Innovation in the Dutch wheat supply chain

A study into the ways of increasing the utilization of Dutch wheat in bread production by means of supply chain innovation

Hanneke Pol

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Management summary

The aim of this research is to provide clarity into ways of increasing the utilization of Dutch wheat in bread production, by means of supply chain innovation. In the Netherlands, 1.2 million tons of wheat is produced each year, which represents 1% of the European Union's total production. Currently, only 15% (180,000 tons) of Dutch wheat is milled into meal and flour for bread production. The remainder is used by the feed industry (55%), starch industry (20%) and for bio-ethanol production (4%). The primary actors of the Dutch milling-wheat supply chain consist of plant breeders, wheat growers, collectors and milling companies. Bakeries, supermarkets and consumers are the secondary actors of the chain. Consumers from the chain's most powerful actor whereas wheat growers and collectors are the least powerful actors.

The most important quality, when aiming to utilize wheat for bread production, is protein quality. However, the milling companies do not set a specific standard for this. This absence of protein quality specifications creates problems for Dutch wheat growers and collectors, who want to supply their wheat to these companies. Furthermore, when compared to their German and French competitors, the circumstances of the Dutch growers and collectors make it more difficult for them to meet the milling companies' requirements. Two specific problems are highlighted. Firstly, it is difficult for wheat growers to produce wheat with a high protein quality. Secondly, and consequently, collectors have difficulty in supplying large batches of wheat with a high protein quality. However, three supply chain innovations will be outlined in this thesis, the aim of which is to largely remove the problems of the wheat growers and collectors. These are: a Decision Support System (DSS) to manage protein quality on the field; a payment system based on protein quality; and a quick measurement- and separation system for protein quality. All three of these innovations have to be realized in order to increase the amount of Dutch wheat utilized by milling companies for bread production. However, before this can happen, it is essential to establish a set of protein quality specifications.

Milling companies, wheat growers and collectors should cooperate in order to formulate protein quality specifications. Milling companies have the most power in this process as they have the knowledge that is essential for formulating them. However these companies are not sufficiently interested in supply chain innovations to do so. Milling companies are able to receive relatively cheap milling-wheat, in large quantities, from Germany and France. The lower transport costs and greater delivery reliability available if Dutch wheat is used on a larger scale do not offset the cost savings of foreign wheat for them. Furthermore, milling companies are resistant to providing the information needed to set protein quality specifications, for fear of revealing company secrets. For their part, wheat growers and collectors are more interested in the supply chain innovations referred to, but a low profit margin does not provide them with the necessary encouragement to convince them to start to innovate. At the moment the price of wheat is high because of a poor harvest. In addition, as things stand, wheat growers and collectors can always supply their wheat to the Dutch feed industry for only a slightly lower price. Therefore, innovations which would increase the use of Dutch wheat in bread production will continue to be just ideas, because the existing circumstances do not encourage their adoption.

In the short term, the milling companies' interest in the three supply chain innovations referred to above will not increase. However, a high general wheat price can be expected in the near future, as worldwide production cannot keep up with the increasing demand for wheat. Accordingly, wheat growers and collectors are likely to become more inclined to invest in the three innovations.

However, as it is clear that these innovations cannot be realized without protein quality specifications, the milling companies have to be convinced to participate. This is most likely to occur if the growers and collectors can encourage supermarkets to sell regional bread. This is not a vain hope because consumers, who are the most significant link in the chain, are increasingly interested in purchasing regional products. When the time comes that market research demonstrates to supermarkets that there is a significant demand by consumers for regional bread made with Dutch wheat, the pressure to cooperate and innovate will increase on all the actors of the supply chain. When this occurs, the increased use of Dutch wheat in bread production will be a step closer.

Management samenvatting

Doel van dit onderzoek is om duidelijkheid te verschaffen over mogelijkheden om gebruik van Nederlands tarwe voor broodproductie te verhogen door middel van keteninnovatie. Nederland produceert per jaar 1,2 miljoen ton tarwe, 1% van de totale productie in de Europese Unie. Op dit moment wordt maar 15% (180.000 ton) van de Nederlandse tarwe vermalen tot meel en bloem voor broodproductie. Het andere deel van de Nederlandse tarwe wordt gebruikt door: de voerindustrie (55%), de zetmeelindustrie (20%) en voor bio-ethanol productie (4%). Het primaire deel van de Nederlandse baktarweketen bestaat uit plant veredelaars, tarwetelers, collecteurs en maalderijen. Het secondaire deel van de keten wordt gevormd door bakkerijen, supermarkten en consumenten. De consumenten vormen de machtigste ketenactor; de tarwetelers en collecteurs bezitten de minste macht.

Belangrijkste kwaliteitseis waaraan tarwe moet voldoen om te worden gebruikt voor broodproductie is eiwitkwaliteit. Maar eiwitkwaliteit wordt door maalderijen niet nader gespecificeerd. Het niet voorhanden zijn van eiwitkwaliteitspecificaties veroorzaakt problemen voor Nederlandse tarwetelers en collecteurs, die tarwe willen leveren aan de maalderij. Daarnaast, vergeleken met Duitse en Franse tarwetelers en collecteurs, maken de omstandigheden van de Nederlandse tarwetelers en collecteurs het nog eens moeilijker om the eisen van de maalderijen te vervullen. Twee specifieke problemen zijn beschreven. Voor tarwetelers is het moeilijk om tarwe met hoge eiwitkwaliteit te behalen. Collecteurs hebben moeilijkheden met het aanbieden van grote partijen tarwe dat een hoge eiwitkwaliteit bevat. Er worden drie keteninnovaties onderscheiden waarmee de problemen voor de tarwetelers en collecteurs voor een groot deel kunnen worden weggenomen: een Beslissing Ondersteuning Systeem (BOS) om eiwitkwaliteit om de akker te controleren; een betalingssysteem waarmee wordt uitbetaald op eiwitkwaliteit; en een meet- en scheidingssysteem voor eiwitkwaliteit. De keteninnovaties moeten alledrie gerealiseerd worden om alle knelpunten te kunnen wegnemen opdat meer Nederlands tarwe kan worden gebruikt door de maalderij en dus voor broodproductie. Maar om de keteninnovaties te kunnen realiseren zijn eerst eiwitkwaliteitspecificaties benodigd.

Maalderijen, collecteurs en tarwetelers zullen samen de eiwitkwaliteitspecificaties op moeten stellen. Maalderijen hebben de meeste macht over dit proces; zij bezitten kennis essentieel om de specificaties op te stellen. Echter maalderijen zijn niet voldoende geïnteresseerd in de keteninnovaties. Maalderijen kunnen baktarwe in grote hoeveelheden tegen relatief lage prijzen uit Duitsland en Frankrijk verkrijgen. Dat lagere transportkosten en hogere leverbetrouwbaarheid kunnen worden gerealiseerd wanneer zij meer tarwe uit Nederland halen, weegt daar niet tegenop voor hen. Daarnaast zijn maalderijen huiverig voor het prijsgeven van specificaties wat zij mogelijk zien als een bedrijfsgeheim. Tarwetelers en collecteurs zijn wel geïnteresseerd in de innovaties, toch moedigt een lage winst hun niet aan tot innoveren. Op dit moment is de tarweprijs hoog doordat de oogst is mislukt; onderaan de streep houdt de tarweteler niet veel meer over. Bovendien kunnen tarwetelers en collecteurs in de huidige situatie hun tarwe altijd kwijt aan de grote Nederlandse voerindustrie voor maar een iets lagere prijs. Daarom blijven innovaties die het gebruik van Nederlands tarwe voor broodproductie zouden verhogen ideeën. De huidige situatie moedigt adaptatie van de innovaties niet aan.

Op korte termijn zal de interesse van de maalderij niet toenemen in Nederlands tarwe en daarmee in de drie keteninnovaties. Wel kan een structureel hoge tarweprijs verwacht worden in de nabije toekomst, doordat wereldproductie de toenemende tarwevraag in de wereld niet zal bijhouden.

Tarwetelers en collecteurs zullen hierdoor eerder geneigd zijn te investeren in de drie keteninnovaties. Echter het is een feit dat de innovaties niet kunnen worden gerealiseerd zonder eiwitkwaliteitspecificaties; maalderijen zullen moeten worden overtuigd mee te doen. Grootste kans om dit te doen slagen is er wanneer tarwetelers en collecteurs de supermarkt kunnen aanzetten om streekbroden te verkopen. Dit is geen tevergeefse hoop omdat consumenten, die de meest dominante link zijn in de keten, toenemend geïnteresseerd zijn in het kopen van regionale producten. Wanneer marktonderzoek aan supermarkt demonstreert dat er veel animo bestaat voor streekbrood geproduceerd van Nederlands tarwe, zal de druk om samen te werken en te innoveren toenemen onder de actoren van de keten. Daarmee komt een toenemend gebruik van Nederlands tarwe voor broodproductie, een stap dichterbij.

Preface

With this Masters' thesis I will complete my Business Administration studies at the University of Twente. I have a keen eye for new opportunities and discoveries, so it was logical for me to choose the Masters' Innovation Management course in my final year. I grew up on a farm and despite it being somewhat unusual at a non-agricultural University, because of my agricultural background I decided to combine the two elements, innovation and agriculture, in this research project.

Ordina Oracle Solutions (previously Vertis B.V.) gave me the opportunity to begin my innovation-agricultural research. Mr. Wouter Zunneberg represents this organization in the KodA-program, which means "Kennis op de Akker" (literally translated: "Knowledge on the Field"). He explained that within this program, questions had arisen among Dutch wheat growers about the possibility of providing more of their wheat to milling companies, thus resulting in them receiving better than average prices. Furthermore, this topic was beginning to actively interest the other actors in the milling-wheat supply chain, namely the wheat collectors and milling companies. From the start, I was keen to be able to provide clarity to the various actors in the milling-wheat supply chain. I also saw the challenge of analyzing a complete supply chain. However, although I had some knowledge of the Dutch agricultural sector, specifically dairy farming, the area of wheat production was new to me.

By means of semi-structured interviews, I was able to collect data for my research. In doing so, it became increasingly clear that there was a real demand for and interest in the outcome. Interviewees frequently asked me if it would be possible to obtain a copy of this thesis. Accordingly, I wish to thank all of the interviewees who participated, for their openness and kindness in answering my questions.

Particular thanks go to the four "KodA-wheat growers": Mr. Lenus Hamster, Mr. Jan Paul van Hoven, Mr. Jeroen Verschoore and Mr. Detmer Wage, who I interviewed more than once and who also granted me a behind the scenes glimpse of their farms. I would also like to thank Mr. Wouter Zunneberg, my internship supervisor, for giving me the opportunity to execute this research and for sharing his thoughts. Finally, I would like to thank my thesis supervisors' at the University, Mr. Klaasjan Visscher and Mr. Barend van der Meulen, for their valuable advice and critical opinions.

I hope you will enjoy reading this thesis.

Hanneke Pol,

Ruinerwold
December, 2007

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Abbreviations

AKK	Community Agricultural Supply Chain Knowledge (Stichting Agro Keten Kennis)
AWT	Advisory Body for Scientific- and Technolgy policy (Adviesraad voor het Wetenschaps- en Technologiebeleid)
BOS	Beslissings Ondersteunings Systeem
C	Carbon
CBS	Central Statistical Office (Centraal Bureau voor de Statistiek)
CP	Central Planning Office (Centraal Planbureau)
DON	Deoxynivalenol (Fusarium)
DSS	Decision Support System (Beslissings Ondersteunings Systeem)
EC	Commission of European Communities
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GLB	European Agricultural Policy (Gemeenschappelijk Landbouw Beleid)
GPS	Global Positioning System
Gr	gram
GZP	Product Community of Cereals, Seeds and Legumes (Productschap Granen, Zaden en Peulvruchten)
IPCC	Intergovernmental Panel on Climate Change
Ha	hectare
HBD	Community Board Retail Trade (Hoofdbedrijfschap Detailhandel)
HPA	Community Board of Arable Farming (Hoofdproductschap Akkerbouw)
IT	Information Technology
Kg	kilogram
KodA	Knowledge on the Field (Kennis op de Akker)
KNMI	Royal Dutch Meteorlogical Institute (Koninklijk Nederlands Metrologisch Instituut)
LEI	Agricultural Economic Institute (Landbouw Economisch Instituut)
LNV	Ministry of Agriculture, Nature and Food Quality (Ministerie van Landbouw, Natuur en Voedselkwaliteit)
LOFAR	Low Frequency Array (Lage Frequentie Telescoop)
Mg	milligram
MIS	Management Information System
Mm	millimetre
MN	Environment- and Nature plan office (Milieu- en Natuurplanbureau)
N	Nitrogen
N/A	Not available
NBC	Dutch Bakery Centre (Nederlands Bakkerij Centrum)
NVM	Dutch Association of Meal manufacturers (Nederlandse Vereniging der Meelfabrikanten)
O	Oxygen
OOS	Ordina Oracle Solutions
PHS	Pre-harvest sprouting (schot)
PVR	Plant Variety Rights
R&D	Research and Development
RP	Spatial Plan office (Ruimtelijk Planbureau)
S	Sulpfur
SCOT	Social Construction of Technology
SME	Small-medium enterprises
SPNA	Association of Experimental Farms of Northern Arable farming (Stichting Proefboerderijen Noorderlijke Akkerbouw)
TNO	Organization for Applied Scientific Research (Toegepast Natuurwetenschappelijk Onderzoek)
UPOV	International union for the protection of new varieties of plants
USA	United States of America

1 Introduction

This chapter introduces this research. The reasoning behind it is outlined, which in turn leads to its goal, namely to lead to innovations in the supply chain taking place centrally. It moves on to deal with the central question of the research, to which this work provides an answer. Thereafter, six research questions are presented, the answers to which provide a solution to the central question. An introduction to the approach taken in this research is also discussed. This chapter concludes with an overview of the chapters contained in this work.

1.1 Reasons for this research

A study conducted in 1990 by Jacobs concluded that Dutch agriculture could be characterized as a strong sector in the country's economy. The sector was prominent worldwide and was a market leader so far as many important agricultural products were concerned (Jacobs, 1990). Several subsequent studies confirmed that the Dutch agricultural sector is still significant economically (De Bont & Van Berkum, 2004; Jacobs & Lankhuizen, 2005) and the conclusion of a study carried out for the Ministry of Agriculture, Nature and Food Quality (Ministerie van Landbouw, Natuur en Voedselkwaliteit (LNV)) confirmed this:

> "The relative weight of the services sector increases and that of the agricultural and industrial sector decreases, but this does not mean that the role and significance of the agricultural and industrial sectors decrease. Without interaction with agriculture and industry, the services sector could not be strong. With the upcoming knowledge, creative, and experience economy, agriculture and industry will not disappear. These developments create new challenges, in particular the development of "new combinations" of agricultural sectors, industries, services and experiences" (Snijders, Vrolijk & Jacobs, 2007).

Focusing on the Dutch arable farming sector in particular, it is claimed that it is possible to lift it to an even higher level. De Bont and Van Berkum (2004) describe how this sector can maintain a strong position internationally because the Netherlands contains a number of leading processing industries and trading companies, which operate worldwide. These companies benefit from a well-developed arable farming sector in their own country. Further research, conducted by the research agency Berenschot (2004) suggested that there is an opportunity to form a strong agrifood-complex, in which the arable farming sector can play an important part. However, in order to grab these opportunities, a combination of knowledge, skills and organization is needed. Innovation requires power, high-quality technology and a well-formed knowledge infrastructure (Berenschot, 2004; Van der Vorst, Beulens & Van Beek, 2005; Verdouw, Wolfert & Beulens, 2005).

1.1.1 Koda-program

In 2006, the KodA-program was set up, with the aim of actively strengthening the position of the Dutch arable farming sector in the world market. KodA stands for "Kennis op de Akker", (literally translated: "Knowledge on the field"). The program's main goal is to easily disseminate greater, usable knowledge, which has not only been developed in institutions but also comes from the wheat growers themselves. Such a program gives the country's arable farming sector a drive to innovate. The basic principle of the KodA-program is that with continuous innovation, it is possible to grow and market crops with a higher added value, which would in turn strengthen the arable farming sector, thereby ensuring that it becomes more sustainable. The KodA-program will operate for four years and in this period agri-business (trading companies and industry) and the ministry of LNV will each invest 4 million Euros into it. Activities in the KodA-program take place in so-called "learning networks", classified by themes and crop groups. Arable wheat growers and processing industries have a central position in these networks, around which others, such as researchers and service providers, participate. Together they identify issues of concern and search for possible solutions. These solutions are then tested and observed in pilot studies (Wolfert, Schoorlemmer, Paree, Zunneberg & Van Hoven, 2005).

One of the participating service providers in the KodA-program is Ordina Oracle Solutions (OOS) (also abbreviated to Ordina). This is an IT company, which hopes to benefit from any issues arising that would require an IT-solution. So far, the learning network that Ordina has joined, known as "Sturen van kwaliteit in het graan" ("Managing quality of grain"), is a long way from producing a relevant IT-system. This is due to a lack of clarity in the Dutch wheat supply chain. While Ordina have not asked for information about specific opportunities for IT-applications, they have sought clarity about the supply chain. This request is the reason for this thesis.

1.2 Research goal

Within the learning network entitled "Managing quality of grain", Dutch wheat growers as well as the largest Dutch milling company and independent researchers, have all worked together to try to identify how to manage high quality wheat, by means of knowledge construction. The reason that this particular network was set up was to deal with the issue of the demand for high quality Dutch wheat, or alternatively, wheat to which a higher value is added. Before I examine this demand further, it is important to explain what is meant by wheat with a higher added value.

1.2.1 Wheat

Wheat (Triticum spp.), along with rice and corn, belongs to one of the most prominent grain varieties used to feed mankind. Because of its high yield capacity in the Netherlands, wheat is the most cultivated grain (others are rye and barley). In 2006 approximately 140,000 hectares (ha) of wheat was grown in the Netherlands, resulting in 1.2 million tons of wheat (FAO, 2007). The quality of the wheat determines how it can be used. There are four main processors of wheat in the Netherlands: the milling industry, the feed industry, the starch industry and the bio-ethanol industry. These industries are described in more detail in Chapter 4 but it is essential to understand that the wheat utilized in the milling industry for bread-preparation purposes, is the wheat with the highest added value.

Bread can be baked from each batch of wheat produced, but its quality can vary tremendously. In the Netherlands, highly risen bread with a lightly coloured crust and a light structure is popular but to create it, the requirements are high of the most important raw material, wheat. Wheat that does not meet these high standards ends up being used in one of the other processing industries. High quality wheat that is suitable for the milling industry, "milling-wheat", is the product to which the most value is added, or in other words, the product for which wheat growers receive the highest price. Forty years ago, 40% of Dutch wheat was used by the milling industry (Kauderer, 1993). However this has changed considerably. Currently, milling companies utilize only 15% (approximately 180,000 tons) of Dutch wheat to produce meal and flour for bread production (GZP, 2007).

Wheat can also be used for other human food sources such as pasta and biscuits. It has to meet quality standards to be used in the production of these items too and relatively high prices are paid. Pastas like macaroni, spaghetti and vermicelli are made from durum wheat, which is cultivated in Mediterranean areas, but cannot grow in the Netherlands. So far as biscuits are concerned, the type of wheat used, must have a low protein content but it is very difficult to produce wheat with a very low protein content (less than 10%) in the Netherlands. Furthermore, the type of wheat grains used for biscuit production is soft, whereas the types of wheat suitable for the Netherlands contain hard grains (Darwinkel, 1997). Accordingly, in the Netherlands the highest added value can only really be achieved with wheat that is suitable for bread production. This study will focus on this wheat, known as milling-wheat (in Dutch: baktarwe).

1.2.2 Interest in milling-wheat

The milling company that is participating in the KodA-program is the biggest company of its type in the Netherlands. It only uses 10% (approximately 63,000 tons) of Dutch wheat for the production of meal and flour. The other 90% of their wheat comes from abroad (NVM, 2007). The company recently stated that it wanted to increase its use of Dutch wheat. By doing so, their transport costs would decrease and delivery reliability would increase. The company assumes that it would be possible to use 20% of Dutch wheat (approximately 126,000 tons) in its production processes. For their part, growers and collectors of Dutch wheat are also interested in the idea of the milling companies utilizing more Dutch wheat, since they are the processors of it who pay the highest prices. However, the wheat growers who are participating in the KodA-program have doubts about the feasibility of the stated aims of the milling company concerned. They argue that significant problems exist with the utilization of Dutch wheat by milling companies, and consequently with bread production. They also foresee obstacles in their own business processes so far as growing milling-wheat is concerned, and in the business processes of the various other members in the supply chain, especially so far as marketing it is concerned. The Dutch wheat growers who are participating in the KodA-program have asked for greater clarity about the possible ways of utilizing more of their wheat in bread production. Of course, this issue concerns all Dutch wheat producers and not just those participating in the KodA-program. It also affects the wheat collectors, as they are the ones responsible for marketing most of the wheat produced to the milling companies, and it affects the milling companies themselves. Therefore Dutch wheat growers, collectors and milling companies are seen as the clients and beneficiaries of this research. Together with the plant breeders, these three groups in the supply chain are the primary actors of the milling-wheat supply chain. However, utilization of wheat for bread production concerns not only the primary actors of milling-wheat supply chain but also the secondary actors, which include the bakeries, the supermarkets and the consumers, who must also be taken into account. Nowadays supply chains are transformed from "pushed by supply" into chains "pulled by

demand". Therefore the actors in the secondary part of the milling-wheat supply chain may well have influence on which opportunities for innovation are adopted by those in the primary part of the chain. In the first paragraph of this chapter, I noted that innovations could strengthen the arable farming sector. Indeed, innovations will enable arable wheat growers to grow and market crops with a higher added value. As a result of this, the issue of supply chain innovations plays a central role in this research. I specifically considered how innovations in this chain could contribute to the increased utilization of Dutch wheat in bread production. This resulted in the following research goal:

Providing clarity about ways of increasing the utilization of Dutch wheat in bread production by means of supply chain innovation

1.3 Central question

Based on the research goal presented in the previous paragraph, the following central question is formulated:

What are the ways of increasing the utilization of Dutch wheat in bread production by means of supply chain innovation?

As explained previously, the term "milling-wheat" means wheat that is suitable for the purpose of bread-production. Therefore the term "Dutch milling-wheat supply chain" refers to all of the links in the primary and secondary parts of the wheat supply chain, with the focus being, to a certain extent, on its end product, namely "bread".[1] [2] In particular, I focused on companies in the supply chain who are based in the Netherlands. Since the Dutch arable farming sector plays a central role in this thesis, the term "Dutch wheat" refers to wheat cultivated by wheat growers on fields in the Netherlands. Transporting wheat over great distances is not worthwhile and accordingly attention should automatically be paid to collectors and milling companies with establishments in the Netherlands. These milling companies in turn deliver most of their products to bakeries established in the Netherlands and the bread produced by these bakeries is consumed by Dutch consumers (whether or not via the supermarkets). Theoretically, the amount of Dutch wheat produced every year is sufficient to meet the demand for bread from Dutch consumers. Furthermore, if I had also chosen to take account of actors in the chain who are based outside The Netherlands, my research would have been too extensive bearing in mind the limitations of time I faced. However, many companies with establishments in the Netherlands also operate in an international arena, and so the influences of foreign companies are to some extent taken into account. In this research with the word "actor" is mentioned a group of supply chain members, in example the wheat growers, the collectors et cetera. When I refer to an individual actor, a single wheat grower or collector is mentioned. Finally, the term "supply chain innovation" refers to an

[1] Traditional mills are not taken into account because of their small size: they produce only 2% of the total Dutch production of meal and flour.

[2] Wholesalers of meal and flour are another chain partner of the secondary part of the chain, but not described separately. It would not contribute to this study so much as problems in the supply chain are more in the primary part of the chain. However the wholesalers are described shortly in this research and their influence on power positions of other actors are taken into account too.

innovation that affects more than one actor in the supply chain and can be realized by either one of the (individual) actors, or by the cooperation of several of them. Chapter 2, headed "Theoretical framework", contains more about supply chain innovation.

1.4 Research questions

The central question in this thesis is resolved by answering six research questions, which are outlined in this paragraph. To provide clarity about the ways to increase the utilization of Dutch wheat in bread production, it is first necessary to examine the Dutch milling-wheat supply chain. To provide the best overview, the actors in both the primary and secondary parts of the chain are outlined. As the majority of Dutch wheat is used in processing industries other than the milling industry, these other wheat-processors are also briefly discussed. This results in the first research question:

1) What does the Dutch milling-wheat supply chain look like?

In this study it is assumed that supply chain innovations are needed to remove problems in the primary part of the supply chain. However as the various actors in the milling-wheat supply chain possess varying degrees of power, not every participant should be expected to be able to enforce supply chain innovations. Accordingly, the power possessed by each of the chain's actors is analyzed, so that it is possible to identify which of them is able to contribute towards enforcing innovation. However, the differing levels of power of the various actors in the supply chain can also cause problems. This leads to the following research question:

2) What are the power positions of the actors in the Dutch milling-wheat supply chain?

Problems relating to the utilization of Dutch wheat in bread production are observed in the primary part of the chain. Therefore, in order to consider how these obstacles can be removed by use of innovations to it, these problems must first be identified. The third research question is:

3) What are the problems in the primary part of the Dutch milling-wheat supply chain?

When the precise factors that cause difficulties for the utilization of Dutch wheat in bread production have been clearly identified, it becomes possible to examine precisely how specific innovations can contribute to the removal of these problems. As this concerns research into a supply chain, only supply chain innovations are considered. This results in the fourth research question:

4) Which supply chain innovations are needed to remove the identified problems?

Once possible innovations have been found to deal with the problems in the primary part of the supply chain, attention must turn to how to put these innovations into practice. Therefore, in order to determine ways of increasing the utilization of Dutch wheat in bread production, there must be careful consideration of whether the suggested supply chain innovations can be realized. This is dealt with by answering the fifth research question:

5) Is it possible to realize these supply chain innovations in the current circumstances?

When/if it transpires that the proposed innovations cannot come into force in the circumstances that currently exist in The Netherlands, the final research question concentrates on ways to ensure that the innovations are realized in the near future, meaning within ten years. The final research question is:

6) What is the possibility of these supply chain innovations being realized in the near future?

In the next chapter, the execution of these research questions is outlined in more detail by using a theoretical framework.

1.5 Research approach

A qualitative survey suits this study best as it allows the views and opinions of the various actors in the supply chain to be clearly outlined. This includes not only their views about the current situation but also their ideas for the future. My research questions are answered by way of interviews held with various members of both the primary and secondary parts of the wheat supply chain. As there is the possibility that opportunities could arise that might be applicable to companies with a non-representative business process, I have chosen to not only describe typical cases. This resulted in there being a choice for the interviewees, which was based on theoretical considerations. Together with a key informant of the Commodity Board for Arable farming (Hoofdproductschap Akkerbouw (HPA)), a representative selection of people who represented several parties in the supply chain was made. Not only do different parties exist in the chain but there are also differences within each specific participating group. However, there is a high degree of heterogeneity among the research group. As a result, a large sample was needed in order to get a complete overview. To enable me to probe the opinions of the interviewees as deeply and thoroughly as possible, and to allow me access to as much data as possible, it was essential to build up a trusting relationship with the participants. Because of this, the decision was made to conduct face-to-face interviews and to use an open, flexible manner of data collection, namely semi-structured interviews. The complex and holistic nature of the research and the goal of gaining the most complete overview of the situation possible, contributed to the decision to apply data and a methodological triangulation. An extensive and more detailed description of the research approach is outlined in Chapter 3 “Methodology”.

1.6 Overview of chapters

In the first chapter entitled “Introduction,” the reasoning behind my chosen research topic and my research goal is presented. Thereafter, the central issue of the research and six related questions are outlined. In addition, the approach I have taken is summarized briefly. In Chapter 2, “Theoretical framework,” the results of a literature study I conducted, in order to lay a solid foundation for this study, are discussed. With a theoretical framework based upon this literature, the six research questions already referred to are further explored and outlined. In Chapter 3, “Methodology,” I describe the way in which data was collected and analyzed so as to enable me to answer the research questions. In Chapters 4 - 9 the results of the research are discussed. In each of these chapters one of the six research questions is answered. Finally Chapter 10, “Conclusion and recommendations,” deals specifically and in detail, with the answer to the central research question. Additionally, I set out my recommendations to the various actors in the Dutch milling-wheat supply chain.

2 Theoretical framework

In this second chapter, the outcome of a literature study is described, resulting in a theoretical framework for this thesis. Within this framework, the six research questions referred to in Chapter 1 are further outlined. The purpose of this research is to predict how a supply chain would behave with regard to innovations. Because differing power positions determine the behaviour of a supply chain (Wassenberg, 1980), it is important to analyze the power positions of the various supply chain actors with whom I am concerned. The first paragraph of this chapter is based upon the question: "What determines power in the supply chain?" Once this is known, consideration can be given to the preconditions necessary for the realization of potential supply chain innovations. Only the essential preconditions are examined, as it is only these that offer up realistic possibilities for realization. Providing a full description of how innovations should be carried out in different circumstances, would not contribute to this research. The question discussed in the second paragraph of this chapter is as follows: "What determines the realization of supply chain innovations?" With the outcomes of the first two paragraphs known, the theoretical framework is presented in the third paragraph.

2.1 What determines power in the supply chain?

To begin with, the concepts of power and how it is gained are discussed. Thereafter, the relative power within the supply chain is clarified, which firstly necessitates examination of the concept of a supply chain. The theories of Pfeffer and Salancik (1978), Mintzberg (1983) and Hickson, Hinings, Lee, Schneck and Pennings (1971) are central. With the help of these established theories, the relative positions of power between the various actors in the chain can be examined. By simply describing power relationships, the implication is that it is just about intra organizational relationships. Pfeffer and Salancik (1978) and Mintzberg (1983) do describe power in this way. However, Hickson et al. (1971) consider the relationships between the different parts within an organization, namely inter organizational relationships. A precondition for the use of their theory is reciprocal dependency and interaction between the actors in a system. As a supply chain meets this precondition, the theory can be used.

