N.V.

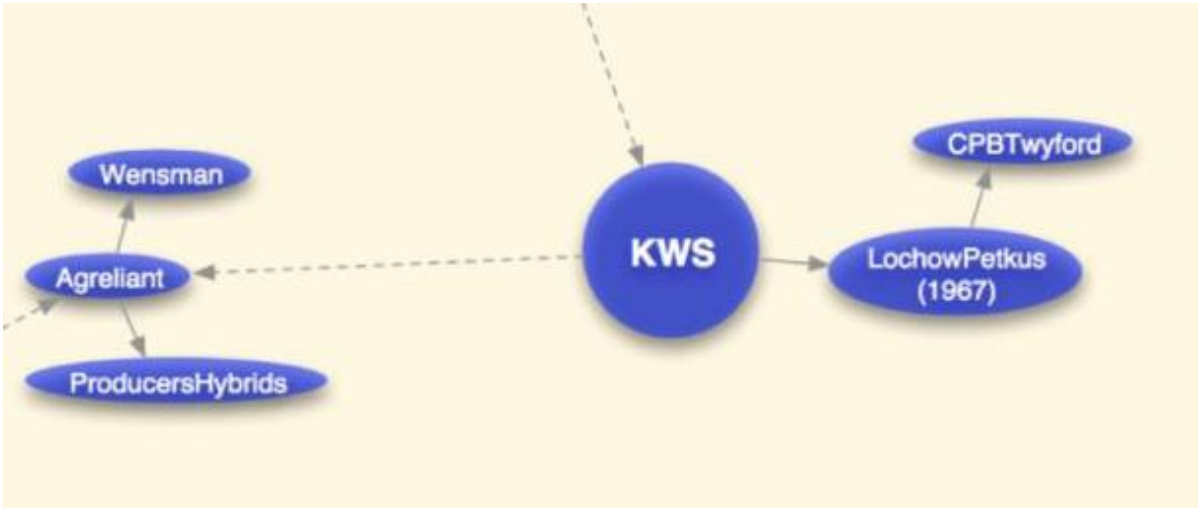
Seed companies Enza Zaden, Rijk Zwaan, Vilmorin & Cie and Takii & Co decided in 1989 to start up Keygene B.V. Keygene objective is to act as a molecular genetic services provider capable of improving the efficiency of the breeding efforts of its partners. Keygene only carries out fundamental or applied molecular/genetic research to support its partners. Keygene has taken a leading role in the scientific society by participating in EU programs, Dutch subsidy projects and strategic alliances with companies or institutes. EU programs like Bio Exploit and eusol, strategic partnerships with KWS, BIO SEED, Dow Agro Sciences and Amplicon Express and research collaboration with USDA, SIBS, Amsterdam University and Wageningen University.[14]

KWS SAAT AG

Founded more than 150 years ago, Kleinwanzlebener Saatzuch AG (KWS) is specialized in breeding field crops in temperate regions. It began in the 1900's as a leader in the sugar beet business and later expanded into other fields such as cereal, corn, oil and potato breeding[15]. During the 60's it began expanding internationally, setting subsidiaries in Europe and abroad as well as merging with cereal breeding company Heini Peragis and LOCHOW-PETKUS. Around the 80's the company showed interested in biotechnology and shifter its direction by reacquiring a breeding station in Kleinwanzleben. Recently, in the last decade, KWS changed its name to KWS SAAT AG and started cooperation with LIMAGRAIN in North America by founding corn company AgReliant[16]. Figure 3.2(4) illustrates further cooperation agreements, joint ventures, mergers or acquisitions that KWS has performed during time.

[14] http://www.keygene.com
[15] http://www.kws.de/aw/KWS/company_info/About_KWS/~clit/Subsidiaries/
[16] http://www.kws.de/aw/KWS/company_info/About_KWS/~ckza/History/

Figure 3.2(4): Networkization of KWS



Source: Howard, 2009

AVEBE U.A.

AVEBE (Aadappelmeel Verkoop Bureau) was founded in 1919 as a cooperative agreement between starch processors and potato producers in the province of Groningen in order to ensure market conditions for the potato farmers. It was not long until this association of growers pushed the privately owned starch companies away and were able to focus more directly on delivering start derivatives. In 1978, the last privately owned potato start company Scholten, an association of starch manufactures, went bankrupt and ended by AVEBE taking a large part of the Scholten Company. Nowadays, approximately 3500 farmers form part of this cooperative, divided into 6 districts: four in the Netherlands and two in Germany. AVEBE not only produces potato, tapioca and wheat starch and its derivatives but also potato protein for use in food, animal feed, paper, construction, textiles and adhesives[17]. AVEBE cooperates jointly with companies in order to make good use of their new product innovations such as ELIANE: a GMO-free potato starch and SOLANIC: a new refining technique to develop products like desserts, baby foods, yoghurts, bread and snacks. In 2007, AVEBE started an alliance with DSM Food Specialities and the National Starch Food Innovation. AVEBE is now worldwide the largest producer of potato starch and potato starch derivatives[18].

- **Averis Seeds B.V.**

Daughter seed company of AVEBE, Averis Seeds B.V. was founded the 31st of July of 2001. Its objective is to breed starch potatoes that are disease resistant, have high yields and high protein content. Averis B.V. has located its main research station KARNA and

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[17] http://en.wikipedia.org/wiki/AVEBE

[18] http://www.avebe.com/food/

their commercial and administrative activities in the headquarters in Foxhol, in the Netherlands and its own office Saatzucht GmbH in Germany. It has a collection of approximately 18 potato varieties that are capable of meeting the requirements of individual farmers[19].

C. Meijer

Family owned C. Meijer B.V. was established in 1920. Its main goal is to develop new potato varieties, deliver high quality seeds to farmers and supplying high quality raw materials for the processing industry. They have a breeding station located in Rijland named "Oosthof" where they develop new techniques and varieties. C. Meijer strength is based on skills and knowledge of their staff and therefore they guarantee good conditions in order to constantly encourage their staff to be highly innovative[20].

McCain Foods Limited

Privately owned and Canadian based McCain Foods was founded in 1957 by the four McCain brothers. Nowadays, it is the world's largest producer of french fries and oven ready frozen products and employs around 20.000 people in 55 production facilities in 12 countries. In the 60's the company started exporting outside Canada into the UK, Australia and the US, which later led to the establishment of a factory in the UK. The 70's was a time of expansion in which several acquisitions were made in Europe and the US and new products such as frozen pizzas were introduced. This tendency continued during the 80's and the company started diversifying in fields such as vegetables, juices, fish and frozen foods. In the 90's McCain bought the Ore-Ida Food Service frozen French fry and appetizer business that led the company one-step closer to becoming the world leader in frozen appetizers. During this time, investments in facility upgrades and information technology were vital to sustain future growth. Finally, during the last decade, McCain has target expansions in developing countries such as India, China, Mexico, Brazil and South Africa were they acquired french fry plant in Delmas and two other frozen vegetable plants[21].

Farm Frites

Family owned Farm Frites Beheer B.V. was established in 1971 in the Netherlands and specializes in breeding, selecting, processing and packaging potato products. Nowadays, it belongs to the top three potato processing companies in Europe, selling quick frozen potato products, with a yearly processing capacity of 900.000 tons of potatoes. It has been able to

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[19] http://www.avebe.com/averiseng/

[20] http://www.meijer-potato.com/htm/uk/forsure.htm

[21] http://www.mccain.com/company/History/Pages/Default.aspx

link global potato competences from around the world, such as the Middle East and South America to provide the consumer with the best quality[22]. Farm Frites Holding B.V. merger and acquisition history began in 1994 when it acquired Bravi Potato Productis from PBE Investments Ltd, followed by the acquisition of Lesudena from Ortiz-Mikosz, a unit from Unilever's Unilever France subsidiary and finally in 1999 when it acquired a stake in Alimentos Modernos[23].

HZPC Holland B.V.

HZPC Holland B.V. materialized in 1999 from the merger between two leading seed potato exporting companies, Hettema and De ZPC, which had more than 100 years of experience in the field. HZPC is one of the leading private seed potato companies in the world. The company focuses in breeding, growing and marketing of seed potatoes. In the last 10 years, HZPC has established subsidiaries in countries like Portugal, Spain, Italy, France, Poland, UK and USA. The objectives of HZPC are to develop new varieties to meet market demands, to enhance the value of seeds in order to benefit breeders, growers and shareholders and to meet customer demands by delivering high quality seeds[24].

Agrico

Agrico was established in 1973, when three companies merged: Groninger Pootaardappel- en Zaaizaadverkoopbureau 'PZVB', Coöperatieve Drentse Telersvereniging G.A. 'DTV' and Coöperatieve Producenten- en Handelsvereniging voor Akkerbouwgewassen G.A. 'Zuiderzeepolders'. Apparently, such a formation will strengthen the position of the company in both business and innovative performance. Later on, Agrico decided to expand its business into onions but this move later proved to be a mistake since profits fell short and costs were too high, leading the company to abandon this unit. In 1989 Agrico acquired a stake in the potato trading company Leo de Kock & Zonen B.V. in Purmered. Later in 1994, Agrico merged together with Wolf&Wolf, a seed potato company, which allowed the company to consolidate in the global market and raise its market share from 25% to 35% in the Dutch market. In 1995, a disinvestment was made in the sales division in France, but in order to maintain participation in the French market, Agrico acquired a stake in the French company S.A. Desmaziéres in Arras. Finally, in 2004, Agrico decided to sell its stake in CelaVita, which was for many years a dedicated partner of Agrico. Agrico has also a series of collaboration agreements in the potato sector with Plantum NL, the Dutch Potato Organisation, the European Seed Association and Europatat[25].

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[22] http://www.farmfrites.com/page_gb_the_world_of_farm_frites.html

[23] http://www.alacrastore.com/mergers-acquisitions/Farm_Frites_Holding_B_V-3398240

[24] http://www.hzpc.nl/about-hzpc?steID=2&catID=141

[25] http://www.agrico.nl/en/about-agrico/history/

3.3 The plant breeding sector and R&D in the Netherlands

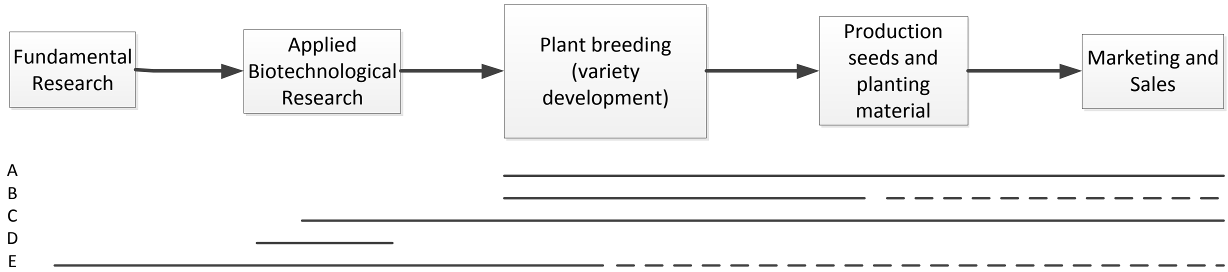
Seed companies are the most important value creation actor within the vegetable supply chain. High levels of innovation will lead to high-quality seeds for growers that in turn will increase profitability and assure high returns for farmers. Essentially, a competitive plant-breeding sector employing top technological platforms will increase the value of every transaction and every member in the supply chain. The global seed business accounted in 2006 for circa 25 B€, of which 22 B€ belong to extensively grown crops such as maize, cotton, wheat, canola, etc. and the rest account for the vegetable seed business, around 3 B€. In this field, the Netherlands plays a unique role in breeding, propagation and production (Dons and Bino, 2008).

Plant breeding plays an essential role in public objectives such as food security and environmental sustainability in today's bio-based economy. Innovation in the sector involves combining techniques and methods from other sciences like genetics, statistics and recently, plant biotechnology. Plant biotechnology, especially developments in molecular biology that led to an IPR war among the biggest companies, has significantly changed the direction of plant breeding in the last twenty years. The goal of these innovations is two-fold: companies aim to increase their market share and profits, while growers and consumers look for new varieties that can meet their expectations. The Netherlands is one of the top three countries in seed and plant material exports, which demonstrates the importance that is placed on knowledge capacity, skills and capital investment in this country. As a result, all of the world's leading plant breeding companies have an active R&D facility or established headquarters in the Netherlands (Louwaars, Dons et al. 2009).

Plant breeding can be categorized as science-based since it requires medium- and long-term investments in capital in order to generate benefits. Often, collaborative research and informal contacts are seen as more important in the plant breeding field compared to other, more applied fields of technology production (Meyer-Krahmer and Schmoch 1998). Although innovation cycles are longer in this sector than other related industries such as the pharmaceutical, once new ideas are generated in academia, they take short periods of time for firms to adopt them (Cohen, Nelson et al. 2002). This implies that the plant breeding industry has a great deal of interest in academic research.

Companies in this sector may adopt a series of business models and may integrate them in a holistic way. Figure 3.3 illustrates the different models used by plant breeding firms: (A) conventional companies develop, propagate and market seed material in their country; (B) Companies develop and propagate material in their country but market and sell it through IP agreements in other countries; (C) Companies have integrated biotechnology in their breeding process; (D) Some companies focus only on applied biotechnology research, developing and transferring knowledge to other companies; (E) Large global companies are capable of integrating all the steps in the chain. In our study, type (C) is the most commonly employed model, where companies make use of biotechnology to innovate, and they depend economically on selling seeds and acquiring new technology via mergers or (IP) acquisitions (Louwaars, Dons et al. 2009).

Figure 3.3: the innovation chain in which plant breeding is a link



Source: Louwaars et al., 2009

Until recently, the plant-breeding sector was highly segmented. In 1985, the top 4 ranked companies, Pioneer, Sandoz, Dekalb and Upjohn-Asgrow had a market share of just 8% in a global seed market worth 18 billion US$. In the 1990's, a tendency towards concentration was observed. At that time, the top four ranked companies, Pioneer, Novartis, Limagrain and Advanta, held 12 % of the US 30 billion world market share. By 2006, Monsanto, DuPont-Pioneer, Syngenta and Limagrain possessed 30% of the world market share worth 30 billion US$. The exponential growth of the market in the last 20 years from 18 billion to 34 billion US$ was caused by several factors: increasing seed needs of developing countries due to globalisation, increasing seed prices and increasing buying capacity of farmers. Mergers and acquisitions mainly caused market share growth from 8% in 1985 to 30 % in 2006. For example, Syngenta was formed from the merger between Sandoz and Ciba Geigy; Monsanto acquired Seminis, Dekalb/Asgrow, the seed programmes of Cargill, and in 2007, Delta & Pine (Louwaars, Dons et al. 2009). (For a detailed description of the mergers and acquisitions that have taken place in the seed industry between 1996 and 2008, see Howard 2009). The high level of mergers and acquisitions proves that not only in the Netherlands but worldwide, the seed industry is highly competitive but also has a high degree of collaborative activities, such as CBSG, Plantum NL and Bio Seeds. Plantum NL is the Dutch association for breeding, tissue culture, production and trade of seeds and young plants, and Bio Seeds is a strategic alliance between family-owned vegetable companies (Dons and Bino, 2008).

The R&D process is vital for the survival of high tech firms in the market, so it is important to elaborate on the procedure that firms employ to develop new products or services. In the Frascati Manual, Research and Development (R&D) is defined as follows (OECD 1994):

Creative work undertaken on a systematic basis in order to increase the stock of knowledge, and the use of this stock of knowledge to devise - ... - new materials, products, or devices - ... - new processes, systems or services, or - ... - improving substantially those already produced or installed.

The OECD (1994) distinguishes among three types of R&D activities: basic research, applied research and experimental development.

Basic (fundamental) research is defined as original investigation undertaken in order to gain new scientific and/or technical knowledge and understanding (Freeman 1982).

Applied research is undertaken to gain new scientific and/or technical knowledge, but it is directed primarily towards a specific practical aim or objective (Freeman and Soete 1997).

Basic research is known for having a long-term approach; it consists of running R&D based on curiosity and the need to unravel phenomena that are not yet understood. Basic research is often connected to accidental discoveries such as Penicillin or Aspartame. The lack of certainty and risk involved in fundamental studies has discouraged investment by the private sector; basic research is often carried out by universities or public institutes. Adams (1990) found a lag in effect of approximately 20 years between the launch of a research project and the time that industry profited from such.

Alternatively, applied research involves connecting practical goals that derive from upstream commercial research with downstream ideas to create lateral and cross-functional project teams with the mission of producing and commercializing technology. Applied research is known for being rather short-term oriented and capable of producing tangible results rather quickly, which encourages investments in R&D by private entities (Fortuin 2006). Public programmes encourage researchers to execute explorative fundamental research. However, since the ultimate goal of public research is to benefit society, academically driven research must be correctly steered by industry. This will lead to enhance the problem-solving capabilities of scientists and increase the probability that their inventions will reach the marketplace (Balconi and Laboranti 2006).

In the following section, we will present some general figures of Dutch R&D expenditure, in order to illustrate how R&D resources are distributed among universities, institutes and companies in the Netherlands. First, university research is essential to technological sectors because it can reduce lag times. A study performed by Mansfield (1991) on 76 firms in the information processing, electrical equipment and instruments, drug, metal and oil sectors, suggested that *10% of new products and processes would have been delayed a year or more in the absence of academic research conducted within the prior 15* *years*. Dutch R&D expenditure as a percentage of GDP decreased from 2.3% in 1988 to 2.02% ($8.3 billion USD) in 2001, well below the 3% target. Sweden and Japan are the leaders, with expenditures in R&D reaching 3.78% (8.3 billion USD) and 2.98% (102.8 billion USD) of GDP respectively. Industries bear 49.7% of these investments, 35.8% is provided by governments and the remaining 14.5% by alternative sources. It is worthy of note that Japanese and Swedish industry cooperation is as high as 72.4% and 67.8% respectively, indicating that Dutch industry is falling behind in its investment role (Gannon, 2003).

Regarding the plant-breeding sector, investment in R&D in this sector is rather high, averaging 20% of a firm's turnover. Such intensity in R&D is expected since companies depend on constant innovation to maintain their market share and achieve growth (Louwaars, Dons et al. 2009), but in the last decade it has stagnated. Factors that have affected a decline in expenditure are: low contribution from industrial sectors, which include budget cuts by big multinationals, declines in the salary level of Dutch scientists compared to those in France and Italy where scientists are better rewarded and high entrance barriers (Porter 1985) that originate from the sectors' high innovation rates.

3.3.1 Tomato versus potato

The agro-sector plays an essential role in the Dutch economy; potato and tomato, in that order, are the most important vegetable crops. In the potato phytophthora project, 5000 different potato strains were used to select those that presented resistant traits against this dreadful disease. Several hundred lines were selected for further, more demanding tests. Due to the immense population, this project could not be run by a single company, but was achieved through a cooperative approach by the leading firms in potato research and cultivation. The research approach for tomato was completely different, because the aim is to improve quality traits such as taste, which requires a higher degree of specialization in the genetics field. Several lines of tomato were crossbred after being tested by a panel, and are now being cultivated to find biomarkers that are indicative of certain taste properties. Below are some key facts that demonstrate the importance of this sector.

- The Gross National Product (GNP) of the total agro-sector was 41.6 B€ in 2003, representing 10.4% of the total.
- 10.1% of the national employment is linked to the agriculture sector, with about 3.5% of the population directly working in agriculture.
- The Netherlands is the second largest world exporter of agricultural products, with 49 B€ in 2004.
- The Netherlands is responsible for 20% of all agricultural trade within the European Union.
- The value of Dutch agricultural export products was 19% of the national total in 2004, of which > 80% is exported to the EU.

Next, some descriptive statistics of tomato and potato that highlight their importance in the agricultural sector are presented.

Tomato

- The Netherlands is the largest single exporter of all horticultural seeds in the world.
- The Netherlands controls 85% of the international professional vegetable seed export market and employs 10.000 people in a sector with an annual turnover of approximately 2.5 B€.
- 1 kg of commercial seed tomato costs € 50.000, 4 times the price of gold.
- Eight out of the ten of the main seed companies have their headquarters or a subsidiary in the country.
- About 95% of the vegetable seed produced by Dutch companies is produced outside the country, but much of it is shipped back to the Netherlands for cleaning, coating and priming before export as a Dutch product.

Potato

- The Netherlands is the largest supplier of potatoes and potato-based products in the EU.
- The Netherlands is the second largest potato processing industry in the world, after the USA.
- Dutch companies are responsible for 75% of the global trade of potato seed.
- About 700.000 tons of potatoes are annually exported from the Netherlands to more than 80 countries.
- In the EU there are around 100.000 hectares of seed potatoes grown, 40% of which is found in the Netherlands.
- The Netherlands is the world's largest exporter of deep frozen potato products with a total export volume of 4.2 million tons

Based on the information just presented, there appears to be marked differences between tomatoes and potatoes. The factors influencing the divergence between products are (1) long versus short life cycles, (2) applied versus fundamental research orientation, (3) slow versus fast reproduction cycles and (4) extensive versus intensive cultivation. These four factors are explained in detail in the following pages.

(1) **Long versus short innovation life cycles**: Potato companies are often searching and breeding to obtain phytophthora-resistant varieties, while tomato-breeding companies are more focused on identifying markers for quality traits such as taste, fragrance and mouth-feel, which are more complex and require more time to be achieved. The goals of tomato breeding companies are: defining the biochemical basis of the flavour and fragrance of the tomato, producing unique populations and breeding lines of tomatoes to decipher the genetics behind quality traits, screening tomato varieties for the natural biodiversity of taste characteristics and identifying genes and genetic markers for quality traits such as taste, fragrance and mouth-feel. The goals of potato breeding companies are: developing a tool for early identification of cold sweating, association mapping and family genotyping

of key quality traits, generating advanced tools for marker-assisted selection and classifying and mapping all available resistance genes in potatoes. Because of the private R&D capability that tomato companies possess, which is far more advanced than that of the CBSG 2007, we assume that tomato-breeding companies are not part of the CBSG 2007 to test and implement new markers. However, because the CBSG 2007 is a good training ground for researchers, CBSG 2007 grants tomato companies with R&D personnel that can dig into data. This creates a feedback loop, where breeding companies retrieve ideas from CBSG 2007 researchers, and companies can cross reference the results that have been previously been obtained in their private laboratories with the results from the CBSG 2007.

(2) **Applied versus fundamental research orientation**: the CBSG 2007 has adapted to the demands of the companies by running and developing projects (applied short-term projects) together with the potato organizations. Whereas tomato projects have to be created and executed by the CBSG 2007 researchers themselves (fundamental long-term projects). The research orientation can also be influenced by the fact that potato companies are rather small compared to the tomato/vegetable breeding sector in terms of turnover [26], employees, R&D and investment. These differences originated mainly because tomato companies also produce other type or horticultural products like lettuce, cauliflower, peppers, etc. while potato companies only focus in potato which caused tomato companies to become more powerful, hence encouraging mergers and acquisitions in the sector. This has also caused a delay in technological competences in core-related technologies, especially in molecular breeding. The degree that tomato companies have reached in molecular breeding technology is far more developed than the one of potato companies. Hence, CBSG is trying to increase the technological capability of potato companies by offering most of all applied projects that are focused in molecular breeding, while tomato companies are doing research that is more complex. Therefore, potato-breeding companies are expected to know what is possible with the new infrastructure and knowledge provided by the CBSG 2007. Conversely, tomato-breeding companies have less of this expectation because research in the CBSG 2007 may be overlapping with their own, and because of the high levels of secrecy involved in the sector.

(3) **Slow versus fast reproduction cycles**: Tomato cultivars require 3 to 5 years to be bred, which allows them to reach their commercial peak before 25 years, while potatoes require 10 to 20 years to be bred and to propagate the necessary material, making 25 years a short period for a cultivar to be profitable. The reason behind potatoes requiring a longer period to introduce new varieties like in the fact that potato companies have to develop

[26] Louwaars, et al,. Breeding Business. The Future of Plant Breeding in the Light of Developments in in Patent Rights and PBR, 2009.

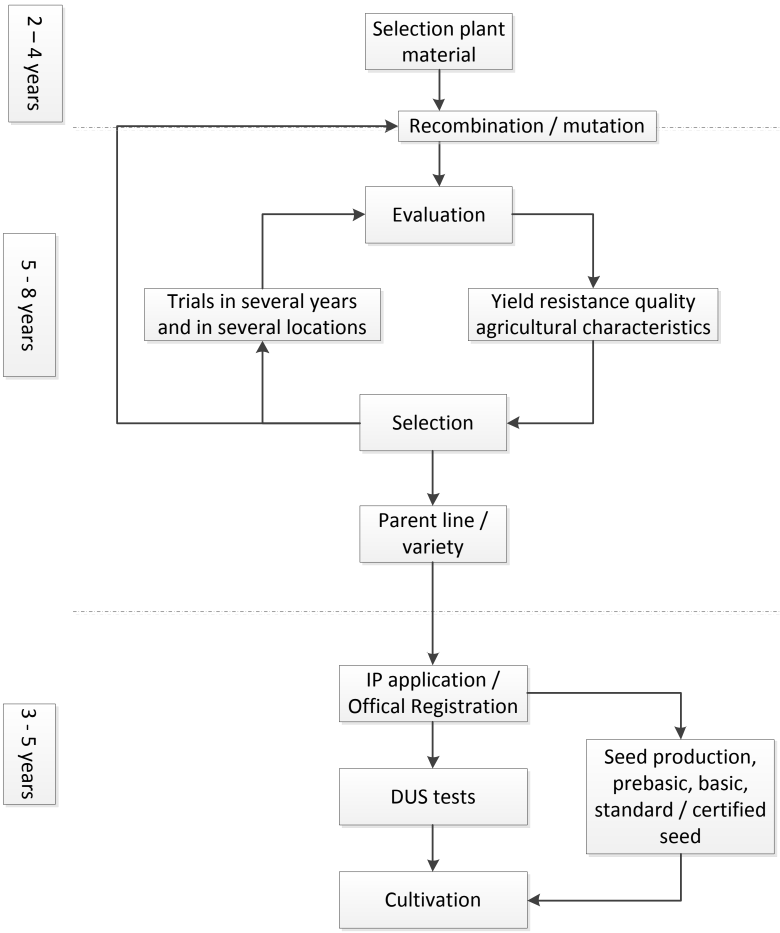
several more study population in order to obtain pure lines, also known as homozigous lines. As a result, PBR for potatoes were extended to 30 years, compared to the standard 25 years that tomato varieties receive. Another difference lies in the fact that tomato cultivars are released as F1 hybrids, which restrict reproduction. (F1 hybrids can be reproduced via seeds, but the next generation will not inherit the same traits as the F1 hybrids, so in order to obtain a similar cultivar you must have access to the parents). Consequently, F1 hybrids can be seen as a natural protection of IP because it limits any intent of piracy on tomato cultivars. Consequently, some tomato companies take the liberty to not request PBR for tomato hybrids, while for potato cultivars it is necessary.

(4) **Extensive versus intensive cultivation**: Potatoes are globally grown field plants that reproduce via tubercles (vegetative propagated crops have higher risk of diseases transmission via tubers, limiting propagation to low disease-pressure areas; this is not an issue with tomato since it reproduces via seed) Because of the volumes of production, large-scale potato growers often keep 10% of their yield for use as planting material the following year. Such a practice is still legal in developing countries under the “farmer’s exemption”, which has been prohibited in developed countries. In addition, royalties paid for "farmers saved potato seed" are slightly less than the royalties component of the potato market price (other components are labour, packing, and transport, which make the seed price higher). Tomatoes are grown intensively in greenhouses where temperature, irrigation, harvesting and other conditions are controlled. Therefore, tomatoes are subject to fewer diseases, and breeding can focus more on qualitative traits.

