DE RUITER SEEDS

HYBRID SEEDS

Lean manufacturing within a seed production and seed processing organization

Master Thesis Management studies

IJara Voskuilen
August, 2010

WAGENINGEN UR

For quality of life

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Lean manufacturing within a seed production and seed processing organization

Master Thesis Management Studies

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Summary

De Ruiter Seeds is an organisation that produces vegetable seeds and operates in the agricultural industry with many uncertainties. It has a wish to decrease lead time in the current processes to increase speed to market and to keep competitive advantage. The organisation decided to implement lean manufacturing to decrease lead time, this research is aimed to give support by implementing lean manufacturing concepts give options to achieve speed to market. Because De Ruiter Seeds is coping with many uncertainties and lean manufacturing focuses on standardised organisations with not many uncertainties, questions arise like: does lean manufacturing have a change to show its effectiveness also in this organisation? Could it be applied at De Ruiter Seeds?

The goal of this research is stated as follows: To give scenarios of different lead times and the influence on service, quality and cost (dimensions of competition) in relation to value and waste proportions and the ability to cope with uncertainties by making an analysis of the current processes of planning, production, processing and distribution at De Ruiter Seeds and give an overview of lead times, current state of service, quality and cost but also the ability to cope with uncertainties.

This goal is fulfilled by stating four scenarios including a change in lead time with corresponding effects on dimensions and the ability of De Ruiter Seeds to cope with uncertainties (demand-, quantity-, quality- and natural production cycle time amplification). Input for these scenarios was an extensive overview of the current state of De Ruiter Seeds regarding the process flow (via a stream map), current state of the dimensions and ability to cope with uncertainties on an organizational level. The current state of the dimensions and ability to cope with uncertainties is based on multiple sources as interviews and extractions of databases. The choice was made to focus on one process, the shipment of seeds from the production location in Guatemala to the Netherlands. This was based on the attention points noted in the interviews, here points were mentioned where lead times could be decreased. A new detailed stream map was made with corresponding lead times. For this process, new scenarios are made where lead time is changed to show the effects on dimensions and the ability to cope with uncertainties.

The six scenarios stated in the results chapter show three scenarios with a decrease in lead time and three with an increase in lead time. In the two scenarios with the largest decrease and increase in lead time, it becomes clear that there are more effects on the dimension (availability of seed, purity and health of the product and flexibility to meet customer demands). The effect becomes stronger in the most extreme scenarios which are most different from the current state. The uncertainties are also affected with the implementation of the scenarios. With an decrease until the minimum of lead times, the uncertainty in relation to quality might fluctuate more. With an increase until the maximum of lead times, no effect is expected on the uncertainties.

The current state of the dimensions details how De Ruiter Seeds is performing on important aspects to excel in achieving competitive advantage. The process of shipping the seeds to the Netherlands from Guatemala was first a black box and now became clear by stream mapping the activities and relating lead times. Recommendations are made for further research in the scientific field and practical field. For science a recommendation is made to add information to the existing theories of lean manufacturing. After implementation, the current state of dimensions can be detailed again together with the ability to cope with uncertainties. Information from this research could be used as a pre-test and the state after implementation of waste elimination could be used as post test. The differences show the effect of the implementation. For practice, it would be beneficial to research different processes and use the same methodology as used for this research to state future scenarios.

Preface

This research would not be presented in this way without the support of a various amount of people. In this way I would like to show my gratitude towards all that have been important for finalizing this last part of my education at Wageningen University.

First, I would like to thank my supervisors at Wageningen University. I would especially like to thank dr. J.L.F. Hagelaar. He has supervised me through the entire research and gave supporting recommendations and advice, without this my report would not have been as it is now. Even at the difficult moments, he kept his enthusiasm and provided me with valuable remarks.

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List of abbreviations

ABS:	Agro Business System
B.V.:	“Besloten vennootschap” meaning private limited liability corporation
Benelux:	Belgium, Netherlands and Luxemburg.
BVAA:	Business value adding activity
CCP:	Crop Capacity Planning
CPR:	Crop Progress Report
COD:	Country of Destination
CODP:	Customer Order Decoupling Point
COO:	Country of origin
DA:	Determinant Assignment
DHL:	Transportation and express post organization founded by A. **D**alsey, L.**H**illblom and R. **L**ynn.
FR:	France
GT:	Guatemala
IDEF:	Integration Definition for Function Modeling
IL:	Israel
JIT:	Just In Time
LM:	Lean manufacturing
NAKT:	Nederlandse algemene kwaliteitsdienst Tuinbouw
NL:	The Netherlands
NVAA:	Non value adding activity
Phyto:	Phytosanitary document
PC:	Personal Computer
PD	Plantenziektenkundige Dienst
PLD:	Parental Line Description
PPD:	Production Planning Document
TPS:	Toyota Production system
VAA:	Value adding activity
VWH:	Virtual WareHouse,
YPG:	Young Plant Growing

1. Introduction

De Ruiter Seeds is an organization that produces vegetable seeds for the horticultural industry. The corporate strategy is emphasized on increasing speed to market to keep competitive advantage. The organization decided to implement lean manufacturing to decrease lead time, this research is aimed to give support by implementing lean manufacturing concepts by giving scenarios to achieve speed to market. De Ruiter Seeds is facing many uncertainties and fluctuations like quantity fluctuations, which is not similar to traditional lean organizations where mass- and standardised productions take place.

Lean manufacturing is normally implemented in organizations with a standardised production process as Toyota, were bulk production takes place with almost none uncertainties (Womack et al, 1998). The question is: can lean manufacturing be used to achieve speed to market for De Ruiter Seeds, which is not similar to the traditional lean organizations?

To state the start of the research the following subjects are discussed in this introduction: 1.1 states the history of lean manufacturing, 1.2 declares Lean Manufacturing (LM) in the agricultural industry and 1.3 gives the goal of the research. Furthermore, 1.4 states the problem statement and the conceptual model, 1.5 includes the research approach. Also, in 1.6 the research questions are given, in 1.7 definitions are stated, 1.8 declares the research framework and at last in 1.9 a reading guide is given for the others parts of the report.

1.1 De Ruiter Seeds

De Ruiter Seeds was founded in July 1945 by Wouter de Ruiter. Wouter de Ruiter set up a small company that produced seed potatoes and horticultural and agricultural seeds. These activities rapidly expanded with selection, breeding and production of seed in Bergschenhoek. This was a successful step for the company.

In the eighties, the product range expanded with pepper and egg plant seeds. In the nineties De Ruiter Seeds became successful in developing rootstocks for tomato. At that moment De Ruiter Seeds became a flourishing internationally operating organization.

In April 2008 Monsanto acquired De Ruiter Seeds Group B.V. Monsanto is an agricultural company which is located in 61 countries all over the world. Monsanto focuses on breeding and biotechnology. The breeding department largely focuses on improving the overall genetic base of a crop by using technology to identify the most powerful plant breeding stock.

More information about the supply chain of De Ruiter Seeds can be found in appendix 1.

1.2 Lean Manufacturing and De Ruiter Seeds

Lean manufacturing became famous in the eighties, where Taichii Ohno and Shingo invented the Toyota Production system (TPS) also called Just In Time (JIT) which was the start of lean production systems. In 1990 James Womack wrote a book: ‘The machine that changed the world’, which presented information about the American, Japanese and European automotive industry. In this book, Womack refers to Lean Manufacturing. Lean Manufacturing has multiple concepts that have a strong link, examples of concepts are waste, value, lead time reduction and so on.

To illustrate links that might occur in organizations before the adaption of lean manufacturing, a quote of Naylor et al, (1999) is given. This emphasizes the link between lean manufacturing and lead time compression:

> "In recent times lead time compression has become a major order winner. Leanness calls for the elimination of all waste. This means the elimination of anything that is not adding value to a process or service. By definition this includes waste time. Therefore time compression is essential for lean manufacturing."(Naylor et al, 1999)

This quote gives the general perception of lean manufacturing on waste elimination and lead time compression. It shows an important link between a change in lead time in relation to value and waste, which is mentioned in the research as proportion value and waste which relates to the ratio value/waste. Lean manufacturing is applied in several industries like: Automotive industry (Womack et al, 1990), PC supply chain (Naylor et al, 1999), steel industry (Abdullah, 2003), radar detectors (Stalk and Hout, 1990) and so on. These industries are mostly assembly lines and mass production with a pull strategy and not similar to De Ruiter Seeds.

Within case studies of lean manufacturing, these industries have been proven to fit in a good way, but what about organizations with more uncertainties and differentiations between products like De Ruiter Seeds? De Ruiter Seeds operates in a competitive market where lead time is of importance. Because De Ruiter Seeds works with natural products, lead time can not be changed without keeping in mind the natural production cycle of the product. Changing lead time might also affect other dimensions that are important in the competition; service, quality and cost. For example, the quality might decrease when lead time is decreased in such a way that processes can not be properly executed anymore. The ability to cope with uncertainties like quality and quantity uncertainties might be affected, which is important for De Ruiter Seeds to keep competitive advantages. It is important to research the effect of decreasing lead time on the dimensions. With this information the following questions rise: does lean manufacturing have a change to show its effectiveness also in this organization? Could it be applied at De Ruiter Seeds? What effect will it have on the other dimensions?

1.3 Goal of the research and relevance

The goal of this research is to study what effect a change in lead time has, in relation to the proportion of value, on the different dimensions of competition at De Ruiter Seeds and its ability to cope with uncertainties. The precise goal is stated as follows:

To give scenarios of different lead times and the influence on service, quality and cost (dimensions of competition) in relation to value and waste proportions and the ability to cope with uncertainties

By

making an analysis of the current processes of planning, production,
processing and distribution at De Ruiter Seeds and give an overview of lead times, current state of service, quality and cost but also the ability to cope with uncertainties.

The research with the above goal has the following scientific and practical relevance:

Scientific

The scientific relevance of this research can be described as follows:

1. Lean manufacturing is focused on different industries like automobile industry, computer industry, radar detector industry etc.
   Application of lean manufacturing at De Ruiter Seeds will give information if lean manufacturing can also be effective in industries that are not similar to the previously investigated sectors.
2. This research will reflect on what influence lead time has on service, quality and cost in relation to value and waste proportion and if the ability to cope with uncertainties is affected.

Practical

The practical relevance of this research can be described as follows:

1. This research will give information about the influence of changing lead time on the service, quality and cost at De Ruiter Seeds.
2. De Ruiter Seeds can use the scenarios made in this research for further development regarding lead time compression or lean manufacturing.

1.4 Problem statement and conceptual model

The problem statement gives a representation of the objective of this research, which will be as follows:

> ***What is the influence of changing lead time on service, quality and cost in relation to the proportion value and waste and the ability to cope with uncertainties, in the processes of De Ruiter Seeds?***

The most important outcome of this research is:

Designing scenarios of different lead times and its effect on service, quality and cost in relation to the proportion of value and waste, including the ability to cope with uncertainties.

This problem statement gives multiple connections between concepts. The link between lead time and service, quality and cost in relation to value and waste is given but also the link between lead time in relation to proportion value and waste and the ability to cope with uncertainties. These relations are set up in a conceptual model that will be used for this research.

Conceptual model

A conceptual model is made for this research, in figure 1 the concepts are shown which are stated in the problem statement. This gives a visual representation of the relations between the concepts at this moment.

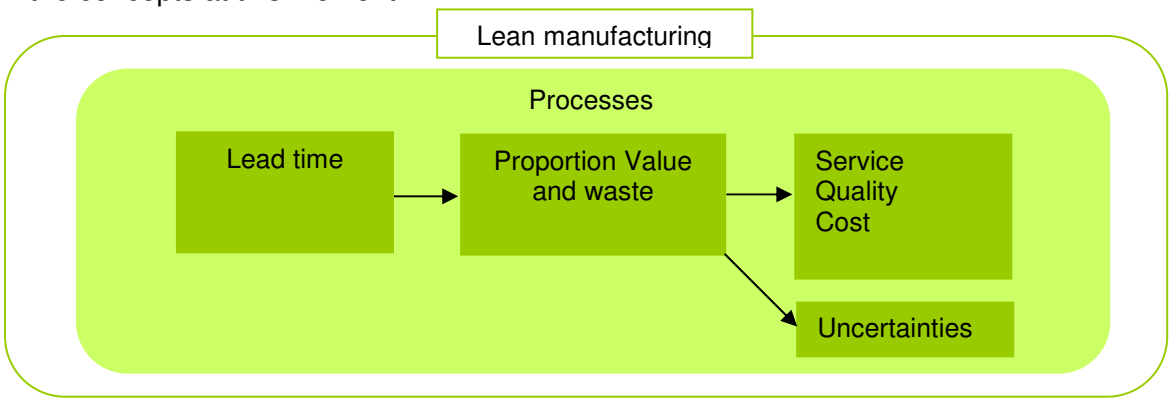

Figure 1; Conceptual model

This conceptual model includes two concepts that fall in this research under lean manufacturing, knowing lead time and proportion value and waste. Other dimensions of competition and uncertainties are included because this is of importance for the processes of De Ruiter Seeds. Lead time is the independent variable (x) the proportion of value and waste and service, quality and cost are dependent variables (y) same as the ability to cope with uncertainties. This conceptual model will be used for stating research questions but also for the content for the theoretical framework.

1.5 Research approach

For the research, information will be used from the general information about lean manufacturing. From this general literature, other cases in different industries were tested on the application effects of lean manufacturing. For De Ruiter Seeds this will also be researched and a similar approach will be used. General information from literature will be used for this research, which is the same method as for the other lean manufacturing cases that are performed. The research approach can be stated as in figure 2:

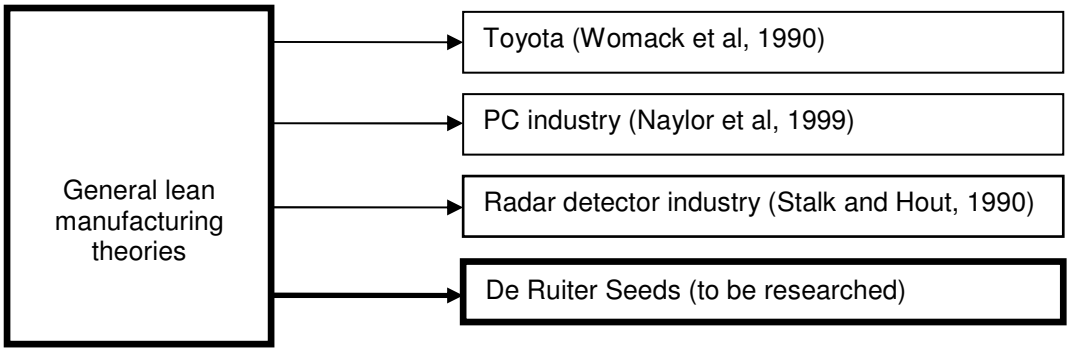

Figure 2; Research approach

General lean manufacturing information will be used because information from the other sectors would differentiate too much and results can hardly be generalised. The automotive, PC, steel and radar detector industry do not work with natural products like in the agricultural industry, natural products have different uncertainties. Therefore, information on uncertainties at De Ruiter Seeds is searched separately, fluctuations in production time, demand, quality and quantity are of great importance that might be affected by a change in lead time. General information for the theoretical framework is gathered from general lean manufacturing theories, as stated in figure 2.

1.6 Research questions

For the research, research questions are formulated to answer the research objective. These questions are formulated in relation to the conceptual model, which is presented in figure 1.

Conceptual questions

Conceptual questions are giving a background to the research, the answer on these questions give information about the concepts that are used to answer the research objective.

1. What elements can be distinguished to analyze lead time?
2. What elements can be distinguished to analyze and evaluate processes?
3. What elements can be distinguished to describe the proportion value and waste?
4. Which uncertainties are of importance at De Ruiter Seeds?

Relational questions

Relational questions are giving answers on the relation between concepts and how strong the relations are.

5. What is the current state of processes, lead time, dimensions and ability to cope with uncertainties in the case study?
6. What are possible scenarios for different lead times and the effect on quality, service and cost in relation to the proportion value and waste?

The questions will be answered as described in table 1:

Table 1; Information sources

Main thesis questions	Theoretical framework	Empirical Results
1. What elements can be distinguished to analyze lead time?	X	
2. What elements can be distinguished to analyze and evaluate processes?	X	
3. What elements can be distinguished to describe the proportion value and waste?	X	
4. Which uncertainties are of importance at De Ruiter Seeds?		X
5. What is the current state of processes, lead time, dimensions and ability to cope with uncertainties in the case study?		X
6. What are possible scenarios for different lead times and the effect on quality, service and cost in relation to the proportion value and waste?		X

Questions one, two and three are answered in the theoretical framework and questions four, five and six in the empirical chapter.

1.7 Definitions

Several concepts and definitions are used during this research. A short explanation is used to give an indication in which way these are interpreted in this research.

Processes

A process is a series of steps which are designed to produce or transform a product. This phrase is based on a statement of Hardjono and Bakker (2006).
When talking about the processes of De Ruiter Seeds, the following processes from the department Production and Logistics are the scope of the research and detailed in figure 3.

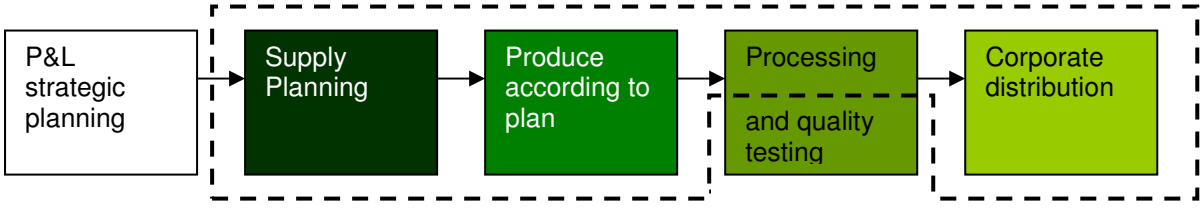

Figure 3: Processes within the production and logistics department

The research focuses on these processes and corresponding activities. Quality testing is not included because this belongs to the quality testing department.

Dimensions of competition
Dimensions of competition are described by (Noori and Radford, 1995) and (Porter, 1980 and 1985) but also (Slack, 2007). Dimensions of competition are factors that can give a competitive advantage; time/speed, cost, quality and service. These dimensions are taken into account during this research.

Value
Value is something that is in line with customer's wishes and what the customer is willing to pay for (Womack et al, 1990).This could be many things; services, color of the product, better features etc. Value is complementary to waste.

Waste
Waste is, for example an activity that takes up time, resources or space but does not add value to a product (Womack et al, 1990). It is the complementary to value, a customer is not willing to pay for waste and therefore it should be eliminated to gain a efficient process.

Lead time
Lead time is the time it takes for a process or activity to be completed. (Mason-Jones and Towill, 1999).

Scenarios
Scenarios are options that are given at the end of the report, these options represent the different situations of a change in lead time that can be concluded from this research. Here also the relation between a change in lead time and the effect on other dimensions and the ability to cope with uncertainties is stated.

Proportion value and waste
The proportion of value and waste is a mechanism for different ratios of value and waste. Examples of the proportion of value and waste are given in figure 4, respectively in the ratios 1:1, 1:3 and 3:1. Value is complementary to waste.

Figure 4; Proportions value and waste

1.8 Research framework

To conduct the research, a research framework is required to show schematically and visually the steps that need to be taken to realise the research objective. The framework is shown in figure 5.

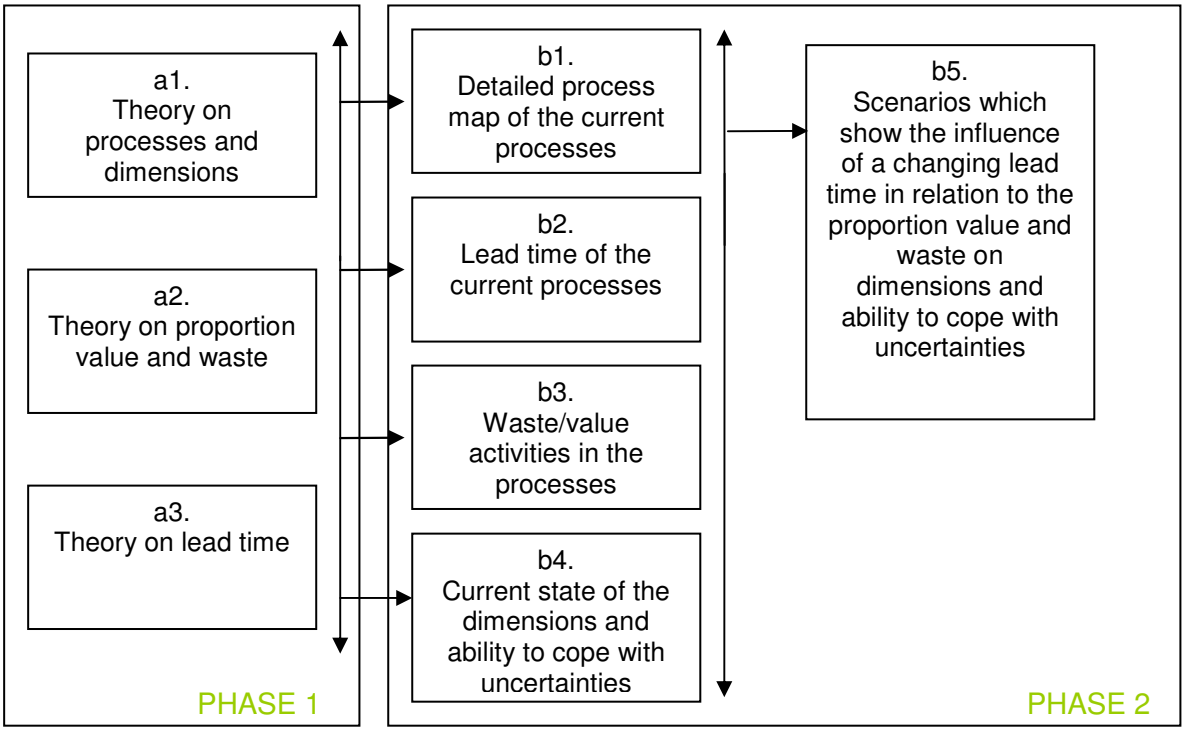

Figure 5; Research framework

The research framework has two phases; the theoretical phase and the empirical phase:

PHASE 1**: Theoretical framework.** A study of several concepts (a1, a2 and a3) will give insight in the details of the concepts; this will be used as input for the empirical study which will show the relationship between the concepts. Concepts as lead time, dimensions and proportion value and waste are included in the literature study.

PHASE 2**: Empirical study and analysis.** With the input from literature, a process map is made of the activities of De Ruiter Seeds (b1), this process map will include lead times (b2). Via interviews, opinions will be gathered where waste in lead time can be found. This will be checked with the lead times that are measured. One process which will benefit most from a decrease in lead time will be chosen, this is done based on the outcome of the interviews and the lead time that is measured. The activities of this process will be split into value and waste activities (b3). The current state of dimensions and ability to cope with uncertainties is stated, with the help of empirical data of De Ruiter Seeds (b4). Scenarios will be given for the selected process (b5).

1.9 Reading guide

This first chapter gives an introduction to the research, with corresponding research questions, strategy etc. The second chapter includes a thorough literature framework and an adjusted conceptual model. In this literature framework research questions one until four are answered. Chapter three includes information on the method that is used, including operationalisation, validity, and reliability. The results of the research are stated in chapter four, where the current state of De Ruiter Seeds is noted and also four future scenarios are detailed. Here questions four, five, and six are answered. The last chapter of this report, chapter five gives the conclusion, discussion, recommendations and further research for this research.

2. Theoretical framework

This theoretical framework is made to gain insight in the description and relationships of the concepts that are of importance in this research. It gives an overview of the body of knowledge that is currently available. In the first chapter, research questions are made to give a handhold for the research and steer it to the right direction. This chapter is made to attain answers on the following research questions:

1. What elements can be distinguished to analyze lead time
2. What elements can be distinguished to analyze and evaluate processes?
3. What elements can be distinguished to describe the proportion value and waste?

Research questions (1) and (2) will be described in paragraph 2.2. This paragraph has the title: effects of processes. These effects include information on lead time as stated in question (1) and elements to analyze and evaluate processes as stated in question (2). Different lead time categories are stated to analyze lead time and different dimensions of competition (service, quality and cost) to analyze and evaluate processes. Both of these concepts will have effect on the organization. Information on the dimensions in a high level are found in literature, to make this literature company specific, empirical data is used to come to sub dimensions for service, quality and cost.

Research question (3) will be answered in paragraph 2.3, Typologies of processes. Here different types of the proportion value and waste are described. The proportion value and waste is here expressed as three different types of activities, value added (VA), business value added (BVA) and non value added (NVA) stated by Monden (1993) instead of only value and waste which is stated by Womack et al, (1998). Therefore this paragraph has the title typologies of processes.

To conclude, this chapter shows the relation between lead time and other dimensions. Further the effect of changing lead time on other dimensions of competition in relation to the proportion value and waste is investigated. Typologies of the proportion value and waste are given to split different types of activities into VA, BVA and NVA activities, which is done in the chapter with results.

2.1 Introduction

Literature research is performed to gain insight in the relations between the proportion of value and waste and lead time in combination with other dimensions of competition as shown in figure 3.

Conceptual model

The conceptual model as stated in figure 6 visualizes the relationship between the concepts. An adjusted conceptual model will be given in the conclusion paragraph, which includes results from this literature chapter. Figure 6 gives a visual representation of the relations between the concepts at this moment.

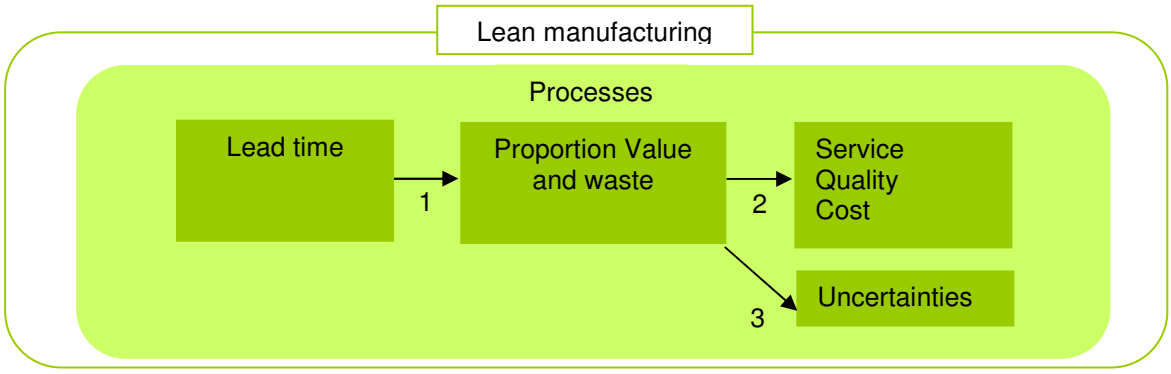

Figure 6; Conceptual model

This model shows the relationship between the concepts. The arrows have the following explanation:

1. For this research, lead time is changed of the different activities that are categorized in coherency with the proportion value and waste (first arrow).
2. The change in lead time in different activities might have effect on the dimensions (service, quality and cost) which is represented by arrow 2.
3. The change in lead time in different activities might also have effect on the ability to cope with uncertainties, this is presented by arrow 3. Information on uncertainties is mostly based on empirical data and stated in chapter 4.

2.2 Effects of processes

Processes have multiple dimensions of competition, one dimension is lead time. The others are service, quality and cost (Noori and Radford, 1995). Dimensions of competition are characteristics of processes that can add value for a customer. Lead time, service, quality and cost are described by many authors in different order and combinations. Noori and Radford (1995) and Porter (1980, 1985) but also Slack (2007) mention these four dimensions of competition.

Figure 7 shows the relation between lead time, service, quality and cost which are included in the research. These dimensions are related to each other, when one decrease/increase it is possible that another will also decrease or increase.

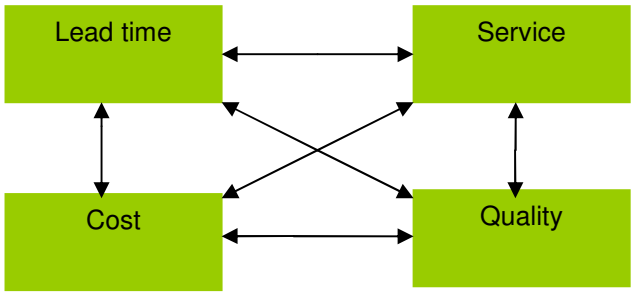

Figure 7; Dimensions of competition. Based on Johansson et al, (1993)

The main focus in this study will lay on researching how different lead times will affect other dimensions of competition in relation to the proportions of value and waste and the ability to cope with uncertainties as stated in figure 6. First it is necessary to detail more information on lead time, service, quality and cost as questioned in research question 2 and 3. Information about these four dimensions was found in literature (lead time) and empirical data (service, quality and cost) of De Ruiter Seeds and expert interviews with the sales manager and manager supply team. Empirical data is based on the strategic requirements that De Ruiter Seeds has set itself to fulfill customer wishes in the form of order winners and order qualifiers. These are important competitive factors specific for De Ruiter Seeds.

2.2.1 Lead time

Lead time is the independent variable and an important factor for the research and therefore more elaborated on than the other dimensions. Lead time of processes is considered the time it takes to complete a process (Mason-Jones and Towill, 1999). There are mentioned many different typologies of lead time like takt time, set up time, (Charney, 1991) etc but these are not relevant for the research because these are too detailed and practically oriented. For this research the following typologies are used from systems2win.com and Mason-Jones and Towill (1999):

(1) Cycle time
This is the average lead time it takes to complete each activity.
(2) Average process time
This is the average process time, including all activities
(3) Minimum lead time
This is the minimal time that is measured for a specific activity, mostly this is an exemption.
(4) Maximum lead time
This is the maximal lead time measured for a specific activity, also this is mostly an exemption where something went wrong.
(5) Standard deviation
The standard deviation shows how much variation there is, in the data, from the average cycle time or process time. A low standard deviation shows that the data is close to the average and a high standard deviation shows that the data is largely spread out and far from the average.
There are some steps to come to a standard deviation:
First, an average lead time should be calculated.
Second, difference between the actual lead time and the average should be stated and all should be squared.
Third, the squared differences should be summed up.
Fourth, the sum should be divided by the amount of samples
Fifth, a square root should be taken from the outcome of step 4.

These five types are used because these are all related to the product flow of the organization.

Further, it is important to measure the cycle time and average process time to see what the current state is of the time that is used to complete the processes. This is the as-is situation, the starting point of changing lead time. An average of the lead time is calculated to include information from all data sets. The minimum and maximum lead times are used to indicate the spread of the times and also to see how long a process takes to be completed in worst case scenarios and best case scenarios. The standard deviation shows the fluctuations of the times, a high standard deviation could be an indication that seeds are waiting for another process. If seeds are waiting, the lead time increases and the standard deviation will rise.

To visualize most of the used lead time typologies, a standard normal distribution is shown in figure 8 on the next page, because with a large sample size the lead time will be distributed normally. Here (1), (3), (4) and (5) are shown. (2) is an average of a process instead of an activity, and therefore is not represented in the figure below which shows the distribution of an activity.

Standard normal distribution of one process

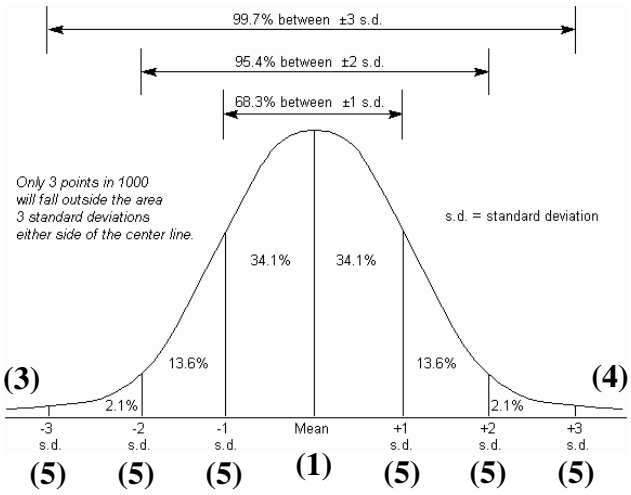

Figure 8; Standard normal distribution.
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For lead time the 'as-is' situation will be stated to show the current lead times. For the research, lead time will be changed and the effect on the other dimensions will be stated. Because only the effect is stated, it is mainly necessary to state the factors which might be affected by a change of lead time. These factors are withdrawn from information of De Ruiter Seeds. Here the most important factors for customer of De Ruiter Seeds are stated.

2.2.2 Service

The empirical data of De Ruiter Seeds show the following important aspects in the production and logistics department in relation to service. These data were stated as order winners and order qualifiers for De Ruiter Seeds and part of the competitive advantage. Also for cost, and quality this is one on one used in this report. Three important detailed aspects of the list with order winners and order qualifiers of De Ruiter Seeds will be included in the research: availability of the product, customer support and complaint handling and flexibility to meet customer demands.

The availability of the product is important for the customer, If the customer wants to place an order and De Ruiter Seeds is out of stock the customer might take its business elsewhere. The products must be available in the right time and the right place. If the seeds are too late, the selling season might be over and the seeds are not sold and missed sales are taking place.

If the customer has questions or complaints, de Ruiter Seeds need to be able to answer quickly and with the correct information. Lower amount of complaints will increase customer satisfaction. If the customer has to wait a long time before De Ruiter Seeds responds, the customer might ask questions on the reliability and ability to trace the seeds.

If a customer has a specific wish, De Ruiter Seeds has to respond flexible to these wishes. It should not be the case that De Ruiter Seeds is not flexible in fulfilling specific wishes regarding the products which need a small adaptation in the process. If there is no time left for responding on wishes that can be performed easily, this will irritate the customer.

These three factors will be included in the scenarios, a table will be made with the effects of changes is lead time on these factors as stated in table 2.

2.2.3 Quality

For the relation between lead time and quality, the following three factors are of importance for the competitive advantage: germination of the product, purity and uniformity of the product and health of the product.

Germination of the seeds are very important, the customers want tomato plants to sell to tomato growers, if the seeds do not germinate it is worthless for the customer. De Ruiter Seeds has germination levels, seed that germinates under this level will not be sold. If time is decreased in such a way that the tomatoes do not ripe and the seeds are not fully grown, the germination might decrease and the seeds might become worthless.

The purity and uniformity of the product is also important, a customer orders one variety and if this is mixed with another variety the batch is impure and not uniform. Purity also means that the plants have the same genetic background and will perform likewise in the greenhouse. If lead time is decreased in such a way that mistakes in variety names are made, this can have large consequences. Customers might complain and want to have the crop refunded.

Product health is very important, is the seeds are sick this is a large risk for complaints and refunds. If all plants die of a disease from the seed, the customer can loose its yearly income. Not taking the time to test the seeds can results in large refunds and damage of the brand name.

Germination, purity/uniformity and health will be included at the end of the research. This will also be detailed in the end of the report.

2.2.4 Cost

The effects of changing lead time on the following three factors related to costs are included in the research: production cost, selling price and missed sales due to not fulfilling customer's wishes

To produce products, costs are made. These production costs are important to determine the selling price for the customers, keeping the costs as low as possible will increase margins or may give a better selling price which may attract or attain customers. If lead time needs to be decreased in such a way that extra people are necessary to perform the process, this might increase the production costs. Increasing production cost will also affect the selling price.

The selling price is something that is of importance for the customer, if this will increase too much the customer might want to look for a different supplier. On the other side, a very low selling price may cause let the customers think that the product is not of high standards and cheap. An decrease in lead time might increase the production cost and therefore also the selling price.

Missed sales is something that every company wants to prevent, missed sales can be caused by out of stock but also when customer wishes and expectations are not met. If the quality or service was not sufficient in the previous years, this may cause missed sales because the customer will leave. If there is no time to fulfil customer wishes, the customer might take its business elsewhere.

The above mentioned factors of cost are included in the scenarios. Here the other factors of the other dimensions of competition are also included. The effect of changing lead time on these factors will be stated in the scenarios.