2.1.1 Power and resources

An article by Dahl, called "The Concept of Power," which dates from 1957, is often cited when describing the concept of power. Dahl (1957, p.203) declared "A has power over B to the extent that he can get B to do something that B would not otherwise do". Pfeffer and Salancik (1978, pp.53-54) concur, stating "Power is the capability to realize own goals, even in resistance against others, whereby that capability is based on the possibilities to enforce certain sanctions. This sanction possibility lies in the fact that organizations are interdependent on each others resources in their functioning".

That resources are closely allied with power becomes clear when the resource dependency theory of Pfeffer and Salancik (1978) is examined in more detail. This theory brings the very existence of organizations up for discussion and goes into the question of how an organization can survive by managing its relationship with the environment. Contrary to other authors, Pfeffer and Salancik (1978) do not consider the management of product-market combinations to be a precondition of the existence of organizations. The authors state that the gaining, managing and controlling of resources is decisive for the survival capacity of the organization. To survive, organizations need resources. However, as a single organization cannot hope to gain its entire resources internally, it is of great importance that it is also able to attract external resources. Because resources are not divided equally between organizations, also called resource asymmetry, certain power relationships between organizations come into existence. These power relationships can determine whether organizations can succeed in developing their own business, or can influence relevant organizations in their environment to the desired degree and in the desired direction (Pfeffer & Salancik, 1978; Pfeffer, 1982).

According to Pfeffer and Salancik (1978), the possession of power by one actor turns on the disposal of resources that the other actor requires. Consequently, one actor is dependent upon another who is in possession of a required resource. This is borne out in Emerson's comments (1962, p.33) about power and dependency: "Power resides implicitly in the other's dependence." The power that B has over A is similar to the dependency of A on B, with A's dependency arising out of his need for the resources possessed by B. Frequently both actors in the chain are dependent upon each other to a certain extent. Pfeffer (1981, p.99) states that when A receives a resource from B that is more important than the resource that B receives from A, A is therefore more dependent upon B than B is dependent upon A. In these circumstances, B has power over A. Therefore, as the dependency of one organization in relation to another increases, due to the other organization possessing more of the resources that the dependent organization requires, the potential influence or power of this other organization increases. In other words, the dependent organization has to take more account of the organization with the resources. Conversely, as the dependency of one organization increases, the ability of the organization with the resources to exert its influence increases (Stijnen, Scheer, Martins & De Graaff, 2002, p.25).

2.1.2 Uncertainty and resources

Pfeffer and Salancik (1978) state that access to external resources increases the survival chances of an organization, or put differently, reduces uncertainty about its existence. Mintzberg (1983) also states that power can be gained with the possession of resources that another actor has an interest in and he raises the issue of uncertainty more explicitly. The author declares that the dependency of one actor on another can be seen as a gap in the power system of the dependent actor, which is also called uncertainty (see also Crozier, 1964; Crozier & Friedberg, 1980). Uncertainty arises from a lack of certain resources. To fill this gap an actor depends upon another who is in control of these resources. The resources can be of a financial, material or contractual nature, but can also involve technical skills or knowledge. Furthermore, power can be generated from exclusive rights by which choices can be enforced. Power can also be gained from having access to another actor who in turn has access to one of these resources (Mintzberg, 1983, p.24).

Like Mintzberg (1983), Hickson et al. (1971) also examine the concept of uncertainty, describing how organizations have to deal with this issue. Uncertainty can be described as a lack of information about future events. Organizations are concerned about uncertainties during the gathering of resources, the process of throughput and the disposal of outputs. Organizations need

resources to cope with these uncertainties and in order to carry out their work effectively. Coping with uncertainty can be achieved by prevention (forestalling uncertainty), by information (forecasting) or by absorption (action after the event). It is not uncertainty itself that gives power but being able to cope with uncertainty does do (Hickson et al., 1971, p.219). A resource, which ensures that uncertainty can be coped with, gives power.

2.1.3 The degree of power

Accordingly to Mintzberg (1983) three characteristics exist that create power. Firstly, the resource that an organization possesses must be of importance to another organization, namely resources that are needed to carry out that organization's business and/or resources that reduce uncertainty for it. Secondly, the degree of power that an organization possesses depends upon the degree of concentration of the resource. More power is gained when resources are in short supply or are in the hands of just one or a few organizations working together. Finally, power is gained when the resource cannot be easily replaced (Mintzberg, 1983, p.24). Hickson et al. (1971) declared that an organization has power over another when the organization has the capacity to fulfill the requirements of the other organization. This fits with what Mintzberg (1983) states; resources must be of importance to another organization. Furthermore, Hickson et al. (1971) also discussed how the concentration of resources determines the degree of power, when they stated that an organization possesses more power when it is the only one possessing these resources. In addition, Mintzberg (1983), Hickson et al. (1971) and Pfeffer (1981, p.99) highlight this issue of the concentration of resources. When two actors are dependent upon each other to a certain extent, the one who is able to obtain resources from elsewhere has the most power.

2.1.4 Power and the supply chain

To indicate how these theories can be applied to demonstrate the current power positions of the various actors in the supply chain, I need to firstly define what is meant by this term, supply chain. There are a number of definitions of this concept. An examination of Van der Vorst's thesis (2000) confirms this by providing fourteen separate definitions of a supply chain. From this extended list, I have chosen the following for use in my work: "A chain is the network of connected and interdependent organizations mutually and cooperatively working together to control, manage, and improve the flow of materials and information from suppliers to end users" (Christopher, 1998, pp.18-19).

From this definition it becomes clear that the actors in a supply chain are linked to each other because of their need for each other's resources (materials and information). Each one produces as good a product or service as possible, in an attempt to make others enthusiastic about it. Valuable financial resources can be gained by selling on their product or service, thereby ensuring their continued existence. Accordingly, it can be seen that every actor is part of one or more supply chain(s) (Lazzarini, Chaddad & Cook, 2001); they produce something in which another is interested. What is produced serve as resources for the preparation of products and services of the next actor in the supply chain. As a result, dependencies arise between those in the chain. They work with each other, looking in the same direction towards a particular end product, namely the end product of the supply chain. The logistics of the primary processes that are needed to generate the end product of the supply chain, serve as a basis for this (see also Van der Aa & Konijn, 2002). The nature of the supply chain's end product determines who the actors are and what resources are needed. These resources and the dependency upon them, generate the relative positions of

power between those involved in the supply chain. By analyzing these power relationships, the behaviour of the supply chain can be seen (Wassenberg, 1980).

2.1.5 Discussion

As this research concerns one supply chain in particular, the actors who are central to it are automatically determined. Precisely who is dependent upon whom to obtain their resources is settled in the primary processes of the supply chains' end product. These said processes also determine the resources required. Accordingly, in these circumstances, there is no need to investigate the degree to which these resources can be substituted, in what Mintzberg (1983) described as the third characteristic. However the other two characteristics do have to be taken into account, namely the importance and concentration of the resource. Resources become important when an actor in the supply chain needs them to carry out his tasks and/or when the availability of resources reduces uncertainty. All the actors in the supply chain are interested to some extent in the resources of the others because they are all members of the same supply chain. The issue is the exchange of resources; two actors are dependent upon each other's resources. The actor of the chain who is most dependent upon the resources of another, or, to put it differently, the one for whom the resources of another are the most important, is the least powerful one of the two supply chain actors.

A resource is regarded as being concentrated when it is supplied by only one, or a by a limited number of actors and/or when it is in short supply. When an actor of the supply chain (nota bene: in this research "actor" means a group of the supply chain) who is in possession of the resource consists of only one individual, and yet there are many actors of the chain (individual actors in one supply chain group and/or other groups in the supply chain) who require that resource, a monopoly is created. An oligopoly exists when the supply chain group in possession of a resource consists of only a few individuals and the supply chain group wanting the resource contains many individuals and/or when there are more supply chain groups wanting the resources. In such a monopoly or oligopoly, the resource is concentrated in the hands of a few suppliers. The suppliers of the resource have power over those who want it. However, in order to gain power as a member of an oligopoly, the suppliers of the resource must work together in controlling it. Actors in other supply chains can also influence the power relationships between those in the supply chain being investigated here. This occurs when an actor in a supply chain demands a resource that can also be supplied by actors in another supply chain. For example, this takes place when A can obtain resources from B, who is a member of a particular supply chain, but also from C who is in another supply chain. C, who is in one supply chain, influences the relationship of power between A and B in a different supply chain. The power of B over A decreases because of the existence of C, who also possesses the resources that are of importance to A. When C's resources are more important to A than B's resources, B's power over A decreases further. Therefore, in examining the power relationships between actors of a certain supply chain one must also consider the possible influence of actors of other supply chains. A resource can also become concentrated when it is in short supply on the market. Let us assume that there are two actors of a supply chain, who have an equal need for each other resources and that the numbers of suppliers of the resources are the same for both of them. If the resource that A supplies is in short supply, unlike the resource supplied by B, A has power over B.

2.2 What determines the realization of supply chain innovations?

To answer this chapter's second question, the concept of supply chain innovation is set out. Thereafter, the necessary preconditions for innovation in general are examined. In order to formulate the preconditions, innovation processes themselves are considered because from these the need for innovation arises. The theory of Rothwell and Robertson (1973) is used since these authors give a clear description of a more general linear innovation process. Additionally, attention is paid to the work of Pinch and Bijker (1984), who go a step further than other authors, by describing the process of technology development as multi-directional. Although these theories are specifically concerned with technological innovation and development, they can also be applied to the issue of innovation in general. Thereafter, I relate these preconditions to supply chain innovation. Central to this is how these preconditions can be met in supply chains and I combine several theories here. Finally, consideration is given to how the situation can change so that supply chain innovation becomes possible. The theories of Frooman (1999) and Blau (1964) served as guidelines for this, as they describe how power can be used to change a situation.

2.2.1 Supply chain innovation

Nowadays innovation is a concept talked about everywhere. Companies see it as one of the most important factors in gaining a competitive advantage (Lukas & Ferrell, 2000; Tidd, Bessant & Pavitt, 2005; Lawson & Samson, 2001). Other authors emphasize the point that being innovative has become a necessity for companies (see for example Bessant, 2003). As long ago as 1947, Schumpeter discussed innovation as the creation of new combinations, which can be "a new product, a new technology for an existing application, a new application of technology, the development or opening of new markets, or the introduction of new organizational forms or strategies to improve results" (1947, p.66). Innovations can be typified as radical or incremental (Damanpour, 1988), technical or administrative (Daft & Becker, 1978), loose or tight (Tornatsky & Klein, 1982) et cetera (see also Wolfe, 1994). So far as the subject of this research is concerned, namely supply chain innovation, what is important is whom the innovation affects and not the particular type of innovation. Most theories tend to discuss innovation as it affects one company and supply chain innovation is hardly discussed in academic literature.

There is written a lot about innovation and dyadic relations such as buyer-supplier relations (Hånkansson, 1982, 1987; Campbell, 1997; Nooteboom, 1999; Kim, 2000; Sandhaya & Mrinalini, 2002; Knudsen, 2007). However, studies within a simple supply chain consisting of only one manufacturer and its single supplier are too limited for this supply chain study. An analysis from a dyadic (or triadic) perspective must be further extended to include the multiple echelons of the supply chain to understand power influences in the supply chain which affect innovation. Omta (2002, 2004) has given an initial impetus to supply chain innovation. He focuses on the question whether cooperation can be realized or not in a chain or network to come to innovation. Omta (2002) argues that the balance of power in a chain or network should be considered, as it plays a role by the realization of innovation. He states that a map of values and interest of relevant actors in the network should be made. However Omta (2002) does not present a model by which these interests or power aspects can be set out. Also Stijnen et al. (2002) undertook a study on supply chain innovation. The authors concluded that collaboration in a chain encourages successful product innovation and product introduction in agrifood chains. In their explorative study Stijnen et al. (2002) exclusively took into account product innovation and tested this in only one supply chain. Therefore the study of Stijnen et al. (2002) could be mentioned as a first start to gain more

insights in supply chain innovation too. It is worthwhile to mention the quantitative study on 328 firms in the Dutch agrifood industry of Batterink, Wubben and Omta (2006). The authors made clear how the role of the network impacts the innovativeness of individual firms. Although the authors discussed innovation and networks (or supply chains), the study focused on firm level not on the level of the supply chain.

In this research purpose is to predict how the Dutch wheat supply chain will behave with regard to innovation. Therefore innovation must be seen in the context of the supply chain, implying that it affects more than one company. Otherwise it would be company innovation. Moreover, innovation should concern companies from different supply chain groups (referred to as actors in this research) to be called supply chain innovation. Therefore, in this research affecting more than one actor in the supply chain is a precondition of supply chain innovation. Omta (2002, 2004) and also Stijnen et al. (2002) took supply chain innovation similar to cooperation for innovation. However this is not the case in this research. Indeed several actors of the chain, cooperating with each other could realize innovation. Alternatively, it may be that just one (individual) actor of the supply chain can realize an innovation in it. Cooperation should be seen as the sharing of resources, as it does not only involve the exchange of resources (more about cooperation for innovation is set out in sub paragraph 2.2.5 "Supply chain innovation by cooperation"). Before the issue of realization of supply chain innovation is further examined, one must first be aware of what is required to realize innovation in general, so-called preconditions for innovation. This is dealt with in the following sub paragraph.

2.2.2 Resources for innovation

The first paragraph of this chapter reveals that an organization needs external resources to maintain its existence. However, an organization not only needs resources to survive but they are also of great importance for innovation (Narayanan, 2001); nota bene innovation is also seen as a prerequisite for an organization's existence (Bessant, 2003). Prahalad and Hamel (1990) state that having at one's disposal the resources required for innovation is decisive in whether one is to able to innovate successfully. Further, Burgelman and Maidique (1988) state that the ability to direct resources, correctly and effectively to where they are required, is of great significance for innovation. This has long been recognized as critical to innovation success.

A long innovation process precedes the realization of innovation. Within this process different resources are needed at different times. This becomes clear when the innovation process is considered. There are various viewpoints about how an innovation process should look and what the source for innovation should be. Burns and Stalker (1961) saw innovation as almost synonymous with the term invention (here it concerned technological innovation in particular), in which the "mother of invention" could be seen in the Research and Development (R&D) department. In this innovation process, innovations are pushed from the R&D department to the market ("market push"). But innovations can also come from a market demanding new products and processes ("market pull") (Mcloughlin & Harris, 1997). Freeman, Clark, and Soete (1982) combined these two views and stated that (technological) capabilities and market needs should be "matched" together within the innovation process. "On the one hand, it involves the recognition of a need or more precisely in economic terms, a potential market for a new product or process. On the other hand, it involves (technical) knowledge, which may be generally available, but may also often include new scientific and technological information, the result of original research activity" (Freeman et al., 1982, p.34). Also, Rothwell and Robertson (1973, p.206) make clear that both the current state of society's aims and needs and the marketplace on the one hand, and the

store of current scientific, technical and production know-how on the other hand, influence the innovation process. Thus it can be seen that a resource for innovation is knowledge, which is market knowledge and also technical knowledge. From the innovation process itself, which contains six steps, as modelled by Rothwell and Robertson (1973), the resources needed for innovation can be applied. The authors see "idea generation" as the first step on the path to innovation. In step two "project definition," the idea behind the innovation is transformed into a project, in which the problem that the idea addresses is defined. The third step "problem solving," is to find a solution to the problem, resulting in a deliberate search for information, both from within and outside the innovating organization. In the fourth step "design and development", by using the information acquired, the innovation is created. In step five "production" and step six "marketing" the innovation is produced and then taken to the market place. Both step three, "problem solving" and step four, "design and development" take place mostly in R&D departments. According to Rothwell and Robertson (1973) this department is central to the innovation process. Step three "problem solving" can be seen as the research phase in which information is created by a search for knowledge, mostly containing a scientific process of experimentation. In the development phase, which is step four "design and development", this created information is physically embodied in a product, service or procedure, namely the innovation. Along with the resource of knowledge (market and technical), skills are also essential to the innovation process. In the R&D department, skills are needed to carry out the scientific experimentation (Nederlof, 1997) and to turn the developed knowledge into real innovations, the physically embodied products, services or procedures. However, this theory does not mention that innovation requires capital as well as knowledge and skills. Carrying out tests in R&D departments requires financial resources. Indeed, the same applies to the steps of product, service or procedure realizations.

2.2.3 *Interest in innovation*

For many authors the innovation process is seen as a linear process (Archer, 1971; Baker & McTavish, 1976; Cooper, 1983; Saren, 1984). Pinch and Bijker (1984) criticize these linear innovation processes:

> "Most innovation studies have been carried out by economists looking for the conditions for success in innovation. Factors searched include various aspects of the innovating firm (…) along with macroeconomic factors pertaining to the economy as a whole. (…) The failure to take into account the content of technological innovations, results in the widespread use of simple linear models to describe the process of innovation. (…) Linear models contributed much to our understanding of the conditions for economic success in technological innovation, but technology is treated as a "black box" with essentially "given" characteristics and capabilities in these models" (Pinch & Bijker, 1984, pp.21-22).

Pinch and Bijker developed their Social Construction of Technology (SCOT) approach. They state that technological innovation should be regarded as "multidirectional" instead of linear. In reality (technological) innovation involves competition and conflict between the views of relevant "social groups" who share a particular set of understandings and meanings about the technology (or here innovation). These groups will have different views about the most appropriate design of the artefact, or even whether it is a desirable technology (or here innovation) at all (McLoughlin & Harris, 1997, p.14). Latour (1997) also demonstrates that active social networks and political struggles constitute an essential part of scientific innovation.

Narayanan (2001, p.6) states that: "Technology development is a process of social construction: The development is the outcome of human beings actively making choices, individually and collectively." Two aspects of technology play a role in the choice of a certain technological development (Narayanan, 2001, pp.6-7), or here innovation:

> *Opportunity* – Technological development takes place when people perceive an opportunity for improvement due to either intrinsic or economic reasons.
>
> *Appropriability* – In many cases, where the technological development is due to economic motives, individuals will pursue development only to the extent that there is a reasonable assurance that the fruits of their labour will flow back to the developers.

A choice of an innovation can evolve out of the following motives (Nijdam & De Langen, 2006, pp.54-55; based on Porter, 1990):

> *Competition* – A company can invest in innovations with the purpose of producing a better product than its competitors. Besides, an extension of a product's series can increase one's lead over the competition.
>
> *Direct demand of customers* - Particularly in business-to-business markets, relationships between suppliers and buyers are often direct. Customers' needs can be so demanding that a supplier has to search for innovations.
>
> *Cost savings* – Innovations that take place in an organization or production process often arise out of cost savings, for example by making the organization flexible, or decreasing the utilization of raw materials, energy or labour.
>
> *Regulations* – The formulation of quality prerequisites or prerequisites concerning safety and pollution, can result in organizations putting more effort into seeking innovations in these areas.

From this it becomes clear that not only are resources a prerequisite for innovation but that in choosing a particular innovation, the innovation itself should have a serious meaning for the innovators. In other words, they must have sufficient interest in the innovations. Accordingly, the two preconditions for innovation are resources for it and interest in it.

Russell (1986) criticizes Pinch and Bijker's theory (1984) and states that "an explanation of technological change must show not only what different social groups think about an artefact, but also what they are able to do about it – their differing abilities to influence the outcome of its development and adoption" (Russell, 1986, pp.335-336). Not all groups have the power to bring about change to suit their objectives. Power results from possessing resources. Only those who own the resources needed for innovation can bring about change. To succeed, these same actors must accept that there is a need to innovate. For innovation to be realized, those who possess the resources needed must also have enough interest in the innovation to be prepared to provide them. Accordingly, these actors have a dominant role over the whole process of innovation.

2.2.4 Supply chain innovation by one (individual) supply chain actor

As already stated, innovation requires resources. It might be that one individual company or one actor in the supply chain is able to provide the resources required for the innovation, without the help of others in the chain. In this scenario, such an actor has a dominant role over the entire innovation process. It is able to make decisions about changes that may affect others in the supply chain, without taking their views into account. Therefore, according to De Man (1993), this supply chain actor is the central authority and central coordinator of the supply chain (see also AWT, 2004). The power positions of the various actors in the chain are important factors in defining how much power and influence they have on it and therefore how it behaves. Someone with a lot of power in the supply chain would not automatically have a dominant role over a particular supply chain innovation. The resources, by which significant power has been gained in the supply chain, might not be those needed for innovation. However, a member of the supply chain with a great amount of power is able to effectively resist any proposed innovation that he does not support.

Why would an actor in a supply chain act autonomously and realize an innovation that affects other actors? Based upon the definition of a supply chain described in paragraph 2.1.4 "Power and the supply chain," it is clear that a certain level of cooperation exists between its members so far as its end product is concerned, in other words, they have a collective goal. However, at the same time, these members are autonomous organizations with their own goals, interests and resources and it cannot be taken for granted that these are always the same. Van der Aa, Beemer, Konijn, Van Roost, De Ruigh and Van Twist, (2002, p.10) state: "A supply chain is directed to a certain extent to bring about harmony in activities and products (…) But besides there is a natural degree of tension between the interests of the several supply chain actors: dependency and at the same time autonomy." It is clear therefore that it should not be assumed that an innovation in the supply chain by one member is favoured by all of its other members. It may be that some are charged by others for an unwanted innovation. Other reasons why an actor in a supply chain might autonomously realize an innovation can be found in Narayanan 's book (2001, pp.289-290). Innovation that is brought about by cooperation can have real disadvantages, such as the risk of losing the right to intellectual property, as well as competitive and organizational risks. Dividing intellectual property rights among several members can generate problems. Competitive risk refers to the danger that companies will begin to imitate and attempt to compete with each other. Organizational risk refers to problems that can arise out of the way that joint ventures are managed.

2.2.5 Supply chain innovation by cooperation

The processes of innovation are always beset with uncertainty (Dosi, 1988). Uncertainties are caused by a lack of information (Hickson et al., 1971) but can also be caused by doubts about the technical and economical problems that innovation might bring and the desire to know all of the steps of the innovation process beforehand. Wolfe (1994, p.411) states "uncertainty is an attribute of innovation and can be defined as the knowledge concerning the link between the innovation's inputs, processes, and outcomes" (Based on Pelz, 1985; Zaltman, Duncan & Holbek, 1973). The perception of uncertainty influences the management of organizations (Damanpour, 1996). As esteemed as the innovation process is, it also leads to a high degree of uncertainty for an organization, which discourages it from innovating and so an innovation does not get off the ground. More often than not, uncertainty about innovations can be reduced if other companies are involved who can also conduct activities related to it. Hånkansson (1987) states that innovation

requires resources and these resources are normally limited within each organization. Most resources for innovation must be acquired with the help of external companies. Clark and Staunton (1989) confirm this. They explain that all innovations require an investment of resources and that the innovation process is not a series of events that occur exclusively within the boundaries of a specific organization. The whole process is grounded in, and contextualized by, its links with external networks, pressures, and forces (Clark and Staunton, 1989, p.202). An exchange of resources with other organizations can provide access to those resources that one company cannot get by itself. However, the exchange of external resources with other companies is not dealt with in this sub paragraph.

When organizations do not have the ability to innovate on their own, they often explore the possibility of co-innovating with other organizations (Bossink, 2002; based on Miles & Snow, 1986, 1992; Ibarra, 1992; Powell, Koput & Smith-Doerr, 1996). Bossink (2002, p.314) describes how the process of co-innovation, occurs. This co-innovative process consists of four stages:

> *1) Autonomous strategy making* – The organization chooses, or is forced to innovate and explore co-innovation possibilities with others.
>
> *2) Cooperative strategy making* – The organizations negotiate about costs and revenues with each other.
>
> *3) Founding an organization for co-innovation* – Organizations establish governance bodies in which they are represented.
>
> *4) Realization of the innovations* – Organizations use methods of managing the process of innovation realization by the use of champions and leaders who drive the creative process, while the organizations themselves deal with the market.

Based on this model, in my research the strategy of cooperating for the purpose of innovation is seen as organizations actively working together in a specifically constituted body and sharing their resources, with the common goal of creating a supply chain innovation. Intensive interaction between the actors in a supply chain precedes cooperation for innovation (Håkansson, 1987, p.5). They not only examine cost-benefit considerations, but social-psychological aspects of trust also play a role in this process of interaction. In these circumstances, trusting the expertise of others is as important as trusting their reliability and integrity (Fisscher, Van Looy, De Weerd-Nederhof & Debackere, 2004).

What are the advantages of cooperation for innovation? By cooperating with others in the supply chain, uncertainty about innovation can be reduced because the process of sharing resources ensures that more resources become available. The theories of Mintzberg (1983) and Hickson et al. (1971) represented that resources can take away uncertainty, or can lead to it being coped with better. As outlined in sub paragraph 2.2.2 "Resources for innovation," in broad terms capital, knowledge and skills are the resources needed in an innovation process. Set out below is an outline of how uncertainty in the supply chain is reduced by the process of pooling resources, that arises from the process of cooperation:

> *Capital* - Some innovations need so much capital that organizations, especially small ones, are unable to generate this (Nederlof, 1997; Francois, Favre & Negassi, 2002). Amassing this capital in cooperation with others is easier and there is more certainty about meeting the capital requirements of the innovation. In addition, the uncertainty levels of the

autonomous organization are reduced as the investment risks are borne jointly and are therefore lower for the single company (Faems, Van Looy & Debackere, 2004).

Knowledge and skills – There are advantages to sharing knowledge, as it leads to a more complete and richer understanding of a subject, simply because it is being considered by more people. Accordingly, the knowledge base is enlarged. Together they can search for solutions that could pass their own limited insights by (Gray, 1989). Another advantage of working together for innovation is that it can bring about an increase in more general knowledge (Fames et al., 2004). Faems et al. (2004) also discuss how cooperation leads to there being access to complementary abilities and skills. Yet another example of an advantage of cooperation, in particular for a supply chain, is that the innovation can be managed better (Stijnen et al., 2002).

When cooperation is needed to realize supply chain innovations, the organizations that are working together are dependent upon each other. The organization with the most power is the one with the highest capacity for reducing uncertainty providing those resources that are essential to the innovation process. It has the dominant role over the supply chain innovation.

2.2.6 Change of situation

When it is not possible to satisfy one or both of the two preconditions, namely, resources for and interest in innovation, innovation cannot be realized. However a change of circumstances can alter this. For example, changes in an actor's environment (see sub paragraph 2.2.3 "Interest in innovation") can bring about a change of attitude to the process of innovation. Such a change of interest can also result from others in the supply chain exerting their power. Pfeffer (1992, p.29) presents a decision making process to follow when considering whether it is possible to exert influence over others to achieve a certain purpose:

1) Determine your goals.
2) Determine, based on dependencies in the power field, which actors are powerful and which are important to achieve your goals.
3) What are their visions? What do they think of the goals you want to achieve?
4) What are their power positions? Which of them determines the ultimate decision to a high degree?
5) What is your power position and your influence? Which power resource can you gain or develop in order to increase your control over the situation?
6) Which of the several strategies concerning the execution of power fits the situation most and will probably give the best results?
7) Make a choice of a strategy to reach your goals, based on the previous steps.

From this model it can be seen that those who are important to the success of the process of innovation, but are insufficiently interested in it to provide resources, can be influenced by the power of others. Applied to this research, actors in the supply chain who possess the resources needed to realize an innovation, but who are not interested enough in it to provide them, can be influenced by the power of others. The influencing strategy chosen should be the one that ultimately achieves the purpose behind it, innovation. The particular action chosen by the actor in the chain should depend upon the amount of power possessed by him in it. When a supply chain actor possesses some power in the supply chain but is unable to realize an innovation without the help of one or more other members of it, a direct influencing strategy should be chosen (Frooman,

1999). This strategy should relate to the resources from which the actor who wants to exert his influence, gains power (Frooman, 1999). When someone who has less power in the supply chain, has an interest in supply chain innovation but needs help of others in the chain to obtain the required resources, an indirect influencing strategy should be used (Frooman, 1999). Blau (1964) argues that when an organization foresees that its autonomy is liable to be affected by an imbalanced dependency of resources, it has four options:

1) *Cooperation* – Striving for an equal exchange of resources.

2) *Conflict* – Trying to obtain the resources with violence, coercion or pressure.

3) *Resignation* – Trying to operate without the resources.

4) *Getting round* – Trying to obtain the resources elsewhere.

In addition Frooman (1999) described five indirect influencing strategies:

1) *Norms* – An actor can indirectly influence another by influencing the norms that the environment puts on the actor concerned.

2) *Values* - An actor can indirectly influence another by influencing the values that the environment puts on the actor concerned.

3) *Decision agenda* – Indirect influence can be achieved by influencing the decision-making agenda of an actor, for example by attracting media attention to a certain subject.

4) *Decision process* – When the relevant subject is (already) on the decision making agenda of the actor, the one trying to exert his influence, can try to influence the decision making process.

5) *Ally* – When possible, it can be helpful to find an ally who is also trying to gain more power by influencing the actor. However, according to Frooman (1999) the choice of ally should be made with great care. Differing goals can lead to a negative outcome for the initiator of the alliance.

Irrespective of whether a direct or indirect influencing strategy is chosen, an actor must put effort into using his power if he is to achieve his purpose. "If orders cannot be given, battles will have to be won (…) Influencers pick and choose their issues, concentrating their efforts on the ones most important to them, and, of course, those they think they can win" (Mintzberg, 1983, p.25). Power should be also used cleverly (Patchen, 1974), by which is meant that political skill should be brought into play. Political skills are "the ability to use the bases of power effectively, to convince those to whom one has access, to use one's resources, information, and technical skills to their fullest in bargaining, to exercise formal power with a sensitivity to the feelings of others, to know where to concentrate one's energies, to sense what is possible, to organize the necessary alliances" (Mintzberg, 1983, p.26). Intrinsic leadership characteristics should be part of, what Kipnis (1974, p.88) calls personal resources: Charm, physical strength and attractiveness. Some actors are powerful simply because other actors support them: "The followers pledge loyalty to a single voice." However, in institutional settings personal resources are of limited value, so far as influencing behaviour is concerned, when they are not coupled with institutional resources of an economical or legitimate nature (Kipnis, 1988).