3.4 Concluding remarks

In this chapter, we explored and gave insights on the structure of the CBSG and defined the goals and objectives that this R&D consortia has for the future. We conclude that measuring the valorisation of knowledge is the top priority of CBSG, along with protecting generated knowledge that may lead to economic as well as social benefits. We also conclude that the Netherlands is a knowledge-based economy that for a long time has been supported by a constant investment in R&D. Plant breeding is an essential innovative sector and two crops, tomato and potato, play an especially important role. These two crops not only differ in terms of product but also in terms of the strategic orientation that CBSG has adopted for each one of them. Figure 3.4 illustrates a clear summary of the plant-breeding stages from selection to protection and to cultivation and the time span required to perform such activities.

Figure 3.4: Plant breeding scheme



Source: van den Hurk, 2009

Chapter 4

Methodology

This chapter integrates the theoretical concepts and standpoints obtained from the Theoretical Review performed in Chapter 2 with the empirical factors extracted from the analysis of the CBSG Valorisation Questionnaire. Section 4.1 will present the conceptual model and will explain each of the factors created in terms of operating principles that serve as means to describe the main overarching principle of Knowledge Valorisation. Section 4.2 and subsections will introduce the different Research Methods used in both desk and empirical studies as well as operationalize the research factors and delimit the study population. Section 4.3 will present the propositions created, based on the conceptual model, that are to be tested. Finally, Section 4.4 will present the conclusions of the chapter.

4.1 Conceptual model

The conceptual framework was derived from insights in knowledge transfer, absorptive capacity and performance theories (Chapter 2, Figure 2.3(1), Figure 2.3(2) and Figure 2.5(2)) and was then adjusted based on the inputs provided by the CBSG Valorisation Questionnaire (Appendix A). We derived the main indicators from the whole set of items (Appendix B) and grouped them into common factors that could be theoretically analysed and would facilitate answering our research questions[27]. The main factors that affect the performance of private-public research collaboration based on both theory and the indicators extracted from the questionnaire were investigated and measured. We found that the main factors affecting the scientific, innovative and business performance of public-private research collaboration are found in knowledge transfer, intellectual property and absorptive capacity.

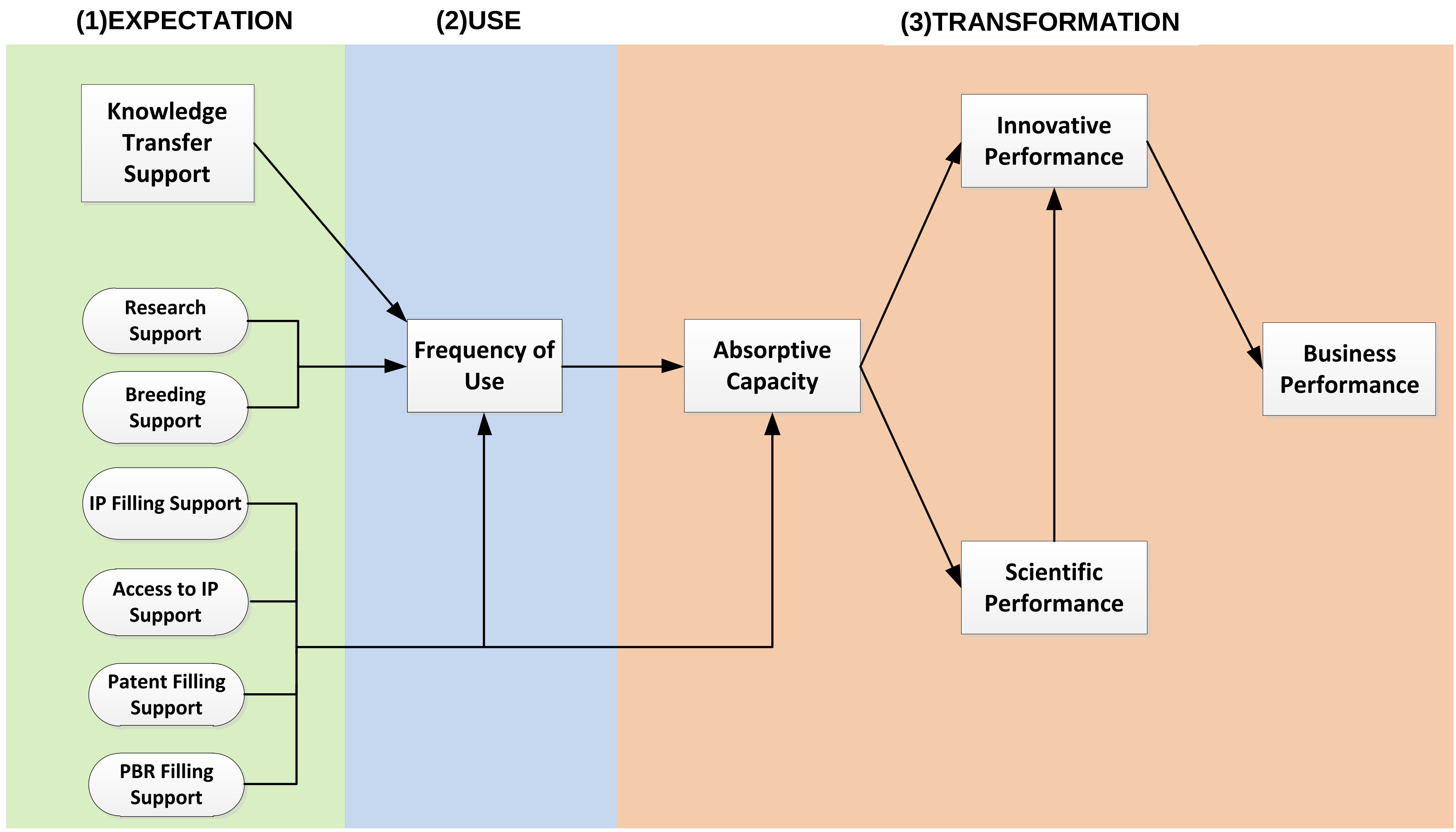
In Figure 4.1, these factors were combined in a conceptual framework underlying the present study. The linkages may be uni- or bidirectional because the scope of this exploratory study is to analyse relationships and not causality. The model is divided into three sections where (1) importance given to services will lead to a certain (2) use, which eventually will be (3)transformed into new products, these sections have been highlighted in green, blue and orange respectively. The CBSG consortia and its members are shown as a bundle of resources and capabilities that lead to competitive advantage in order measure the direct benefits. Firms have different expectations regarding the resources to be assimilated from such consortia, especially regarding external knowledge and activities. Depending on the requirements and internal capabilities of the firms, the available resources will be tapped. We will measure and compare the resource expectations that this group of firms have versus the real frequency of use that they have on the support activities provided by the CBSG consortia. Knowledge transferring activities, the frequency in which companies make use of CBSG services and the way they exploit this knowledge have been merged in common constructs named Knowledge Transfer Support, Frequency of Use and Absorptive Capacity respectively, due to their formative nature. While Research & Breeding Support, IP Filing, Access to IP, Patent and PBR's Filing Support remained as independent indicators in line to their reflective behaviour.

The acquisition and utilization of resources by the firm will lead to differences in Scientific, Innovative and Business performance depending on the how the resources are exploited. Resource or knowledge exploitation, which is termed as knowledge valorisation in this study, will also be dependent on the different IP Support expectations that firms have in CBSG. The IP Support indicators were taken into account because of its important relation with the plant-breeding sector. Finally, we consider Absorptive Capacity as a concept capable

[27] The only factor extracted from theory that did not apply to our empirical model was the human capital factor (Lane, Koka et al., 2006).

of mediating both sides of the conceptual framework, enhancing the power of the model by making it easier to grasp and work with (Szulanski, 1996, Liao, Fei et al., 2007 and Lane, Koka et al., 2006). In the following lines we would like to explain in depth, each of the operating principles measured. “An Operating Principle explains a particular valorisation effect in terms of a subset of the defined elements from the Knowledge Valorisation Model” (Goorden et al., 2008).

Figure 4.1: Valorisation model



4.1.1 Overarching and operating principles

Knowledge valorisation is defined as “the formal transfer of knowledge resulting from basic or applied research in universities and research institutes, as well as from applied research and development in companies, to (other parties in) the commercial sector for economic benefit” (Goorden, 2008). A definition that is commercially oriented fits well with our study since we are analysing the knowledge capitalization of the private sector. The essential elements of a knowledge valorisation strategy aimed at the commercial sector are to transfer technology efficiently and to protect the knowledge created in order to assure profits. This goal has become the new panacea of research programmes, especially those in which technology has a strong involvement. The reason behind this is that public money has been used to invest in R&D programmes, together with private companies and universities. Consequently, the main expectation that the public has towards such cooperation agreements is the social or economic benefits are to be generated.

Unfortunately, the theoretical basis of knowledge valorisation is not yet founded, and many streams of academic research point in different directions, preventing an effective, unified knowledge valorisation theory from being shaped (Swarte, 2005). The idea behind this principle is to bring the private sector closer together with social needs, making science beneficial for society by developing new products, processes or services (de Jonge, 2009). Entities such as CBSG are in charge of enhancing the partners’ knowledge transfer and protection capabilities by providing a set of tools that can be measured. Measuring the valorisation performance of the participants of public-private partnerships using economic indicators is key to ensure long-term agreements, but our definition of valorisation and the pure use of economic indicators may still inadequate in solving this problem.

- **Knowledge Transfer Support**

Knowledge Transfer Support refers to the importance that the members belonging to CBSG give to a group of activities developed to improve the sharing of information through the network and among the network participants. Normally, companies belonging to a cooperation agreement have high expectations regarding the benefits that can be obtained by participating in these activities. Knowledge can be transferred from private partners or can originate from public settings like scientists working for the CBSG, public meetings, websites, intranets or other companies. An efficient way to optimize knowledge transfer would be to mix knowledge exploration and exploitation activities and include a set of both public and private multidisciplinary knowledge transfer activities that could adapt to the needs of every firm.

- **Research and Breeding Support**

The operating principle Research & Breeding Support is used to transform the expectations that partners have towards process innovation. It express the importance that companies give to improving either their basic research or breeding process. For example, we expect that companies that are more fundamentally oriented should allocate more importance towards improving the basic research and breeding process than those that are realizing more applied research.

- **IP Support Instruments**

The operating principle IP Support Instruments encapsulates four important IP Support factors that measure the importance that companies give to receiving IP assistance from CBSG. These factors are PBR Filing Support, IP Filing Support, Access to IP Support and Patent Filing Support. An example of how IP awareness may be increased may be achieved by providing IP lectures, so that members gain consciousness and are capable of properly steering their research to avoid mistakes that can later on carry IP disruptions. It also captures the importance that companies give to IPR as an instrument to valorise knowledge for gaining economic benefits. From a knowledge valorisation point of view, IP Support Instruments are oriented towards increasing only the wealth of the private sector in the partnership and not society as a whole.

- **Frequency of Use**

The operating principle Frequency of Use is evidently connected to the other three operating principles. A certain level of expectations will lead to a definite actual use of CBSG services by its members. It actually aims at correctly measuring the frequency in which they have made use of the CBSG-related services. This is an essential element because it reduces the uncertainty linked to the previous expectancy principles and can provide valuable information for companies to increase the chance of long-term participation in the partnership.

- **Absorptive Capacity**

Absorptive Capacity is a central and bridging operating principle in our model. It represents the capability level of each participant by measuring the amount of knowledge that has been applied. This knowledge may derive from prior art knowledge, from knowledge that was present before the partnership took place, and from knowledge generated by the services provided by the public-private institution. Absorptive Capacity functions as a linking factor between companies' expectations, real use of CBSG services and performance measurement. For example, Company A starts a project with the support of the public, based on the ideas generated by constantly contacting scientists working for CBSG. This proliferation of projects will lead to a higher degree of knowledge utilization and has greater probability of influencing the performance of the company and the partnership as a whole.

- **Innovative, Scientific and Business Performance**

This operating principle is formed by three relatively similar operating principles: Innovative Performance, Scientific Performance and Business Performance. This operating principle demonstrates the effectiveness of the capabilities that the different companies have put into use. For example, some companies may perform higher in the scientific performance field by achieving more recognition from peer-reviewed publications, while others may perform higher in the innovative performance area by having developed a new technology. These operating principles reflect the benefits that have been gained by making use of or participating in a set of activities. While these operating principles are incapable of being linked to the external environment, and must therefore depend on the few measured indicators, the aim of these principles is rather exploratory.

4.2 Overall research design

This research will make use of a concurrent mixed methodology, as the triangulation of qualitative and quantitative data will provide us with the information required to measure the valorisation factors and performance indicators of the CBSG project. A small sample (n=15) and the lack of randomization prompted the researcher to enhance the validity of the project through mixed methodology. A dual methodology allows for complementary and synergistic data gathering and analysis, which is expected to enhance the internal and external validity of the empirical studies.

In the desk research, the method used is content analysis with proposition generation. This research will use the snowball method on the relevant literature that has been acquired. It will also be steered by the knowledge collected from meetings with experts in the different fields of study. The next stage is an in-depth qualitative survey of the literature found. This analysis will provide a set of insights, which together with the examination of the research issue, will lead to the validation of the propositions, which will later be tested using a survey design. To strengthen our research and findings, historical data on the 15 companies that are members of the CBSG will be gathered.

Table 4.2: Experts interviewed in the course of the research.

Interviewee	Organization – Expertise
prof.dr. Hans Dons	Managing Director Bio Seeds – Triple Helix
dr.ir. Gionata. Leone	CBSG – Valorisation Manager
prof.dr.ir. Gerco Angenent	CBSG – Director of Technology and External Affairs
dr. Herman van Eck	WU Plant Sciences – Plant Breeding
ir. Steven Flipse	Researcher at Delft University – Biotechnology
dr. Janneke de Jonge	WU Social Sciences – Statistics
dr.ir. Chris Maliepaard	WU Plantenwetenschappen – Bio-Informatica
dr. Ron G.M. Kemp	WU Social Sciences – Quantitative Research Methodology

This section of the study will perform a cross-sectional survey in order to test the propositions proposed in the qualitative section. The purpose of this study is to test the validity of our propositions and infer conclusions about the observed sample. It is important to mention that due to the limitations of the data (15 CBSG participants) randomization was not possible. This constraint prevents the study from performing a statistical generalization of the results towards a bigger sample; the aim of this study is analytical generalization. Analytical generalization refers to generalization from empirical observations, in order to predict a new theory or lead to changes in the current theories (Yin 2009). In addition to this study, data will be collected on the number of patents, Plant Breeders' Rights, Plant Variety Protection and Community Plant Variety that CBSG members and non-CBSG companies have applied for in the US and Europe during 2003-2008.

4.2.1 Operationalization of the research variables

To test the conceptual framework (Figure 4.1) empirically, the concepts were split into research variables that are operationalized by providing operational definitions and indicators to produce measurable items. The exact operationalization of the different research variables in the CBSG Valorisation Questionnaire are presented in Appendix A. This questionnaire requests quantitative and factual information regarding the sector in which the company is positioned (e.g. market share, sales and organization unit), specific information regarding the respondent representing the company (e.g. name, function and role) and expectations that they have regarding the CBSG services (e.g. website, intranet, training, conferences, etc.). The questionnaire asks for the respondent's personal perception of CBSG-related activities, R&D and collaboration, Valorisation of CBSG results and their organization's figures, using seven-point Likert scales. This questionnaire was completed by 10 R&D heads of department and 5 breeding directors in each company. In section 4.2.2, this questionnaire is discussed in more detail. Table 4.2.1 presents an operationalization of the variables that construct part of the conceptual model.

Table 4.2.1: Operationalization of the dimensions of the valorisation model

Research Variable	Operational Definition	Measures
Knowledge Transfer Support		
Access to information on international research programs Contact with qualified CBSG researchers Access to CBSG website information Access to CBSG intranet information Enhanced interaction with other companies in the potato/tomato industry	Importance of these CBSG-related activities, as indicated by the organizations	3.c, 3.d, 3.k, 3.l & 3.n
Intellectual Property Filing Support		
Assistance with filing for Intellectual Property (plant breeding rights patents)	Importance of these CBSG-related activities as indicated by the organizations	3.h
Access to Intellectual Property Support		
Assistance gaining access to Intellectual Property (licences, plant breeding rights, patents)	Importance of these CBSG-related activities as indicated by the organizations	3.i
Patent Filing Support		
Increased number of filings for patents	Extent to which organizations agree or disagree with the statements. “By participating in the CBSG program my organization expects to …“	6.h
Plant Breeders Rights’ Filing Support		
Increased number of filings for plant breeding rights	Extent to which organizations agree or disagree with the statements. “By participating in the CBSG program my organization expects to …“	6.i
Research Support		
Improvement of basic research process	Extent to which organizations agree or disagree with the statements. “By participating in the CBSG program my organization expects to …“	6.n
Breeding Support		
Improvement of breeding process	Extent to which organizations agree or disagree with the statements. “By participating in the CBSG program my organization expects to …“	6.o
Frequency of Use		
Access to information on international research programs Contact with qualified CBSG researchers Access to CBSG website information	Frequency which most accurately describes the organization’s use of these CBSG-related activities between 2003-2008	

Access to CBSG intranet information Enhanced interaction with other companies in the potato/tomato industry Assistance in filing for Intellectual Property (plant breeding rights, patents) Assistance gaining access to Intellectual Property (licences, plant breeding rights, patents)	Frequency which most accurately describes the organization's use of these CBSG-related activities between 2003-2008	3.c, 3.d, 3.h, 3.i, 3.k, 3.l & 3.n
Absorptive Capacity		
Development of new products Increased number of tomato/potato markers that will be tested Increased number of tomato/potato markers that will be implemented	Extent to which organizations agree or disagree with the statements. " Participating in the CBSG program enables my organization to …"	6.a, 6.k & 6.l
Innovative Performance		
Launch of new products to the market	Extent to which organizations agree or disagree with the statements. "By participating in the CBSG program my organization expects to …"	6.b
Increased sales of new products Enter new markets Introduction of new products to the market faster than competitors	Extent to which organizations agree or disagree with the statements. " Participating in the CBSG program enables my organization to …"	6.d, 6.e & 6.v
Scientific Performance		
Increased number of peer-reviewed publications	Extent to which organizations agree or disagree with the statements. " Participating in the CBSG program enables my organization to …"	6.aa
Business Performance		
Increased sales Strengthened image Improved technical advice to customers Recruitment of new researchers or assistants	Extent to which organizations agree or disagree with the statements. " Participating in the CBSG program enables my organization to …"	6.c, 6.t, 6.u, 6.x, 6.y & 6.z
Increased chance of successful research completion	Extent to which organizations agree or disagree with the statements. "Participating in the CBSG program…"	

4.2.2 Data collection and study population

Data were collected in 2008 by means of a pre-designed questionnaire (Appendix A), containing 76 main items measured on a 7-point Likert scale with the according sub-items divided into five main stages. The first stage was called “Introduction” and asked for factual data such as name of the organization, name of the respondent, function in the organization, role in and experience with CBSG, type of unit and whether the unit is part of a larger company. The second stage, named “CBSG related activities”, had 19 Likert-like items on a scale from “Not important” (1) to “Very important” (7), with no verbal labels for the intermediate continuous scale points. This stage also included 19 frequency items based on a scale that began with “never”, followed by “once every 3 years”, “once per year”, “once per quarter”, “once per month”, “once per week” and “daily”. In the analysis, these items were transformed into a 1 “never” to 7 “daily” Likert-like continuous scale. The third stage, “R&D and collaboration”, consisted of 8 Likert-like items on a continuous scale from “Completely disagree” (1) to “Completely agree” (7), with no verbal labels for the intermediate scale points and with several scale (percentage) and categorical scale sub-items. The fourth stage, “Valorisation Support of CBSG results”, was formed in its majority by 27 Likert-like items based on a continuous scale from “Completely disagree” (1) to “Completely agree” (7), with no verbal labels for the intermediate scale points and with several continuous scale (percentage) sub-items. The final fifth stage, called “Organization’s facts and Figures”, was made up of 14 items measuring continuous scale (percentages) and categorical scale data. Table 4.2.2 presents a summary of the instruments used in this research and the validity and reliability of the findings, proposing that individual validity types are not independent but build on each other.

Table 4.2.2: Validity and reliability scores of this study

High-Medium		**Medium-Medium**	
Internal validity →	**Construct validity**	**External validity** →	**Reliability**

• Mann-Whitney and Spearman’s rho
• Pre-structured questionnaire
• Operationalization of concepts
• Clear Conceptual Framework derived from the questionnaire and supported by theory
	• Data Triangulation
	  • Questionnaire
	  • Internet
	  • Theory
	• Cluster formation
		• No random data (no generalization)
		• Low sample (n=15) In Depth Literature Survey
			• Items grouped are on the same scale (they measure on the same level: expectancy, frequency or level of agreement.
			• Knowledgeable people were in charge of answering the questionnaire
			• No re-test

Source: (Gibbert, Ruigrok et al. 2008 & Fink, Bourque et al. 1995)

These 76 items were subjected to two stages of data refinement. The first stage focused on compressing the instrument by selecting items that had consistent and complete values throughout the multiple observations. Exploratory tests were then performed and items were selected that had different value perspectives but were capable of measuring similar dimensions: expectancy, frequency of use and performance. The second stage consisted primarily of re-evaluating the elaborated factors by performing reliability tests and re-testing the scales. 32 out of these 76 items were consistent enough to represent the various dimensions in our model. The factors were measured as the average of the items that form part of each dimension. All items were measured in an ordinal scale, posing no problems to the formation of the multiple factors. Significant differences were searched for in both item and factor levels, comparing different groups. Data analysis consisted of comparing group means (tomato versus potato and high frequency users versus low frequency users). For clarity of presentation, we use non-parametric methods, median, significance and Mann-Whitney U. We chose one-tailed tests because propositions were developed concerning the direction of expected relationships. Correction for ties using the Mann-Whitney Tests did not change the conclusions.

In order to assess the differences in expectation, frequency of use and performance between different groups, the questionnaire was sent to all partners of CBSG, organizations that are in the top 10 tomato seed companies operating in the global market, and the main Dutch potato organizations in the Dutch and European potato market. Participants were selected based on their involvement with CBSG: they were contact persons, project leaders, or CBSG Management Team (MT) members. Within their organizations, the participants fulfil the role of researchers, breeders, R&D managers or directors. It is important to mention that the questionnaire data was collected personally and that of the 16 completed questionnaires, 1 questionnaire was not relevant because the participants had marked differences from the selected homogeneous group.

4.3 Propositions

This section describes the propositions, which are based on the theoretical review performed in chapters 3 and 4 and on the conceptual model introduced in Chapter 5; these propositions will be empirically tested in the cross-industry study.

Collaboration and knowledge creation are essential elements in cooperation agreements where government, universities and companies interact. When research is funded with subsidised public money, the strategic orientation of for-profit entities is redirected from innovation seeking to competence- and idea-generation. As a result, in such arenas, members of public-private partnerships have high expectations regarding the support that the resulting institution can provide in fields such as knowledge transfer, IP support and process innovation. Based on our conceptual model, we expect that a high degree of expectations regarding the services provided by CBSG will lead to a high degree of use of such services by the companies.

Proposition 1: *Knowledge Transfer Support, Research Support, Breeding Support and IP Support factors will have a positive relationship with Frequency of Use of CBSG-related services.*

In the scientific community, journal publications are an expression of knowledge sharing and of a quasi-open system where information can travel freely across borders. Peer reviewers who assess the quality of the information must first filter this knowledge to become available. This setting creates a two-sided stream of benefits where scientists acquire recognition for their discoveries and other academics, private researchers, entrepreneurs or even the public can often make use of the knowledge generated from the findings of academic research. Hence, peer reviewing and publishing incentivize the transfer of knowledge in society, consequently leading to the generation of new ideas and development of new technology that put this knowledge into use. Omta (1995) concluded in his empirical study that the difference in scientific performance between European and Anglo-American pharmaceutical companies could be one of the reasons behind differences in innovative and industrial performance. Opposing this view is Horrobin (1990), who in the same field concluded that, "many scientists-reviewers are against innovation unless it is their innovation. Innovation from others may be a threat because it diminishes the importance of the scientist's own work*".* Additionally, it is known that frequently researchers excel in performing breeding activities and fall behind in scientific writing, which can influence dramatically when measuring the scientific performance of companies part of CBSG due to delayed or second-rate publications. Based on these studies, no clear direction can be given to our proposition. Consequently, we will base the following proposition in the valorisation model developed and state that Scientific Performance has a positive relationship with Innovative Performance.

Proposition 2*: Scientific Performance will have a positive relationship with Innovative Performance.*

Plant breeders' rights are a form of IP protection available for plant varieties, whose strength lies in its restrictions. The farmer's privilege, research exemption and especially the breeders' exemption allows competitors to use the variety as a base to improve and breed new varieties. Louwaars et al., (2009) in a case study for the Centre for Genetic Resources, found that the role of PBR is not that of encouraging innovation but that of transferring knowledge, for example through the breeder's exemption. This lack of relationship between the number of PBR applications and innovation is caused mainly by high access barriers present in the breeding sector, opposed to what happens in the chemical and pharmaceutical sectors where small companies are the source of innovation. Therefore, the encouragement of free exchange of knowledge expressed as the number of PBR applications, will lead to an increase in the expectations that companies have regarding the amount of markers to be tested and implemented and the amount of new products to be developed. Unfortunately, it will also hinder the innovative capability of individuals and companies. The Absorptive Capacity factor is essential to the valorisation model since it acts as a bridge between the expectation and performance indicators.

Proposition 3*: The number of Plant Breeder's Rights applications will have a positive relationship with Absorptive Capacity and a negative relationship with Innovative Performance.*

Patenting in the breeding sector has been limited to research tools or genetic material that can be inserted to enhance or develop new plant varieties. Lei et al., (2009) concluded that delays in research is strongly positively correlated with IP protection, which has increased the frequency in which studies have been delayed or blocked due to protected research tools. Now, often in private research, the main goal is to develop a product and to protect it with patents in order to monopolize the market for a certain period, the opposite happens in CBSG, which aims at pre competitive research. Pre competitive research aims to benefit society by generating new technology or putting it into use. It encourages the spread of knowledge in order to increase the amount of research projects conducted. Product innovation is not the direct objective of pre competitive research. Instead, companies collaborate with the purpose of creating new ideas that in further stages can be transformed into a final product via spill overs. The ideas that are generated in such environment are yet immature and require intensive investment from private partners that wish to continue developing them. Therefore, for a final product or technology to be developed and patented, companies must continue investing privately in the improvement and transformation of this knowledge into technology.

Proposition 4*: The number of patent applications will have a negative relationship with Innovative Performance.*

Research can have two different directions in triple helix environments: product orientation or academically orientation. Product orientation refers to projects in which companies are deeply involved in obtaining short-term results that can quickly benefit them in terms of market share, profits, penetrating new markets, etc. Academically oriented projects aim to unravel unknown phenomena for their own interest and the well-being of society in the long-term. In our study of CBSG, tomato companies have been classified as carrying out fundamental research projects, while potato companies have been classified as doing more applied research projects. According to this classification, we expect that in the time during which the partnership has taken place, approximately 5 years, the innovative and scientific performance of potato companies will be higher than that of tomato companies. There are many reasons supporting our expectations: (1) resource availability, (2) molecular breeding technology and (3) industry development stage. About resource availability, it is clear, based on Section 3.2, that tomato companies have a higher amount of resources available for private research than the potato companies do. Tomato companies often have their own laboratories with accessible technology far more advanced than that provided by CBSG. While potato companies, hampered by long reproduction cycles and breeding complexity, have rather low amount of resources available to run their own research. (2) Molecular breeding technology is highly advanced in tomato companies while potato companies have yet to develop into molecular breeding. (3) Tomato companies are also vegetable seed companies that participate in all the stages of the plant breeding chain (See Figure 3.3), while potato companies only breed or produce potato. Thus, size is a limiting factor for potato companies. Based on these three reasons, CBSG has oriented potato projects towards a more applied field while tomato projects are more fundamentally oriented. These will cause that on one hand, low resource-based potato companies will innovate and publish intensively during the first years of partnership, taking advantage of the support provided by CBSG in projects concerned with marker development and improving molecular breeding. While on the other, tomato companies are more interested in collaborative precompetitive research with the academic sector and have a rather long-term approach. Hence, improvements in innovative and scientific performance will only be perceived in future studies, since most of their applied research can be carried out in private laboratories.