Looking at research question 1 and 2, important aspects to analyze lead time are: 1) cycle time, (2) Average process time, (3) minimum lead time, (4) maximum lead time, (5) standard deviation of lead time and (6) process delay. Elements to analyze and evaluate processes are lead time, service, quality and cost.

2.3 Typologies of processes

An important aspect in this research is the proportion value and waste, as stated in research question 3. The typologies or processes are here stated as the proportion of value and waste. Processes can be divided into different activities. First was assumed that the proportion value and waste consisted of only value and waste activities and therefore a proportion of value and waste was stated (Womack and Jones, 1990). After reading an article of Monden, (1993) a threefold was found of the following activities: (1) value adding activities (VA), (2) necessary but non value adding activities, also stated as business value adding (BVA) and (3) non value adding activities (NVA) also called waste (Monden, 1993). This threefold is used as the proportion of value and waste.

To differentiate VA, BVA and NVA in the process and activities the following questions should be asked:

1. Does the value of the product for the customer decrease when this activity is eliminated? If yes, this activity is a VA. If not, the second question should be asked.
2. Does the activity add value to the business process? Also possible: is the total flow of processes negatively affected when removing this activity? If yes, this is a BVA. If not, the third question should be asked.
3. Is it possible to eliminate this activity without loosing customer value or business value? If yes, this activity is a NVA. If no, questions 1 and 2 should be asked again.

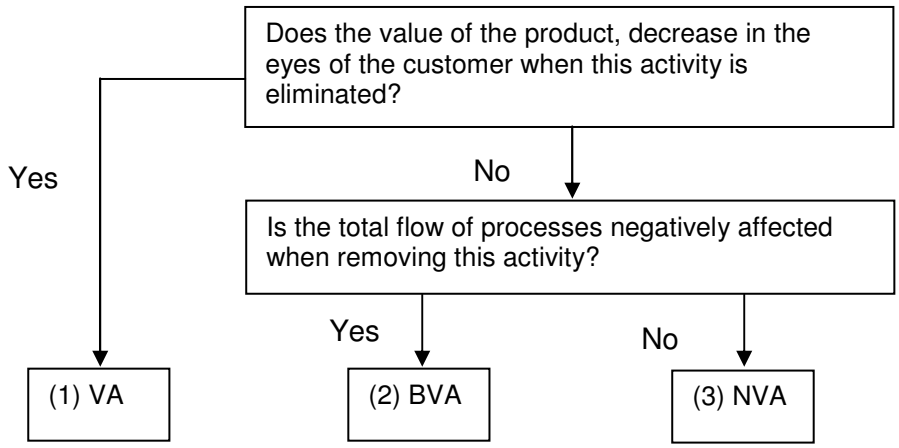


Figure 9; Differentiation in activities

Figure 9 shows three different typologies of activities, VA, BVA and NVA activities. These are further explained in separate paragraphs.

2.3.1 Value adding activities

(1) VA activities add value to a product or service that a customer is willing to pay for and fulfills the needs and wishes of a customer. It could also be stated as customer value adding, but in this research the word value adding is used in coherency with many articles and case studies of lean manufacturing.

Value is not an absolute value, value is something that is perceived and therefore hard to describe because one customer can perceive value as something totally different than another customer. If a customer does not see any value in the product or service, it will switch to a competitor and in due time the company will loose many customers. (Womack et al, 1990) Therefore it is important to satisfy the customer wishes. An activity will fall in the category of VA when it is effective and if it will directly contribute to satisfying customer expectations. This can improve the customer perception of the product.

2.3.2 Business value adding activities

(2) BVA activities are activities that are needed to continue the process but do not add value in the eye of the customer. An example is setting up a order form for a supplier. The customer does not consider that as value adding, but without an order form, no materials are ordered and delivered.

BVA activities are activities which satisfy customer requirements and support the business process, but add no value from the customer point of view like preparing a financial report and maintaining human resources records. Bicheno and Holweg, (2009) call these activities muda type one, in this research formulated as BVA. Type one muda are activities that create no value but are currently necessary to maintain operations. These activities do not do anything for the customers, but may well assist the managers or stakeholders.

2.3.3 Non value adding activities

(3) NVA activities are considered waste, because these do not add value to the customer and also not to the business. More information about waste can be found in below.

NVA activities are activities which do not enhance the customer image of the product and do not support the business process. If the activity could be removed from the process without an effect on the end product, it is an NVA activity.
NVA are also referred to as waste activities, often indicate deficiencies in the process design. Bicheno and Holweg, (2009) mention NVA as muda type 2 activities. Type 2 muda is pure waste. It creates no value, in fact destroys value.

Waste is not an absolute value, waste (NVA) is anything that a customer is not willing to pay for and is not business value adding (Womack et al, 1990). An activity can be considering waste if it would not have an effect, on the processes and value of a product, after removal.

In relation to research question 3, the proportion value and waste was extended with another type of activity, business value added. So instead of only value and waste, now VA, BVA and NVA are used. This differentiation is needed to split the activities of a process in VA, BVA and NVA activities. The effect of change in dimensions is stated per typology of process.
Looking at the scenarios that will be made at the end of the report, changing lead time in these different activities will have a different effect on the dimensions.

2.4 Relation between concepts

The concepts used in the research are explained per concept, but another important aspect is the relationship between these concepts. The relationships and concepts are detailed in a new adjusted conceptual model where information from literature is included. Figure 10 shows this adjusted conceptual model.

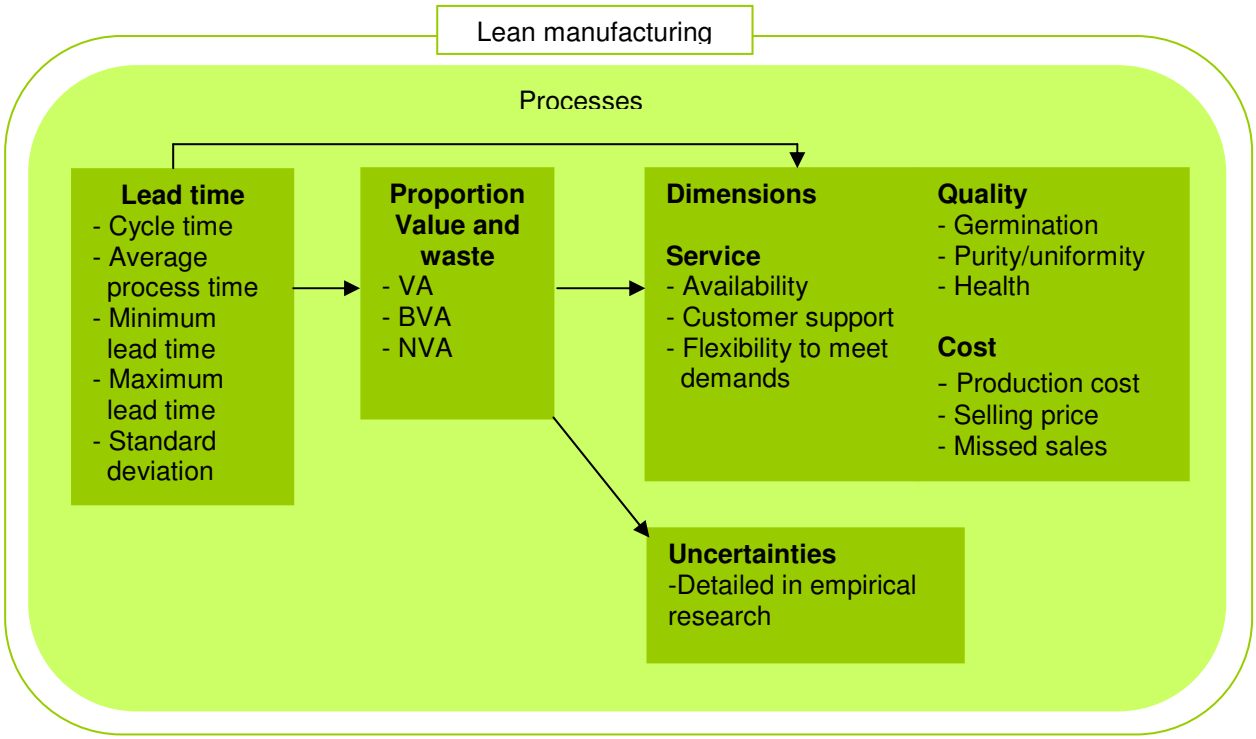


Figure 10; Adjusted conceptual model

Figure 10 shows the relation between the concepts. Here is shown that changing lead time will have effect on the dimensions, this can be positive, negative or neutral. This positive or negative effect will have different effects on different types of activities (VA, BVA and NVA). Decreasing lead time can not be done unlimited, because with a lead time of zero days a process does not exist anymore.

Looking at this figure there are two relationships, the first is the effect of changing lead time in VA, BVA and NVA activities on the other dimensions. The second is the effect of changing lead time in VA, BVA and NVA activities on the ability to cope with uncertainties. The ability to cope with uncertainties is further detailed in chapter 4.

It is possible that the total lead time will increase if for example sales people have to explain to customers why value adding activities are not performed and the product is not as valuable as it used to be. Decreasing lead time in business value adding activities could result in a defect in the product flow. For example, if administration of the product is not done, it might be possible that products get lost which cost more time to search than to administrate. If time in non value adding activities is decreased, lead time will decrease and this will be beneficial for the total lead time. Waste activities do not add value for the customer nor for the business, so removing these activities carefully, will decrease the total lead time.
Looking at the other lead times such as minimum and maximum lead time, if a waste activity is removed which causes large fluctuations, the minimum and maximum lead time will be affected, same as the standard deviation. The large fluctuations could be caused by a product that is waiting for another process. If process delay time can be reduced, the processes will follow up quicker which will lead to a lower total lead time.

In a VA activity a decrease of lead time will mostly lead to a decrease of the other dimensions. A decrease of lead time in a BVA activity will probably also cause the decrease of other dimensions because some of the needed business activities are decreased.
With a NVA activity, a decrease in lead time will not have an effect on the other dimensions because the activity was not giving a competitive advantage anyway.
It will probably increase the other dimensions because when lead time is decreased, the service to the customer could be faster.

These effects on lead time and its typologies will be further elaborated on in the scenarios at the end of the report. The scenarios will include a table as stated in table 2. Here an example is given of the effect of changing lead time on the other dimensions and typologies. The effects (0), (-) etc are fictive and only to show how this table will be visualised in paragraphs with scenarios. This table is for illustration purposes.

Table 2 ; Example of effect of changing lead time on dimensions and typologies

	VA	**BVA**	**NVA**
Service			
Availability of product	++	-	0
Support and complaint handling	- -	++	- -
Flexibility to meet customer demands	0	+	0
Quality			
Germination of the product	- -	0	+
Purity of the product	0	++	0
Health of the product	+	-	++
Cost			
Production cost	+	++	-
Selling price	0	0	0
Missed sales due to not fulfilling customer wishes	0	++	- -

There might also be an effect on the uncertainties that De Ruiter Seeds is coping with, these are stated in chapter 4.

2.5 Conclusion

From the theoretical framework several important issues came forward. The main focus was to research the effect of changing lead time on other dimensions of competition, typologies (VA, BVA and NVA) and the ability to cope with uncertainties. These concepts of lead time, dimensions, uncertainties and typologies are used to analyze and evaluate processes as asked in research question (2) What elements can be distinguished to analyze and evaluate processes? The typologies of processes (VA, BVA and NVA) are used to describe the proportion of value and waste as questioned in research question (3) What elements can be distinguished to describe the proportion value and waste? The threefold of (Monden, 1993) will be used to describe the proportion value and waste but also the effect of changing lead time.

Lead time is here divided in six different elements as questioned in research question (1) What elements can be distinguished to analyze lead time? (1) cycle time, (2) average process time, (3) minimum lead time, (4) maximum lead time and (5) standard deviation. Changing lead times will probably have effect on the other dimensions, this will be researched and also the effect on the proportion value and waste, which is now stated as typologies of processes. In what way the lead times will affect other concepts and will be included in the scenarios.

3. Methodology

This methodology chapter provides insight in methods of disclosure, operationalisation, data sources, reliability, replication and validity of the research. There is chosen to include many different aspects that are considered valuable for the scientific background and purposes of the research. This methodology shows how the following questions are answered during the research, different methods that are used in this research will be explained. Research question 5, about the current state of lead time, dimensions and ability to cope with uncertainties in the case study will be answered. For research question 6, an explanation will be given on how the research comes to scenarios which include the effect of different lead times on quality, service and cost in relation to the proportion value and waste.

3.1 Method for disclosure

A significant decision that has to be made is what kind of approach should be taken to conduct the research. Gathering material and the way to process the information are important aspects. There can be chosen for depth or breadth, these types of decisions need to be written down.

There are several basic designs of qualitative research: case study, comparative study, retrospective study and longitudinal study according to Flick, (2009). De Vaus, (2001) mentions experimental designs, longitudinal designs, cross sectional designs and case study designs.

For this research a case study is suitable, because the case study focuses on one research unit. It is a labour intensive way of data generation (a selective sample requires more qualitative data and information and needs an open observation at site). The information of this research can be hardly generalised. This is not a problem because the information is solely used for De Ruiter Seeds. The internal validity is high, because of the in depth approach. The case examined has the relation between lead time, dimensions, value and waste proportion, and uncertainties as one case unit. Because existing data is used, a holistic design is most appropriate, so the case is a single and holistic case design as detailed in figure 11. (Yin, 2003)

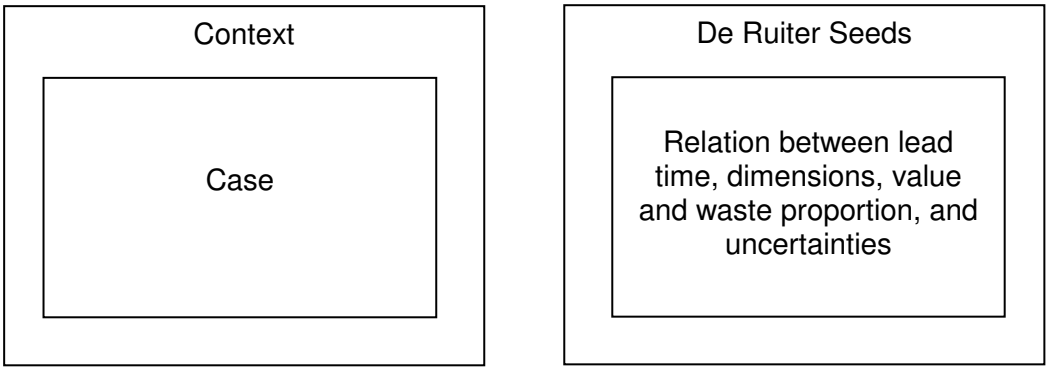


Figure 11; Single holistic case design (Yin, 2003)

Looking at table 3, this will represent characteristics of a case study. It includes approach criteria and a basic design. This will fit this research because the focus on the case under study is De Ruiter Seeds, there is one case selected. An analysis of an institution is made via stating the processes and the lead times, also suitable scenarios are stated for this particular case. A problem can be the integration of different perspectives on the case, in an organization where many persons are questioned multiple perspectives are present. For the research, many persons are questioned.

These have all a different function, background and information knowledge. This could result in different perspectives on one subject, the integration of these different perspectives might be difficult. By checking the perspectives with other persons, it is prevented that wrong perceptions are taken into the research.

Generalisation of the data is rather difficult, other seed production companies will probably not have the same lead times, processes etc. But the methodology to come to the findings of this report can be used in other organization for being able to state future scenarios.

Table 3; Characteristics of case study design (Flick, 2009; Ragin & Becker, 1992)

Approach criteria	**Basic design is Case study**
Openness to the issue by	Focus on the case under study (individuals, institutions, field etc)
Structuring the issue by	Selection of one case
Contribution to the general development of qualitative methods	Most consequent approach to the particular case
Domain of application	* Analysis of institutions * Life histories
Problems in applying the approach	Integration of different perspectives on the case
Limitations of the approach	Generalization rather difficult

3.2 Operationalisation

For being able to detail how the operationalisation will be, it must be clear what has to be done. Therefore figure 12 is made. This shows the red line of the research, all activities that have to be performed to come to a conclusion for this report are stated.
Looking at figure 12 a distinction is made between organizational level and process level via horizontal arrows. Another distinction is made between current situation and options for a new situation, also indicated with horizontal arrows.

3.2.1 Research steps

The following steps are taken in the research, this will function as a roadmap and red line through the research.

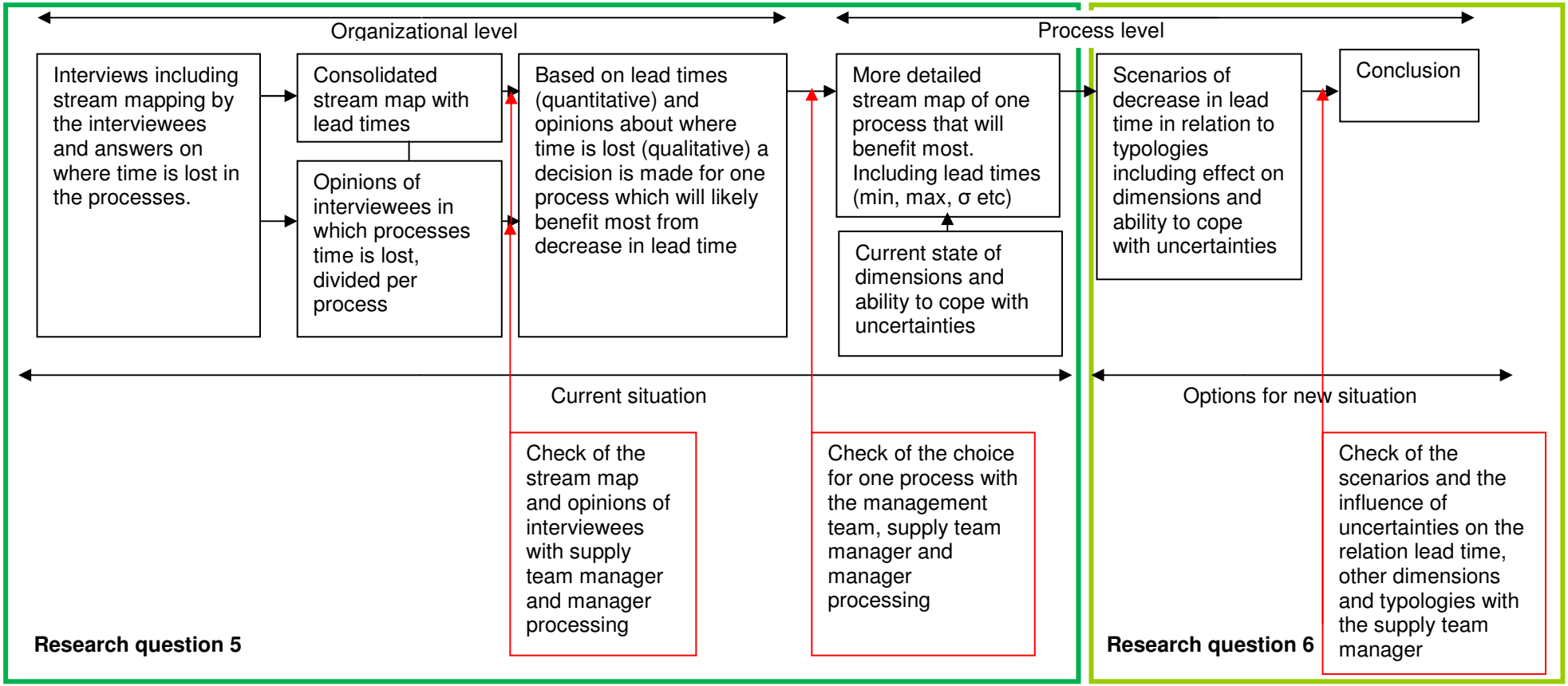


Figure 12; Overview of the research steps

Figure 12 shows the research steps that will be taken during the research per research question. It starts with interviewing employees to come to a stream map of the processes, as in the interview questions are asked where time could be decreased and where time is lost. These opinions are stated and a consolidated stream map is made, including lead times of different batches. The stream map and opinions are checked with the supply team manager and manager processing.

According to Ohno (2002) there are the following seven waste categories: (1) transport, which can be internal and external export of products. (2) inventory, a large stock is considered waste, (3) motion, which includes excessive motion of employees or products. (4) waiting, this is for example waiting of a product to be processed, (5) overproduction, producing more products than needed is considered waste. (6) over processing, over processing of products that are not needed is also a waste, (7) defects, products that can not be sold are also a waste of resources and time. A process is chosen which falls under one of the seven wastes of Ohno (2002).

Information from the organization is used and employees are questioned about where most waste is hidden. The choice for a process is presented to the management team after consulting the supply team manager and manager processing. The specific process will be visualised in a more detailed stream map including lead times. The current state of the dimensions and abilities to cope with uncertainties are stated. This together with the stream map and lead times will be the answer on question 5, what the current state is of the case. This is indicated with the dark green rectangle, the activities within this rectangle are done to answer question 5. To answer research question 6, what the possible scenarios are for different lead times and the effect on quality, service and cost in relation to the proportion value and waste, multiple scenarios are made to show the effect of changing lead time. The steps in the light green rectangle belong to research question 6.

Below a detailed description is stated to show the specific content of the research steps and how these will result in the answer on the research questions.

3.2.2 Interviews

To answer research question 5, first is started with interviewing the managers and specialist related to the processes of supply planning, produce according to plan, processing and corporate distribution. These processes fall under the department of production and logistics, which are closely related to the product flow of the organization. This can be detailed as described in figure 13.

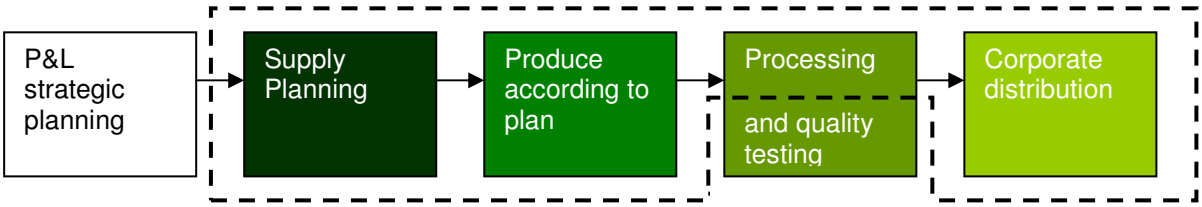


Figure 13: Processes within the production and Logistics department

The processes in the dotted area will be considered as the scope of the research. The lead time and value and waste proportion of the physical product flow is the main focus of this research. Within these processes, the product is timed and waste in lead time will be described.

The processes of supply planning, produce according to plan, processing and corporate distribution as detailed in figure 13, are briefly explained by mentioning important aspects in the process. These aspects give a better insight in the type of process and which activities are included. The inputs for supply planning are forecasts, running productions and inventory levels. Production and processing are mainly forecast driven. Packing and distribution are order driven.

Supply planning includes the following activities: master scheduling, production planning and logistic planning

Produce according to plan includes: capacity management, young plant growing, seed production, extraction and drying and seed shipment

Processing includes the following activities: reception of seeds, plant planning, scheduling and follow up, seed reception and cleaning and seed upgrading

Corporate distribution includes: distribution planning and scheduling, packing, expedition and documents and certificates.

Above is detailed what the scope is of the interview, the content of the interview is divided in several parts; stating the process and detailing possible delays in the processes or where waste in lead time could be hidden. This last is done by questioning the interviewees if there is time inefficiency in the process that is of importance. Time inefficiency could be delays in the process or waiting time and so on. These delays are noted, preferably accompanied with an example. This opinion is checked with the other interviewees to check the reliability of this statement.

Semi structured interview

For stream mapping a semi structured interview is used because these are not standardized and the researcher can vary the list of themes and questions per interview. The questions may be adapted given a specific context of a process or department that is encountered to the research topic. The interviewees have knowledge about the topic under study. The interviewees must be supported by methodological aid, like an agenda for the interview and brown wall paper to make an stream map etc. In the interview open questions will be asked, also theory driven questions to check theory with practice and confrontational questions to check the statements of the interviewees during the interview. This to make sure that the statement represents the opinion of the group which makes it more reliable (De Vaus, 2001).

The advantage of semi structured interviewing is that it is more flexible than standardized methods as the structured interview or survey. Because the interviewees should share the knowledge about different processes it is an advantage that the questions may be adapted for every interviewing group. Although the interviewers will have established topics as stream mapping and mentioning bottlenecks, this method allows exploration of other themes and ideas. (De Vaus, 2001) This allows the researcher to ask questions on themes that come up during the interview and are of importance for this research (Flick, 2009). Further elaboration is done, if needed. If an interviewee mentions a large delay of tomato seeds, it is possible to ask more in depth questions to understand the problem and possible solutions. With semi standardized interviews it is possible to include relevant additional questions which are often noted as prompts on the interview schedule (Flick, 2009).

Interview groups

Table 4 shows which groups are interviewed and in what part, of the four processes that are stated in figure 3, the interviewees are working in. Also what kind of flow type is discussed during the interview.

Table 4; Interview groups

Group		Process	Input for flow type
1	Supply planning	Forecast to demand	Information flow
2	Supply planning	Demand to production order	Information flow
3	Produce according to plan	Produce according to plan	Product flow
4	Processing	Processing according to plan	Product flow
5	Supply planning	Assign to VWH	Information flow
6	Supply planning	VWH to order	Information flow
7	Corporate distribution	Order to delivery	Product flow

The interviews with the different groups have the following topics that are discussed:

Group 1: Forecast to demand
Group 1 includes two master schedulers and these will be questioned about master scheduling.

Group 2: Demand to production order
In the interview two seed production specialists will get questions about the rolling production planning.

Group 3: Produce according to plan
Group 3 includes a strategic manager and a farm manager who are interviewed about capacity management, young plant growing, seed production, extraction and drying, seed shipment and crop management.

Group 4: Processing according to plan
This group will consist of a inventory planner and a team leader seed processing and will be questioned about rolling logistic planning, plant planning, scheduling and follow up, the time aspect of quality testing, seed reception and cleaning and seed upgrading.

Group 5: Assign to Virtual Warehouse
This group includes two inventory planners and a team leader documents and planning and will be interviewed about rolling logistic planning, this process is done in cooperation with processing and therefore discussed by both groups. Also documents and certificates will be discussed with group 5.

Group 6: Virtual Warehouse to order
Questions about the customer order processing and communication with the production and logistics department are included in the interview with the region managers medium and a sales assistant North West Europe.

Group 7: Order to delivery
Group 7 includes a team leader corporate distribution and plant planner corporate distribution and will discuss distribution planning and scheduling, packing, expedition and documents and certificates.

Interview guide

The interview will be held as follows:
It starts with a general email about the subject, date and time of the meeting, also including attendees and location.

1. The first point on the agenda is an introduction of all attendees of the interview group, including the interviewer. That way the backgrounds are known and responsibilities are clear.
2. An introduction to the research, what the overall goal is and what part the interview takes in the overall picture. Important aspects are:
   - Thesis at Wageningen University for finalizing education
   - Introduction of Lean manufacturing
   - All processes of the department of production and logistics excluding quality testing
   - Main focus on lead time reduction
   - The knowledge of the interviewees is needed to translate the current situation into a stream map
   - The focus will lay on commercial tomato seed varieties
   - A consensus should be reached on the correctness of the stream map
3. The interview will be detailed so that the structure is clear. There will be started with explanation and check of the Integration Definition for Function Modelling (IDEF) maps, that give some information on the processes of De Ruiter Seeds. A stream map will be made by the interviewees and attention points regarding lead time are asked.
4. The IDEFs are checked to ensure that these are accurate and suitable for the current state map. This also encourages critical thinking which will be helpful for stream mapping and stating attention points. The IDEFs also help with visualising the process and be used as guideline for the stream map and gives the interviewer more information about the process flow next to the IDEFs.
5. The managers and specialists are asked to make a stream map. Discussion between the interviewees is necessary to get one opinion about the stream map. If there is no discussion the interviewer will ask both interviewees to give an opinion.
6. After stream mapping the interviewer asks the interviewees where time delay occurs or where it can occur. A more detailed explanation of these points are necessary to check the correctness of the points, preferable with an example or data.
7. Questions can be asked or remarks can be given at that moment.
8. The interviewer closes the meeting. Here is asked it the interviewees are available for questions via email of phone. Also if there is information concerning time available about the process that is discussed.

During the interview it should be clear for the interviewees that it is of great importance that the processes are detailed in a way that it is executed in the company. This way, a correct visualization of the current situation will be made. For the interviewees it should also be clear that the input of the interview is of great importance for the research and that contribution is valued.

3.2.3 Stream mapping

An organization has many different processes with many activities per process. To define the processes in an organization there are many methods to state the process, like photographing the activities or usage of work instructions. The disadvantage of these tools is that the coherency of the processes and the links and loops with other processes are not stated or visualized. A suited and well know method in lean manufacturing is stream mapping (Hines and Rick, 1997).

Stream mapping originated from value stream mapping which is a well known and used technique in lean manufacturing according to Hines and Rick, (1997). Stream mapping differentiates from value stream mapping when value is not stated in the map. Stream mapping includes also current state mapping. This is stating the “as-is” situation of the organization. The ‘as-is’ situation is important to visualize problem areas that can be used as focus of the research. There are multiple advantages of stream mapping: (1) giving simplicity and objectivity regarding the process design, (2) can visualize problems and delays in the processes, (3) ensures a common language when discussing processes and (4) it is a start for improvement projects like lean manufacturing (Lasa et al, 2009).

A stream map refers to all activities the company must do to design, order, produce and deliver its products or services to customers. The stream map that is made must consist of three parts: (1) The flow of materials, from receipt from suppliers to delivery to customers, including lead times. (2) The transformation of raw materials into finished goods and (3) Information flow that supports and directs both the product flow (Fawcett, et al 2007).

It is important to state lead times with the stream map. This to make sure that lead time of value adding time is differentiated from waste in lead time and being able to change lead time in the types of activities and show the effect on dimensions and uncertainties.

3.2.4 Current state of dimensions and uncertainties

The current state of the other dimensions will be stated in quantitative way. This shows how De Ruiter Seeds is performing at the moment. For all sub dimensions is tried to find qualitative information, if this is not found the general policy of De Ruiter Seeds is stated to show what the maximum level is. When changing lead time, some of the might be balancing on the edge of unacceptability for the customer. De Ruiter Seeds are currently also facing and dealing with uncertainties. In chapter four is also stated how De Ruiter Seeds is currently facing these uncertainties. This is the as-is situation (stream map, lead times, VA, BVA and NVA, status of dimensions and facing uncertainties) of De Ruiter Seeds and serves as input for the choice for on process and eventually for the scenarios.

3.2.5 Choice for focus on one process

For being able to state current lead time of processes, a consolidated stream map is made of the seven different process maps after the seven interviews, the details of the interviews can be found in appendix 2. Here possible problems areas will be stated according to the remarks of the interviewees about areas where lead time is wasted. This list includes the attention points that every interview group mentioned as detailed in appendix 3. There has been also an interview with the manager supply team, manager seed processing to check the correctness of the process map and to think of processes that will probably include considerable waste in lead time which can be eliminated. These eight interviews are a basis for the decision to zoom in on one process.

The method for determining processes to zoom in can be depicted in a scheme mentioned in figure 14.

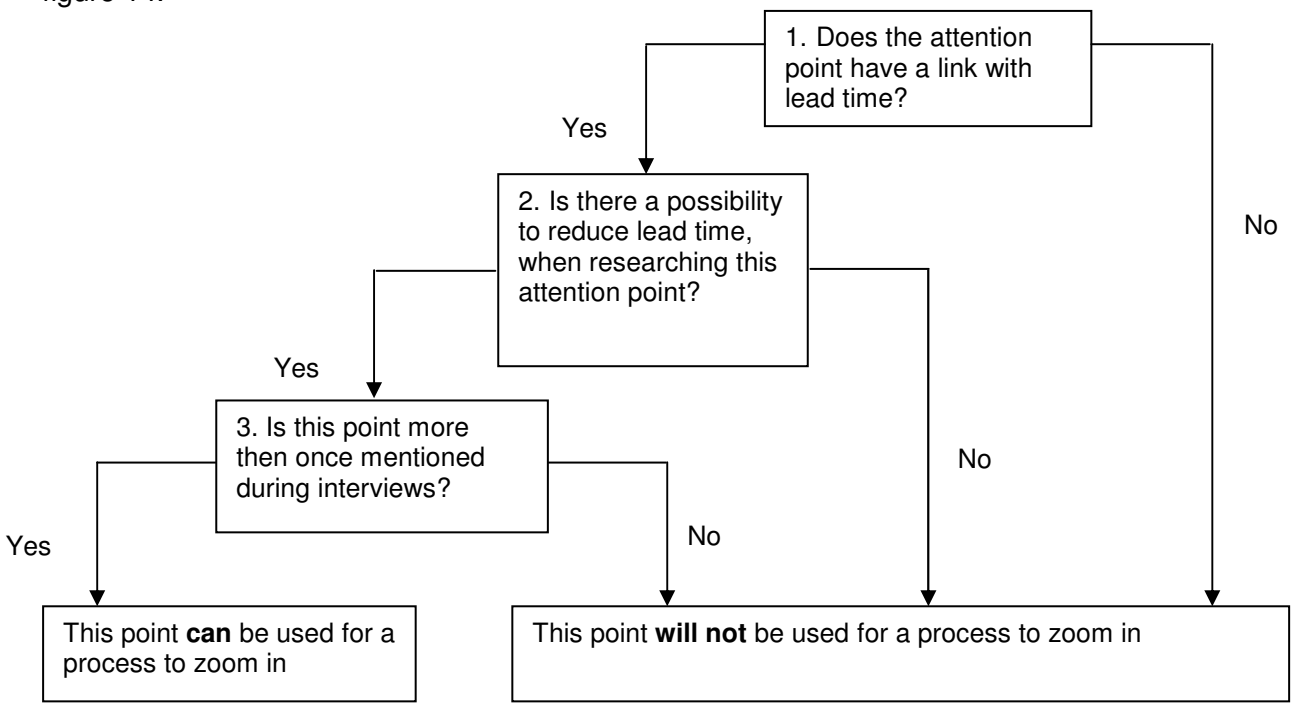


Figure 14; Method for decision to zoom in

There are several points that are of importance for choosing a process to zoom in, a proposal will be made for a choice for one process. This proposal will be presented to the management team to make sure that the process is the right one to choose. From that point, this process is further elaborated on and the other activities will only be in relation to this specific process.

3.2.6 Detailed stream map of one process

A detailed stream map will be made of the specific process, with details about the activities that are performed in this process. This stream map will include lead times, including minimum and maximum lead time, standard deviation as stated in paragraph 2.2. The lead times are based on all batches that were involved in the period August 2008 until August 2009 because these show a total production year with relating uncertainty effects like seasonal fluctuations. The processes are grouped in VA, BVA and NVA, according to the method stated in chapter 2.

3.2.7 Future scenarios

Six scenarios are made, three with a decrease in lead time and three with an increase in lead time. For the three scenarios with a decrease in lead time, in one the lead time is decrease until the minimal possible lead time (the minimum lead time is used from the table with lead times per activity). One scenario represents a large decrease in lead time, and another scenario details the effects of a small decrease in lead time. It is expected that the scenario which presents a decrease in lead time until a minimum gives the largest effects because it might be possible that activities can not performed properly anymore. So a larger decrease in lead time will probably give a larger positive/negative effect than a small decrease in lead time.

For the other three scenarios with an increase in lead, the opposite applies. A scenario with an increase until the maximum lead times (the maximum lead time is used from the table with lead times per activity) is stated. Further, a scenario with a large and small increase in lead time is stated to show the effect of having more time on the dimensions and proportion value and waste. If an increase of lead time gives a massive increase in the other dimensions, this could be more desirable for the overall organization than decreasing lead time.

The effect of changing lead time will be stated in a table as in table 2 in chapter 2. Here the effects on dimensions in relation to typologies are stated.