2.2.7 *Discussion*

A supply chain innovation affects more than one company or actor in the supply chain and can be realized by either one of them acting alone, or by the cooperation of several actors in the chain. Depending upon the type of resources needed for supply chain innovation, generally capital, knowledge and skills, it is possible to see which of the two approaches has the greatest possibility of success, namely realization of innovation. One company or actor in the chain can realize supply chain innovation, if it possesses all of the resources needed, however sometimes, regardless of these resources, cooperating to innovate has more advantages. However, in order to realize innovation, the supply chain actor(s) who possess the required resources must also be sufficiently interested in the proposed innovation to be prepared to provide them. The two preconditions for the realization of both general innovation and, as herein supply chain innovation, are resources for and interest in it. The actors' interest in supply chain innovation can be changed by the environment, which includes influencing strategies used by others in the supply chain who apply the power they possess (after it has been increased by indirect influencing strategies) to achieve innovation.

2.3 Theoretical framework

The power positions of the various actors in the supply chain should be examined but even by knowing these it is not possible to say, with certainty, which of these actors has power over supply chain innovation. However, knowledge of the power positions enables appropriate assumptions to be made, not only about the behaviour of the supply chain but also about supply chain innovation. The importance and concentration of a resource to a supply chain actor, defines the power of the actor in the chain who possesses the resource. It involves a mutually beneficial exchange of resources between supply chain actors. Therefore, to see who has the most power in a relationship, the importance and concentration of an actor's resources must be seen in relation to the importance and concentration of another actor's resources. To be able to analyze the resources possessed by actors in the supply chain, the primary process of the supply chains' end product should be considered. The reasoning behind what is required in the primary process to generate the supply chains' end product, determines both the resources needed and who the relevant actors are. To predict the likelihood of realizing a supply chain innovation, the actors in the supply chain firstly need to know which resources are needed. Based upon this information, and knowledge of the kinds of resources possessed by the various actors in the chain, consideration should be given to which form of supply chain innovation is most appropriate and is most likely to result in an innovation being realized, in example by one actor (or company) in the chain or by several of them cooperating. Thereafter, an examination should be carried out into how interested the actor(s) in the supply chain in possession of the resources required for a particular innovation, are in it. Levels of interest depend upon how important the proposed innovation is to an actor in the chain. If supply chain innovation is not feasible in the existing circumstances, consideration should be given to how the situation can be changed so as to increase the possibility of it occurring. The theoretical framework consists of five steps.

1) Consider the primary processes of the particular supply chain to determine the relevant supply chain actors.

2) Analyze the power positions of the supply chain actors. Power is based on the importance and concentration of an actor's resources in relation to another actor. As it

involves an exchange of resources, the importance and concentration of one actor's resources must be seen in relation to the importance and concentration of those possessed by another actor. What the relevant resources are can be deduced from the outcome of step one.

3) Consider the resources needed for innovation. Based upon these resources and the outcome of step two, there should be an examination of which form of supply chain innovation has the greatest chance of being realized; supply chain innovation by one actor or supply chain innovation by cooperation.

4) Define the level of interest in the supply chain innovation of the actor(s) in possession of the necessary resources. Decide if the opportunity currently exists to realize the supply chain innovation.

5) Determine if the situation can be changed by an alteration in levels of interest, whether or not caused by the influencing strategies of actors in the supply chain.

2.3.1 Research questions

In this sub paragraph the theoretical framework is transformed into the six research questions.

1) What does the Dutch milling-wheat supply chain look like?

To answer the second research question, which is about power positions in the supply chain, it is first necessary to examine the Dutch wheat supply chain itself. The focus is on the actors in this particular chain, but as most Dutch wheat is used in processing industries other than milling, these other types of wheat-processors are also briefly discussed. Both primary and secondary actors in the chain are taken into account as they can both have resources for and interest in certain supply chain innovations.

2) What are the power positions of the actors in the Dutch milling-wheat supply chain?

In this second research question, the power positions and relevant resources of the actors in the Dutch wheat supply chain are considered and analyzed. It always involves an exchange of resources between two actors who are dependent on the resource that the other has. As it entails such an exchange, the importance and concentration of the resources possessed by one actor must be seen in relation to the importance and concentration of another's. A resource becomes important to an actor, when it is needed to allow him to carry out his business and/or reduces his level of uncertainty. A resource is concentrated when it is supplied by either one individual (a monopoly) or by several of them working together to some extent (an oligopoly). It may concern either the suppliers of the resource within the Dutch milling-wheat supply chain or the suppliers in another (Dutch) wheat supply chain. A resource can become also concentrated when it is in short supply in the market.

3) What are the problems in the primary part of the Dutch milling-wheat supply chain?

In order to consider the resources needed for supply chain innovations, there should first be an examination of what innovations are needed to remove the problems regarding the large-scale utilization of Dutch wheat by milling companies. The third research question outlines the

problems faced by wheat growers and collectors and involves tracing the business processes of the primary chain. To be able to analyze where the problems are in the business processes of the primary part of the supply chain, it is firstly necessary to examine what are the standards for wheat that is to be used in bread-production.

4) Which supply chain innovations are needed to remove the identified problems?

Once it clear precisely what the problems are, so far as the large-scale utilization of Dutch wheat by milling companies is concerned, an examination into how these problems can be solved by innovation can take place. Here, supply chain innovations are considered, in example innovations affecting more than one company. These innovations should be described in detail to see how effective they could be at resolving the identified problems.

5) Is it possible to realize these supply chain innovations in the current circumstances?

The answer to this fifth research question should clarify if it is possible to realize the proposed supply chain innovations in the circumstances that currently exist. The resources needed for the supply chain innovations should be considered first, followed by an examination of the type of innovation that has the greatest chance of being realized. Is this going to be by one (individual) actor in the supply chain working alone or innovation by cooperation? Thereafter, the extent of the interest in the supply chain innovations by the actor(s) in possession of the required resources should be considered. Interest is based upon the importance of the supply chain innovation to the actors.

6) What is the possibility of these supply chain innovations being realized in the near future?

If it transpires that the proposed supply chain innovations cannot be realized as circumstances stand, the final research question concentrates on the possibility of the innovations bearing fruit in the near future (within ten years), due to changes in circumstances. Change can come about by shifting levels of interest in the suggested innovation, whether or not as a result of influencing strategies' employed by actors in the supply chain. Several scenarios, in which the opportunity to increase the likelihood of a supply chain innovation being realized, will be described.

In this second chapter, within the theoretical framework, the six research questions are explored and outlined. In Chapters 4 - 9 these questions are answered. However, before proceeding with this, the following chapter, "Methodology" sets out the way in which data was collected and analyzed, to enable the research questions to be answered.

3 Methodology

Paragraph 1.5 of Chapter 1 has already outlined the research approach. In this chapter, more detail is given about how the methods used in this research. The first paragraph describes why a qualitative survey fits this study best. The second discusses the selection of the interviewees and the third paragraph deals with the methods by which the data was collected. Data and method triangulation are applied. As interviews form the central data collection method, a sub paragraph is devoted to this. The fourth paragraph describes how data collection took place and the final paragraph provides more insight into the analysis of the data, which provided the answers to the research questions.

3.1 Research design: Qualitative survey

To examine the opportunities for increasing the utilization of Dutch wheat in bread production by way of innovation in the Dutch wheat supply chain, the views and opinions of the actors in the supply chain had to be analyzed. Realization of such an innovation is probably more difficult when the actors in the chain have differing opinions. Accordingly, both the similarities and dissimilarities between the ideas and points of view of the relevant actors had to be considered. Accordingly, I chose to conduct a qualitative survey. Such a research design enables opinions about current circumstances to be aired and ideas about the future to be debated and analyzed. Research into a supply chain is quite complex, because several parties in the chain have a role to play. Each has their own views and visions about current problems and how these should be resolved. Because of this, it was difficult at first to imagine the direction that the research would take. Indeed, during the course of the study, new and unexpected information surfaced. A qualitative survey allowed for this to occur.

3.2 Selection of interviewees

The milling-wheat supply chain is the central unit of analysis in this study. To be able to investigate this supply chain, groups of the supply chain functioned as research units; the group of wheat growers, the group of collectors, the group of milling companies et cetera. Every group contributes something to the process of the chain, leading to the production of the end product, bread. To explore the opportunities available to the supply chain, the processes of interaction between these chain groups were analyzed. Focus was on the primary part of the milling-wheat supply chain, as it seemed that more problems were present there. However, attention was also paid to the chain groups in the secondary part, as they may have some influence on the primary part. In supply chains that are being increasingly influenced by demand, consumers probably also have a finger in the pie. Individuals belonging to a certain chain group were interviewed to obtain information about the views and opinions of the group. In addition, informants were interviewed.

A rational sample survey was carried out; the choice of interviewees was based on theoretical considerations. The purpose was to get the most complete overview of the current situation and

future opportunities. Not only typical cases were considered, as there was a chance that opportunities might be available for companies with a non-representative business process. Interviewees who represented chain groups that were largely divergent from each other were selected, at which point a range of possible opportunities was covered. Interviewees were selected on the basis of important characteristics, which influenced the business process and consequently the supply chain process. For example, both wheat growers with and without wheat storing facilities were interviewed. Furthermore, interviewees were chosen on the basis of the size and structure of their company. The locations in which the companies were established were also taken into account. Most wheat is grown in the Provinces of Groningen and Zeeland, and in the Province of Flevoland on a smaller scale. Wheat growers from all of these three areas were interviewed, as weather or soil conditions can make a difference in growing (milling-) wheat.

At the start of data collection it was not known how big the survey sample had to be. Different groups exist in the supply chain and there were differences within these groups and between the individuals in them. There was a high degree of heterogeneity. As a result, a large sample was needed to get a complete overview. The central method of data collection was interviewing. As interviewing is an intensive form of research, and as it had to be completed in approximately six months, the research unit was restricted in the first instance, to only the chain groups in the primary part of the chain. After interviews had been held with these actors, actors in the secondary part of the chain were then questioned. This took less time because enough information had already been gathered to enable directed questions to be drawn up. Together with a key informant, who had a good overview of this supply chain (HPA), a selection was made of interviewees who represented several chain groups. Interviewing was continued until the subject reached saturation point. This resulted in 39 interviews with 30 different interviewees (see Appendix 1: List of interviewees).

3.3 Data collection method

In the collection of data, data and method triangulation took place, which is outlined in the first sub paragraph below. Following this, the interviewing that was the central method of data collection in this qualitative research, is described.

3.3.1 Triangulation

This research had a holistic nature; the central research unit and its context had to be seen as a whole. The Dutch milling-wheat supply chain cannot be examined separately from the European wheat market. Supply and demand for European wheat determines the price and to some extent the standards that Dutch wheat has to meet. The business is based upon availability. The world wheat market determines the European wheat market. Moreover, the Dutch milling-wheat supply chain should be considered in the context of the Dutch wheat supply chain in general. When milling companies do not utilize wheat, it goes to other wheat processors. Furthermore, the subject is complex as the various actors in the chain see the problem from different standpoints; to some of them, there may not even be a problem at all. The holistic and complex nature of the research and the goal of obtaining the most complete overview possible of the situation, contributed to the decision to apply triangulation. Data triangulation was used in this study. As described in the previous paragraph, all of the supply chain's groups were involved in the research. Within these groups, one or more individuals were interviewed and use was also made use of (key) informants

to obtain additional information. Methodological triangulation was also used in this research. Data was collected by means of interviews so as to obtain opinions and knowledge, but information was also garnered from documentation. These materials illustrated and complemented the interviews, as information was found about topics that the actors in the supply chain were uncertain of or simply did not have information about.

3.3.2 Interviews

The subject matter of the research was important to the interviewees. Most of them were entrepreneurs, proud of their (family) businesses, but who were also aware of problems. It is understandable that is difficult to be open about such problems. Even more so as competitors and others in the chain upon whom they are dependent, were also involved in the research. To enable me to delve deeply and thoroughly into their opinions and to get as close as possible to the data, I first had to establish a reasonably trusting relationship with the interviewees. Because of this, the decision was made to use face-to-face interviews and to use an open, flexible manner of data collection. In other words, semi-structured interviews. To make them feel as comfortable as possible, interviewees would have to be able to speak in their own words and in the way they wanted to, not feeling forced by a methodological structure. Another advantage of this flexible approach was that new and relevant, but unexpected subjects could be discussed. For the first interviews a topic list was formulated, which included some headlines because less was known at this stage. In later interviews, a semi-structured list of questions was used, with some specific issues being central, although the possible answers were open. There was a logical sequence to the subject matter in the list of topics and the semi-structured questionnaire. This was a deliberate ploy to try to ensure that the most sensitive subjects were discussed in the final part of the interviews, when some trust had been established (see Appendix 2: Interview questions). To enable the interviewees to talk freely and without feeling the need to be restrained, they were interviewed separately.

3.4 Data collection

To carry out the interviews in a realistic way and in their usual environment, they were held at the interviewees' company premises. To obtain a complete view of the business processes, by which I mean the way that the supply chain is made up, actual observations of what took place on a day-to-day basis in the companies were noted. Three arable farms, a collector, a milling company and a bakery were involved. This was an attempt to gain as clear a picture as possible of the realities of the situation. Moreover, I attended a meeting of KodA, in which several of the chain's actors participated.

Five face-to-face "preparatory interviews" were held first, to enable this research's central question to be formulated. Thereafter the choice of interviewees was made and a second round of interviews then followed. These were all face-to-face interviews with actors in the primary chain. Emphasis was not only on collecting data as it was analyzed between each set of interviews. This enabled fresh lists of topics to be created and semi-structured interviews to be set up. The people who represented the different chain groups were interviewed in such a way as to enable them to reflect upon the views of others. Those who were interviewed in the first "preparatory" round were interviewed again in the second round of interviews. This lead to 24 face-to-face interviews. In the third round of interviews, focus was on the secondary part of the milling-wheat supply

chain. Most of these interviews were held by telephone. This was a good option since problems existed more in the primary part of the chain and so actors in the secondary part of the chain were dealing with less sensitive subject matters. In addition, by this time a large amount of information had been gathered, which made it possible to ask some well defined questions. Telephone interviews were also used to obtain supplementary information from those who had taken part in face-to-face interviews in the second round. Finally, the outcome of the research was discussed with four other people (member-checking) namely two wheat growers, a collector and a milling company. Documentation supported the findings of the interviews.

3.5 Analysis

All of the face-to-face interviews were recorded on a tape-recorder and were transcribed either on the same day or within a maximum of two days in order to keep any possible distortion to a minimum. Moreover, notes were also made about any relevant emotions, non-verbal behaviour and other issues observed about the companies. The interview documents were then divided into sections, which were the units for analysis. This was done because the goal of the research was to obtain a detailed overview of the supply chain, and to relate different aspects of the chain to others. These sections were represented by catchwords or labels. Thereafter, scrapping irrelevant text reduced the amount of material collected and a smaller interview summary, consisting of seven pages, was further dissected. In doing so, core and sub labels came into existence. The research questions served as a starting point for this whole process. Firstly, nine of the interviews were analyzed and labelled so as to keep the process well organized. The same thing was then done to the remaining nine interviews. After these two steps had been completed, the labels covered all of the sections. To ensure greater objectivity, another researcher then reviewed and commented upon the sectioned summary and analysis drawings.

The research questions themselves, influenced the way in which the data was analyzed. Research questions 1, 2 and 3 are more descriptive in nature whereas questions 4, 5 and 6 are explanatory questions. To answer questions 1, 2 and 3, a hierarchical order was used (taxonomy). However a process model was also applied to question 3 because some problems seemed to follow from others and the process model was needed to ensure that there was clarity about this. So far as question 4 was concerned, a network analysis helped to answer and gain an insight into the relationship between problems and supply chain innovations. An iterative process arose. Time and again there was interplay between ideas and data. The data presented problems but the interviewees proposed solutions to them. As a result, the supply chain innovations were formulated. These innovations were then checked against the available data, to see if they really were solutions to the identified problems.

The theoretical framework and the six research questions are explored and outlined in Chapter 2 of this work. This chapter details the methods used to collect and analyze data so that the research questions could be answered. In the following Chapters, 4-9, the answers to the six research questions are discussed.

4 The Dutch milling-wheat supply chain

Research question 1: What does the Dutch milling-wheat supply chain look like?

To answer this first research question "What does the Dutch milling-wheat supply chain look like?" the Dutch supply chain of wheat is analyzed. The supply chain's end product, bread, determines who the relevant actors in the chain are and the resources needed to produce it. The business processes of the supply chain's actors, together form the primary process of the Dutch milling-wheat supply chain. Therefore, the roles and business processes of each of these actors are outlined. In doing so, what resources the chain's actors need from each other becomes clear, which then enables their relative power positions to be described in the chapter that follows. As other industries also influence the functioning of the Dutch milling-wheat supply chain, these are taken into account. In order to understand the context of the Dutch milling-wheat supply chain, a start is made with information about the production and prices of wheat in general.

4.1 Wheat production

The world produced 598 million tons of wheat in 2006. The five top producing wheat countries are China, India, United States of America (USA), The Russian Federation and France. Not far behind are Canada, Germany, Australia and the Ukraine (FAO, 2007). The European Union (EU) produces 117.6 million tons of wheat, which is 20% of the world's total. So far as the individual EU countries are concerned, France (35.4 million tons), Germany (22.4 million tons) and Great Britain (14.7 million tons) are at the top so far as production quantity is concerned. Together they produce more than 60% of the total EU wheat production. In producing 1.2 million tons of wheat in 2006, which is 1% of EU production, the Netherlands is ranked 17th of the EU countries (FAO, 2007).

The Netherlands is a "wheat-importing country" as the demand for wheat (5.6 million tons) exceeds the amount of wheat produced (1.2 million tons), resulting in an import need of around 4.4 million tons a year (FAO, 2007; GZP, 2004a). Most of the wheat is imported from the EU, particularly from Germany and France. Imports from non-EU countries are small. Less than 1% of Dutch wheat is exported. Of the 1.2 million tons of wheat produced in the Netherlands, 55% is used in the feed industry. Around 20% goes to the starch industry and around 15% goes to the milling industry. About 4% is used in the fuel industry. The remaining 6% is used either as seed for sowing, in other industries (beer industry) or for export. The amount of Dutch wheat utilized by these industries varies and depends upon its quality and market prices (GZP, 2007).

4.2 Wheat prices

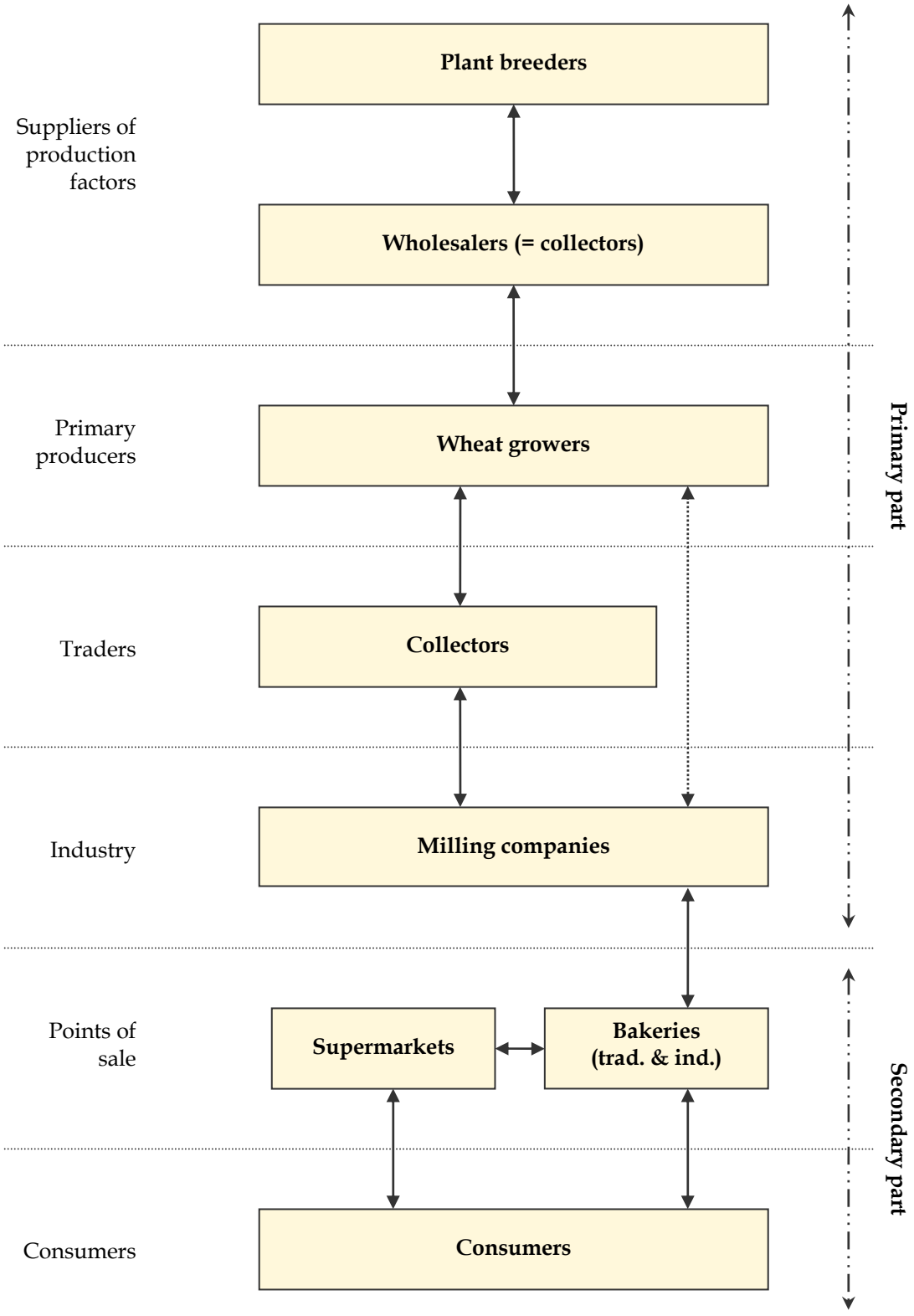
The price of wheat is determined by supply and demand. If the supply is low and the demand is high, the price increases. Conversely, if the supply is high and the demand is low, the price decreases. To guarantee provision of wheat in Europe, the EU-market regulation for grains, part of

the European Common Agricultural Policy (Europese Gemeenschappelijk Landbouwbeleid) (GLB), was set up. This market regulation focuses on the stabilization of prices and income for crop growers. As part of this intervention system, a fixed price of 101.31 Euros per ton is paid to the wheat growers when they sell their wheat for public storage, in the event that they cannot market their wheat on the free market. Not all of the wheat offered for intervention is actually taken in. Only milling-wheat qualifies. Wheat of feed-quality has to be marketed on the free market. Wheat stored by the EU is sold in seasons when production is low and prices are high (GZP, 2007).

To satisfy its total internal wheat demand, the Netherlands is highly dependent on deliveries from other EU-countries. Thus price levels in other countries determine the prices that the Dutch processing industries can themselves offer. The price of wheat used by milling companies is always higher than the price paid by other wheat processors. Milling companies need wheat to produce meal and flour, whereas other industries can replace wheat with other raw materials.

In the following paragraphs, the actors in the supply chain are described. When reading these paragraphs, it may be helpful to review Figure 4-1: Simplified illustration of the Dutch milling-wheat supply chain. The production figures mentioned in these paragraphs can be found in Appendix 3: Production figures.

Figure 4-1: Simplified illustration of the Dutch milling-wheat supply chain



4.3 Plant breeders

Role

The milling-wheat supply chain starts with the development of wheat varieties by plant breeders. Plant breeders' profits are enhanced when they develop and improve wheat varieties. In recent years, significant numbers of plant breeders have begun to merge and become internationally operating companies. These big companies dominate the seed business. There are a few plant breeding companies located in the Netherlands who develop wheat varieties. However their focus is on the European market. Most of the varieties developed by companies located in the Netherlands are exported.

Business process

Plant breeders obtain information from specialist literature, TNO (Organization for Applied Scientific Research) and from sporadic contact with industry. As plant breeders operate internationally, information comes from more than one country. Plant breeding requires specialist knowledge. In extended Research and Development (R&D) laboratories, new varieties are developed and existing varieties are improved. However plant breeders do not breed on detailed factors, as this is very labour and cost intensive. Instead they carry out a so-called "quick test" which gives a general impression. Based on the outcomes of these tests, varieties are selected. Development time for a new variety is about ten years. After that, multiplying new varieties takes about five years. As a new variety is developed and multiplied, the Plant Variety Rights (PVR), also known as plant breeders' rights, are sold by Dutch wholesalers. As a result, these wholesalers, who are mostly collectors, are licensed to sell the seeds to wheat growers. Plant breeders also supply information about a specific product, for example whether the wheat variety is winter hardy. Plant Variety Rights (PVR), are intellectual property rights granted to the breeder of a new variety of plant. These laws typically grant the plant breeder control of the propagation and harvested material of a new variety, together with the right to collect royalties for a number of years. This provides income, which covers the costs of R&D. The purchase of protected varieties gives wheat growers the benefits of superior varieties (UPOV, 2002).

4.4 Wheat growers

Role

In 2006, the agricultural areas of the Netherlands comprised 1,000,000 hectares (ha). Of these, 22% was used for growing grain (including 14% wheat), 16% for growing potatoes and 8% for growing sugar beets. In that year, 13,000 wheat growers grew wheat on their fields and 75% of them had less than 15ha grain[3] (CBS, 2007; LEI, 2007). The Dutch wheat grower typically has a relatively small company compared to the other actors in the chain. Normally, only one or two people work on a farm and turnovers are small. Wheat growers grow wheat on their fields with the aim of making profit from yields. But there is also a secondary reason, namely crop rotation. Crop rotation is the practice of growing a series of dissimilar types of crops in the same space in sequential seasons, to avoid the build-up of pathogens and pests that can often occur when one species is continuously cropped. Crop rotation also seeks to balance the fertility demands of various crops to avoid excessive depletion of soil nutrients. In the Netherlands there is a

[3] Most of this grain is wheat but it can also be rye, barley, oat or corn.

traditional crop rotation plan consisting of sugar beets, potatoes and grain. However in the North of the country, in an area called Oldambt (Groningen), the wheat growers are only able to grow grains like wheat and barley as the clay is too heavy for other crops. Year after year they grow "wheat on wheat" without having (many) problems with pathogens and pests. Accordingly, for these wheat growers, their primary focus is on wheat (Darwinkel, 1997).

Business process

Wheat growers do not buy wheat directly from the plant breeders. They get seed from Dutch wholesalers, who are mostly also collectors. Based on their experience, product information and market prices of wheat, the wheat growers choose a specific wheat variety. The growers make this decision year after year, time and time again. They also buy nitrogen fertilizers, pesticides, herbicides and fungicides from wholesalers. Most of them carry out the activities such as ploughing, sowing and harvesting on their fields themselves. However, smaller farms do not own all of the necessary machinery (for example combine harvesters) and therefore make use of contracting firms. Information Technology (IT) and other technologies have become more and more important on the modern farm. Examples are Global Positioning Systems (GPS) on tractors and Management Information Systems (MIS). Nevertheless, most wheat growers grow wheat on their field based on experience," tacit knowledge". After the harvest, wheat is transported to a storage facility. When wheat has a high humidity percentage, it must first be dried, otherwise it can become mouldy in storage (Darwinkel, 1997).

Most of the wheat growers (approximately 95%) do not have their own storage facility. They are part of a cooperative, or do business with a grain trader. Cooperatives and grain traders collect, store and sell the wheat growers' wheat. After the harvest, growers who do not have their own storage facility, transport the wheat on their tractors directly to the traders' and cooperatives' collection points, or silos. Around 5% of Dutch wheat growers have invested in their own storage facilities, particularly those in the North of the country. The advantage for them is that they have complete control over when they sell their wheat. The time that wheat is sold determines the price received for it, since prices fluctuate. They can sell their wheat directly to the processing industry, with the help of an agent ("commissionair") and can also do business with cooperatives or grain traders. Cooperatives and traders can either directly resell the wheat produced by growers who have their own storage, or can first store the wheat in their own silos. Wheat growers, who deliver directly to the processing industry or to grain traders, get a price for their wheat that is based on the market price and its quality. The buyer measures the quality. However, the wheat growers are also able to conduct simple quality measurements themselves. The growers who have a contract with a cooperative, become participants in a grain pool. In May, they receive a first loan for the grain that has been sown. At the time of delivery of the wheat, during the harvest in August, they get a second loan. By this stage, approximately 80% of the yield price has been received. At the end of following spring, a final payment follows, which is determined by the quality of the delivered wheat. Where there is a favourable market, an extra interim loan is paid in December.

4.5 Collectors

Role

Cooperatives and grain traders collect, store and market the wheat. In this research project they are called "collectors". As collectors are positioned in the middle of the supply chain, they have an important (logistical) function in it. As well as a few large collectors, there are also many small

ones. Around two-thirds of the grain trade is in cooperatives. The other third consists of private operating companies (Rabobank, 2001). Almost half of the Dutch wheat that is produced (48%, 576,000 tons) is bought by two big cooperatives, one in the North and one in the South of the Netherlands. Most of the collectors are also wholesalers of seeds, nitrogen fertilizers, pesticides, herbicides and fungicides. Some cooperatives also produce dried feed.

Business process

Every year, contractual arrangements are set up between the wheat growers without their own storage and the collectors. Large collectors make plans to store the wheat based on variety and on information received from the wheat growers contracted to them. After the wheat is harvested, the growers transport their wheat to the collectors' collecting points, normally fenced concrete areas. Here, the quality of each load of wheat received is measured. Thereafter, collectors transport the wheat in trucks to larger storage facilities, from where it is then transported on to processing industries, by truck or by ship.