Proposition 5: *Innovative Performance and Scientific Performance are more important for potato companies than for tomato companies.*

Precompetitive research is characterized by encouraging the production of knowledge so it can be used to develop new products. CBSG provides the companies with a number of instruments that are capable of enhancing collaboration in the network. Although CBSG also provides a set of IP Support instruments, the level of interest that companies are expected to present on such tools, considering the type of research been carried, will be rather low. Companies will not be interested in protecting incomplete knowledge, but rather using it to develop products or knowledge with greater value, which can eventually be protected at a later or final stage.

Proposition 6: *Knowledge Transfer Support is more important than the four IP Support factors.*

The model developed has been adapted to both tomato and potato companies that are members of the CBSG in order to make them comparable. As argued before, potato companies will have higher expectations regarding CBSG-related services than tomato companies. Public-private research agreements often have a larger effect on applied sectors in the short term because they are more eager to communicate and collaborate with each other. They want to work together to develop innovative competencies that can help the sector as a whole become more competitive. Tomato companies, however, are already highly competitive and dynamic. Hence, their interest is towards radical innovations that can cause a long-term effect. Within tomato companies, there are two different categories, large and small tomato companies, and as previously discussed, we would expect that small companies are more inclined toward applied projects that achieve quick results. This is different from potato companies, as small tomato companies are not looking to benefit the group as a whole, but rather seek to become one of few market leaders and avoid been acquired by large companies.

Proposition 7: *Frequency of Use of CBSG-related services is more important for potato companies than for tomato companies.*

The central factors of the model, which link the expectations of companies with the performance outcomes, are Frequency of Use of CBSG-related services and Absorptive Capacity. We expect a positive relationship between these factors because the knowledge base of a company increases as it makes use of more instruments that incentivize knowledge generation and transfer. A company's knowledge base will not change as a result of the expectation it has, but on the real use, it makes of knowledge services. Based on Cohen and Levinthal (1990) and Zahra and George (2002) prior knowledge is an important factor to be aware of in order to understand possible differences in the absorptive capacity of different companies. Hence, as companies learn and acquire knowledge more intensively their prior related knowledge will increase linearly in what Todorova and Durisin (2007) define as knowledge feedback loops. Some companies' absorptive capacity will be lower due to differences in their competence base, but as they make use of CBSG services and collaborate with other companies, their individual capability to absorb knowledge will increase as well as that of the whole group.

Proposition 8*: Frequency of Use of CBSG-related services will have a positive relationship with Absorptive Capacity.*

4.4 Concluding Remarks

In this chapter, we presented the operating principles of our knowledge valorisation conceptual model. These are divided into three different areas: expectations, utilization and performance. We argue that knowledge transfer and its protection are strategic for achieving an efficient capitalization of knowledge. Absorptive Capacity is an essential bridging factor model as it transforms expectations and use into important knowledge by-products that can later be converted into new technologies and services. All of these principles will differ depending on the company's capability to acquire and manage knowledge. We also described the strategies to be implemented for both empirical and desk research have been presented in this chapter. Meetings with experts in different fields are essential for assuring a high quality literature study, while proper delimitation of indicators and empirical methods to analyse the data are critical. We further operationalized the factors portion of the conceptual model that was extracted from the CBSG Valorisation Questionnaire, explained in detail the data collection methods, and finally, we defined the study population. In the last section, we extracted from both theory and the model a set of propositions that are listed in Table 4.4.

Table 4.4: Summary of the propositions to be tested in the empirical research

Proposition #	Statement
1	Knowledge Transfer Support, Research Support, Breeding Support and IP Support factors will have a positive relationship with Frequency of Use of CBSG-related services.
2	Scientific Performance will have a positive relationship with Innovative Performance.
3	The number of Plant Breeder's Rights applications will have a positive relationship with Absorptive Capacity and a negative relationship with Innovative Performance.
4	The number of patent applications will have a negative relationship with Innovative Performance.
5	Innovative Performance and Scientific Performance are more important for potato companies than for tomato companies.
6	Knowledge Transfer Support is more important than the four IP Support factors.
7	Frequency of Use of CBSG-related services is more important for potato companies than for tomato companies.
8	Frequency of Use of CBSG-related services will have a positive relationship with Absorptive Capacity.

Chapter 5

Results

This chapter reports the findings obtained from the data analysis and the empirical study that was set up to answer each of the eight propositions established in Chapter 4. Sections 5.1 to 5.3 perform a general pre-analysis of the data: an assessment of the response rate, representativeness and reliability of the model. Section 5.4 and subsections show the results of the of the analysis done to the data collected from the CBSG Valorisation questionnaire in order to prove Propositions 1, 2, 5, 6, 7 and 8. This section will also demonstrate the robustness of the general and sectorial conceptual model developed by focusing in the relationships among factors to extract the valorisation factors at the factorial and individual level. Additionally, a comparison between tomato breeding companies with higher IP Support instruments, Innovative Performance and Absorptive Capacity is made. Section 5.5 presents a baseline description of the study and the companies involved in the research in order to validate our study. A descriptive analysis of the companies in terms of patent, Plant Breeders' Rights (PBR), Community Plant Variety Rights (CPVR) applications, Full Time Employees (FTE) and revenue is performed within this section. Propositions 3 and 4 are to be proved in section 5.6 and subsections, were an analysis of the relationships between the valorisation performance indicators is performed and additional results are presented on the in depth study of the performance indicators that were measured: PBR, CPVR, PVP and patents. In section 5.7, the valorisation factors are associated with the previously described performance indicators using different bi-variate statistical techniques in order to obtain the key factor of knowledge transfer and valorisation performance indicators of the general and individual models. Finally, section 5.8 provides the reader with some concluding remarks about the final models and provides the answer for the each of the eight propositions.

5.1 Response rate

The 16 companies that are members of the CBSG were approached (See Section 3.2). In total, 15 structured interviews were conducted with R&D managers, program managers, R&D directors and pre-breeders. Two cases were dropped from the Absorptive Capacity analysis because they presented marked trails of heterogeneity with the rest of the group, as they represent more downstream producers of potato derivatives oriented towards consumer products. This left an average of 15 cases to analyze per dimension--7 tomato and 8 potato companies--with the exception of the Absorptive Capacity factor, which is composed of only 13 cases, 7 tomato and 6 potato companies.

5.2 Representativeness

There was a special interest in comparing tomato companies against potato companies. An additional measurement was realized on the Frequency of Use dimension, using a median split (3.28). A clear division could be observed between high frequency users: five tomato companies and three potato companies, and low frequency users: five potato companies and two tomato companies. This suggests that comparing groups based on their frequency of use will lead to results comparable to those obtained in the industry study. The comparison between potato and tomato companies therefore provides the research with the strongest sample.

5.3 Reliability of instruments

Table 5.3 shows that in all cases Cronbach's α is sufficient in this exploratory study (> 0.60) to warrant confidence in the internal consistency of the scales constituting the empirical dimensions (Fortuin et al., 2007). The reliability analysis was only performed in the formative factors previously elaborated in the valorisation model and reflective items were omitted from this section, but will be used in further tests.

Table 5.3: Reliability analysis of all the models' dimensions, using Cronbach's α

Dimension	Number of Items	Cronbach's α		
		Complete Model	Tomato	Potato
Knowledge Transfer Support	5	0.78	0.63	0.86
Frequency of Use	7	0.76	0.63	0.84
Absorptive Capacity	3	0.82	0.75	0.69
Innovative Performance	4	0.82	0.83	0.82
Business Performance	5	0.72	0.62	0.81

5.4 Valorisation factors: bivariate associations

The following section and subsections will prove Propositions 1, 2, 5, 6, 7 and 8:

Proposition #	Statement
1	Knowledge Transfer Support, Research Support, Breeding Support and IP Support factors will have a positive relationship with Frequency of Use of CBSG-related services.
2	Scientific Performance will have a positive relationship with Innovative Performance.
5	Innovative Performance and Scientific Performance are more important for potato companies than for tomato companies.
6	Knowledge Transfer Support is more important than the four IP Support factors.
7	Frequency of Use of CBSG-related services is more important for potato companies than for tomato companies.
8	Frequency of Use of CBSG-related services will have a positive relationship with Absorptive Capacity.

This Section will also demonstrate the robustness of our valorisation models and will identify the valorisation factors extracted from the data collected from the CBSG Valorisation questionnaire. Regarding our general valorisation model in Table 5.4(1), we will list the most significant results in the following lines:

- PBR Filing Support has a very significant correlation with Absorptive Capacity
- Absorptive Capacity has a very significant relationship with Innovative Performance
- Breeding Support has a very significant relationship with Innovative and Business Performance

- Innovative Performance has a significant relationship with Business Performance

- PBR Filing Support has a marginal significant correlation with Frequency of Use
- Access to IP Support has a marginal significant relationship with Frequency of Use and Absorptive Capacity

Table 5.4(1): Spearman correlation matrix of the complete model (n=15)

	1	2	3	4	5	6	7	8	9	10	11	12
1. Knowledge Transfer Support	X											
2. IP Filing Support	**.35***	X										
3. Access to IP Support	-.17	**.50****	X									
4. Patent Filing Support	.30	**.52****	**.42***	X								
5. PBR Filing Support	-.05	.04	.27	.18	X							
6. Research Support	.01	-.19	**.42***	.28	.20	X						
7. Breeding Support	.23	-.18	.04	.26	**.47****	**.60*****	X					
8. Frequency of Use	.02	.07	**.39***	.02	**.44***	.07	.21	X				
9. Absorptive Capacity	.14	.22	**.39***	.32	**.80*****	**.38***	**.54****	.31	X			
10. Innovative Performance	.25	.33	**.38***	**.40***	**.62*****	**.47****	**.73*****	.24	**.86*****	X		
11. Scientific Performance (n=13)	-.35	-.37	.05	-.32	-.06	.17	.03	.32	-.37	-.28	X	
12. Business Performance	.24	-.12	.31	.12	**.36***	**.55****	**.63*****	.32	**.41***	**.57****	.34	X

*Correlation is significant at the 0.1 level (1-tailed).
**Correlation is significant at the 0.05 level (1-tailed).
***Correlation is significant at the 0.01 level (1-tailed).

There is a strong connection between obtaining PBR Filing Support from CBSG and the extent to which companies expect to increase the amount of new products developed, tested and implemented markers. The link between Breeding Support and Innovative and Business Performance is a rather strange one, since it appears odd that simple expectations may lead to actual differences in performance. What we can suggest is looking at the industry valorisation models of both tomato and potato to clarify this result. Finally, marginal relationships are rather exploratory than supportive, but can give indications of the direction in which the data is behaving. Such relationships will be later analyzed by examining each company individually.

Now, regarding our tomato valorisation model in Table 5.4(2), we will list the most significant results in the following lines:

- Absorptive Capacity has a very negative significant relationship with Scientific Performance
- Patent Filing Support has a very significant correlation with Absorptive Capacity and a very negative significant relationship with Scientific Performance
- Frequency of Use has a very significant relationship with Bussiness Performance

- PBR Filing Support has a significant relationship with Absorptive Capacity
- Absorptive Capacity has a significant relationship with Innovative Performance

- Breeding Support has a marginal significant correlation with Frequency of Use
- Access to IP and IP Filing Support have a marginal significant relationship with Absorptive Capacity

Table 5.4(2): Spearman correlation matrix of the factors assessed by tomato companies (n=7)

	1	2	3	4	5	6	7	8	9	10	11	12
1. Knowledge Transfer Support	X											
2. IP Filing Support	.41	X										
3. Access to IP Support	.14	**.77****	X									
4. Patent Filing Support	.37	**.83****	**.60***	X								
5. PBR Filing Support	.28	.14	-.01	**.59***	X							
6. Research Support	-.03	.16	**.62***	.14	-.29	X						
7. Breeding Support	**.55***	.08	-.29	.14	.48	-.41	X					
8. Frequency of Use	.50	.05	.22	.08	.40	.19	**.62***	X				
9. Absorptive Capacity	.45	**.58***	**.60***	**.87*****	**.73****	.32	.16	.41	X			
10. Innovative Performance	.18	**.77****	**.73****	**.77****	.46	.22	.29	.44	**.71****	X		
11. Scientific Performance (n=6)	-.25	**-.65***	-.56	**-.89*****	-.48	-.10	.30	.25	**-.94*****	-.50	X	
12. Business Performance	.09	-.09	.21	-.09	.26	.23	.48	**.90*****	.21	.46	.52	X

*Correlation is significant at the 0.1 level (1-tailed).
**Correlation is significant at the 0.05 level (1-tailed).
***Correlation is significant at the 0.01 level (1-tailed).

The fact that there is a negative association between expecting to develop new products, testing and implementing markers and Scientific Performance for tomato companies is interesting because it clearly opposses the direction of our proposition statement. There is also a strong connection between Patent Filing Support and Absorptive Capacity and a negative relationship between Patent Filing Support and Scientific Performance. This result strengthens the reliability of our previous outcome and proves that tomato companys' Absorptive Capacity is very much related to patents. Additionally, we could observe a negative tendency in the Scientific Performance factor, which indeed may tell us the lack of interest that tomato companies have in publishing peer-reviewed articles.

Now, regarding our potato valorisation model in Table 5.4(3), we will list the most significant results in the following lines:

- Innovative Performance has a very significant relationship with Business Performance
- PBR Filing Support has a very significant correlation with Absorptive Capacity

- Absorptive Capacity has a significant relationship with Innovative Performance

- Breeding Support has a marginal significant correlation with Frequency of Use

Table 5.4(3): Spearman correlation matrix of the factors assessed by potato companies (n=8)[28]

	1	2	3	4	5	6	7	8	9	10	11
1. Knowledge Transfer Support	X										
2. Access to IP Support	-.49	X									
3. Patent Filing Support	.12	.34	X								
4. PBR Filing Support	-.18	**.63****	-.21	X							
5. Research Support	.31	.38	**.53***	.43	X						
6. Breeding Support	.42	.27	**.55***	.45	**.91*****	X					
7. Frequency of Use	-.28	.44	-.14	.47	-.11	.02	X				
8. Absorptive Capacity (n=6)	.12	.18	-.52	**.88*****	-.02	.00	.22	X			
9. Innovative Performance	.23	.28	.05	**.78****	**.66****	**.78****	.08	**.78****	X		
12. Scientific Performance (n=7)	-.26	**.73****	.26	.27	.29	.02	.24	.52	.15	X	
11. Business Performance	.48	.39	.40	.55	**.69****	**.78****	-.06	.58	**.79*****	.30	X

**Correlation is significant at the 0.05 level (1-tailed)
***Correlation is significant at the 0.01 level (1-tailed).

Our valorisation model is empowered by the strong association between Innovative and Business Performance and between Absorptive Capacity and Innovative Performance, which were expected. Surprisingly, potato companies Absorptive Capacity is linked to the expectations they have regarding obtaining PBR Filing Support from CBSG, which greatly differs from the patenting orientation of tomato companies. Moreover, as differed from the tomato companies, the potato companies Scientific Performance appears to have a possitive inclination that can tell us the interest that potato companies researchers have in gaining recognition and publishing articles. The marginal relationship between Breeding Support and Frequency of Use will be analyzed in later sections, as it requires a more in depth examination of the data.

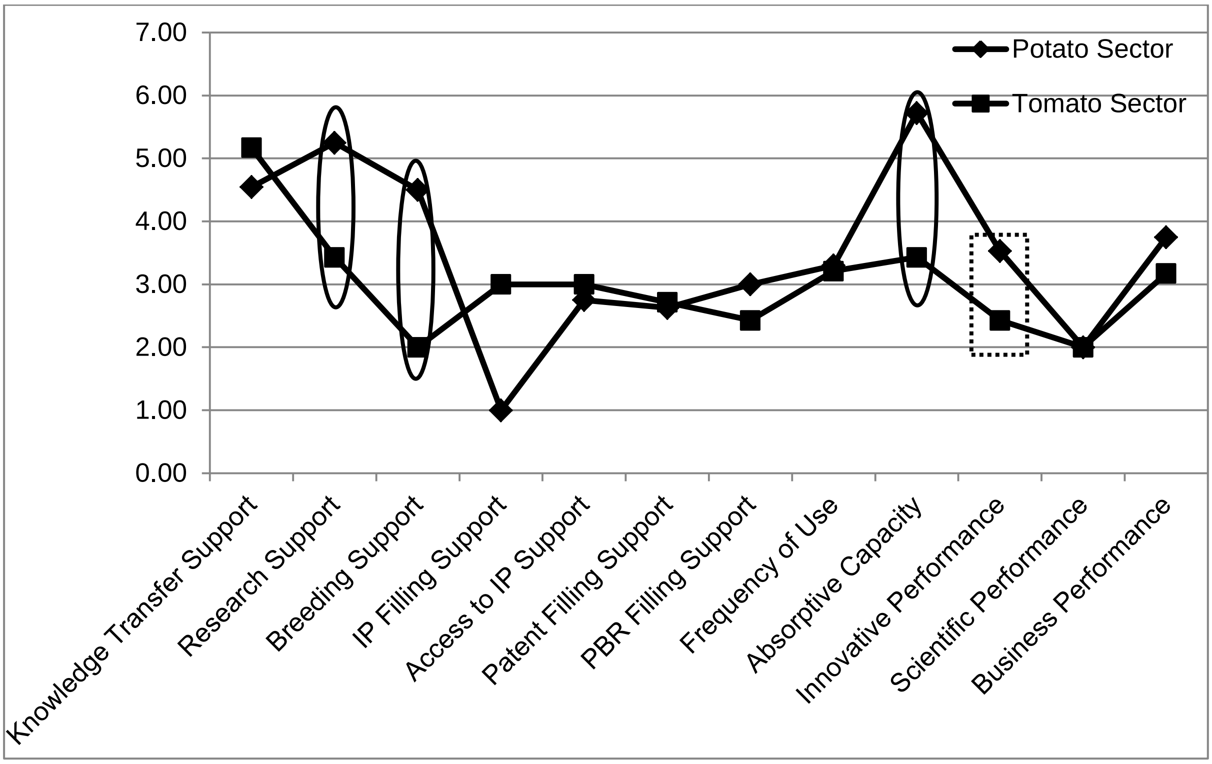
5.4.1 Valorisation factors at the factorial level

Figure 5.4.1 is based on a study on key success factors of innovation in 12 multinational agrifood prospector companies by Fortuin, et al. (2007). It shows the results obtained by comparing potato companies with tomato companies, where significant differences are highlighted with ovals ($p<0.05$), and marginally significant differences are enclosed by a dashed rectangle ($p<0.1$).

- Research Support is significantly higher for potato companies
- Breeding Support is significantly higher for potato companies
- Absorptive Capacity is significantly higher for potato companies
- Innovative Performance is marginally significantly higher for potato companies

[28] IP Filing Support was removed from the analysis due to zero variance (all values were identical)

Figure 5.4.1: the valorisation factors in the CBSG, including the median scores and significant values (n=15)



The median for the potato companies is on average higher than the median for tomato companies. Potato companies have lower medians in the Knowledge Transfer, IP Filing, Access to IP and Patent Filing Support factors and in the Business Performance dimension[29]. We can interpret these findings as a signal that potato companies are far less technologically developed, it will have far more ambition, willingness and curiosity towards what can be achieved with resources provided by the CBSG program, while tomato companies find IP instruments more intresting. Nine companies (five potato and four tomato), agreed that their organization expects to improve the basic research process; one was indifferent and four disagreed. One potato company indicated time reduction of 80% and cost reduction of 50% in the basic research process because of participating in CBSG. One company from each industry identified a 10% time reduction and four companies reported that no time reduction was achieved. Six companies (two potato and four tomato), indicated no cost reduction in basic research. Regarding improvement of the breeding process, five potato companies agreed that their organization expects to improve their breeding process; two tomato companies were indifferent and six disagreed. Three potato companies indicated time reduction in the breeding process ranging 20-37%; the remaining seven indicated no time reduction. Seven companies indicated no cost reduction in the breeding process, while the other four did not provide a response (For detailed information on this matter please refere to Appendix C).

[29] Not significant $p > 0.1$

5.4.2 Valorisation factors at the item level

As the evaluation of the model deals with in-depth information concerning the valorisation assessment of CBSG, we also performed statistical tests at the individual indicator level for several constructs. Table 5.4.2 shows each indicator with a significant difference, the medians for tomato and potato companies and the corresponding t-values indicating the level of significance (For a complete detailed results of each indicator at the individual level, please refer to Appendix C).

Interestingly, two statements concerning the Knowledge Transfer Support factor were significant. Tomato companies score higher in contact with CBSG researchers and access to CBSG website information at the p < .05 level. What is surprising, are the relatively low scores that potato companies assigned to access to the CBSG website information, suggesting that website information from the CBSG plays a less important role in their transfer of knowledge. However, it is important to consider that there may be differences in the website service provided to the two industries. For example, the website of tomato companies might update more frequently than the potato website because more research or activities are been carried out with this product.

Table 5.4.2: Non parametrical tests, Mann-Whitney, performed at the item level to the formative factors, 7-point Likert scales, mean, standard deviation and significance level (n=15)

Factor **Item**	**Tomato** **Mean(s.d)**	**Potato** **Mean(s.d)**	**Significance** **Level (U)**
Knowledge Transfer Support			
Access to CBSG website	5.71(1.38)	3.63(2.45)	**
Absorptive Capacity			
Increase # of markers that will be tested	3.71(2.36)	6.33(0.52)	**
Increase # of markers that will be implemented	3.00(2.52)	6.00(0.89)	**
Innovative Performance			
Increase sales of new products	2.14(1.68)	3.75(1.28)	*
Introduce new products faster than competitors	1.71(0.76)	3.88(2.17)	*

** p < .05 (1-tailed)
* p < .1 (1-tailed)

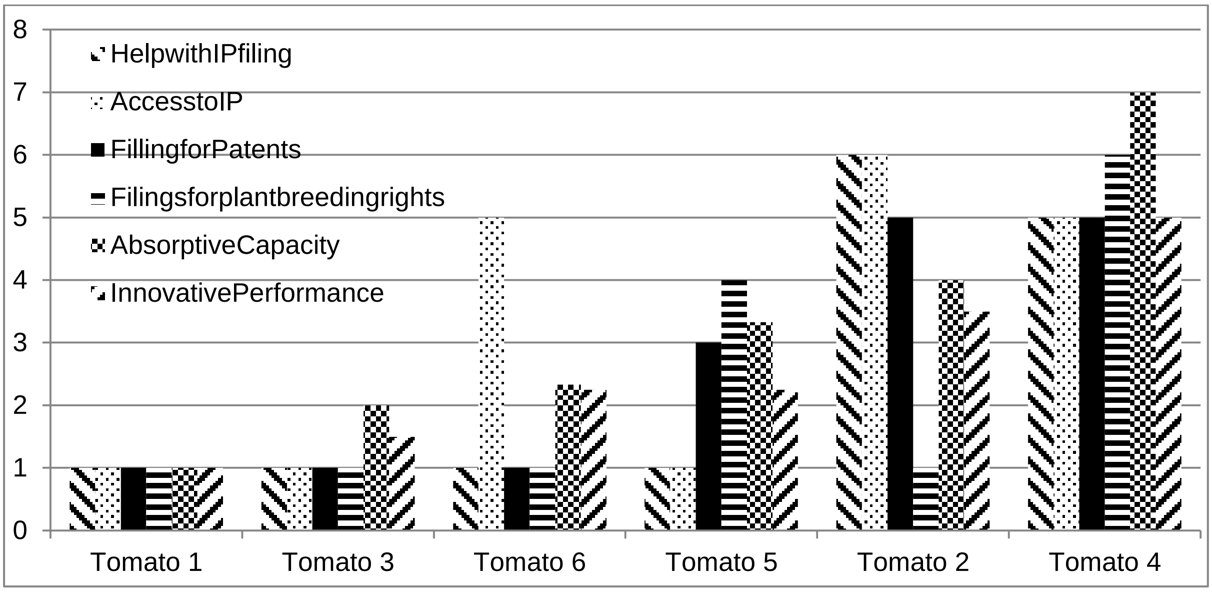
Potato companies scored significantly higher in Absorptive Capacity and Innovative Performance. As follows from the correlation 5.4(1), the number of markers tested and implemented is clearly related to the increase of sales of new products and the ability to introduce them to the market faster than competitors. Nine companies (6 potato and 3 tomato) agreed that the CBSG program enables their organization to improve the number of markers that will be tested, while four disagreed. Five companies (3 potato and 2 tomato) indicated that the number of tested markers has increased by 25, 2, 11, 100 and 1, respectively, with use of CBSG services. Eight companies (6 potato and 2 tomato) agreed that the CBSG program enables their organization to improve the number of tomato/potato markers that will be implemented, while five disagreed. Four companies (3 potato and 1 tomato) quantified that the number of implemented markers would increase by 8, 2, 5 and 100, respectively. Two tomato companies indicated zero markers implemented. With regard to Absorptive Capacity - Innovative Performance relationships, only 3 companies (2 potato and 1 tomato) indicated that CBSG program enables their organization to increase the sales of new products, while six disagreed and five were neutral. One potato company reported that the increase in the sales of new products resulting from participation in the CBSG program was of 10% of the total sales of new products. Two tomato companies indicated 0% and the rest gave no response to this item. (For detailed information, please refer to Appendix C). We are aware that tomato companies underestimate these items due to product differences in their program objectives. The important question here is whether the Absorptive Capacity and Innovative Performance of tomato companies will rise in the long term.

5.4.3 Valorisation factors at the company level

Figure D.1 shows that tomato companies two and four behave more like potato companies in the following factors: IP Filing, Access to IP, Patent Filing and PBR Filing Support, Absorptive Capacity and Innovative Performance. A Mann-Whitney test was conducted in order to identify the significant dimensions that explain where the difference lies between these two companies and the other four[30]. These two companies are among those with the least amount of full-time employees FTE, but they also have the highest values for all the IP instruments, Absorptive Capacity and Innovative Performance. The individual item findings show that these companies implemented markers more intensively than their counterparts did. Smaller companies appear to be more interested in performing applied research than fundamental research, and consequently are more interested in transferring knowledge to develop more products and increase their sales. Companies with a low number of employees rely on the assistance they receive from the CBSG in the field of IP Support and are very active implementing markers. Therefore, we suggest that because of the limited number of FTE that small tomato companies have to spare, they are conducting more applied research, while larger companies have a longer-term, fundamental approach.

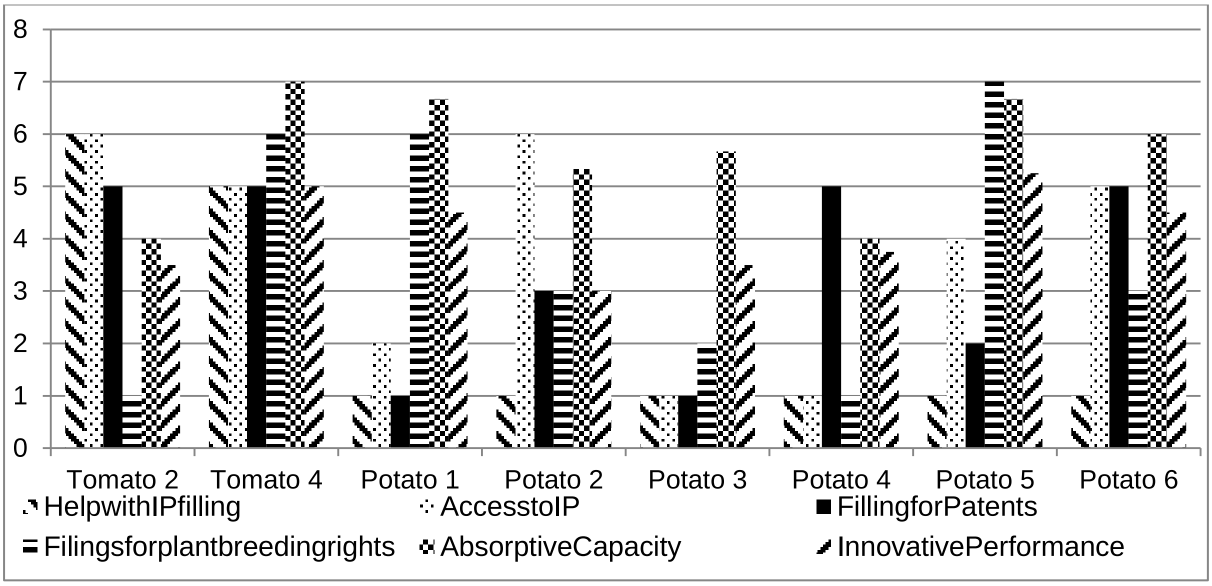
[30] Significance at the $p < 0.1$ level found in Innovative Performance factor and in the amount of implemented markers individual item

Figure 5.4.3(1): Descriptive values of the tomato companies for the following factors: IP Support instruments, Absorptive Capacity and Innovative Performance



Now, taking a further look at Table 5.4.3(1) and 5.4.3(2) our findings are supported. Tomato companies 2 and 4 indeed behave more like potato companies in several factors. Such findings suggest that tomato companies two and four are valorizing resources provided by the CBSG more effectively, therefore enhancing Innovative Performance which could, in the long-term, result in a competitive advantage. The important question that remains is why these two companies are different from the rest.