This effect is retrieved to answer the following questions for respectively, decrease until minimum lead times, large decrease, small decrease, small increase, large increase and increase until maximum lead times:

- What effect has a decrease until the minimum lead time of VA / BVA / NVA activities on the separate dimensions?
- What effect has a large decrease in lead time of VA / BVA / NVA activities on the separate dimensions?
- What effect has a small decrease in lead time of VA / BVA / NVA activities on the separate dimensions?
- What effect has a small increase in lead time of VA / BVA / NVA activities on the separate dimensions?
- What effect has a large increase in lead time of VA / BVA / NVA activities on the separate dimensions?
- What effect has an increase until the maximum lead time of VA / BVA / NVA activities on the separate dimensions?

With the scenarios, information is given on the possibilities of De Ruiter Seeds for still being able to cope with the uncertainties as in the current state. Information on the ability to cope with uncertainties is discussed with the master scheduler, who is directly involved in coping with uncertainties. Calculations and forecasting is done by the master scheduler. More information can be found in the chapter with results.

3.3 Data sources

The largest data source for answering research questions is De Ruiter Seeds itself. The managers and specialists that are interviewed for the research are stated in paragraph 3.2.2. Documents that state lead time will provide part of the answer on research question 5. Literature and options for scenarios will give answer on research question 6.

Especially the manager seed processing and the supply team manager are of great importance to check the correctness of the work that is done for this research. The managers are sparring partners for any misunderstandings and other factors that complicate the research.

Inside De Ruiter Seeds there are some information systems and documents that will provide information. IDEF procedure descriptions and the interviews provide information for the stream map.

The following data sources are used for detailing lead time (question 5):

- Information from ABS, where date could be found about the lead times of the seed batches. This includes lead time for production, processing etc.
- The other sources depend on the type of process that is chosen. For a process in relation to the department in the Netherlands, information from the head office is used. When a process is chosen that is in relation to a foreign production site, information from that site is chosen and preferably information from official institutes.

A choice is made for these sources because these are the most complete and reliable sources. Information from official documents are considered most reliable because it includes data from official institutes. Information from the head office or production site gives also more detailed information about the processes.

3.4 Reliability and validity

Reliability issues will be stated in this paragraph. Reliability and replicability are mentioned together. Validity of the research will be divided into internal validity and external validity.

3.4.1 Reliability

“A reliable measure is one that gives the same ‘reading’ when used on repeated occasions.“ (De Vaus, 2001)
Unreliability can be caused by many sources. Poor questioning may cause a interviewee to understand the question differently on different occasions. The answer to some questions might be influenced by the mood and the particular context in which the questions are asked. Measures will never be perfectly reliable and perfectly valid, these are not all or nothing concepts and the purpose is to maximize the reliability and validity (De Vaus, 2001).

Looking at the reliability of the findings using non standardized research methods, it is shown that the findings are not necessarily meant to be repeatable. The outcome is accurate for the moment in time that the information was collected. (Marshall and Rossman,1999). The value of using non standardized interviews is because the researcher is flexible to explore the complexity of decreasing lead time and stating the processes in a stream map. “Therefore an attempt is made to ensure that qualitative, non standardized research could be replicated by other researchers is not realistic or feasible without undermining the strength of this type of research.” (Marshall and Rossman,1999).

For this research, the reliability is increased by stating all steps in the research in detail, these can be found in the appendix and for example figure 5 and 13 give details on the steps that are done in this research. This can be repeated and will give a similar result. Further the data is cited with most care, authors are paraphrased. Further, for the data about lead times, a triangulation is used of independent literature, qualitative information as opinions of interviewees but also quantitative as lead times from administration and information systems.

3.4.2 Internal validity

“This is the question of whether the results obtained within the study are true. In other words, for internal validity there has to be confidence that causal variation among variable the study is suggesting is true.” (Bryman and Bell, 2003.)

The internal validity is high with a case study design according to De Vaus, (2001). This depends on how the research is executed, if sources are not stated correctly the internal validity can decrease. Asking questions to people who have no opinion or do not have enough information can lead to unreliable data and data that is not true. For this research an in-depth approach is used, which gives insight in possible other effects of changing lead time, therefore a more reliable causal relationship can be given. To increase internal validity, the conceptualization is done with much care, the concepts and relationships are chosen with background information from literature which stated the relationship and the need for research, as stated in chapter one. Also the operationalisation is done precisely as stated in figure 5 and 13. The research steps are made to come to an answer on the research questions and come to a final result of the research. The steps of the operationalisation will not all be included in the main report, but are stated in the appendix to check the arguments and check the validity, for example the information from the interviews are detailed in appendix 2. Here are also the small stream maps stated, where the large stream map of the chapter results is made from.

There are several factors that might influence this research in a negative way; maturation is one factor (De Vaus, 2001). Maturation can hardly be prevented, almost every researched has outdated details after new researches are executed. Another aspect is that because the situation is stated as the ‘as-is’ situation, it might be possible that if the ‘as-is’ situation is stated a few months later that this may differ due to changes in procedures, or outsourcing of several activities. The interviewees that are questioned for this research are selected based on the perceived knowledge, but others might also have given a constructive input. Other interviewees might also have given a different perception on the current situation and different results in possible problem areas. This effect is tried to be mineralized by interviewing 15 managers and specialist from different departments and different places in the hierarchy of the company (De Vaus, 2001).

3.4.3 External validity

External validity concerns the question to what extend the researcher can safely generalize the internal valid causal relationship or interference to other populations (Bryman and Bell, 2003.)

The relation between lead time and other dimensions might be generalized over other organizations, the traditional lean organizations as well as the organizations with more uncertainties like De Ruiter Seeds. Also the effect of changing lead time on the dimensions might be information that can be used for other organizations, when applying a similar research. There are some factors that may give a negative influence on the generalizability of the research. One factor is applicable, multiple treatment interference might cause a different opinion towards De Ruiter Seeds, some colleagues attended a Lean course, which might influence the thoughts about the activities and the organization (Flick, 2009).

4. Results

This chapter states the results from the empirical part of the research. This is done according the order of figure 12.

4.1 Introduction

The research questions that will be answered in this chapter are:
(4) Which uncertainties are of importance at De Ruiter Seeds?
(5) What is the current state of processes, lead time, dimensions and ability to cope with uncertainties in the case study?
(6) What are possible scenarios for different lead times and the effect on quality, service and cost in relation to the proportion value and waste?
To give answers on these research questions, the results chapter has three main themes, first is the current state of the organization that can be found in 4.2, in 4.3 the second theme is stated namely the current state of a specific process. In 4.4 the third theme is stated which includes possible future scenarios and a summary of this chapter.

The first theme is the current as is situation of De Ruiter Seeds on organization level is stated. A stream map of the department of Production and Logistics is made with the total product flow which is stated in 4.2.1. In 4.2.2 is information detailed from the interviews that are performed, in 4.2.3 corresponding lead times are stated. The current state of the dimensions is stated in 4.2.4 and current ability to cope with uncertainties is stated in paragraph 4.2.5. At last, a choice for focusing on one process is made based on the above stated information. This theme result in the answer on research question 4 and 5.

The second theme is the current state of a detailed process.
This theme has the following sub categories, in 4.3.1 is started with information on the specific process, in 4.3.2 a detailed stream map is made of the process of shipping seeds from Guatemala to the Netherlands, this includes the differentiation between processes (VA, BVA and NVA). This is followed by lead times corresponding to the stream map and showing the current state of the process regarding lead time as stated in 4.3.3.

The third theme gives an overview of six scenarios for the future which includes three scenarios with a decrease in lead time, paragraphs 4.4.1 and 4.4.2 and 4.4.3. Three scenarios represent an increase in lead time, paragraphs 4.4.4 and 4.4.5 and 4.4.6. A table is used per scenario to show the effect of these changes in lead time on the dimensions in relation to the proportion of value and waste. Also information on the possibilities for being able to cope with uncertainties in the new scenarios will be included. This will result in an answer on research question 6. At the end a small summary will be given in paragraph 4.4.7.

4.2 Current state – organizational level

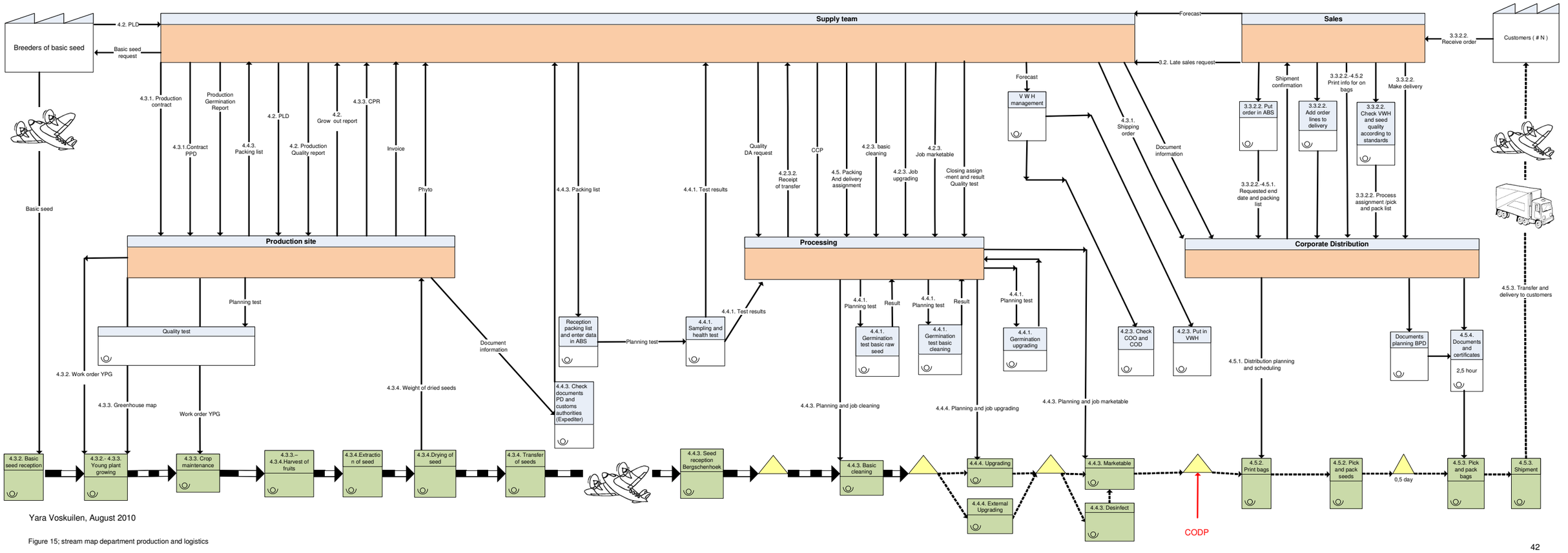
As stated in the methodology chapter, seven interviews have taken place.
In total 15 persons are interviewed about the processes corresponding to the daily work of the interviewees. These interviews gave two types of input to the research, first are opinions about waste in lead time stated and second is a consolidated stream map of the department production and logistics made.

4.2.1 Stream map

During the seven interviews, small stream maps are made. These maps are consolidated to one total stream map for De Ruiter Seeds for the commercial tomato seed varieties. This stream map is of importance because most employees know the processes in their department, but not the total process from start until the end. Also to show the relations between consecutive processes and relations between department activities. Detailed information from the interviews and the seven separate stream maps are included in appendix 2. The stream map in figure 15 starts in the right upper corner from the forecast that is based on historic data and calculations of the sales for the coming year. The stream map can be followed by starting from the right upper corner and against the clock towards the right lower corner. This is also the general direction that is used for value stream maps (Lasa et al, 2009).The top layer is mostly a flow of information and the lower layer is the product flow which is linked to the information flow. An explanation of the pictograms that are used in the stream map are given below the stream map. Abbreviations that are used to make the stream map more readable are stated below.

Abbreviations used in the stream map.

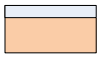
VWH:	Virtual WareHouse, here the batches are visible for sales
CCP:	Crop Capacity Planning, here is stated how many greenhouses are planned for which crops.
DA:	Determinant Assignment, tracking number for tests
COO:	Country of Origin, origin of the seeds
COD:	Country of destination, where the seeds are sold to
ABS:	Agro Business System
PD:	Plantenziektenkundige Dienst
YPG:	Young Plant Growing, this happens at the nursery part of the greenhouse
PLD:	Parental Line Description, this is a form where the characteristics of the parental lines are described
PPD:	Production Planning Document, here is stated which varieties and in which quantities are planned at a site
CPR:	Crop Progress Report, here the site states the current status of the productions with corresponding expectations on quantity
Phyto:	Phytosanitary document, which states that the seeds are declared free from diseases etc.
CODP:	Customer Order Decoupling Point

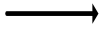


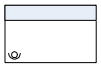
Yara Voskuilen, August 2010

Figure 15; stream map department production and logistics

Legend:


Production control

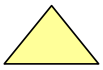

Information flow (manually and electronically)


Activities outside the product flow


Push arrow (the product is pushed into the stream, not dependent on the customer wishes)


Process box representing the product flow


Pull arrow (the product is treated with specialised processes dependent on the customer wishes)


Inventory/storage

CODP Customer order decoupling point

4.2.2 Opinions about waste in lead time

During the interviews the interviewees were questioned as stated in paragraph 3.2.2. The interviewees made a stream map of the part of the organization that was the main topic of the interview. Together with creating a stream map, the interviewees stated attention points where lead time could be decreased. All the attention points are stated in appendix 3. The main topics of the attention points are of importance because from these main topics a decision is made to zoom in on a particular process.

Main topics after interviews with managers

Looking at the attention points that are listed in appendix 3, some remarks are mentioned more than once and can be consolidated in one main topic.
The stream map is reviewed with the supply team manager, manager seed processing. Together with the researcher, there is concluded on a set of topics with possible lead time reduction options. The information from the attention points and the review are consolidated in six main topic that are an option to zoom in. The numbers below the main topic are related to the groups that are interviewed. For example, attention point 2.2. is the second comment that group 2 mentioned. The attention points related to the main topic are noted below:

1. The shipment between the production site and the processing department in Bergschenhoek has large differences in time. Especially if the seeds are transported overseas, the arrival times are uncertain and long after the first harvest at site.

    2.2. The transfer from the production location to the processing department.
    3.5. Transfer of the seeds from the production location to the processing department.
    5.5. The phytosanitary documents that are needed to ship the seeds.
    5.6. The batch size that is send to the Netherlands, linked to the document department.
    7.2. Approval for the documents and certificates (at the embassy).

2. The time between the end of a process and the start of the following process is long. There are long periods between two processes. It is worth investigating the reason of this delay.

    4.1 The batch sizes are not large enough at reception, so the batch needs to wait for blending with another batch.
    4.3 When the packing list does not arrive, the processing department is faced with unexpected batches, which takes time to include in the work schedule.
    5.1 This is the same point as 4.3, the packing list is not present which results in unexpected batches for seed processing.

3. In the processing department there are differences in standard times (mostly measured in days) and actual process times.

    4.2 Try to create a flow in the processes of seed processing, less storage etc.

4. The time between the end of the last process at the processing department and assigning to virtual warehouse is long. This can also cause delay; investigating the time needed to put batches in the virtual warehouse can be done.

    4.2 Try to create a flow in the processes of seed processing, less storage etc.
    4.3 When the packing list does not arrive, the processing department is faced with unexpected batches, which takes time to include in the work schedule.
    5.1 This is the same point as 4.3, the packing list is not present which results in unexpected batches for seed processing.

5. There are troubles with the different requested documents and certificates for commercial seeds. The countries where the customers are located have a fluctuating policy about import and export of seeds. Therefore it is difficult to give bag information to corporate distribution. The corporate distribution department can not print bags if the information is not correct. Corporate distribution must contact the sales department about the right information on the bags, which sometimes should be collected from the customer which cause a delay.

    1.1 The sales department does not include information of Country of origin (COO) and Country of Destination (COD).
    5.4 Have a better look at the COO requirements.
    6.2 Wrong information printed on bags.
    6.4 Responding to changing country requirements.
    7.3 Availability of COO and COD requirements.
    7.4 Wrong information printed on bags.

6. The submission date of the forecast is not based on the last sowing dates of the different production locations. If the last sowing date is early September and the seed request is made in October, the seeds can not be sown on that specific location. The seeds must be produced on a less preferred location or the production will be delayed until the preferred location has a possibility to sow.

1.2 The forecast are not always in time and complete.
1.3 The forecasts are too high, there is a buffer included. The other managers also include a buffer; this will increase until the end of the process.
1.4 No accurate and detailed information is used for the production decision
3.4 There are differences in time per production country, the best location is preferred.
5.3 The forecast is not optimal, these are not always accurate.

Looking at the attention points that are given, there are six important main topics to distinguish: (1) shipment production site to the Netherlands. (2) waiting time between processes, (3) difference between standard times and actual times, (4) time between last process and assign to virtual warehouse (5) difficult information flow between corporate distribution and sales and (6) difference in submission date of the forecast and last sowing dates for production. Looking at point (2), (3) and (4), these can all be combined into one topic; time between processes including standard times and actual time. These topics are of importance because from these topics one process will be chosen to zoom in upon. Not only the process that is chosen to zoom in, in this research, but also the main topics stated above are worth researching. Also, all separate attention points stated in appendix 3.

4.2.3 Lead times

After the stream map is made for the specific activities, lead times are sought of the product flow in conformity with the research steps outlined in chapter 3. The lead times are extracted from the data bases (ABS and rolling production planning) of De Ruiter Seeds, consolidation of the information gave in put to table 5. These lead times will show on a high level the amount of time that is spend. Together with the opinions about waste in the process, according to the interviewees, a decision will be made to focus on one process. The abbreviation BCL means basic cleaning which includes filtering of black seeds etc. UPGR means upgrading, where the quality of the seeds is improvement by treatments etc. MKT means that the seeds are made marketable and are visible in the virtual warehouse to be allocated to customers and that the seeds are inspected and processed so that the batch is ready to be sold.

Table 5; Lead times coherent to the stream map

Production number	Variety name	Production country	Time between sowing and harvest	Time between harvest and receiving	Time between receiving and BCL	Time between BCL and UPGR	Time between UPGR and MKT	Time between MKT and send to customer	Total lead time
61072	SHANG x HAI	NL	115	9	21	4	473	293	**915**
61728	SHA x MARK	NL	89	7	21	16	2	0	**135**
61757	TAAL x SCHAT	FR	160	6	9	206	0	102	**483**
61910	HITTE x PETIT	NL	153	4	3	4	3	359	**526**
62204	COM x FLE	NL	110	2	6	9	144	133	**404**
62371	FEEST x TAART	NL	165	7	30	168	153	10	**533**
62463	MONO x NOVA	NL	118	4	101	81	95	3	**402**
62529	BETA x LEVEL	NL	88	28	9	6	189	3	**323**
63271	TALL x STORY	FR	132	7	4	11	17	5	**176**
63272	DIRTY x STORY	FR	134	5	28	2	1	4	**174**
62738	RING x LORD	GT	140	32	67	6	99	1	**345**
63174	TALL x STORY	GT	133	27	14	30	103	39	**346**
63482	VASCO x GAMMA	IL	130	9	19	9	1	143	**311**
63114	MARCO x POLO	IL	146	11	22	60	28	148	**415**

Looking at table 5 there are 14 batches mentioned. These batches are chosen because it represents the fluctuations that will have influence on lead time; production location, production season, crop type (rootstock, cherry tomato etc) and batch size as stated in appendix 4. These fluctuations are stated together with the farm manager. This is done to give a complete overview on differences in lead times that can occur during the process. This difference also comes forward in the total lead time of the 14 batches, which have an average total lead time of 392 days, spreading between 135 days and 915 days.

One explanation of the large difference in production time (time between sowing and harvest), is that without sun the production time takes longer. SHANG x HAI has 473 days between upgrading and made marketable, this is considered waiting time. Also there are 293 days between made marketable and send to the customer. This indicates that this batch was not urgently needed and could have been produced the year after because the batch is waiting at least two year in between processes. This could indicate a large difference in forecast, which might have been decreased. Looking at SHA x MARK, this batch was needed urgently, all the lead times are low and the seeds are send the same day as it was made marketable.

Looking at the table, a distinction can be made between the lead times. The lead times belong to three types of processes. The fourth column, the time between sowing and harvest, belongs to the production process. This is a natural cycle and can hardly be influenced. The fifth column, the time between harvest and receiving belongs to the shipment process as mentioned in attention point one in paragraph 4.2.2. Column six until nine state the time between processes, as mentioned in attention points two and three in paragraph 4.2.2. The lead times belonging to the different processes fluctuate largely, although these 14 batches do not show the total overview of lead times (more than 10000 batches per year are sold) but represent the fluctuations that De Ruiter Seeds is coping with and indicates large differences in the total process lead time. Not only the lead time of one process fluctuates heavily, but all processes include large differences in lead time. The time between processes as BCL, UPGR and MKT are fluctuating in a large extend. This also depends on when the customer orders the product, otherwise the product is stored between processes until a customer orders. After the order is made, some last processes are performed as picking the seeds and finalising the order.

4.2.4 State of dimensions

It is important to state the current status of the dimensions at De Ruiter Seeds, because this is an input for the scenarios. Also in the adjusted conceptual model, stated in chapter two, uncertainties are noted. A future scenario will be made based on the current situation with a decrease or increase in lead time compared to the current dimension. Table 6 shows the current status, explained per sub dimension. For three sub dimensions, no quantitative data could be found, below table 6 the policy/strategy is explained how De Ruiter Seeds is coping with these three sub dimensions.

Table 6; Current state of dimensions

	Current state
Service	
Availability of product	Shipment takes place within one day inside Benelux and 2 days outside Benelux.
Support and complaint handling	There are 115 complaints stated, these are completed within an average lead time of 114 days with a spread of 6-289 days.
Flexibility to meet customer demands	Within in reasonable limits, depending on time/cost and effort.
Quality	
Germination of the product	The seeds are sold with a germination higher than 85%, current status is 83% on average, with a spread of 13-100. Sample size is 4333 batches and 2415 batches score above 85%, this is 55%. With lower germination an overfill is used
Purity of the product	The seeds must score above 99.8%. The average is 93,9% with a minimum of zero and maximum of 100%. 94% of the batches have a purity higher than 99.8%. The total sample size is 14302.
Health of the product	There is a zero tolerance. Sample size is 16152 batches, 1 positive on Clavibacter and is send to plant protection services and blocked from sales, other 13335 batches are clear. Some are not tested yet but also not sold. 1 positive on Pepino Mosaic Virus and send to plant protection services, 13452 are clear and some are not tested yet. 362 are tested positive on Tobacco Mosaic Virus and not sold, 12623 are clear and the others not yet tested.
Cost	
Production cost	Cherry tomato: average € 5484 with min of € 2757 and max of € 9304 per kilogram Determinant tomato: average of € 2244 with min € 1385 and max of € 3852 per kilogram Rootstock tomato: average of € 2584 with min of € 1312 and max € 4062 per kilogram Specialty tomato: average of € 3711 with min of € 505 and max of € 5466 per kilogram Standard tomato: average of € 2344 with min of € 505 and max of € 4730 per kilogram This price is calculated including seed usability percentage, surface used, labour usage and gross yield in kilogram.
Selling price	The average price of tomato seeds is € 31.496 per kilogram with a minimum of € 12.349 and maximum € 92.638 per kilogram.
Missed sales due to not fulfilling customer wishes	This is not allowed but sometimes the choice is made to not fulfil a customer's wish instead of making high costs or increase lead time of other batches etc.

Above mentioned information is based on data between August 2008 and August 2009. This is the same time period as used for searching batches for tracing lead times. More information on the dimensions is stated below.

Service

The average time it takes for complaints to be handled is rather high. Before the customer gets a final answer on the complaint it takes on average 114 days. Especially the maximum of 289 days is high, the crop is already finished before an answer comes about the source or solution of the problem. The complaints include several subjects; germination, delivery, packing, physiological, phytopathological and purity. Especially phytopathological is of importance, this is in relation to the health of the product. If the plants have a disease, this could have serious consequences regarding refunds and claims.

The availability of the product depends on where the customer is located. If this is inside the Benelux and the processing department gets the order for delivery before 12 o'clock in the afternoon, the seeds could be shipped after 3PM the same day. This is because the documents needed to ship the seeds are not complicated. Shipment to customers outside the Benelux takes 2 days because more documentation is needed, for example phytosanitary documents and import permits etc.

De Ruiter Seeds tries to be flexible in meeting customer demands. Sometimes countries have specific demands regarding packaging (aluminium foliage) and documentation like a country of origin document. On a country basis these demands are tried to be met, if a customer request a special treatment that is already possible at De Ruiter Seeds (like coating etc) than this is possible to perform. If the customer requires a different treatment that cost time and money to implement only for this customer the decision is made based on the cost for implementation and the sales order that the customer wants to place. Specialised treatments for one customer would not be beneficial if the employees have to learn a total new procedure and equipment need to be bought. So, the flexibility depends on the request and the investment. Request that can be fulfilled easily (different package etc) will be fulfilled where possible.

Quality

Looking at the germination of the product, the product is sold for the best quality with a germination higher than 85%. The spread is between 13% and 100%. 56% of the batches have a higher percentage than 85% and can be delivered according to the standards. If the seeds are slightly below 85% and further upgrading is not possible, an overfill can be used. If the seeds are performing between 65% en 85%, extra seeds are delivered. This way the customer sows more seeds, but gets the amount of plants needed. Seeds below 65% are not used for sales. These fluctuations are a quality uncertainty that De Ruiter Seeds must deal with, so a part of the products can not be sold and are worthless which increases the production costs of the other seeds.

Purity of the product indicates if the seeds are the variety that is ordered. Sometimes other seeds are mixed with the batch, than the purity will decrease. The purity should be above 99,8 percent. The average purity is 93,9%, everything below 99,8 is not sold. The seeds of that batch are sown in a grow out, here a sample of the seeds are sown and later is checked if the plants are all the same. If not, samples are taken for DNA tests to find out what went wrong and caused the impurity. From all the batches that are in the sample size, 94% has a purity higher than 99.8%.

The health of the product is extremely important. If seeds have an disease and infect a total greenhouse, the refund claims can be extremely high because a total crop year could be claimed. Not only the price of seeds can be claimed, but also the labour that the grower already used and disinfection of all greenhouse related products, including irrigation systems etc. Also the profit of the grower is damaged. Therefore there is a zero tolerance on diseases. Positive batches are blocked and sent to plant protection services. It can happen that if that batch is already transported inside the organization, a quarantine protocol must be applied. On 16152 batches there was one positive result on Clavibacter. This batch is withdrawn from further processing. There is also one positive result on Pepino Mosaic Virus, this batch got the same treatment as the positive on Clavibacter. For Tobacco Mosaic Virus 362 batches were positive. But there are some reliability issues on the test that is performed, but no risk is taken and the batch is blocked for sales and withdrawn from further processing. Seeds are not shipped without a negative test result on the above mentioned three diseases.

Cost

The production prices are of importance for the choice for a production location to produce the seeds. If the seeds have a high selling price, a better and more expensive location can be chosen, for example the Netherlands or France. The production price is based on the labour and surface that is used, gross yield in kilogram and usability. The production cost differs from € 505 for specialty and standard tomato seeds per kilogram in Mexico until € 9.304 for cherry tomato seeds per kilogram in Israel. This difference is because cherry tomatoes seeds are more difficult to produce and are more labour intensive. This difference is also because the cherry tomato seeds weigh less, so more seeds need to be produced to get one kilogram of seed.

The selling prices of tomato seeds differ. This differs per country according to the pricing level in that country and depends on the quality of the product. This is related to the germination of the seeds. Different types of tomatoes also have different prices, for example, the average kilogram price for standard or specialty tomato seeds are respectively € 26.530 and € 30.251 per kilogram. For cherry tomato seeds this is much higher, € 92.638 per kilogram. Producing cherry tomato seeds cost € 9.304 but the seeds are also sold for a higher price.

Missed sales due to not fulfilling customer wishes are actually not allowed if it could be prevented in a easy way. But if fulfilling the wishes of the customer is a large investment that is not paid by the customer, the choice can be made in favour of missed sales instead of a large investment. In the organization, there is a policy that everyone needs to try to prevent missed sales. This can be done by offering the customer something similar to its wishes. Fulfilling wishes need to be reasonable in the eyes of De Ruiter seeds, and actions should be weighed carefully and done in the best interest of the organization according to the company strategy.

4.2.5 Coping with uncertainties

For De Ruiter Seeds four uncertainties are important and of influence in the daily work process; demand-, quantity-, quality-, and natural cycle time amplification. These four uncertainties are discussed with a master scheduler, in the function of master scheduler uncertainties play a large role. The scheduler plans which varieties should be produced in which period and with a certain quantity and quality. Uncertain issues are related to research question 4 and partly related to question 5. This is also a factor that could be influenced by a change in lead time in relation with service, quality and cost and proportion of value and waste.

Looking at De Ruiter Seeds, it differs on many aspects from the standard lean manufacturing case study organizations. De Ruiter Seeds has demand amplification, quality and quantity fluctuations and differences in the natural cycle times. Because amplification means that there are large differences, a decrease in time might give unexpected effects on the dimensions and uncertainties. An example of unexpected effects on other dimensions is that the lead time is decreased during the process of treating the seeds with disinfection liquids. When no time is calculated to clean the buckets before new seeds are entered, it can cause impurity of the batch because seeds that are left in the bucket are mixed with the new batch. This action can decrease lead time, but influences the quality in such a way that this is not acceptable. The choice is made to keep the lead time to prevent more quality fluctuations and uncertainties.

It should be kept in mind when making scenarios different outcomes can be expected compared to traditional lean case studies. Below is explained how the current status is of De Ruiter Seeds regarding uncertainties and how it is currently coping with these uncertainties.

Looking at figure 16 where some uncertainties are categorized between different supply chains. A volatile market demand, the high product variety, lead time and availability belong to a agile supply chain. Also the forecast mechanism that De Ruiter Seeds uses is consultative and not algorithmic. The master scheduler of De Ruiter Seeds consults product managers for predictions of the demand for the coming 24 months. All these attributes belong to an agile supply chain and give an indication that the company specific data as uncertainties, do not fit within a lean supply chain and this should be taken in mind when researching effects of lean theories at De Ruiter Seeds. There are non lean aspects as uncertainties, which play a role in this organization

Distinguishing attributes	Lean supply chain	Agile supply chain	Leagile supply chain
Market demand	Predictable	Volatile	Volatile and unpredictable
Product variety	Low	High	Medium
Product life cycle	Long	Short	Short
Customer drivers	Cost	Lead-time and availability	Service level
Profit margin	Low	High	Moderate
Dominant costs	Physical costs	Marketability costs	Both
Stock out penalties	Long term contractual	Immediate and volatile	No place for stock out
Purchasing policy	Buy goods	Assign capacity	Vendor managed inventory
Information enrichment	Highly desirable	Obligatory	Essential
Forecast mechanism	Algorithmic	Consultative	Both/either
Typical products	Commodities	Fashion goods	Product as per customer demand
Lead time compression	Essential	Essential	Desirable
Eliminate muda	Essential	Desirable	Arbitrary
Rapid reconfiguration	Desirable	Essential	Essential
Robustness	Arbitrary	Essential	Desirable
Quality	Market qualifier	Market qualifier	Market qualifier
Cost	Market winner	Market qualifier	Market winner
Lead-time	Market qualifier	Market qualifier	Market qualifier
Service level	Market qualifier	Market winner	Market winner

Figure 16; Comparison of lean, agile and leagile supply chain. Sources: Extracted from (Agarwal et al, 2006) which included information from Naylor et al (1999), Mason-Jones (2000), Olhager (2003), Bruce et al, (2004).

Demand amplification

Looking at the type of uncertainties that occur at De Ruiter Seeds, demand amplification/volatility and forecasting over 24 months are issues that De Ruiter Seeds is coping with for several years. Looking at the cause of demand amplification at De Ruiter Seeds, if the customers do not order the product, the demand is lower than expected. In the meantime the product might be already produced based on the forecast that is done for the next 24 months. This will cause that some products are not sold or that last moment changes occur in the production and the production is cancelled. This can be half way the production cycle and half of the cost price should be paid to the suppliers. To illustrate the demand amplification, table 7 states that every year there is a new top 20 varieties with a different requested amount of kilogram. So the amount ordered in 2008 is not the same as ordered in 2009 and therefore difficult to forecast with precision. Forecasting is done with the expected sales that are stated by the product managers.

Table 7; top 20 varieties stated in kilogram and germination (normal, weak, abnormal germination)

Female	Male	2006, kilogram	2007, kilogram	2008, kilogram	2009, kilogram	2006, germ	2007, germ	2008, germ	2009, germ
BARIN	OWL				500				67-6-16
FID	LEBOW		40	62	388		79-4-9	79-7-11	77-5-15
POZNAN	KANO	48	134	141	273	61-8-13	65-5-15	68-5-15	71-5-11
POZNAN	HN33	186	51	17	240	72-5-9	73-5-13	74-5-11	60-4-21
DELI	CATE				232				79-4-9
CARNI	VORE				226				
HUMPBACK	WHALE				219				44-7-29
HAZEL	GROUSE				196				90-2-4
BLOEM	KROON	88	186	5	193	63-6-13	72-7-17	61-4-17	64-4-19
MARCO	POLO	50	97	29	189	76-5-10	77-5-13	87-3-8	78-5-12
GOUR	METTE	136	356	49	180	77-6-10	66-5-13	70-5-19	73-6-16
OOST	KAAP	178	35	166	169	76-7-13	82-5-10	79-5-13	80-5-13
RING	LORD	148	145	157	161	69-5-12	68-5-15	73-4-17	73-5-15
BULL	FIGHT				156				46-6-32
DAME	BLANCHE				155				59-8-22
COM	FLE	3	81	185	146	65-6-16	65-6-17	68-5-17	65-6-18
HOOG	VLIET				118				40-7-31
NASI	GORENG				90				88-2-5
FABRI	KANT			16	86				69-4-19
GROUND	PEL		2	21	80				85-3-7

The amount of kilograms produced on forecast differs per year extremely. For example of BLOEM x KROON 88 kilogram is produced in 2006, 186 kilogram in 2007, 5 kilogram in 2008 and 193 kilogram in 2009. This list of figures fluctuates extremely. Another issue is the sudden popularity of a variety like DELI x CATE. Suddenly 232 kilograms need to be produced in 2009. This demand uncertainty has a large influence on the organization. Looking at the germination figures, this shows three figures in a row. The first number represents the percentage of normally germinated plants. The second number shows the percentage of plants that germinated, but are weak and smaller. The third number represents the percentage of plants that germinated but are abnormal, with a strange shape of leafs or leafs that are attached to each other etc.

The cumulative of these three percentages does not always reach 100%, which indicates that the difference between the cumulative and 100% are the seeds that did not germinate at all.

Not only the kilogram per variety differ, but also the total amount of kilograms produced differ every year and this need to be calculated for the amount of surface needed in the greenhouse. In 2008 a total of 4.931 kilogram was received, in 2009 this was 8.487 kilogram as stated in table 8. These kilograms were forecasted and produced according to the forecasts based on the product manager's expectations.

Table 8; received kilogram per year

	2006	2007	2008	2009
Breeding	17	20	22	8
Production	2.504	3.500	3.739	6.658
3rd parties	514	810	1.116	1.820
total	3.036	4.329	4.931	8.487

De Ruiter Seeds is coping with these fluctuations by letting the sales managers put the forecast for the area into a database. The master scheduler checks this forecast on irregularities. The product manager checks the forecast monthly, to keep it updated. In Eastern European countries, the varieties have a long selling period. The growers do not switch easily to another variety when a new improved version is available. In USA and North-West the varieties are sold for approximately two years and after that a new variety comes in its place. It is difficult to predict when a variety is on its return and when a customer will chose for another variety. This is important, because if seeds are produced but the customer switches to another variety, the seeds will not be sold and a shortage of the new variety will occur. A decision must be made if seeds will be held on stock for security or that missed sales are accepted. The seeds for the market in USA and North West Europe, are more expensive than for Eastern European countries. For the more expensive countries, stock is allowed quicker because missed sales becomes expensive very quickly. For the less expensive countries, it is more expensive to have large stock than missed sales because the margin is low.