As most of the collectors are also wholesalers of seed, they know how different varieties perform in Dutch fields and they carefully measure the quality of wheat that they collect. They get the results of measurements taken, from the wheat processors. Milling companies carry out specific tests before and after they buy the wheat from collectors. With this information they support and advise the wheat growers about the best varieties. In addition, collectors get information from their buyers, the processing industry, about the market's demands. Big cooperatives, their wheat growers and three of the four Dutch milling companies, work together to find out which of the wheat varieties demanded by milling companies, perform the best in the Netherlands, based upon quantity, quality and milling characteristics.

4.6 Milling industry

Role

The Dutch milling industry processes around 900,000 tons of wheat a year into wheat meal and wheat flour (GZP, 2007). In the Netherlands, there are four milling companies with a total market share of 98%. The other 2% belongs to traditional mills (Meeusen, Sengers, Puister & Daane, 2002). The biggest milling company has a 70% market share. Two other milling houses have around a 10% market share and the smallest one has a 6% market share (NVM, 2007).

Business process

Milling companies do not have a large storage capacity. Therefore, they can only buy wheat from collectors or wheat growers with their own storage facilities. The milling companies use approximately 80% (720,000 tons) of wheat from other countries. The majority comes from Germany, followed by France and then Great Britain (GZP, 2007). Milling companies measure the quality of the cargo of wheat themselves. Based on quality and market price, a price for the wheat is set by a milling company and its supplier. Although natural products of different qualities are delivered to the milling companies, they have experience, knowledge, laboratories with measurement instruments and even test-bakeries to ensure that they produce meal and flour of a consistent quality. In a milling company's business processes, wheat is first crushed and becomes meal, which is then sieved and becomes flour. Depending on the type of flour the company wants to produce, it can take about 20 million passes before the process is completed. Milling companies

mix flour in order to achieve the desired quality, based on the outcome of quality measurements and experience. Most of the by-products of the milling process, like coarse meal and grit, go to the feed industry. The companies also sell products or by-products to starch processors (who have insufficient milling capacities).

Meal and flour are delivered to bakeries and must be of a consistent quality. If the quality of meal or flour changes it no longer meets the requirements of the recipes used by the bakeries, thereby resulting in a different products. These milling companies produce approximately 680,000 tons of meal and flour. This is transported to Dutch bakeries and to other countries; 40% is exported (270,000 tons) (GZP, 2007). Sometimes flour goes directly from the milling companies to retail outlets for consumer use, for example to make bread or pancakes. Milling companies are in direct contact with bakeries and thereby receive market information. They also develop new bakery products, as a service for bakeries and advise them when they are having problems with baking processes. Milling companies are able to do so, as they test meal and flours with bake-tests. By doing so, they are able to obtain much useful information about baking processes.

4.7 Other wheat industries

So far as the milling-wheat supply chain is concerned, the processing industry consists of milling companies. However, most of the time Dutch wheat does not find its way to milling companies. To gain insight into this situation, the other processing industries are described herein.

4.7.1 Feed industry

Of Dutch wheat, 55% (660,000 tons) is used in the production of feed for, for example dairy and meat cattle, poultry and pigs. The feed industry also buys some by-products of the other grain processing industries such as the gluts from the milling industry and wet by-products of the starch industry. As well as wheat, the feed industry uses other raw produce, for example soy, tapioca and citrus pulp. The composition of the feed fluctuates with the market prices of the raw produce. Approximately 15% of the raw produce used by the Dutch feed industry comes from the Netherlands (Rabobank, 2001).

4.7.2 Starch industry

Approximately 20% (240,000 tons) of the wheat grown in the Netherlands goes to the Dutch starch industry, comprising one company with locations in Sas van Gent and Bergen op Zoom. This company buys Dutch wheat from near to these locations but almost all of its wheat is imported from France and Belgium. The factory produces items that vary from bulk starch to syrups, for example glucose, and modified starch. Grain starch has a lower cost price than potato starch because the percentage of starch in grain is higher and the total production costs of grain crops are lower. Moreover, the by-products of grain are more valuable. Wheat has "vital wheat gluten", which is an important ingredient used by the milling industry to enhance the quality of wheat meal and flour. Wet by-products are also used in factory farming as pulp feed (Rabobank, 2001).

4.7.3 Bio-ethanol industry

In May 2003, the European Union introduced a Directive with targets aimed at partly substituting petrochemical transport fuels with bio-fuels (EC, 2005). The target defined by the EU is a 5.75% substitution of energy by 2010. Bio-ethanol is currently one of the main bio-fuels. In Europe, bio-ethanol is produced from materials containing sugar, such as sugar beets or molasses (by-product of sugar production), and from materials containing starch, such as grains, and to a lesser extent potatoes. By-products of bio-ethanol production can be used as feed. In 2006 1.4 million tons of wheat in the EU was used to produce bio-ethanol (GZP, 2007).

In the Netherlands there are no bio-ethanol production plants (yet). The nearest country to have them is Germany. Others are in Spain and Sweden. In the Netherlands in 2006, all of the wheat used for bio-ethanol went to a company in Germany, approximately 4%, 50,000 tons. Dutch wheat used for bio-ethanol production is grown on fallow fields because they cannot be used for the production of crops for human consumption (Agriholland, 2007).

4.8 Bakeries

Role

In the Netherlands, a distinction can be made between traditional bakeries and industrial bakeries. The traditional bakeries are small-medium enterprises (SME). They are mixed bakeries and all of them produce bread, with 20% of them also producing confectionary. In 2004, 2,470 traditional bakeries existed. These companies had almost 4,300 outlets. The number of industrial bakeries amounted to 111 in to 2004. The total number of bakeries is decreasing, caused by a reduction in numbers of traditional bakeries. The number of industrial bakeries, however, is growing (HBD, 2006). Traditional bakeries face more and more difficulties. The industrial bakeries are able to work more efficiently due to economies of scale. Traditional bakeries also have problems because of the start up costs and investment needed, and due to there being less interest in the generations succeeding each other in family businesses (CBS, 2004). Around 80% of the traditional bakeries have less than twenty employees (HBD, 2006), although they do have a big influence on the industry's turnover, realizing almost half of the total of 2 billion Euros (CBS, 2004).

Business process

Most traditional bakeries buy their meal and flour from a wholesaler, because of economies of scale. One large wholesaler of meal and flour in the Netherlands has an 80% market share and other smaller companies together have a 20% share. Some of the medium-sized, traditional bakeries buy meal and flour directly and have weekly contracts with a wholesaler or milling companies. There are three large industrial baking companies in the Netherlands, who dominate the industrial bakery market. They buy their meal and flour directly from the milling companies and have six monthly contracts. In total, Dutch bakeries use approximately 710,000 tons of meal and flour each year in the production of bread. Forty-two percent of this is imported (300,000 tons) (GZP, 2007). In addition to milling companies providing bakeries with meal and flour, they also give them advice about the utilization of meal and flour in their milling-processes. In these processes, the bakeries use machines such as dough machines, rising machines, ovens et cetera by which the meal and flour is turned into dough and finally into bread. The traditional bakeries produce bread in small runs, whereas the industrial bakeries work in shifts by using so-called continual-ovens. In the Netherlands, approximately 1 million tons bread is produced annually

(GZP, 2007), of which 6% (60,000 tons) is exported. The Netherlands imported 3% (30,000 tons) of bread in 2006 (CBS, 2007). Traditional bakeries combine their manufacturing locations with shops to sell their products directly to consumers. Industrial bakeries also sometimes own a number of selling points that enable them to sell bread directly to consumers (Meeusen et al., 2002), but more often they sell their products to supermarkets. The traditional bakeries, together with the supermarkets, garner information about the demands of Dutch consumers.

4.9 Supermarkets

Role

In total there are approximately 4800 supermarkets (Deloitte, 2007a). They have become bigger and more dominant and the total turnover of Dutch supermarkets in 2006 was 27.2 billion Euros, an increase of 21% on 2000 (CBS, 2007). Seventy-eight percent of bread (780,000 tons) is sold by supermarkets and 15% (150,000 tons) is sold by traditional bakeries. The other 7% (70,000 tons) is sold at other points of sale (for example the ambulatory market). The amount of bread sold by supermarkets is increasing, at the expense of the traditional bakeries (Voorlichtingsbureau brood, 2004). Most consumers prefer to do their shopping in one shop instead of at the traditional bakery then the butcher and the greengrocers These supermarkets are also able to offer good quality bread due to their contacts with industrial bakeries who are able to produce the kind of bread the supermarkets demand. Moreover, because of economies of scale, supermarkets can offer cheaper bread than traditional bakeries.

Business process

The supermarkets have direct contact with the end users of the chain, the consumers of the bread. Based on consumer demands, supermarkets determine what kind of bread they want to offer for sale to their customers. Long-standing relationships exist between supermarkets and the industrial bakeries that supply their bread. Supermarket account managers are in contact with the account managers of these big industrial bakeries and discussions are held about the kind of bread the bakeries should produce for the supermarkets (Meeusen et al., 2002). In addition, each individual supermarket has contact with an industrial bakery, whereby the supermarket can order the quantities of bread required. The bread received from the industrial bakery can be ready-to-eat, although supermarkets sometimes finish it off in their own ovens in the shops. Thereafter, the supermarkets sell the bread to consumers.

4.10 Consumers

The Dutch consumer appreciates light, highly risen bread. The colour of the crust, structure of the crumb, colour of the crumb and tenderness of the crumb are the most important factors determining its quality. The Dutch bakery centre (Nederlands Bakkerij Centrum (NBC)) measures these, and another seven factors. Approximately 1 million tons of bread is consumed in the Netherlands. In 2006, bread consumption per person was an average of around 62 kilograms (kg). The expenditure on bread (and Dutch Rusk) increased by 16% compared to 2000. This resulted in a price increase of 11% and an increase in volume of 5%. In 2006, 121 Euros was spent per person on bread (and Dutch Rusk). This meant that Dutch consumers spent almost 2 billion Euros on bread (and Dutch Rusk) in 2006 (HBD, 2006). Families with children account for most of the Dutch bread consumption (GfK, 2005).

The bread market in the Netherlands is sizeable, compared to other countries, due to the amounts consumed. Although alternatives to bread at breakfast time have entered the market, it remains the most important of the breakfast products. Almost everyone eats bread for lunch in the Netherlands. Indeed this is when most bread is eaten. For a few consumers, bread is also part of their dinner, mainly when food is served and eaten outdoors. Moreover, there are more and more dishes on the market that include bread, for example Naanbread accompanies Indian dishes and pitta bread is eaten with kebabs. The number of bread-making machines bought by consumers has also increased in recent years, which was anticipated by the suppliers of bread-making mixes and meal (GfK, 2005).

5 Power positions

Research question 2: What are the power positions of the actors in the Dutch milling-wheat supply chain?

In the previous chapter, "The Dutch milling-wheat supply chain", the roles and business processes of the chain's actors were discussed. In doing so, the resources needed by the actors in the supply chain became clear. The aim of this chapter is to examine the power positions of the actors in Dutch milling-wheat supply chain. Once these are known, the behaviour of the supply chain can be seen. Problems in the chain, set out in Chapter 6, arise out of these power positions but they also allow us to see which of the supply chain's actors are able to contribute to and enforce supply innovations. This is explored in Chapters 8 and 9. To clarify the power positions of the supply chain's actors, the relationships of power between them are analyzed. These relationships arise because actors in the supply chain need each other's resources. It always involves an exchange of resources between two supply chain actors. So far as the Dutch milling-wheat supply chain is concerned, there are seven power relationships. In each of the following paragraphs, one of these is discussed. However, first the approach is outlined.

5.1 Approach

Power arises from the importance of an actor's resources to another actor, and the concentration of these resources. A resource becomes important to an actor, when it is needed to carry out his business activities and/or reduce his uncertainty. A resource is concentrated when it is supplied by only one individual (monopoly), or a few individuals of a supply chain group (oligopoly) who work together to a certain extent. It might involve suppliers of a resource within the Dutch milling-wheat supply chain. However, suppliers to other supply chains can influence the power relationships in the Dutch milling-wheat supply chain. A resource can also become concentrated when it is in short supply on the market. As it concerns an exchange of resources, the importance and concentration of an actor's resources must be seen in relation to the importance and concentration of the resources of the other actor. In this chapter, by referring to an actor in the supply chain, reference is also being made to a group of supply chain actors, namely the plant breeders, the wheat growers et cetera. These groups of supply chain actors consist of individual plant breeders, wheat growers et cetera. The power relationships between these chain groups are central. However, when big differences exist between individuals within a supply chain group, this is taken into account. Larger individuals in a supply chain group might be more powerful than the smaller members.

5.2 Plant breeders – Collectors

The collectors buy Plant Variety Rights (PVR) from the plant breeders. With these PVRs, the collectors become licensed to supply a variety of seeds to the wheat growers. The collectors serve

the wheat growers, not only by supplying seeds, but also by collecting, storing and selling the wheat that they produce. Therefore, the collectors are doubly interested in what types of wheat varieties are suitable for the Dutch climate, so that they can keep their customers satisfied by selling them good quality wheat after the harvest. Furthermore, the collectors also receive information from plant breeders about the characteristics of the wheat varieties. With this information, predictions can be made about which variety will perform the best under certain conditions. This reduces uncertainty for the collectors and their customers, the wheat growers. On the other hand, the plant breeders are dependent on the collectors, as they receive money from them buying PVRs. But that is not all, as the collectors also possess worthwhile information, which is of interest to the plant breeders. The collectors receive information about how a particular variety of seed performs in practice due to their contacts with the wheat growers. They also have contacts within the wheat processing industries to which they sell the wheat. The plant breeders do not have these contacts themselves and obtain this information from the collectors. With this market information, the plant breeders try themselves to make the right decisions about seed variety development. In doing so, it can be seen that the information from the collectors also reduces the uncertainty levels of the plant breeders.

There are only a few big international plant breeders in the market yet conversely, there are many Dutch collectors, resulting in an oligopoly. The plant breeders do not gain much power from this oligopoly, as they do not work together. However, they do have power over the Dutch collectors as a result of the existence of foreign collectors. These foreign collectors reduce uncertainty levels more than their Dutch counterparts for the plant breeders. The seed varieties that the plant breeders develop are not able to grow in all countries. Therefore, the breeders have to pick the countries where the most wheat is grown, in order to make the most money out of the developed varieties. The Dutch market is a small one for the plant breeders, as the country only produces 1.2 million tons of wheat. The plant breeders get more of their income from the big wheat producing countries such as France (35.7 million tons), Germany (22.4 million tons) and Great Britain (14.7 million tons) (FAO, 2007). Consequently, the plant breeders are not particularly interested in developing "Dutch varieties", meaning that Dutch collectors are powerless with respect to the plant breeders.

5.3 Collectors - Wheat growers

The collectors receive money for the variety of seeds, fertilization applications and crop management advice that they supply to the wheat growers. After the wheat is harvested, the collectors receive wheat from the growers, which they then sell to the processing industries. The collectors also get money for storage, collection and selling services. The wheat growers are dependent on the collectors for the seeds, and for fertilization applications that allow them to carry out their work. In giving crop management advice, the collectors also reduce the uncertainty levels of the wheat growers and as a result, also obtain the optimal result. Ninety-five percent of Dutch wheat growers do not have their own storage facilities and so supply their wheat to the collectors straight after the harvest. The collectors have direct contact with the processing industries and because of this they have a good overview of price. Wheat growers do not have this complete market overview and price information and accordingly, the collectors decrease their uncertainty about whether they will receive the best price for their wheat. Furthermore, many collectors can transport wheat in large batches over waterways to the processing industries, which like to operate in this way. Single wheat growers are not able to do so. Moreover, by the collectors having contact with industries, they are able to pass on their requirements to the wheat growers.

The wheat growers are dependent upon the collectors for both their products and services. In return, the collectors are dependent on wheat growers, from whom they obtain money for the sale of these products and services. In this relationship, the collectors have power over the wheat growers because it is not worthwhile for the wheat growers to transport wheat over long distances and they have no time for such transportation during the busy harvest period. Therefore, the wheat growers depend on the collectors, which means that collectors are also dependent on wheat growers. However, more often than not, there are many wheat growers in an area in which a collector is established and oligopolies and sometimes, even monopolies exist. If there are more collectors present in an area, wheat growers can switch between collectors, which reduces the collector's power. If there are only a few collectors present in an area, the products and services are concentrated, which makes the collectors more powerful. It should be recognized that there are two big collectors in the Netherlands, who market almost half of the total wheat produced in the country (Rabobank, 2001). The area in which these large collectors are established is extensive and there is great demand for their resources, which in turn ensures that they are powerful companies in the chain. As a result of their size, these two companies are better able to handle setbacks than their smaller colleagues. Furthermore, other actors in the supply chain have to take these big players into account. Foreign collectors, or other buyers of wheat, are not present on a grand scale and so do not influence the power relationships.

5.4 Collectors – Milling companies

The collectors supply the wheat growers' wheat to milling companies, for which they receive money. The milling companies translate their own needs and those of the bakeries into specifications. Only wheat that meets these specifications is suitable for the milling companies. As there are only four Dutch milling companies and many Dutch collectors, an oligopoly exists. The four milling companies do not cooperate, but they nevertheless obtain power from the oligopoly, as their formulated specifications are almost the same. They control the relationship with the collectors as a result of these specifications. They also gain power because of the fact that the collectors cannot measure the most important quality specification, protein quality. Only milling companies are able to conduct the specific and complex tests needed to examine the protein quality of wheat. Power is gained by the fact the protein quality cannot be measured from wheat but only from meal, flour and dough, by way of complicated and time-consuming tests. Only milling companies can carry out these tests and thus gain information about protein quality. Based on this information, they are able to decide if they want to buy the wheat from the collectors and eventually offer a price for it. The collectors do not have any information about the protein quality of the wheat that they offer for sale to the milling companies. They simply have to trust these buyers. More about protein quality specifications and measurements will be outlined in the following chapter.

Bearing in mind transport costs and delivery reliability, it clearly makes sense that it is more efficient for Dutch milling companies to receive their wheat from the Netherlands and so from Dutch collectors. But Dutch milling-wheat can also be easily supplied from other countries. The companies use 80% (720,000 tons) of foreign wheat (GZP, 2007); buying wheat that has a high added value, from abroad is worthwhile. Even two milling companies that transport their wheat by truck use 70% of foreign, particularly German wheat. The presence of other, foreign suppliers reduces the power of the Dutch collectors in relation to the milling companies. Wheat from foreign collectors has a higher quality assurance level than Dutch wheat and so, despite its higher transport costs and lower delivery reliability, the foreign wheat is important to Dutch milling companies. As its quality assurance is higher, it reduces uncertainty for them. Moreover, these

other countries often produce more wheat than they need, so their collectors are market-driven, which in turn leads to relatively low prices.

The Dutch collectors would prefer to supply wheat to the milling companies, as opposed to other wheat processing industries, since the price of milling-wheat is higher than the price that other industries offer for wheat. Therefore the Dutch collector is dependent on the milling companies if he is to achieve the best price for wheat. However, it should be noted that as there is a large feed-industry in the Netherlands, the feed-wheat prices are only slightly lower than milling-wheat prices, 4.5 Euros per ton of wheat (see Appendix 4: Wheat prices). This feed-industry needs a lot of wheat and it is more efficient to transport this over short distances. This means that the Dutch collectors are not highly dependent on the milling companies. Additionally, there are even collectors who produce feed themselves. Thus, the presence of the "other-wheat" industries decreases the collectors' dependence on the milling companies.

5.5 Milling companies - Bakeries

The bakeries need the milling companies to obtain their meal and flour. To meet the consumers' demands (or supermarkets' demands) the bakeries themselves require certain dough characteristics from the meal and flour. The milling companies have information about the baking processes and so are be able to reduce uncertainty levels for the bakeries by supplying products of a consistent quality. As a result, the bakeries do not have to constantly change their recipes and bakery processes. Moreover, bakeries get advice from milling companies about the use of meal and flour in (new) recipes, or when they have problems in their baking processes. The milling companies receive money for the meal and flour that they sell to the bakeries and also receive information about their clients' needs, so that they are able to determine the requirements of the meal and flour. Dutch milling companies and bakeries are both interested in the best meal and flour quality for the optimal price.

There are only four Dutch milling companies and many Dutch bakeries. However, the bakeries are concentrated. There are some big industrial bakeries to which milling companies can supply their products. In addition, traditional, small bakeries buy wheat from some big Dutch wholesalers. The Dutch milling companies compete with each other for contracts with these big customers. As well as these customers, milling companies also sell meal and flour to some medium-sized bakeries. The medium-sized bakeries order meal and flour weekly, which results in weekly switching possibilities. Large milling companies may be able to offer better prices, because of their economies of scale compared to smaller companies, but they are not only competing with each other for contracts with bakeries, but also with foreign milling companies. Forty-two percent (300,000 tons) of the meal and flour used by Dutch bakeries is imported (GZP, 2007). This is because of the overcapacity in the meal and flour market in Europe. Because of this overcapacity, prices of meal and flour are low and it is therefore worth transporting it over long distances. On the other hand, 40% (270,000 tons) of meal and flour produced by Dutch milling companies is exported (GZP, 2007). They also have the opportunity to supply their products abroad. As milling companies produce more meal and flour than is needed by the bakeries, this overcapacity exists. The money that the milling companies obtain from the bakeries by selling their meal and flour is in short supply. Consequently, the bakeries have power over the milling companies.

5.6 Traditional bakeries - Consumers

The traditional bakeries try to meet the demands of their consumers as much as possible. They sell their bread directly to consumers and get money in return. As there are many consumers of the traditional bakeries' produce, but there are only a few of them around, an oligopoly exists. But these bakeries do not generate power from this oligopoly, as they do not work together. The bakeries compete with each other for consumers. But this is not the whole story. The traditional bakeries do not only compete with each other, but are also in competition with another supplier of bread in the chain, namely the supermarkets. Due to the presence of the supermarkets, the number of suppliers of bread has increased. This makes the traditional bakeries less powerful in relation to the consumers, and their power is further decreased by the existence of the supermarkets, which are also able to offer other resources of importance to their customers. The market power of supermarkets in the bread market has increased, and so pushed aside the traditional bakeries. At the current time, 15% (147,000 tons) of bread is sold by traditional bakeries and 78% (763,000 tons) is sold by supermarkets. The amount of bread sold in supermarkets will only increase further (Voorlichtingsbureau brood, 2004).

In earlier times, the traditional bakeries were known for making quality bread but nowadays supermarkets are also able to do so, as a result of their contact with industrial bakeries. These bakeries produce the kind of bread the supermarkets demand (more about this is outlined in the next paragraph). Because of this, the qualities that distinguished the traditional bakeries from the supermarkets have diminished. Bread produced in industrial bakeries is produced on a large scale, as a result of which economies of scale come into existence and the bread can be sold more cheaply to supermarkets. In turn, supermarkets are then able to sell their bread to consumers for a lower price. The supermarkets have another advantage over traditional bakeries, as the consumers increasingly prefer to buy their bread in supermarkets because of the convenience of doing all of their shopping in one store. Thus, by the very existence of supermarkets, consumers have gained power over the traditional bakeries.

5.7 Industrial bakeries - Supermarkets

Supermarkets need bread because of consumer demand and buy it from the industrial bakeries. The supermarkets are aware of consumer demand because of its direct contact with the ultimate consumers of the supply chain. Furthermore, in addition to the industrial bakeries receiving money from the sale of its bread to supermarkets, they are also able to obtain information from them about the market's needs. Supermarkets translate consumer demand into bread specifications for industrial bakeries and with this information, industrial bakeries become able themselves to produce the kind of bread demanded by consumers. Accordingly, the supermarkets reduce uncertainty for industrial bakeries.

The number of small local supermarkets is decreasing and the Dutch retail market has become dominated more and more by some of the big supermarket chains. Similarly, three large industrial baking companies dominate the industrial bread market. There is neither a monopoly nor an oligopoly in existence, by which one of these two actors in the chain is able to garner much power over the other. Foreign companies also have no influence over this power relationship. Only 6% (60,000 tons) of bread is exported, and 3% (30,000 tons) of the bread eaten in the Netherlands is produced abroad (GZP, 2007). This is probably as a result of consumer preferences, which differ between countries. For example, in Germany consumers want bread containing a higher

percentage of rye than is the norm to Dutch consumers. Consequently, Dutch industrial bakeries and supermarkets are highly dependent on each other. They share a common goal, offering up the bread that Dutch consumers demand. Because of this, the industrial bakeries and supermarkets have long-term relationships with each other. The consumer information that supermarkets can obtain, and which industrial bakeries in turn have to follow, gives slightly more power to the supermarkets. However, the difference in power between the industrial bakeries and the supermarkets is minimal.

5.8 Supermarkets - Consumers

Paragraph 5.6 "Traditional bakeries – Consumers" has already drawn attention to the relationship between the supermarket and the consumer. As already noted, the supermarkets are pushing the traditional bakeries aside more and more. In this paragraph, the relationship between the supermarkets and the consumers is central. Like the traditional bakeries, the supermarkets also try to meet the bread preferences of the consumers as far as possible. Then, for the bread that they sell, the supermarkets receive money. For the supermarkets, the resource of money is not concentrated to a great extent as there are many consumers who want bread. Since consumers do not want to make long journeys to get it, there are a small number of supermarkets. An oligopoly exists between supermarkets and consumers. However supermarkets do not obtain power from this oligopoly, as they do not work together. Indeed, the opposite is true in that the supermarkets compete strongly with each other for consumers in a price war. The fact that consumers can easily switch to another supplier of bread, another supermarket or even a traditional bakery, gives them power over the supermarkets. However the difference in power is not great. Stable contacts with industrial bakeries, result in high quality bread for low prices and these, together with the ability to allow consumers to do their shopping in just one store, are strong weapons in the competition with the traditional bakeries. Moreover, consumers tend to be dedicated to their supermarket and will not switch to another easily (Deloitte, 2007b).

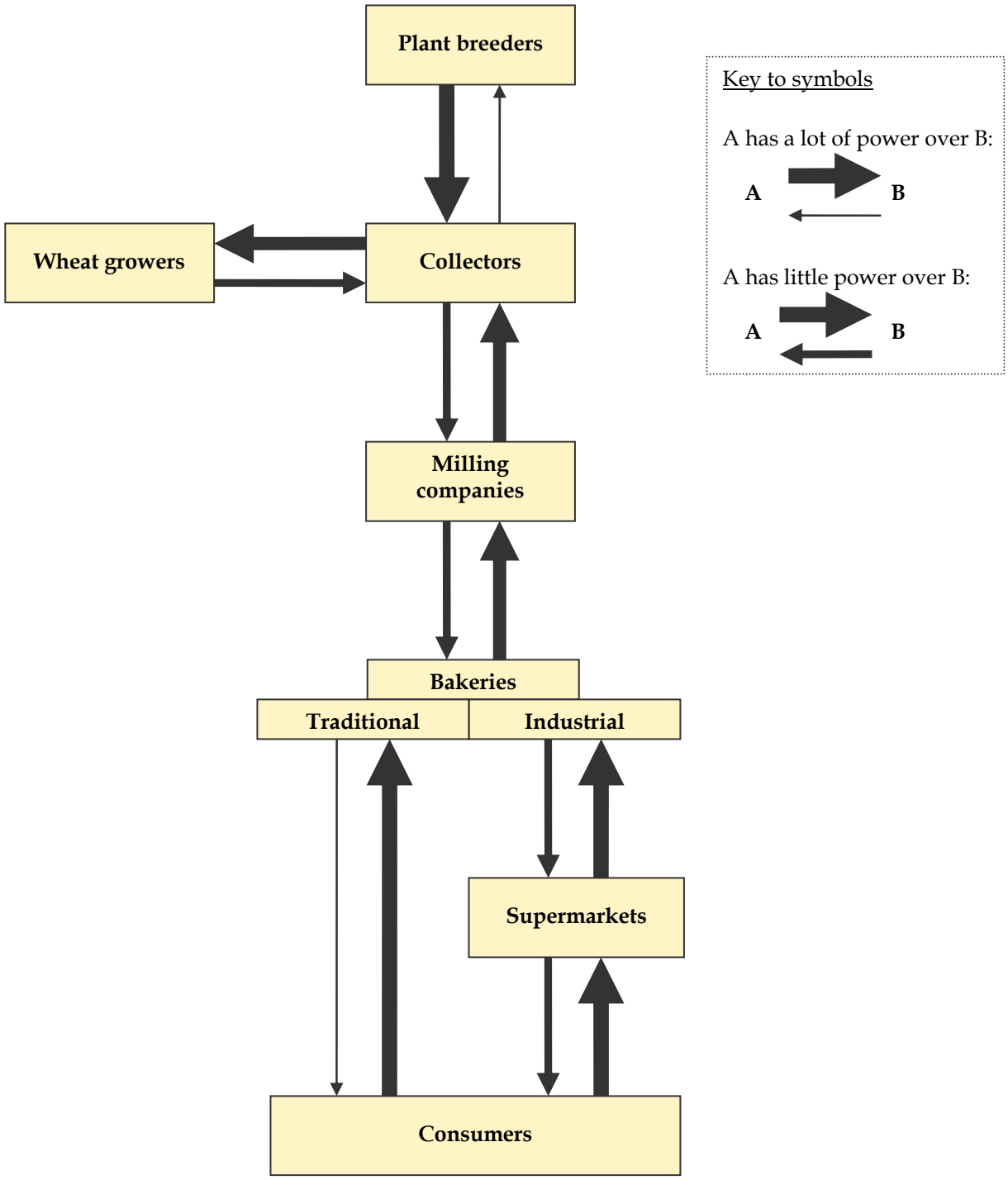
5.9 Conclusion

The power relationships between the actors in the Dutch milling-wheat supply chain are summarized in Figure 5-1: Power relations. Each actor is linked to another by two arrows. When the arrow emanating from one actor in the direction of another is wide, this indicates that the actor from whom the arrow emanates has power over the other actor. In turn, the actor from whom the narrow arrow emanates is the less powerful of the two. This actor is the dependent one. In the Dutch milling-wheat supply chain, a pull market exists. This can also be seen in Figure 1. The consumers have the greatest amount of power and other actors in the chain react to their demands. Put differently, all of the other actors are dependent on the user of the end product in the chain.[4] The consumers have power over the supermarkets (although this power difference is minimal) and the traditional bakeries. Both the supermarkets and traditional bakeries compete with each other for consumers. The supermarkets and industrial bakeries are highly dependent on each other and both have the same goal; selling the bread demanded by Dutch consumers. However, the supermarkets have slightly more power over the industrial bakeries because they can obtain information about consumers. The bakeries translate the consumers' bread preferences into meal and flour specifications for the milling companies. Bakeries that are represented by the big

[4] The plant breeders have power over collectors because of their size. But plant breeders do try to develop milling-varieties satisfying collector demands.

wholesalers have slightly more power over the milling companies, and this is exacerbated by an overcapacity of meal and flour on the European market. In turn, milling companies have power over the collectors, as they control the relationship. The milling companies translate meal and flour specifications into wheat specifications to ensure that the wheat is good enough to be used in the milling industry. The milling companies have an interest in wheat meeting these specifications, but this does not have to be Dutch wheat. The wheat growers and collectors both want to receive as much money as possible for the wheat, but they do not care so much about the processing industry that buys it. The price differences, in relation to other industries, are not significant in the eyes of the collectors and wheat growers. However the milling-industry gives the highest price for their wheat. In addition, the plant breeders have power over the collectors; the Dutch collectors are less important to the international plant breeders than foreign collectors. However, collectors do have power over the wheat growers. This is caused by the existence of oligopolies or even monopolies. Two big wheat collectors dominate the collectors' market. The wheat growers have no power over any of the other actors in the supply chain. In the Dutch milling-wheat supply chain, the wheat growers form the least powerful chain actor.