Figure 5.4.3(2): Descriptive values of tomato companies 2 and 4 and potato companies in the following key dimensions: IP Support instruments, Absorptive Capacity and Innovative Performance



5.5 Baseline description of companies

The following sections will present the results obtained from the descriptive data and will pinpoint the performance indicators extracted from the data collected from annual reports and online databases. Table 5.5(1) presents the definition of the indicators measured at scale level

Table 5.5(1): Definition of performance concepts prior to analysis

Concept	Definition
Revenue 2008 in € million	Turnover or net sales that the company accounted for in the year 2008 in € (Sales – cost of production).
Number of full time employees (FTE) 2008	The number of a company's fulltime employees during 2008.
Number of CBSG related varieties 2010	Amount of varieties that the company has developed until 2010 on their industry.
Number of CBSG related Community Plant Variety Rights (CPVR) applications in the period of 2003-2008	Amount of CPVR applications (a type of plant breeders' rights) that the company has applied for at the European level in tomato or potato through the Community Plant Variety Office (CPVO).
Total number of Plant Breeders' Rights (PBR) applications in the period 2003-2008	Amount of Plant Breeders' Rights applications that the company has applied for at the Dutch level in tomato or potato via the NAK Tuinbouw.
Total number of patent applications in the plant field	General patent search done for seed companies without any restrictions, but for agro biotech companies the word "plant" was searched for in the title, abstract, full text and description of patent applications.
Number of CBSG related patent applications in the period of 2003-2008	European Classification code (ECLA) attributed to the filed CBSG patent applications. A01H (New plants or process to obtain them; plant reproduction by tissue cultures techniques); and/or C12N (Micro-organisms or enzymes; compositions thereof) including C12N15 (Mutation or genetic engineering; DNA or RNA concerning genetic engineering, vectors, e.g. plasmids, or their isolation, preparation or purification; use of hosts as a result); and/or C12Q (Measuring or testing processes involving enzymes or micro-organisms).
Total number of patent applications in the period 2003-2008	The same as previously stated, but restricted to applications done during the period 2003-2008.

As for the descriptive analysis of the companies, Table 5.5(2) shows that the average revenue for tomato companies is €1642 million, while for potato companies it is €1687 million. As could be expected from these Figures, tomato companies employ an average of 4675 FTE, while potato companies only employ 3541 FTE. Tomato companies are more innovative; they produce on average 32% more new varieties than potato companies do. Based on this result, we can also expect that the number of PBR applications for tomato varieties is higher, on average 35, compared to an average of 11 made by potato companies. Finally, tomato companies apply for patents 20 times more frequently than potato companies do. Considering the difference in resources, this result was not surprising.

Table 5.5(2): Descriptive statistics for revenue, number of varieties, number of PBR, CPVR and patent applications and number of FTE (n=15) [31]

	Potato Mean	Potato Std. deviation	Potato Range	Tomato Mean	Tomato Std. deviation	Tomato Range
Revenue 2008 (€ million)[32]	1687 (n=6)	3123	7823	1642 (n=6)	3239	8118
Number of FTE 2008	3541 (n=7)	6474	17965	4675 (n=7)	8705	24018
Number of varieties CBSG Related Research 2010[33]	37 (n=5)	28	63	49 (n=6)	26	73
Number of CPVR applications 2003-2008 CBSG Related Research	18.8 (n=6)	17.9	47	20.2 (n=6)	24.1	52
PBR applications 2003-2008 CBSG Related Research	11.6 (n=5)	7.3	18	37.3 (n=6)	35	93
Number of patent applications 2003-2008 CBSG Related Research[34]	3.3 (n=3)	2.1	4	23.6 (n=7)	45.5	124
Total Number of patent applications CBSG related research	5.33 (n=3)	5.1	10	73.1 (n=7)	158.8	430
Total Number of plant patent applications in the plant field	31.3 (n=3)	29.7	59	293.4 (n=7)	658.3	1780

[31] Source: Annual reports and Seed Quest. Exchange rate adapted from 31/12/2008 at 1.3917 $/€ and 19/04/2010 at 125 Yen/€. Information regarding family owned companies: Rijk Zwaan, Agrico, Enza Zaden, KWS, Takii and C. Meijer was gathered from websites and estimations. Figures obtained for Takii are based on 2010 information from their website. Averis Seeds is the daughter company of AVEBE, therefore the Figures for Averis Seeds were not available.

[32] Mc.Cain and Syngenta are outliers in turnover with 8 B€ each. Without these outliers the potato and tomato mean would switch to 345 M€ and 271 M€ respectively.

[33] Source: http://www.plantenrassen.nl

5.6 Performance indicators: bivariate associations

In the following section and subsections, Propositions 3 and 4 will be proved by associating valorisation performance indicators with each other, using the number of FTE as a control indicator for size.

Proposition #	Statement
3	The number of Plant Breeder's Rights applications will have a positive relationship with Absorptive Capacity and a negative relationship with Innovative Performance.
4	The number of patent applications will have a negative relationship with Innovative Performance.

In Table 5.6(1), the performance indicators of the general model are correlated, we will list the most significant results in the following lines:

- Number of varieties CBSG Related Research 2010 correlates very significantly with Community Plant Variety Rights (CPVR) applications and significantly with PBR applications.
- CPVR have a very significant relationship with PBR applications and a marginal correlation with the number of patent applications.
- Patent applications have a marginal significance with PBR and CPVR applications.
- No relationship between revenue and the other performance indicators

Table 5.6(1): Pearson product-moment correlation of the performance indicators in the period 2003-2008 for all the companies (n=12)

	1	**2**	**3**	**4**	**5**
1. Revenue 2008 (€ million)	X				
2. Number of varieties CBSG Related Research 2010	.33	X			
3. Number of PBR applications 2003-2008 CBSG Related Research	-.07	**.67**** (n=10)	X		
4. Number of CPVR applications 2003-2008 CBSG Related Research	.08	**.76***** (n=10)	**.82***** (n=10)	X	
5. Number of patent applications 2003-2008 CBSG Related Research	.25	.45	**.55*** (n=8)	**.55*** (n=8)	X

In Table 5.6(2), the performance indicators of the potato model are correlated, we will list the most significant results in the following lines:

- Revenue correlates marginally with the number of of CPVR applications.
- The number of varieties correlates marginally with the number of CPVR applications.
- Very significant relationship between number of varieties and revenue excluded due to low unreliable sample (n=3)

Table 5.6(2): Pearson product-moment correlation of the performance indicators in the period 2003-2008 for potato companies[35] (n=5)[36].

	1	2	3	4
1. Revenue 2008 (€ million)	X			
2. Number of varieties CBSG Related Research 2010	**1***** **(n=3)**	X		
3. Number of PBR applications 2003-2008 CBSG Related Research	0.50	0.20	X	
4. Number of CPVR applications 2003-2008 CBSG Related Research	**0.80*** **(n=4)**	**0.80*** **(n=4)**	0.40	X

*Correlation is significant at the 0.1 level (1-tailed).

In Table 5.6(3), the performance indicators of the tomato model are correlated, we will list the most significant results in the following lines:

- Revenue correlates very significantly negatively with number of CPVR applications and significantly negatively with number of PBR applications
- CPVR applications has a significant association with PBR applications
- Revenue correlates negatively with all the performance indicators

Table 5.6(3): Pearson product-moment correlation of the performance indicators in the period 2003-2008 for tomato companies (n=7)

	1	2	3	4	5
1. Revenue 2008 (€ million)	X				
2. Number of varieties CBSG Related Research 2010	-.31	X			
3. Number of PBR applications 2003-2008 CBSG Related Research	**-.77**** **(n=6)**	.54	X		
4. Number of CPVR applications 2003-2008 CBSG Related Research	**-.94***** **(n=6)**	.26	**.83**** **(n=6)**	X	
5. Number of patent applications 2003-2008 CBSG Related Research	-.26	-.03	.49	.49	X

*Correlation is significant at the 0.1 level (1-tailed).

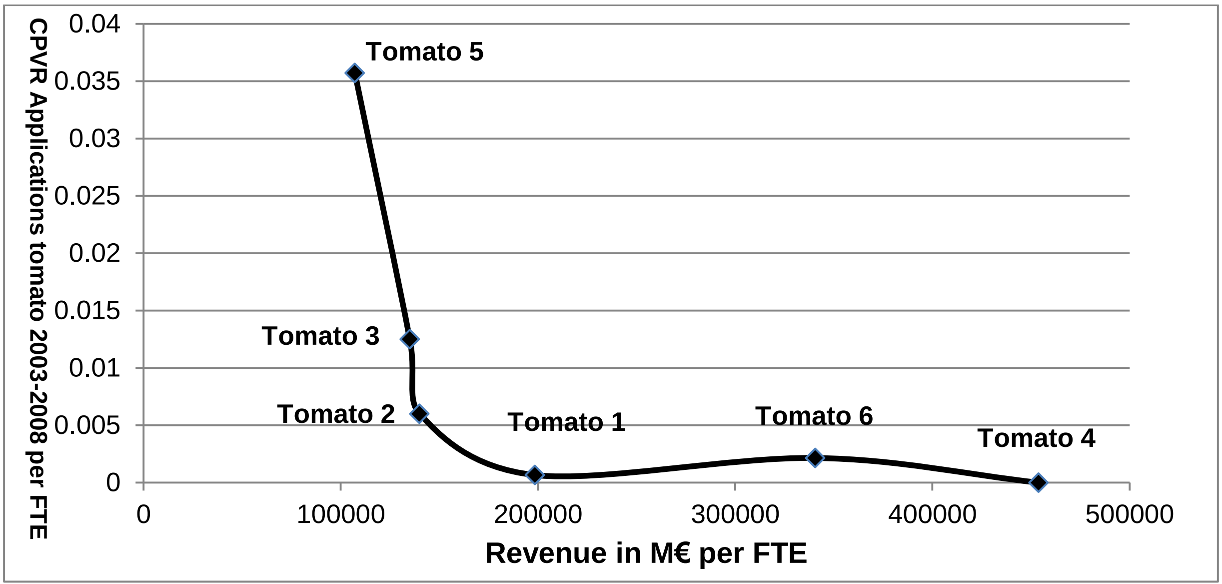
Figure 5.6 illustrates the number of CPVR applications versus the revenue per FTE. We can appreciate that small tomato companies apply more intensively to CPVR, the opposite happens with high revenue tomato companies. CPVR application and protection is more economical than applying for patents. Hence, low revenue tomato companies prefer to apply for CPVR to save costs and protect their varieties. This strategy also allows them to collaborate in the scientific aspect because they estimate knowledge sharing among companies that apply for CPVR. Curiously, size (revenue) has a negative link with all the other performance indicators that indeed lets us think about the role of big companies in CBSG. Apparently, small companies are interested in developing new varieties or tools that can later be protected and can strengthen their position in the market, while big companies

[35] Analysis of patent data was excluded due to an unreliable sample size (n=3)

[36] Potato 1 was excluded from the revenue analysis because the company does not disclose this type of information.. Potato 6 and 7 were excluded from the PBR analysis because they present clear differences with the rest of the group.

may indeed be more interested in participating in fundamentally oriented projects in order to generate new radical ideas that can be further developed in their private labs.

Figure 5.6: CPVR applications per FTE plotted versus the revenue per FTE of tomato companies



5.6.1 Performance indicator #1: Community Plant Variety Rights

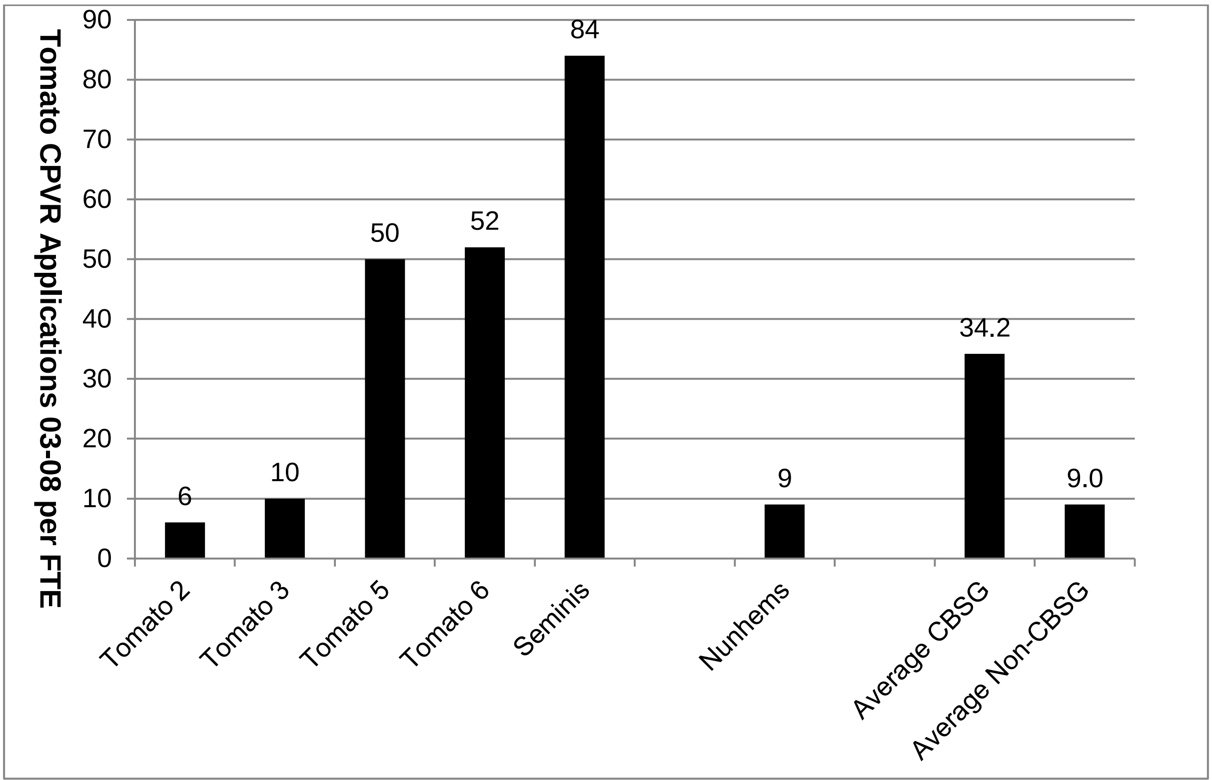
Based on the empirical results from the sections above, the importance of PBR, CPVR and patents in our study became clear. Hence, in Figures 5.6.1(1) and 5.6.1(2) we illustrate and compare the number of CPVR applications done by the CBSG members with other companies that do not form part of the CBSG consortia in both tomato and potato companies. The average[37] of CPVR tomato applications among CBSG members during 2003-2008 is 34, while the average of non-CBSG companies, in this case only Nunhems, is 9. Figure 5.6.1(1) shows that Seminis[38], Tomato 6 and Tomato 5 are leaders in applications with 84, 52 and 50 respectively, while Tomato 2 and Tomato 3 do not apply frequently for CPVR[39]. Tomato companies appear to be rather concentrated because the number of companies outside the CBSG that are executing breeding in the vegetable field is rather limited.

[37] The CPVR and PVP averages were calculated based on the average of the annual averages of companies belonging to the same group. Patent average is different because multiple classifications existed; patent average is the average number of patent applications among companies belonging to the same group.

[38] Acquired by Monsanto in 2005

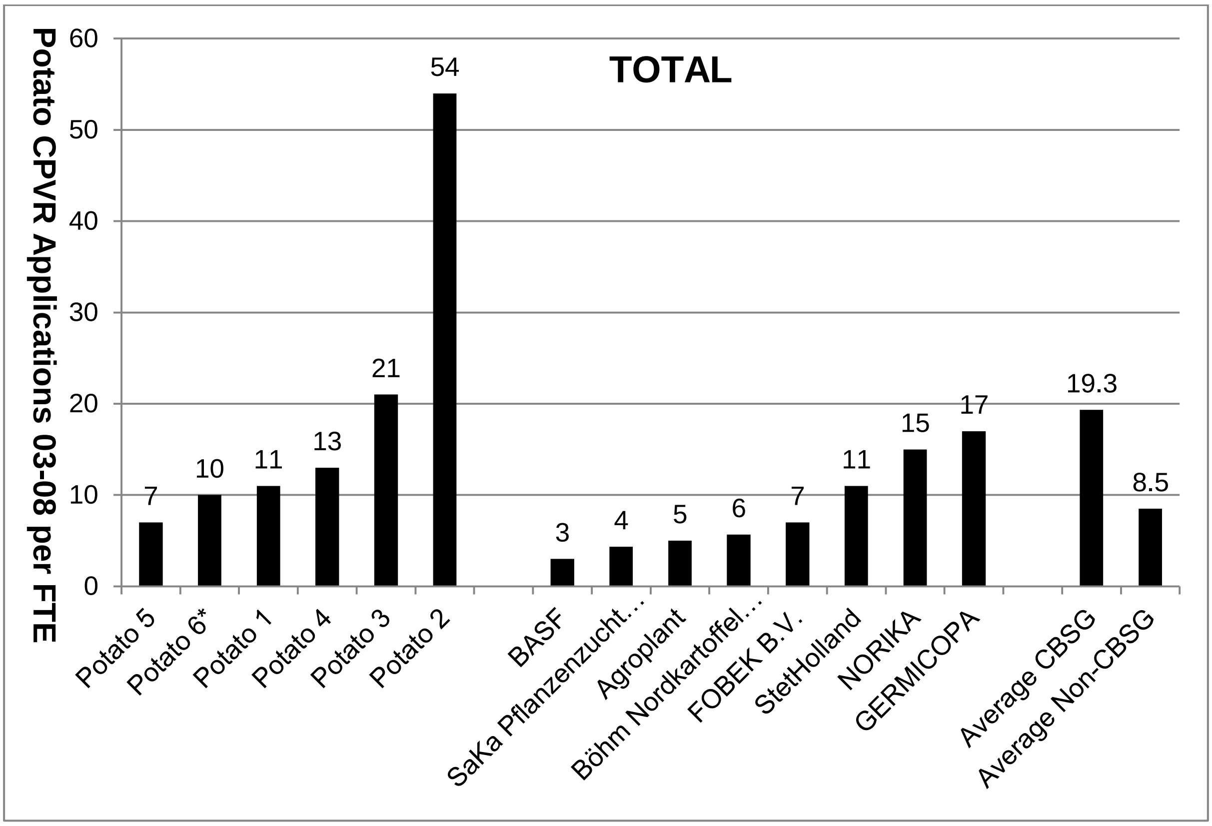
[39] Tomato companies 1 and 4 were excluded from the analysis because they have no CPVR applications

Figure 5.6.1(1): Total number and average of tomato CPVR applications of tomato companies belonging to CBSG and Nunhems in the period of 2003-2008.



In Figure 5.6.1(2), it is clear that potato 2 is the company that applies the most for potato CPVR. The average number of CPVR among CBSG-member potato companies is 19.3, compared to 8.5 among non-CBSG companies. Although CBSG companies have a higher average than non-CBSG companies, it is important to clarify that potato 2 behaves like an outlier, and if removed, the average of CBSG companies decreases to 2. The number of potato companies available for comparison is higher than the number of tomato companies because the potato industry is more diversified, allowing more companies to execute research and develop varieties. For example, BASF, Agroplant and Norika are German companies, Germicopa is French and StetHolland and Agroplant are Dutch potato companies, indicating a great deal of international diversity in the field.

Figure 5.6.1(2): Total number of CPVR applications by CBSG-member potato companies and other companies of European origin in 2003-2008.



5.6.2 Performance indicator #2: Plant Breeders' Rights

Based on our previous result that PBR appears to be a more effective indicator than patents, a trend analysis was performed in order to observe the behaviour of tomato companies in this field. Unfortunately, a lack of data of potato companies prevented us from conducting such an analysis in the PBR field. Figure 5.6.2(1) shows the number of tomato applications as a fraction of the total number of PBR applications applied for per year in the period of 2005 to 2008. In 2005, Tomato 2 had the highest number of PBR applications, followed by Tomato 6 and Tomato 3. However, only Tomato 3 and Tomato 6 had a high amount of PBR applications in the tomato field; Tomato 4 had the lowest amount of PBR applications and no tomato applications. In 2006, Tomato 6 was the company with the highest amount of PBR applications, followed by Tomato 2 and Tomato 3. Tomato 3 was the top company applying for PBR in tomatoes, followed closely by Tomato 6. In 2007, the peak in Figure 5.6.1(2) corresponds to Tomato 6, with the highest number of PBR applications (108), followed by Tomato 5 and Tomato 2. Tomato 1 also increased its number of PBR applications. Finally, in 2008, Tomato 5 was the top company applying for PBR, followed by Tomato 6, Tomato 2 and Tomato 3. This last company increased considerably its number of applications in the tomato field to aproximately 30. It can appreciated that 2007 was the year in which the total number of PBR applications was the highest, while it is clear that since 2005 the overall interest in PBR applications increased noticeably.

Figure 5.6.2(1): Number of PBR applications in tomatoes represented as a fraction of the total number of PBR applications per year from 2005 to 2008. Labels express the tomato company and patterns represent the year to clarify differentiation between years.

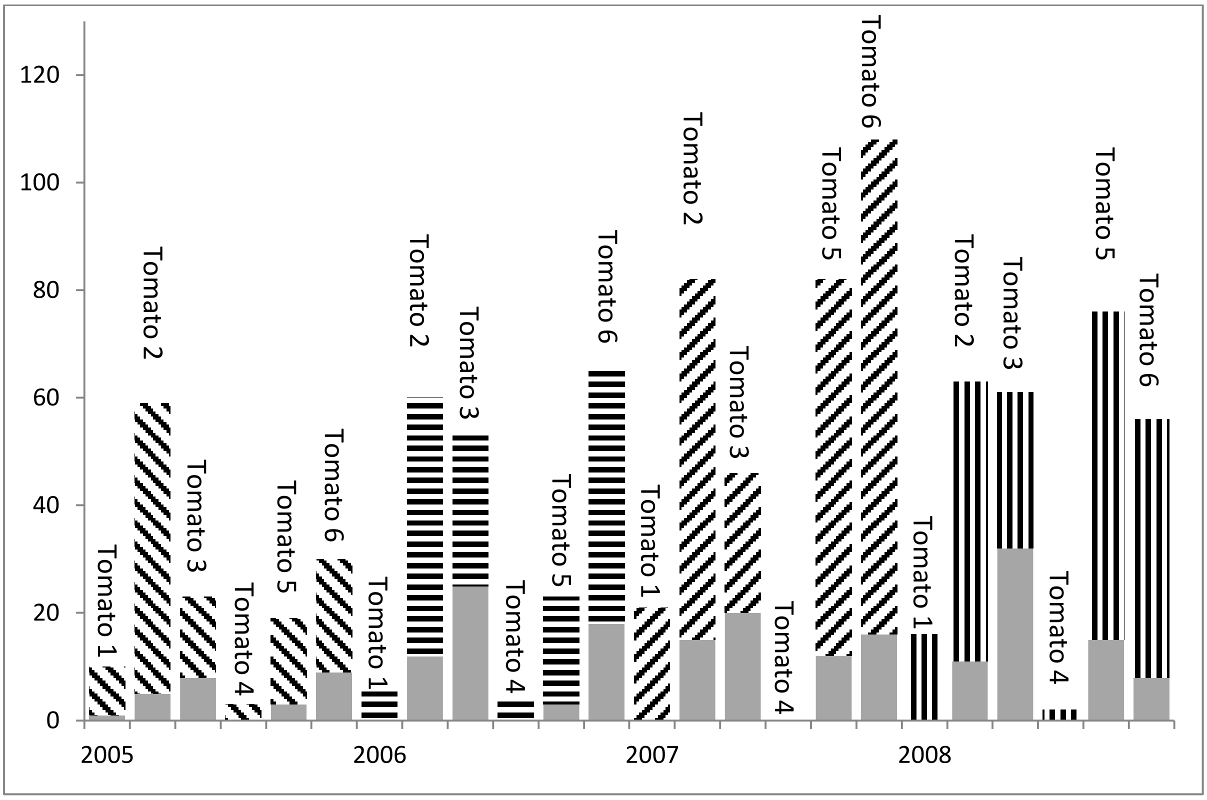


Figure 5.6.2(2) illustrates the number of tomato PBR applications during 2003-2008 per € spent on R&D as a percentage of total revenue. Tomato 5, Tomato 3 and Tomato 2 appear to be the most innovative, while Tomato 4, Tomato 1 and Tomato 6 have low levels of innovation. Previously, we found that tomato companies 2 and 4 were similar to potato companies, but based on this table, we appreciate that there is marked difference in their efficiency when applying for PBR per € spent in R&D. It is important to mention that the data on PBR applications was only collected for the Netherlands. Therefore, it appears that the top three companies are highly interested in the Dutch breeding sector, suggesting that most of their R&D is carried out in the Netherlands. Conversely, the rest of the companies perform R&D more intensively in other parts of the world, which may reduce their numbers of PBR applications submitted in the Netherlands, as they tend to apply for protection in other countries. PBR rights is not only a way to protect the varieties, but also a system to enhance further variety development through the breeder's exemption.