Quantity amplification

Because De Ruiter Seeds is working with natural products that can not be steered much, the planned quantity is mostly not the same amount as received quantity. It is possible to steer te productions by using two stems to produce or to use cuttings from the plants to increase the amount of plants and quantity. Even when the production is steered in a way, the amplifications still exist. Normally a difference between 90 and 120 percent of the planned quantity is already expected, but this can also fluctuate more due to diseases or excellent weather conditions. This also has an effect on the processing department who also has to process more kilograms than planned.

Looking at table 9, this shows the planned kilograms and the received kilograms per site. This gives an indication on the level of quantity fluctuation, if there are more or less kilograms received than planned.

Table 9; planned, and received amount in kilogram per site.

Location	Planning	Received	Amount of lotnr	Kilogram per lotnr	Received/planned %
NL	1240	1499	138	9	121
FR	2009	1957	174	12	97
IL	921	1065	82	11	115
GT	1281	1210	100	13	94
CL	801	540	27	30	67
PE	1200	1581	64	25	132

In this table, NL represents the Netherlands, FR represents France, IL means Israel, GT means Guatemala, CL represents Chile and PE represents Peru.

Looking at the quantity amplification, the site in Peru produced 146% of the planned kilograms, the site in Mexico produced 56% of the planning. These kinds of fluctuations are difficult to control due to weather conditions and level of difficulty of the variety. If the variety is susceptible to diseases or is light sensitive, a lower amount of kilograms might be harvested.

Looking at table 10, this shows the percentage of batches within the 90-120% range that is inside the comfort zone of quantity amplification. For a natural product, there is already calculated that the received amount will likely differentiate between 90-120% from the planning. This table shows that a large percentage also falls in the range of <90% and > 120%. This is a large fluctuation, and can cause extra stock >120% or missed sales <90%.

Table 10; total overview of % lot numbers per production site in certain class

Location	Batches <90% of planning	Batches 90%>120% of planning	Batches >120% of planning
NL	29%	28%	43%
FR	43%	30%	26%
IL	17%	30%	52%
GT	43%	23%	34%
CL	44%	44%	11%
PE	21%	18%	61%

To cope with the quantity fluctuations, reliable production sites are used to get the best results based on quantity. Historical data are used for the coming years. Also if a variety gives a lower yield, the yield/square meter will be lowered to give a realistic view on the planning. More time is included for the processing department to have time to use different upgrading possibilities to increase the usability. To decrease risks, most productions are planned on multiple locations. If one location is performing badly or is infected, the other location can guarantee at least a part of the forecast. At least two production cycle time periods are used to cover the forecast. Two times the production lead time is used, to ensure that not the total forecast coverage depends on one production cycle.

Quality amplification

Seeds are a natural product and the quality (germination, purity and health) will fluctuate. This is partly due to growing conditions which can not be changed. The germination fluctuates heavily and De Ruiter Seeds uses upgrading techniques to upgrade the germination, but seeds are sometimes unusable. The purity of the seeds is mostly determined at the breeder but also the precision to separate different varieties. Health is strongly linked with diseases that might occur, a batch can not be sold if a certain disease occur.

Table 11; average germination 2006 until 2009

Location	2006 average	2007 average	2008 average	2009 average
NL	77-5-10	70-5-20	75-4-14	70-5-16
FR	81-4-8	75-4-12	82-4-10	76-4-13
IL	79-5-9	78-5-12	77-5-14	75-5-15
GT	71-6-15	68-5-14	71-6-16	70-5-15
CN	66-5-12	70-5-11	78-4-9	
CL	72-7-12	73-4-12	70-5-16	79-5-11
PE			85-5-7	76-5-12

Table 11 shows that the germination differs per production country but also per year. So this is a large uncertainty that De Ruiter Seeds has to cope with. For example the average germination of the seeds from Peru decreased from 85% in 2007 to 76% in 2009 for the plants that germinated normal. The weak plants stayed the same with 5% and the abnormal plants increased from 7 to 12% from 2008 to 2009. More seeds should be produced than the requested amounts, due to the usability factor of the seeds. Seeds with a germination below 65% will not be sold.

Table 12; average germination per crop type in 2009

Location	Cherry	Determinate	Specialty	Standard
NL	82-2-11		74-4-16	74-4-14
FR	86-3-8	76-6-13	82-4-10	81-4-10
IL	78-4-13	75-5-15	75-6-16	74-5-15
GT	72-3-16	73-4-11	79-4-12	76-4-12
CL		85-4-8	77-5-13	77-4-14
PE	46-7-32	76-5-13		80-4-9

The average germination does not only depend on production location and production year but also on crop type as stated in table 12. For example, Israel (IL) is fairly stable in germination over the crop types, but Peru is producing cherry tomato seeds with a low germination, whilst the standard tomato seeds fro Peru germinate around 80%, based on the germination of normal plants.

Table 13; usability of the seeds over 2007, 2008 and 2009.

	2007				2008				2009			
Location	% raw usable	% raw almost usable	% raw not usable	% raw not known	% raw usable	% raw almost usable	% raw not usable	% raw not known	% raw usable	% raw almost usable	% raw not usable	% raw not known
NL	22	15	64	24	20	14	66	10	23	5	31	41
FR	33	10	57	15	57	14	29	14	46	7	30	18
IL	50	14	36	7	54	18	28	12	38	13	34	16
GT	27	10	63	7	25	16	59	16	36	10	49	4
CL	14	20	66	4	26	15	59	20				100
PE					78	12	9	6				100

Table 13 shows the percentage of usable seeds, this is the percentage of seeds that can be sold according to the quality standards of De Ruiter Seeds. The highest percentage of seeds that can be used are the seeds from France. Israel decrease in usability level from 54% in 2008 to 38% in 2009. The usability of the seeds from Peru and Chili are not calculated yet. Looking at the non usable seeds, than this is between 30% and 49%. These figures are high, these seeds can not be sold and are considered waste. Non usable seeds can be seeds that are empty and will not germinate or are black and can not be sold etc. This non usable seed will increase the production cost for the other seeds, the costs should be divided over a lower amount of seeds that will be sold to cover the production costs of all seeds produced.

Quality is related to quality in this case, if the quality is not good, the amount of seeds that can be sold will decrease which will lead to quantity fluctuation. For varieties that have showed that a large percentage was usable in previous years, the usability index will be changed to a lower percentage to keep the planning reliable. Productions are planned on multiple locations to spread the risk of bad quality, if the other location has good quality, than these seeds will be sold first.

Natural production cycle time amplification

The natural production cycle of seed production fluctuates this production cycle is more than four months depending on location, variety, season etc. This differs per production location (table 14), variety (table 15) and so on. A detailed planning is made by the master scheduler and seed production specialists, but due to these differences the exact delivery date at the processing department or customer can not be planned. This causes speed orders at the processing department or the product is not available for the customer in time. This will have effect on the customer's perception of De Ruiter Seeds and its reliability. Trying to influence the natural production cycle time is done using different growing systems like artificial light when the light percentage is low or growing on two stems when seeds are needed earlier. The use of these systems is not unlimited, the abilities of a plants should be taken into consideration.

Table 14; natural production cycle time per location

	2009		
Location	Average lead time	Minimum lead time	Maximum lead time
NL	250	126	361
FR	219	125	385
IL	189	138	293
GT	207	152	294
CL	232	202	268
PE	194	175	232
Total	213	125	385

Looking at table 14, this shows that there are large differences between the lead times of the different production locations. This is caused by the growing circumstances per country. During the winter it is cold in the Netherlands and France, this will increases the lead time. The lead times are also strongly dependent on the planned production time, it takes longer to produce 10 tomato clusters than 7 tomato clusters so these figures can not be compared in much detail.

The difference in natural cycle time is also dependent on the type of tomato seeds that are produced. Rootstock tomato seeds are on average produced in a longer period of time than determinant varieties. Table 15 shows the differences in lead time per crop type.

Table 15; natural production cycle time per crop type

	2009		
Crop type	Average lead time	Minimum lead time	Maximum lead time
Cherry	193	134	280
Rootstock	251	180	362
Standard	219	136	385
Specialty	209	126	382
Determinant	192	125	278
Total	213	125	385

Table 15 shows that there is a large difference between minimum and maximum lead time for standard and specialty tomato seed varieties. Cherry and determinant tomato seed varieties have a lower average lead time.

The average lead times of the production locations have a large difference of 2 months. This is already calculated in the planning. The planners have time to plan the productions, even if the lead time is longer of a specific production site. It is hard to change the production lead time and this is also not tried often. There are limited sowing windows, and before the sowing window the planning has to be ready for the site. Therefore, the master scheduler decides the amount of seeds needed before the sowing window to use the production site optimally. Sometimes when the forecast is increased, the productions are increased on the production location if possible. This increases the surface used, but more seeds are harvested.

4.2.6 Choice for one process

Looking at the attention points mentioned and the lead times stated in table 5, the following three main topics are chosen from the listed six, based on the amount of time that is expected to be wasted. Examples of lead times from table 5 are stated with the three options below. Point two is a combination of main topic two and three, which are both related to time between processes. The three points stated below are also discussed and approved during a presentation for the management team consisting of six managers of the department of production and logistics where one process is chosen from these three topics.

The precise content of the attention points can be found in appendix 3, here it has a goal to state the amount of attention points mentioned for this process.

1. *Shipment production site to the Netherlands*

It takes a considerable time for the seeds to be shipped from the production sites to the processing department in the Netherlands. This can be caused by the embassy of the country that wants to check the products, if the documents are not satisfactory etc. Seeds that are produced in Guatemala, take 32 days to arrive in the Netherlands. The seeds from France can also take 28 days to come to the Netherlands. This is a point where time is lost for an activity where no customer value is added.

This first zoom in can include the following attention points:

- 2.2
- 3.5
- 5.5
- 5.6
- 7.2

2. *Waiting time between processes, uncluding difference between standard times and actual times*

All time that is not spent on a process that creates value for a customer is considered waste. Therefore, the time between two processes is a waste of time according to Ohno, 1988.
It is worth investigating how long the seeds are waiting for a new process to start. For example, the time between receiving and BLC, between BCL and UPGR, between UPGR and MKT and between MKT and send to customer are all waiting times between processes. It can be researched, why the batch is waiting.

This second zoom in can include the following attention points:

- 4.1
- 4.2
- 4.3
- 5.1

3. *Forecast efficiency*

Submission of the forecast is not connected to the moments that the seeds need to be sown in the greenhouse. This connection can be improved, due to final decisions on production location and quantity. For example, the decision to sow should have been made in September and the final decision is made in October. At that moment the most optimal production location is not available any more. Also the choices are restricted for some low margin varieties; these can only be sown on low cost production locations. There are differences in the type of production location that is preferred; new introductions, commercial and low margin varieties have a different preferred location. So with the forecast that is linked to the sowing dates, the most preferred location becomes more often available. This point is mainly supported by the opinions of the interviewees, because this point became urgent during this research this point is already researched inside the company and will not be part of the research.

This third point can include the following attention points:

- 1.2
- 1.3
- 1.4
- 3.4
- 5.3

There are seven categories of waste areas knowing: transport, inventory, motion, waiting, overproduction, over processing and defects according (Ohno, 2002). Investigating all seven categories of waste areas inside the stream map can not be executed due to time constraints. A decision must be made to focus on one process, preferably in coherency with the list of Ohno (2002). The choice is made after giving a presentation to the management team, where together is decided which process to take. Before the presentation, the manager supply team and manager processing where presented the attention points (that belonged to the department of both managers). There is discussed which main topice to take, looking at the attention points from the interviews, the stream map, and the lead times.

4.3 Current state – process level

The three main topics; shipment production site to the Netherlands, waiting time between processes and forecast efficiency are topics that can be zoomed in upon. Due to time constraints this research will focus one topic as in line with the research steps mentioned in the methodology chapter.

A choice is made to focus on the shipments from the production sites to the Netherlands because here most of the processes are unknown. The reason little is know, is that the activities are divided over multiple countries and organizations. Waiting time between processes is a large topic if this is not split into departments or processes. Forecast efficiency became an urgent problem and is in the meanwhile researched by another employee of De Ruiter Seeds, using data of this research. The subject of shipment between production sites was partly a black box were managers guessed for reasons of delay.
It would be a challenge to research the actual situation due to international complications and interference of other companies in the process.
Looking at the lead time in figure table 16, a month should be calculated before the seeds can be expected in Bergschenhoek. This is a long time, where no customer value is added. It is also one of the seven waste categories of (Ohno, 2002). So this process will probably give opportunities to decrease lead time and show the relation between lead time, dimensions and proportion value and waste.

Because investigating all sites would take too long, there is chosen to research one site. This will be the site in Guatemala because it is the only company owned site that is also on a different continent. This might cause the most problems for the shipment, because the products need to be shipped overseas and need intercontinental documents. There is chosen for a company owned location because this location only produces for De Ruiter Seeds, and therefore possible scenarios could be implemented more easily than at third parties where De Ruiter Seeds represents 10 percent of the total productions.

4.3.1 Shipments from Guatemala to the Netherlands

De Ruiter Seeds has one location in Guatemala, based in San Pedro, Jalapa.
DHL takes care of all activities between the moment that the shipment leaves the production site until arrival in Rotterdam. These activities are out of hands from the production site in Guatemala but also out of hands from the headquarter in Bergschenhoek. The site and head office can give directions to DHL for the shipment, but DHL arranges all documentation and time schedules etc.

To visualise the process of the shipment in more detail, another stream map is made of the shipment with individual activities. This is made together with the site manager of Guatemala and the expeditor at the head office. The site manager of Guatemala provided information from the harvest and shipment, the expeditor supplied information on documents, clearance, airport handling etc. The stream map is accompanied by tables for every activity which states the cycle time, average process time, minimum lead time, maximum lead time and standard deviation as mentioned in paragraph 2.2. These lead times are based on data from:

- Information from ABS, where several date could be found about the shipments and harvest of the seeds.
- Information from the expeditor at the head office, this is the data that is retrieved from DHL, Guatemala and Bergschenhoek
- Official documentation from Guatemala Ministry of Agriculture, airway bills, Nederlandse algemene kwaliteitsdienst Tuinbouw (NAKT) inspection reports etc.
- Information from the administration that is kept on the production site in Guatemala, based on own data.

This is done because these are the most complete and reliable sources. Gaps are filled with information from the other sources that can be trusted and are not conflicting with other information. In this data there is searched for all shipments of tomato seeds from August 2008 until August 2009. There is chosen for a whole year because any seasonal fluctuations are included, also because the sample size is 1211 batches divided over 122 shipments, which would give a good representation of the lead times. There is a difference between shipments and batches. A shipment mostly contain multiple batches of seed, a batch consist of one harvest from one variety. The amount of shipments delivered is considerably lower than the amount of batches delivered. There is chosen for August 2008 and August 2009 because these are the most current data available for a year. For this research most information is used from official documents and the administration of the production sites.

4.3.2 Detailed stream map

Figure 17 is a snap shot of the large stream map of the Production and Logistic department, stated in figure 15. Here is indicated where the shipment of the seeds take place in relation to the surrounding processes. The red circle shows the area of shipment. Because this stream map is on a high level and does not show the specific activities performed for shipment to the Netherlands, a new stream map is made for the shipment which details the specific activities which is stated in figure 18. This stream map gives an overview of the activities, later in the report information will be given on what the lead times are of the separate activities and the activities will be divided into Value Adding (VA), Business Value Adding (BVA) and Non Value Adding (NVA) according to the threefold of Monden (1993) as stated in chapter 2.

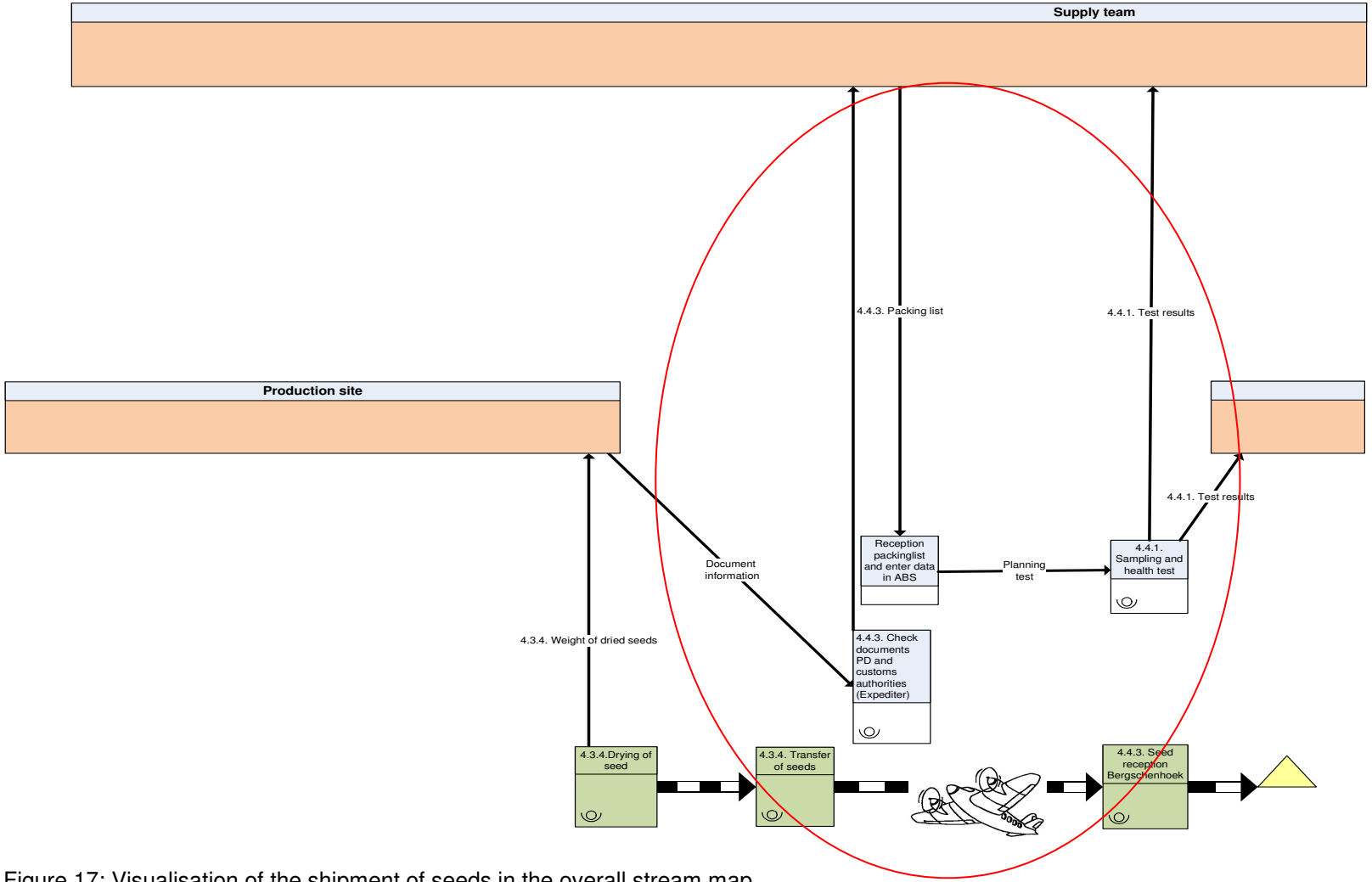


Figure 17; Visualisation of the shipment of seeds in the overall stream map

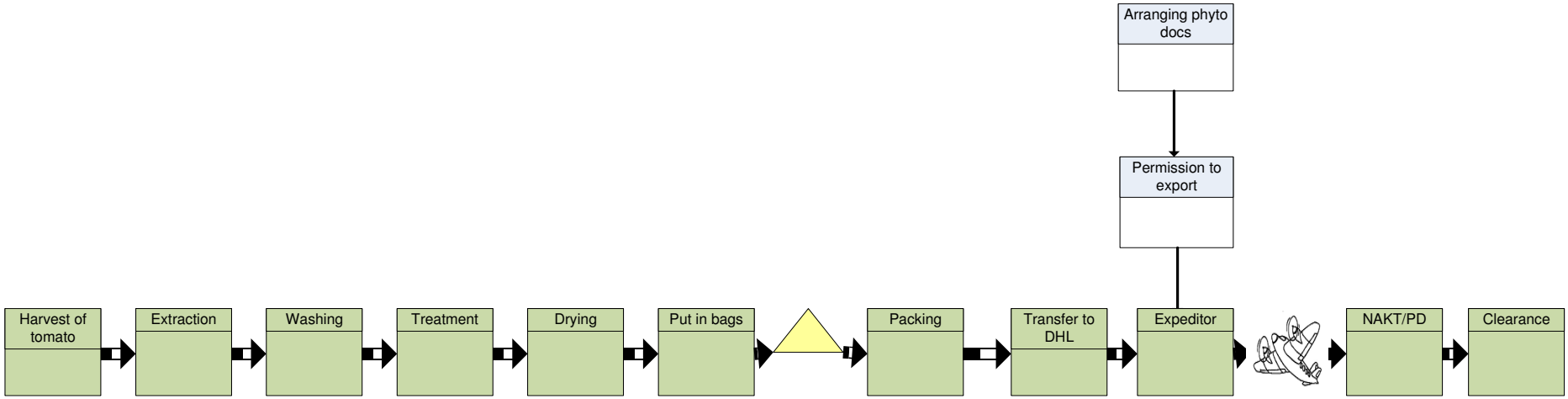


Figure 18 ; Stream map shipments from Guatemala

Figure 18 shows two types of activities. The green boxes indicate activities in the product flow, the blue/white activities are information flow. The yellow triangle indicates a storage point, the seeds are stored until DHL gives a notice that an airplane is available, a day before DHL collects the seeds, the seeds are packed. The activities in relation to the information flow are done simultaneously with activities of the product flow.

To differentiate the processes, the following questions are asked as stated in chapter 2.

1. Does the value of the product for the customer decrease when this activity is eliminated? If yes, this activity is a VA. If not, the second question should be asked.
2. Does the activity add value to the business process? Also possible: is the total flow of processes negatively affected when removing this activity? If yes, this is a BVA. If not, the third question should be asked.
3. Is it possible to eliminate this activity without loosing customer value or business value? If yes, this activity is a NVA.

The following processes are considered VA because the value would decrease/customers would not accept the product. The activities are stated with the reasons why it is considered VA:

- Harvest: The customer wants to have seeds, these should be harvested. It is not possible to deliver plants to the customers.
- Extraction: To withdraw the seeds from the tomatoes, extraction is performed. It is not possible to deliver tomatoes with seed to the customer.
- Washing: The seeds need to be washed, the customer does not accept tomato pieces in the batch.
- Treatment: The seeds are treated against diseases, the customer does not accept seeds with diseases.
- Drying: The seeds are dried, wet seed can not be transported and sold.

The following processes are considered BVA because it does not add value to the customer but are value adding for the organization. The processes would not proceed properly without these activities. The activities are stated with the reasons why it is considered BVA:

- Put in bags: This does not add value for the customer because these bags are only used for transport, but without putting the seeds in bags the seeds can not shipped.
- Packing: The seeds need to be packed in a box to prevent damage to the seeds and being able to send it, the customer does not get the seeds in this package.
- Transfer by DHL: DHL collects the boxes for transport, this does not add value to the product but without collection, the seeds are not shipped.
- Arranging phytosanitary docs: These documents are needed to transport, but the customers do not get these documents.
- Permission to export: The Ministry of Agriculture, Food and Livestock in Guatemala should give permission to send the seeds, the customers do not notice that but without permission the seeds stay in Guatemala.
- Expeditor: The expeditor at the airport arranges that the seed will be put on the airplane, no value is added to the product.
- Flight: The seeds need to be transported to the Netherlands, but this does not add value to the product.
- NAKT check: In the Netherlands, the Nederlandse algemene kwaliteitsdienst Tuinbouw (NAKT) freely translated as Dutch general quality institute for horticultural practices or Plantenziektenkundige Dienst (PD) freely translated as Institute for Plant diseases, will check the documents and the seeds before clearance. Without the check of NAKT or PD the other processes can not start.
- Clearance: After clearance by NAKT or PD the seeds can be used for further processing in Bergschenhoek. This does not add value to the product, but without clearance the seeds can not be used.

The following process is considered NVA because the process does not add value to the product or business. For the activity is stated what the reason is why it is considered NVA:

- Storage between processes (including yellow triangle): Every time the seeds are waiting until the next activity is considered NVA. This does not add value to the product, and without waiting the business are not delayed or affected.

Only one activity is considered NVA, this indicates that all the other activities are needed to satisfy customer wishes or for being able to proceed in the process and is needed to continue the business.

The activities belonging to the process of shipping seeds to the Netherlands are visualized, in the next paragraph is stated what lead times belong to the activities.

4.3.3 Lead times per activity

It is important to state lead times with the activities because this indicates what the current lead time is of the several activities and of the total process of the shipment. From this current point, future scenarios are stated. The shipment starts from the harvest and preparing the seeds for shipment until the clearance at De Ruiter Seeds where the processing process starts. To show which activities from the stream map are in relation to lead time, the list below is made:

Product flow

First harvest until last harvest of batch
Harvest activity from the stream map

Time between last harvest and picking list
Put in bags: Packing: Transfer by DHL

Time needed for completion of phytosanitary treatment
Extraction: Washing: Treatment: Drying:

Time between arrival expeditor and the flight
Expeditor as mentioned in the stream map

Flight from Guatemala to Rotterdam Airport
Flight as mentioned in the stream map

Time between arrival in Rotterdam and permission NAKT or PD
NAKT checking activity from the stream map

Time between check of NAKT or PD and clearance of the shipment
Clearance activity from the stream map

Information flow

Time spent at Ministry of Guatemala for permission to export
Arranging phytosanitary docs activity from the stream map

Time between export permission and arrival at the expeditor
Permission to export activity from the stream map

Storage; time between processes (including yellow triangle)

In table 16 are the lead times stated for the activities, here is shown: cycle time of the activity, average time of the total process, minimum lead time, maximum lead time and standard deviation. From a large data base with information on the shipments, table 16 is made but also graphs to show the deviation and spread. These graphs can be found in appendix 5 for more details on the shipments. A summary is stated in table 16 with the relevant lead times per activity.

The average process time is 20 days and this stated with every activity because this is the average time to complete the total shipment process. The minimum and maximum shows mostly exemptions of one shipment. The standard deviation shows the spread in the data compared to the average. High standard deviation shows large differences between the data and the average and visa versa for low standard deviations.

Table 16; lead times of shipment activities

Lead time/Activity	First harvest until last harvest of batch	Time between last harvest and picking list	Time needed for completion of phytosanitary treatment	Time spent at Ministry of Guatemala for permission to export	Time between export permission and arrival at the expeditor	Time between arrival expeditor and the flight	Flight from Guatemala to Rotterdam Airport	Time between arrival in Rotterdam and permission NAKT or PD	Time between check of NAKT or PD and clearance of the shipment	**Total shipment time from harvest until clearance**
Cycle time	2,6	3,5	6,5	3,1	3,2	1,1	3,9	2,8	0,9	**26**
Average process time	26	26	26	26	26	26	26	26	26	**26**
Min lead time	0	1	1	0	0	0	2	2	0	**6**
Max lead time	14	11	44	9	21	5	11	11	3	**58**
Standard deviation	3,2	2,2	5,4	1,9	3,9	1,6	1,9	1,6	0,5	**5,1**

First harvest till last harvest

The average amount of days between the earliest harvest in the shipment and the latest harvest is 2,6 days with a minimum of zero days meaning that all batches in the shipment are harvested on the same day. The maximum is 14 days, meaning two weeks between the first harvest in the shipment and the latest harvest. This is because the shipments are sent once a week and if DHL does not have space for the shipment, it has to wait at the site. Therefore shipments can be combined with two weeks of variance in harvest dates.

Time between last harvest and picking list

There are on average 3,5 days between the last harvest and making a picking list. The picking list is only made when the shipment will be collected trough DHL within short time. Therefore, the picking list will be made later due to waiting on DHL. Here it is also the case that if DHL does not have space available, the shipment will not be send and the picking list will be made later in time. The minimum is 1 day and the maximum is 11 days.

Time needed for completion of phytosanitary treatment

The picking list will be made at the same time as the phytosanitary treatment of the seeds at the production site. This treatment will also be communicated to the Ministry, for requesting phytosanity documents for transport. A treatment can be done with Hydrochloric acid 37% (HCl). In average this is done in 6,5 days, with an exemption of 44 days, all other data is below 15 days. This is because if the seeds can not be transported during that week, the treatment can also be delayed a week because the seeds need to wait anyway.

Time spent at Ministry of Guatemala for permission to export

The average time between requesting a phytosanitary document and the release by Ministry of Agriculture, Food and Livestock in Guatemala is 3,1 days with a minimum of zero day and a maximum of 9 days. This is because the Ministry receives many export requests and needs time to handle all the requests.

Time between export permission and arrival at the expeditor

Between the permission to export of Ministry of Agriculture, Food and Livestock in Guatemala and arrival at the expeditor there are on average 3,2 days, with a minimum of zero days and two exemptions above 21 days. Here there might have been a problem, documents could have been lost or not correct.

Time between arrival expeditor and the flight

The average amount of time that the expeditor needs between receiving the shipment and the actual flight is 1,1 day with a minimum of zero days and a maximum of 5 days. This is quite short, but that is due to the fact that DHL only picks up the seeds when an airplane is reserved. So the waiting time until a flight does not take place at the expeditor but at the site.

Flight from Guatemala to Rotterdam Airport

The flight from Guatemala towards Rotterdam takes on average 3,9 days with a minimum of 2 days and a maximum of 11 days. These amount of days fluctuate heavily, also here there might be problems with the documentation so that the shipment could not proceed.

Time between arrival in Rotterdam and permission of NAKT or PD

On average there are 2,8 days between the arrival in Rotterdam and the permission of NAKT to import the seeds. There is a minimum of two days and a maximum of 11 days, which could be causes by wrong documents or a problem at NAKT with the seeds.

Time between check of NAKT or PD and clearance of the shipment

There is on average 0,9 day between the release of NAKT and approval at De Ruiter Seeds to process the seeds and put them in ABS. A minimum of zero days and maximum of 3 days is counted.

Total shipment time from harvest until clearance

The total duration varies from 11 days until 35 days with an average of 20,4 days. Looking at all the minima of the separate activities, it might be concluded that the shipment can be handled in 6 days. This is not realistic because all these minima are exceptions that occurred in different shipments.

Looking at table 16 it is shown that there are fairly large differences between the minimum and maximum lead time. This indicates that the lead times differ a lot, also looking at the standard deviation. This causes uncertainties for the processing department when seeds can come in within 11 days but also after 35 days. This is difficult for human resource planning and capacity planning. Also for sales, this might cause a problem when seeds are arriving later then expected. The amount of time that is spent at the expeditor before the seeds are shipped is low, this is because the seeds are not picked up from the site when there is no airplane available. So the waiting time is not expected at the expeditor but at the production site. This is included in the time needed for the treatment, here waiting time is most likely included. The time between the check of NAKT or PD and clearance is also short, this is because NAKT or PD comes to De Ruiter Seeds to give clearance to the seeds, within one day this could be arranged if the NAKT or PD are at De Ruiter Seeds.

4.4 Future scenarios – process level

This part is largely based on the input that is gathered in paragraph 4.2 and 4.3. This part describes six possible scenarios where lead time is changed compared to the current status of De Ruiter Seeds for the shipment of tomato seeds from Guatemala to the Netherlands. Every scenario includes a table where is what effect the change in lead time has on the dimension. If there is no effect (0), decreases marginally (-), decreases in a large amount (- -), decreases in a very large amount (- - -) increases marginally (+) or increases in a large amount (++) and increases in a very large amount (- - -). These effects will be further explained underneath the corresponding table. To decrease/increase lead time in activities that belong to VA, BVA or NVA activities, it should be clear which activities belong to VA, BVA and NVA. This is stated in paragraph 4.3.2.

The six scenarios show a decrease until minimum lead times as state in the current state, a small decrease and large decrease in lead time. It includes scenarios with a small increase in lead time, large increase in lead time and increase in lead time until the maximum times stated in the current state. The effects on dimensions are stated conform the relationships in the conceptual model. For being able to state the effect in the table, the questions should be asked as stated in the methodology chapter in 3.2.7.

The six scenarios that are detailed, can be visualized in a figure that show the range of scenarios in relation to lead time. The horizontal line shows the range of the lead times that are stated in the scenarios. The current state is in the middle, this is largely and extensively expressed in the results chapter. There are three scenarios that present a decrease in lead time (scenario 1, 2 and 3). For scenario 1, the minimum lead times of the activities of the current state are used. On the right side of the current state, there are three scenarios that state an increase in lead time (scenario 4, 5 and 6). For scenario 6, the maximum lead times of the activities of the current state are used to detail the effects on the dimensions.

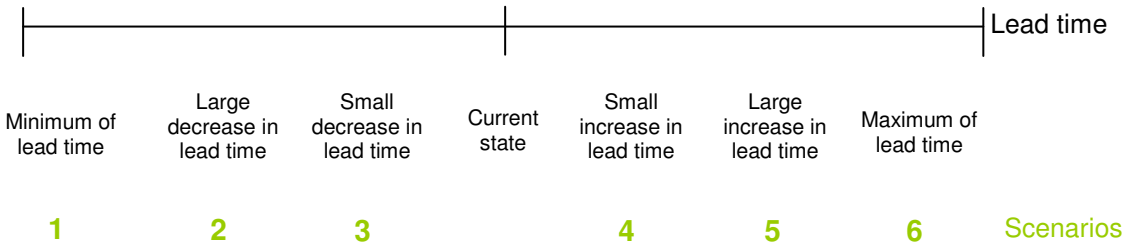


Figure 19; range of scenarios

To give a summary which activities from the stream map and lead times belong to VA, BVA and NVA activities, a consolidated table is made. Table 17 shows the activities from the stream map that belong to the lead times, and in which categories these belong. NVA activities are not mentioned in the table because NVA is considered every moment that the product needs to wait for another process. This time is included in the VA and BVA activities mentioned and can not be calculated or detailed separately.

Changing lead time might affect the status of the attention points mentioned in paragraph 4.2.2. Here the points are of the interviewees are stated where lead time could be decreased and where lead time is longer than necessary in the eyes of the interviewees. These situations might become better or worse when changing lead time compared to the current status. The attention points are stated for the current situation, so a change in the current situation might also include a change in the current status of the attention points.

The effect of a change in lead time on these attention points are stated with the most extreme scenarios, scenario 1 and 6. The other 4 scenarios, scenario 2-5 will give a similar effect but in a lower degree because these are closer to the current state than the most extreme scenarios, see figure 19. The following attention points of the shipment from the production site to the Netherlands are included:

Attention points:

1. *Overall transfer takes too long.*

The transport of the seed from production sites takes too long in the eyes of the seed production specialist. It should be possible to have it within ten days, in June the time for a batch was much longer. This causes a large delay.

2. *Seeds are waiting at production site.*

The transfer of the seeds that arrived from the production location to the processing location is not scheduled every day. Seeds with a Dutch origin are waiting a few days before transferred to the processing department. International seeds need a longer time to arrive at the processing department in the Netherlands.

3. *Phytosanitary documents are too late.*

The production sites must ensure that the phytosanitary documents are correct and in time. If the documents are too late, there will be problems with the time issue.
Also the phytosanitary documents can not be amended or manipulated in any way, it should be correct to get the seeds exported.

4. *Fluctuations in approval time for documents at Ministry.*

At the moment there are differences in time for approving documents and certificates. Some documents must be checked by the embassy of the country (South America) which can take three weeks and others do not need documents at all. This depends on the import restrictions per country.

5. *Many small batches cause longer lead time.*

It would be efficient if the production sites send one large batch with seed instead of small amounts. This saves time at the department of documents and certificates for checking documents for small batches.