Figure 5-1: Power relations



6 Problems

Research question 3: What are the problems in the primary part of the Dutch milling-wheat supply chain?

Only 15% of Dutch wheat is utilized for bread production. Wheat growers see problems in the primary part of the supply chain as the cause of this. In Chapter 5, "Power positions" it emerged that the milling companies have power over the collectors (and thus over the wheat growers, as wheat growers are dependent on the collectors). The collectors want to supply wheat to the milling companies as they pay the highest prices for it, although the difference in price is minimal compared to other wheat-processors. Only the milling companies are aware of precisely what they need to produce meal and flour. With this knowledge, they set the specifications that the wheat has to meet in order to be utilized for bread production. With these specifications, the milling companies control their relationships with the collectors and wheat growers. Furthermore, milling companies have power over Dutch collectors and wheat growers because they can also utilize German and French wheat. These foreign collectors and wheat growers are better able than their Dutch counterparts to meet the required standards. To find out if the utilization of Dutch wheat in bread production can be increased, one must first identify where it is going wrong for the Dutch wheat growers and collectors. This chapter analyses why Dutch wheat growers and collectors cannot meet the requirements of the milling companies. Firstly, the requirements of the milling companies are set out. Thereafter, the reasons why the Dutch wheat growers and collectors are unable to meet these requirements are outlined. Comparisons to foreign wheat growers and collectors are made.

6.1 Requirements of the milling companies

Firstly, the most important requirements, the quality requirements are described. When wheat satisfies these quality requirements, it qualifies as milling-wheat. However milling companies also formulate other requirements that affect their efficiency. Herein, these are called efficiency requirements. As well as quality and efficiency requirements, the milling companies also have logistical requirements.

6.1.1 Quality requirements

The Dutch consumer appreciates light, highly risen bread. Most of the time a high bread volume produces good bread, but the quality is also determined by the colour of the crust and the structure, colour and the tenderness of the crumb. Bread quality is influenced by a number of factors, such as the amount and types of bread improvers, the amount of yeast, rising circumstances (duration, temperature and humidity) et cetera. In addition, the quality of meal and flour has much influence on the bread. This means that there are high requirements for the meal and flour and consequently on wheat (NBC, 2007). Protein quality, and when this is sufficient, also

protein content, Hagberg falling number and DON content are the parameters that determine the suitability of wheat for bread preparation (Darwinkel, 1997).[5]

Protein quality and protein content

In order to get high quality bread, protein is particularly important. Although the prices that the collectors receive are based on protein content, the amount of protein is not necessarily a measure of bread quality. Protein quality is more important than protein content. "When protein content of wheat is low but protein quality is high, we still want to buy the wheat", a manager-employee of a company explained. Wheat that contains the same amount of protein can nevertheless produce big variances in bread volume. This is because a certain type of protein is important, gluten protein. This relates to the gluten network and the functioning of the gluten. Within the gluten network, the amount of gluten protein is a feature. So far as the functioning of gluten is concerned, the issues are water-binding capacity, elasticity and the elastic resistance of the gluten. A high water-binding capacity and a long dough-development-time are considered to be the characteristics that promise good quality. However, elasticity and elasticity resistance of the gluten are the most important factors, as these determine the elasticity and elasticity resistance of meal and flour and thus bread volume. From this it can be seen that the gluten network and gluten functioning determine protein quality. A high protein quality of wheat results in high quality bread (Chinachoti & Vodovotz, 2000; Shewry & Tatham, 2000; Hui & Smith, 2004; Classofoods, 2007a; Classofoods 2007b). As for protein content, there is a specification that it must be 12% or higher. This has not been done for protein quality.

Pre-conditions: Hagberg falling number and DON content

There are two other quality parameters that should be taken into account when the suitability of wheat for bread production is considered, Hagberg falling number and DON content. Enzyme functioning is of great importance in the bread preparation process. The Hagberg falling number represents the α-amylase-activity. A Hagberg falling number lower than 200 means that there are too many α-amylases. When the number of α-amylases is too high, this leads to a high decomposition of starch, which results in sticky, non-processable dough. Numerous α-amylases come about when there is pre-harvest sprouting in the wheat (Darwinkel, 1997). More about pre-harvest sprouting appears in paragraph 6.2.4 "Weather in harvest period causes problems". For wheat to be utilized by milling companies, the DON content must also be low. DON is a mycotoxin produced by a group of Fusarium fungus. DON content has no effect on the baking characteristics of wheat, but in high concentration these mycotoxins can damage human and animal health. Accordingly, milling companies do not buy wheat with a content of 0.75 mg DONs per kg wheat or higher. For the use of wheat for animal feed, standards depend upon the animal species' and its age (Darwinkel, 1997).

6.1.2 Efficiency requirements

Wheat with a humidity percentage lower than 15% can be stored directly after the harvest. With higher humidity percentages, wheat has to be dried, unless it is quickly processed. Milling companies are unable to dry wheat themselves and are thus concerned about humidity percentages. A milling company wants to buy wheat instead of water. Further, the impurity

[5] Ash-content is also a parameter for dough. However it represents a type of dough, not dough quality. Therefore it is not taken into account here.

percentage is an efficiency parameter. If there are impurities, no flour can be created in the milling process. Therefore, the presence of dust, chaff, weed (seeds), stones et cetera is taken into account in the determination of price. Additionally, broken grains, "strange" grains and small grains are removed from wheat in the cleaning process. A percentage of a maximum of 2% is the norm. Moreover, the weight of a hectolitre is determined by the weight of a volume hectolitre of wheat. This means that the heaviest component of the grain, the endosperm, has to be present in the greatest amounts. Big, thick grains generate a high weight of hectolitres. The endosperm generates meal and flour and so is a high output of milling companies. Minimal weights of hectolitres are about 75kg (Darwinkel, 1997). In the milling process, wheat is milled into the flour used for bread preparation. The milling efficiency percentage can vary to a large extent and thus influences process efficiency. The milling efficiency percentage is determined to a great extent by variety and growing circumstances. A percentage of 72% or higher is preferred. In Table 6-1: Quality- and efficiency requirements are presented.

Table 6-1: Quality- and efficiency requirements

Quality requirements:	
- **Protein quality: Gluten network and gluten-functioning**	**No specifications**
- Protein content (when protein quality is right)	12% or higher
- Hagberg falling number	Higher than 200
- DON content	Less than 0.75 mg per kg
Efficiency requirements:	
- Humid percentage	Less than 15%
- Less impurities	Maximal 2%
- Weight of hectolitre	Minimal 75kg
- Milling efficiency	Minimal 76%

(Source: Darwinkel, 1997; Milling companies, 2007)

6.1.3 Logistical requirements

Although the quality and efficiency requirements for wheat are the same for milling companies, their logistical requirements differ a little. In general, milling companies demand homogenous batches of good quality wheat. However the bigger milling companies demand larger batches of wheat than the smaller ones. "We need a supplier that delivers more or less the same quantity every time, being a minimal amount of several hundred tons a week", a purchaser of a big milling company declared. More samples have to be taken if small batches are involved and the milling companies' silos have to be emptied before a new batch of wheat can be stored. The smallest milling company stated that it prefers to take in smaller quantities because their storage capacity is smaller. Although this means that they have to take in more samples, which is time consuming and more expensive due to rising administrative costs, the benefits are that it results in greater insight into the quality of wheat.

Two milling companies with good water connections and who are willing to receive large batches of wheat, much prefer to receive it on ships instead of trucks. Unloading a truck takes about three or four times longer than discharging the same amount of wheat from a ship. Another advantage of receiving wheat on ships is that in this way, the milling companies can easily import wheat from other (European) countries. "We buy our wheat from areas that have good waterways and

where large homogenous batches are collected and can be transported in relatively large ships to our factory. A ship can have a capacity of between 250 and several thousand tons. When we collect wheat from Germany this is done with ships containing several thousand tons," a purchaser for a milling company said. The two other companies do not have waterways; they have to use trucks to get their wheat. As transportation by truck is expensive, these companies prefer to transport the wheat over short distances to their factories. This means that these companies take in a higher percentage of Dutch wheat for their milling process. Milling companies without waterways take in approximately 30% of Dutch wheat a year, whereas milling companies who prefer to transport their wheat by ships, use 10% of Dutch wheat.

6.1.4 (Not) the ideal situation

Although the milling companies set efficiency and logistical requirements, these do not directly influence the suitability of wheat for the milling industry. Quality requirements are the most important, as they determine if wheat can be classified as milling-wheat. If the wheat growers' and collectors' wheat, cannot meet these quality requirements, it can never be used for bread production. Of these quality specifications, Hagberg falling number and DON content must be seen as pre-conditions. If these can be satisfied, then protein quality is the most important quality requirement. When protein quality is sufficient, it is also important that the wheat contains high protein content. Accordingly, it can be seen that protein quality is the most important factor in determining whether wheat is milling-wheat and so can be utilized in bread production.

Wheat growers and collectors should pay the most attention to protein quality. The growers should select which wheat varieties score highly on protein quality and the collectors should give them advice about this. In addition, wheat growers should add nutrients to the soil during the wheat's growth process, in order to obtain a high protein quality. After the harvest, the price that the collectors pay the wheat growers should be based on protein quality, as this is the most important quality parameter. The collectors should separate the batches of wheat received from individual wheat growers on the basis of its protein quality. When collectors separate out the wheat that meets this quality parameter, they are able to create large batches of wheat of the quality demanded by the milling companies. For their part, the milling companies should pay the collectors based upon protein quality.

However, as can be seen from Table 6-1: Quality- and efficiency requirements, there are no specifications for protein quality, despite it being the most important quality parameter. Milling companies do not produce protein quality specifications. As the milling companies specify other quality and efficiency parameters, the wheat growers and collectors put effort into meeting these less important parameters. As a result, the primary part of the supply chain does not operate in the most efficient and effective way. Furthermore, compared to their German and French colleagues, the circumstances of Dutch wheat growers and collectors make it more difficult to meet the milling companies' requirements. This results in two specific problems, one for the Dutch wheat growers and one for the Dutch collectors. These problems and underlying sub problems are outlined in the next two paragraphs.

6.2 Wheat growers: Difficult to achieve high protein quality

For wheat growers in the Netherlands it is difficult to produce wheat with a high protein quality. This is caused by three underlying sub problems. Although some of those interviewed maintained that there were insufficient wheat varieties available in the Netherlands from which protein quality could be gained, this study does not identify this as a problem. An explanation for this is given in the first sub paragraph.

6.2.1 Varieties scoring high on protein quality

Protein quality, the most important milling-wheat requirement, is strongly determined by wheat variety (as far as is known). Therefore wheat growers should sow varieties with good protein quality attributes. In the Netherlands, wheat varieties are divided by milling-wheat varieties and feed-wheat varieties. In Germany elite-milling-wheat varieties (further abbreviated as E-wheat varieties) are sown, from which wheat of an elite-quality can be produced. This E-wheat is highly appreciated by milling companies for its outstanding quality, although they consequently have to pay the highest prices for it. In Germany a classification system is used, by which quality of wheat is indicated by a character "E", "A", "B" and "C" (Table 6-2: Variety qualifications).

Table 6-2: Variety qualifications

Dutch qualification	German qualification	Quality	Tons per hectare in NL	Sowed in NL?
Milling-wheat	E-wheat	Elite-quality	6-7 ton	No
Milling-wheat	A-wheat	Milling-quality*	8-9 ton	Yes
Feed-wheat	B-wheat	Feed-quality	8-9 ton	Yes
Feed-wheat	C-wheat	Feed-quality	8-9 ton	Yes

* In the Netherlands A-wheat is divided into "better-milling-quality" and milling-quality. By "better milling-quality" E-wheat is not referred to.

As the Netherlands produces only 1% of the EU's total wheat, plant breeders do not develop specific varieties for it, and as Dutch collectors do not have power over the international plant breeders, they cannot make them do so. Because varieties of wheat have their own regions in which they perform better, not all the varieties developed by plant breeders for other countries can be used in the Netherlands. Dutch collectors and also wheat growers are dependent on the Dutch suitability of the "foreign varieties". For example "French varieties" cause "winter hardy problems". None of the E-wheat varieties used in Eastern Germany are suitable for the Dutch climate. These E-wheat varieties are greater in length and because of this, in the maritime climate of the Netherlands, there is a higher chance that they will be flattened. Furthermore, although these E-wheat varieties are of a high quality, a reasonable production quantity cannot be achieved with them. The production quantities of E-wheat varieties are even lower in the Netherlands than in Germany. Accordingly, they are rarely cultivated in the Netherlands. The additional payment received because of their quality is insufficient to make up for the loss in quantity. However, the fact that none of the E-wheat varieties are suitable for the Dutch climate should not be seen as a problem, as the milling companies' demand for wheat of the quality of E-wheat, is small. They use approximately 20% of E-quality wheat per annum. Further, these E-varieties are sown on a small scale in Germany. Even the big wheat producing country of France does not produce wheat of

such a high quality. Therefore, the utilization of Dutch wheat on a low scale is not as a result of the absence of E-wheat varieties suitable for the Dutch climate, because the milling companies use only 20% of it. There are presently enough A-wheat varieties available that are suitable for the Dutch climate.

Milling-wheat varieties that have been developed for other countries are put onto the recommended Dutch varieties-list, after they have been tested by the Foundation Experimental farms Northern Arable farming (Stichting Proefboerderijen Noordelijke Akkerbouw (SPNA)). The varieties tested by the SPNA are tested for protein quality by the Zélèny-test (more about this test is explained in sub paragraph 6.3.2). From the SPNA's list it can be seen that varieties exist which can produce a high protein quality. In the maritime climate of the Netherlands, there are good temperatures (15-20^{o}C) and high humidity, so that a high production quantity (in tons) is possible. The varieties Illias and Globus both score 8.5 in the Zélèny-test, which measures protein quality[6] (see Appendix 5: Wheat varieties). Although there are A-wheat varieties that score highly on protein quality, wheat growers nevertheless have difficulties producing high protein quality wheat. A Dutch wheat grower said: "I do not know how to control milling-wheat (protein-quality) and the price difference between milling-wheat and feed-wheat is very low. Therefore I try to get a high production quantity instead of high quality". Moreover, the weather during the harvest reduces the chances of Dutch wheat growers producing milling-wheat. These sub problems are outlined in the next three sub paragraphs.

6.2.2 Not knowing how to manage protein quality

After wheat growers have sown milling-wheat varieties, they do not know precisely what they can do to achieve high protein quality in their fields. Wheat growers can make choices about times to sow, harvesting, pest and disease control and fertilization, which is known as crop management (Darwinkel, 1997). The issues of control of flattening of the grains, weed, (viral) diseases and plagues are not dealt with here as they are not particularly important for the growing of milling-quality wheat but they are matters that the wheat growers must always pay attention to, no matter what the crop. The same applies to the best times for sowing and harvesting. Attention is paid here to the application of nutrients because these can influence protein.

Nitrogen can increase protein content in wheat, but to achieve milling-wheat, protein quality is more important. But it has become clear that protein quality depends (to a large extent) on the wheat variety. There is an assumption that protein quality can be managed in the field. As nitrogen and sulphur are both building blocks for amino acids and thus for proteins, protein quality might indeed be influenced by these nutrients. There are however even greater indicators that protein quality could be influenced by nutrients. Differences are found in protein quality by the growing of one specific variety in different regions, for example Oldambt as compared to Eastern Germany. It may be that place specific variations within one variety are bigger than diversification between the varieties. However, both wheat growers and the researchers believe that more research should be done.

[6] Nota bene: These tests are based on the Zélèny test, which only gives an indication of protein quality.

6.2.3 No sufficient payment on protein quality

Milling-wheat variety seeds are no more expensive than feed-wheat variety seeds. However, wheat growers must be certified to be able to sell to milling companies, which leads to them incurring additional costs. Further, wheat growers are strongly advised to follow "crop instructions" set by the milling companies, which can result in lower yields per hectare. These crop instructions also advise the growers to add more nitrogen fertilizations, which additionally raise production costs. However, wheat growers believe that the quality premium available for milling-wheat is very low. The wheat grower receives on average only 4.5 Euros more for a ton of milling-wheat than for a ton of feed-wheat (see Appendix 4: Wheat prices). Seventy-five percent of Dutch wheat growers have less than 15ha grain[7] (CBS, 2007; LEI, 2007). A wheat grower with 15ha wheat and a yield of 9 tons per hectare will only be paid an additional 600 Euros if all his wheat is supplied to a milling company instead of to the feed industry. Accordingly, wheat growers tend to choose varieties that generate many tons and do not feel it is worthwhile putting much effort into achieving high quality. Slightly less is gained from a hectare of milling-wheat varieties than from feed-varieties. On average milling-wheat varieties score 99.3 on production quantity and feed-wheat varieties score 100.8 (see Appendix 5: Wheat varieties). Ninety percent of wheat sown by the wheat growers involves milling-wheat varieties. This is because when a wheat grower is certified, there is always a chance that his wheat can be delivered to milling companies, for which the grower receives a small bonus. If the wheat grower chooses to plant only feed varieties, his wheat can never be supplied to the milling companies. Thus he wants to keep his options open without having to expend (much) effort on achieving quality. However, even if the wheat growers did focus on quality, they would not pay attention to protein quality, but instead strive for other quality factors for which they are paid by milling companies. Milling companies do not pay for protein quality but instead they base their payments on "less relevant" quality and efficiency requirements. To a large extent payments are based on protein content.

6.2.4 Weather in harvest period causes problems

To understand how the weather causes problems in achieving milling-quality, the life cycle of wheat must first be briefly explained. The life cycle of wheat consists of a vegetative phase (germination and formation of sprouts and leafs) and a generative phase (bloom and grain filling). After grain filling ends, the grains are in a rest period, which is called embryo dormancy. This dormancy prevents early germination. The duration of embryo dormancy is about one or two months, depending on wheat variety and the temperatures at the end of the grain filling period. High temperatures shorten embryo dormancy. The dormancy period ends gradually and after some time grain is completely germinative. Under wet conditions grains can lose their dormancy and germinate. When grain loses its dormancy before wheat is harvested, this is called pre-harvest sprouting (PHS) (in Dutch: schot). Pre-harvest sprouting results in many α-amylases. When the Hagberg falling number, which measures α-amylases, is lower than 200, wheat can no longer be used for milling companies (Darwinkel, 1997).

In recent decades, the harvesting period has moved to a later time. The growth period has increased and has lead to higher production quantities. In most years, the harvesting period is now in August, when there is a higher chance of rainfall in the Netherlands and so there is more chance of pre-harvest sprouting. In wet weather conditions wheat cannot be harvested, as grains become stuck to each other and the combine harvesters become blocked. Besides, the heavy

[7] Most of this grain is wheat but it can also be rye, barley, oat or corn.

machines become stuck in the wet field. Moreover, in a wet period, the humidity percentage becomes very high, resulting in drying activities. This is seen as a big problem by the interviewees: "Once every four years it goes wrong. (…) Only once in the last ten years in Eastern Germany and France have there been problems with harvesting wheat because of rainfall, (which may cause pre-harvest sprouting of the wheat) compared to once every four years in the Netherlands". There is a higher risk of pre-harvest sprouting in the Netherlands compared to Eastern Germany and France (a lot of wheat comes from areas around Rheims), as there is less risk of August rainfall in these countries. In addition, they can even harvest in July. On average in July in Rheims, the total amount of rainfall is 50mm, compared to 53mm for Berlin and 75mm for De Bilt. The total amount of rainfall on average in August is 54mm for Rheims, 65mm for Berlin and 71mm for De Bilt (KNMI, 2007). A milling company's purchasing agent stated: "The reliability of Dutch wheat's quality is often low. We do not want to buy Dutch wheat in advance, but we do dare to do so with German and France wheat. In the Netherlands we have to wait until wheat is harvested in order to first check its quality". In Germany and France quality assurance is higher.

6.2.5 Wheat growers with own storage capacity cannot deliver large batches

The final problem is of a logistical origin and does not contribute to the central problem in this paragraph, namely "Wheat growers have difficulties in achieving protein quality". Furthermore, this problem only affects wheat growers with their own storage capacity, approximately 5% of the total number. Nevertheless, it is worth briefly mentioning it. An advantage for growers with their own storage facilities is that they can sell wheat throughout the year. Their wheat is separated from that of other growers with other wheat qualities. Yet hardly any of the wheat from growers with their own storage facility goes directly to milling companies. This is because the three biggest milling companies prefer to buy in higher volumes than (most of the) wheat growers with their own storage facilities can supply. On the other hand, the smallest milling company is able to buy small amounts of wheat, but there are no farms with their own storage capacity near to it. Almost without exception, if any wheat produced by growers with their own storage capacity goes to the milling companies, this is done indirectly with the help of collectors.

6.3 Collectors: Difficult to supply large batches of high protein quality wheat

For collectors it is difficult to supply large batches of high protein quality wheat to the milling companies. Three sub problems underpin this problem and are outlined in the following three sub paragraphs.

6.3.1 Wheat growers have difficulties in achieving high protein quality

Not all of the 90% of milling-varieties sown produce wheat of milling quality. This is caused by the wheat growers' problems of achieving protein quality, because they do not know how to manage this on their fields. They are not paid for protein quality and the weather during harvests causes problems. As collectors have to sell this wheat to milling companies, these "wheat-grower-problems" also affect the collectors. Compared to German and French collectors, it is more difficult for Dutch collectors to supply milling quality wheat to milling companies. As already mentioned, plant breeders concentrate on these foreign wheat-producing countries when developing seed varieties. Furthermore, the quality assurance of German and French wheat is higher. Yet even

when Dutch wheat growers have produced wheat with a high protein quality, other problems exist for the Dutch collectors. These concern two problems in the marketing of wheat by collectors to milling companies.

6.3.2 Wheat cannot be measured and therefore separated on protein quality

Almost all of the wheat taken in by milling companies is supplied by collectors. The collectors collect and store wheat, and thus have higher volumes than wheat growers with their own storage facilities can achieve. In addition, most of the collectors have the opportunity to transport wheat by ship as many of them are established near waterways. The collectors' problems are caused by the small structure of the Dutch agricultural sector. This structure produces many sub standard qualities of wheat. Wheat production is carried out by a large number of small farms, each with their individual growing circumstances, approaches to growth and choices of wheat variety (although advised by cooperatives, they make their own choices). Wheat growers do not all expend the same effort in achieving high quality wheat. "The small scale structure of the Netherlands is a problem", someone from a milling company explained. "And if farms are large", a collector stated, "they sow more than one variety of wheat." Furthermore, as a milling company spokesman pointed out: "The average of a good and bad wheat product is always a bad product." Foreign collectors have less difficulty in supplying large batches of wheat of sufficient quality. This is due to higher quality assurance and the larger scale of the agricultural sectors in France and Germany. "Germany wanted to be self-supporting during Communism. They wanted to grow wheat on large fields. Nowadays we reap the benefits of that", a purchaser for a Dutch milling company said. In France the agriculture is also on a large scale; collectors can fill a silo with one field of wheat. Wheat growers are so large that just one of them can fill three boats, each one containing one variety of wheat. Of course the quality of the wheat can be different between fields, but in Germany they apply nitrogen fertilizer to the places it is needed, with the help of Global Positioning System (GPS). The use of precision agriculture results in large homogenous products.

Because so many sub standard varieties exist in the Netherlands, the Dutch collectors have to separate the wheat out to obtain a large batch of wheat of a good quality. But, only the big Dutch collectors have a separation process. Small grain traders cannot afford to separate wheat themselves, as it is not possible for them to invest more in several, different storage facilities. The big collectors separate wheat by its variety. Wheat varieties that have more or less the same characteristics are stored in one silo. In addition, this variety-based separation takes place based on humidity percentages and weight per hectolitre. However, by operating in this way, much of the sub quality wheat is still put in the silos, which results in a product that is of insufficient quality for the milling companies. In this separation process, collectors are not focused on the most important quality parameter, protein quality, as they are not paid for this (further discussed in the next sub paragraph). But even if the collectors wanted to separate on protein quality they could not do so because they do not have the ability to measure it. The protein quality of wheat cannot be measured. This can only be done if wheat is first transformed into meal and flour or dough. The Zélèny-test, for example, gives an indication about protein quality. In this test an amount of flour and a lactic acid solution is shacked. After this, sediment of swollen flour particles comes into being. The bigger the sediment, the higher the volume of the bread will be. With the alveograph of Chopin (and also the extensograph of Brabender) elasticity and the elasticity resistance of dough, which influences bread volume, can be measured The Brabender farinograph can also measure water-binding capacity. However none of these quality tests determine quality conclusively. For example the results of the Zélèny-test are influenced by the milling-diagram of the mill, so it is not helpful to compare meal and flour processed by different mills. Only the bake-test gives the

definitive answer to the question of whether dough, meal and flour and therefore the wheat from which it is produced, are of a sufficient standard for bread preparation (De Molenaar, 2001). Yet, no matter what tests are available, all of them are too complicated and time-consuming for collectors to use to separate and store wheat in silos during the busy harvest period. Only milling companies can carry out these tests and thus gain information about protein quality.

6.3.3 No payment on protein quality

As already mentioned in paragraph 6.2.3, wheat growers are not paid enough to produce wheat with a sufficient protein quality. Moreover, the price difference between milling-wheat and feed-wheat is low. This is due to collectors paying wheat growers for their wheat based upon the price that they can obtain when they sell the wheat to the processing industries. Accordingly, the payments are not based on protein quality and the collectors' approach is also influenced by the fact that there is not much difference in price between the wheat used by the milling companies compared to that used in other processing industries. These small price differences do not encourage the collectors to invest in the storage facilities needed to separate the wheat. Furthermore, the collectors pay attention to those quality requirements for which they are paid and which can be measured. In other words all the quality requirements except the most important, protein quality.

6.4 Conclusion

Protein quality is the most important quality parameter. When protein quality is high, wheat can be classified as milling-wheat and be utilized for bread production. However, milling companies do not specify protein quality standards. By doing so milling companies control their relationships with the collectors and wheat growers and obtain power over the wheat growers and collectors. Only milling companies can carry out tests by which protein quality can be measured and thus gain information about protein quality. The collectors do not have any information about the protein quality of the wheat that they offer for sale to the milling companies and they are also not paid on protein quality. Besides, the wheat growers do not know how to manage protein quality on their field. Furthermore, the lack of protein quality specifications causes that the wheat growers and collectors focus on other, less important, specifications. The absence of protein quality specifications combined with specific Dutch conditions concerning weather circumstances during the harvest and the structure of the Dutch agricultural sector, makes that the Dutch wheat growers and collectors cannot fulfill the requirements of the milling companies extensively compared to their German and French counterparts.

German and French wheat growers and collectors can meet the milling companies' requirements better than their Dutch colleagues. Although German and French wheat growers and collectors also lack protein quality specifications, they operate under better conditions than their Dutch counterparts. Wheat varieties are developed exclusively for these countries by plant breeders and weather circumstances in Germany and France are better during the harvest period compared to the Netherlands. This results that German and French wheat has a higher quality assurance compared to Dutch wheat. Besides, the larger agricultural structure in Germany and France compared to the Netherlands, results in large batches of the same quality milling companies demand for. Furthermore, the price of German and French wheat is relatively low because these countries produce more wheat than they need. In the Netherlands due to a lower quality

assurance and a smaller scale agricultural structure compared to Germany and France, the absence of protein quality specifications causes problems for Dutch wheat growers and collectors. For Dutch wheat growers it is difficult to achieve high protein quality. For Dutch collectors it is difficult to supply large batches of wheat of high protein quality. These two problems and underlying sub problems are summarized in Table 6-3: Problems in the primary part of the supply chain.