Figure 5.6.2(2): Total number of PBR applications in 2003-2008 for all tomato companies per € spent on R&D

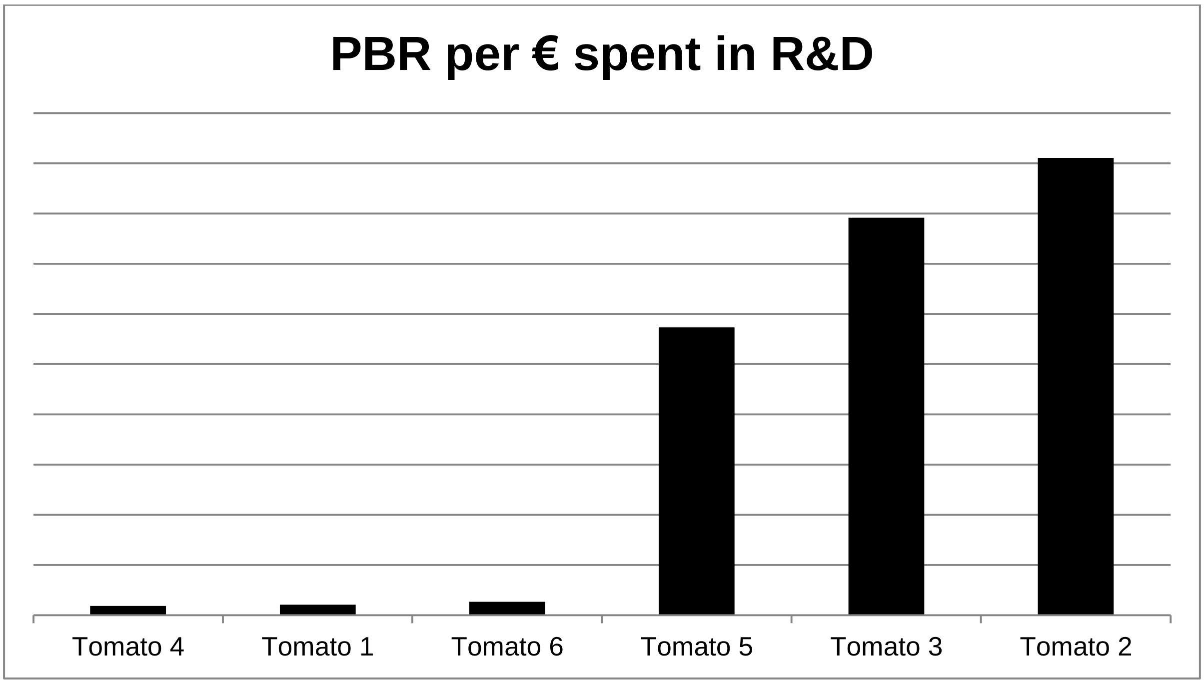


Table 5.6.2 shows the ratio of tomato PBR applications compared to the total number of PBR applications and further decreases the complexity of Figure 5.6.2(1), see previous page. Tomato 3 applications are almost 50% of its total PBR application, Tomato 6, Tomato 5 and Tomato 2 are 20%, 17% and 18% respectively. Tomato 1 and Tomato 4 have a fair number of PBR applications but few of them are in tomatoes, which suggests that they are not interested in protecting their varieties in the Dutch market or that they have a low interest in this crop. Tomato 3 is the leading company in PBR applicationsn which gives us an indication of the innovative capability of this company and both the interest and strength that it has in the market of tomatoes. Tomato company 3 was recently acquired and one of the reasons was due to its power in the tomato breeding sector.

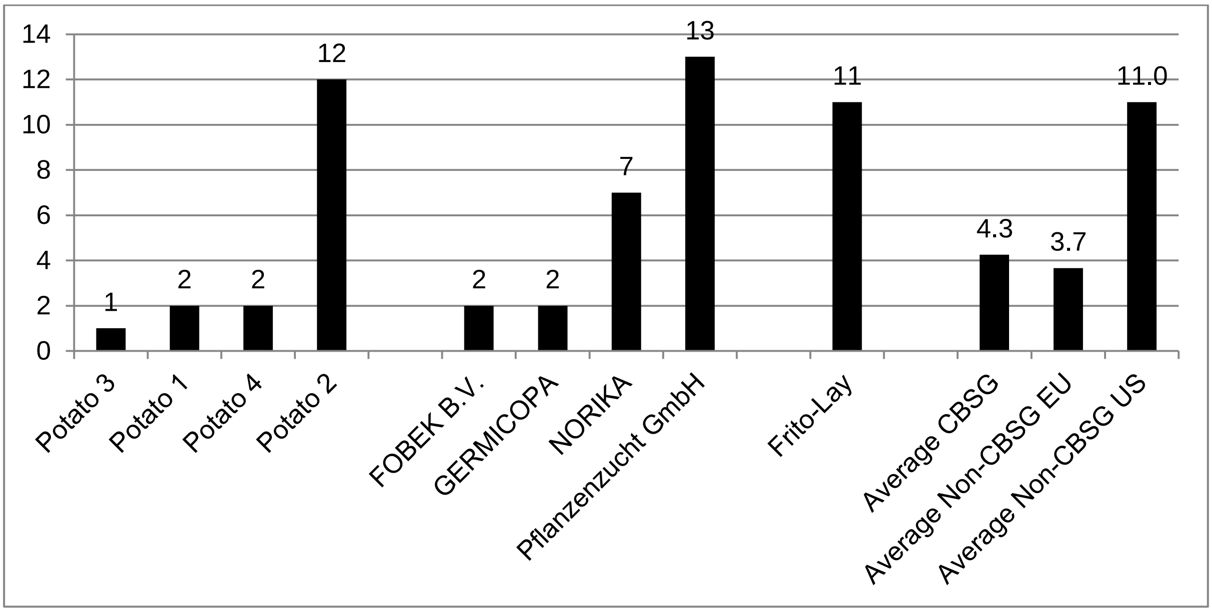
Table 5.6.2: Number of PBR applications in tomatoes as a percentage of the total number of PBR applications in 2005-2008 for all tomato companies

	05	06	07	08	Average Total
Tomato 1	10% (10)	0 (6)	0 (21)	0 (16)	1.8%(53)
Tomato 2	17 %(29)	20%(60)	18% (82)	17%(63)	18.1%(234)
Tomato 3	35%(23)	46%(54)	44% (46)	53%(61)	46.4%(184)
Tomato 4	0 (3)	0 (4)	-	0 (2)	0%(9)
Tomato 5	16%(19)	13%(23)	15%(82)	20%(76)	16.8%(200)
Tomato 6	30%(30)	27%(66)	15%(108)	14%(56)	19.6%(260)

5.6.3 Performance indicator #3: Plant Variety Protection[40]

The Plant Variety Protection Act of 1970 (PVP) is the main representation of PBR in the U.S., granting up to 25 years of protection to the applicant. Figure 5.6.3 compares CBSG-member potato companies, European non-CBSG companies and Frito Lay. Once again, potato 2 is the CBSG company that applies most frequently for PVP, as in CPVR, while Pflanzenzuch GmbH is the European company that applies the most. The average number of PVP applications for the period 2003-2008 is 0.71 for CBSG companies, 1.00 for non-CBSG companies and 1.83 for Frito Lay. It is important to mention that Frito Lay is the only American company that applies for PVP because research institutes and universities[41] develop most of the potato varieties in the U.S. There were no tomato companies aside from the CBSG members Seminis and Tomato 6 that applied for PVP. The average number of PVP applications by these CBSG tomato companies was 5.1.

Figure 5.6.3: Total number of potato PVP applications by potato companies part of CBSG and other companies of European and American origin in 2003-2008



5.6.4 Performance indicator #4: patents

Patents have a significant relationship with Knowledge Transfer Support for potato companies and IP Support and Innovative Performance for tomato companies. Hence, it is important to understand and further analyse patenting behaviour in both fields. Figure 5.6.4(1) illustrates measurements that this study made in three different categories: the average number of patent applications in the plant field, CBSG-related research overall and CBSG-related research during 2003-2008. The large CBSG seed companies (Tomato 6, Limagrain and Seminis) have a lower

[40] http://www.ars-grin.gov/cgi-bin/npgs/html/pvplist.pl

[41] Cornell University, University of Idaho, State of Oregon, University of California, Idaho Research Foundation, Michigan State University, President Colorado

average than the large non-CBSG seed companies (Monsanto, DuPont, Pioneer Hi-Bred and Delta and Pine Land Company) in all the patent categorizations made. Differences in the patenting totals and averages were expected because patenting law is different in the EU from the US.

Figure 5.6.4(1): Total number of plant patents, patents applied for in CBSG-related research overall and patents applied for in CBSG-related research during 2003-2008 by large seed companies members of the CBSG and large Non-CBSG seed companies

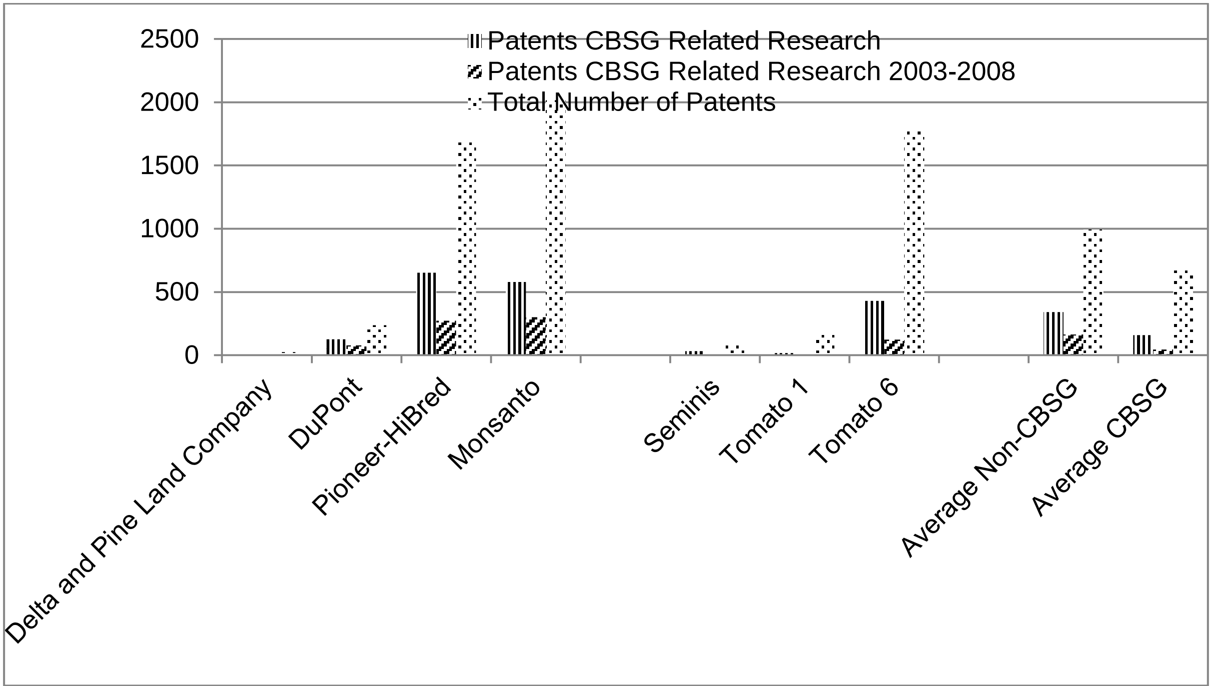


Figure 5.6.4(2) makes the same comparison as the previous Figure, but for small vegetable breeding companies. Tomato 5 is the top applicant among CBSG companies, followed by Tomato 2, Tomato 3 and Tomato 4. The CBSG companies have an average of 13 total patent applications 4 of which are in CBSG-related research, and 3.3 of which were done during 2003-2008. The average among non-CBSG companies, Nunhems and Bejo Zaden, is lower with 8 patent applications of which 1.5 are CBSG-related and 0.5 were done during 2003-2008. The difference is quite marked, which can help explain the reason why these companies decided not to be part of the CBSG.[42]

[42] Bejo Zaden and Nunhems probably have a different strategy than CBSG companies and focus in different areas, therefore making it difficult to find patent data on CBSG related research.

Figure 5.6.4(2): European Non-CBSG tomato seed companies compared with CBSG tomato seed companies

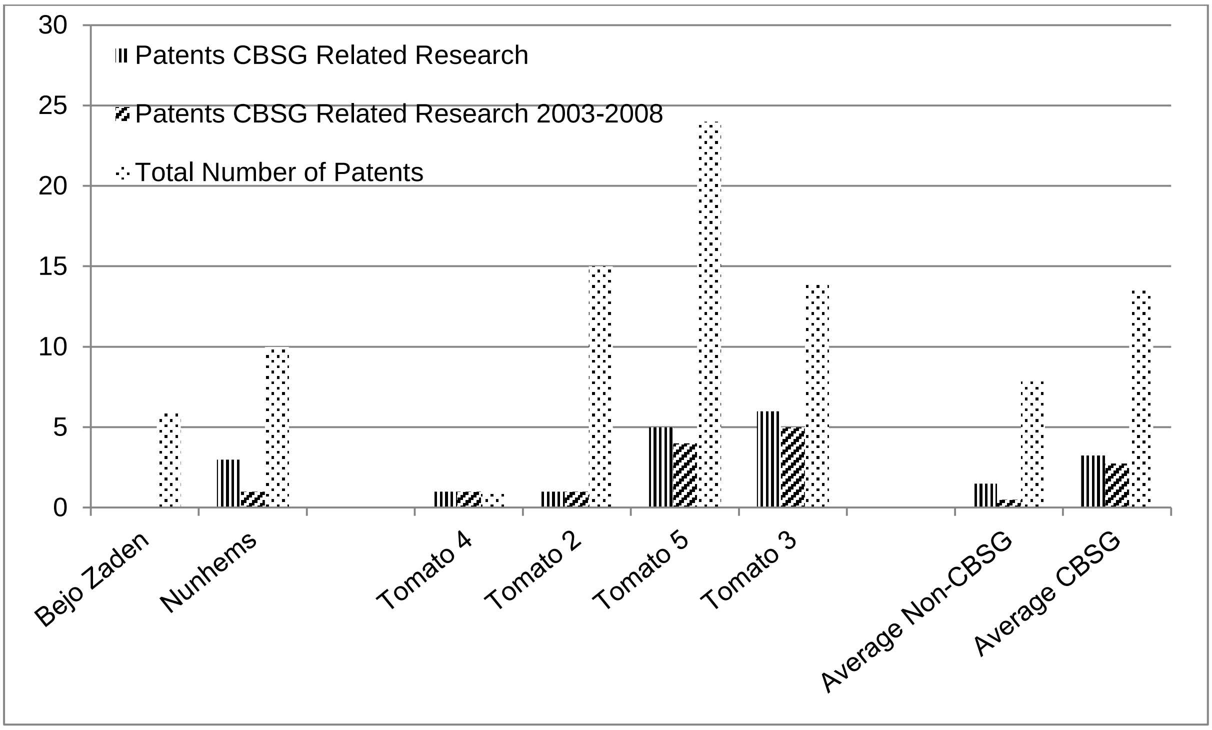


Figure 5.6.4(3) shows the same characteristics as Figure 5.6.4(2): the average number of patent applications in the plant field, CBSG-related research overall and CBSG-related research during 2003-2008, but for potato companies (Potato 3, Potato 5 and Potato 4, CBSG members, and Frito-Lay North America). Evidently, CBSG companies have a higher average of total patent applications but a lower average of patent applications in the CBSG-related research field. This suggests that patent application data is not an adequate performance indicator for the CBSG potato companies.

Figure 5.6.4(3): American potato company Frito Lay compared with CBSG potato companies

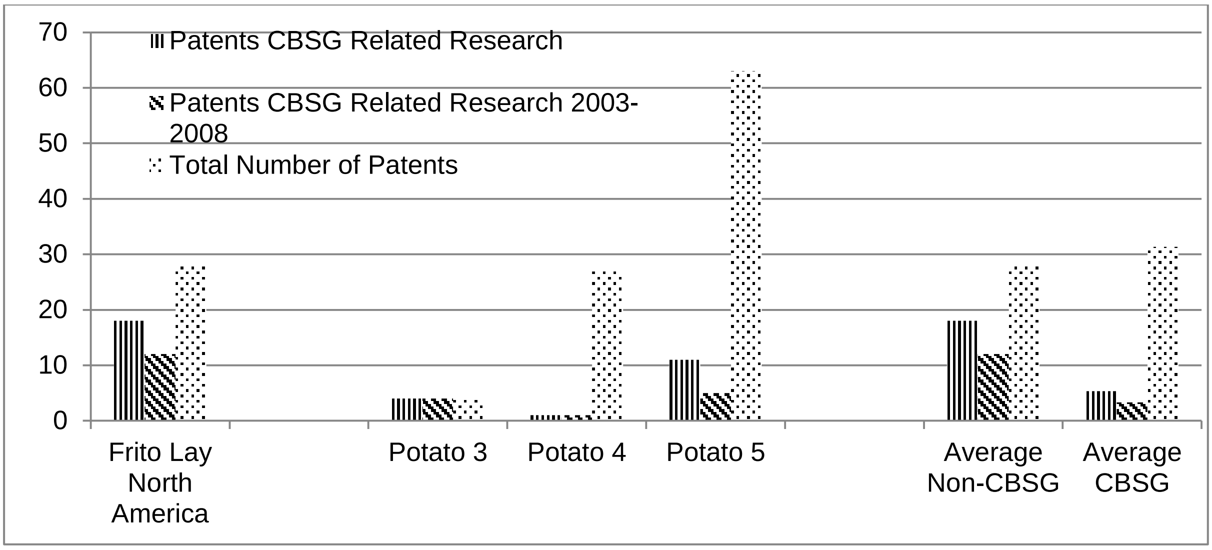
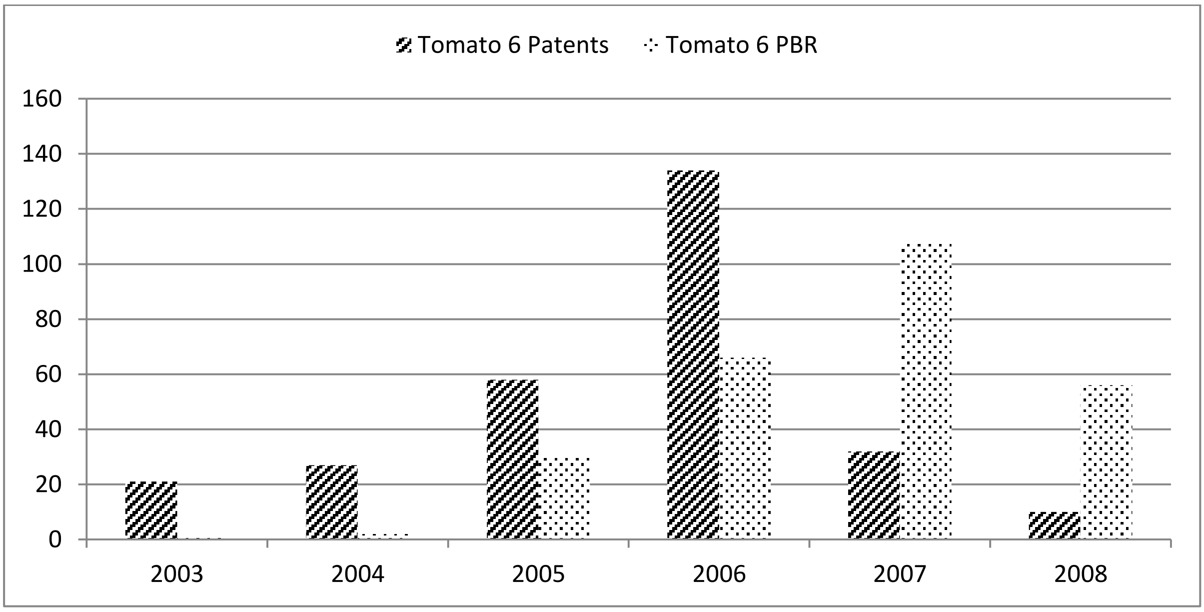


Figure 5.6.4(4), demonstrates the behaviour of Tomato 6 in the fields of patent and PBR applications during 2003-2008. A difference in tedencies can be observed between both: patent applications increase considerably until 2006 and then start decreasing while PBR increase fairle until reaching a maximum in 2008 to then decrease again. It is important to understand that varieties take 10 to15 years to develop; therefore a patent or PBR application submitted in 2008 is the result of a decade of research, which adds complexity to the interpretetion of the data. It would be interesting to study why in 2007 company 6 changed its strategy from patenting to PBR.

Figure 5.6.4(4): Total number of patent and PBR annual applications in the CBSG related research between 2003 and 2008 of tomato company 6.



5.7 Key valorisation factors and performance indicators

In the following sections, valorisation performance indicators and the factors of knowledge transfer are associated with each other. FTE is used as a control indicator for size.

This Section will demonstrate the robustness of our valorisation models and will identify the valorisation factors extracted from the data collected from the CBSG Valorisation questionnaire in relationship to the performance indicators exctracted from the companies' financial figures. We will list the most significant results from Table 5.7(1), in the following lines:

- Revenue correlates significantly with Absorptive Capacity and Innovative Performance
- Patent Filing Support correlates significantly negatively with Patent applications CBSG related research 2003-2008 and with Total Patent applications
- Total patent applications correlates significantly negatively with IP Filing Support
- Number of varieties correlates significantly with Absorptive Capacity

- Knowledge Transfer Support correlates marginally negatively with CPVR and Total patent applications
- Revenue correlates marginally significantly with Frequency of Use
- PBR Filing Support correlates marginally with Number of varieties

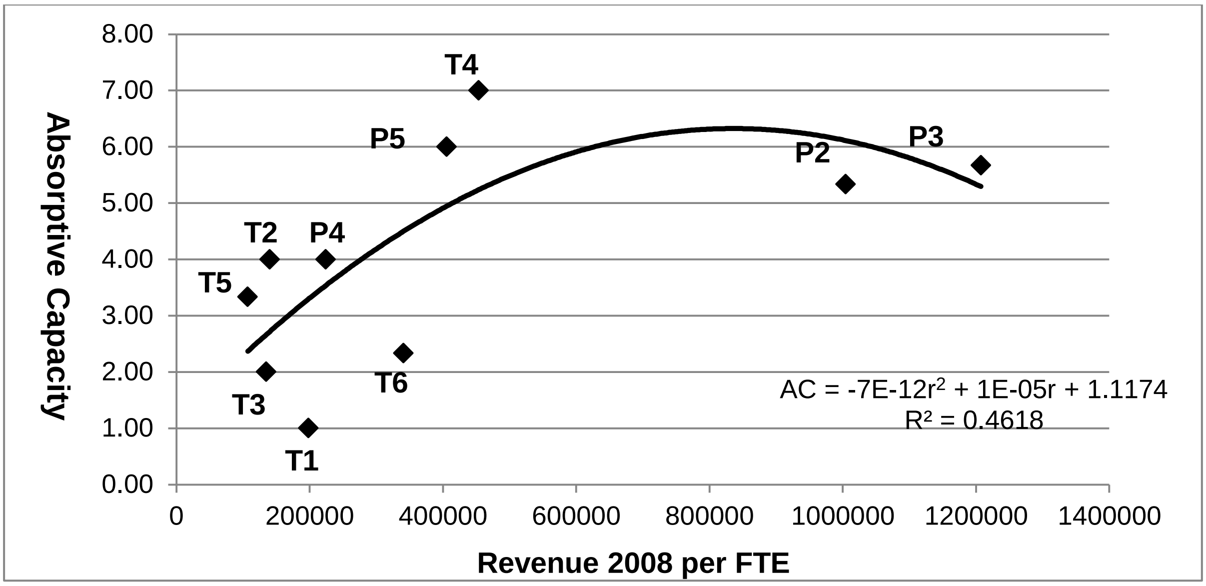
Table 5.7(1): Spearman correlation matrix of the valorisation factor assessment done by all companies versus performance indicators (n=12)

	Revenue 2008 (€ millions)	**Number Varieties 2010 (n=10)**	**PBR applications CBSG related research 2003-2008 (n=10)**	**CPVR applications CBSG Related Research 2003-2008 (n=11)**	**Patent applications CBSG related research 2003-2008 (n=10)**	**Total Patent applications CBSG related research (n=10)**
Knowledge Transfer Support	-.14	-.21	-.32	**-.50***	-.25	**-.45***
IP Filing Support	-.04	.10	-.30	-.34	**-.53***	**-59****
Access to IP Support	.23	.22	-.01	-.03	-.07	.01
Patent Filing Support	-.04	-.15	-.30	-.24	**-.67****	**-.64****
PBR Filing Support	.37	**.51***	-.04	.26	.21	.03
Research Support	.05	.12	.32	.25	-.04	.14
Breeding Support	.34	.28	.32	.25	-.32	**-.44***
Frequency of Use	**.43***	.14	.25	.06	**.51***	.38
Absorptive Capacity	**.70****	**.60****	.04	.19	.18	.07
Innovative Performance	**.51****	.37	-.14	.02	-.24	-.33
Scientific Performance	-.43	-.44	.16	-.11	.22	.19
Business Performance	.02	-.31	-.18	-.15	-.06	-.13

Interestingly the Absorptive Capacity of companies increases as the revenue increases, this can be connected to the higher competence level that big companies have developed. Surprisingly, CPVR and total patent applications have a negative significant marginal correlation with Knowledge Transfer Support and other factors. Apparently, any type of IP hinders the activities related to Knowledge Transfer Support, opposing theory and believes of these indicators.

Figure 5.7, illustrates the difference between the Absorptive Capacity of tomato and potato companies versus the revenue per FTE. Tomato companies indeed have lower revenues per FTE than potato companies do but they also have lower Absorptive Capacity, with the exception of T4, which is the company with the highest Absorptive Capacity. The reason behind tomato company 4 resembling potato companies in the Absorptive Capacity factor could be explained by the level of technological development of such company. Tomato company 4 is interested in testing and implementing new markers may be caused by its low competence level in molecular breeding, which is comparable to the situation of potato companies. Therefore, based on this situation tomato company 4 is eager to use the support of CBSG to carry on molecular breeding research while the other tomato companies have other different interests. Additionally, the Absorptive Capacity of potato companies is in average much higher as well as their revenue, with exception of P4. Considering the circumstances, P4 is among the small companies with the highest Absorptive Capacity.

Figure 5.7: Absorptive Capacity plotted versus the Revenue of the CBSG companies in 2008 per FTE.



Next, we will list the most significant results from Table 5.7(2), which analyses the relationships of potato companies:

- Knowledge Transfer Support correlates marginally negatively significantly with CPVR
- Unfortunately the low sample available from the performance indicators prevents any signicant result from been reliable and therefore have been excluded

Table 5.7(2): Spearman correlation matrix of the valorisation factor assessment by potato companies versus performance indicators (n=8).

	Revenue 2008 (€ millions) (n=6)	Number Varieties 2010 (n=4)	PBR applications CBSG related research 2003-2008 (n=4)	CPVR applications CBSG related research 2003-2008 (n=5)	Patent applications CBSG related research 2003-2008 (n=3)
Knowledge Transfer Support	-.43	-.20	**-1*** **	**-.70***	**-1*** **
Access to IP Support	-.03	.21	.63	.41	.00
Patent Filing Support	-.40	**-.95****	-.32	-.62	**-1*** **
PBR Filing Support	.46	**.80***	.40	.40	.50
Research Support	-.52	-.63	-.63	-.63	-.87
Breeding Support	-.06	-.63	-.63	-.63	-.87
Frequency of Use	.56	.20	**1*** **	.21	.50
Absorptive Capacity (n=6)	.40	**1*** **	.20	.46	.50
Innovative Performance	.14	.40	**-.80***	-.20	-.50
Scientific Performance	-.58	n/a	n/a	-.26	0
Business Performance	-.35	-.11	-.74	-.31	-50

*Correlation is significant at the 0.1 level (1-tailed).
***Correlation is significant at the 0.01 level (1-tailed).
n/a = no sample available

Next, we will list the most significant results from Table 5.7(3), which analyses the relationships of tomato companies:

- IP Filing Support correlates significantly negatively with Patent applications 2003-2008 and total patent applications

- Number of varieties correlates marginally significantly with Knowledge Transfer Support and IP Filing Support
- Patent Filing Support correlates marginally negatively significantly with Patent applications 2003-2008 and total patent applications
- Innovative Performance correlates marginally negatively significantly with total patent applications

Table 5.7(3): Spearman correlation matrix of the valorisation factor assessment by tomato companies versus performance indicators (n=7).