At the end of scenario 1 and 6 is also explained what effect the change in lead time has on coping with uncertainties. This is done for only these two scenarios because these are most extreme and different compared to the current state. The other 4 scenarios, scenario 2-5 will give a similar effect but in a lower degree because these are closer to the current state than the most extreme scenarios.

Table 17; activities belonging to VA, BVA and NVA

		Value adding activities (VA)				Business value adding activities (BVA)				Non value adding activities (NVA)			
Lead times for activities	Activity	VA Average lead time	VA Minimum lead time	VA Maximum lead time	VA Standard deviation	BVA Average lead time	BVA Minimum lead time	BVA Maximum lead time	BVA Standard deviation	NVA Average lead time	NVA Minimum lead time	NVA Maximum lead time	NVA Standard deviation
First harvest until last harvest of batch	Harvest	2,6	0	14	3,2								
Time needed for completion of phytosanitary treatment	Extraction, drying, washing, treatment and drying	6,5	1	44	5,4								
Time between last harvest and picking list	*Put in bags, packing and transfer by DHL*					3,5	1	11	2,2				
Time spent at Ministry of Guatemala for permission to export	Phytosanitary documents					3,1	0	9	1,9				
Time between export permission and arrival at the expeditor	Permission to export					3,2	0	21	3,9				
Time between arrival expeditor and the flight	Expeditor					1,1	0	5	1,6				
Flight from Guatemala to Rotterdam Airport	Flight to Rotterdam					3,9	2	11	1,9				
Time between arrival in Rotterdam and permission NAKT or PD	NAKT Check					2,8	2	11	1,6				
Time between arrival in Rotterdam and permission NAKT or PD	Clearance					0,9	0	3	0,5				

This table 17 shows that many activities are done for continuation of the process but do not add value to the customer. Every activity has some waiting time (NVA) included. Looking at the standard deviation, fluctuations occur which indicates waiting time. NVA activities could not be quantified and are not included in the table separately but are hidden in the other activities.

4.4.1 Scenario 1; decrease until minimum of lead time

This scenario shows the effect of a decrease in lead time until the minimum lead times that are stated in table 18. Here is stated that for VA activities (0+1) there is a minimum of 1 day of lead time. For BVA activities this is (1+0+0+0+2+2+0) in total 5 days. The lead times of NVA activities are included in the VA and BVA activities, this is also mentioned below the table. The effect of decreasing the lead times until the minimum on the dimensions is stated in table 18.

Table 18; Scenario 1, decrease until minimum of lead time

	VA 1 day	**BVA 5 days**	**NVA**
Service			
Availability of product	+++	+++	+++
Support and complaint handling	0	0	0
Flexibility to meet customer demands	0	0	0
Quality			
Germination of the product	0	0	0
Purity of the product	-	-	0
Health of the product	-	-	0
Cost			
Production cost	-	-	0
Selling price	0	0	0
Missed sales due to not fulfilling customer wishes	0	0	0

Note that the amount of days that need to be counted for NVA activities are included in VA and BVA activities because these days could not be separated in such detail. Because waiting time between processes (NVA) are included in the time for VA and BVA activities, this could not be put separately in days in the column of NVA. Because the waiting time does exist, it is put separately in a column to show the effect of a decrease in lead time on the other dimensions. The column of NVA gives a qualitative effect, for example if waiting time is decreased until a minimum, the seeds are available earlier. This effect can be stated without quantifying the lead time for NVA activities.

Table 18 shows that there is an effect on the availability of the product, purity of the product, health of the product and production costs. With an extreme decrease of the lead time, it becomes clear that other dimensions are affected. The availability of the product is shorter, when the seeds have a much shorter shipping time, the seeds can be sold quicker to the customer after processing. When VA activities like harvesting, extraction etc has to be so fast that the employees are working above the normal work pace, the purity and health of the seeds come in danger. If the employees are working hard to get the seeds extracted, it can result in mistakes between varieties which influences the purity but also the health can be in danger. This is also the case with some BVA activities like putting the seeds in bags, if a mistake is made, it can influence the purity and health. If the health and purity is influenced, the amount of complaints does not necessarily rise because the process controls are high at De Ruiter Seeds, so a higher amount of batches with bad purity and germination will not be delivered to the customer because of these controls. Decreasing waiting time does not influence the health and purity of the seeds, because this is already spare time that is not needed to complete the task normally. The production cost may also be negatively affected, and become more expensive. If De Ruiter Seeds wants to decrease lead time below the normal standards, more employees might be used to work faster. This is for VA and BVA activities, because in these activities the employees have to do the same work in less time.

Decreasing waiting time does not influence the work speed of the employees, because here nothing is done with the product. The effect of decreasing lead time till a minimum might also influence the attention points that are stated in paragraph 4.4.

1. *Overall transfer takes too long.*

This attention points states that the overall transfer of the seeds takes too long, this point with not be accurate when the lead time is decreased until a minimum. This point will be solved within this scenario. When decreasing the lead time, the overall transfer will be shortened and the seeds will be earlier at the head office to be processed.

2. *Seeds are waiting at production site.*

When the lead time is decreased to a minimum, the seeds are not waiting at the production site because also the NVA activities are decreased to a minimum and therefore there will be hardly waiting time. The seeds will be processed earlier because the lead time is decreased.

3. *Phytosanitary documents are too late.*

The documents are made separately from the shipment of the seeds, these are two different processes as can be seen in figure 18. When the documents are too late, the shipment of the seeds will also be delayed. When decreasing lead time till a minimum the documents are made quicker but also the seeds are transported quicker. The connection that the seeds and the documents have to be ready at the same time still exists. So this attention point will still be present even with a very decreased lead time.

4. *Fluctuations in approval time for documents at Ministry.*

This attention point has some connections with point three, the documents can be too late if the Ministry has to check the certificates with the corresponding embassy. When decreasing the lead time as stated in this scenario, the fluctuations will not be so severe anymore and approval time will be decreased.

5. *Many small batches cause longer lead time.*

If lead time is decreased, this could have an effect that the batch size decreases. If the production site would gather two harvests (one per week) then the first harvest has to wait a week on the second harvest. If the lead time is decreased and waiting time is also decreased, smaller batches are send (one harvest). The documents for shipment need to be prepared more often, but the time needed per shipment decreases. On the other hand, the time needed for processes is prolonged because separate batches need separate processes and therefore with more batches, more time is needed to process all batches.

It is not only important to see the effect on the dimensions when decreasing/increasing lead time, but also the ability for De Ruiter Seeds to keep coping with uncertainties in the new scenario is of importance. If the effect of changing lead time on the capabilities of De Ruiter Seeds to cope with uncertainties will be negative, this can result in a decrease of the competitive advantage of De Ruiter Seeds and also the efficiency will be in danger. Therefore the effect on the uncertainties will be explained.

Demand amplification
Demand amplification is mainly important for the production of seeds, shortening the shipping of the seeds will not have influence on the customer's decision to choose another variety of seeds or even chose another supplier. Also the amount of seeds ordered will not be affected by a large decrease in lead time during transport.

Quantity amplification
A change in lead time until the minimum will not have influence on the quantity amplification, this amplification mainly takes place during production and processing of the seeds when seeds are produced and bad seeds are filtered. But the percentage that is filtered out, is directly caused by the production circumstances. The difference between planned and received amount of kilograms will also not be affected by changing lead time of the shipment. Changing the shipping time will not have influence on the amount of usable seeds or quantity that is produced.

Quality amplification
The quality amplification might change in substantial amount if the lead time is decreased until the minimum lead time. As mentioned before, the purity and health might decrease when the employees need to speed up the working pace, mistakes are made more easily. Seeds could be mixed up and if the machines are not cleaned properly after a process, seeds might transmit diseases to other varieties. If the employees have to harvest the tomatoes quickly, mistakes can be made with labelling the boxes and tomatoes might come in the wrong box etc. This can be very dangerous and is not advisable.

Natural production cycle time amplification
Natural production cycle time amplification is caused during the production of the seeds at the production site, and not during transport. Therefore a change in lead time of the transport procedure will not influence the natural production cycle time amplification.

4.4.2 Scenario 2; large decrease in lead time

This scenario shows the effect or a large decrease in lead time on the dimensions and uncertainties. It is important to see how the dimensions respond per type of activity on a large decrease in lead time. This response is stated in table 19 which shows the difference between this scenario and the current state of De Ruiter Seeds which is stated in paragraph 4.3.

Table 19; Scenario 2, large decrease in lead time

	VA	BVA	NVA
Service			
Availability of product	++	++	++
Support and complaint handling	0	0	0
Flexibility to meet customer demands	0	0	0
Quality			
Germination of the product	0	0	0
Purity of the product	0	0	0
Health of the product	0	0	0
Cost			
Production cost	0	0	0
Selling price	0	0	0
Missed sales due to not fulfilling customer wishes	0	0	0

Looking at table 19, this shows that there is only an effect on the availability of the product when decreasing lead time in a large amount in VA, BVA and NVA activities of the shipment between Guatemala and the Netherlands. The effect of decreasing lead time in a large extent is not dependent on the type of activity, decreasing lead time in all three types of activities will have a large positive effect on the availability. When time is shortened, the products can be available earlier at the customer. Looking at the effect on other dimensions, it is clear that no effect will take place when largely decreasing lead time. Support and complaint handling will not be quicker if the shipment is shorter. The quality of the product will not change when shortening the shipment procedure. The production cost, selling price and percentage missed sales will also no differ when a shorter shipment time is implemented.

4.4.3 Scenario 3; marginal decrease in lead time

This scenario is different from the current state because here the lead time will be decreased marginally. It is important to see how the dimensions respond per type of activity on a small decrease in lead time. This response is stated in table 20, which shows the difference between this scenario and the current state of De Ruiter Seeds which is stated in 4.3. of this chapter.

Table 20; Scenario 3, small decrease in lead time

	VA	BVA	NVA
Service			
Availability of product	+	+	+
Support and complaint handling	0	0	0
Flexibility to meet customer demands	0	0	0
Quality			
Germination of the product	0	0	0
Purity of the product	0	0	0
Health of the product	0	0	0
Cost			
Production cost	0	0	0
Selling price	0	0	0
Missed sales due to not fulfilling customer wishes	0	0	0

Looking at table 20, this shows that there is only an effect on the availability of the product when decreasing lead time in VA, BVA and NVA activities of the shipment between Guatemala and the Netherlands.

The effect of decreasing marginal lead time is not dependent on the type of activity, decreasing marginal lead time in all three types of activities will have a small positive effect on the availability. When time is shortened, the products can be available earlier at the customer. Looking at the effect on other dimensions, it is clear that no effect will take place when marginally decreasing lead time. Support and complaint handling will not be quicker if the shipment is shorter. The quality of the product will not change when shortening the shipment procedure. The production cost, selling price and percentage missed sales will also no differ when a shorter shipment time is implemented.

4.4.4 Scenario 4; marginal increase in lead time

This scenario shows the effect or a marginal increase in lead time on the dimensions and uncertainties. It is important to see how the dimensions respond per type of activity on a marginal increase in lead time. This is important because it could be the case that a small increase in lead time will be beneficial for the other dimensions. These benefits could be so important that a small increase in lead time is worth it. This response is stated in table 21, which shows the difference between this scenario and the current state of De Ruiter Seeds.

Table 21; Scenario 3, marginal increase in lead time

	VA	BVA	NVA
Service			
Availability of product	-	-	-
Support and complaint handling	0	0	0
Flexibility to meet customer demands	0	0	0
Quality			
Germination of the product	0	0	0
Purity of the product	0	0	0
Health of the product	0	0	0
Cost			
Production cost	0	0	0
Selling price	0	0	0
Missed sales due to not fulfilling customer wishes	0	0	0

Looking at table 21, this shows that there is only an effect on the availability of the product when increasing lead time in a small amount in VA, BVA and NVA activities of the shipment between Guatemala and the Netherlands. The effect of increasing lead time in a small extent is not dependent on the type of activity, decreasing lead time in all three types of activities will have a small positive effect on the availability. When time is prolonged, the products will be available later at the processing department and this can also be offered at a later moment to the customer. Looking at the effect on other dimensions, it is clear that no effect will take place when marginally increasing lead time. Support and complaint handling will not be longer if the shipment is longer. The quality of the product will not change when prolonging the shipment procedure. The production cost, selling price and percentage missed sales will also no differ when a longer shipment time is implemented.

4.4.5 Scenario 4; large increase in lead time

In this scenario, the current lead time will be largely increased. It is important to see how the dimensions respond per type of activity on a large increase in lead time. This response is stated in table 22 which shows the difference between this scenario and the current state of De Ruiter Seeds.

Table 22; Scenario 4, large increase in lead time

	VA	BVA	NVA
Service			
Availability of product	- -	- -	- -
Support and complaint handling	0	0	0
Flexibility to meet customer demands	0/-	0/-	0/-
Quality			
Germination of the product	0	0	0
Purity of the product	0	0	0
Health of the product	0	0	0
Cost			
Production cost	0	0	0
Selling price	0	0	0
Missed sales due to not fulfilling customer wishes	0	0	0

Looking at table 22, this shows that there is an effect on the availability of the product when largely increasing lead time in VA, BVA and NVA activities of the shipment between Guatemala and the Netherlands. The effect of increasing lead time in a large extent does not dependent on the type of activity, increase lead time in all three types of activities will have a large negative positive effect on the availability. When time is prolonged, the products will be available later at the customer. Looking at the flexibility to meet customer demands, this could be negatively affected. If the shipping time exceeds the calculated times to have the seeds ready for the customers, the seeds might be too late for the selling season due to the prolonged shipment process. If this is still on time for the selling season, the flexibility to meet the customer demands is not affected concerning delivery times. If a shipment is prolonged, there is less time left for other demands like extra treatment, this could not be done if the seeds should be rushed through processing. Looking at the effect on other dimensions, it is clear that no effect will take place when an increase in lead time takes place. Support and complaint handling will not be quicker if the shipment is shorter. The quality (germination, purity and health) of the product will not change when shortening the shipment procedure. The production cost, selling price and percentage missed sales will also no differ when a shorter shipment time is implemented.

4.4.6 Scenario 6; increase until maximum lead time

This scenario shows the effect of an increase in lead time until the maximum lead times that are stated in table 23. Here is stated that for VA activities (14+44) there is a minimum of 58 days of lead time. For BVA activities this is (11+9+21+5+11+11+3) in total 71 days. The lead times of NVA activities are included in the VA and BVA activities, this is also mentioned below the table. The effect of increasing the lead times until the maximum on the dimensions is stated in table 23.

Table 23; Scenario 6; increase until maximum lead time

	VA 58 days	**BVA 71 days**	**NVA**
Service			
Availability of product	- - -	- - -	- - -
Support and complaint handling	0	0	0
Flexibility to meet customer demands	-	-	-
Quality			
Germination of the product	0	0	0
Purity of the product	0	0	0
Health of the product	0	0	0
Cost			
Production cost	0	0	0
Selling price	0	0	0
Missed sales due to not fulfilling customer wishes	0	0	0

Note that the amount of days that need to be counted for NVA activities are included in VA and BVA activities because these days could not be separated in such detail. Because waiting time between processes (NVA) are included in the time for VA and BVA activities, this could not be put separately in days in the column of NVA. Because the waiting time does exist, it is put separately in a column to show an increase in lead time on the other dimensions. The column of NVA gives a qualitative effect, for example if waiting time is increased until a maximum, the seeds are available later. This effect can be stated without quantifying the lead time for NVA activities.

Looking at table 23, this shows that there is an effect on the availability of the product when increasing lead time in VA, BVA and NVA activities of the shipment between Guatemala and the Netherlands until the maximum. Because the shipment is very late at the processing department, the availability of the seeds is delayed in a large extent. The effect of increasing lead time in a large extent does not dependent on the type of activity, increase lead time in all three types of activities will have a large negative effect on the availability. When time is prolonged, the products will be available later at the customer. Looking at the flexibility to meet customer demands, this could be negatively affected. If the shipping time exceeds the calculated times to have the seeds ready for the customers, the seeds might be too late for the selling season due to the prolonged shipment process. If this is still on time for the selling season, the flexibility to meet the customer demands is not affected concerning delivery times. If a shipment is prolonged, there is less time left for other demands like extra treatment, this could not be done if the seeds should be rushed through processing. Looking at the effect on other dimensions, it is clear that no effect will take place when an increase in lead time takes place. Support and complaint handling will not be longer if the shipment is longer. The quality (germination, purity and health) of the product will not change when shortening the shipment procedure as long as the seeds are under control and stored properly during the waiting time.

The production cost, selling price and percentage missed sales will also not differ when a shorter shipment time is implemented.

The effect of prolonging the lead time on the attention points stated during the interviews should be noted, maybe this effect is not expected or not desirable.

1. *Overall transfer takes too long.*

The overall transfer of the seeds are considered too long in the current state, prolonging this shipment with many days will only make this worse. This is not desirable in the eyes of the interviewees, the overall time that seeds can be available should be prolonged. This attention point will be negatively affected.

2. *Seeds are waiting at production site.*

When the lead time is increased to a maximum, the time that the seeds are waiting at the production site will also increase. This is not favorable for the process, as mentioned during the interviews. The whole process of seed production and processing is delayed and prolonged.

3. *Phytosanitary documents are too late.*

If the maximum lead time is used for the shipment, the phytosanitary documents can also easily been made in that time frame and will most likely not be too late. Also because the maximum time needed for the phytosanitary documents is 9 days, getting the seeds at the expeditor takes more days so these documents will most likely not be too late. The roles might be changed, and the seeds might be too late and the document has to wait until the seeds arrive at the expeditor. So this attention point will not occur that often anymore.

4. *Fluctuations in approval time for documents at Ministry.*

This attention point has some connections with point three, the documents can be too late if the Ministry of Agriculture has to check the certificates with the corresponding embassy. When the lead time is increased until the maximum, the fluctuations will probably also more. If the spread is higher between the lead times, the standard deviation will increase and fluctuations will become more severe.

5. *Many small batches cause longer lead time.*

If lead time is increased, this could have an effect that size of the batches will increase too. If the production site would gather more than two harvests (one per week), then the first harvest has to wait a week on the second harvest. So here the time is maximal and more batches a send together. The processing department can blend all these batches until one large batch that takes less time than three small batches. The seeds have to wait at the production site, so here there is a choice between letting the seeds wait at the production site to create a larger batch or send small batches so that the seeds do not have to wait, but the processing department has more batches to process. The documents have to be created less often, this is an advantage. There is a risk that when the total production is send in two shipments, if one shipment is hold back by customs, the seeds might not be in time for the customers. Sending for example six batches and one gets stuck at customs, there are 5 batches that can be used for the customers.

When lead time is changed to a maximum, this might also give an unexpected effect on the uncertainties that De Ruiter Seeds is coping with. This increase in lead time might have an effect on the following uncertainties:

Demand amplification
Demand amplification is mainly important for the production of seeds, prolonging the shipping of the seeds until the maximum lead times will not have influence on the customer's decision to choose another variety of seeds or even chose another supplier. Also the amount of seeds ordered will not be affected by a change in lead time during transport.

Quantity amplification
An increase in lead time until the maximum lead times will not have influence on the quantity amplification, this amplification mainly takes place during production and processing of the seeds when for example black seeds are filtered out. But the percentage that is filtered out, is directly caused by the production circumstances. The difference between planned and received amount of kilograms will also not be affected by changing lead time of the shipment. Changing the shipping time will not have influence on the amount of usable seeds or quantity that is produced.

Quality amplification
The quality amplification will most likely not change when the lead time is increased until the maximum. If the seeds have to wait, the seeds are stored in a controlled environment like in a safe on the site etc. Here, the quality of the seeds will not change.

Natural production cycle time amplification
Natural production cycle time amplification is caused during the production of the seeds at the production site, and not during transport. Therefore a change in lead time of the transport procedure will not influence the natural production cycle time amplification from sowing until harvest.

4.4.7 Summary
Looking at the results from this research, the following research questions can be answered:

(4) Which uncertainties are of importance at De Ruiter Seeds?
The following uncertainties are of importance, as described in paragraph 4.2.5.: demand-, quantity-, quality-, and natural cycle time amplification.

(5) What is the current state of processes, lead time, dimensions and ability to cope with uncertainties in the case study?

The current state of the shipment processes is detailed in figure 18. This shows the process from the moment that the fruits are harvested until the clearance at De Ruiter Seeds, which is the last activity before the processing takes place.

The state of the lead time is detailed in table 16 here is stated what the average, minimum, maximum and standard deviation is of every activity. The total average lead time of the shipment process is 26 days.

The current state of the dimensions is stated in table 6, three dimensions could not be quantified and the policy for this dimension is stated.

Also for the ability to cope with uncertainties is detailed in paragraph 4.2.5 here is detailed that De Ruiter Seeds already found ways to cope with uncertainties. These uncertainties are on a company level.

(6) What are possible scenarios for different lead times and the effect on quality, service and cost in relation to the proportion value and waste?

There are six possible scenarios for De Ruiter Seeds, a decrease until the minimum lead times, a large decrease in lead time, a small decrease in lead time, a small increase in lead time, a large increase in lead time and a increase until the maximum lead times, to show the effect on dimensions. For scenario two until five, there was only an effect on the availability of the seeds. The other dimensions were not affected by a change in lead time. The ability to cope with uncertainties was also not affected. Because these uncertainties were not caused in the process of shipment of the seeds to the Netherlands. For scenario 1, there was also an effect on availability, purity, health and production costs. Availability was influenced positively. Purity, health and production costs are influenced negatively. The attention points where influenced. The overall transfer time would decrease, which was perceived as too long. The seeds would not wait too long at the site, so this attention point would also not be so severe. The phytosanitary documents could still be too late and the seeds might still need to wait for the documents. Fluctuations in approval time will not be so severe anymore because the lead time decreased and therefore also the spread and standard deviation. More small batches will be send to prevent harvests to wait for another harvest to be combined in a shipment. So the size of the batches will be small, but this will also cost the processing department more time to complete multiple small batches than one large batch. Only one uncertainty is negatively affected by a decrease in lead time until the minimum, this is quality uncertainties. When lead time is decreased, the employees have less time to double check the varieties and clean the machines etc, which could result in mixing the varieties which results in purity and health problems. For scenario 6, the availability and flexibility to meet customer demands are influenced negatively. The interviewees mentioned that the seeds are waiting at the production site, this will also be prolonged when increasing lead time, so this is not favorable. If there is enough time to prepare phytosanitary documents, these will be most likely not too late anymore. When lead time is increased until the maximum, the batches will be combined and will be larger, therefore the processing department only needs to process one batch instead of multiple. For this scenario, the amplifications do not differ compared to the current stated and are not affected by increasing the lead time until the maximum.

In this results chapter, at least the following five subjects are considered to be valuable to this research.

1. A stream map is made of the total product flow of the tomato seeds. This give an overview that can be used in the total organization for procedure building and as a start for other lean initiative to visualize the processes involved. This stream map was not present at the organization and not many employees know the total product flow with relating information flow of the total process.
2. The total shipment procedure of the seeds from Guatemala to the Netherlands was a black box, even for the supply team managers. To state a stream map with the exact activities and its lead times gives a clear view on this procedure.
3. De Ruiter Seeds does not state how it is performing currently on the dimensions. These dimensions are stated by De Ruiter Seeds as important for the customer and business. It is not researched how the organization is performing on these dimensions and not stated together in relation to lead time.
4. The method described in the methodology chapter was actually very successful for attaining the information needed to complete the research. The methodology fitted well by this problem statement and deliverables. This was a good guidance for stating the results chapter.
5. The six different scenarios show different effects on the dimensions. Scenario 1 gives positive effects on some of the dimensions, gives a positive effect on the attention points but gives a negative effect on quantity amplification. Scenario 6 gives negative effects on some of the dimensions, negative and positive influences on the attention points and no effects on the uncertainties. Four scenarios, two until five, are presenting the scenarios between the extreme and the current state.

In figure 20, a final adjusted conceptual model is stated. This includes the information from the results chapter, only information is added to the box with uncertainties. This figure shows the complete conceptual model that is used for this research.

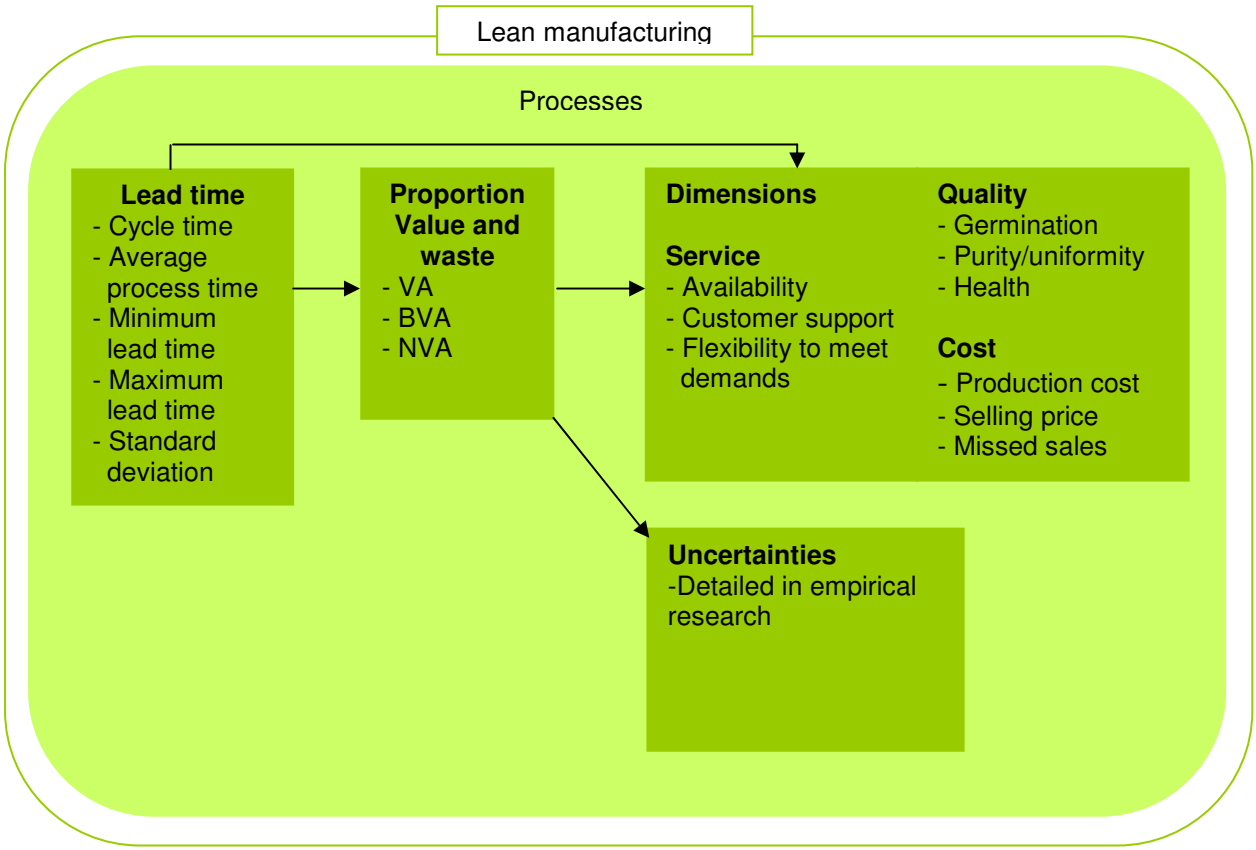


Figure 20, adjusted conceptual model

5. Conclusion

In this chapter the final conclusions will be given. In paragraph 5.1 the conclusion concerning the research objective and relevance is given and in 5.2 the answer on the research questions are stated. Paragraph 5.3 includes the discussion and paragraph 5.4 recommendations and paragraph 5.5 includes further research both scientifically and practically oriented.

5.1 Research objective

The research objective as stated in chapter one is as follows:

> To give scenarios of different lead times and the influence on service, quality and cost (dimensions of competition) in relation to value and waste proportions and the ability to cope with uncertainties
>
> By
>
> making an analysis of the current processes of planning, production, processing and distribution at De Ruiter Seeds and give an overview of lead times, current state of service, quality and cost but also the ability to cope with uncertainties.

In this objective, several deliverables were mentioned. Six scenarios are stated in the results chapter which represent different lead time including the influence on service, quality and cost in relation to value and waste proportions. The analysis of this current state gave a large input in stating the different scenarios, because insight was gained on the relationship between lead time, dimensions and the proportion value and waste. Also the effect on the ability to cope with uncertainties is stated for the two most extreme scenarios.

This research has significant relevance on a scientific and practical basis as described in chapter one, here a reflection is stated on the preliminary expected relevances.

Scientific

The scientific relevance of this research can be described as follows:

1. Lean manufacturing is focused on different industries like automobile industry, computer industry, radar detector industry etc. Application of lean manufacturing at De Ruiter Seeds will gave information that lean manufacturing can also be effective in industries that are not similar to the previously investigated sectors.

Lean manufacturing can be applied in an organization, which does not have a non standardised process flow. Most information on lean manufacturing is based on case studies in standardised process flows, for being able to apply lean manufacturing successfully in a different organization, the irregularities of an organization should be included. Looking at the example of De Ruiter Seeds, general information on lead time, value and waste and areas where waste could be hidden is used. To ensure a company specific research, the aspects that are not addressed to in lean manufacturing, for example company specific uncertainties and dimensions, could be included by the researcher as done in this research. General lean manufacturing information and company specific information together can ensure a successful implementation of lean manufacturing.

2. This research will reflect on what influence lead time has on service, quality and cost in relation to value and waste proportion and if the ability to cope with uncertainties is affected.

There are six different scenarios presented in the results chapter, all with different effects of changing lead time on dimensions and the ability to cope with uncertainties. In scenario two until five the dimensions are not affected with the exception of the availability of the seeds. For the first scenario, multiple dimensions are affected and the ability to cope with uncertainties as well. Here the quality amplification will most likely be negatively influenced. For the sixth scenario, also multiple dimensions are affected but not the ability to cope with uncertainties because there is plenty of time to execute the processes properly.

After this research, the following scientific relevance should be added.

3. This research shows important aspects of the methodology used for detailing the current state of an organization; stream map including lead times, current state of dimensions which are of importance for the organization and current abilities to cope with uncertainties in the sector.

In other case studies regarding lean manufacturing, a similar methodology can be used as in this research. This methodology ensured that a detailed current state could be presented, for another organization, this could be repeated using company specific details for that organization. The uncertainties that were relevant in this case, will most likely not be relevant for organizations in different sectors.

Practical

The practical relevance of this research can be described as follows:

1. This research has given the influence of changing lead time on the service, quality and cost at De Ruiter Seeds.

In this research, six scenarios are given. These scenarios show an effect on the availability of the seeds when lead time is changed. When De Ruiter Seeds wants to decrease lead time, it will be beneficial for the availability of the seeds but the quality might come in danger.

2. De Ruiter Seeds can use the scenarios made in this research for further development regarding lead time compression or lean manufacturing.

Looking at the three scenarios where lead time is decreased, De Ruiter Seeds can start a lean manufacturing project to detail ways of decreasing lead time in the shipment process. It gives De Ruiter Seeds insight in the options that are possible for the future.

Now the results of this research are known, the following practical relevance should be added.

3. De Ruiter Seeds can use the information from the current state to proceed with continuous improvement actions and projects. For example, attention points mentioned during the interviews can be researched in small group activities to improve the related activities. The current state of the dimensions could be improved by a research project where improvement actions are stated and executed.

During the research, the stream map was requested by the strategic manager for initiating lean and improvement projects. Input of this stream map was set as an example to detail other processes for improvement options. The stream map is also used when clients get a tour through the organization, for a better understanding of the processes. Further, SAP is implemented in De Ruiter Seeds, this stream map is used to detail where in the organization specific SAP programs are needed and to give an overview to the SAP specialists.

5.2 Research questions

To come to an answer on the below mentioned problem statement, the research was divided into six research questions.

What is the influence of changing lead time on service, quality and cost in relation to the proportion value and waste and the ability to cope with uncertainties, in the processes of De Ruiter Seeds?

The conclusion for each of the research questions is stated below.

Question 1: *What elements can be distinguished to analyze lead time?*
Lead time is divided in five different elements: (1) cycle time, (2) average process time, (3) minimum lead time, (4) maximum lead time and (5) standard deviation. These five lead times are used in the results chapter to give an impression of the lead times per activity of the shipment of seeds from Guatemala to the Netherlands. These five elements were sufficient to detail the specific time related data and give an indication of the spread between data and the uncertainties and fluctuations that are included. If there are no uncertainties or uncertainties are covered, less fluctuation could be expected. The standard deviation shows clearly many fluctuations.

Question 2: *What elements can be distinguished to analyze and evaluate processes?*
To analyze and evaluate processes, except from lead times and proportion value and waste (research question 1 and 3), information is searched on important dimensions for De Ruiter Seeds. The dimensions are split into service (availability of the product, support and complaint handling, flexibility to meet customer demands), quality (germination, purity and health of the product) and cost (production cost, selling price and missed sales due to not fulfilling customer wishes). These sub dimensions are company specific and the dimensions of service, quality and cost are based on (Noori and Radford, 1995) and (Porter 1980, 1985) but also (Slack, 2007) and (Johansson et al, 1993).

Question 3: *What elements can be distinguished to describe the proportion value and waste?*
The typologies of processes (VA, BVA and NVA) are used to describe the proportion of value and waste as. First, literature was found on the proportion value and waste, but after a more thorough search, a threefold was found (Monden, 1993) which fitted the research better and than the differentiation between value and waste by (Womack and Jones, 1990). This because BVA is something that certainly exists, also looking at the amount of activities from the shipping process that falls under BVA. If these BVA activities should be divided between VA and NVA (to comply with the statements of Womack and Jones, 1990) it would not give a fair view on the categorization of these activities.

Question 4; *Which uncertainties are of importance at De Ruiter Seeds?*
The uncertainties, literature on these concepts are too general to use in this research. Therefore, company specific information is retrieved during interviews and searching in databases of the company. The uncertainties are as follows: demand-, quantity-, quality- and natural production cycle time amplification. These four are influencing the day to day working days at De Ruiter Seeds most.

Question 5: *What is the current state of processes, lead time, dimensions and ability to cope with uncertainties in the case study?*
The current state of De Ruiter Seeds is stated in large detail and with many examples in the result chapter. There are four main aspects; stream map, lead times, dimensions, and the ability to cope with uncertainties.

Stream map

There are two stream maps made, one of the total product flow of the seeds including information from different departments that are related to the product flow. This stream map shows the relations between processes and departments. The average lead time of the 14 batches is 392 days with a minimum of 135 and a maximum of 915 days. This already indicated that there are uncertainties causing this spread. Stream mapping proved to be a valuable tool to visualize the process and the relations with other departments. For the shipment process, this visualized the process and therefore it was easier to communicate about lead times with the interviewees. It also cleared the fact that this process was perceived as a black box.

Dimensions

The current state of the dimensions (service, quality and cost) is stated in table 7.
The dimensions are applicable to the situation of De Ruiter Seeds, all dimensions are of importance for the competitive advantage compared to competitors. These data together gives a good impression of how De Ruiter Seeds is currently performing on dimensions that are of importance for the customer. For three sub dimensions; availability of the product, flexibility to meet customer demands and missed sales due to not fulfilling customer wishes, no quantitative information could be found. Here only the policy is stated, this is a pity because quantitative information gives a better indication on the performances on these sub dimensions. It would be an option for De Ruiter Seeds to state the data of these sub dimensions for a complete overview of the current state of the most important dimensions for the organization.

Uncertainties

Demand amplification is one uncertainty that De Ruiter Seeds has to cope with. The amount that is demanded changes also every year and can go up and down and almost no pattern can be detected. Quantity amplification is also an uncertainty that De Ruiter Seeds has to face. In a standard lean production organization, it is one-in-one-out. Here one kilogram can be planned but mostly a different amount is received.

Another uncertainty that is present at De Ruiter Seeds is quality amplification. Quality is determined by several aspects, examples are given of germination and usability.
The last uncertainty is natural cycle time amplification. This amplification is hard to decrease or even eliminate. The seeds have a natural cycle which can be slightly modified by using technical equipment as artificial lights etc. Because these amplifications are natural, De Ruiter Seeds includes that in the decision where to plan a production but also see it as part of the product that can not be steered.