Table 6-3: Problems in the primary part of the supply chain

Wheat growers: Difficult to achieve high protein quality
- Not knowing how to manage protein quality
- No sufficient payment for protein quality
- Weather in harvest period causes problems
- (Wheat growers with own storage capacity cannot deliver large batches)
Collectors: Difficult to supply large batches of wheat of high protein quality
- Wheat growers have difficulty in achieving high protein quality
- Wheat cannot be measured and therefore separated on protein quality
- No sufficient payment for protein quality

Collectors do want to fulfill the requirements of the milling companies, so that they can obtain the highest price for their wheat. If Dutch wheat growers and collectors were able to supply large batches of wheat of a high protein quality, their power position in relation to the Dutch milling companies increases. If collectors can supply milling-wheat to milling companies, they become more important to them than the German and French collectors are. Milling companies' transport costs are lower and delivery reliability is higher when they can get their wheat from the Netherlands. But to be able to increase the amount of milling-wheat supplied to milling companies by Dutch wheat growers and collectors, so that consequently more Dutch wheat can be used for bread production, large batches of wheat of a high protein quality must be produced. Accordingly, the wheat growers' and collectors' problems have to be dealt with. In this research, it is assumed that innovations can remove these problems. Therefore, in the following chapter "Supply chain innovations", there is an analysis of precisely what supply chain innovations are needed to deal with these problems.

7 Supply chain innovations

Research question 4: Which supply chain innovations are needed to remove the identified problems?

Chapter 6 "Problems", outlined how the Dutch wheat growers' and collectors' problems arose from lower quality assurance, a smaller scale agricultural structure (compared to Germany and France) and the absence of protein quality specifications. Quality assurance is influenced by the weather. The weather and the small scale of the Dutch agricultural sector cannot be changed (easily). However, it might be possible to deal with these circumstances better. If protein quality specifications could be set up, wheat growers and collectors could focus on the most optimal quality parameter for wheat if it is to be used in bread production. If protein quality specifications are available, the first step has been made on the road to realizing three supply chain innovations. These three innovations would solve most of the problems in the primary part of the Dutch milling-wheat supply chain. Precisely why these innovations need protein quality specifications and how the problems would be resolved, is outlined in this chapter.

7.1 Decision Support System to manage protein quality

It is difficult for wheat growers to achieve high protein quality because they do not know how to manage protein quality in their fields and they are not paid the kind of money that would encourage them to focus on this issue. In addition, the weather generally experienced during the harvest, lowers the quality assurance of Dutch wheat. In the next paragraph the "payment-problem" is discussed. This paragraph also deals with the subject of managing protein quality, at which point how to increase quality assurance is also outlined.

7.1.1 Managing protein quality

It is known that the protein quality of wheat is determined by variety but the relationship between the weather and protein quality is not known. This also applies to the relationship between soil factors (nutrients) and protein quality. Wheat growers can choose varieties that score highly on protein quality, but they also want to know how they can manage protein quality in their fields. They should be informed about what can be done to improve protein quality as this is the most important quality parameter for whether wheat is classified as milling-wheat or not. But when protein quality is achieved, wheat growers also need to know how to achieve high protein content and how to fulfill the pre-conditions of Hagberg falling number and DON content.

It is already known that nitrogen can influence protein content in the field. There are however indications that protein quality can also be influenced in the field. Wheat growers and researchers have stated that something could perhaps be achieved by using nitrogen and sulphur to manage protein quality. But weather conditions also influence the growth process of wheat and thus its quality. It may however be possible to cope better with the Dutch weather conditions when trying

to produce milling-wheat. For example, it is thought that to prevent pre-harvest sprouting, and the consequential high Hagberg falling number, it might be possible to sow the wheat (with low pre-harvest sprouting resistance) earlier in the season. In addition, wet conditions increase the chances of Fusarium and so a high DON content in the wheat. The use of pest and disease control measures means that this risk can be decreased. Establishing the relationship between nutrients and milling-wheat and how weather conditions can be best coped with are the first steps towards managing milling-wheat. Yet it is still difficult for wheat growers to deal with these matters, even though they provide the greatest chance of obtaining the best results. In order to control protein quality (and other quality factors) within a chosen wheat-variety, the growers have to make many decisions during the growth season. They must firstly know what kind of nutrients the soil contains and must then adapt their crop activities to the soil so as to produce milling-wheat. This means that the wheat growers have many decisions to make. They have to add important nutrients to the soil at the right time in the season and also in the correct locations. Applying many nutrients will increase costs for the wheat growers and they are also bound by strict governmental regulations that determine the amount of nutrients that can be used. They also have to make decisions about pest and disease control and the use of growth regulators, so as to get the desired quality. Their decisions about the best times to sow and harvest the wheat, so as to reduce the chances of pre-harvest sprouting, also have an impact on the production of milling-wheat.

7.1.2 Decision Support System

The supply chain innovation "Decision Support System" (DSS) can support the wheat growers in their decision-making processes and enable them to produce milling-wheat. A DSS goes one step further than the current crop manuals. It automatically combines the desired quality wanted by the wheat growers with the appropriate soil conditions and weather conditions during the growth process. For example, with the help of LOFAR (Low Frequency Array) weather conditions can be measured on the field[8] (Lofar, 2007). Based upon calculations that the DSS makes with this input, the DSS gives the wheat growers advice about which crop activities are needed to lead to the best chance of producing milling-wheat. In Appendix 6: Simplified illustration of a Decision Support System, this supply chain innovation is presented.

The wheat growers import the chosen wheat-variety, decide on the best time to sow and deal with the weather and soil conditions during the growth period. In addition, they put in place the protein quality and other quality parameters that they are aiming for. The tool provides advice about which minerals to add, which methods to use for pest and disease control and growth regulation, at the right time in the season and at the correct soil location. When it is known what amounts of nitrogen, sulphur or other nutrients that the wheat growers should add to the soil at the right time, they can then use a GPS (Global Positioning System) to make sure that the right amounts are applied to the right locations in the field. Advice is also given about the optimal sowing and harvesting periods. At first sight, this DSS might not be seen a supply chain innovation as it appears to only concerns wheat growers. This is not the case. Collectors are also involved. Collectors give wheat growers advice, and so they can use the DSS as an extension of their current systems. These companies in the chain are also wholesalers of nitrogen fertilizations, namely the means to deal with pest and disease control and growth regulators. Therefore, with the help of such a system, collectors would be better informed about what the wheat growers need. An ordering system between wheat growers and collectors could be linked to the DSS.

[8] In the agricultural sector the sensor network of LOFAR can be used to execute precision agriculture. With the sensor, attention can be paid to the crops, influence on weather, pests and diseases on the crop.

But before such a Decision Support System can be realized, the relationship between protein quality (and other quality parameters) and soil and weather conditions must be known. To obtain this information, protein quality specifications are needed. Within the KodA-program, two studies have already commenced, with the aim of finding out how wheat quality can be managed on the field. But the milling companies have not yet provided exact specifications, namely an upper and lower limit of the protein quality parameter. Therefore, without such limits is very difficult for the KodA research to determine how quality should be managed.

7.2 Payment system based on protein quality

With the Decision Support System, wheat growers would be better able to manage the protein quality of the wheat. Difficulties in achieving protein quality are thereby reduced. However the payment-problem also contributes to these difficulties. The "payment-problem" concerns both the wheat growers and the collectors.

7.2.1 Wheat growers' and collectors' "payment-problems"

If wheat growers are not rewarded for producing protein quality, even when a Decision Support System is available, they are unlikely to put much effort into achieving it. If wheat growers have to incur a lot expense for certification, fertilization applications and other crop management activities to be able to produce milling-wheat, they should be adequately compensated. Currently, the wheat growers believe that the quality premium available to them for milling-wheat is very low. For a ton of milling-wheat, the wheat growers receive only 4.5 Euros more (on average) than they would receive for a ton of feed-wheat. Accordingly, they choose varieties that will generate a high tonnage and do not want to put much effort into achieving high quality. Even if a wheat grower decides to pay attention to the quality of his wheat, the tendency is to focus on "less relevant" quality and efficiency requirements (See Table 6-1: Quality- and efficiency requirements), instead of protein quality. Wheat growers are not encouraged to focus on protein quality because milling companies do not pay for it. To reduce the wheat growers' difficulties in achieving it, another payment system is needed as well as a DSS.

In order to create large batches of milling-wheat, the collectors have to separate milling-wheat from "other"-wheat. However when the price difference between the two is low they themselves cannot afford the storage facilities needed to enable them to conduct the separation process more precisely. Moreover, as with the wheat growers, collectors focus on the less important quality parameters instead of on protein quality. Milling companies pay collectors based on all these other parameters instead of on protein quality. In turn collectors also pay wheat growers on the basis of less relevant parameters.

7.2.2 Fixed price difference and focus on protein quality

To solve these problems payment should be based on quality instead of quantity. Therefore the price for milling-wheat should be higher than the price that other industries pay for their wheat. Milling companies should apply a fixed price difference between milling-wheat and "other"-wheat, to ensure that wheat growers and collectors put more effort into achieving high quality. In addition, the quality parameter "protein quality" must be emphasized in the payment system, in

order to turn the wheat growers' and collectors' focus to this optimal quality parameter. Accordingly, protein quality should be quantified to enable scores to be determined on the basis of which collectors are paid by milling companies, and they in turn pay the wheat growers. For example, if the protein quality score is 5, wheat is worth 150 Euros per ton. If wheat scores 6 on protein quality, it is worth 160 Euros per ton et cetera. Furthermore, other quality requirements (protein content, Hagberg falling number and DON content) and efficiency requirements should be taken into account, on condition that a weighting-factor is ascribed to them. Wheat price is determined by supply and demand of the product. Thus the payment system should be allied to the market and be flexible. Accordingly, the score of 5 on protein quality may be worth 150 Euros per ton one year and 160 Euros per ton in another. However, the price difference between milling-wheat and "other"-wheat should be fixed. A calculation model could be made by which collectors are paid by milling companies. In turn, collectors use this calculation model to pay wheat growers. Thus it can be seen that such a payment system is indeed a supply chain innovation as it affects more than one actor in the supply chain.

To create a payment system based on protein quality, protein quality should be quantified. Milling companies should make clear which kind of wheat would be classified as poor and which would be classified as containing sufficient protein quality. What precisely determines protein quality should be clear. What kind of gluten network is appreciated? What kind of water-binding capacity, elasticity and elasticity resistance of the gluten is required? How should this be rewarded? These are questions that have to be answered first. Therefore, it is clear that protein quality specifications are needed before the type of payment system described can be realized.

7.3 Quick measurement- and separation system for protein quality

Collectors are not able to measure the protein quality of wheat and are therefore unable to separate wheat on this quality parameter. Currently, the small scale of the agricultural sector in the Netherlands, results in many substandard varieties being put in the silos. This leads to the production of large batches of wheat that is of insufficient quality for the milling companies. This paragraph deals with this problem.

7.3.1 Measurement- and separation system

To produce large batches of wheat that are of a quality that the milling companies desire, the wheat has to be separated, based upon the most important quality parameter, protein quality. However before wheat can be separated on quality, the quality must be measured. Measurement and separation should be based on the quality requirements of protein quality, protein content, Hagberg falling number and DON content. However it should also be possible to take account of the efficiency requirements that the milling companies prefer. After the harvest, wheat has to be stored quickly in order to maintain quality. Therefore it should be made possible to conduct both measurement and separation quickly as there is little time for intensive measurements to be carried out in the busy harvesting period. This results in the third supply chain innovation, a "Quick measurement- and separation system for protein quality". Appendix 7 presents a simplified illustration of such a system. The margins for protein quality and other quality parameters should be input onto the measurement system's computer. A sensor would then measure the quality of the wheat. Quality information would then be sent to the controller. Based on the margins that have been input into the system, the controller is able to determine which

wheat grain meets the quality requirements and which does not. With this information the controller is able to activate the mechanism that separates the wheat into milling wheat and "other"-wheat.

7.3.2 Measurement- and separation system in the business process

The growers and collectors can use the measurement- and separation system described, either during or after the harvesting-process. When measurement and separation is carried out during the harvesting process, there should be a measurement- and separation system on the combine harvester and as well as two (or more) receiving tanks, one for milling-wheat and one for "other"-wheat. If harvesting is carried out by a combine harvester that does not have a measurement- and separation system, this should take place before the wheat goes either to the silos of growers who have storage capacity or to the silos of collectors. However, as the Dutch wheat growers who have their own storage facility cannot themselves send large batches to milling companies, their wheat should firstly go to collectors (separated or unseparated). Wheat growers would then be paid by the quality supplied, since the system can trace precisely what the growers have delivered.

In order to be able to separate the wheat, it must first be possible to quickly measure the protein quality (and other quality parameters) of it. To be able to measure protein quality, how to measure the gluten network and the functioning of the gluten needs to be established. As is already clear from the previous paragraph, answers have to be found to the questions: What kind of gluten network is best? What kind of water-binding capacity, elasticity and elasticity resistance of the gluten is needed? Therefore protein quality specifications are needed before the measurement and separation of wheat, based upon its protein quality, can be realized.

7.4 Conclusion

With a "Decision Support System to manage protein quality" and "Payment based on protein quality", wheat growers would be better able to produce wheat with a high protein quality. The problem for the wheat growers, "Difficulties in achieving protein quality" is reduced by the two supply chain innovations proposed. However, it should be noted that although a DSS might mean that weather conditions can be dealt with better, the problem of pre-harvest sprouting could not be removed totally. It is a characteristic of plants in general, and plant breeders can only try to develop varieties that offer a little more resistance to this phenomenon. Although such measures might only slow the pre-harvest sprouting process down by a few days, this could be enough. Moreover, even with the best pest and disease control system in place, it would be difficult to be free from Fusarium in extremely wet summers. The other problem for wheat growers with their own storage facility "Wheat growers with their own storage capacity cannot deliver large batches" is resolved by the measurement- and separation system. These growers should supply their wheat to the collectors in order to have large batches available and, by use of the measurement process they will be rewarded for the wheat that they produced. However some wheat growers might find it problematic if they cannot decide by themselves about the time to sell the wheat, because this also affects the price that they receive. This problem cannot be resolved because milling companies demand large batches.

The problem for collectors "Difficult to supply large batches of wheat with a high protein quality" is partly reduced by the first two supply chain innovations discussed in this chapter. With a

"Decision Support System to manage protein quality" and "Payment based on protein quality", wheat growers are better able to produce wheat with a high protein quality. As a result the collectors are able to obtain a greater amount of milling-wheat from them. The new payment system based on protein quality, would also lead to the collectors doing more to achieve milling-wheat. They can invest in more storage and apply a differentiated separation process. In this separation process, the last supply chain innovation "A quick measurement- and separation system" is needed to separate milling-wheat from "other"-wheat and to enable large batches of wheat with a high protein quality to be supplied.

As these three supply chain innovations supplement each other, they all have to be realized and implemented to remove the problems outlined in Chapter 6. In that chapter, consideration was given to the fact that problems arose from an absence of specifications for protein quality. In this chapter the need for protein quality specifications has been confirmed. Without them, protein quality cannot be measured. As a result, separation and payment based on this most important quality parameter cannot be achieved. Moreover, without specifications it is difficult to formulate crop management instructions so as to achieve high protein quality. In conclusion, without protein quality specifications, the quality of wheat cannot be managed, properly paid for, measured and consequently separated. Without protein quality specifications the three supply chain innovations proposed herein cannot be realized. And without the realization of all three innovations, the utilization of Dutch wheat in bread production cannot be increased.

8 Realization of supply chain innovations

Research question 5: Is it possible to realize these supply chain innovations in the current circumstances?

Realization of the three supply chain innovations, from which it would become possible to supply large batches of milling-wheat to milling companies, would put Dutch wheat growers and collectors in a better position to compete with their German and French counterparts. One advantage for the Dutch collectors is that they are located near to the milling companies, which reduces transport costs and increases delivery reliability. Thus milling companies should be interested in the three innovations. In circumstances where Dutch collectors are able to supply large batches of milling-wheat, they would become more important than foreign collectors to Dutch milling companies. Put differently, Dutch collectors become more powerful in their power relationship with the Dutch milling companies. In the previous chapter, it was outlined how protein quality specifications are needed to result in the realization of the proposed innovations. By defining protein quality specifications, milling companies would lose further power over the collectors. Their ability to control their relationship with the collectors decreases when collectors know exactly what kind of wheat is needed and when they become able to measure it. To make valid comments about the possible realization of the three supply chain innovations, the focus here will be on possibility of achieving protein quality specifications. Two questions are important: "Who has the resources needed to formulate protein quality specifications?" and "How much interest do these relevant actors have in realizing the innovations?"

8.1 Formulating protein quality specifications

Protein quality specifications are needed to realize the three supply chain innovations. Therefore milling companies should first determine the kind of protein quality that they need in order to produce their meal and flour. Nevertheless, it is remarkable that milling companies do not know this precisely themselves. From a physical-chemical perspective (molecular structures) milling companies do not know exactly what is going on in their own milling processes. This became clear when their production processes were examined.

8.1.1 Tacit knowledge

By using their experience, or tacit knowledge, milling companies buy certain batches of wheat and produce meal and flour of a constant quality. It is of great importance to know the characteristics of the different wheat batches. Samples are taken and measured when wheat is bought from collectors. These measurements are taken again during processing time in laboratories every day. Based on the characteristics found, the composition of the wheat used in the mill is changed in order to achieve a consistently high quality of flour. The experience of the milling companies is essential when it comes to repeating measurements and to changing the wheat blend to achieve a

better outcome. Thus the milling companies, partly by experimentation, can create meal and flour of a sufficient quality. Finally, practice-tests in the milling companies' test-bakeries are decisive in ascertaining whether all quality standards have been achieved. The characteristics of the products are examined and the companies then decide if these characteristics satisfy the requirements set by their buyers, the bakeries.

8.1.2 From tacit knowledge to protein quality specifications

When it is known what kind of protein quality that the milling companies want, information about the composition of it must be determined, in order to formulate specifications. Gluten proteins determine protein quality. The amount of gluten and its water-binding capacity, elasticity and elasticity resistance, should be taken into account when it comes to managing, paying for, measuring and separating wheat based upon its protein quality. It is already known that 20-27% of gluten and a water-binding capacity of 160-200% are normal for good quality meal or flour (De Molenaar, 2001). There are no available values as to the most appropriate levels of the elasticity and elasticity resistance of gluten when it comes to making wheat suitable for bread preparation. A wheat grain contains 25 to 100 different gluten proteins. Gluten proteins are divided into families. Based upon their solubility in alcohol, two types can be found that determine the quality of bread, glutenins and gliadins. Glutenins in particular determine the development time of dough and bread volume. Gliadins are able to form a compound with water. These gliadins are singular proteins, consisting of one long chain. Conversely, glutenins are compound proteins, composed of different chains bound together by bridges. Links of these chains are formed by some twenty amino acids. These amino acids are the building blocks of proteins. Gluten contains many amino acids called proline and glutamine. Amino acids are built from carbon (C), oxygen (O), nitrogen (N) and also occasionally from sulphur (S) molecules (Chinachoti & Vodovotz, 2000; Shewry & Tatham, 2000; Gilissen, 2006, Classofoods, 2007b).

Once it is possible to define the optimal composition of protein, amino acids or protein molecules, protein quality specifications can be formulated. With these, scores can be adjusted to reflect the degree to which batches of wheat meet this composition. Investigations can start into developing a measurement- and separation system and a payment system. Research about managing the protein quality of wheat in the fields can be more focused if more is known about the composition of the molecules from which amino acids, and thus gluten proteins are built. To summarize:

1. Get information about the kind of protein quality wanted by milling companies;
2. Examine the composition of this kind of protein quality; gluten proteins, amino acids, molecules;
3. Formulate protein quality specifications.

8.2 Power over innovation: The milling companies

8.2.1 Resources needed

In Chapter 5 it became clear that Dutch milling companies, particularly the large ones, are strong members in the Dutch milling-wheat supply chain. The milling company is the dominant player in the primary part of the supply chain. Milling companies have power over collectors and indirectly

over wheat growers. This is because collectors and wheat growers get most money when they are able to supply their products to milling companies. Moreover, the power of the Dutch milling companies over Dutch collectors is caused by the existence of foreign wheat growers and collectors who can better meet the requirements of the companies. Furthermore, milling companies control the relationship with the collectors with their requirements. Do milling companies also have power over the innovations needed in the primary part of the supply chain? The answer is yes. Their participation is essential, as without more knowledge about the desired protein quality composition, the three supply chain innovations proposed herein cannot be realized. More than anyone else in the supply chain, the milling companies are aware of how to produce a certain kind of meal or flour and to generate a product of a consistent quality.

However, the milling companies should not be expected to provide all of the resources needed. The task of determining the composition of protein quality that the milling companies want might be too complex for these companies to establish themselves. In addition, they may not have the capacity to carry out this research, as their laboratories are also used for daily processing tests. Therefore, the help of external laboratories may be needed. Indeed, the chemical and biological knowledge of the researchers working in such laboratories may also be crucial. Nevertheless, this research not only requires research capacity and chemical and biological knowledge. Wheat samples are also needed to define the composition of the desired protein quality. It will require expensive and lengthy research, with costs particularly rising when help from external researchers is necessary. Accordingly, financial resources are also important. Resources, and who possesses them, are outlined in Table 8-1: Resources and possessors.

Table 8-1: Resources and possessors

Goal: Protein quality specifications	
Resources needed	**Possessors**
- Laboratory	Milling companies, external laboratory
- Chemical & biological knowledge	Milling companies, external laboratory
- Samples of wheat	Wheat growers, collectors
- Financial capital	Milling companies, wheat growers, collectors

8.2.2 Cooperation for innovation

The implicit knowledge of the milling companies has to be made explicit, to enable specifications to be formulated, so that there can be a step forward in the Dutch milling-wheat supply chain. By putting their important information into words or numbers, the other actors in the chain can use it and anticipate the demands of the milling companies. Making implicit knowledge explicit is a difficult undertaking; all four milling companies cooperating with each other is the best approach as they can benefit from each other's knowledge. Wheat growers and collectors do not know enough themselves to garner information about the desired protein quality, but they do possess a critical resource, wheat. There is another reason for the milling companies, wheat growers and collectors to cooperate. The specifications for protein quality would lead to transparency among the chain's actors, enabling them to operate more efficiently and to focus on the optimal quality parameter, which is the parameter that determines whether wheat is suitable for bread preparation. To ensure that implicit knowledge is understandable by wheat growers, collectors

and milling companies, the ideal solution would be total cooperation in this formulation process. The specifications should become a standard in this part of the supply chain. Another benefit from everyone participating in the research is that more money can be raised. Small milling companies, wheat growers and collectors are unable to make large financial contributions on their own. If they are organized they will be able to innovate. However the question remains whether all of the chain's actors are interested in putting effort into this research. This is discussed in the following paragraph.

8.3 Interest

A major question is whether the possessors of the resources, the wheat growers, collectors and milling companies, would be prepared to invest in order to formulate protein quality specifications. This depends upon their interest in the supply chain innovations and the ultimate goal of more Dutch wheat being used in bread production, which would be a step closer to realization with these specifications. Whether the milling companies are interested is the most important issue since they possess essential resources. The milling company is the dominant actor so far as the realization of specifications is concerned, and is thus the dominant actor so far as the supply chain innovations are concerned.

8.3.1 Milling companies

The milling companies are interested in the utilization of Dutch wheat, as compared to the current situation, whereby they obtain 80% of it from abroad, transport costs would be reduced and delivery reliability increased. Moreover, they are interested in one of the supply chain innovations, namely a system that would allow them to measure protein quality more quickly and precisely than the Zélèny-test. To use this test, wheat has to first be transformed into meal or flour, which takes time. Furthermore, the test gives only an indication of protein quality. By using a measurement system to measure the protein quality of wheat, milling companies would have more certainty over the batches of wheat that they buy. Thus with such a measurement system, they could operate more efficiently and effectively than currently. However, if collectors could also measure wheat, the milling companies' power in this relationship would be reduced. If collectors knew that they were in possession of a batch of high protein quality wheat, the milling companies would have no choice but to pay for it. The milling companies seem to be full of good will. They have declared that they would like to pay for the quality they buy. Indeed, the reason that the biggest milling company is participating in the KodA-program is that it wants to develop a system by which collectors and wheat growers can be paid for the quality they supply.

However, their interest in the supply chain innovations in general is low because of other factors. So far as the proposed payment system is concerned, they would have to add in a fixed price difference between milling-wheat and "other"-wheat, to guarantee that the wheat growers put enough effort into achieving high quality. This is not attractive to milling companies, as they would have to pay a higher price than they do currently, since the difference in price between milling-wheat and "other"-wheat (4.5 Euros per ton) is only slight. In addition, they are able to receive large batches of wheat of sufficient quality from Germany and France for a relatively low price. In Germany there is no competition with feed-wheat driving the price of wheat. Feed industries are not near to the wheat producing areas, so they do not compete for the wheat. Moreover, both Germany and France are net exporters of wheat. This makes them more market-

driven. Because of this their prices are not so high (they can also produce wheat more cheaply because their farms are large-scale compared to the Netherlands) and it is therefore possible for milling companies to get their wheat from these countries, even if they have to pay the transport costs to transport it to the Netherlands. This largest milling company that is participating in KodA, declared that they want to pay for the quality they receive on the condition that wheat growers can better control the quality of wheat. With a Decision Support System to manage quality of the wheat, the wheat growers will become able to better cope with the weather, but it can never be totally controlled. Wheat growers can react to the weather but they cannot control weather conditions. The chances of pre-harvest sprouting can therefore probably not be altered to a great extent. Because of this, the quality assurance of Dutch wheat remains lower than the quality assurance of German and French wheat.

The advantage of lower transport costs and greater delivery reliability are not significant for the Dutch milling companies. Transport costs rise when smaller ships have to be used to transport wheat over rivers, due to either low or very high water levels. Delivery reliability also decreases in these circumstances. Both Germany and France have water connections with the Netherlands. All the wheat transported from Eastern Germany to the Netherlands is done over the Mittelland canal. Most of the wheat is stored in silos in the West of Magdeburg, where this canal begins. Its water levels can be controlled by sluice valves, which result in less fluctuation. Wheat transported from France to the Netherlands over the North Sea does not lead to problems. For wheat transported from Northern France (Rheims) to the Netherlands, the Mosel is used. Although the water levels of this river can cause problems they are minimal as the Mosel is a big waterway (Kantoor Binnenvaart, 2007).

Accordingly, it may be that milling companies would not want to present specifications for protein quality as they might see "the right protein quality" as part of their trade secrets. This could cause them to hold back from working with other milling companies and communicating their needs to collectors and wheat growers.

8.3.2 Wheat growers and collectors

As the wheat growers and collectors are also needed to realize the proposed innovations, their interest levels in it must also be considered. Wheat growers are interested in a Decision Support System because they want to know how they can manage protein quality in their fields. This also applies to collectors; if they use the Decision Support System they could give better advice to wheat growers. However, both wheat growers and collectors realize that they cannot control weather conditions and so problems with pre-harvest sprouting will remain. They are interested in the other two supply chain innovations. When it becomes possible for them to measure the protein quality of wheat, it then becomes quite clear what kind of quality wheat growers have produced and they can be paid accordingly. Milling companies can appropriately pay collectors too. Besides, by SPNA carrying out variety research, there would be benefits from a system that measures the protein quality of wheat more precisely than the Zélèny-test, which in turn leads to more accurate information about how the different varieties perform in the Netherlands. Both wheat growers and collectors profit from this. As the protein quality of wheat can be measured and separated, wheat growers and collectors would be able to offer large batches of wheat of the high protein quality demanded by the milling companies. Being rewarded for protein quality would motivate wheat growers and collectors to put more effort into achieving higher quality. Milling companies setting a fixed price difference between milling-wheat and "other"-wheat would be stimulating. However, as the general wheat price is caused by supply and demand, the

price of milling-wheat is flexible. If the general wheat price is low, the drive to invest in innovations will decrease. But if the general wheat price is high, caused by the low availability of wheat, including Dutch wheat, Dutch wheat growers are still affected by a lower yield in tonnage per hectare. The question is whether the wheat growers would still gain in that situation. Only when the general wheat price becomes structurally high, wheat growers and collectors would be stimulated to innovate. Furthermore, it should be remembered that Dutch wheat growers and collectors can always sell their wheat to the big Dutch feed-industry. Wheat growers in Eastern Germany for example do not have such an opportunity.

8.4 Conclusion

To realize the three-supply chain innovations proposed, protein quality specifications are needed. Firstly, information is needed about the kind of protein quality that the milling companies want. Thereafter, the composition of this protein quality has to be examined. Only then protein quality specifications can be formulated. As milling companies are the only members in the supply chain who know the kind of protein quality needed, they have the dominant power position over the supply chain innovations. However, the resources of wheat growers and collectors are also needed to realize supply chain innovations. Milling companies, collectors and wheat growers should cooperate to set up the protein quality specifications needed to realize all three of them.

Milling companies are interested in the utilization of Dutch wheat because this decreases transport costs and increases delivery reliability. However, the advantages that the Dutch wheat growers have so far as being located near to the milling companies is concerned, does not outweigh the greater price that the milling companies would have to have to pay if the innovations were set up. The transport costs are only slightly more and delivery reliability is only slightly lower for Dutch milling companies if they receive their wheat from Germany and France instead of the Netherlands. It is tempting for milling companies to import, for a relatively low price, large homogenous batches of wheat of the quality they need from Germany and France. Dutch wheat growers and collectors are not able to compete with their German and French counterparts. Moreover, to realize the supply chain innovations, the milling companies would have to set up protein quality specifications, which would reduce their power over Dutch wheat growers and collectors. Especially when protein quality can be measured by collectors. In addition, strategic considerations and company secrets would also prevent them from presenting specifications for protein quality. Therefore, it should be expected that milling companies will not contribute significantly. Dutch wheat growers and collectors are interested in the three supply chain innovations and therefore willing to invest their resources to resolve the knowledge questions. However, while the price difference between milling-wheat and “other”-wheat can be fixed, the price of wheat in general cannot be kept steady. Therefore, the growers and collectors have to deal with uncertainty investing their resources in innovation. Moreover, as things stand, without a payment system whereby a fixed difference is made between the price of milling-wheat and “other”-wheat, the Dutch wheat growers and collectors have the easy option of supplying their wheat to the feed-industry for only a slightly lower price.