	Revenue 2008 (€ millions) (n=6)	**Number Varieties 2010 (n=6)**	**PBR applications CBSG related research 2003-2008 (n=6)**	**CPVR applications CBSG Related Research 2003-2008 (n=6)**	**Patent applications CBSG related research 2003-2008**	**Total Patent applications CBSG related research 2003-2008**
Knowledge Transfer Support	.32	**.67***	-.06	-.41	.16	-.13
IP Filing Support	.30	**.68***	-.07	-.31	**-.80****	**-.76****
Access to IP Support	.49	.31	-.09	-.34	-.34	-.28
Patent Filing Support	.12	.59	-.15	-.12	**-.66***	**-.66***
PBR Filing Support	.17	.03	-.51	-.17	-.20	-.37
Research Support	.00	.27	.53	.27	.32	.34
Breeding Support	-.09	.37	.06	.09	-.56	**-.58***
Frequency of Use	.41	.03	-.18	-.20	.52	.20
Absorptive Capacity	.26	.43	-.20	-.14	.18	-.25
Innovative Performance	.38	.38	-.23	-.23	-.18	**-.64***
Scientific Performance	-.41	-.31	.46	.41	.40	.33
Business Performance	.43	-.26	-.14	-.14	.38	.11

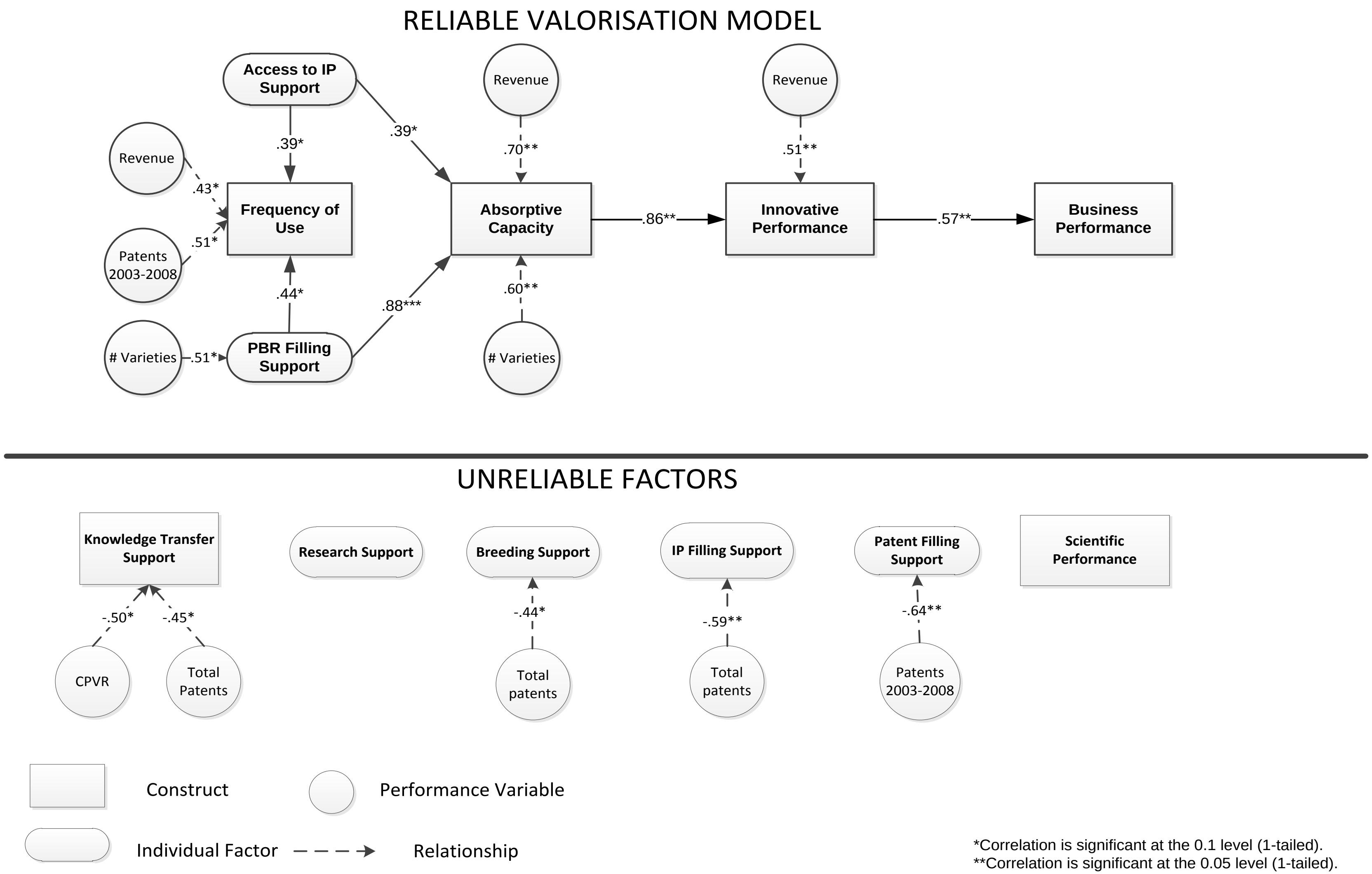
*Correlation is significant at the 0.1 level (1-tailed).

IP and Patent Filing Support been negatively associated with patent applications were expected since companies that apply for a large number of patents posses the expertise and resources for Filing IP applications. Now, the negative relationship between Innovative Performance and the number of patent applications supports proposition 4 but what could be the reason behind it. We suppose that the outcome of tomato research carried on in the CBSG leads to no finalized technology or products that can be directely patented. Instead, curiosity driven research may be leading to more projects been carried out in the CBSG or spiling over to private laboratories.

5.8 Concluding remarks

In this chapter, the results obtained from the general data collection and from the empirical study were presented. Figure 5.8 provides an overview of the significant relationships found between dimensions and performance indicators. It demonstrates the general conceptual model for all the companies involved in CBSG, where revenue appears to be a good indicator for Absorptive Capacity and Innovative Performance. It is the most relevant performance indicator been marginally significant with Frequency of Use, while patent applications and number of varieties are marginally and significantly correlated with Frequency of Use, PBR Filing Support and Absorptive Capacity. We conclude that the most important valorisation factors are PBR Filing Support, Absorptive Capacity and Innovative Performance and the performance indicators that best represent Innovative Performance, PBR Filing Support and Absorptive Capacity are revenue, number of varieties and patent applications. Additionally, important performance indicators that correlate significantly with non-reliable factors such as Scientific Performance, Knowledge Transfer Support, Research, Breeding, IP and Patenting Filing Support were patent applications and CPVR. Finally, PBR applications were not empirically significant for any reliable or unrealible valorisation factor.

Figure 5.8: General conceptual model, including significant relationships observed in data analysis between factors and performance indicators



*Correlation is significant at the 0.1 level (1-tailed).
**Correlation is significant at the 0.05 level (1-tailed).
***Correlation is significant at the 0.01 level (1-tailed).

Chapter 6

Discussion and Conclusions

In this final chapter, the research questions and the different propositions will be addressed.

What factors can be used to assess the transfer of knowledge and valorisation performance of public-private partnerships?

In order to answer the main research question we looked mainly at two core theories: innovation theory and absorptive capacity. Such analysis resulted in the extraction of an exploratory model that was divided into two different parts. The first part consisted of identification of factors from the valorisation model that were expected to have a relationship with the absorptive capacity of the companies involved. The second part involved measuring the relationships that these factors had with the of the companies. It was concluded in Chapter 2 that the following aspects have to be taken into consideration when studying the phenomenon of knowledge valorisation in public-private partnerships:

- Cooperation is the main driver to enhance innovation and fund new projects in public-private partnerships.
- Competence development is key to valorise externally acquired knowledge.
- Absorptive Capacity is an important factor capable of connecting knowledge transfer with innovative performance.

A cross-sectional study was conducted with fifteen seed companies' that are members of the CBSG to obtain an exploratory insight into the valorisation factors and performance indicators of public-private partnerships. To this end, knowledge valorisation was used as an overarching principle together with a combination of quantitative and qualitative measurements capable of properly analysing the factors related with performance.

In Section 6.1 the results of the study are summarized, the research questions are answered and the empirical results are compared with the propositions developed in Chapter 4. Section 6.2 provides a set of recommendations for CBSG, future research and the companies. Section 6.3 elaborates on the limitations present in this study.

6.1 The cross-sectional study

The cross-sectional study and the empirical results discussed in Chapter 5 focus on answering three research questions:

RQ1. *How is the conceptual model designed and applied in view of the set of theories and indicators?*

RQ2. *Which factors can be used to assess knowledge transfer in CBSG?*

RQ3. *Which indicators can be used to assess valorisation performance in CBSG?*

Table 6.1 summarizes the results obtained from this Chapter regarding the status of each proposition statement. Proposition 2 was clearly rejected, while Propositions 1, 3, 5, 7 and 8 were not supported either because the relationships found were not significant enough to prove them or because only part of the statement was proved correct. Finally, propositions 4 and 6 were supported based on our empirical analysis.

Table 6.1: Proposition statements with their respective number and status

Proposition	Statement	Status
1	Knowledge Transfer Support, Research Support, Breeding Support and IP Support factors will have a positive relationship with Frequency of Use of CBSG-related services.	**Not Supported**
2	Scientific Performance will have a positive relationship with Innovative Performance.	**Rejected**
3	Plant Breeder's Rights applications will have a positive relationship with Absorptive Capacity and a negative relationship with Innovative Performance.	**Not Supported**
4	Patent applications will have a negative relationship with Innovative Performance.	**Supported**
5	Innovative and in Scientific Performance are more important for potato companies than for tomato companies.	**Not Supported**
6	Knowledge Transfer Support is more important than the four IP Support factors.	**Supported**
7	Frequency of Use of CBSG-related services is more important for potato companies than for tomato companies.	**Not Supported**
8	Frequency of Use of CBSG-related services will have a positive relationship with Absorptive Capacity.	**Not Supported**

6.1.1 The valorisation factors

Propositions 1, 2 and 8 can be answered with the help of Table 5.4(1), 5.4(2), 5.4(3), E.1 and E.2.

The first proposition, which had to be answered, was whether the importance that companies placed on the first set of factors would positively affect the Frequency of Use of CBSG related services. The empirical results from the three models could not fully support this proposition, but if we take a closer look at the marginal correlations, together with the help of Table E.1 and E.2 we may be able to obtain some explorative findings. Marginal correlations between PBR Filing Support, Access to IP Support, Breeding Support and Frequency of Use were present in the general valorisation model, and with the help of Table E.2, we could confirm that the data is not tending towards any particular direction. What can be observed from Table E.1 is that potato companies are indeed highly interested[43] in the Research and Breeding Support factors. Data suggests that there might be an indication of a positive relationship between Knowledge Transfer Support and Frequency of Use among potato users, which supports Bekkers and Bodas' (2008) finding, in which working in an applied field had a positive relation with giving importance to open communication channels and intensive collaboration, as opposed to fundamentally-oriented fields. More importantly, these findings redirect CBSG efforts towards increasing the Frequency of Use of their services by focusing on providing Knowledge Transfer Support services to tomato companies and Research and Breeding Support to potato companies. Potato companies are significantly more interested in receiving research and breeding support from the CBSG, due to the technological lag in molecular breeding they suffer from when compared to tomato companies.

Proposition 2 was rejected as well based on the empirical results from the tables. The general and the tomato conceptual models reject this proposition by presenting negative correlations between factors, while the potato model presents a very weak relationship. Table E.3 supports our findings, where low Innovative Performance appears to be positively correlated with high Scientific Performance based on the disparity in the factors' frequency. This finding is in clear contrast to what Omta (1995) concluded between Anglo-American and continental European pharmaceutical companies, where scientific achievements were positively related to the innovative and industrial performance of the companies. The high barriers present in the breeding sector mark a clear difference from the pharmaceutical sector, not only in innovative performance but also in scientific performance (Louwaars et al., 2009). Horrobin's (1990) view that scientific reviewers are turning against innovation to protect their own may indeed resemble the situation at CBSG. We can conclude from such findings that Scientific Performance has no positive relationship with Innovative Performance within CBSG

[43] Above the 3.29 mean

and that special attention should be placed on encouraging entrepreneurship and spill-overs, as well as on the effect of peer-reviewing on innovation.

Finally, proposition 8 aims at testing a possible positive relation between Frequency of Use of CBSG related services and Absorptive Capacity. The low significance of the positive correlations in all three of the models, together with the results from Table E.3 indicates a lack of empirical supports for this proposition. Low and high Frequency of Use companies have a high compatibility with low and high Absorptive Capacity. Additionally, the finding that the correlation between factors found within tomato companies is higher than that in the general and potato models suggests that Absorptive Capacity depends on knowledge sharing and transfer practices that enhance connectedness at the individual and organizational level (Lane et al., 2006, Bosch et al., 1999 and Jansen et al., 2005). Link and Rees (1990) found that small companies are able to transfer knowledge from university to industry more effectively than larger companies However, the competence level of large tomato companies with regard to absorbing, acquiring and transforming knowledge is initially higher than that of small tomato and potato companies, respectively. This is because large tomato companies have a higher technological degree and have previously performed R&D related to the field in which they are collaborating with partners, even to the point of launching private projects similar to those being realized in the public environment (Harrigan, 1985). CBSG intends to tackle this problem by developing a public research infrastructure that supports the long-term innovativeness of the sector, thus aiming to shorten the technological gap between big and small companies. Hence, CBSG infrastructure provides the required capital to conduct research in the core technology areas of CBSG for potato and small tomato companies. The opposite happens with large tomato companies, which have been carrying out research in CBSG-related areas since 1990 and are now interesting in conducting research that is more complex. We also found that small tomato and potato companies' show great interest in increasing their Absorptive Capacity via CBSG support activities. Therefore, CBSG should focus on (1) providing the required tools for marker testing and implementation to potato and small tomato companies in order to increase their technological competence and (2) encouraging large tomato companies to participate in such projects in order to share knowledge and enhance the learning process.

Propositions 5, 6 and 7 can be answered with the help of Figure 5.4.1 and Table E.3

Proposition 5 states that potato companies will score higher in Innovative and Scientific Performance. This proposition has not been supported because although potato companies and tomato companies 2 and 4 indicated higher Innovative Performance than the other tomato companies. Unfortunately, the data demonstrates that there is no difference in the Scientific Performance factor among companies. Omta's (1995) finding that European companies are less publication-driven than American companies holds for tomato companies;

but unluckily no such comparison could be done for potato companies since they are all European based.

The explanation behind the difference in Innovative Performance lies in the fact that the results from fundamental projects are not yet available and therefore it is rather difficult to measure the performance of tomato companies. Conversely, potato companies rapidly obtain results from applied projects. Such difference in innovative performance could be explained due to position taken by CBSG to projects carried out by both potato and tomato companies. CBSG is conducting applied projects together with the potato companies, while with the tomato companies CBSG is performing fundamental projects. Applied research is known for being capable of producing results rather quickly (Fortuin, 2009), which in turn would increase the innovative performance of potato companies in the short-term. Cohen et al., (2002) found that public research on industrial R&D has a larger effect on applied than on fundamental science fields, supporting our results.

Back to the differences between tomato 2 and 4 and the rest of tomato companies, they could be explained by many reasons (1) low technological development in core-related technologies such as molecular breeding. (2) Lack of state-of-the-art infrastructure that leads to a more intensive use of CBSG facilities. (3) Fear of acquisition due to small size and weak position in the market and (4) high interest in CBSG research as it relates to a core product. Finally, the lack of relationship between these two factors stated in Proposition 2 is supported by the findings of Table E.2 where companies with low Innovative Performance are frequently associated with companies that have high Scientific Performance.

Proposition 6 further builds on proposition 1 and based on the quantitative data obtained and Table 5.4.1, Knowledge Transfer Support is significantly more important than any of the IP Support instruments for both the tomato and potato companies, therefore corroborating the direction of the Proposition. Archibugi et al., (1991) support our findings, stating that the breeding industry is product innovation-oriented and thus relies more on external sources of innovation than on patents to develop new products. Moreover, Etzkowitz (2003) found that newsletters, websites, meeting, conferences and especially channels where open science can be practiced in public spaces are found to be most frequently used by firms, while official channels such as patents and licences play a limited role in the transfer of knowledge between institutions. Even more important, we found that small potato companies have low interest in Knowledge Transfer Support activities offered by the CBSG, while large potato companies have high interest in Knowledge Transfer Support services. Bekker and Bodas (2008) and Chakrabarti (2002) found that small firms are prone to collaborate less due to restricted resources in core-related technologies, further supporting our discovery. We conclude that CBSG should first focus on resolving the resource competence problem of small potato companies in core-related technologies of CBSG-related research. Subsequently, CBSG should encourage such companies to make use of the Knowledge Transfer Support services it offers.

Proposition 7 aimed to test the Frequency of Use of CBSG services among potato companies versus tomato companies. Based on the empirical results obtained from the CBSG Valorisation Questionnaire, there is no significant difference in Frequency of Use between the two sectors. These results can be explained by sectorial differences as well as differences between projects within the CBSG. The overall differences between sectors described in Chapter 3 make it clear that tomato research is carried out rather quickly and results can be obtained in the short term. Conversely, potato research is rather long term-oriented due to the long potato life cycles. CBSG has transformed the behaviour of the fundamental potato sector by providing a series of applied projects that have provided a number of short term results, consequently increasing its performance. This change in the potato sector has closed the gap between sectors in the CBSG. Potato companies are more interested in making use of CBSG services more frequently due to the innovative capability they are gaining from such. It is a very different story though, when we look at the individual companies' Frequency of Use in Table E.3. Six out of eight potato companies have low Frequency of Use and 4 out of 7 tomato companies have a high Frequency of Use. Hence, based on these findings, tomato and potato companies have similar Frequencies of Use. Proposition 7 is not supported and therefore we suggest further data collection to fully prove this indication.

RQ2. Which factors can be used to assess knowledge transfer in CBSG?

We conclude that they key factor of knowledge transfer extracted from the CBSG Valorisation Questionnaire for large tomato companies was Knowledge Transfer Support, while for small tomato companies it was Absorptive Capacity. For potato companies, Research Support, Breeding Support, Absorptive Capacity and Innovative Performance were the most important factors.

6.1.2 The performance indicators

Propositions 3 and 4 can be answered with the help of Tables 5.7(1), 5.7(2), 5.7(3) and Table E.4.

An in-depth analysis concerning CPVR, PBR and PVP was realized in section 5.6. Based on the data collected, CPVR (see Figure 5.6.1(2)) and PVP (see Figure 5.6.3) are indicators that can be collected and compared efficiently for potato companies due to the homogeneity present among companies and a large number of competitors. Unfortunately, the lack of tomato breeding companies that are not part of CBSG forbid us the possibility of correctly comparing them in terms of PBR, CPVR and PVP; although certain conclusions can be obtained from analysing the different tables in sections 5.6.1 and 5.6.2.

We can appreciate a higher average number of CPVR applications from CBSG-member tomato companies than from Nunhems, the only tomato breeding company that applied for PBR in the Netherlands (see Figure 5.6.2(1)), but no clear conclusion could be extracted because there are not enough cases. The findings that small Dutch tomato companies apply more intensively for CPVR per FTE as well as PBR per Euro spent in R&D confirm that: (1) the cost of PBR or CPVR is more accessible and helps them to compete against market leaders and position themselves in the market, (2) small companies are more innovative and (3) intellectual property permissions encourage the use of PBR and CPVR by offering independency from suppliers, adapting easily without litigation and preventing potentially useful tools from being left on the shelf (Hope, 2009). From this group of companies Tomato 3 is the breeding leader in tomatoes with more than 46% of their PBR applications done in tomatoes, but Tomato 2 has the market leading tomato variety in the Netherlands. In the case of potato companies, Table 5.6.1(2) showed that CBSG members are indeed more innovative than their competitors, especially Potato 2, which is also one of the leading private seed potato companies in the world. This same tendency can be seen in Table 5.6.3, where Potato 2 is one of the top applicants ahead of Frito Lay and behind GmbH.

Proposition 3 states that PBR is a good indicator of Absorptive Capacity and that it has a negative association with Innovative Performance. This statement has not been supported based on the Tables in Section 5.7, where no significant relationship was found between CPVR, PBR and Absorptive Capacity and Innovative Performance. Although a small marginal negative relationship is found in the potato model between PBR and Innovative Performance, the sample is too low to be reliable. Additional support is provided by Table E.3, where the individual company behaviour was analysed, presenting no indication of an existing positive relationship. PBR, PVP and CPVR have no strong correlation with Absorptive Capacity, but CPVR holds an interesting negative relation with Knowledge Transfer Support in the complete model. Louwaars et al., (2009) supports the negative relationship between CPVR and Innovative Performance, but not the negative relationship between CPVR and Knowledge Transfer Support.

Additionally, in the potato model, the relationship between these variables was also very strong. We conclude that although PBR, CPVR and PVP hold no relation with Absorptive capacity, they can be used as good negative indicators of Knowledge Transfer Support, which proved to be a good indicator of knowledge transfer for tomato companies in the previous section. In other words, top innovative companies such as Potato 2, Tomato 2, 3 and 5 are in fact the least interested in making use of CBSG Knowledge Transfer Support activities.

The 4th proposition to be answered was whether there is a negative relationship between patents and Innovative Performance. Figures 5.6.4(1), 5.6.4(2) and 5.6.4(3) proved that patents can be used as indicators to compare the performance of CBSG members and other companies. While this finding was not capable of answering our proposition, it was explorative. In the case of large tomato companies, CBSG members apply less frequently for patents in CBSG-related research than other companies, where Monsanto is the leading patent applicant, followed by Pioneer-HiBred and Tomato 6. A special analysis was performed on Tomato 6s' PBR and patent applications in Table 5.6.4(4). The finding suggests that Tomato Company 6 has changed from a patenting strategy to PBR since 2006. Small tomato companies show results opposite those of large tomato companies, where the average among CBSG companies is higher than that of Bejo Zaden and Nunhems. Tomato 5 and 3 are the leading applicants, strangely Tomato 5 was not a strong PBR applicant while Tomato 3 was the leading applicant for PBR as well as the company that applies for the most patents in CBSG related research. Now, regarding potato companies, only potato 3, 4 and 5 made patent applications, but unfortunately, their average is much lower than that of Frito Lay. Curiously though the top patent applicant among all was potato 5, which is a family-owned company.

Concerning proposition 4, the empirical study from Section 5.7 clearly confirms this proposition where a marginally significant negative relationship was observed between Total Patent applications in CBSG-related research and Innovative Performance for tomato companies. Table E.4 further supports this statement by individually analysing the behaviour of the companies: 60% of the companies present a negative relationship between patents and Innovative Performance. In support of this result are Lei et al., (2009) who concluded that intellectual property has a negative effect on research. Additionally, there was an important negative correlation between Knowledge Transfer Support and Total Patent applications in the complete model. Bekkers and Bodas (2008) found a negative relationship between the number of published patents and the importance given to personal contact, further supporting our result.

We conclude that patents not only have a negative relationship with the innovative capability of companies but also with the importance that companies give to Knowledge Transfer Support services provided by the CBSG. Therefore, we can determine that tomato companies 6 and 5 and potato company 5 have the lowest innovative performance. This was not a surprising result considering the size of tomato 6 and the market orientation of tomato 5, but it was interesting for potato 5 because it is a small cooperative.

RQ3. Which indicators can be used to assess valorisation performance in CBSG?

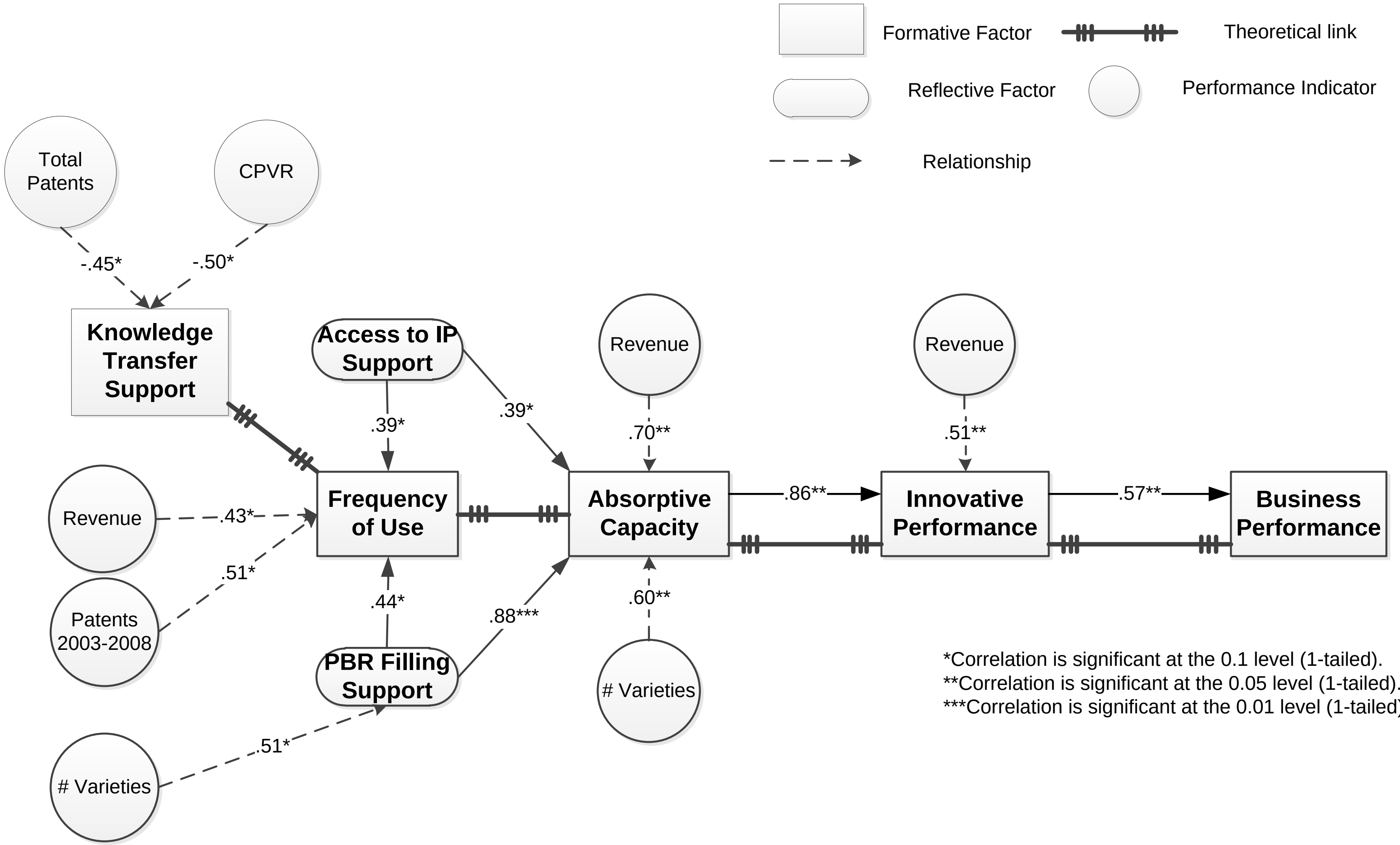
We conclude that the key indicators that can be used to assess the valorisation performance of CBSG is CPVR in the case of negative Knowledge Transfer Support for the most innovative tomato companies 2, 3 and 5 and potato company 2. In addition, patents proved to be a negative indicator of Innovative Performance as well as Knowledge Transfer Support.

6.1.3 The valorisation model

RQ1. How is the conceptual model designed and applied in view of the set of theories and indicators?

After combining both empirical results and theoretical insights regarding knowledge transfer factors and valorisation performance, several factors and indicators proved to have strong validity while others demonstrated to be unreliable. The Figure above clearly illustrates the final version of our valorisation conceptual model for CBSG, providing an overview of the significant empirical relationships found between valorisation factors and performance indicators as well as strong theoretical support connections among them. (1) Revenue is a good indicator for absorptive capacity and innovative performance. (2) CPVR applications are a negative indicator of the importance that companies give to activities supporting knowledge transfer. (3) Patent applications and number of varieties are significantly correlated with Frequency of Use and PBR Filing Support. (4) Theory supports the links between knowledge transfer support, frequency of use and absorptive capacity is purely theoretical (Lane, Koka et al. 2006, Bosch, Volberda et al. 1999, Szulanski 1996 and Liao, Fei et al. 2007).

Figure 6.1.3: Final valorisation model including the most reliable valorisation factors and performance indicators.



*Correlation is significant at the 0.1 level (1-tailed).
**Correlation is significant at the 0.05 level (1-tailed).
***Correlation is significant at the 0.01 level (1-tailed).

6.2 Recommendations

6.2.1 CBSG

Applied projects in potato have apparently increased Innovative Performance, Research and Breeding Support and Absorptive Capacity, when compared to the tomato. This shift of focus from fundamental to results-oriented research may be leading to short term benefits for the companies and the CBSG model, but we must consider the opportunity cost, not only for the companies but for society. This overall 4-year anxiety for results, the time it takes for a PhD to finish research, embodied as the publication of scientific articles in high ranking journals is appropriate for CBSG but not for the potato companies. This industry requires longer cycles to develop innovative varieties that can enhance the valorisation of knowledge. Restructuring the current research methodology by encouraging knowledge transfer across projects and granting liberty to researchers can increase the quality of research and results as well as maximize the utilization of the advanced infrastructure provide by CBSG. The behind this is to grant researchers not only one but also two projects: the first project would be in the starting phase while the second project would be in the finishing phase. This would provide researchers, companies and CBSG with high quality research, enhanced results and improved valorisation of knowledge.