The differentiation between these four uncertainties was a clear one and no overlap was present. These four uncertainties are uncertainties with the largest influence on the processes of De Ruiter Seeds and therefore this company specific information fulfilled the goal of detailing an organization’s ability to keep coping with uncertainties for specific scenarios.

Question 5: *What are possible scenarios for different lead times and the effect on quality, service and cost in relation to the proportion value and waste?*
The scenarios show always an effect on the availability of the seeds, is a strong or less strong degree. Many sub dimensions are not affected. The six scenarios show different future options, and positive and negative effects are stated. The low amount of sub dimensions affected by a change in lead time could be expected looking at the type of process that is taken to zoom in upon. The lead time of this process has no relation with the most sub dimensions; complaint handling, germination etc. Therefore no relation could be expected. A different process, where the lead time does affect multiple dimensions, e.g. production process, would have given more effects in the scenarios. The goal of this research is not to search for a process that will lead to the largest effects on dimensions but to search for a process which has the best options to decrease lead time. The results from applying the methodology used in this research and the triangulation of sources indicated that the process of shipping seed to the Netherlands was the best process to research. The fact that there are not many sub dimensions influenced is a result of this research.

The answer to question 5 also gives an answer to the problem statement: The influence of changing lead time in the shipment process from Guatemala to the Netherlands has an influence on the availability (service) in relation to the proportion value and waste. Also the health, purity and flexibility to meet customer demands will be affected. The other dimensions are not affected. The ability to cope with quantity uncertainties is only affected with a very large decrease in lead time. The other uncertainties are not affected.

5.3 Discussion

In a research there is always room for discussion, when designing a research in a proposal, the precise path of the research can not always be stated. Some ideas may not be effective or contributing and other methods may be used. Therefore the points of discussion are mentioned in this chapter in order of appearance.

Literature

Most literature on Lean manufacturing is general or based on a case study. These case studies are mostly performed at mass production organizations and organizations with almost no uncertainties regarding the product quality, quantity and production time. Literature on these uncertainties could not be found in, therefore internal data is used. This is company specific and therefore also detailed, but it fitted the research in the best possible way. This is also the case for the specific dimensions that are of importance for De Ruiter Seeds. Service, quality and cost are found in general literature, but to specify these dimensions there was a need of internal data for being able to use it in this case study. Because no literature could be found, there is no general view from scientific literature included in these concepts.

Methodology

In the methodology chapter many issues are discussed on operationalisation, case study design, validity etc. For this research non standardized research methods are used, and these do not necessarily mean to be repeatable. Triangulation is used to ensure reliability, but in this research the repeatability is almost not possible. Another researcher would probably choose different interviewees, different examples of uncertainties and different tables etc. Even if it would choose the same interviewees, the opinion of the interviewees on the matter might have changed and procedures might have changed and therefore the stream map might be made differently. Also the as-is situation will mature, next year the uncertainties will be different and the lead times will also change per year. That is why it is called as-is situation, measured on that certain moment.

Choice for process

The choice for one process was made by using a triangulation of literature where most waste in lead time could be detected (Ohno, 2002), attention points of the interviewees where most time is waste, lead times per batch and the experience of the managers who indicated that the shipment process is a black box and time could be saved because here almost no value is added. Looking at the scenarios, not all dimensions are affected with a change in lead time. This is because the shipment process does not include the dimensions mentioned and the uncertainties are not caused during the shipment process. A different process, like the production process of the seeds, would have given more effect on the dimensions and uncertainties. Health, purity and germination are determined in this process. Also the uncertainty in quantity, quality and cycle time are determined in this process, this would have given more effects in the scenarios. On the other side, this is not a process where a lot of lead time could be reduced, because of the natural cycle time, and this process was also not indicated in the interview as the best option.

Data from shipments

There are different sources used for data about the shipments from Guatemala towards the Netherlands. Two sources were perceived as reliable, knowing; data from official documents and from the administration in Guatemala. The data from the official documents are stated as most reliable and the data from the administration is used to detail some activities and fill the gaps were needed. There might be mistakes in typing the information from the official documents and administration in Guatemala by hand in an excel document, but for this research it is unavoidable that there were some mistakes made when using a sample size of 1211 batches.

VA, BVA and NVA separation

In chapter 4 the activities belonging to the shipment from Guatemala towards the Netherlands are separated and categorised as VA, BVA and NVA. This is done according to a list of questions. It might be possible that customers do not agree with this categorisation, but it was no option to interview random customers if the categorisation was correct in the eyes of the customer. There are many different customers (cost-focused, quality-focused, brand-focused, variety-focused etc) and because of time limits this could not be checked by the customers. The effect of changing lead time in these activities on the dimensions would not change when activities would shift from one category to another, so the result of the research is not influenced by not checking the categories with the customers.

5.4 Recommendations

In this chapter recommendations are point wise given which are related to the total research and options for further research are given. First recommendations are given.

Stream map

The stream map is made specifically for the commercial tomato seed varieties. This stream may be adapted for non commercial tomato seed varieties and also for other crop seeds like cucumber or sweet pepper. This could give valuable information, although most parts of the stream map can be generalized to other crops. It would be wise to check the stream map after every major change in the organization relating to the information or product flow stated in the map, this way the stream map stays up to date and a valuable source for lean initiatives.

Small group activities

During the interviews many attention points are stated, see appendix 3. These attention points could be researched in small group activities to ensure that also on an activity level the lead time can be decreases. Cumulative marginal decreases can also result in a large decrease in the total process.

Shipment from Guatemala towards the Netherlands

During the interview with the site manager of Guatemala and the expeditor, and during processing the document information it came forward that some points could be changed to make the process more fluent, which is also stated in scenario one and six:

1. *Overall transfer takes too long.*

The transport of the seed from production sites takes to long in the eyes of the seed production specialist. It should be possible to have within ten days, in June the time for a batch was around seven weeks. This causes a large delay.

2. *Seeds are waiting at production site.*

The transfer of the seeds that arrived from the production location to the processing location is not scheduled every day.

Seeds with a Dutch origin are waiting a few days before transferred to the processing department. International seeds need a longer time to arrive at the processing department in the Netherlands.

3. *Phytosanitary documents are too late.*

The production sites must ensure that the phytosanitary documents are correct and in time. If the documents are too late, there will be problems with the time issue.
Also the phytosanitary documents can not be amended or manipulated in any way, it should be correct to get the seeds exported.

4. *Fluctuations in approval time for documents at Ministry.*

At the moment there are differences in time for approving documents and certificates. Some documents must be checked by the embassy of the country (South America) which can take three weeks and others do not need documents at all. This depends on the import restrictions per country.

5. *Many small batches cause longer lead time.*

It would be efficient if the production sites send one large batch with seed instead of small amounts. This saves time at the department of documents and certificates for checking documents for small batches.

A recommendation should be made that it is worthwhile to check the above mentioned points to achieve improvements, not only with using a new scenario which includes a change in lead time.

Conversation with DHL

DHL arranges documents and availability of the airplane for the seeds. From the moment that the seeds leave the production site until that the seeds arrive in Bergschenhoek the seeds are undervision of DHL. On average 11, days of the average 26 days of the total shipment is under supervision of DHL. It would be wise to have a meeting where agreements are made on the maximum duration of that process, this to stimulate DHL to decrease the lead times.

Decrease in lead time in other processes

As mentioned in the report a decision is made for the shipment between Guatemala and the Netherlands. This is one of the many processes performed at De Ruiter Seeds. It would be wise to research more processes on the ability to decrease lead time. One example is waiting time between processes, this was one of the three main topics mentioned in the results chapter. In literature, waiting time is considered waste (Ohno, 2002) and should be eliminated. Other processes could also be researched if lead time could be decreased.

Dimensions
Looking at the current state of the dimensions mentioned in table 7 there are some dimensions that have a current state that could be improved. An example is support and complaint handling. On average this takes 114 days, which is long. Although the maximum lead time of 289 days is something to research. If it takes almost 10 months to find out what went wrong in the process, the cause of this long lead time should be researched. It can indicate that the tracking and tracing of the batches is not sufficient or that administration is not clear etc. Complaints should be taken seriously, the customer could choose for another supplier and complaints can result in a damaged brand name and law suits.

Coping with uncertainties
De Ruiter Seeds is already coping with uncertainties for a long time because it is part of the business. Many tools are used, like monthly updates of the forecast, producing seeds on multiple locations and upgrading possibilities for a low germination.
There are no recommendations, due to the large experience of the employees working with uncertainties and many possibilities are already implemented.

Scenarios
Looking at the scenarios that are stated in the results chapter, this shows always an effect on the availability of the seed. Some other dimensions are also affected; purity, health and flexibility to meet customer demands. There is a risk in more quality amplification when lead time is decreased until a minimum. These scenarios give an overview on the effects of changing lead time and are made with the input of the current state.

5.5 Further research
Further research can be done in various fields and directions. These remarks are split into further research in the direction of scientific research and practical research. The remarks for practical research are strongly linked with the recommendations made, here further research is also indirectly stated.

Scientific research
This research gives an example of the relation between changing lead time and dimensions that are of importance for this case. In this case, there were some effects, but more effects could be expected when using a different process. This could lead to larger effects between lead time and dimensions. It would be an idea to perform more researches on this relation, to get a broader view on this matter.

This research is performed on multiple dimensions with relating sub dimensions. For a more in-depth research in this relation and effects, a research could be performed on the relation between changing lead time on one specific dimensions, more detailed information could be searched. This to gain a more thorough understanding of the relationship.

It might be an option to perform a comparative study where this method is used for multiple organizations with the same dimensions, the sub dimensions will differ. This way a comparison can be made between different organizations and this can lead to a better generalizability.

It is possible to do further research on how to decrease lead time in the process of shipment of seeds and compare it to the current situation as stated in this research. This can function as a pre test and post test, before and after implementing lead time reduction strategies (De Vaus, 2001).

Because there was no information available on uncertainties within lean manufacturing organization, it would be an option to perform a theory based research. Here information can be sought on how organizations cope with uncertainties and which strategy fits best with the lean manufacturing philosophy.

Practical research

There are options for further research in a practical way that can be an option for De Ruiter Seeds to focus on.

The following aspects could be further researched:

- A similar research could be performed for other crop seeds that are sold by De Ruiter Seeds, for example; cucumber, pepper etc.
- A research could be performed what the best options are to decrease lead time in the shipment from Guatemala to the Netherlands. This is a follow up on this research, to actually decrease lead time in the process.
- This research could be performed again from the moment that a choice was made for one process, in the new research a different process could be used to see if a change in lead time will be more beneficial to other dimensions as well. An example would be the complaint handling process, because the current state shows a long lead time before the complaint is completed.
- All the attention points that are mentioned could be researched and improved via a small group activity. This will be beneficial for the organization and way of working.

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Interviews with: process specialist, project manager, two seed production specialists, two master schedulers, two inventory planners, team leader seed processing, shipping document employee, team leader documents and planning, sales unit manager, region manager medium, sales assistant North West Europe, plant planner and team leader corporate distribution.

Appendix 1: Supply chain of De Ruiter Seeds

The following figure shows the supply chain where De Ruiter Seeds is operating in:

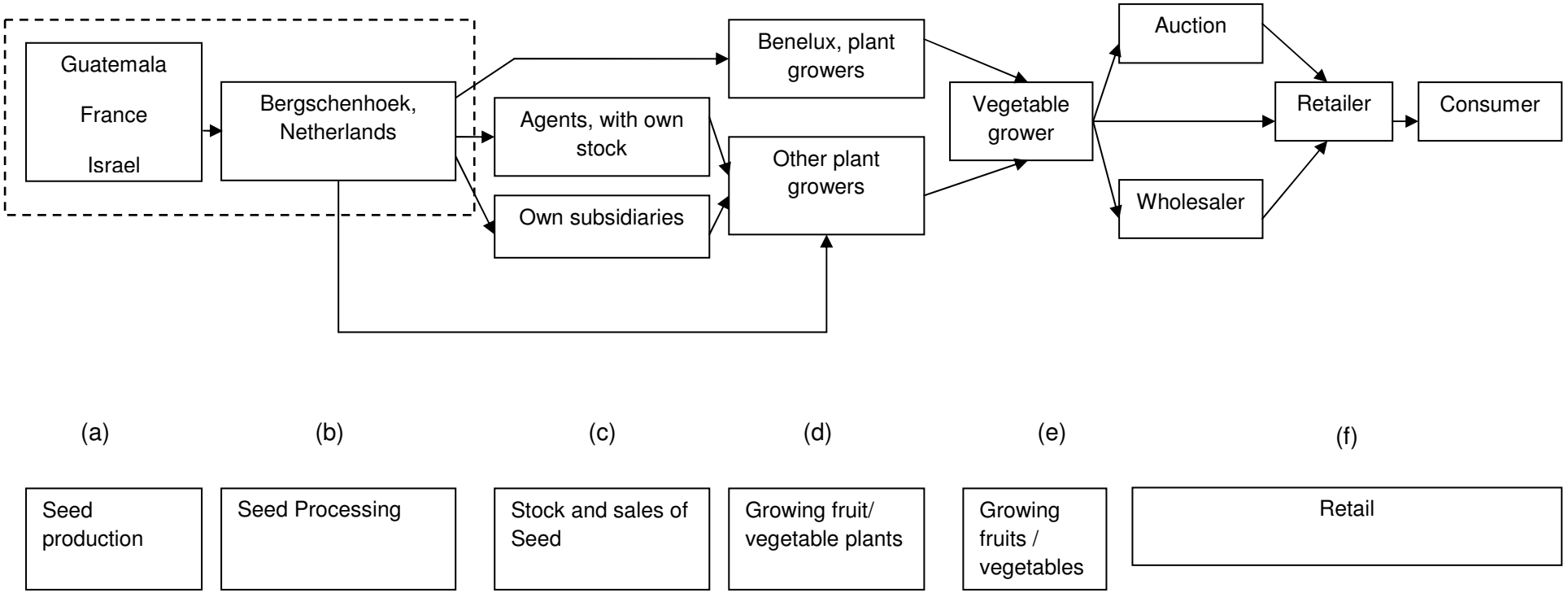


Figure 1a; supply chain of De Ruiter Seeds

The main production sites / plants that are shown in the figure are owned and managed by De Ruiter Seeds. Guatemala, France and Israel are company owned production locations. All the seeds are send to Bergschenhoek were the head office is located.

From the processing and distribution department, the seeds are transported to agents which have stock or owned subsidiaries, also plant growers inside and outside the Benelux can order seeds directly from the head office. The plant growers, grow small plants until around 40-50 cm and sell the plants to vegetable growers who grow the fruits. The tomatoes are sold to the auction or wholesales, which sells it to the retailer. At the end the consumer will buy the tomatoes for consumption.

Appendix 2: Interviews

Below are the results of seven interviews stated. This includes information about the functions of the interviewees, type of process, attention points and a stream map that the interviewees made during the interview. These separate stream maps will be consolidated to one large stream map and can be found in chapter 3.

1. Forecast to demand

In this interview two master schedulers participated, each with different tasks:

Master scheduler:
This master scheduler ensures that the production planning will be made. The scheduler informs the sales department about the shortage of the seeds. Also the availability of the seeds is the responsibility of the scheduler, same as the returned seeds from processing.

Master scheduler:
This master scheduler monitors the supply and demand. Too much deviation is not wanted. The master scheduler is also responsible for the middle long and long term stock levels. There is a buffer but no safety stock level. Looking at the forecast, production space is allocated to ensure capacity.

Introduction

In forecast to demand the following process can be determined:

- Master scheduling

The main focus of forecast to demand is that the forecast is translated to demand on a high level, to ensure that the departments know what is roughly expected for the coming period concerning seed. This is done to plan manpower and capacity of the machines.

During the interview several processes were checked and the following points were mentioned:

The forecast to demand starts with an evaluation, consolidation and amendment of the forecast. This is done under the supervision of the marketing and sales unit; this is also an activity in the information system. The marketing and sales department has a time frame of 20 days per month that the forecast can be changed, after the 20 days there is a time-out of 10 days for the planners to include the latest changes in the planning. This requires quick thinking of the planners because production locations need to be informed for changes in the plans.

The rolling supply planning is updated and varieties are selected which do not have enough stock for the coming 24 months. This has a monthly planning cycle, which is changed and amended when needed. A rolling supply planning includes country of origin and destination information, the forecasts, and targets for the coming 24 months. Also the stock levels are included with information about the germination test of the stock and the status of the stock. Some seeds are basic cleaned, others are already upgraded. Information about expected arrival of seed is also included.

In a meeting the rolling supply plan and the variance is discussed and a decision for actions is made. This rolling supply plan is sometimes not up to date, which should be prevented.

A crop processing plan is made for 24 months of sales, although this is separate from master scheduling. This is linked with processing department.

A monthly variance report is made; this can be used as a document for other departments to get information on variety, short term planning etc. Especially the master scheduler and the inventory planner are involved.

The master schedulers mention that the top-20 of the varieties should be grown in house to manage the seed production in a better way. The other seeds can be grown at third parties.

There are many last moment changes that should be included in the planning, a forecast can increase with 100% within days. This must be communicated as soon as possible to start the production. This saves time, because the other parts of the chain are informed and can adjust the scheduling.

Attention points

- The marketing and sales department does not include the information of country of origin and country of destination in the delivery that is made. Sometimes the seeds can not be used due to country restrictions.
- The forecasts are not always on time or not complete. From some countries like Spain it is unknown what the expected sales will be, this has a negative influence on the planning. It takes time to check the forecast and to call the sales department, to receive a correct forecast. In the meanwhile the planners can not make planning schedules.
- Some forecasts are too high; the sales department includes a buffer to ensure sales. The buffer grows when the process continues; also know as the Bullwhip effect. If every part in the process includes a buffer, the buffer will grow enormously until the end of the process.
- The decision moments to produce should include more detailed information and should be more accurate. This will increase the efficiency and also the correctness of the planning.

The activities of the master scheduler are mainly within the supply team and are translated by the seed production specialist into contracts etc. Therefore these activities will not be made visible in the value stream map.

2. Demand to production order

Two persons participated in this interview:

Two seed production specialists:
The seed production managers are the link between the forecast and the actual production. The forecast is translated in information for the production locations about the amount of seed that is needed and the quality that is required. The planning is based on historical data from the site, some sites delivery better quality then others, also the greenhouse conditions vary. The production sites are also supported by the seed production specialist via advice about the plants and growing conditions. The specialists ensure that the seeds from the production sites are in time for processing also in the right quality and quantity.

Introduction

In processing according to plan the following process can be determined:

- Rolling production planning

The main focus of demand to production order is to ensure that the forecast is translated in actual production data. This concerns location preference, quality requirements and needed quantity of the seed within a particular time frame.

During the interview several processes were checked with the Integration DEFinition (IDEF)s and the following points were mentioned:

In the rolling production planning a translation of a production decisions made from the Rolling Supply Plan into a production plan. Here a decision is made for a certain amount of seeds that is requested for the forecast, with an end date that the seeds should be ready. So the seed production specialist has a planning file with variety, quantity and end date.

A production plan is made or updated. To make a production plan different information sources are used. Historical data about the production, location and quantity is used but also germination data and quality data. Information should be available about the capacity of the locations and if the timing is right to start sowing on that particular location.

The production contract is checked with the site and, if there is enough capacity, approved. The production includes the sowing date, the first and last harvest, square meters that are needed for the crop and comments of the site about the production.

The data is entered in ABS and a request is made for basic seed that the breeders will send. Also a request is made for a Parental lines Description. If the PLD is not complete the production site will fill it in according to the crop that is growing in the greenhouse.

There is a check on quality specifications and basic seed is prepared for shipment to production site. The seed production specialist has knowledge and experience from previous years, like the quality that every site produces etc. This is checked with the quality specifications.

Transportation of the basic seed is organised. Shipping documents are optional for outside the European Union. The documents include information as the quantity of the seeds and the location where is should be transported to. The seed production specialist takes care of the sending assignment, bureau documents and planning ensures that the other requirements are take care of.

Registration of deviations on planning including the latest yield estimates takes place and crop progress information is noted. The seeds are produced on the location. The location sends once a month a CPR where deviations are registered, the seed production specialist can make a decision about the contract. If the expected quantity is lower then forecasted, the specialist might decide to adjust the contract and increase the square meters or start sowing on a different location. This is to ensure that the quantity of the forecast is reached.

The quality data per production site is monthly send. This is to inform the specialist about the germination and other quality factors.

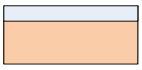
The consolidation and analysis of production data takes place yearly. The report gives information about the seed production; this will be used as historic data for the coming years. Also a feedback is given to the breeder is the purity is not correct, if there are unexpected seeds in the batch.

Attention points

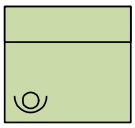
The following points were mentioned to improve and possibly speed up the process.

- The parental line description is not always present. The seed production specialist should call and email before it is send to the seed production specialist. It is also not complete; details are missing about the parental lines like a description of the variety.
- The transport of the seed from Mexico takes to long in the eyes of the seed production specialist. It should be possible to have within ten days, in June the time for a batch was around seven weeks. This causes a large delay.
- The seed production specialist mentions that there are many activities that not belong to the function tasks, for example calling the breeder about the parental lines description etc. This will lead to less efficiency concerning job activities.

Explanation of the figure below:


Production control


Information flow (manually and electronically)


Process box representing the product flow

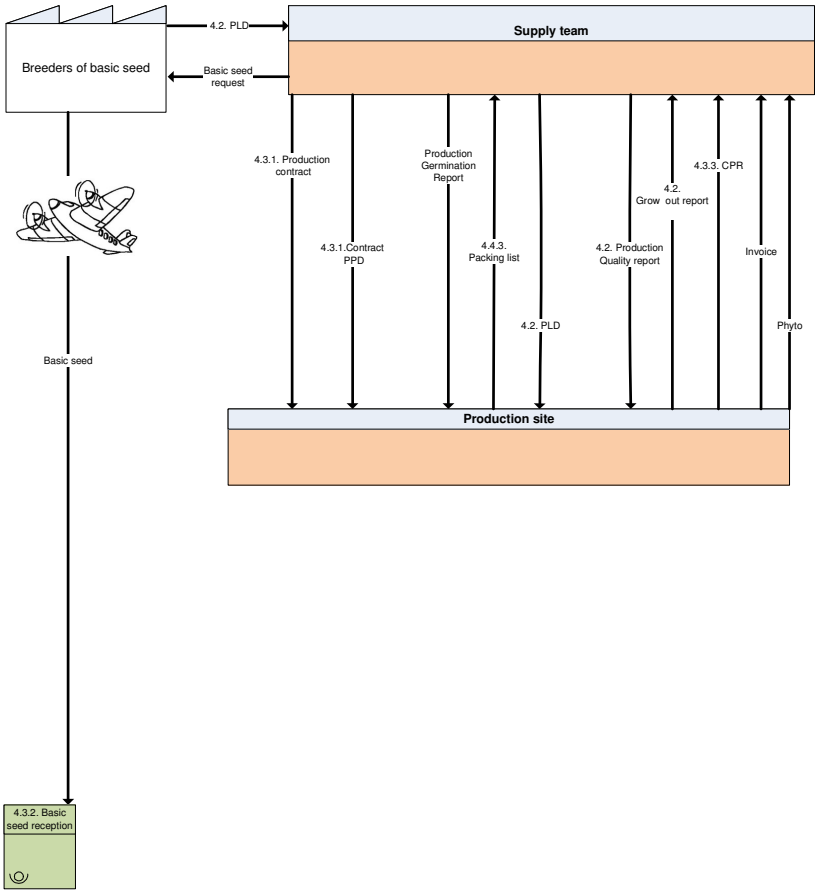


Figure 2a; stream map of demand to production order

3. Produce according to plan

For this interview two persons participated:

Project manager / strategic manager:
The project manager is responsible for the implementation of the strategy inside the firm. For example: implementation of lean manufacturing within De Ruiter Seeds. Also trying to create a platform of people who are willing to invest time for implementation and brainstorm for new ideas.

Process specialist / farm manager:
The process specialist is responsible for all operations that belong to the production of seeds.

Introduction

In processing according to plan the following six processes can be determined:

- Capacity management
- Young plant growing
- Seed production
- Extraction and drying
- Seed shipment (foreign production locations)
- Crop management

The main focus of producing according to plan is to produce large quantities of seed that are sold to customers. The product has different phases from basic seed to small plants. From small plants to large crops with fruits that include seed. After extraction the final product is seed for the market.
In these processes is quality testing like germination tests an important aspect, the time issue of quality testing is included in the research.

During the interview several processes were checked with the IDEFs and the following points were mentioned:

Capacity management
The evaluation of the last cropping and knowledge about the macro planning is shared with the supply team and especially with the seed production specialist.

After the evaluation an agreement is reached on the production contract e.g. amount of hectares planted with a specific variety. The detail planning is reviewed and approved; this includes a document with production planning details (PPD) which includes kilograms of seeds and rows in the greenhouse of a specific variety.

The contract planning is made, consolidated analysis and follow up of production contracts. Simultaneously product trails are set up to research the possibilities of improving the growing circumstances like water, temperature and other greenhouse conditions. The procedure is reviewed at the end of the process.

Young plant growing
For the process of young plant growing a work order is made which includes details about sowing dates etc. After the work order a verification of the parental seed / hybrid seed must be made. This to ensure that the right seeds are sown.

Task assignments are made and handed to the employee who performs the sowing. Before the sowing the materials are prepared. The sowing is done in the greenhouse, germination is checked a couple of days later. The germination results are send to the Seed Production Specialist.

The small plants are checked for unusable plants and the good plants are transplanted. After the plants are transplanted, plant treatment, like watering and fertilisation, takes place. If the plants are the right size, about 30 centimeters, a final check is performed to report inconsistencies.

The plants are picked and prepared for transport to the right location. This is where the crop growing takes place. After transport a process analysis is performed.

Seed production
The young plants are transported to the greenhouse were the plants are planted according to the greenhouse map, which is made to plan the different varieties in different compartments. A task assignment is made before the physical planting in the greenhouse.

After planting, the crop is maintained for several weeks, according to the variety and amount of seeds that need to be harvested. Crop maintenance includes watering, fertilisation and so on. Crop management is adjusted where needed.

The crop is evaluated and the decision to start emasculation and pollination is made. A task assignment for these activities is made.
The flowers on the female are emasculated. The parental line purity is checked via a parental lines description (PLD). This includes what type of fruit will be harvested and what the characteristics are, this to check the correctness of the variety. A check is performed on selfings which are vegetative parts of the plant that are not propagated via pollination.
The pollen are collected from the male, there is an option to store the pollen for later use. The pollen are prepared and distributed to the correct female plant, which is pollinated. After the pollination the yield is estimated and the decision to finish the pollination is made. The process is analysed and measured.

After the last pollination the plants are topped. If the plants get the first fruits, the first harvest is planned. Harvesting takes place when the fruits are ripe enough to extract the seeds. The fruits are transported to the extraction location.
A planning is made to clean the greenhouse after the last harvest.

Extraction and drying
A task assignment is made for the extraction and drying of the seeds. Label number and lot management includes separating the varieties of seeds and ensure that a notation is made of the label and lot where the seeds are coming from. This is important because if the seeds become totally anonymously it becomes worthless. Without any information about variety or row number, the seeds can not be traced and variety can not be recognised from raw seed.

The seeds are extracted from the fruits. An acid treatment is performed to clean the seed from possible diseases. After this the seeds are dried and put in bags. Weighing of the seeds takes place because there are differences in the weight of seeds what might lead to a wrong impression of quantities harvested.

There is temporary storage of seeds on the location until the seeds are shipped to the processing area in the Netherlands where all the seeds are processed. The data of extraction and drying are evaluated.

Transport for the seeds is arranged, the documents should be included for transport. The document requirements differ per country, inside the European Union no documents are needed, outside the European Union the document requirements are frequently changing and more tests are needed.

At the end a confirmation is made to the processing department and the supply team that the seeds are shipped from production location to processing location.

Crop management
Crop management takes place at the same time as crop maintenance. The climate of the greenhouse is checked and adjusted where needed. The climate computers are used as measure for the growth circumstances.

Phytosanitary management is an activity that is performed after the seeds are shipped and are not related with the lead time of the seeds. It includes implementation of preventive phytosanitary measures, company clothes and crop protection.

Attention points

- Regularly the Parental Lines Description (PLD) is not present. So the production manager has no information about the variety, shape and germination of the seeds. The breeders of basic seeds should include a PLD, this takes time and regularly this is not included in the sending. During the seed production the production manager should check the plants and note specific information like variety and expected germination. This takes time, but it does not delay the lead time because this is performed simultaneously with the crop maintenance.
- Regularly the basic seeds are not ready in time. This give a delay in the process from production because the sowing starts later then planned.
- An advantage of tomato seed production is that is possible to break off the seed production if the harvested quantity is between 90%-120% of the demanded quantity. Therefore overproduction that exceeds this criterion should not be necessary.
- There are differences in production time per country. Seed can not produced as quick in the winter as it does in the summer, especially in the South of Europe and Mediterranean countries. This increases the lead time of production. Although it is possible to sow earlier if extra light is used in the greenhouse. This can lead to an early harvest.
- The transfer of the seeds from the production location to the processing location is not scheduled every day. Seeds with a Dutch origin are waiting a few days before transferred to the processing department. International seeds need a longer time to arrive at the processing department in the Netherlands.

Explanation of the figure below:

Production control

Information flow (manually and electronically)

Activities outside the product flow

Push arrow (the product is pushed into the stream, not dependent on the customer wishes)

Process box representing the product flow

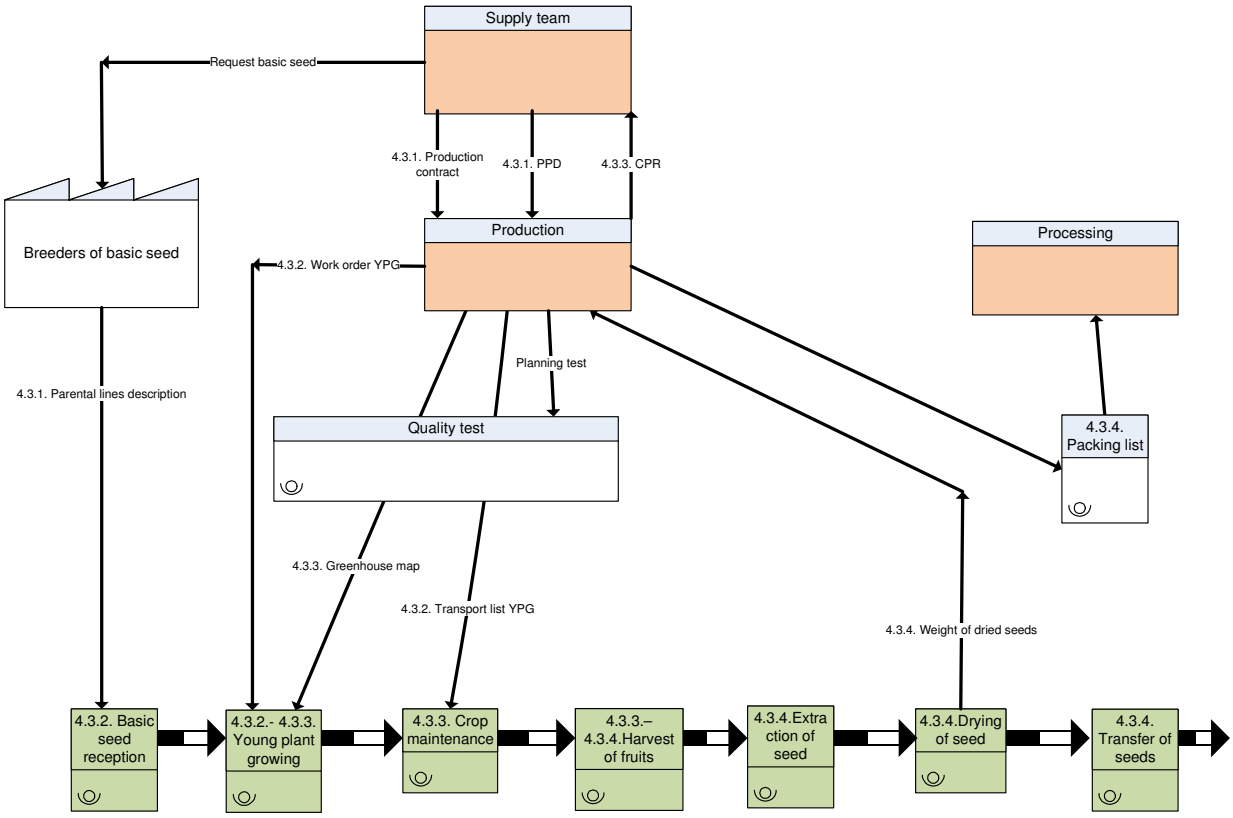


Figure 3a; stream map of produce according to plan

4. Processing according to plan

Three persons participated in this interview:

Inventory planner:
The inventory planner at De Ruiter Seeds takes care of the digital transfer of the seeds from production sites to the processing department. Planning the demand of seeds for the coming season, according to the forecast of the sales department, is part of the job of the master schedulers. It is monitored that quality checks are performed for every batch. The inventory planner ensures that the batch gets a basic cleaning, if necessary upgrading and is made marketable (ready for sales) and put in the virtual warehouse where it is available for the sales department to allocate seeds to a customer order. Iinitiate seed destruction is also included.

Team leader seed processing:
The team leader seed processing is responsible for the processes that are taking place with and after the reception of raw seed at the entrance until the seeds are stocked for sales. Quality tests are done under the supervision of the team leader quality testing.
The team leader delivers input to the plant planner to check capacity of machines and manpower. Also seed sample management is taken care of.

Plant planner seed processing:
The plant planner seed processing interacts with the supply teams and sales department about the end date of the jobs. This is the latest moment that the seeds should be available to sell. Also scheduling of the processes are responsibility of the plant planner seed processing according capacity of machines and manpower.

Introduction

In processing according to plan the following four processes can be determined:

- Rolling logistic planning
- Plant planning, scheduling and follow up
- Seed reception and cleaning
- Seed upgrading

The main focus of processing according to plan is to treat the raw seeds that come from the production location i.e. blending, polishing, heat-treatment, cleaning and priming. It is important that the seeds are available for shipment to the customers in time with all quality tests.
In these processes is quality testing like germination tests an important aspect, the time issue of quality testing is included in the research.

During the interview several processes were checked with the Integration DEFinition (IDEF) and the following points were mentioned:

Rolling logistic planning
Rolling logistic planning is a tool to start with the processing of seeds. Most activities are used as information. There is started with checking the seeds, these are not always blocked in ABS. If the seeds are blocked, these need to be unblocked to be usable in the system.

A crop processing plan is made which is based on 24 months of sales. This plan is made simultaneously with the other activities. Here a prognosis is made of the need for capacity of manpower and machines in discussion with the team leader of seed processing and the supply team.

The rolling supply plan is checked with the consolidated crop process plan, inventory status, overview and variance report. This will give information to trigger jobs in the seed production process.
The comparison of quality of the seeds in stock and needed stock levels also results in jobs. The current stock is compared with the needed stock, a job includes the processing of seed that are needed to increase stock.

With the comparison of the results of processing jobs to the forecast in ABS, the inventory planners initiate jobs if the forecast levels are not met. This activity is ongoing. The processing of seeds is regularly checked with the forecast. This is done to see if the forecast demands are met and if not, supply team takes action e.g. initiating and planning a new production.

The batch is allocated to the virtual warehouse were the sales department can see what type of seeds came in and in which quantities. From here sales can use the batches to meet the orders.

The inventory planner is informed about the incoming seeds via a packing list that is send from the production location.

Tracking and tracing of the shipment is done by the expediter and will contact the inventory planner about incoming shipments and receivings.

The inventory planner enters the data about the incoming seeds in ABS so that this can be used by the seed processing employee to receive the seeds physically.

After a check and registration of the incoming shipment and documents, the seeds are physically received.