Although wheat growers and collectors would be more interested in the three supply chain innovations than the milling companies, in the current circumstances it is not possible to realize these innovations. The milling companies, who are the ones who have the power over the most essential resource, namely the ability to produce the specifications needed to realize the innovations, are not sufficiently interested in them to be prepared to put in (enough) effort. For them, the investments needed for the supply chain innovations do not outweigh the advantages.

9 Future possibilities

Research question 6: What is the possibility of these supply chain innovations being realized in the near future?

In Chapter 8, it became clear that the milling companies, whose cooperation is essential for the provision of protein quality specifications, by which the three supply chain innovations come a step closer, do not have enough interest in the proposal to put in (enough) effort to formulate the specifications. They are not interested enough in the idea of utilizing more Dutch wheat in their productions processes. Furthermore, the interest of the Dutch wheat growers and collectors is insufficient to persuade them to put in their resources. The environment could stimulate a change in the interest levels of these actors in the supply chain, whether or not this is brought about by the power of the chain's other actors. In this chapter, consideration is given to whether it would be possible to realize the supply chain innovations in the near future. Accordingly, scenarios are outlined that might stimulate the interest of the milling companies, wheat growers and collectors in realizing the proposed innovations. In the second part of the chapter, the influence of the actors in the secondary part of the supply chain is considered.

9.1 Scenarios stimulating the interest of milling companies

Milling companies have power over the three supply chain innovations. They possess the essential resources needed to take them a step closer to realization. However, milling companies do not currently have enough interest in Dutch wheat to put in their resources. To consider if there is any chance of these supply chain innovations bearing fruit in the near future, scenarios are outlined by which the interest of milling companies in these innovations would increase.

9.1.1 Uncertainties buying wheat

When there are more milling companies, or other industries, demanding wheat and/or the amount of available milling-wheat decreases, it will become more difficult for the Dutch milling companies to obtain milling-wheat. They will then become interested in the proposed measurement system, by which protein quality can be more precisely and quickly measured. The system would enable the milling companies to conduct its buying processes more efficiently and effectively. Demand for wheat will increase in the future because there are more industries demanding it (for example bio-ethanol industry) both in the Netherlands and worldwide. More about this will be discussed in paragraph 9.2. The supply of wheat was reduced in recent years due to some poor harvests worldwide. Because of this, less wheat is in available worldwide, which has increased and will further increase uncertainty for the milling companies. This will in turn increase their interest in operating more effectively and thus in a measurement system. Furthermore, when milling companies know exactly the protein quality of the wheat they have

purchased, their milling processes will become more efficient. This will lead to them being in a better position vis a vis the competition.

9.1.2 Climate change

If climate change results in less rainfall in July and August in particular, fewer harvesting problems would be expected so far as pre-harvest sprouting is concerned. The quality assurance of Dutch wheat would increase and the milling companies would become more interested in it. Nowadays climate change receives a lot of attention, as a result of global warming. Since the beginning of the 20th century, the temperature of the earth has greatly increased, by approximately 0.74°C. At the moment there is an ongoing debate about the causes and consequences of this phenomenon. It is predicted that temperatures could rise by as much as 1.4°C to 5.8°C between 1990 and 2100 (IPCC, 2007). In the Netherlands it is expected that temperatures will be 0.5°C to 2°C higher in 2050. It is also expected that the chances of drier summers will increase, but that the intensity of the rain that does fall in the summer will be greater. In the winter more precipitation is expected (KNMI, 2002). If these forecasts are correct, it is not clear if the change in climate will be positive for wheat production in the Netherlands.

9.1.3 Transport costs increase

Milling companies will be more interested in Dutch wheat when logistical bottlenecks exist and transport costs rise, meaning that it is less attractive to transport wheat from Germany and France. Transport costs will increase due to higher fuel prices and/or when smaller ships have to be used for the transportation of wheat, due to the fact that water levels have become too low for large ships Or problems arise if water levels are too high for any transport on them. In addition, delivery reliability may well decrease as a result of extremely low or high water levels. So far as fluctuations in water levels are concerned, it is not expected that such problems will increase significantly in the near future (Kantoor Binnenvaart, 2007). Further, milling companies can store wheat for two or three weeks. However, it may be that the situation changes in the future because of the climate changes discussed in the previous paragraph. Fuel prices are determined by the price of crude oil. In the short term the price of oil fluctuates, because the supply of and demand for it does not adjust sufficiently. Because of these fluctuations, caused by many environmental factors, it is very difficult to estimate how fuel prices will develop in the near future. However transport costs, form only a small percentage of a milling company's total costs, especially when ships are used for transportation. More than 80% of the wheat used by milling companies is received by ship. Taking into account fluctuating water levels and fuel prices, the chances in the near future of transport costs increasing so much that it becomes too expensive for milling companies to receive their wheat from abroad, are small.

To conclude, it may be that milling companies become more interested in a system by which the protein quality of wheat can be measured. However three things must be noted. Firstly, a measurement system can also be used for foreign wheat, so would not automatically result in greater use of Dutch wheat. Secondly, when milling companies come under pressure, they would probably develop a measurement system by themselves without sharing it with other partners in the chain. Thirdly, as outlined in Chapter 7, all of the three supply chain innovations must be realized before it becomes feasible to market more Dutch wheat to milling companies. So far as climate change is concerned, this will not lead to significant changes within ten years, and it is not yet clear whether climate change would favour Dutch wheat production in any event. Finally,

rising transport costs are unlikely to be so high that the milling companies' interest in Dutch wheat increases in the near future. Accordingly, it is clear that milling companies are unlikely to be prepared to contribute more towards the realization of these three innovations in the near future.

9.2 Scenario stimulating the interest of wheat growers and collectors

Wheat growers and collectors might perceive that, although a price difference is established between milling-wheat and "other" wheat in the new payment system, the general wheat price is too low to recover the financial investments needed for innovation. Because of a disappointing harvest in the EU, Australia and the Ukraine in 2006, the world wheat production was 2.1% lower than in previous years. This resulted in the demand for wheat being higher than the supply. Accordingly, in 2007 wheat prices in the EU were the highest for ten years (Bakkerswereld, 2007). But the general wheat price was high because of a poor harvest. Since this was also the case in the Netherlands, the yield per hectare was low and the higher wheat price only slightly compensated for this. Therefore, there should be consideration of whether a structurally higher general wheat price can be expected for the wheat growers and collectors in the coming years. This would not be caused by the vagaries of the weather but by differences in the world demand and production of wheat.

Demand increases

Production of biomass on a large scale is not feasible for the Netherlands. Other possible uses of the land for agricultural or none agricultural purposes are too attractive (CP, MN & RP, 2006). However, in other European countries more wheat will be used in the bio-ethanol industry. As a result, demand for wheat will increase because of the increased activity of this new wheat-processor. It is also expected that, in the long term, first generation bio-ethanol will be replaced by second- generation bio-ethanol. First generation bio-ethanol is made of for example wheat or potatoes. Second generation bio-ethanol is made of by-products, for example starch or wheat straw. This means that the demands of the bio-ethanol industry for wheat might decrease in the future.

Demand for wheat on the world market will however increase. Because of rising prosperity and population growth in China and India, the number of bakeries in these countries will rise. However, rising prosperity and population growth will also result in higher meat-consumption and thus a higher demand for wheat that is used for feed-production. Both China and India are big wheat producers, but will not be self-supporting in the future. Indeed, China has not been self-supporting since 2004 (GZP, 2004b).

Production increases

The production of wheat is strongly dependent upon the weather and is therefore difficult to predict. However some matters can be analyzed so far as the "new or increasing" wheat producing countries are concerned. India could become an important wheat producer in the future, although it does have the disadvantages of insufficient storage facilities and a poor infrastructure. The production levels of countries that already produce large amounts of wheat, such as the Ukraine, Kazakhstan and Russia, could increase by the introduction of modern technologies like GPS and/or area enlargement. However, the harvests in these countries are volatile and it is difficult to transport wheat to processing industries on the current waterways from these countries. Improving the infrastructure between the producing and the processing

countries would be fraught with difficulty, as big waterways are needed to connect them to Western Europe. Furthermore, Hungary's wheat cannot be transported to the inhabited world, as the water levels of the Danube extremely fluctuate (GZP, 2004b).

In the past year, wheat production could not satisfy the worldwide demand for it and so the world's stock of wheat decreased. This situation should not be expected to change in the near future. Both demand for and production of wheat will increase, but the production will not be able to keep up with the demand (also caused by logistical problems). Therefore, it is to be expected that the general wheat price will increase in the coming years. The structurally higher general wheat price of the future might decrease levels of uncertainty for the wheat growers and collectors. However they would not be able to realize the three supply chain innovations without the help of the milling companies. The following paragraph outlines how these two actors can obtain the power needed to achieve their goals.

9.3 Secondary part of the supply chain

In Chapter 5, "Power positions," it became clear that milling companies have power over collectors and also over wheat growers. To stimulate the milling companies' interest in contributing to innovation by formulating protein quality specifications, the wheat growers and collectors need to get power over them. According to Frooman (1999), indirect influencing strategies have to be used in these circumstances. As the actors in the secondary part of the supply chain have power over the milling companies, wheat growers and collectors should use them to influence these companies.

9.3.1 The consumers

In Chapter 5 it was made clear that bakeries influence milling companies. In turn, traditional bakeries are dependent on consumers and industrial bakeries are dependent on supermarkets. Supermarkets are dependent on consumers. Although the milling company is the dominant actor in the primary supply chain, the consumer is the actor who dominates the entire Dutch milling-wheat supply chain. The consumers can make a difference to the supply chain. Applied to this research, if consumers demand bread made of Dutch wheat, the other actors have to accede to their wishes. It would lead to bakeries demanding meal and flour made of Dutch wheat and the milling companies would in turn need to obtain Dutch wheat. In these circumstances, the Dutch wheat growers' and collectors' resource, Dutch wheat, becomes extremely important to the milling companies. Accordingly, the Dutch wheat growers and collectors would get more power over the milling companies and also (indirectly) over the bakeries and supermarkets. Bakeries and supermarkets have to offer the type of bread demanded by consumers and when consumers begin to demand Dutch bread, these two actors in the chain become more dependent on the resources of the Dutch wheat growers and collectors. Thus, when consumers demand bread made of Dutch wheat, Dutch wheat growers and collectors become more powerful in the Dutch milling-wheat supply chain.

The most important question is: Is there any chance of more bread being produced that is made from Dutch wheat? The answer is "yes" because of the fact that consumers' interest in regional products is increasing. Within the EU there is a trend towards regional products. The expansion of the EU and internationalization has lead to people believing that they are losing their identity. The

increased interest of consumers in regional products is a reaction to this. Between 20 and 40% of consumers are sensitive to the idea of regional products (AKK, 2005) and 26% of Dutch consumers would consider buying regional products (Agro & Co, 2007). In 2005 in the Netherlands, the turnover of regional products was 90 million Euros and it is estimated that the Dutch market for them could grow to 380 million Euros by 2015. So far as supermarkets are concerned, the turnover of regional products supermarkets is expected to be 30 million Euros (AKK, 2005).

9.3.2 Influencing the supermarket

At the present time, therefore, it seems that consumers are ready for regional products, and so far as this supply chain is concerned, for regional bread. There are examples of regional bread: Polderbrood, Groninger landbrood, Zeeuwse Vlegel and Speltbrood from Ommen (Van der Meulen, 1999). But these are niche markets and also use only a small amount of Dutch wheat. To increase the utilization of Dutch wheat in bread production, the three proposed supply chain innovations are needed. These innovations can and will only be realized when there is a big demand for regional bread. Thus, it is only when supermarkets want to sell it that the chances of more Dutch wheat being used in bread production will increase. One Dutch supermarket already sells bread with the name "Streekbrood" (Regional bread) on the packaging. However this does not necessarily mean that this bread is made of Dutch wheat or that it is produced in a specific region, or even that the recipe comes from the specific region. It is doubtful if consumers realize this. To contribute towards the goal of this research, the regional bread sold by supermarkets should be made of Dutch wheat in example wheat that has come from regions within the Netherlands.[9] As the wheat growers and collectors are two actors in the chain with the least power, it is not an easy job for them to influence the powerful actor in the chain, namely the supermarkets. However, there are some influencing strategies that the Dutch wheat growers and collectors can use to encourage the supermarkets to offer regional bread for sale in their shops.

Regional bread is already on the supermarkets' agenda. But to ensure that this issue concerns not only bread produced in the region but also made of Dutch wheat, wheat growers and collectors must raise their voices. They should form an alliance to ensure that they will benefit from the sale of regional products and they should use the consumers' values and desires to encourage the supermarkets to put bread made with Dutch wheat on their shelves. The growers and collectors should make it clear to supermarkets what the benefits would be to them of selling regional bread. Firstly, by selling regional bread made with Dutch wheat, the supermarkets would be offering products that consumers are interested in. Secondly, regional bread can be used as a weapon in the ongoing "price war", because it is a product by which supermarkets can distinguish themselves. In Great Britain two big supermarket chains have distinguished themselves from other competitors by introducing labels that highlight when food has been produced locally. Consumers are able to trace suppliers via the supermarkets' websites.

Wheat growers and collectors can support their arguments in favour of regional bread made from Dutch wheat, with positive results of consumer research. Research into consumers' views of regional products has already been carried out but not specifically into their opinions of regional bread. Eventually, the growers and collectors can use the media to draw widespread attention to the positives of this consumer research. However, it would be better to cooperate with

[9] It would be difficult to produce bread made of exclusively Dutch wheat, caused by lower quality assurance compared to German and French wheat. Therefore, regional bread is defined here as bread made of 50% Dutch wheat or more.

supermarkets in undertaking consumer research because they already have direct contact with consumers. Furthermore, another reason to involve the supermarkets directly in consumer research is that their direct involvement (and this also applies to the bakeries) is needed to realize the three supply chain innovations. The supermarkets (and bakeries) should contribute financially to the realization of the supply chain innovations.

A simple calculation makes it clear that there is the chance of realizing the three supply chain innovations with use of the money that would be gained by offering bread made of Dutch wheat. Let us assume that 26% of Dutch consumers who would consider buying regional products, actually decide to buy regional bread and that these consumers replace 25% of the "normal bread"[10] that they consume annually with regional bread. This would result in a yearly consumption of 65,689,000kg of regional bread. If a regional bread of 800 grams (gr) costs 1.50 Euros and "normal bread" of 800gr costs 1.20 Euros on average, the supermarkets would earn an extra 26.3 million Euros in one year alone by the sale of regional bread. For an extensive calculation, (see Appendix 8: Calculation). Therefore it should be possible to spend a couple of million Euros per year on the three supply chain innovations, leading to the production of regional bread, baked from Dutch milling-wheat. However, supermarkets earning money from the sale of regional bread should guarantee that their profits are shared with the actors in the primary supply chain. In this way, those actors, namely the milling companies, collectors and wheat growers, are to some extent reassured that they can earn back the money needed to carry out the innovations. The bakeries should also confirm this. Accordingly, the market-mechanism would be replaced by a system of agreements to cover the costs of all chain members who have to invest in research and innovation and to guarantee higher profits. But simply replacing the market-system is not enough. Chain actors should be aware that cooperating to innovate is a difficult undertaking, which places great demands on them. The research of Wiskerke and Oerlemans (2004) on the niche "Zeeuwse Vlegel" teaches that continuous participation and a feeling of responsibility for the collective is required to be successful in the bread market.

9.4 Support of other actors

With a financial contribution of the government taking the first step towards protein quality research would become easier. But it does not make any sense to carry out research activities without the support of the milling companies. Research centers can provide insights in protein quality of different wheat samples. However, gaining insight in protein quality is only one part of the solution. It is not just about unraveling the structure of protein. There should been found out which protein quality is needed to generate the kind of bread consumers demand for. It concerns linking protein quality with bread quality. In this research with the goal of setting up protein quality specifications, milling companies cannot form the black box as they possess knowledge about milling-, blending- and baking processes. Therefore milling companies have to cooperate intensively with other actors to draw up protein quality specifications. In the first place the absence of protein quality specifications does not concern a shortness of money. Milling companies are not motivated enough to put effort in such a protein quality research. But, when milling companies are prepared to contribute, government money can help to carry out a thorough study to protein quality. The research is of a pre-competitive nature so it would not restrain to apply for government money. However one should realize that legitimizing government funding becomes more and more important. Furthermore, a contribution of the actors themselves has to be quite large to guarantee continuous motivation.

[10] When "normal bread" is mentioned, it refers to all the bread that is not offered as regional bread.

Cooperation with foreign chain actors could be a possibility to come to protein quality specifications. A broader shared knowledge base could probably lead to a complete and richer understanding of protein quality and speed up the research. The EU has to cope with wheat deficits and the available wheat should been utilized in the most optimal way. Gaining insights into the kind of wheat needed for bread production more exactly would not been a luxury. Identifying the wheat which meets the requisites for bread production in an early stage becomes more significant. But research to protein quality on a European level can be done as far as it goes. Bread preferences of European consumers are different. German bread can be typified as sour and this bread contains much rye. French consumers prefer to eat banquettes. These foreign kinds of bread have another structure than Dutch bread and probably the protein quality of the wheat utilized in this foreign bread is also different.

9.5 Conclusion

Milling companies, who are essential to setting up the protein quality specifications needed to realize the three supply chain innovations, will not be encouraged to realize these innovations by changes in their environment. Wheat growers and collectors would be more willing to innovate, because of the likelihood of a structurally higher wheat price in the coming years but the contribution of the milling companies is needed to realize the innovations. Wheat growers and collectors cannot directly influence the milling companies into contributing, as they do not have much power over them. Therefore, they should use indirect-influencing strategies. Wheat growers and collectors should focus on the consumers, as they are the most powerful and dominant actors in the Dutch milling-wheat supply chain. As the interest of Dutch consumers in regional products is rising, there are opportunities to create a market for regional bread made of Dutch wheat. The greatest chance of realizing the supply chain innovations in the future is when supermarkets start to demand bread made of Dutch wheat. Such a demand would in turn give a big push to bakeries to demand Dutch meal and flour, and for milling companies to demand Dutch wheat. In these circumstances, the milling companies would be willing to contribute to the realization of the three supply chain innovations. In order to convince supermarkets of the demand for regional bread, wheat growers and collectors should stress the advantages to the supermarkets of selling regional bread to consumers. When convinced, supermarkets (and also bakeries) should also contribute financially to the realization of the innovations. The actors in the primary and secondary chains should cooperate and invest, so as to realize the supply chain innovations needed to increase the utilization of Dutch wheat in bread production. However the realization of the necessary protein quality specifications and thereafter the supply chain innovations is likely to take some years. Government money and/or cooperation in protein quality research with foreign actors could contribute to set up protein quality specifications. But only under the condition that milling companies join this research.

10 Conclusion and recommendations

The central question of this research was: "What are the ways of increasing the utilization of Dutch wheat in bread production by means of supply chain innovation?" The most important results of each individual research question are summarized in the first paragraph, "Discussion". Thereafter, an answer is given to the central question. Recommendations to the supply chain's actors are made, based upon the findings of this study in example what should be done and by whom is outlined. This final chapter ends with reflections on the methodology and theory used in this research and lastly presents what can, theoretically, be learnt from this study; the scientific contribution.

10.1 Discussion

In the first research question "What does the Dutch milling-wheat supply chain look like?" a description is given of all the actors in the Dutch milling wheat supply chain; their roles, business processes and the context in which they operate. In the Netherlands, 1.2 million tons of wheat is produced annually, which is 1% of the total EU-production. Fifteen percent of Dutch wheat ends up at milling companies; 55% is used in the feed industry; 20% is used by the starch industry and 4% is used in the production of bio-ethanol. The primary part of the Dutch milling-wheat supply chain consists of, plant breeders who develop and improve wheat varieties; wheat growers, who grow wheat on their fields; collectors, cooperatives or grain traders who collect, store and sell wheat to industries; and milling companies who mill wheat into meal and flour. The secondary part of the supply chain consists of traditional and industrial bakeries who produce bread out of meal and flour, traditional bakeries who sell bread directly to consumers, industrial bakeries who supply bread to supermarkets and supermarkets, who sell bread to the final actor in the chain; consumers.

With this description of the supply chain, the second research question was addressed: "What are the power positions of the actors in the Dutch milling-wheat supply chain?" All of the supply chain's actors have a certain relationship with each other because the primary process that underpins the end product of this chain connects them. Power is based on the importance of one actor's resources to another actor and the concentration of these resources. As it involves an exchange of resources, the importance and concentration of one actor's resources must be seen in respect to the importance and concentration of the other actor's resources. Seven direct power relationships are described. It emerged that the consumers have the greatest amount of power and the other chain actors react to their demands. The consumers have power over the supermarkets, although this power difference is not significant. The wheat growers and the collectors are the least powerful actors in the supply chain. The collectors have some power over the wheat growers, who therefore have the least power of all in the Dutch milling-wheat supply chain.

After answering the first and second research questions, in which the subject matter was the total milling-wheat supply chain, research question three "What are the problems in the primary part of the Dutch milling-wheat supply chain?" focussed in on the primary part of the chain. Wheat

growers and collectors want to supply their wheat to milling companies. Although the price difference compared to that paid by other processors is low, milling companies give the highest price for wheat they buy. The most important quality requirement in utilizing wheat for bread production is protein quality, but the milling companies do not specify protein quality and obtain power from this. The absence of protein quality specifications causes problems for Dutch wheat growers and collectors. They focus on less important requirements and so the primary part of the supply chain does not operate in the most efficient and effective way. Moreover, compared to German and French wheat growers and collectors, the circumstances of the Dutch wheat growers and collectors make it more difficult for them to meet the requirements of the milling companies. Two specific problems are described. It is difficult for wheat growers to produce wheat with a high protein quality. This is caused by three sub problems: Wheat growers do not know how to manage protein quality; there is no payment for protein quality and the weather in harvest periods also causes problems. Collectors have difficulty in supplying large batches of wheat of high protein quality. This is partly caused by the wheat growers' problem of producing wheat with high protein quality. But it is also caused by two other sub problems: Wheat cannot be measured and therefore separated based on protein quality and collectors are not paid for protein quality.

In the fourth research question, "Which supply chain innovations are needed to remove the identified problems?" three supply chain innovations are outlined. With the Decision Support System, wheat growers become able to manage protein quality in their fields. Wheat growers and collectors would and could do more to achieve wheat with a high protein quality if there was a payment system based on protein quality. With a quick measurement- and separation system, milling-wheat containing the right (protein) quality could be separated out from wheat that does not meet these quality requirements. With such a system, collectors would become able to create large batches of wheat with a high protein quality. All three of the supply chain innovations must be realized in order to increase the amount of Dutch wheat utilized by milling companies in bread production. However to realize these three innovations, specifications of protein quality are needed.

Research question five was formulated as follows: "Is it possible to realize these supply chain innovations in the current circumstances?" It considered which resources are needed to specify protein quality and which supply chain actors possess the resources needed to do this. Based on this, it was concluded that milling companies, wheat growers and collectors should cooperate in order to formulate protein quality specifications. Milling companies have the most power over this process, as they possess the essential knowledge. However, they are not sufficiently interested in the proposed supply chain innovations. Milling companies can obtain good quality wheat in large batches and for a relatively low price, from Germany and France. The lower transport costs and higher delivery reliability that comes from using Dutch wheat on a larger scale do not outweigh this. Furthermore, milling companies are hesitant about delivering the information needed to set specifications, as they may see this as revealing their company secrets. Wheat growers and collectors are interested in the three supply chain innovations mentioned, but a low general wheat price does not encourage them to innovate. In addition, wheat growers and collectors can always supply their wheat to the big Dutch feed industry for only a slightly lower price. In the current situation the innovations will remain simply ideas.

In the final research question "What is the possibility of these supply chain innovations being realized in the near future?" the focus widened out onto the supply chain again; the total milling-wheat supply chain is considered here. Scenarios are mentioned in which milling companies might become more interested in the supply chain innovations. However, none of these scenarios result in a level of interest that would be high enough to realize the innovations. It is expected that

the general wheat price will be high, as production cannot keep up with the increasing demand for wheat in the near future. Wheat growers and collectors will thus be more inclined to invest in the three supply chain innovations. However it remains the case that that the innovations cannot be realized without protein quality specifications and so the milling companies have to be convinced to join. The best chance of success is when wheat growers and collectors can stimulate the powerful chain actor, the supermarkets, to sell regional bread, baked from Dutch milling-wheat. The demand for regional bread is increasing because of greater consumer interest in regional products. When supermarkets start to demand bread made of Dutch milling-wheat, the first step will be taken towards realizing the three supply chain innovations and with that a large-scale utilization of Dutch wheat by milling companies. However this will take some years.

10.2 Conclusion

In the current circumstances, the utilization of Dutch wheat for bread production cannot be increased. The problems that exist in the primary processes of the supply chain can only be resolved with three supply chain innovations. These are: a Decision Support System (DSS) to manage protein quality on the field; a payment system based on protein quality; and a quick measurement- and separation system for protein quality. However the chain's actors, who are able to realize these innovations, the milling companies, wheat growers and collectors, are insufficiently motivated to actively accomplish them. Milling companies are able to receive relatively cheap milling-wheat, in large quantities, from Germany and France. The lower transport costs and greater delivery reliability available if Dutch wheat is used on a larger scale do not offset the cost savings of foreign wheat for them. Furthermore, milling companies are resistant to providing the information needed to set protein quality specifications, needed to realize the supply chain innovations, for fear of revealing company secrets. For their part, a low profit margin does not provide wheat growers and collectors with the necessary encouragement to convince them to start to innovate. In addition, as things stand, wheat growers and collectors can always supply their wheat to the Dutch feed industry for only a slightly lower price.

In the future, there might be the possibility of increasing the utilization of Dutch wheat in bread production, when supermarkets seek to offer regional bread to consumers, made of Dutch milling-wheat. When supermarkets stimulate the need for Dutch wheat, the pressure to cooperate and innovate will increase on all the actors of the supply chain. But the formulation of protein quality specifications and afterwards the realization of the three supply chain innovations will take some years. Therefore, in the coming years, the utilization of Dutch wheat for bread production will not increase.

The results of this study outline the possible ways in which the utilization of Dutch wheat for bread production, by means of supply chain innovation could be increased. The research also provides insight into the problems of the primary chain. With this study, Dutch wheat growers, collectors and milling companies have a clear overview of their relative positions and opinions in the current circumstances and of future opportunities. Furthermore, bakeries, supermarkets and consumers can also use this study to see what opportunities exist for them.

10.3 Recommendations

It should not be expected that the amount of Dutch wheat utilized in bread production will increase in the coming years. Wheat growers and collectors will be dependent for their income, to a great extent, on the price that other wheat processing industries offer. Dutch milling companies, focussing on foreign wheat, take the slightly higher transport costs and lower delivery reliability of such an approach in their stride. Consumers should not expect that regional bread will be offered in the supermarket in large quantities in the short term. In the future, supermarkets might sell regional bread made from wheat produced in the Netherlands but at the moment, the most important raw material in this bread, wheat will, in the main, not be Dutch (approximately 80% or more). If supermarkets want to change the situation, the three important supply chain innovations have to be realized so as to bring about this product innovation, regional bread, on a large scale. This conveys the notion of a reversal of the chain, by which the supply chain becomes more and more directed by the demands of consumers instead of by the suppliers of products. Primary supply chain actors might want to supply their wheat to milling companies but whether this happens and is feasible will depend on the decisions of the secondary chain actors, consumers and supermarkets. All of the chain's actors should realize this when taking decisions and creating their visions of the future.

There may be the opportunity in the future, to increase the utilization of Dutch wheat in bread production, when supermarkets are encouraged to sell regional bread made of Dutch wheat. Three steps are outlined here as to what should be done, and by whom, to make use of these eventual opportunities.

10.3.1 Step 1: Market research

To make decisions about offering regional bread, the needs of the most dominant supply chain actor, the consumers, should be taken into account. Consumer research about the issue of regional bread should be conducted to see how great an opportunity, the sale of regional bread, is for the Dutch milling-wheat supply chain. Quantitative aspects should be investigated. Answers must be found to the following questions: How many consumers would buy regional bread? How much regional bread would consumers consume? What price would consumers pay for regional bread? And concerning regional bread itself, do consumers expect that the raw materials come from the specific region? Wheat growers and collectors should together increase their demand for market research to be carried out by the organization which represents them both; Product community cereals, seeds and legumes (GZP). On the instructions of the wheat growers and collectors, GZP should take responsibility for this market research.

If the regional bread opportunity is big enough, the supermarkets should contribute financially to the realization of the three supply chain innovations, along with the actors in the primary part of the supply chain. Therefore GZP should convince supermarket organizations that market research into regional bread is needed and that there might be opportunities for wheat growers, collectors and supermarkets as well. Wheat growers and collectors could get a higher price for wheat when supplying it to the milling companies, and supermarkets would probably be meeting the demands of their consumers better by selling regional bread. As these two parties in the supply chain are both concerned with the outcome of the market research, to guarantee impartiality and objectivity, it would be better to delegate it to a market research agency.

If the market research shows that consumers are sufficiently animated by the idea of regional bread, the actors in the primary and secondary parts of the supply chain should work together towards the realization of regional bread. Moreover, the bakeries and the milling companies should be convinced to contribute towards its realization on a large scale. The supermarkets should give bakeries and milling companies this drive, by a strong demand for regional bread.