Another option that arises from one of our conclusions is that CBSG should focus on breeding research in order to shorten the life cycle of potatoes. The life cycle refers to the stages through which the crop has to pass before reaching commercialization. Apparently, it is commonly accepted that the potato life cycle is slow and there exists no monitoring of the possible impact that technology has had. This type of research is been done by other entities and CBSG should be able to invest resources in such a project that could potentially benefit future research to a great degree. Adams (1990) found a lag in effect of approximately 20 years between the launch of a research project and the time that industry profited from such.

6.2.2 Management

The following sets of recommendations are based on the CBSG valorization goals and outputs described in Chapter 3.

The conceptual model is very general and has a rather exploratory approach. Therefore, it would be interesting to find individual variables at the factor level and add complexity to the model in order to increase its generalizability. For example, in the case of knowledge transfer, to build a specific questionnaire devoted only to measuring knowledge transfer within the CBSG. We suggest building individual models for each of the operating principles of knowledge valorisation with the objective of finding the real key performance indicators and not just the exploratory performance indicators. Additionally, the valorisation model that was developed is targeted only towards the private sector belonging to the CBSG.

Generating a complete valorisation model would involve forming two additional valorisation models for the academic sector and the public sector and integrating them with the private sector model. We further propose using the factor of Absorptive Capacity as a possible bridging factor among these three sectors with the final goal of developing a concise model for measuring valorisation for both public and private partners.

The indicators used to measure performance were acquired from public archives; this caused several problems in the analysis due to missing data, since family owned companies are reluctant to share this information publicly. Indicators such as revenue and number of FTE are often used as performance indicators of publicly-owned companies, while family-owned companies tend to measure their performance in terms of product quality, long-term innovation, personnel and society development, etc. The use of public information might therefore be a good performance indicator for publicly-owned, but not for privately-owned companies. We suggest conducting an in-depth analysis of these companies in order to find the indicators that these companies use to measure their performance. Such a study would lead to the discovery of a performance indicator that could be used as a control for the whole sample, increasing the interpretability and reliability of the results.

The findings and conclusions from the previous Section proved to have exploratory importance. Regarding the use of patents as strong indicator, we suggest performing a longitudinal analysis to demonstrate causality between patents and Knowledge Transfer Support and Innovative Performance. In addition, we recommend making distinctions between the multiple types of patents and cross-referencing among the different patent databases since we found anomalies in our study due to the European Classification (ECLA) codes employed. By multiple types of patents we refer to segregating among US, EU and World patent applications to obtain a clear view of the patent trends in CBSG-related research.

6.2.3 The companies

Innovation in the seed industry has been hampered by allowing companies to protect their IP using instruments such as PBR and patents that were not designed to target precompetitive private-public research but rather to incentivize research carried out in private labs. Companies are interested in obtaining higher returns on their investment by monopolizing the market via patents for a certain period of time, but blocking and restricting competitors from knowledge that originated from public research is backward thinking. Therefore, enhancing the built-in valorisation approach by establishing a new agreement between the public and private members of the CBSG in the intellectual property field that not only benefits the companies but also society as a whole is imperative in order to maximize the effects of public investments. We propose that:

- The biological material and plant varieties developed in public labs or with public funds and protected by patent rights should be freely available without restrictions in terms of licensing for the development, use and commercialization of new varieties.
- CBSG should assess the licensing procedures of publicly developed knowledge or technology derived from public efforts in order to assign and select entities that will benefit society to a greater degree.

The tomato industry is a consolidated industry, where very powerful multinationals are constantly aiming to acquire smaller companies that could threaten their innovation capability and performance. Thus it is necessary to encourage knowledge transfer within tomato companies and among researchers in the sector through the implementation of social innovation platforms and development of competencies to small players and empowerment among small players. Empowering small players and nurturing spin-offs is a fundamental topic on which CBSG-member companies should focus in the future.

6.3 Limitations

Although the cross-industry analysis has the advantage of identifying the differences between industries, it posed a series of disadvantages. We hesitate to over-interpret these results due to several factors: the small sample used and its heterogeneity, lack of causality due to lack of time trends and longitudinal analysis, and measurement problems caused by the scale in which the data were measured, which allowed only for tentative conclusions to be drawn. Furthermore, the conclusions are oriented as exploratory descriptive results to support an underlying behavioural model. It is important also to mention that although we took several precautions in both the testing and design phase, the issues regarding key informant bias and common method bias cannot be completely discarded. However, the concerns regarding respondents artificially altering answers was tackled by assuring confidentiality and respondent reliability. Additionally, Cronbach's α reliability analysis provided evidence that supported the validity of our constructs and the model itself. New scales were also created to develop constructs that are usually difficult to measure, such as IP Support, Knowledge Transfer Support, Absorptive Capacity, etc.

List of Tables

List of Figures

Reference List

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Index

T

V

W

Glossary

Absorptive capacity: The ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends.

Applied research: is undertaken to gain new scientific and/or technical knowledge, but it is directed primarily towards a specific practical aim or objective (Freeman and Soete 1997).

Basic (fundamental) research: is defined as original investigation undertaken in order to gain new scientific and/or technical knowledge and understanding (Freeman 1982).

Breeder's exemption: allows competitors to use the variety as a base to improve and breed new varieties.

CBSG: *Centre for Bio Systems Genomics*, a consortium of major Dutch and international companies and top plant scientists working on potato, tomato, Arabidopsis and Brassica. It is a unique public-private partnership in plant genomics involving universities, research institutes, (inter)national companies and branch organizations active in potato, tomato and Brassica research and development. CBSG was established in 2002 as a Centre for Excellence under the auspices of the Netherlands Genomics Initiative with a total research budget of 53 M€.

CBSG 2007: Centre for Bio Systems Genomics, First Phase 2003-2007

CBSG 2012: Centre for Bio Systems Genomics, Second Phase 2008-2012

Competencies: activities and processes through which an organisation deploys its resources effectively (Johnson, Scholes et al. 2008).

CRADA: Cooperative Research and Development Agreements.

CPVO: Community Plant Variety Office.

CVR: Community Variety Rights

Farmer's privilege: consists of preserving a certain amount of seeds after harvesting to be used for the next harvest research exemption stipulates that the breeder of a variety cannot act against third parties that are using the protected variety for experimental uses only.

EU: European Union.

FTE: Full Time Employees.

INE: Spanish Statistical Institute.

IP: Intellectual Property.

IT: Information Technology.

ITC: Inter-sector Technology Cooperation.

Knowledge valorisation: "is the formal transfer of knowledge resulting from basic and applied research in universities and research institutes, as well as from applied research and development in companies, to (other parties in) the commercial sector for economic benefit" (Goorden 2008).

Ltd: Limited.

MT: Management Team.

NGI: Netherlands Genomics Initiative

Open Innovation: a model that frees businesses from an isolated environment, where valuable ideas and knowledge from external sources are welcome to be incorporated (West and Gallagher 2006) and ideas from the inside are capable of leaving the organization. In this model both R&D and the customers have new roles: R&D compiles and organizes the information gathered from internal and external sources and finds ways to generate and capture value from it, while customers become the creators of their own products (Chesbrough 2003).

OS: Open Source.

PBR: Plant Breeders' Rights.

PVP: Plant Variety Protection.

Research and Development (R&D): Creative work undertaken on a systematic basis in order to increase the stock of knowledge, and the use of this stock of knowledge to devise new materials, products, or devices, new processes, systems or services, or improving substantially those already produced or installed (OECD 1994).

SME: Small Medium Enterprises.

STW: Dutch Science Foundation.

Triple helix model: consists of three independent yet interlinking environments: (1) industry, (2) university and (3) government (Leydesdorff and Meyer 2006).

US: United States.

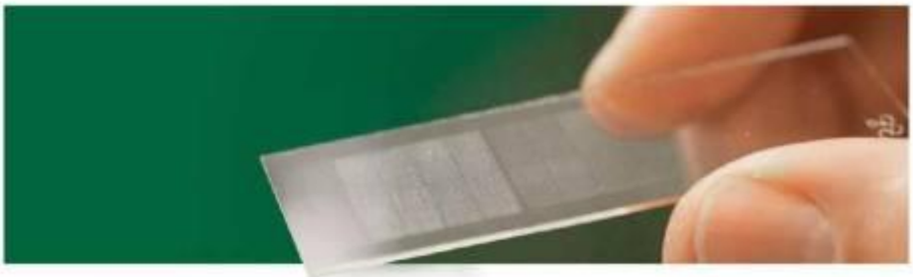
WU: Wageningen University.

List of Appendices

"We create our lives symbiotically as we explore our talents in relation to the circumstances they help to create for us."

~Sir. Ken Robinson

Appendix A: Survey Questionnaire



CBSG Valorisation Questionnaire

BICORE

Frances Fortuin, senior researcher
Susanne Koster, consultant
Jac Goorden, managing consultant

Wageningen, June 2009

1. Introduction

1. Please provide your respondent details.

Name Organization ....

Name Respondent ....

Function in the organization ....

Role in and experience with CBSG ....

(MT member, project leader, etc.)

2. Please describe your company's organization.

Please choose an organization unit that covers your worldwide tomato/potato activities.

a. Is your unit:

- independent
- part of a larger firm

b. If the unit is part of a larger firm, please specify whether this is:

- subsidiary or division
- head office
- central R&D unit
- Other: ....

2. CBSG related activities

3. How important are these CBSG related activities for your organization? Also, which frequency most accurately describes your organization's use of the CBSG related activities in the years 2003-2008?

Please circle the importance on the scale and tick the most accurate answer for the frequency where asked.

a. Possibility to share R&D costs with other companies (conducting research collectively with CBSG partners and your organization)

Not important 1 2 3 4 5 6 7 Very important

b. Access to infrastructure (e.g. R&D labs, equipment, instruments)

Not important 1 2 3 4 5 6 7 Very important

never once per 3 year once per year once per quarter once per month once per week daily

c. Access to information on international research programs

Not important 1 2 3 4 5 6 7 Very important

never once per 3 year once per year once per quarter once per month once per week daily

d. Contact with qualified CBSG researchers

Not important 1 2 3 4 5 6 7 Very important

never once per 3 year once per year once per quarter once per month once per week daily

e. Access to CBSG workshops and training programs

Not important 1 2 3 4 5 6 7 Very important

never once per 3 year once per year once per quarter once per month once per week daily

f. Access to the annual CBSG summit

Not important 1 2 3 4 5 6 7 Very important

g. Help to set up bilateral research programs with other CBSG partners

Not important 1 2 3 4 5 6 7 Very important

never once per 3 year once per year once per quarter once per month once per week daily

1 BICORE

h. Help with Intellectual Property filing (plant breeding rights, patents)

Not important | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Very important

never | once per 3 year | once per year | once per quarter | once per month | once per week | daily

i. Help with getting access to Intellectual Property (licences, plant breeding rights, patents)

Not important | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Very important

never | once per 3 year | once per year | once per quarter | once per month | once per week | daily

j. Conducting tests for research (e.g. DNA tests, plant breeding tests)

Not important | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Very important

k. Access to CBSG Website information

Not important | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Very important

never | once per 3 year | once per year | once per quarter | once per month | once per week | daily

l. Access to CBSG intranet information

Not important | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Very important

never | once per 3 year | once per year | once per quarter | once per month | once per week | daily

m. Access to publications

Not important | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Very important

never | once per 3 year | once per year | once per quarter | once per month | once per week | daily

n. Enhanced interaction with other companies in the potato / tomato sector

Not important | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Very important

never | once per 3 year | once per year | once per quarter | once per month | once per week | daily

o. Help with new technology monitoring and roadmapping

Not important | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Very important

never | once per 3 year | once per year | once per quarter | once per month | once per week | daily

p. Help with troubleshooting

Not important | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Very important

never | once per 3 year | once per year | once per quarter | once per month | once per week | daily

q. Access to technological advice

Not important | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Very important

never | once per 3 year | once per year | once per quarter | once per month | once per week | daily

r. Access to databases

Not important | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Very important

never | once per 3 year | once per year | once per quarter | once per month | once per week | daily

s. Access to bio-informatics knowledge and services

Not important | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Very important

never | once per 3 year | once per year | once per quarter | once per month | once per week | daily

2

BICORE

3. R&D and collaboration

4. Has the CBSG program led to new research in the scientific domain covered by CBSG?
Please circle the answer on the scale and further detail the new research projects.

a. The CBSG program has led to new or extra research in the scientific domain covered by CBSG in my own organization.

Completely disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Completely agree

Please specify:
- the annual R&D budget of these new research projects in 2008 as a percentage of the total R&D budget: .....%
- the research domain or type of research

Please tick the right answer(s).

Plant pathology (including resistance tests, diagnostics, etc.)
Plant breeding (including MAB, resistance, flavour, GMO, etc.)
Biotechnology (including marker technology, metabolomics, proteomics, etc.)
Plant derivatives (including modified starches or proteins, etc.)
Other, namely ....

b. The CBSG program has led to new or extra research in the scientific domain covered by CBSG in collaboration with a knowledge centre within CBSG.

Completely disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Completely agree

Please specify:
- the number of collaborations..........
- the annual R&D budget of these new cooperations in 2008 as a percentage of the total R&D budget: ....%
- the research domain or type of research

Please tick the right answer(s).

Plant pathology
Plant breeding
Biotechnology
Plant derivatives
Other, namely ....

c. The CBSG program has led to new or extra research in the scientific domain covered by CBSG in collaboration with other commercial partners within CBSG.

Completely disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Completely agree

Please specify:
- the number of collaborations..........
- the annual R&D budget of these new cooperations in 2008 as a percentage of the total R&D budget:..........%
- the research domain or type of research

Please tick the right answer(s).

Plant pathology
Plant breeding
Biotechnology
Plant derivatives
Other, namely ....

d. The CBSG program has led to new or extra research in the scientific domain covered by CBSG in collaboration with other commercial partners outside CBSG.

Completely disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Completely agree

Please specify:
- the number of collaborations..........
- the annual R&D budget of these new cooperations in 2008 as a percentage of the total R&D budget:..........%
- the research domain or type of research

Please tick the right answer(s).

Plant pathology
Plant breeding
Biotechnology
Plant derivatives
Other, namely ....

3

BICORE

5. Has the CBSG program led to extra collaborations in commercialisation in the scientific domain covered by CBSG?
Please circle the answer on the scale.

a. The CBSG program has led to extra commercialisation in the scientific domain covered by CBSG in collaboration with knowledge centres within CBSG.

Completely disagree	1	2	3	4	5	6	7	Completely agree

b. The CBSG program has led to extra commercialisation in the scientific domain covered by CBSG in collaboration with other companies within CBSG.

Completely disagree	1	2	3	4	5	6	7	Completely agree

c. The CBSG program has led to extra commercialisation in the scientific domain covered by CBSG in collaboration with other companies outside CBSG.

Completely disagree	1	2	3	4	5	6	7	Completely agree

d. The CBSG program has led to extra non-R&D collaboration in the scientific domain covered by CBSG with other companies outside CBSG (such as joint marketing or joint purchasing).

Completely disagree	1	2	3	4	5	6	7	Completely agree

- type of collaborations……………………………………………………………………………

4. Valorisation of CBSG results

6. Please indicate the extent to which you agree (or disagree) with the following statements. Also, please quantify the output that is the result from participating in the CBSG program.
Please circle a number on the scale and write down the percentages of the outputs where asked.

a. Participating in the CBSG program enables my organization to develop new products.

Completely disagree	1	2	3	4	5	6	7	Completely agree

Please quantify the number of new product development projects resulting from participating in the CBSG program……………………………………………………………

Please quantify the number of new product development projects resulting from participating in the CBSG program as a percentage of total number of new product development projects ………………%

b. By participating in the CBSG program my organization expects to launch new products to the market.

Completely disagree	1	2	3	4	5	6	7	Completely agree

Please quantify the number of new product market launches resulting from participating in the CBSG program……………………………………………………………

Please quantify the number of new product market launches resulting from participating in the CBSG program as a percentage of the total number of new product market launches ………………%

c. Participating in the CBSG program enables my organization to increase its sales.

Not at all	1	2	3	4	5	6	7	Considerably

Please quantify the increase in the amount of sales resulting from the participation in the CBSG program as a percentage of the total amount of sales ………………%

d. Participating in the CBSG program enables my organization to increase the sales of new products.

Completely disagree	1	2	3	4	5	6	7	Completely agree

Please quantify the increase in the amount of sales of new products resulting from the participation in the CBSG program as a percentage of the total amount of sales of new products ………………%

e. Participating in the CBSG program enables my organization to enter new markets.

Completely disagree	1	2	3	4	5	6	7	Completely agree

Please quantify the potential amount of sales of the new markets resulting from the participation in the CBSG program as a percentage of the total amount of sales ………………%

f. Participating in the CBSG program stimulates my organization to invest in new R&D equipment.

Completely disagree	1	2	3	4	5	6	7	Completely agree

Please quantify the increase in the amount of investment in R&D equipment resulting from the participation in the CBSG program ……………………………………………

Please quantify the increase in the amount of investment in R&D equipment resulting from the participation as a percentage of the total investment in R&D equipment ………%

BICORE

g. Participating in the CBSG program stimulates my organization to invest in R&D facilities (greenhouses, laboratories).

Completely disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Completely agree

Please quantify the increase in the amount of investment in facilities resulting from the participation in the CBSG program ......

Please quantify the increase in the amount of investment in facilities resulting from the participation in the CBSG program as a percentage of the total amount of investment in R&D facilities ......%

h. By participating in the CBSG program my organization expects to increase the number of filings for patents.

Completely disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Completely agree

Please quantify the increase in the number of filings for patents resulting from the participation in the CBSG program ......

Please quantify the increase in the number of filings for patents resulting from the participation in the CBSG program as a percentage of the total number of filings for patents ......%

i. By participating in the CBSG program my organization expects to increase the number of filings for plant breeding rights.

Completely disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Completely agree

Please quantify the increase in the number of filings for patents resulting from the participation in the CBSG program ......

Please quantify the increase in the number of filings for plant breeding rights resulting from the participation in the CBSG program as a percentage of the total number of filings ......%

j. Participating in the CBSG program enables my organization to improve the level of knowledge and skills of the personnel.

Completely disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Completely agree

Please quantify the increase in the investment for training the personnel resulting from the participation in the CBSG program ......

Please quantify the increase in the investment for training the personnel resulting from the participation in the CBSG program as a percentage of the total training investment for personnel ......%

k. Participating in the CBSG program enables my organization to increase the number of tomato/potato markers that will be tested.

Completely disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Completely agree

Please quantify the increase in the number of markers that will be tested resulting from the participation in the CBSG program ......

Please quantify the increase in the number of markers that will be tested resulting from the participation in the CBSG program as a percentage of the total number of tested markers ......%

l. Participating in the CBSG program enables my organization to increase the number of tomato/potato markers that will be implemented.

Completely disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Completely agree

Please quantify the increase in the number of markers that will be implemented resulting from the participation in the CBSG ......

Please quantify the increase in the number of markers that will be implemented resulting from the participation in the CBSG program as a percentage of the total number of implemented markers ......%

m. Participating in the CBSG program enables my organization to increase the number of genotypes that will be included in the breeding material.

Completely disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Completely agree

Please quantify the increase in the number of genotypes that will be included in the breeding material resulting from the participation in the CBSG program ......

Please quantify the increase in the number of genotypes that will be included in the breeding material resulting from the participation in the CBSG program as a percentage of the total number of included genotypes ......%

n. By participating in the CBSG program my organization expects to improve the basic research process.

Completely disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Completely agree

Please quantify the percentage of the basic research process time reduction ......%

Please quantify the percentage of the basic research process costs reduction ......%

o. By participating in the CBSG program my organization expects to improve its breeding process.

Completely disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Completely agree

Please quantify the percentage of the breeding process time reduction ......%

Please quantify the percentage of the breeding process costs reduction ......%

5

BICORE

p. By participating in the CBSG program my organization expects to improve its production process.

Completely disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Completely agree

Please quantify the percentage of the production process time reduction ....%

Please quantify the percentage of the production process costs reduction ....%

q. Participating in the CBSG program enables my organization to improve its basic research strategy.

Completely disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Completely agree

r. Participating in the CBSG program enables my organization to improve its breeding strategy.

Completely disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Completely agree

s. Participating in the CBSG program enables my organization to improve its production strategy.

Completely disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Completely agree

t. Is your organization's market share expected to grow as a result of participating in the CBSG program?

Not at all | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Considerably

u. Participating in the CBSG program increase the chance of successful research completion.

Completely disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Completely agree

v. Participating in the CBSG program enables my organization to introduce new products to the market faster than competitors.

Completely disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Completely agree

w. Participating in the CBSG program enables my organization to increase the organization's competitive advantage.

Completely disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Completely agree

x. Participating in the CBSG program enables my organization to strengthen its image.

Completely disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Completely agree

y. Participating in the CBSG program enables my organization to improve its technical advice to customers.

Completely disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Completely agree

z. Participating in the CBSG program enables my organization to recruit new researchers or assistants.

Completely disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Completely agree

aa. Participating in the CBSG program enables my organization to increase the number of peer reviewed publications.

Completely disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Completely agree

Not important for us | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Very important for us

6 BICORE

7. If your organization had not had access to services of CBSG, what would have been the consequences?
Please circle a number on the scale.

a. We would have collaborated on a bilateral base with our current private CBSG research partners.

Much less [1 2 3 4 5 6 7] Much more

b. We would have collaborated on a bilateral base with our current public CBSG partners.

Much less [1 2 3 4 5 6 7] Much more

c. We would have collaborated with private research organizations.

Much less [1 2 3 4 5 6 7] Much more

d. We would have collaborated with other universities or public research centres in the Netherlands.

Much less [1 2 3 4 5 6 7] Much more

e. We would have collaborated with other universities or public research centres outside the Netherlands.

Much less [1 2 3 4 5 6 7] Much more

f. We would have allocated internal resources to R&D.

Much less [1 2 3 4 5 6 7] Much more

g. We would have taken no further actions.

Completely disagree [1 2 3 4 5 6 7] Completely agree

8. In general, which grade would you assign to the valorisation of the CBSG research resulting from the participation in the CBSG program?
Please circle a number on the scale.

Very low [1 2 3 4 5 6 7] Very high

BICORE

5. Organization's facts & figures

9. What were the total annual sales of your organization in 2008?
Please choose an organization unit that covers your worldwide tomato/potato activities.
....

10. How have the total annual sales changed since 2003?
Please mark one answer and, if applicable, give an indication of the size of the change.
decrease since 2003 with ....%
no changes since 2003
increase since 2003 with ....%
What percentage of this is expected to be attributable to the activities in CBSG? ....%

11. How do you expect the total annual sales to change in the coming three years?
Please mark one answer and, if applicable, give an indication of the size of the change.
decrease with ....%
no changes
increase with ....%
What percentage of this is expected to be attributable to the activities in CBSG? ....%

12. What was the organization's market share in 2008?
....

13. How has the market share changed since 2003?
Please mark one answer and, if applicable, give an indication of the size of the change.
decrease since 2003 with ....%
no changes since 2003
increase since 2003 with ....%
What percentage of this is expected to be attributable to the activities in CBSG? ....%

14. How do you expect the market share to change in the coming three years?
Please mark one answer and, if applicable, give an indication of the size of the change.
decrease with ....%
no changes
increase with ....%
What percentage of this is expected to be attributable to the activities in CBSG? ....%

15. Please indicate the number of R&D ftes working on the scientific domain of CBSG that is allocated over the R&D phases in 2008 and in 2003. Please also indicate which percentage of the R&D ftes is allocated to CBSG related research in 2008.

R&D phase	R&D ftes in 2008	R&D ftes in 2003	% of the R&D ftes allocated to CBSG in 2008
Basic research			
Breeding programs			
Other, namely			

16. How do you expect the number of R&D ftes to change in the coming three years as a percentage of the current number of R&D ftes?
Please circle a decrease or increase and quantify the percentage of decrease of increase.
Breeding research: a decrease / increase of ....%
Basic research: a decrease / increase of ....%
Other, namely: .... a decrease / increase of ....%
....

BICORE

17. Please indicate how the number of R&D ftes is allocated over the different research topics of the scientific domain of CBSG in 2008 and in 2003? Please also indicate which percentage of the R&D ftes is allocated to CBSG in 2008.

Research domain	R&D ftes in 2008	R&D ftes in 2003	% of the R&D ftes allocated to CBSG in 2008
Plant Pathology (incl. resistance tests, diagnostics, etc.)			
Plant Breeding (incl. MAB, resistance, flavour, GMO, etc.)			
Biotechnology (incl. marker technology, metabolomics, proteomics, etc.)			
Plant Derivatives (incl. modified starches or proteins, etc.)			
Other, namely			

18. How do you expect the number of R&D ftes per research domain to change in the coming three years as a percentage of the current number of R&D ftes per research domain?
Please circle a decrease or increase and quantify the percentage of decrease of increase.
Plant pathology: a decrease / increase of ....%
Plant breeding: a decrease / increase of ....%
Biotechnology: a decrease / increase of ....%
Plant derivatives: a decrease / increase of ....%
Other, namely: .... a decrease / increase of ....%
....

19. Please indicate how the R&D budget related to the scientific domain of CBSG as a percentage of the total annual sales is allocated over the R&D phases in 2008 and in 2003?

R&D phase	R&D budget in 2008	R&D budget in 2003
Basic research		
Breeding programs		
Other, namely		

20. How do you expect the R&D budget as a percentage of the total annual sales to change in the coming three years?
Breeding research: from ....% to ....%
Basic research: from ....% to ....%
Other, namely .... from ....% to ....%
....

21. Please indicate the number of R&D ftes that have been recruited from other CBSG partners since 2003 as a result of the participation in the CBSG program (e.g. PhD students)?
....