Plant planning, scheduling and follow up
There were no comments on the IDEF procedures, only remarks for improvement. These are listed underneath attention points.

First the processing plan is updated and consolidated. Possible future capacity problems are checked and discussed with the team leader seed processing, manager seed processing and the supply team. Actions are defined and the processing plan is finalised.
The request for seeds is checked with the capacity and planning of the processing department. The request for seeds is converted into assignments. These assignments are scheduled, followed up and controlled.

Seed reception and cleaning
There were no comments on the IDEF procedures.

For the seed reception and cleaning the following activities are defined and approved:
First task assignments are made for the reception and cleaning. The materials including seeds are picked. The machine parameters for the process are defined. After that the resources are set up to perform the processing activities. After processing the product is visually checked and put on location. The status of the seeds is changed in ABS to cleaned seeds. The physical storage of seeds is managed.

Seed upgrading
There were no comments on the IDEF procedures belonging to seed upgrading, so the process is as follows:

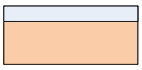
For the seed upgrading a task assignment is made which leads to picking the materials that are needed for the upgrading. This includes the seeds that are needed. The materials are picked and the machine parameters are defined. Sources are set up and after the process the product is visually checked. After the check the seeds are put on location and the status is changed in ABS to upgraded seeds.

Attention points

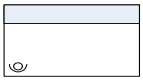
The following points were mentioned to improve and possibly speed up the process.

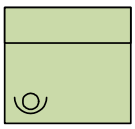
1. Tomato seeds regularly are holded back at the seed reception because the batch is not large enough to test. Therefore waiting time is approximately two weeks for another harvest to combine two batches of the seeds and take one sample of the combined batch. Taking two tests is more expensive then one, due to extra costs the batch is enlarged with a batch of another harvest.
2. Basic cleaning of the seed is a standard procedure for every batch of seeds. After basic cleaning the seeds are stored. This is worth investigating to see if more processes could be in a flow. To decrease the points in the process that seeds are stored.
3. The packing list which should be send from the production sites is sometimes not present. The packing list gives information about the kilograms of seeds, variety of the seeds and other seed specific information. At the moment, it is not clear what amount and at which date is delivered. Processing is then faced with unexpected batch sizes. If this is known in advance, the processing department can plan the workload.
4. Looking at the necessity of every step in the process is essential. Some steps only take ten minutes but because the employees are busy with multiple tasks it might take a day before the step is done and the process can continue.

Explanation of the figure below:

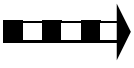
 Production control

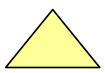
 Information flow (manually and electronically)

 Activities outside the product flow

 Process box representing the product flow

 Pull arrow (the product is treated with specialised processes dependent on customer wishes)

 Push arrow (the product is pushed into the stream, not dependent on customer wishes)

 Inventory/storage

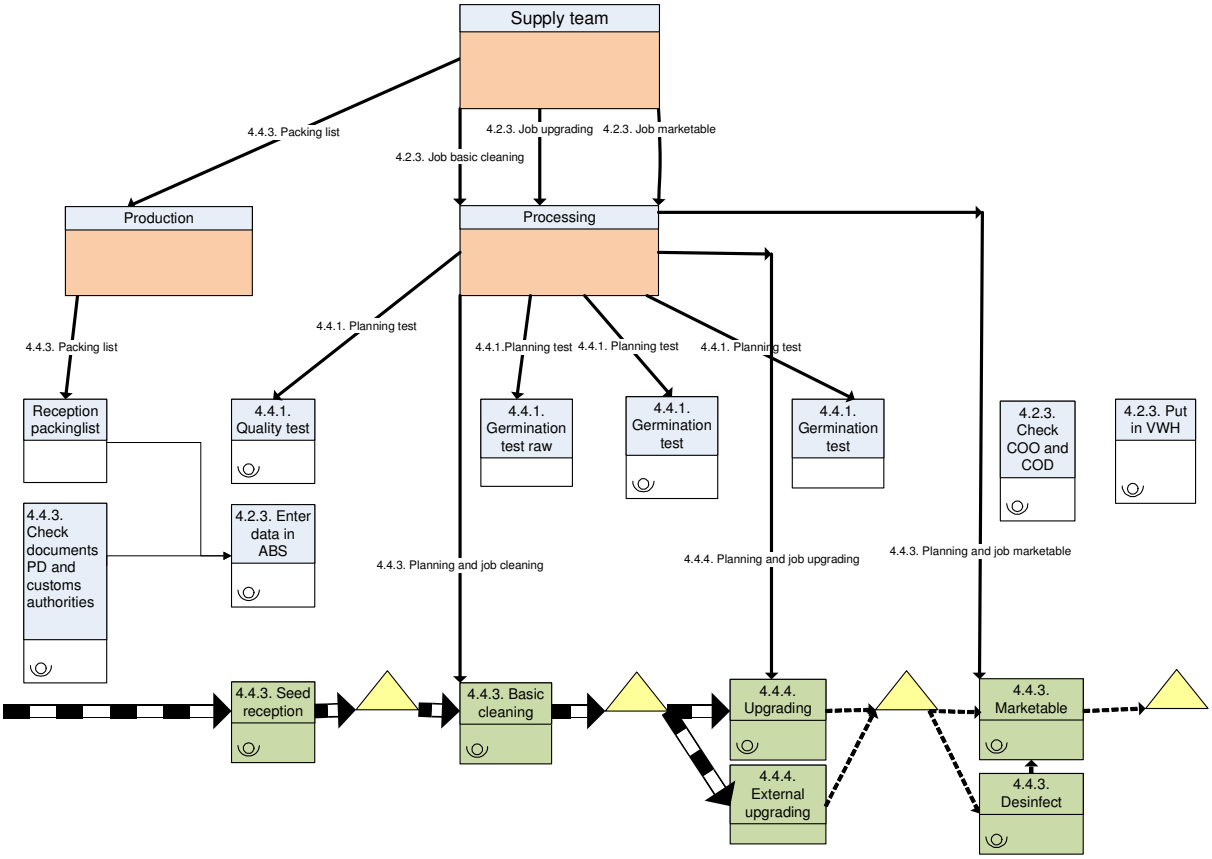


Figure 4a; stream map of processing according to plan

5. Assign to virtual warehouse

In this interview three persons participated:

Two inventory planners
The inventory planners at De Ruiter Seeds take care of the digital transfer of the seeds from production sites to the processing department. Planning the demand for the coming season is part of the job. It is monitored that quality checks are performed for every batch. The inventory planner ensures that the batch gets a basic cleaning, upgrading and is made marketable (ready for sales) and put in the virtual warehouse where it is available for the supply teams to allocate seeds to the virtual warehouse. Administration of raw seed reception and initiate seed destruction are also included.

A team leader documents and planning
The team leader of documents and planning is involved with the work floor planning of processing, the delivery of the seeds, rules and legislation of the different countries of origin and countries of destination. Also import and export document and certificates are important. Physical import and receiving with documents are part of the responsibilities.

Introduction

In assign to virtual warehouse the following two processes can be determined:

- Rolling logistic planning
- Documents and certificates

The main focus of assigning seeds to the virtual warehouse is to ensure that the forecast can be fulfilled. That seeds are ready in time, in the right quantities and with the correct documents. Assigning seeds to the virtual warehouse is also important for corporate distribution and processing because these departments use information for detailed planning.

During the interview several processes were checked and the following points were mentioned:

Rolling logistic planning
The rolling logistic planning starts with checking the seeds and batches. After the check a crop processing plan is made by the plant planner of seed processing and the master scheduler.

The rolling supply planning is compared and with the consolidated crop process plan(which includes data about production like the amount of jobs and the status of the crops), inventory status and variance report to create jobs. The level of inventory is adjusted to the information from the rolling supply planning, this is an important documents. It includes information and data of for example the country of origin. Some locations can not produce for a certain customer in a specific country. Saudi Arabia does not accept seeds that are produced in Israel. This type of information is included in the rolling supply planning.

The results of the processing jobs are compared with the rolling supply planning. Results can be based on the amount of manpower used or the machine hours. Action is taken when the results are not satisfactory.

At the end the batch is allocated to the virtual warehouse, special attention should be given to the country of origin and country of destination. Also quality of the seed should be checked before assigning.
The inventory manager is informed about the incoming shipment. Tracking and tracing of the shipment is done by the expeditor. Also the seed production specialist might track the seeds.

The package list of the shipment in entered in ABS. Here is it visible to every person who has access to ABS. Enter data is ABS is done at the same time as tracking and tracing of the shipment. This is a critical point; a lot of mistakes can be made with tracking and tracing but also with entering the data in ABS.

The incoming shipment, documents including forwarding of invoice to finance, are checked and registered. With the shipment, the finance department should be contacted after the supply team manager signed the incoming shipment.

At last, the handling of transfer is arranged. The seeds are physical received. The seeds are booked into the system after arrival. The department that arranges the basic cleaning that is performed for every batch is informed.

Documents and certificates
The department where the documents and certificates are handled receives the certificates that are needed like health tests, batch certificate, Naktuinbouw Accredited Laboratories (NAL) certificate that ensures seed quality and laboratory tests.
http://www.naktuinbouw.nl/nederlands/nal/nal-main.html

After reception of the test results, the documents are distributed or administrated. Documents are directly distributed if the seeds are needed within the European Union, these documents are not as strict as the documents that are administrated for distribution outside the European Union.
If the batch is allocated, the required documents and certificates are known. This includes country requirements, customer requirements etc.

After administration the documents and certificates are made according to the standards of the country, customer and De Ruiter Seeds. The production sites need to send a correct phytosanitary report, to be handled as quickly as possible. Otherwise a delay occurs.
This is the first moment in time that documents can be made for an extra delivery.

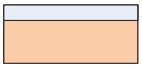
If the documents are made, these are distributed to corporate distribution which inserts the documents inside the boxes of seeds that need to be send to the customer.

Attention points

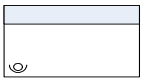
- Sometimes there is no packing list, or it is too late. This causes irritation and delay in the process because the department does not know in advance which seeds are arriving.
- Entering data in ABS is a point where mistakes are made. That way the wrong information is visible for multiple departments like processing and corporate distribution. If a mistake is made, it is hard to correct it when it is noticed at the end of the process. The information need to be checked and corrected, this will delay de process.
- The forecast is not yet optimal; there are improvement possibilities in the accuracy of the forecast.
- De Ruiter seeds should look in more detail what the country requirements are. Sometimes extra tests are needed and if a batch does not have the tests, a different batch is needed or a test need to be performed which takes extra time.
- The production sites must ensure that the phytosanitary documents are correct and in time. If the documents are too late, there will be problems with the time issue. Also the phytosanitary documents can not be amended, manipulated in any way, it should be correct to get the seeds exported.

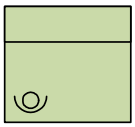
- It would be efficient if the production sites send one large bad with seed instead of small amounts. This saves time at the department of documents and certificates for checking documents for small batches.

Explanation of the figure below:

 Production control

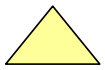
 Information flow (manually and electronically)

 Activities outside the product flow

 Process box representing the product flow

 Pull arrow (the product is treated with specialised processes dependent on customer wishes)

 Push arrow (the product is pushed into the stream, **not** dependent on customer wishes)

 Inventory/storage

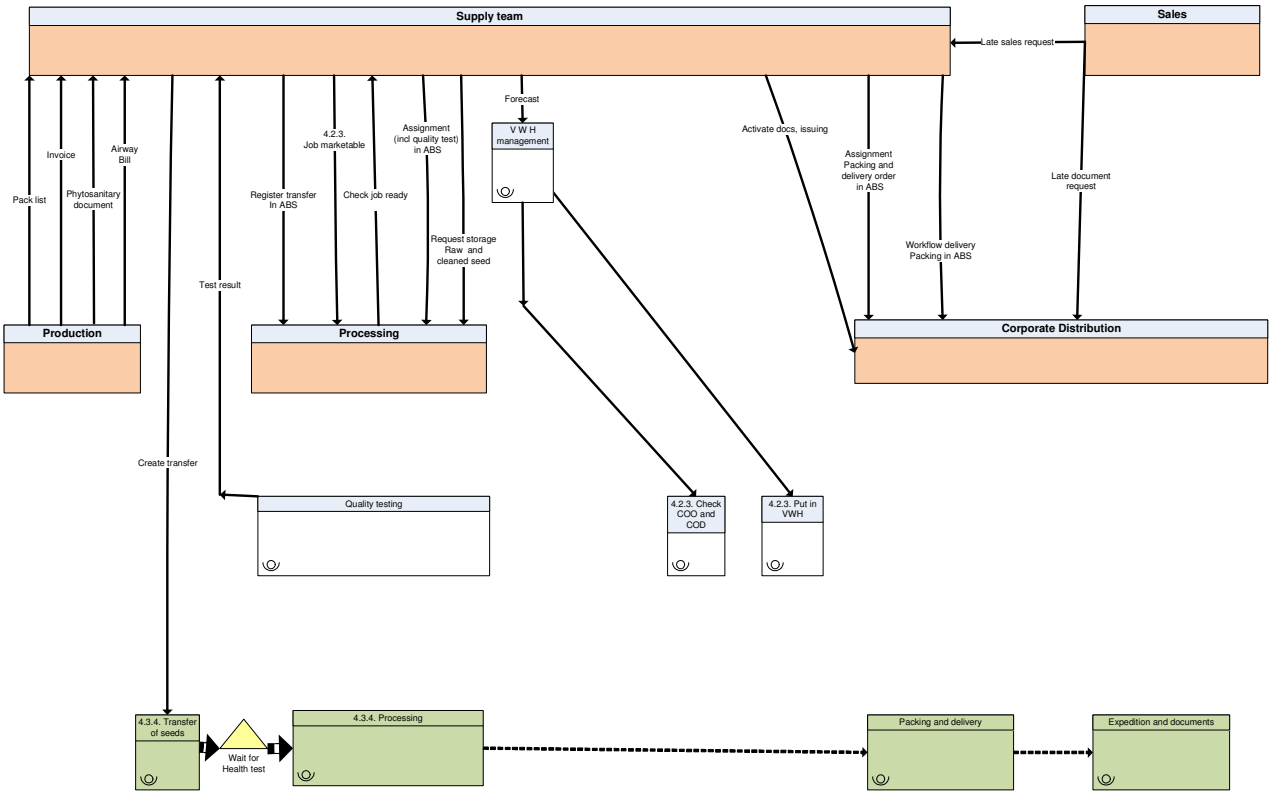


Figure 5a; stream map of assign to virtual warehouse

6. Virtual warehouse to order

In this interview two persons participated:

Region manager/business area manager:
The region manager supervises the representatives that are mainly working in the Middle East and South East Asia, New Zealand and Australia. It is important that there is a market in these countries and that the seeds can be distributed from the Netherlands.

Sales assistant North West Europe:
The sales assistant ensures that the communication inside the firm concerning sales activities is running smoothly. The orders need to be handled, the price lists need to be administrated, the payments need to be checked and the finance department need to be informed.

Introduction

In virtual warehouse to order the following two processes can be determined:

- Customer order processing
- MSU inventory management

The main focus of virtual warehouse to order is that the seeds that are assigned in the virtual warehouse need to be allocated to a specific order from a customer.

During the interview several processes were checked and the following points were mentioned:

Customer order processing
The customer order processing starts with an order that comes in. The order can come in via a fax, email or telephone call. The seeds already need to be assigned to virtual warehouse to enable sales to use that particular batch. The order form includes information like variety and quantity.

The information from the order form is entered into ABS and it is given a process number. This is related with the stock that is in virtual warehouse. Whilst the process of picking is done at corporate distribution, a delivery request is made. Corporate distribution is responsible for picking and packing of the seeds. Shipping documents and expedition confirmation are needed for the shipment of the seeds.

An invoice is made by the sales support department, which is printed for the finance department. The marketing and sales unit is informed about the order that is being handled.

Important factors for the customer order processing is the price list, the sales and delivery conditions, payments terms and credit limits, import and export rules and legislation and the forecast that is made. The import and export rules and legislation is changing and difficult to amend when this is changed.

MSU inventory management
The inventory management starts with making or amending a forecast. This is based on historical data, market data and ABS.
Some of the seeds are pre packed, this to speed up the process and send the seeds as soon as possible to the customers, this packing is done in quantities of example 1000 seeds.

Distribution of inter company purchase order takes place, which also results in a packing and/or delivery request. The intercompany purchase order is used for the reception, check and storage of seeds. The stock is virtually and physically managed.

Return of seed from the customer is exceptional. If it happens, the seeds are returned and destroyed if it is returned from customers that didn't store the seeds in proper conditions.

Attention points

- It is possible to gain time via monitoring the seeds during the transport, and then it is possible to detect delay of the seeds in an early stage. Actions could be taken to resolve the delay.
- At the moment there are differences in time for approving documents and certificates. Some documents must be checked by the embassy of the country (South America) which can take three weeks and others do not need documents at all. This depends on the import restrictions per country.
- The documents for country of origin and country of destination should be available as early as possible. Some countries do not accept seeds from specific countries. E.g. Saudi Arabia does not accept seeds from Israel. So documents about the origin of the seed are necessary. There are missed sales due to delay in documents. The supply team thinks that it was made, whilst it was not and distribution is waiting for the documents. This might cause a delay of one week.
- The information that is needed on the seed bags should come from the sales department. Mostly the information is not correct or unreadable. Corporate distribution has to check the information via the sales department. For example: a seed bag for Algeria did not have the right information. This caused a delay of almost two weeks. It would be convenient if there is a general database with information to put on the bag.
- There is a mismatch between the amount of seeds that are in the virtual warehouse and the physical amounts that are in stock. This might lead to a wrong perception of the stock levels; this could lead to out of stock and missed sales.

Explanation of the figure below:

Production control

Activities outside the product flow

Information flow (manually and electronically)

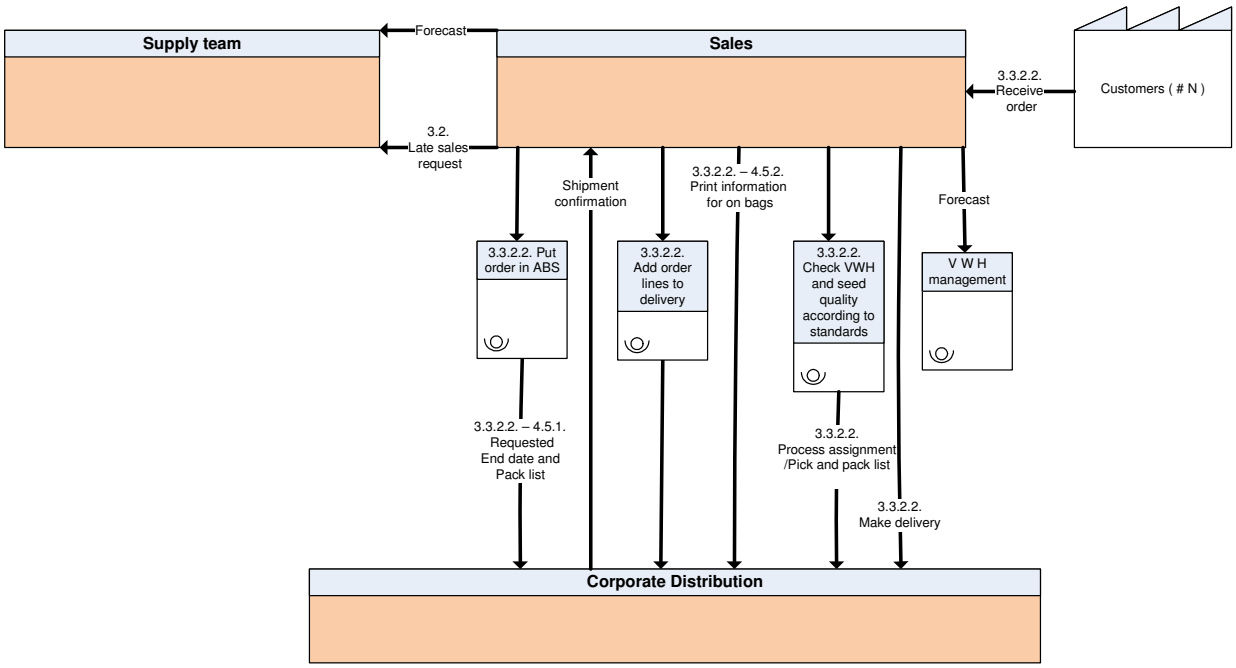


Figure 6a, stream map of virtual warehouse to order

7. Order to delivery

In this interview two persons participated:

Team leader corporate distribution:
The team leader corporate distribution is responsible for the packaging of the seeds according to the agreement with the supply team. The stock with saleable seeds is under the control of the team leader corporate distribution; this is done after communication with the supply team.

Plant planner corporate distribution:
The plant planner corporate distribution plans the orders from sales to distribution. The sales department gives the orders, together a consensus is made about the quantities and end date when the seeds should be shipped.

Introduction

In corporate distribution the following four processes can be determined:

- Distribution planning and scheduling
- Packing
- Expedition
- Documents and certificates

The processes in corporate distribution are mainly focused on getting the seeds ready for distribution. Packaging and documents are important aspects.

During the interview several processes were checked and the following points were mentioned:

Distribution planning and scheduling
The distribution planning is updated, and entered in ABS. There is no forecast on the distribution department; there is also no capacity plan available. A capacity plan is very hard to produce due to unexpected speed orders and uncertainty.

The check for future capacity problems is not performed at corporate distribution, sales gives an order and this is finalised within four days excluding the time that is needed for the documents. Sales can pre-pack the seeds, so the seeds can be shipped earlier to the customer.

The request is not checked with the capacity because there is no capacity plan. Sales reserves seeds for the customers and the supply team make sure that the seeds are available in the virtual warehouse to allocate to customers.

Convert request into assignments is done after a request from sales, a process assignment is made on order level. Orders can be combined to deliver as many products, at the same time, as possible.

The assignments are scheduled, followed up and controlled. The assignments are planned for the employees, this is necessary because there are some due dates. For example, if a grower inside the Benelux orders seeds before 12am, it must be ready after 15pm to be send.

Packing
The packing of seeds is started with an assignment to finalise an order.

The materials that are needed are picked from stock. Seeds are needed, also bags and information for on the bags.

The resources are set up to pack the seeds, this is done from the planning that is made.

The seeds are packed, this can be done automatically by robot or with the hand. The day is split into 3 timeslots because several deadlines must me met over the day. If documents are needed (outside the European Union), the seeds should be packed and ready before 12am. If there are no documents needed (inside the European Union) then the seeds should be packed and ready before 3pm.

The results of packing are checked. The quantities in ABS and the physical quantities are compared.

After packing the seeds are stored on location until needed.

The activity status will change. This is for administration, the customer can see that the order is ready and it will be assigned to a delivery.

The package order status will also change. The seeds are allocated and send, after delivery at the customer the process is completed.

Expedition
The first step in expedition is to make a task assignment which includes a picking list for the seeds and combining the bags for delivery.

The materials are picked from location and need to be combined for a customer. The results are checked with the picking list making sure that all order lines are included.

The seeds are packed in a box together for the customer so that all seeds can be shipped. In ABS the seeds are also withdrawn from the stock and tagged as shipped.

The box with seeds is combined with the documents, if the seeds are shipped outside the European Union.

The box is handed to the carrier like DHL. The carrier will transport the box with seeds to the customer. After transport the reception of seeds takes place at the customer.

Documents and certificates

Documents for outside the European Union takes around 2,5 hours to produce.

Attention points

1. It is possible to gain time via monitoring the seeds during the transport, then it is possible to detect delay of the seeds in an early stage. Actions could be taken to resolve the delay.
2. At the moment there are differences in time for approving documents and certificates. Some documents must be checked by the embassy of the country (South America) which can take three weeks and others do not need documents at all. This depends on the import restrictions per country.

3. The documents for country of origin and country of destination should be available as early as possible. Some countries do not accept seeds from specific countries. E.g. Saudi Arabia does not accept seeds from Israel. So documents about the origin of the seed are necessary. There are missed sales due to delay in documents. The supply team thinks that it was made, whilst it was not and distribution is waiting for the documents. This might cause a delay of one week.
4. The information that is needed on the seed bags should come from the sales department. Mostly the information is not correct or unreadable. Corporate distribution has to check the information via the sales department. For example: a seed bag for Algeria did not have the right information. This caused a delay of almost two weeks. It would be convenient if there is a general database with information to put on the bag.
5. There is a mismatch between the amount of seeds that are in the virtual warehouse and the physical amounts that are in stock. This might lead to a wrong perception of the stock levels, this could lead to out of stock and missed sales.

Explanation of the figure below:

Production control

Information flow (manually and electronically)

Activities outside the product flow

Process box representing the product flow

Pull arrow (the product is treated with specialised processes dependent on the customer wishes)

Inventory/storage

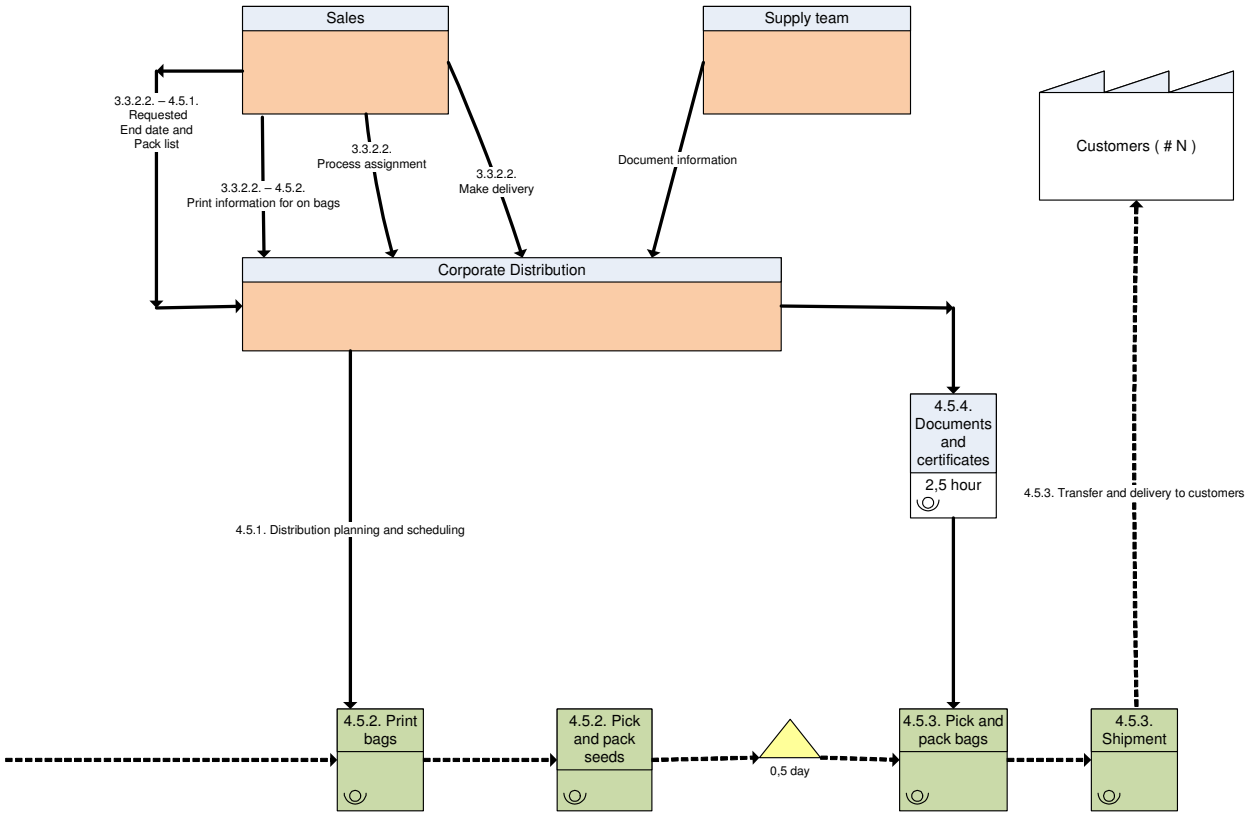


Figure 7a, stream map of order to delivery

Appendix 3; Attention points from interviews

The attention points that are mentioned during the interviews are listed per interview group:

Group 1: Forecast to demand

1.1 The marketing and sales department does not include the information of country of origin and country of destination in the delivery that is made. Sometimes the seeds can not be used due to country restrictions.

If the marketing department does not use the information from COO and COD and the seeds are send but not accepted, this becomes a problem because new seeds must be send. This can cause a delay and therefore it can be an option to research in more detail.

1.2. The forecasts are not always on time or not complete. From some countries like Spain it is unknown what the expected sales will be, this has a negative influence on the planning. It takes time to check the forecast and to call the sales department, to receive a correct forecast. In the meanwhile the planners can not make planning schedules.

This point is important, because the whole production of seed is based on the forecast. If there are inefficiencies or delay in the forecast, the whole process will delay. This is an important issue to investigate.

1.3. Some forecasts are too high; the sales department includes a buffer to ensure sales. The buffer grows when the process continues; also know as the Bullwhip effect. If every part in the process includes a buffer, the buffer will grow enormously until the end of the process.

Overproduction is not directly linked with delay in lead time but it is one of the wastes of Ohno, 1988. Because the buffer is increasing over time, it is a possibility to include this point in a process that will be zoomed in. To investigate it there is a possibility to get one buffer in the total process.

1.4. The decision moments to produce should include more detailed information and should be more accurate. This will increase the efficiency and also the correctness of the planning.

If decisions are made without accurate information or detailed information, the decision will be made upon incomplete information. This can be structured in a better way, the other parts in the chain are influenced by this decision.

Group 2: Demand to production order

2.1. The parental line description is not always present. The seed production specialist should call and email before it is send to the seed production specialist. It is also not complete; details are missing about the parental lines like a description of the variety.

The absence of the parental line description does not have an influence on the lead time, it is frustration to call and email the breeders, but for the research it is not worth to investigate this in depth. A recommendation can be made to improve the contact about the parental lines.

2.2. The transport of the seed from Mexico takes to long in the eyes of the seed production specialist. It should be possible to have within ten days, in June the time for a batch was around seven weeks. This causes a large delay.

Not only the seeds from Mexico are late but also other countries that are transporting the seeds from overseas. Transport is also a waste according to Ohno, 1988. Because the time between sending the seed and the seed reception at Berschenhoek is long, this can be an option to zoom in.

2.3. The seed production specialist mentions that there are many activities that not belong to the function tasks, for example calling the breeder about the parental lines description etc. This will lead to less efficiency concerning job activities.

This comment has no influence on the lead time, although this remark should be communicated. It has a link with the absence of the Parental Line description; a discussion can be started about the reason of absence of the description. This could also solve the fact that the seed production specialist is performing tasks outside its function description.

Group 3: Produce according to plan

3.1. Regularly the Parental Lines Description (PLD) is not present. So the production manager has no information about the variety, shape and germination of the seeds. The breeders of basic seeds should include a PLD, this takes time and regularly this is not included in the sending. During the seed production the production manager should check the plants and note specific information like variety and expected germination. This takes time, but it does not delay the lead time because this is performed simultaneously with the crop maintenance.

This is the second time that a group mentions the absence of the PLD, this is a serious issue even though it is not related with the lead time. This is a point to consider for an improvement action, but not within the research.

3.2. Regularly the basic seeds are not ready in time. This give a delay in the process from production because the sowing starts later then planned.

The reception of basic seed is the start of the process in the research. If the seed is already late at the start, the whole process is delayed. This will have consequences for the other parts of the process. This is something that can be investigated.

3.3. An advantage of tomato seed production is that is possible to break off the seed production if the harvested quantity is between 90%-120% of the demanded quantity. Therefore overproduction that exceeds this criterion should not be necessary.

This attention point is not related to delay in lead time in the current process. It is more a remark that can be kept in mind. Although overproduction is a waste according to Ohno, 1988, it is not relevant to include further in the research.

3.4. There are differences in production time per country. Seed can not produced as quick in the winter as it does in the summer, especially in the South of Europe and Mediterranean countries. This increases the lead time of production. Although it is possible to sow earlier if extra light is used in the greenhouse. This can lead to an early harvest.

Although the plants have a natural cycle, there are differences in the season that the seeds are produced. This also can cause a delay in the process further on. So this can be included in a point for zooming in.

3.5. The transfer of the seeds from the production location to the processing location is not scheduled every day. Seeds with a Dutch origin are waiting a few days before transferred to the processing department. International seeds need a longer time to arrive at the processing department in the Netherlands.

This about the same point that group 2 mentioned. The transport between the production locations and the Netherlands takes a considerable time. This can be researched.

Group 4: Processing according to plan

4.1. Tomato seeds regularly are held back at the seed reception because the batch is not large enough, so the batch needs to be blended with another harvest. A lot of small batches increase the amount of processes for the department. Therefore waiting time is approximately two weeks for another harvest to combine two batches of the seed.

This comment should be taken into account, here a trade off is made between the batch size and the time that a batch should wait. This is related with the reduction of lead time and can be included in the research.

4.2. Basic cleaning of the seed is a procedure for every batch of seeds. Although sometimes combined with another process, all seeds get a basic cleaning. After basic cleaning the seeds are stored. This is worth investigating to see if more processes could be in a flow. To decrease the points in the process that seeds are stored.

This attention point can be investigated when it falls under a larger topic, on its own it can be faced as a trade off between batch size and time. This is a choice that has to be made; more batches result in more processes, which also uses capacity. This can ultimately lead to waiting because the machines are in use.

4.3. The packing list which should be send from the production sites is sometimes not present. The packing list gives information about the kilograms of seeds, variety of the seeds and other seed specific information. At the moment, it is not clear what amount and at which date is delivered. Processing is then faced with unexpected batch sizes. If this is known in advance, the processing department can plan the workload.

This attention point results in unexpected batches that arrive at Bergschenhoek, this causes uncertainty in the planning of processing. If the batches are expected, the manpower can be planned which smoothens the processes. Otherwise the batches need to wait. This can be included in the research but as a sub topic and not as one process to focus on.

4.4. Looking at the necessity of every step in the process is essential. Some steps only take ten minutes but because the employees are busy with multiple tasks it might take a day before the step is done and the process can continue.

The necessity of the steps is already investigated for the topics to zoom in. The fact that an employee is busy with other tasks might be a cause of delay in the process. If this is the case, it will be made visible during the research. It can be kept in mind, but will not be the focus of the processes to zoom in.

Group 5: Assign to Virtual Warehouse

5.1. Sometimes there is no packing list, or it is too late. This causes irritation and delay in the process because the department does not know in advance which seeds are arriving.

This is the same point as 4.3. This causes delay at the processing site but also irritation of the inventory planner because seed information should be put in the information system as soon as possible.

5.2. Entering data in ABS is a point where mistakes are made. That way the wrong information is visible for multiple departments like processing and corporate distribution. If a mistake is made, it is hard to correct it when it is noticed at the end of the process. The information need to be checked and corrected, this will delay de process.

This is point that may delay the process, but human mistakes are made. A remark can be made about being precise when entering data in ABS. This will not be included in the zoomed in processes.

5.3. The forecast is not yet optimal; there are improvement possibilities in the accuracy of the forecast.

If the forecast is not optimal, it will result in wrong perceptions of the amount of seed that is needed. Because all the processes are directly or indirectly linked to the forecast, this is an important factor. This is a factor to consider whilst making a decision for processes to zoom in.

5.4. De Ruiter seeds should look in more detail what the changing country requirements are. Sometimes extra tests are needed and if a batch does not have the tests, a different batch is needed or a test need to be performed which takes extra time.

Because the countries change the amount and type of documents and tests that are required to export, some batches that are in the warehouse do not have the newly required results of the tests. Therefore the batches that might have been allocated to a specific country, need to be tested according to the new requirements. This takes time and can be further researched under a main topic.

5.5. The production sites must ensure that the phytosanitary documents are correct and in time. If the documents are too late, there will be problems with the time issue. Also the phytosanitary documents can not be amended, manipulated in any way, it should be correct to get the seeds exported.