10.3.2 Step 2a: Financial agreements

If wheat growers, collectors, supermarket, bakeries and milling companies agree that they need to attend to the issue of the realization of regional bread, a start can be made. Firstly, wheat growers, collectors and milling companies should contribute with their laboratories, knowledge, wheat samples and financial capital, to enable protein quality specifications to be formulated. When protein quality specifications exist, a start can made on the three supply chain innovations that are needed to produce bread, made from Dutch wheat on a large scale. To guarantee the recovery of the investments into the research needed to formulate protein quality specifications, and thereafter the investments in the supply chain innovations, the market-mechanism should be replaced by a system of financial agreements. Supermarkets earning money with the sale of regional bread after realization of the supply chain innovations, should guarantee that their financial profits are shared with the actors of the primary supply chain, who also invested in the supply chain innovations. As bakeries are positioned between the supermarkets and the actors in the primary part of the chain, they should also have to confirm this. Milling companies, wheat growers and collectors should make an innovation plan, in which they formulate the likely cost of realizing the supply chain innovations. When it is known how much financial capital is needed to realize regional bread, the actors should confirm in an agreement how much each of them would put in. Milling companies should make the greatest financial contribution and this is further outlined in Step 2b. The goal of the collective purpose, the sale of regional bread, will be established by the financial contribution of the actors. Only if the sale of regional bread succeeds, will the actors get back the money that they have invested.

10.3.3 Step 2b: Task agreements

Cooperating to innovate is a difficult undertaking, which puts high demands on the chain's actors. Therefore the groups should establish a governance body in which they are represented. In this new organization it is not only agreements about financial contributions that are needed. Agreements should also precisely detail the tasks that each actor has to undertake to realize the supply chain innovations. The groups can use ways to manage the process of innovation realization, by the use of innovation champions and leaders who will drive innovation creation. Milling companies form the dominant actor in the chain when it comes to the realization of the supply chain innovations; they need to formulate the protein quality specifications. But a big concern is that these milling companies might not be willing to clearly express their needs for fear of revealing trade secrets. To reduce their concerns, the milling companies should be made aware of the fact that this research is pre-competitive research, not competitive research. Their trade secrets are the blending processes that underpin their specific mélanges of meal and flour. Thus, by making their needs (specifications) clear, the milling companies will not be giving away valuable company information. Milling companies should also be aware that they have to express their needs to chain partners, which is not, or should not be "the secrets of the trade", in order to get the supply chain focussed on the right quality parameter; protein quality. For the Dutch milling-wheat supply chain, the focus on protein quality must become transparent and will lead to

the whole process becoming more efficient and effective. This is essential if Dutch milling-wheat is to be produced on a large scale, thereby leading to regional bread production.

To ensure that milling companies contribute as much as possible to the formulation of the protein quality specifications, they should be charged with a prominent and dominant position in the so-called first project "Formulation of the protein quality specifications". Milling companies should take the lead in the project and they should make the biggest financial contribution at the start of the research. The success or failure of the project is in their hands and it is important that they are aware of this responsibility as it will make them put in the effort needed. Furthermore, by taking on this responsibility, the milling companies would also remove any doubts about their intentions so far as the wheat growers and collectors are concerned. It would encourage the wheat growers and collectors to contribute to formulating the protein quality specifications. When the actors in the primary part of the chain have successfully formulated these specifications, a base for the further realization of the three supply chain innovations will have been built. It is a bridge too far for this research to divide up the tasks for the three supply chain innovations. However, the wheat growers, collectors and milling companies have to put in the greatest effort in order to realize these innovations, since they will result in resolutions to problems in the primary part of the supply chain.

10.3.4 Step 3: Marketing regional bread

By the realization of the supply chain innovations, large batches of milling-wheat can be supplied by collectors to milling companies. In turn, milling companies can offer meal and flour made of Dutch wheat to bakeries, from which regional bread can be made. In this last step, the role of the bakeries and supermarkets becomes more active. To anticipate the demands of the consumers wanting to buy regional bread, supermarkets should label it as being "made of Dutch quality wheat". To distinguish this special kind of bread from the "normal bread" a quality mark should be introduced. Standards should be applied to the bread before such a quality mark and a label can be used. It would be difficult to produce bread made of exclusively Dutch wheat, due to the lower quality assurance compared to German and French wheat. Therefore, regional bread should be defined, for example, as being made of 50% Dutch wheat or more. When bread satisfies this standard it can be labelled with the quality mark "made of Dutch quality wheat". The profits that each supply chain actor will achieve by the sale of regional bread will depend on the amount of money each supply chain actor has put into producing this regional bread and the amount of money each of them has put into the realization of the supply chain innovations.

With these steps, recommendations are made about how regional bread can be realized in the supply chain. However, not all of the uncertainties arising from the innovations can be taken away with cooperation and agreements. None of the supply chain's actors, including the supermarkets can guarantee success. The realization of the supply chain innovations, and with this the production of regional bread, will take some years and has risks for all the participating supply chain actors. These actors should have a long-term vision and also the courage that innovation requires.

10.4 Reflection

In this paragraph, reflections are made about the methods described in Chapter 3 "Methodology". The reliability and validity of the outcomes of this research are discussed. Thereafter, there is discussion about the extent to which the theory set out in the Chapter "Theoretical framework" contributed to this study.

10.4.1 Reliability and validity

In Chapter 3, "Methodology", a description of the steps taken to ensure that reliability and validity were as high as possible is set out. A few aspects should be taken into consideration. The problems described in Chapter 6 are based on interviews with informants and with respondents in the primary part of the supply chain. In these interviews, solutions and innovations were also discussed. This resulted in three supply chain innovations. However, these three innovations were not presented as feedback to all the interviewees. Two wheat growers, a collector and a milling company discussed them. They commented that these innovations could resolve the problems. Interest in the three supply chain innovations is based on the answers of these four respondents. Moreover, interest in the three supply chain innovations, is based upon the reasoning of the wheat growers and collectors who supply wheat to milling companies, and the reasoning of the milling companies, as to whether or not they were interested in utilizing more Dutch wheat. Options for regional bread were discussed with some wheat growers, collectors, a researcher studying regional products and someone who established a regional product trademark. Unfortunately, supermarkets were not willing to give an interview from which more inside information about choices and purchasing decisions concerning regional bread could have been gleaned. As some wheat growers have some distrust of milling companies, it was necessary to listen to many opinions in order to get a satisfying overview. Examination of the views of all chain actors of all chain groups, except supermarkets, and interviews with informants helped to achieve a reliable outcome.

Most of the information gained from the interviews converged with the data found in documentation. The opinions of some interviewees were a little bit different, as a result of their locations. For example wheat growers in the North thought that approximately 5% of wheat was used by the starch industry; wheat growers in the South, established near this industry, believed that this was 22%. GZP provided exact figures, 20%. Weather conditions might also have had a strong influence on opinions and therefore additional data was checked, so as to counteract these "season-influenced-opinions". Reviewing documentation strengthened validity. Moreover, it was possible to compare different information in documents with other documents, which lead to almost the same results. When a certain definition, formulated in the written materials, was not clear, the writers were contacted. Most of the additional information was used to generate (production) figures or knowledge about growing grain. The writers did not know that their publications were used for this research. Most of the documentation can be expected to have given an objective overview of the situation, as they almost all came from independent research institutes: Central Statistical Office, Commodity Board for Arable farming, Commodity Board Retail trade et cetera.

10.4.2 Utility of theory

Pfeffer and Salancik (1978), Mintzberg (1983) and Hickson et al. (1971) described power arising from bilateral relationships. Pfeffer and Salancik (1978) and Mintzberg (1983) discussed that power came from a relationship between two organizations, intra organizational relations. Hickson et al. (1971) analyzed power as arising from a relationship between different parts in one organization; inter organizational relations. In this study, the goal was to better understand the behaviour of a certain supply chain. This was in order to deal with problems arising from the power positions and to consider supply chain innovations that would remove these problems and the consequent feelings of the supply chain's actors towards these innovations. To do this, the power positions of the different groups had to be considered. Therefore, the relationships between groups in the supply chain had to be described, instead of relationships between individual organizations. The theories of the authors mentioned above, in describing bilateral relationships between individual organizations (or parts of organizations) were not directly usable. However, they gave worthwhile leads into how to describe the power of one supply chain group in relation to the power of another group in the supply chain.

Since the primary process of the supply chain underpinned the supply chains' end product, the tasks of the individuals of one group of the supply chain were more or less the same. Therefore generalizations about individuals in a group could be made. Because of these generalizations, bilateral relationships between groups could be taken into account when describing the power of the supply chain groups. In this way, the importance of the resources of one supply chain group to another supply chain group could be considered. Besides, as problems in the supply chain under investigation were revealed from the relationships between chain groups, generalization could take place and the theories of the authors became useful. If big differences existed between individuals within a certain supply chain group, attention was paid to this.

Pfeffer and Salancik (1978), Mintzberg (1983) and Hickson et al. (1971) described how the concentration of resources also influenced the power positions of actors. In a bilateral relationship, the power of an individual that has been generated by him possessing resources in which another individual is interested, lessened in a situation in which a third actor also possessed these resources. This situation can also be adapted to this study, when supply chain groups are generalized. As supply chain groups can also be part of another supply chain, a third supply chain group of another supply chain, can influence the power relationships of groups in the supply chain under investigation in this research. But in this study, bilateral relationships between groups are considered; groups are the unit of analysis, instead of individuals. Therefore to consider which of the two groups has the most power in the bilateral relationship, the groups have to be reflected on each other in this study. By examining if a monopoly or oligopoly arises in such a situation, the power relationships can be described. Resources might not be divided equally within the individuals of one group but it might be that the concentration of resources between groups is more or less the same. In such a situation a group does not have much power over another group. The primary process of the supply chains' end product also determines the resources needed. Therefore, to consider power relationships, there is no need to investigate the degree to which these resources can be substituted, as Mintzberg (1983) described. Bilateral relationships between groups are considered so as to describe power positions. But as a whole supply chain is central to this research, as well as direct bilateral relationships existing, indirect bilateral relationships also came into being. Milling companies have power over the collectors, and also indirectly over the wheat growers, as wheat growers are dependent on the collectors.

To realize innovations, resources are needed. The actors that possess these resources must have an interest in utilizing them for innovation. The resources needed for supply chain innovations were adapted from a general innovation process described by Rothwell and Robertson (1973), which could be used for this study. This also applies to the other precondition; interest in innovation. The strategies of Frooman (1999) could be used to alter a situation for the supply chain groups. However, although the strategies of Blau (1964) could be used for individual organizations, they could not be used in this work. Strategies such as "Trying to operate without the resources" and "Trying to obtain the resources elsewhere" cannot be applied to a study in which a supply chain is central and where focus is on supply chain groups. A group choosing such a strategy would throw itself out of the particular supply chain. Focusing on the end product of bread made of Dutch wheat does not leave much room for the outplacement of a Dutch supply chain group.

10.5 Scientific contribution

This study contributes to a broader understanding on the possibilities for the realization of supply chain innovation and highlights the need for power awareness within the supply chain. Most studies discuss innovation so far as they affect one company and supply chain innovation is hardly discussed in academic literature. Omta (2002) has made a start with research on supply chain innovation. He argues that the power in a chain should be considered, as it plays a role in the realization of innovation. But the author does not discuss the effect of power on supply chain innovation to a large extend and he does not present a model by which power positions of actors in a chain can be set out. This study about innovation in the Dutch wheat supply chain goes a step further. It is the first study analyzing the realization of supply chain innovation, extensively focusing on the power relations in the supply chain. Furthermore, the study presents a concrete approach by which power positions of supply chain groups can be set out.

Omta (2002, 2004) and Stijnen et al. (2002) define supply chain innovation exclusively as innovation realized by cooperation of actors. However in this research supply chain innovation, here seen as affecting more than one supply chain actor directly, is taken as a starting point, not cooperation. Depending on the resources needed to realize the supply chain innovation can be seen whether the innovation should be realized by one actor or by cooperation of actors. With regard to the purpose of this research making pronouncements about possibilities to realize supply chain innovation, studies of Omta (2002, 2004) and Stijnen et al. (2002) go a bridge to far. First there must be enough interest for the innovation among the actors possessing the relevant resources to cooperate. When cooperation is the best option to come to supply chain innovation and there is enough support for realization of the supply chain innovation, studies of Omta (2002, 2004) and Stijnen et al. (2002) can be used to see how cooperation for innovation in the supply chain should be organized.

Two preconditions have to be fulfilled to realize supply chain innovations. The resources needed for the innovations must be available and the actors in possession of them should be interested in providing them. Knowledge and skills are the resources needed for supply chain innovations. Although not mentioned in the literature, capital is also required in example to carry out R&D experiments. But interest in innovations must be seen as a precondition too. From research findings, it transpired that this could be interest in the supply chain innovation itself or interest in the outcomes that can be gained with the supply chain innovations. A supermarket would not have an interest in a Decision Support System to manage protein quality, but it might have an interest in what this supply chain innovations supports; regional bread. Therefore, the precondition for supply chain actors who ought to contribute to innovation because of the

resources they possess, is that the purpose to which the supply chain innovation supports is to great extent in line with the purpose of these supply chain actors.

In order to see the purposes or goals of the supply chain groups, the whole supply chain should be analyzed. Although chain groups are combined together in a certain supply chain, supply chain actors can also be part of another supply chain at the same time. The role of a supply chain actor in a certain supply chain is determined by his purpose. For example, Dutch milling companies are part of the Dutch milling-wheat supply chain, but also of the German and French supply chains. They buy German and French wheat and with that supply money to foreign collectors. This is because the milling companies do not care which country the wheat comes from. Their only purpose is to gain wheat of milling quality. On the other side, Dutch collectors would have the most interest in supplying their wheat to milling companies, as these are the companies that pay the highest price for it. From this it can be seen that, although actors are part of the same supply chain, they do not have the same purposes or goals. Differences of purposes between chain groups, might lead to different levels of interest in certain supply chain innovations.

If a supply chain group is dependent on another supply chain group, the less powerful group has to take the demands, or purposes, of this powerful chain group into account. Because of this, groups who have power over the supply chain can change the least powerful groups' interest in innovation. If the powerful group demands supply chain innovation, the less powerful group should adapt. Therefore, when considering if supply chain innovations can be realized, the power positions of supply chain groups should be considered. The behaviour of the supply chain can be explained by the power positions. Best thing to do is to generalize the supply chain groups, by which bilateral relations between groups can be analyzed. Power positions can be examined from these bilateral relations.

Because supply chains transform from "pushed by supply" into chains "pulled by demand" these days, consumers have become the most powerful actor in the supply chains. To consider the feasibility of a certain innovation in the supply chain, particularly when it was invented in the primary part of the chain more far away of consumers, the innovations must be examined for compatibility with consumer demands. If supply chain innovations contribute significantly to the fulfillment of consumers' demands, there is a real chance that these supply chain innovations can be realized.

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Appendix 1: List of interviewees

- Community Board of Arable farming (HPA): Product community cereals, seeds and legumes (GZP)
- Agricultural Economic Institute (LEI)
- Independent researcher Dutch grain cultivation
- Dutch Bakery Centre: Consumer and bakery advice (NBC)
- Office Inland shipping (Kantoor Binnenvaart)
- Dutch Association of Meal manufacturers (NVM)
- Researcher Rural sociology
- Agro & Co, initiator of StreekSelect
- Plant breeder
- Wheat growers:
    - Groningen (3), Zeeland (3), Flevoland (1)
    - Storage capacity (5), Without storage capacity (2)
- Collectors:
    - Two bigger cooperations: North (2) and South (1)
    - Two smaller grain traders: North (1) and South (1)
- Milling companies:
    - Three smaller ones: North (1), North/Middle (1) and South (1) and a bigger one: Middle (1)
    - Delivery by ship (2), delivery by truck (2)
- Bakeries and wholesalers:
    - Traditional bakery (1)
    - Industrial bakery (2)
    - Wholesaler of raw materials for traditional bakeries (1)
- Supermarkets: Customer service (2)

- Interviews: 39 with 30 different persons
    - Face-to-face interviews: 24
    - Telephonic interviews: 15
    - Pre-interviews: 5
        - Wheat growers (4), Collectors (1)
    - Main part: 29
    - Member-checking: 5
        - Wheat growers (2), collectors (1), milling companies (1)

(n) Stands for number of persons

Appendix 2: Interview questions

I) Introductie

- Voorstellen
- Doel van het gesprek is bekijken of ik met mijn onderzoek in de gewenste richting heb gekozen.

II) Vragen

Aanleiding onderzoek

Naar aanleiding van het door maalderij x, geschetste positieve perspectief voor het verbouwen en afzetten van substantiële hoeveelheden tarwe met bakkwaliteit in Nederland, bestaat er behoefte aan een onderzoek naar de haalbaarheid van dit perspectief.

Ketenpartijen

1. Keten schetsen

2. Tarwe deel ik in naar kwaliteit in de volgende drie groepen. Is deze indeling volgens u juist?

    - Voertarwe, bestemd voor veevoer;
    - Non-food/Non-feed tarwe, bestemd voor vergistingdoeleinden (ethanolproductie) of verbranding;
    - Baktarwe, bestemd voor bakkerijen en andere bedrijven in de voedingsindustrie.

3. Welke ketenpartijen zijn volgens u van belang in dit onderzoek?

Keuze tarweteelt

4. Met welk doel wordt de tarwe geteeld? Waarom?

5. Waardoor wordt nu de keuze bepaald voor het telen van wel of geen baktarweras?

6. Onder welke voorwaarden zou u kiezen voor het verbouwen en afzetten van baktarwe?

7. Is het volgens u belangrijk dat er in Nederland substantiële hoeveelheden baktarwe worden verbouwd en afgezet? Waarom?

Het onderzoek kent drie doelen. Het eerst doel is:

    i. Het in kaart brengen van de factoren die de omslag naar het verbouwen en afzetten van substantiële hoeveelheden baktarwe in Nederland beïnvloeden;

8. Wat zouden voor u de belemmerende factoren zijn als het gaat om het verbouwen van baktarwe?

9. Wat zouden voor u de belemmerende factoren zijn als het gaat om het afzetten van baktarwe?

Andere twee doelen van het onderzoek zijn:

ii. Afleiden wat de belangrijkste innovaties zijn, nodig om het wensbeeld van alle betrokken ketenpartners met betrekking tot het verbouwen en afzetten van substantiële hoeveelheden baktarwe naar maalderijen te realiseren;
iii. Aangeven hoe de ontwikkeling en implementatie van deze innovaties in zijn werk zou moeten gaan (globale aanpak).

10. Primaire producenten twijfelen aan de haalbaarheid van het door maalderij x geschetste positieve perspectief. Waar komen deze twijfels vandaan?

11. Welke garanties heeft u als primaire producent nodig om over te gaan tot het verbouwen en afzetten van baktarwe?

III) Afsluiting

- Hebt u nog aanvullingen of vragen?
- Gegevens uitwisselen.

Appendix 3: Production figures

Wheat growers			
	Wheat production	**1,200,000 ton**	**100%**
	Utilization of wheat by:		
	Feed industry	660,000 ton	55%
	Starch industry	240,000 ton	20%
	Milling industry	180,000 ton	15%
	Fuel industry	48,000 ton	4%
	Other (incl. export)	72,000 ton	6%
Milling companies			
	Total wheat utilization	**900,000 ton**	**100%**
	Dutch wheat	180,000 ton	20%
	Import	720,000 ton	80%
	Meal & flour production	**680,000 ton**	**100%**
	Sale of meal & flour to:	**680,000 ton**	**100%**
	Dutch bakeries	410,000 ton	60%
	Export	270,000 ton	40%
Bakeries			
	Total meal & flour utilization	**710,000 ton**	**100%**
	Dutch meal & flour	410,000 ton	58%
	Import	300,000 ton	42%
	Bread production[11]	**1,000,000 ton**	**100%**
Points of sale			
	Total sale of bread	**1,000,000 ton**	**100%**
	Supermarkets	780,000 ton	78%
	Traditional bakeries	150,000 ton	15%
	Other sale channel	70,000 ton	7%
Consumers			
	Total bread consumption	**1,000,000 ton**	**100%**
	Per person	62 kilogram	
	Total bread spending	**2,000,000,000 Euros**	**100%**
	Per person	121 Euros	

[11] As import and export of bread are small and almost equal, bread production is equal to bread consumption.

Appendix 4: Wheat prices

Year	2004	2005	2006	2007*
Price milling wheat*	€116	€106	€132	€154.2
Price feed wheat*	€117	€102	€127	€149.7
Difference in price	**€-1**	**€4**	**€4.5**	**€4.5**
Difference	**-0.9%**	**3.9%**	**3.5%**	**3.0%**

* Average of January until June of 2007
** Euros per ton

(Source: LEI, 2007)

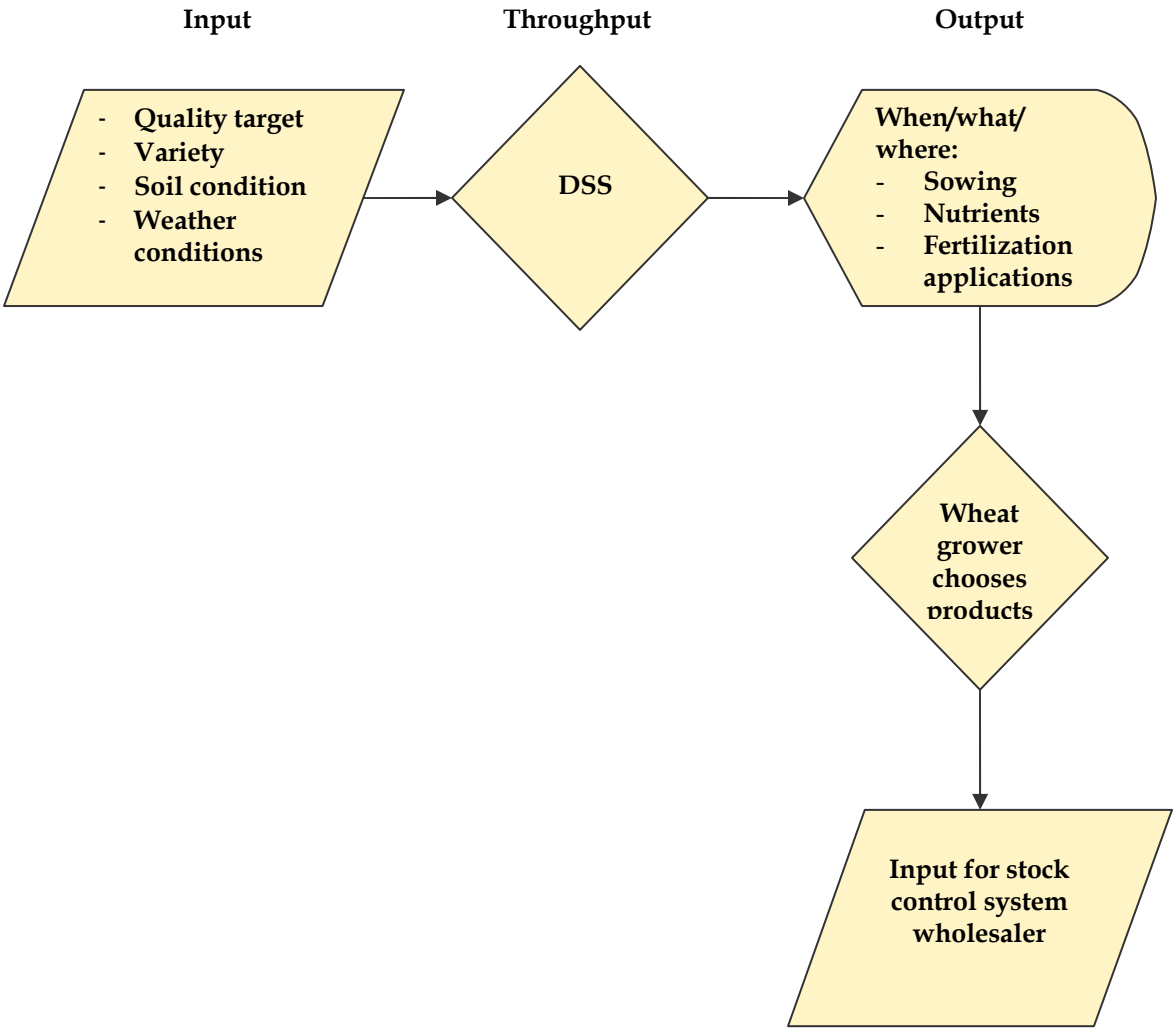
Appendix 5: Wheat varieties

	Quality				Yield
	Bread quality	Dough quality	Milling quality	Zélèny indication	Grain yields*
Better Milling-wheat	**8.5**	**7.5**	**7.0**	**8.5**	**97.4**
- Ilias	8.5	7.5	7.0	8.5	97.4
Milling-wheat	**7.9**	**6.6**	**8.4**	**7.6**	**99.7**
- Globus	8.0	7.5	9.0	8.5	99.6
- Residence	8.0	6.0	8.0	7.0	97.2
- SW Tataros	8.5	6.0	9.0	7.5	110.4
- Drifter	7.5	6.5	8.0	7.5	100.0
- Anthus	7.5	7.0	8.0	7.5	101.2
Feed wheat	**-**	**-**	**-**	**-**	**100.8**
- Bristol	-	-	-	-	98.0
- Limes	-	-	-	-	101.4
- Robigus	-	-	-	-	103.0
- Tulsa	-	-	-	-	99.6
- Patrel	-	-	-	-	101.8

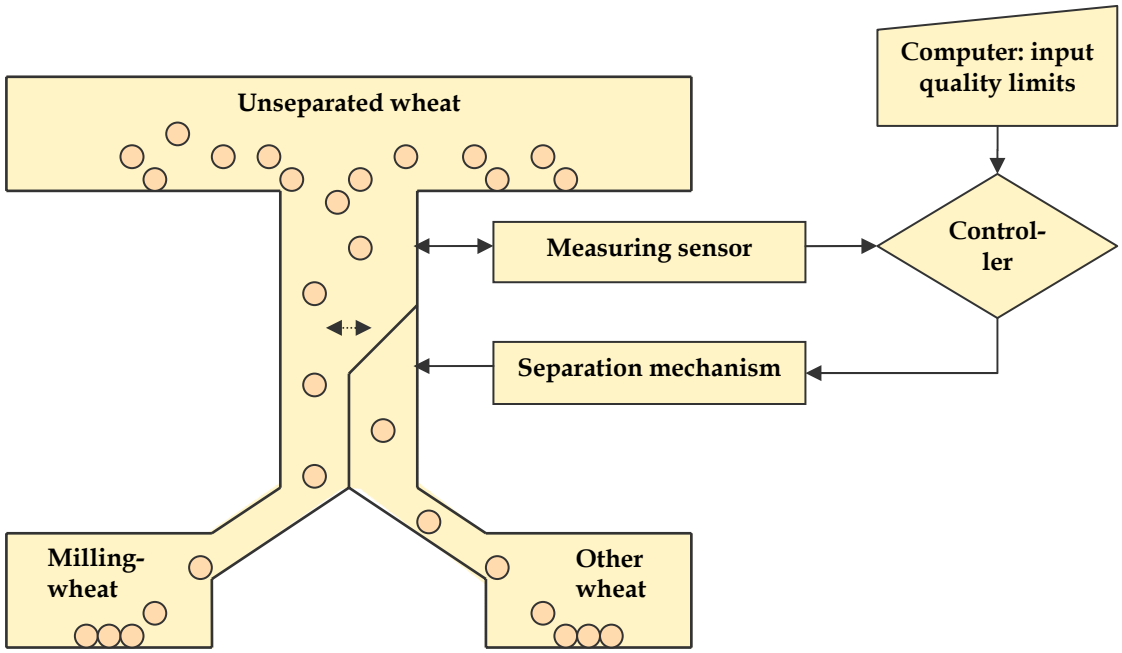
* With use of herbicide and fungicide

(Source: SPNA, 2006)

Appendix 6: Simplified illustration of a Decision Support System



Appendix 7: Simplified illustration of a measurement- and separation system



Appendix 8: Calculation

Assumptions:

- In the Netherlands there are approximately 16,300,000 bread consumers, based on the number of people living there (CBS, 2007).
- A consumer consumes 62kg bread per year (HBD, 2006). If consumers only eat bread of 800gr, a consumer would eat 77.5 breads a year. (62kg / 0.8kg = 77.5 breads)
- A consumer spends €121 each year on bread (HBD, 2006). If consumers buy only bread of 800gr, a bread would cost €1.56 (77.5 breads / €121 = €1.56). However also luxury breads are included in the €121. Therefore it is assumed that a "normal bread" (800gr) costs €1.20.
- A regional bread (800gr) would cost €1.50.
- 26% of Dutch people would consider buying regional products (Agro & Co, 2007). It is assumed that 26% of the Dutch consumers will buy regional bread. These consumers substitute 25% of the "normal bread"[12] they consume yearly with regional bread.

Calculation:

It assumed that 26% of t Dutch consumers would buy regional bread. 26% of the Dutch consumers is 0.26 * 16,300,000 consumers = 4,238,000 consumers. 4,238,000 consumers would buy regional bread.
These 4,238,000 consumers substitute 25% of the bread that they usually buy with regional bread.
On average a consumer consumes 62kg of bread a year. Thus the regional bread buyers would consume 0.25 * 62kg = 15.5kg regional bread each year.
Total amount of regional bread consumed in one year is 4,238,000 consumers * 15.5kg = 65,689,000kg.
When a "normal bread" of 800gr would cost €1.20, 1kg "normal bread" would cost (€1.20 / 800gr) * 1000g = €1.50.
When a regional bread of 800gr would cost €1.50, 1kg regional bread would cost (€1.50 / 800gr) * 1000g ≈ €1.90.
When "normal bread" is bought instead of regional bread, this results in €1.50 * 65,689,000kg = €98,533,500
When 26% of Dutch consumers substitute 25% of their "normal bread" consumption with regional bread, this results in €1.90 * 65,689,000kg = €124,809,100
The difference is €124,809,100 – €98,533,500 = €26,275,600
So the supermarkets could earn 26.3 million Euros when they sell regional bread instead of "normal" bread. Therefore it should be possible to spend a couple of millions each year on the three supply chain innovations.

[12] When "normal bread" is mentioned, it means all the bread that is not offered as regional bread. When regional bread is mentioned, it refers to bread containing 50% or more Dutch wheat.