22. How do you expect the share of R&D staff recruited from other CBSG partners to change in the coming three years as a result of participation in the CBSG program?
Please mark one answer and, if applicable, give an indication of the size of the change.
decrease with ....%
no changes
increase with ....%

9 BICORE

6. Wrap-up

23. Are you willing to participate in follow-up on this survey and future research of this type?
yes
no

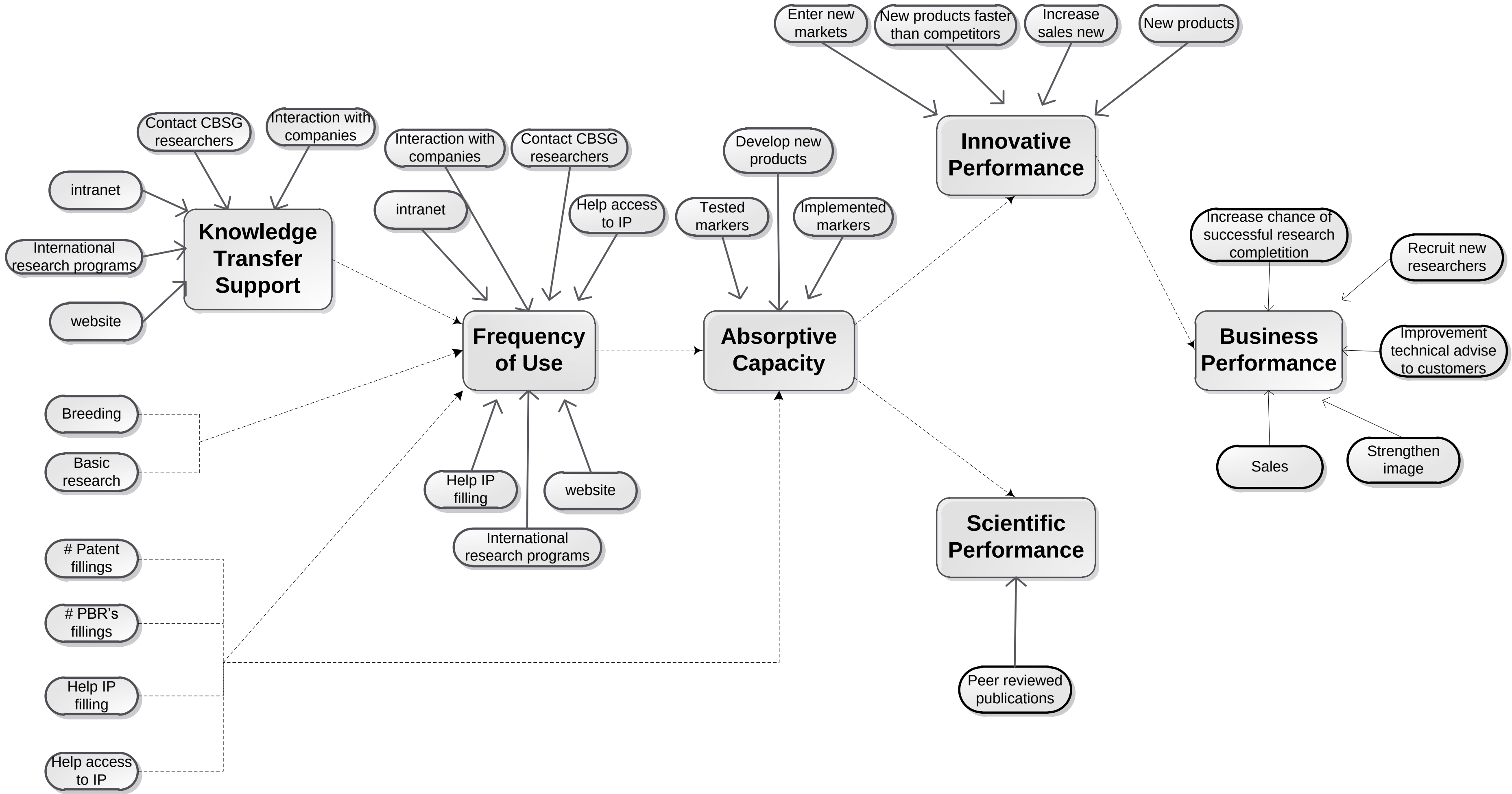
24. Please add any remarks or recommendations for improving this survey.

....
....
....
....
....
....
....
....

25. Are you interested in receiving the results of this research?
yes
no

BICORE

Appendix B: Detailed Conceptual Model



Appendix C: Detailed results I

Table C.1: Tomato versus Potato breeding sectors factors, seven-point Likert scales, median, standard deviation and significance value

	T(s.d)	P(s.d)	Significance Level
Knowledge Transfer Support	5.40(0.88)	4.78(1.43)	
Research Support	4.00(1.72)	6.00(1.83)	**
Breeding Support	1.00(1.41)	5.00(2.27)	***
IP Filing Support	1.00(2.22)	1.00(0.00)	
Access to IP Support	2.00(2.24)	2.00(1.98)	
Patent Filing Support	3.00(1.80)	2.00(1.60)	
PBR Filing Support	1.00(1.99)	2.50(2.33)	
Frequency of Use	3.33(0.45)	3.21(0.56)	
Absorptive Capacity	3.33(1.96)	5.83(1.00)	**
Innovative Performance	2.25(1.39)	3.63(1.32)	*
Scientific Performance	1.50(1.27)	1.00(1.41)	
Business Performance	3.33(1.12)	3.67(1.05)	

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$ (1-tailed)

Table C.2: Tomato versus Potato breeding sectors at the item level belonging to the Knowledge Transfer Support factor, seven-point Likert scales, median, standard deviation and significance value

	T(s.d)	P(s.d)	Significance Level
Access to information	5.00(1.68)	4.00(1.58)	
Contact with CBSG researchers	6.00(0.90)	5.50(1.69)	
Access to CBSG website	6.00(1.38)	3.00(2.45)	*
Access to CBSg intranet	6.00(1.07)	6.00(0.71)	
Enhanced interaction companies	4.00(1.72)	4.00(2.38)	

* $p < 0.1$ (1-tailed)

Table C.5: Tomato versus Potato breeding sectors at the item level belonging to the Frequency of Use factor, seven-point Likert scales, median, standard deviation and significance value

	T(s.d)	P(s.d)	Significance Level
Access to information	3.00(0.89)	3.00(0.84)	
Contact with CBSG researchers	4.00(0.49)	4.00(0.52)	
Access to CBSG website	5.00(1.07)	5.00(1.25)	
Access to CBSg intranet	5.00(0.97)	5.00(0.76)	
Enhanced interaction companies	4.00(1.38)	4.00(0.35)	
Help with IP Filing	1.00(0.00)	1.00(0.46)	
Help with getting access to IP	1.00(0.00)	1.00(0.92)	

Table C.6: Tomato versus Potato breeding sectors at the item level belonging to the Absorptive Capacity factor, seven-point Likert scales, median, standard deviation and significance value

	T(s.d)	P(s.d)	Significance Level
Develop new products	4.00(2.30)	5.50(1.94)	
Increase number of tomato/potato markers that will be tested	3.00(2.36)	6.00(0.52)	**
Increase number of tomato/potato markers that will be implemented	2.00(2.52)	6.00(0.89)	**

** $p < 0.05$ (1-tailed)

Table C.7: Tomato versus Potato breeding sectors at the item level belonging to the Innovation Performance factor, seven-point Likert scales, median, standard deviation and significance value

	T(s.d)	P(s.d)	Significance Level
Expectation to launch new products to the market	3.00(2.37)	4.50(1.77)	
Increase sales of new products	1.00(1.68)	4.00(1.28)	*
Enter new markets	2.00(1.62)	2.00(1.07)	
Introduce new products to the market faster than competitors	2.00(0.76)	5.00(2.17)	

* $p < 0.1$ (1-tailed)

Table C.8: Tomato versus Potato breeding sectors at the item level belonging to the Scientific Performance factor, seven-point Likert scales, median and U

	T(s.d)	P(s.d)	Significance Level
Increase # peer reviewed publications	1.50(1.27)	1.00(1.41)	

Table C.9: Tomato versus Potato breeding sectors at the item level belonging to the Business Performance factor, seven-point Likert scales, median and U

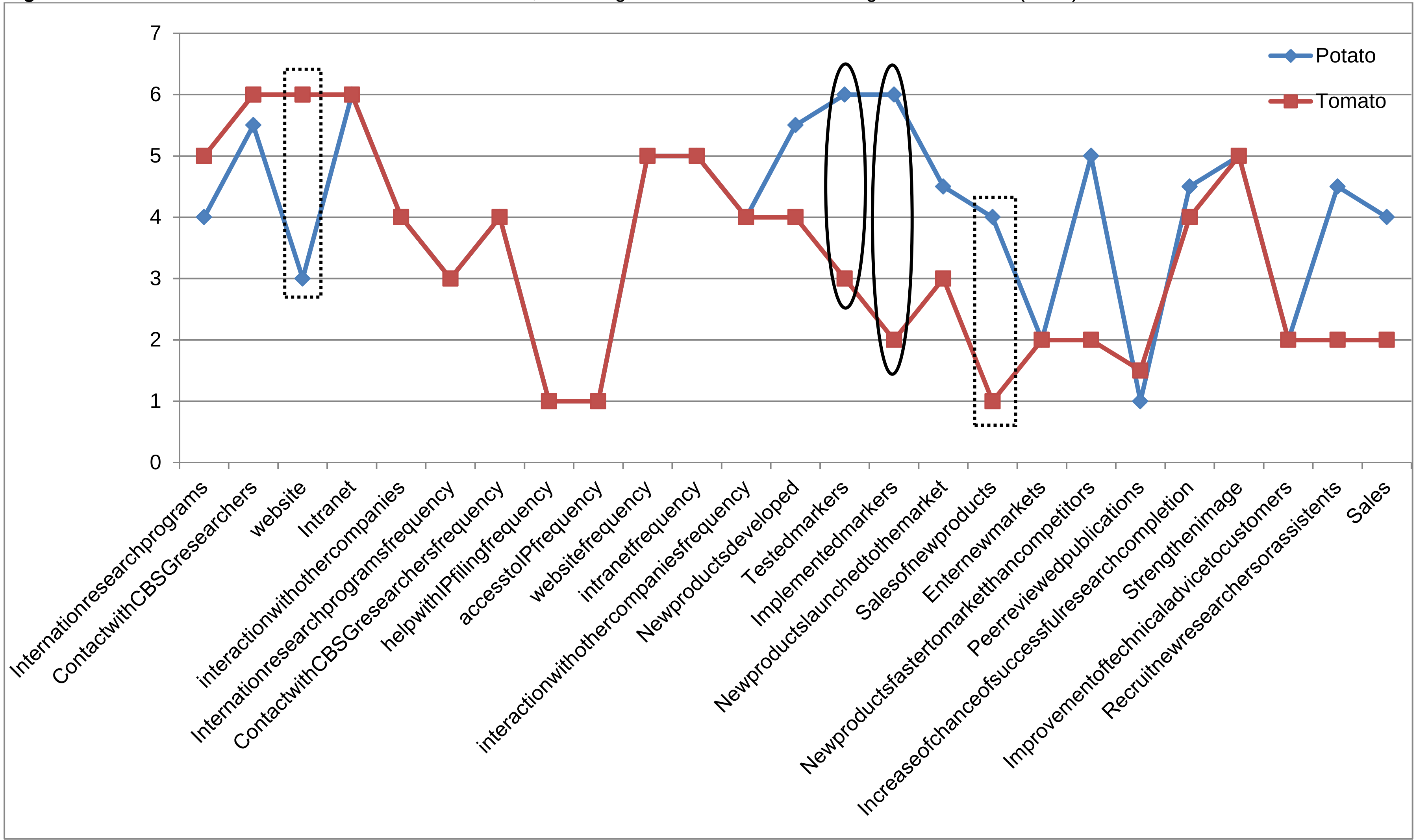
	T(s.d)	P(s.d)	Significance Level
Increase sales	2.00(2.23)	4.00(1.51)	
Expectation of market share to grow	2.00(1.63)	3.00(1.81)	
Increase the chance of successful research completion	4.00(1.99)	4.50(1.19)	
Strengthen image	5.00(2.16)	5.00(1.60)	
Improve technical advice to customers	2.00(1.60)	2.00(1.36)	
Recruit new researchers or assistants	2.00(2.15)	4.50(2.07)	

Table C.10: Detailed results for items belonging to certain factors

Factor	Item	Description
Filing for patents		4 companies (2 potato and 2 tomato) lightly agreed that by participating in the CBSG program their organization expects to increase the number of filings for patents and 11 disagreed. - 2 companies (1 potato and 1 tomato) quantified the increase in the number of filings for patents resulting from the participation in the CBSG program to 2-3 and 1 respectively, 5 said 0 and the rest did not give an answer. - 4 companies (3 potato and 1 tomato) quantified the increase in the number of filings for patents resulting from the participation in the CBSG program as a percentage of the total amount of filings for patents to 20%, 100% , 5% and 5% accordingly; 5 indicated 0% and the rest gave no answer.
Filing for plant breeders' rights		3 companies (2 potato and 1 tomato) agreed that by participating in the CBSG program their organization expects to increase the number of filings for plant breeders' rights, 10 disagreed, 1 remained neutral and 1 gave no answer. - 1 tomato company quantified the increase in the number of filings for plant breeders' rights resulting from the participation in the CBSG program to 2 , 5 said 0 and the rest did not give an answer. - 1 tomato company quantified the increase in the number of filings for plant breeders' rights resulting from the participation in the CBSG program as a percentage of the total amount of filings for patents to < 0.5%; 1 potato company indicated 100%, 5 indicated 0% and the rest gave no answer.
Absorptive Capacity	*Number of new products developed*	8 companies agreed that the CBSG program enables their organization to develop new products, 5 disagreed. - 1 potato company quantified the number of new product development projects resulting from participating in the CBSG program to 4 and 4 other companies (2 potato and 2 tomato) said 2. 2 companies said 0 and the rest gave no answer. - 6 companies (4 potato and 2 tomato) quantified the number of new product development projects resulting from participating in the CBSG program as a percentage of total number of new product development projects to 5%, 50%, 10%, 100%, 1% and 0.5% respectively, 3 answered 0% and the rest remained unanswered.
Innovative Performance	*Enter new markets*	1 tomato company slightly agreed that the CBSG program enables their organization to enter new markets, the rest disagreed.

		• 3 companies (1 potato and 2 tomato) quantified the potential amount of sales of the new markets resulting from the participation in the CBSG program as a percentage of the total amount of sales of new products to 0 and the rest gave no answer.
	Launch new products to the market	6 companies (3 potato and 3 tomato) agreed that by participating in the CGSG program their organization expects to launch new products to the market, 3 tomato companies and 2 potato comanies disagreed and the rest remained neutral. - Only 2 companies (1 potato and 1 tomato) were able to quantify the number of new product market launches resulting from participating in the CBSG program to 2 and 1 respectively. 1 tomato company gave a 0 and the rest remained unanswered. - 4 companies (2 potato and 2 tomato) quantified the number of new product market launches resulting from participating in the CBSG program as a percentage of the total number of new product market launches to 10%, 100%, 1% and < 0.5% accordingly, 1 tomato and 1 potato company answered 0 and the rest gave no answer
Business Performance	*Increase sales*	3 companies (2 potato and 1 tomato) said that the CBSG program enables their organization to increase their sales considerably, 8 companies (3 potato and 5 tomato) disagreed. - 1 potato company quantified the increase in the amount of sales resulting from the participation in the CBSG program as a percentage of the total amount of sales to 90%, the rest companies quantified 0 or gave no answer.

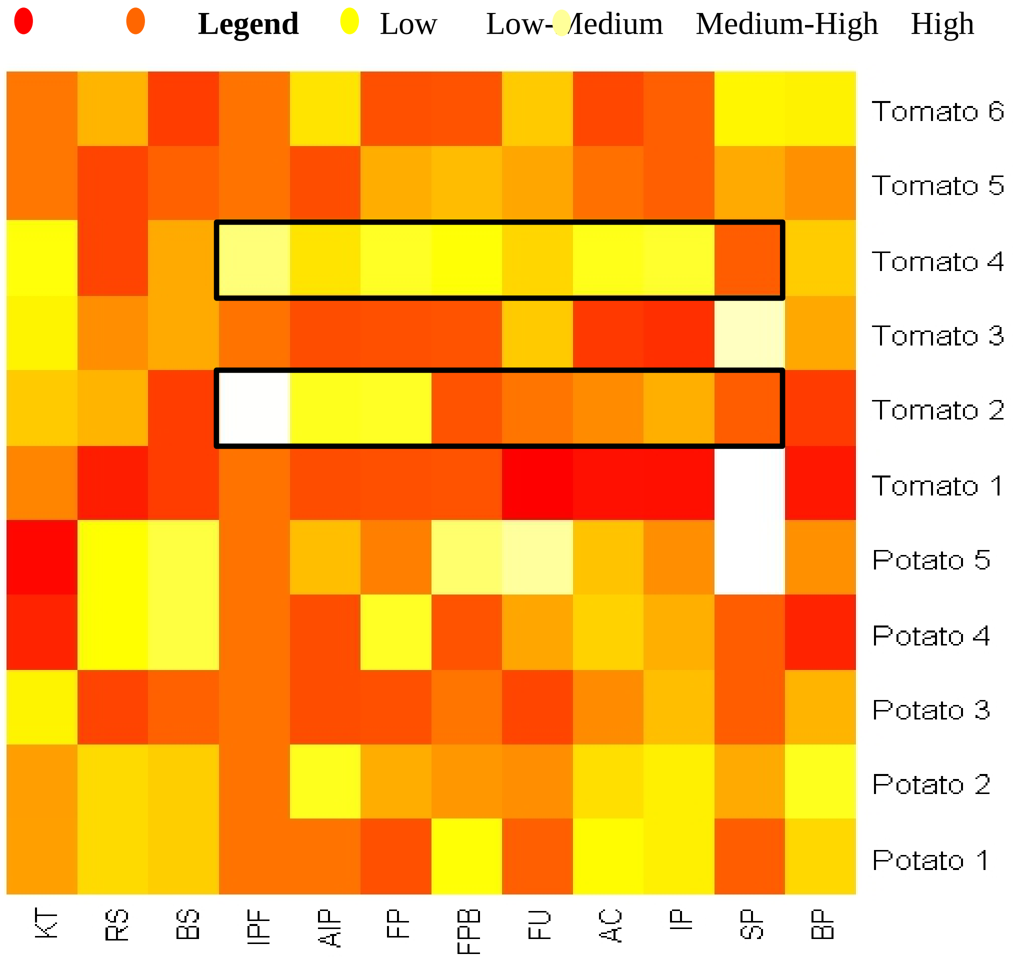
Figure C.1: the individual valorisation items in the CBSG, including the median scores and significant results (n=15)



Circle = significant difference $p < 0.05$
Dashed square = marginal significant difference $p < 0.1$

Appendix D: Detailed Results II

Figure D.1: heat map with the group indicators based on their answers given my companies. Empty values are coloured with white. The black square pinpoints at the important differences among companies.



Appendix E: Detailed Results III

Table E.1: Coded figures of the potato and tomato companies that measure the level of expectation or use that they have for different factors

Company	Knowledge Transfer Support	Frequency of Use	Company	Research Support	Frequency of Use	Company	Breeding Support	Frequency of Use
P2	**L**	**H**	T1	L	L	T1	L	L
P3	L	L	P3	L	L	P7	L	L
P7	L	L	T4	**L**	**H**	T2	L	L
T6	L	L	T5	L	L	T6	**L**	**H**
T5	**L**	**H**	P8	L	L	T7	**L**	**H**
T1	L	L	T3	**L**	**H**	P3	L	L
P6	L	L	P7	L	L	T5	L	L
P1	L	L	T2	L	L	P8	L	L
P5	H	H	T6	**L**	**H**	T4	H	H
T2	**H**	**L**	T7	**L**	**H**	T3	H	H
T7	H	H	P1	H	L	P1	**H**	**L**
T3	**H**	**L**	P2	H	H	P2	H	H
P2	H	H	P6	**H**	**L**	P6	**H**	**L**
T4	H	H	P4	**H**	**L**	P4	**H**	**L**
P8	**H**	**L**	P5	H	H	P5	H	H

Code: L = lower mark (1st half of the chart)
H = higher mark (2nd half of the chart)
P = potato company (from 1 to 8)
T = tomato company (from 1 to 7)
Yellow = contrast produced between companies that had a low mark in one factor and a high mark in the other. This expresses a negative relationship and can help us to observe the individual behaviour of companies.

Table E.2: Coded figures of the potato and tomato companies that measure the level of expectation or use that they have for different factors

Company	PBR Filing Support	Frequency of Use	Access to IP Support	Frequency of Use	Patent Filing Support	Frequency of Use	IP Filing Support	Frequency of Use
P1	**H**	**L**	L	L	L	L	L	L
P2	**H**	**L**	**H**	**L**	**H**	**L**	L	L
P3	L	L	L	L	L	L	L	L
P4	**L**	**H**	**L**	**H**	H	H	**L**	**H**
P5	H	H	H	H	**L**	**H**	**L**	**H**
P6	**H**	**L**	**H**	**L**	**H**	**L**	L	L
P7	L	L	L	L	L	L	L	L
P8	L	L	L	L	L	L	L	L
T1	**L**	**H**	**L**	**H**	**L**	**H**	**L**	**H**
T2	**L**	**H**	H	H	H	H	H	H
T3	L	L	L	L	L	L	L	L
T4	H	H	H	H	H	H	H	H
T5	**H**	**L**	L	L	**H**	**L**	L	L
T6	L	L	**H**	**L**	L	L	L	L
T7	H	H	**L**	**H**	H	H	**L**	**H**

Code: L = lower mark (1st half of the chart)
H = higher mark (2nd half of the chart)
P = potato company (from 1 to 8)
T = tomato company (from 1 to 7)
Yellow = contrast produced between companies that had a low mark in one factor and a high mark in the other. This expresses a negative relationship and can help us to observe the individual behaviour of companies.

Table E.2: Coded figures of the potato and tomato companies that measure the level of expectation or use that they have for different factors

Company	Innovative Performance	Scientific Performance	Company	Frequency of Use	Absorptive Capacity
P7	L	-	T1	L	-
T1	**L**	**H**	P4	L	L
T3	L	L	P7	L	L
T7	**L**	**H**	P1	**L**	**H**
T6	**L**	**H**	T2	**L**	**H**
T5	**L**	**H**	P6	**L**	**H**
P8	L	L	P8	L	L
P2	L	-	T5	L	L
T2	**H**	**L**	P3	L	L
P3	**H**	**L**	T7	H	H
P4	**H**	**L**	T3	H	-
P6	**H**	**L**	T6	**H**	**L**
P1	H	H	T4	H	H
T4	**H**	**L**	P2	H	H
P5	H	H	P5	H	H

Code: L = lower mark (1st half of the chart)
H = higher mark (2nd half of the chart)
P = potato company (from 1 to 8)
T = tomato company (from 1 to 7)
- = no reported value or excluded from the analysis
Yellow = contrast produced between companies that had a low mark in one factor and a high mark in the other. This expresses a negative relationship and can help us to observe the individual behaviour of companies.

Table E.3: Coded figures of the potato and tomato companies that measure the level of expectation or applications that they have for different factors.

Company	CPVR	Absorptive Capacity	Company	PBR NL	Absorptive Capacity	Company	Total Plant Patents	Innovative Performance
T4	**L**	**H**	T4	**L**	**H**	T4	**L**	**H**
T1	L	L	T1	L	L	P4	**L**	**H**
T6	**L**	**H**	T6	**L**	**H**	T2	**L**	**H**
P4	L	-	P4	L	-	T5	L	L
P5	**L**	**H**	T5	**L**	**H**	T3	L	L
T2	L	L	T2	**H**	**L**	P3	H	H
T3	**H**	**L**	P1	H	H	T1	**H**	**L**
T5	H	H	P3	**H**	**L**	P5	H	H
P3	**H**	**L**	P2	**H**	**L**	T6	**H**	**L**
P2	**H**	**L**	T3	**H**	**L**	T7	**H**	**L**
P1	H	H						

Code: L = lower mark (1st half of the chart)
H = higher mark (2nd half of the chart)
P = potato company (from 1 to 8)
T = tomato company (from 1 to 7)
- = no reported value or excluded from the analysis
Yellow = contrast produced between companies that had a low mark in one factor and a high mark in the other. This expresses a negative relationship and can help us to observe the individual behaviour of companies.

Table E.4: Coded figures of the potato and tomato companies that measure the level of expectation or applications that they have for different factors.

Company	CPVR	Absorptive Capacity	Company	PBR NL	Absorptive Capacity	Company	Total Plant Patents	Innovative Performance
T4	**L**	**H**	T4	**L**	**H**	T4	**L**	**H**
T1	L	L	T1	L	L	P4	**L**	**H**
T6	**L**	**H**	T6	**L**	**H**	T2	**L**	**H**
P4	L	-	P4	L	-	T5	L	L
P5	**L**	**H**	T5	**L**	**H**	T3	L	L
T2	L	L	T2	**H**	**L**	P3	H	H
T3	**H**	**L**	P1	H	H	T1	**H**	**L**
T5	H	H	P3	**H**	**L**	P5	H	H
P3	**H**	**L**	P2	**H**	**L**	T6	**H**	**L**
P2	**H**	**L**	T3	**H**	**L**	T7	**H**	**L**
P1	H	H						

Code: L = lower mark (1st half of the chart)
H = higher mark (2nd half of the chart)
P = potato company (from 1 to 8)
T = tomato company (from 1 to 7)
\- = no reported value or excluded from the analysis
Yellow = contrast produced between companies that had a low mark in one factor and a high mark in the other. This expresses a negative relationship and can help us to observe the individual behaviour of companies.

Appendix F: qualitative research questionnaire for public-private partnerships

Questionnaire
Public-Private Partnerships Indicators

Questionnaire for the needs of the MSc. Thesis "Key Performance Indicators of Public-Private Research and Development Collaboration: Cross-Cluster comparison at the Centre of Bio Systems Genomics". A research project carried out by the MSc. student Sebastián Sánchez Gerritsen from the Management Group of Wageningen University, April 2010 - November 2010

Verification

Interviewer:
Interviewee:
Organization (PPP):
Position in the organization:
Date:
Time:

Introduction

This questionnaire is part of a larger research project carried out by the MSc. student Sebastián Sánchez Gerritsen in order to achieve the degree of Masters in Management and Economics at the University of Wageningen.
The objective of this questionnaire is to obtain insights about the different Public-Private Partnership settings, expectations, behaviour and outputs in order to validate an exploratory model aimed at identifying the key performance indicators of PPP.
This questionnaire is being asked to a number of professors from Delft University that have experience in the PPP environment. The respondent is expected to have been involved in the setting up of the PPP or to be involved in its management team.
The questionnaire is comprised of 5 segments. **Part A** is related to **the General Settings of PPP**, **part B** to the **Knowledge Transfer Support policy, part C** to the **Innovation Support policy part D** to the **Management Support** and part **E** to the **Evaluation Tools**.
The researcher appreciates very much your contribution and collaboration, and is willing to share all the results with the participating companies upon request. Confidentiality is guaranteed, and the materials generated in this Research are used exclusively for educational purposes.

Instructions

The time necessary to answer the following interview is approximately 45 minutes. To do so, a time frame is provided per each question!!
The interviewer is going to keep track of the time. If important comments are missed, there will be 5 minutes for overall discussion at the end.

Part A: General Setting

1. **What is your experience with PPP? Could you provide documentation supporting the results of this PPP? If there are any special remarks, please feel free to point them out.**

____
____
____
____
____

2. **What is the current situation regarding the PPP? (i.e. financial streams, supply vs. demand, shared costs, etc.)**

____
____
____
____
____

3. **Is knowledge valorisation a well-known concept in your organization? Please comment on the matter.**
   No / Yes
   If yes, what activities are implemented by the PPP to maximize valorisation?

____
____
____
____

Knowledge valorisation – is a concept defined by Goorden et, al. (2008) as *the formal transfer of knowledge resulting from basic and applied research in universities and research institutes , as well as from applied research and development in companies, to (other parties in) the commercial sector for economic benefit*

This definition is adapted to the NGI as to *spot the potential of scientific results at a very early stage and provide all the necessary means and expertise to transform the scientific result into a commercially viable product or service*, in order to *get the most out of genomics*

Part B: Knowledge Transfer Support

4. **What kind of information and communication technology (ICT) do you use (video conferences, electronic meeting rooms etc.? What is your experience with these?**

____
____
____

5. **Do you make research data available in the PPP, for instance via shared databases, electronic discussion forums or via the intranet?**

____
____
____

6. **Do you make non-critical research data available to the public, e.g. via the Internet?**

____
____
____

Part C: Innovation Support

7. What is the policy on research cooperation with industry (i.e. sponsoring and bilateral contracting, cooperation with suppliers and buyers, strategic alliances or joint ventures)? How about critical projects been run in the PPP and steering by private partners?

____
____
____

8. What is the company's attitude towards scientific publishing and patenting (screening and assessment)?

____
____
____

Part D: Management Support

9. How is innovation stimulated in your organization (i.e. awards, funds, recognition and/or fellowships)?

____
____
____

10. Comparison of the management of your PPP (or project) with that of PPP's or projects (Weak and strong points).

____
____
____

Part E: Evaluation

11. Can clear differences be pointed out in the behaviour between the partners regarding goals, objectives, expectations and participation/cooperation?

____
____
____

12. Which indicators are the most important for measuring the impact and utilization degree of the PPP (e.g. new products, services, scientific publications)?

____
____
____

13. What are the main activities/factors that stimulate the on-going participation of industrial partners?

____
____
____

14. On what terms is this PPP creating benefit from its public funding (i.e. increased level of innovation, increased value creation, etc.?