This topic is an issue that can be included in a main topic of seed transport from the production location to the processing department. Also this topic is related to lead time reduction. It is not an issue on itself, but can be a part of a main topic of seed transport.

5.6. It would be efficient if the production sites send one large batch with seed instead of small amounts. This saves time at the department of documents and certificates for checking documents for small batches.

This attention point is also related to the fact that a batch need to be blended when it is too small, because then the amount of processes for the department increase. This can be investigated in more detail.

Group 6: Virtual Warehouse to order

6.1. When the delivery is made and the amount of bags is not correct, a week is lost with requesting a new Ista document and making new arrangements.

The Ista document is based on a certain amount of bags, if this is not correct a new document should be requested. This means a time delay, it is an option to consider as part of a main topic.

6.2. The interviewees mention that the amount of bags that are not correctly printed is low. It is exceptional. This in addition to the point that is mentioned in 7.4. about information that should be printed on the bags.

Group seven mentions that there are bags that do not have the correct distribution information. The sales department does not have the information complete or correct. This is also due to changing country requirements. Here a delay in lead time can be detected. This topic can be further researched.

6.3. Batches that don not have the right quality, but are assigned to virtual warehouse can not be used due to the level that is used for Ista documents. Sometimes batches with low quality are assigned which can not be used. It takes time to assign a new batch with the right quality.

This is a point that can be taken into consideration. Wrong batch allocation can be prevented and saves time to re allocate a batch. Although the amount of time that can be saved will be limited, it is a point that can be included in a main topic.

6.4. There are changing country requirements; this affects the information that is needed on the bags but also the documents requirements. This is an uncertainty that sales tries to cope with, but with sudden changes it is difficult to react immediately. This can cause miscommunication and irritation, because it is not clear what is expected.

Group seven mentions that there are bags that do not have the correct distribution information. This point is mentioned several times, it seems to be a topic that multiple departments are facing. It also can cause delay, therefore it can be further researched.

Group 7: Order to delivery

7.1. It is possible to gain time via monitoring the seeds during the transport, then it is possible to detect delay of the seeds in an early stage. Actions could be taken to resolve the delay.

De Ruiter Seeds uses an external transportation firm to transport the seeds from the processing department to customers. Not often the seeds are too late or not arriving at all. An option would be to assign an employee to follow the shipment until it is at the customer. Because it is not regularly happening and the transportation company is responsible for the shipment, this point will not further researched.

7.2. At the moment there are differences in time for approving documents and certificates. Some documents must be checked by the embassy of the country (South America) which can take three weeks and others do not need documents at all. This depends on the import restrictions per country.

This point can be important when looking at the differences in time between harvesting the seed on a overseas production location and the arrival in Bergschenhoek. This is a factor that can be included in the research whilst it might be a cause of the delay.

7.3. The documents for country of origin and country of destination should be available as early as possible. Some countries do not accept seeds from specific countries. E.g. Saudi Arabia does not accept seeds from Israel. So documents about the origin of the seed are necessary. There are missed sales due to delay in documents. The supply team thinks that it was made, whilst it was not and distribution is waiting for the documents. This might cause a delay of one week.

This is a point that should be given some attention, although the link of country of origin and country of destination is handled by the inventory planners. Missed sales are an important topic, which can be further researched.

7.4. The information that is needed on the seed bags should come from the sales department. Mostly the information is not correct or unreadable. Corporate distribution has to check the information via the sales department. For example: a seed bag for Algeria did not have the right information. This caused a delay of almost two weeks. It would be convenient if there is a general database with information to put on the bag.

This attention point is already stressed in point 6.2 and 6.4. regarding bag information. This point is further researched.

7.5. There is a mismatch between the amount of seeds that are in the virtual warehouse and the physical amounts that are in stock. This might lead to a wrong perception of the stock levels, this could lead to out of stock and missed sales.

The mismatch between the virtual warehouse and the actual stock levels are caused by human mistakes. Typing errors, labelling errors are mistakes that can be prevented but never eliminated in its total. This is also not a topic that will be researched.

Table 1a; main topic options

Attention points	Part of a main topic				Attention points	Part of a main topic		
	Yes	Maybe	No			Yes	Maybe	No
1.1.		X			5.1.		X	
1.2.	X				5.2.			X
1.3.		X			5.3.	X		
1.4.		X			5.4.		X	
					5.5.		X	
2.1.			X		5.6.		X	
2.2.	X							
2.3.			X		6.1.		X	
					6.2.		X	
3.1.			X		6.3.		X	
3.2.		X			6.4.		X	
3.3.			X					
3.4.		X			7.1.			X
3.5.	X				7.2.		X	
					7.3.		X	
4.1.		X			7.4.		X	
4.2.		X			7.5.			X
4.3.		X						
4.4.		X						

Main topics after interviews with managers

Looking at the attention points that are listed, some remarks are mentioned more than once and can be consolidated in one main topic.
After review of the process map the supply team manager, manager seed processing and the researcher concluded on a set of points with possible lead time reduction options. The information from the attention points and the review are consolidated in six main topic that are an option to zoom in. The attention points related to the main topic are noted below:

1. The shipment between the production site and the processing department in Bergschenhoek has large differences in time. Especially if the seeds are transported overseas, the arrival times are uncertain and long after the first harvest at site.

   2.2. The transfer from the production location to the processing department.
   3.5. Transfer of the seeds from the production location to the processing department.
   5.5. The phytosanitary documents that are needed to ship the seeds.
   5.6. The batch size that is send to the Netherlands, linked to the document department.
   7.2. Approval for the documents and certificates (at the embassy).

2. The time between the end of a process and the start of the following process. There are long periods between two processes. It is worth investigating the reason of this delay.

   4.1. The batch sizes are not large enough at reception, so the batch needs to wait for blending with another batch.
   4.3. When the packing list does not arrive, the processing department is faced with unexpected batches, which takes time to include in the work schedule.
   5.1. This is the same point as 4.3., the packing list is not present which results in unexpected batches for seed processing.

3. In the processing department there are differences in standard times (mostly measured in days) and actual process times. This can be research together with the times between two processes.

   4.2 Try to create a flow in the processes of seed processing, less storage etc.

4. The time between the end of the last process and assigning to virtual warehouse. This can also cause delay; here virtual warehouse management can be included.

   4.2. Try to create a flow in the processes of seed processing, less storage etc.
   4.3. When the packing list does not arrive, the processing department is faced with unexpected batches, which takes time to include in the work schedule.
   5.1. This is the same point as 4.3., the packing list is not present which results in unexpected batches for seed processing

5. There are troubles with the different requested documents and certificates. The countries have a fluctuating policy about import and export of seeds. Therefore it is difficult to give bag information to corporate distribution. The corporate distribution department can not print bags if the information is not correct.
   Corporate distribution must contact the sales department about the right information on the bags, which sometimes should be collected from the customer which cause a delay.

   1.1. The sales department does not include information of COO and COD.
   5.4. Have a better look at the COO requirements.
   6.2. Wrong information printed on bags.
   6.4. Responding to changing country requirements.
   7.3. Availability of COO and COD requirements.
   7.4. Wrong information printed on bags.

6. The submission date of the forecast is not based on the last sowing dates of the different production locations. If the last sowing date is early September and the seed request is made in October, the seeds can not be sown on that specific location. Or the seeds must be produced on a less preferred location or the production will be delayed until the preferred location has space.

   1.2. The forecast are not always in time and complete.
   1.3. The forecasts are too high, there is a buffer included. The other managers also include a buffer; this will increase until the end of the process.
   1.4. No accurate and detailed information is used for the production decision
   3.4. There are differences in time per production country, the best location is preferred.
   5.3. The forecast is not optimal, these are not always accurate.

Appendix 4; Fluctuations in the product flow.

According to the production manager the following five fluctuations are most influencing the lead time in the total process: season, crop type, batch size and country of production. Also an exemption (a lot of things were wrong in this batch, blockings/low germinations etc) is included to see what the lead time would be in an extreme situation.

Table 2a, fluctuations in the product flow

Production	Season		Crop type			Batch size			Speed of seed		Country			
number	Summer	Winter	Cherry	Standard	Rootstock	Large (> 15kg)	Average (4-15kg)	Small (> 4kg)	Standard flow	Urgent	NL	FR	IL	GT
62463	**x**			x			x		x		x			
61910		**x**		x			x		x		x			
61728	x		x				x		x		x			
61757		x			x		x		x			x		
62204	x			x		x			x		x			
62529	x			x				x	x		x			
61072	x			x			x			x	x			
63271		x		x			x		x			x		
63272		x		x			x		x			x		
62738		x		x			x		x					x
63174		x		x			x		x					x
63482		x		x			x		x				x	
63114		x		x			x		x				x	
62371	x			x			x		x		x			

There are large differences in time if a seeds are produced in summer or winter, in the winter there is less light and therefore the plants grow slower. The crop type is also a factor that can increase lead time, for example cherry tomatoes take longer to be produced. The batch size can influence the time that is needed for the processing department. Many small batches need more work because every batch is handled separately. The speed of the process is normal on average batches, if a batch is needed quickly the lead time can be shortened to give priority to the batch. At last, the production location also influences the lead time, especially the transport from the location to the headoffice in Bergschenhoek takes some time.

Lead times of the total stream map of De Ruiter Seeds

There is chosen to follow batches trough the stream map processes to calculate the lead time. This will give an indication of the time that is spent on every activity. These batches have different characteristics as stated in table 2, these are the characteristics that have the most influence on the lead time according to the production manager.

Table 3a; data stream map

Production number	Name	Production country	Sowing date male	1st harvest	Receiving BHK	BCL	UPGR	MKT	Packed/sold
61072	SHANG x HAI	NL	27-6-2007	20-10-2007	29-10-2007	19-11-2007	23-11-2007	10-3-2009	28-12-2009
61728	SHA x MARK	NL	11-6-2008	8-9-2008	15-9-2008	6-10-2008	22-10-2008	24-10-2008	24-10-2008
61757	TAAL x SCHAT	FR	7-12-2007	15-5-2008	21-5-2008	30-5-2008	22-12-2008	22-12-2008	3-4-2009
61910	HITTE x PETIT	NL	18-12-2007	19-5-2008	23-5-2008	26-5-2008	30-5-2008	2-6-2008	27-5-2009
62204	COM x FLE	NL	1-5-2008	19-8-2008	21-8-2008	27-8-2008	5-9-2008	27-1-2009	9-6-2009
62371	FEEST x TAART	NL	15-5-2008	27-10-2008	3-11-2008	3-12-2008	20-5-2009	20-10-2009	30-10-2009
62463	MONO x NOVA	NL	3-6-2008	29-9-2008	3-10-2008	12-1-2009	3-4-2009	7-7-2009	10-7-2009
62529	BETA x LEVEL	NL	26-6-2008	22-9-2008	20-10-2008	29-10-2008	4-11-2008	12-5-2009	15-5-2009
63271	TALL x STORY	FR	30-12-2008	11-5-2009	18-5-2009	22-5-2009	2-6-2009	19-6-2009	24-6-2009
63272	DIRTY x STORY	FR	30-12-2008	13-5-2009	18-5-2009	15-6-2009	17-6-2009	18-6-2009	22-6-2009
62738	RING x LORD	GT	25-8-2008	12-1-2009	13-2-2009	21-4-2009	27-4-2009	4-8-2009	5-8-2009
63174	TALL x STORY	GT	11-11-2008	24-3-2009	20-4-2009	4-5-2009	3-6-2009	14-9-2009	23-10-2009
63482	VASCO x GAMMA	IL	18-12-2008	27-4-2009	6-5-2009	25-5-2009	3-6-2009	4-6-2009	25-10-2009
63114	MARCO x POLO	IL	20-10-2008	15-3-2009	26-3-2009	17-4-2009	16-6-2009	14-7-2009	9-12-2009

Above are found the dates when a certain activity was performed. These data are input for the table that is stated in the results chapter with the corresponding lead times.

Appendix 5; Graphs of lead time of shipment

For this research most information is used from official documents and the administration of the production sites. This because these are the most complete and reliable sources.

There is chosen to measure for a period of twelve months from September 2008 until August 2009. This to ensure that any seasonal fluctuation is included. There is a difference between shipments and batches. A shipment mostly contains multiple batches of seed, a batch consist of one harvest from one variety. The amount of shipments delivered is considerably lower than the amount of batches delivered.

Information from the official documents

Information from official documents includes data from the Ministry of Agriculture, Food and Livestock in Guatemala, Rotterdam Airport, San Pedro Airport, the expeditor, the production site in Guatemala etc. These documents are collected at the office of the expeditor in the Netherlands. One shipment contains many forms of different authorities and organisations.

First harvest till last harvest

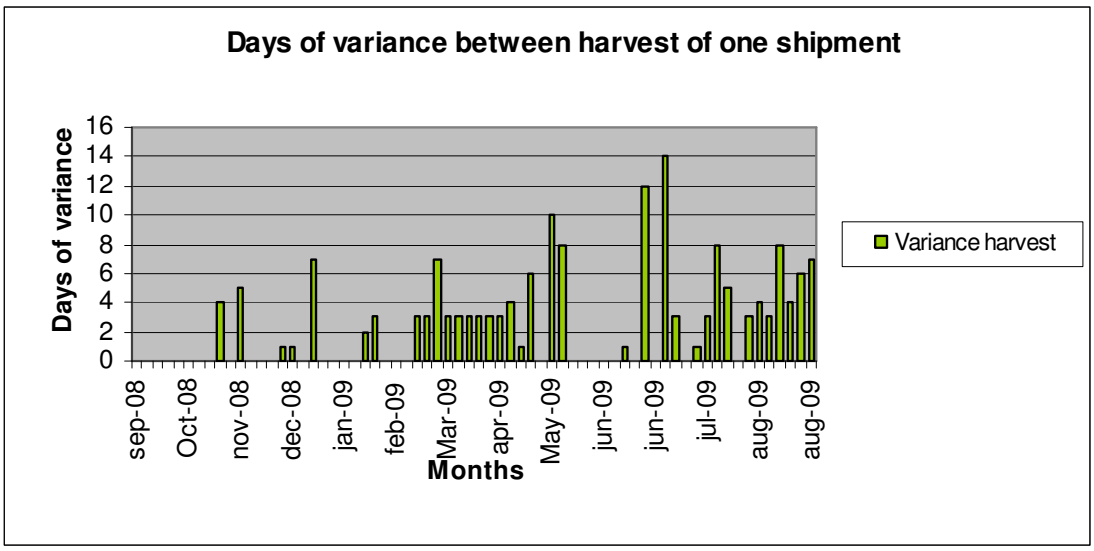


Figure 8a; first harvest till last harvest

The average amount of days between the earliest harvest in the shipment and the latest harvest is 2,6 days with an minimum of zero days meaning that all batches in the shipment are harvested on the same day. The maximum is 14 days, meaning two weeks between the first harvest in the shipment and the latest harvest. This is because the shipments are sent once a week and if DHL does not have space for the shipment, it has to wait at the site. Therefore shipments can be combined with two weeks of variance in harvest dates.

Time between last harvest and picking list

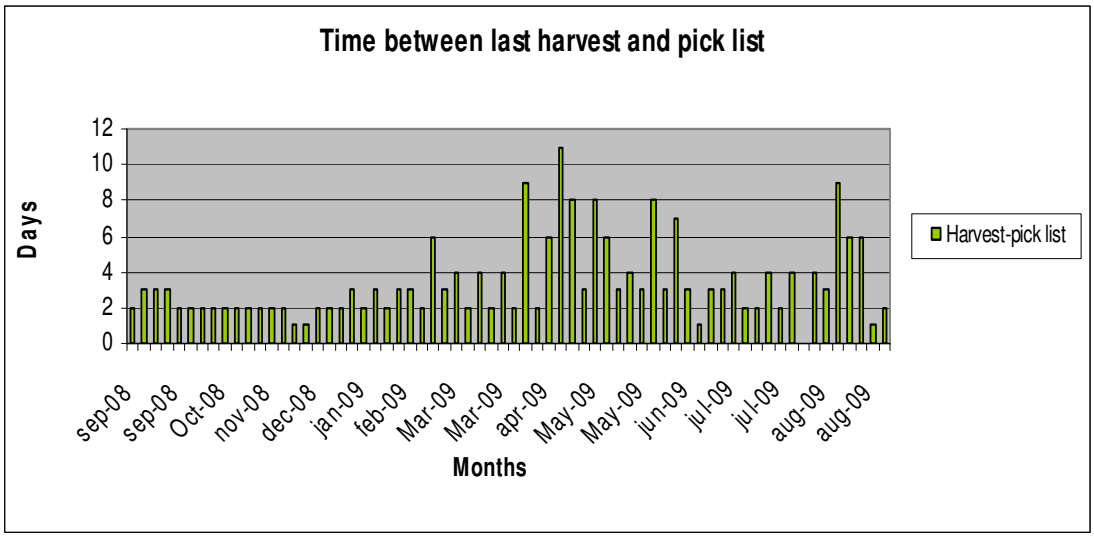


Figure 9a; Time between last harvest and picking list

There are on average 3,5 days between the last harvest and making a picking list. The picking list is only made when the shipment will be collected trough DHL within short time. Therefore, the picklist will be made later due to waiting on DHL. Here it is also the case that if DHL does not have space available, the shipment will not be send and the picking list will be made later in time. The minimum is 1 day and the maximum is 11 days.

Time needed for completion of phytosanitary treatment

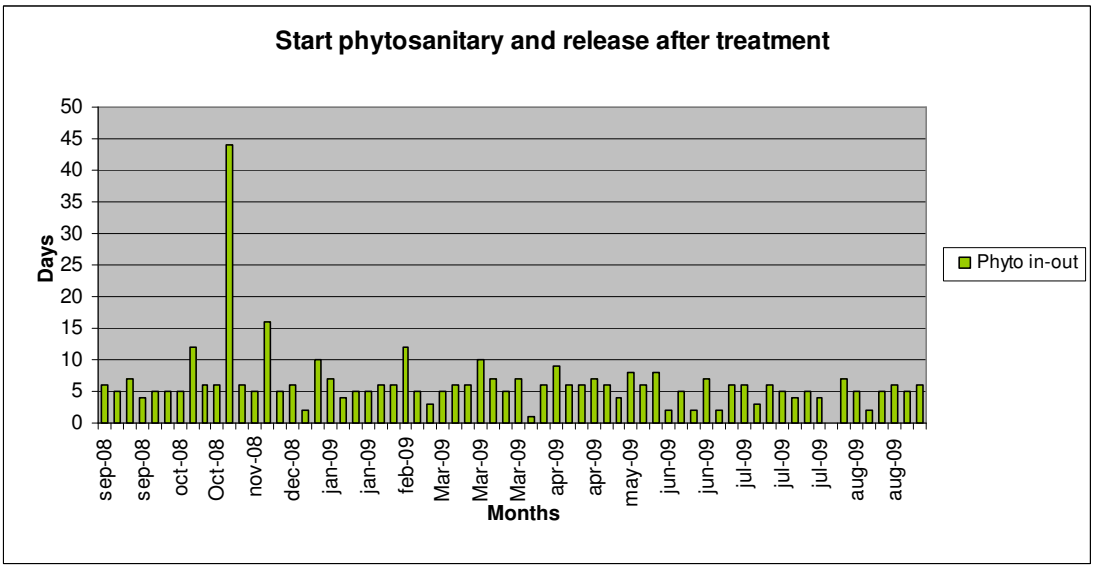


Figure 10a; Time needed for completion of phytosanitary treatment

As soon as the picking list is made, phytosanitary treatment will be requested at Ministry of Agriculture, Food and Livestock in Guatemala. The average time between requesting a phytosanitary treatment, for example Hydrochloric acid 37% (HCL), and the release by Ministry of Agriculture, Food and Livestock in Guatemala is 6,5 days with a minimum of 1 day and a maximum of 44 days. This 44 days is an exemption, all the other data are below 15 days.

Time spent at Ministry of Guatemala for permission to export

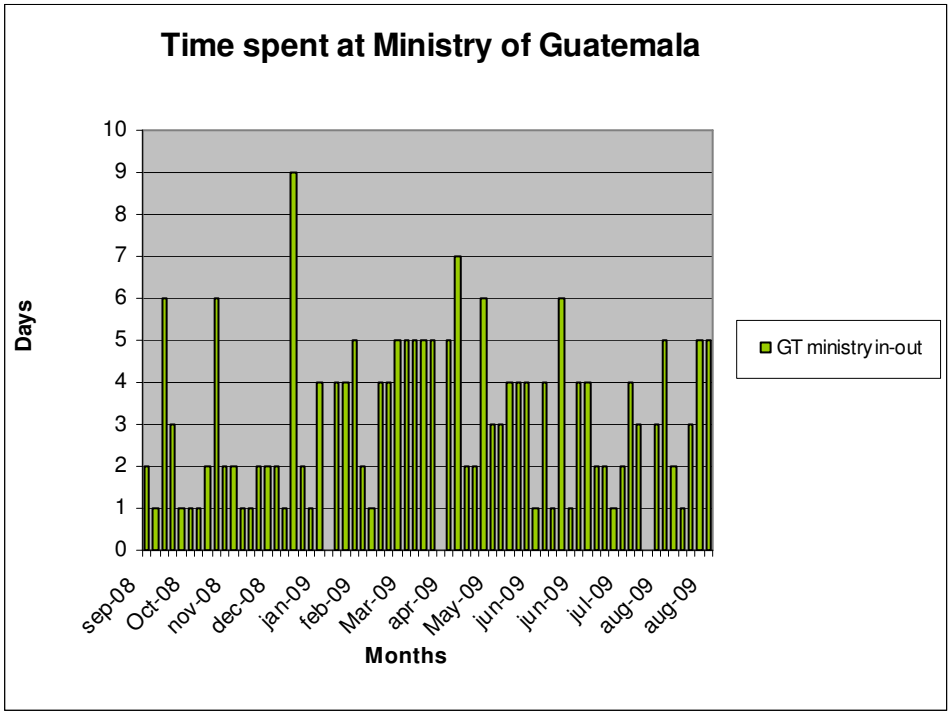


Figure 11a; Time spent at Ministry of Guatemala for permission to export

The average amount of days between a request for export at Ministry of Agriculture, Food and Livestock in Guatemala and the release of the export permit is 3,1 days. With a minimum of zero days, meaning that the request and release were on the same day, and a maximum of 9 days. This because the Ministry receives many export request and needs time to handle all the requests.

Time between export permission and arrival at the expeditor

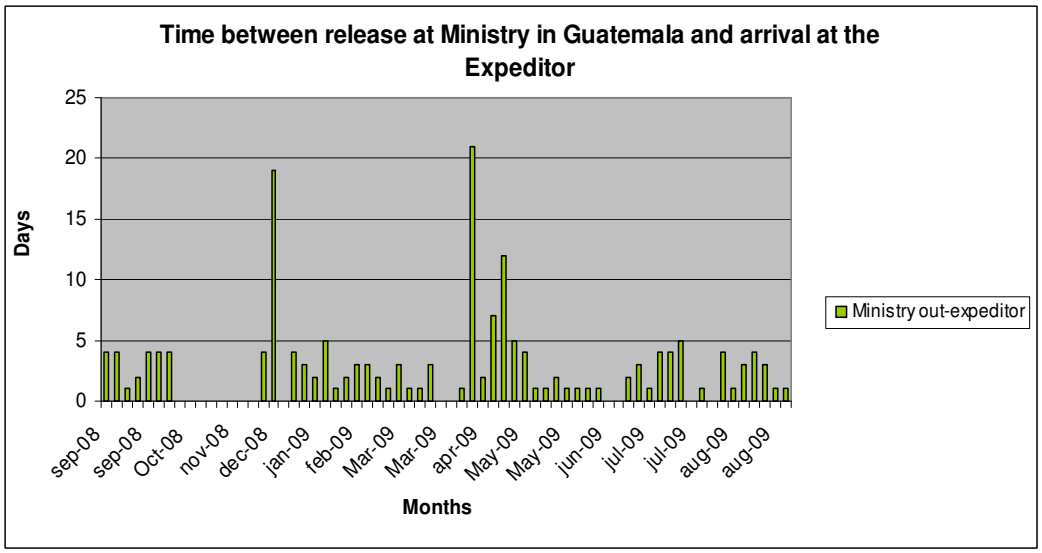


Figure 12a; Time between export permission and arrival at the expeditor

Between the permission to export of Ministry of Agriculture, Food and Livestock in Guatemala and arrival at the expeditor there are on average 3,2 days, with a minimum of zero days and two exemptions above 17 days. Here might have been a problem, documents could have been lost.

Time between arrival expeditor and the flight

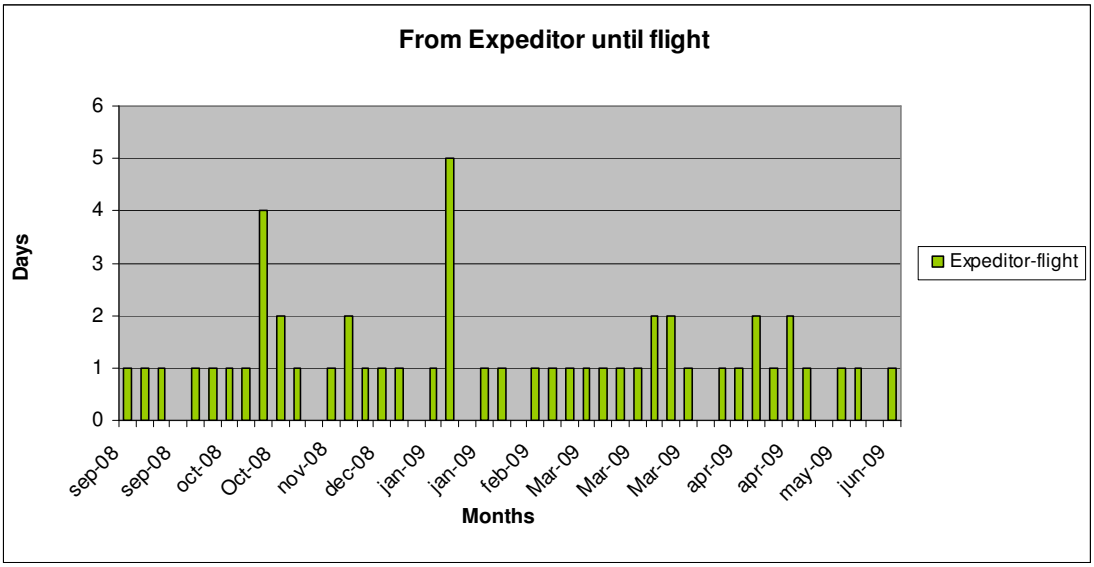


Figure 13a; Time between arrival expeditor and the flight

The average amount of time that the expeditor needs between receiving the shipment and the actual flight is 1,1 day with a minimum of zero days and a maximum of 5 days.

Flight from Guatemala to Rotterdam Airport

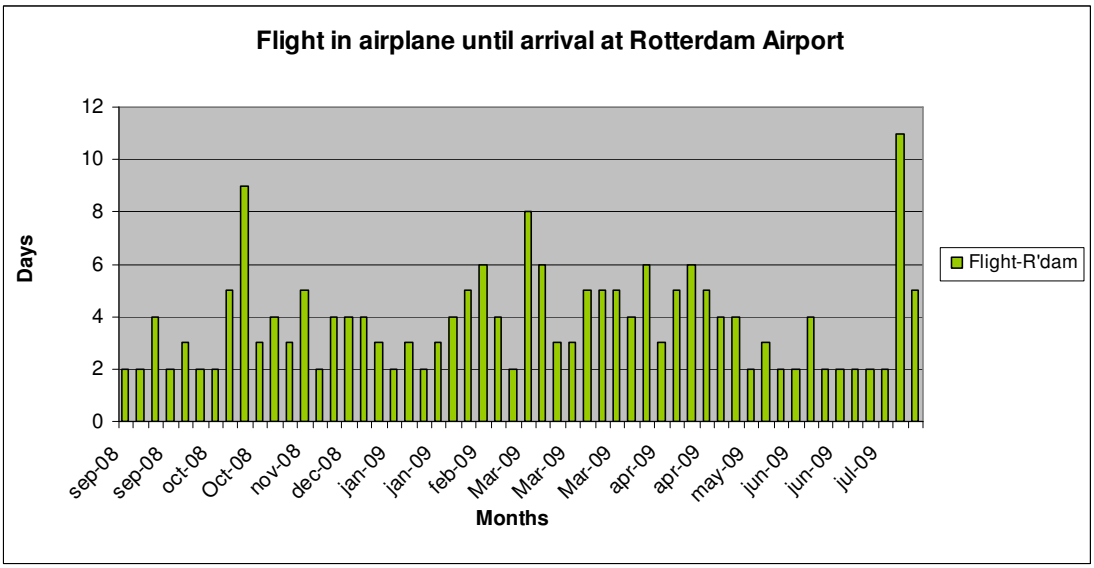


Figure 14a; Flight from Guatemala to Rotterdam Airport

The flight from Guatemala towards Rotterdam takes on average 3,9 days with a minimum of 2 days and a maximum of 11 days. These amount of days fluctuate heavily, also here there might be problems with the documentation.

Time between arrival in Rotterdam and permission of Nederlandse algemene kwaliteitsdienst Tuinbouw (NAKT) or Plantenziektenkundige Dienst (PD)

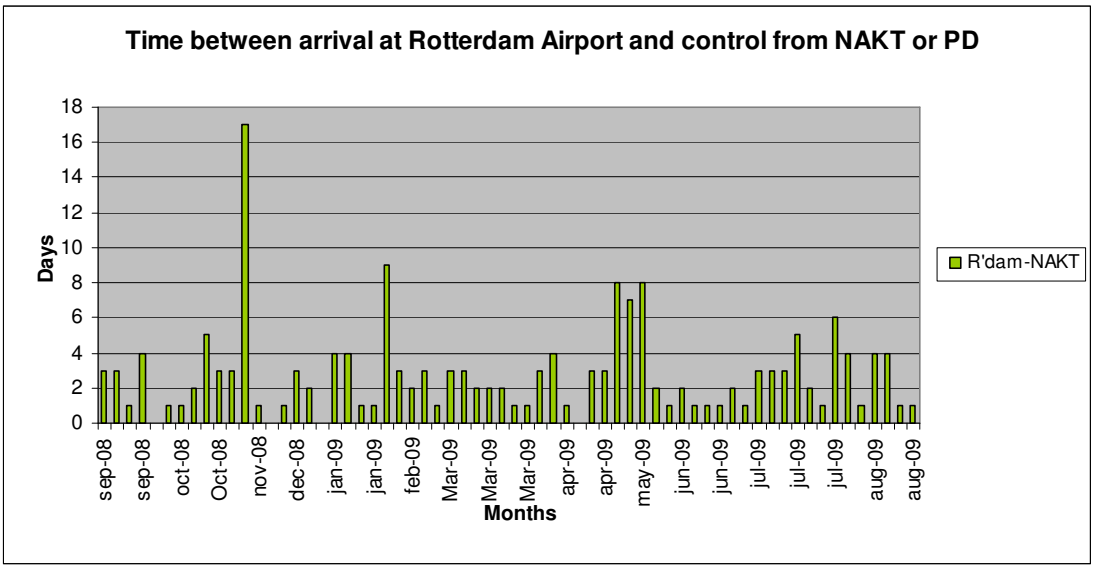


Figure 15a; Time between arrival in Rotterdam and permission of NAKT or PD

On average there are 2,8 days between the arrival in Rotterdam and the permission of NAKT to import the seeds. There is a minimum of zero days and a maximum of 17 days, which could be causes by wrong documents or a problem at NAKT with the seeds.

Time between check of NAKT or PD and clearance of the shipment

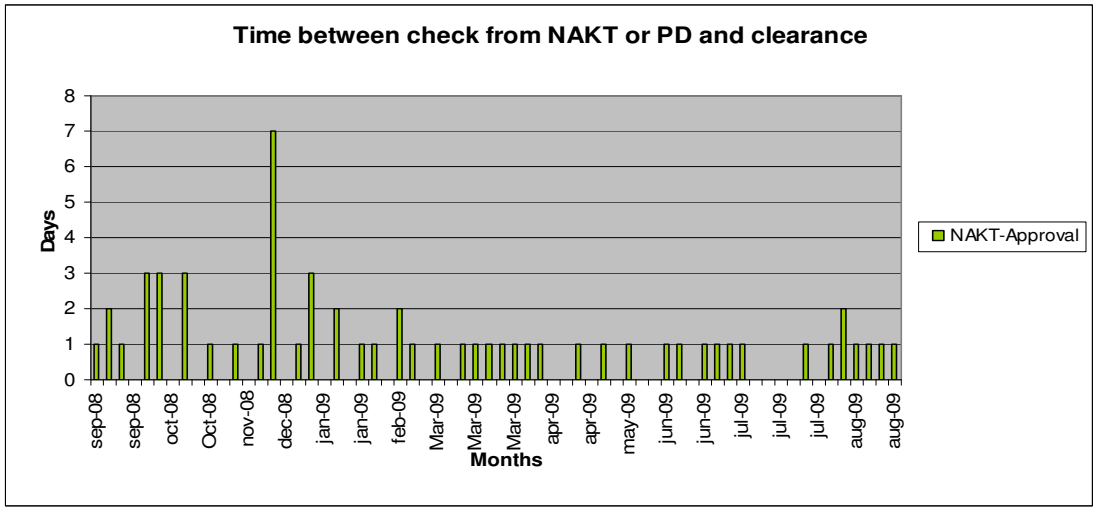


Figure 16a; Time between check of NAKT or PD and clearance of the shipment

There is on average 0,9 day between the release of NAKT and approval at De Ruiter Seeds to process the seeds and put them in ABS. A minimum of zero days and maximum of 3 days is counted.

Total shipment time from harvest until clearance

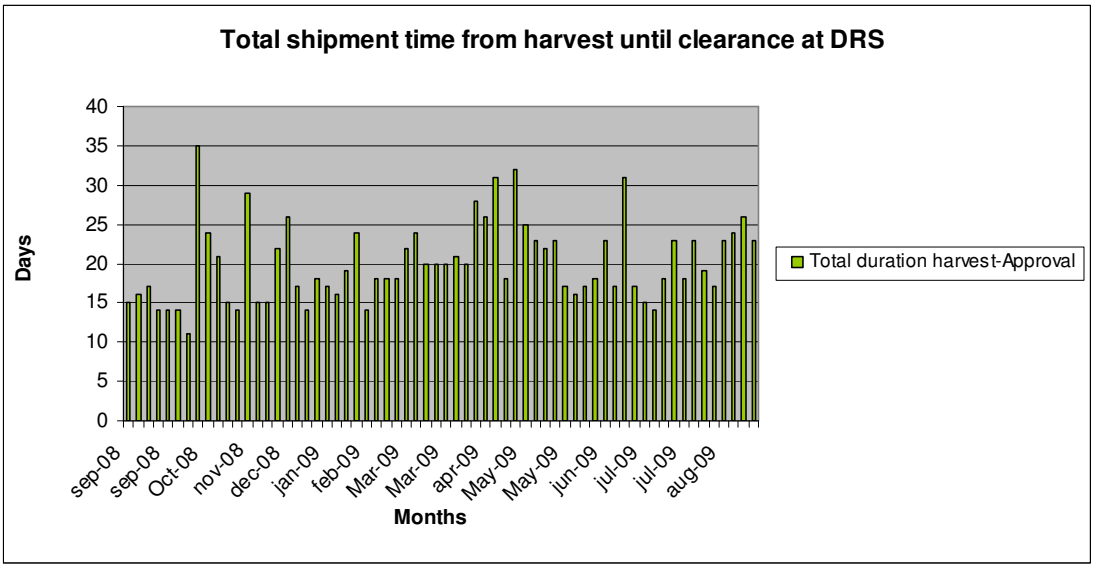


Figure 17a; Total shipment time from harvest until clearance

The total duration varies from 11 days until 35 days with an average of 20,4 days. Looking at all the minima of the separate activities, it might be concluded that the shipment can be handled in 4 days. This is not realistic because all these minima are exceptions that occurred in different shipments.