



**SAVONIA**

# **Materials Management and Development**

Case: Famifarm Oy

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<p>Abstract</p> <p>The purpose of this thesis was to research a practical concept of materials in a manufacturing organization, methods for inventory management, some critical problems and their consequences. The research also aimed at finding out potential reasons to such problems and thereby providing promising solutions.</p> <p>There are four chapters in this thesis. In chapter 1 the readers are given a general view on how the topic was chosen along with clarifying the research questions; moreover the scope, limitations and thesis structure are also discussed in chapter 1. Chapter 2 discusses all issues concerning inventory management of raw materials such as definitions, types of inventory, inventory costs, stock rotation, physical inventory and so on. Research on practical inventory management is discussed in chapter 3. This chapter consults not only the case company and current model of raw materials at Famifarm Oy but also problems existing in inventory management. The last chapter suggests some interesting ideas to improve inventory management and brings up some conclusions for the whole thesis.</p> <p>Two research methods were used in this thesis, and the first one was observation. By using participant observation, researchers could become one of the respondents and experience themselves, therefore completed a detailed and thorough description of the situation inside the company.</p> <p>Qualitative interview was used as the main tool for researching. Interviews were semi-structured and conducted either directly or indirectly. In both ways, research results brought great insight of the current methods, occasional stock-outs even though happen rarely but still cost the company a lot of extra efforts and time, the inefficient physical inventory, as well as the unsuitable division. Interview results therefore were used as the foundation to bring out suggestions for both improvements and further researches.</p>			
Keywords Logistics, Inventory Management, Raw Materials			

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## 1 INTRODUCTION

The first chapter gives readers a general view on how this topic was chosen along with clarifying the research questions. Moreover scopes, limitations and structure of the thesis are also discussed.

### ***Background***

The subject of this thesis is the development of inventory management for raw materials which belongs to logistics; it is conducted for Famifarm Oy Operation Department. In the modern business environment, competitions are getting stiffer than ever. Thousands of companies declare bankruptcy every day at the same time with the starts of thousands of new companies. Therefore, organizations are investing; academies are researching in order to make production more efficient. As a result, inventory management, one of the most important factors deciding the efficiency and cost level of a product became the centre of discussions in many business conferences all over the world.

This case study of this thesis is based on the importance of inventory management. Comparing to 7 years ago, Famifarm Oy's inventory management system hasn't changed at all; meanwhile the company's business has grown double. This critical fact led to many mistakes and unbalances in stock control, causing a lot of waste to Famifarm's production. The main purpose of this study is to describe how inventory management system, particularly raw material control is being implemented at the company, as well as to indicate existing problems and in the end, provide suggestions on the usage and development.

### ***Research targets***

This thesis is directed at answering research questions surrounding the inventory management- materials control. There are three main research targets toward the topic, which are stated below:

- Detailed description of Famifarm's production process, as well as their current methods in controlling inventory.
- Problems existing with this management mechanism, their consequences and potential causes.
- Probable recommendations to prevent further problems and improve performance.

**Scope and limitations**

Since the subject of this thesis is inventory management for raw materials, its scope belongs to logistics. However, logistics has been referred to by a number of different terms; each one has a slightly different meaning. The list below includes some terms used to refer to logistics (Murphy and Wood 2011, 22):

- Business logistics
- Distribution
- Industrial distribution
- Logistics
- Logistics management
- Marketing logistics
- Physical distribution
- Supply chain management

According to Council of Supply Chain Management Professionals (CSCMP), *“Logistics management is the part of supply chain management that plans, implements, and controls the efficient, effective forward and reserves flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customer’s requirements.”*

However, there are many sub-categories in logistics, thus a limitation is required. The chosen sub-category in this report is inventory management, which includes a variety of concepts such as Economic order quantity, ABC classification, Stock-out, Inventory costs... To understand deeply every single concept is necessary to have a complete understanding of inventory management.

**Thesis structure**

The thesis report is divided into four chapters. Chapter 1- Introduction discusses the context in which the thesis's topic was chosen. This chapter also states the purpose and defines clearly scope and limitations of the topic.

The second Chapter - Inventory Management of Raw Materials is the theoretical framework of this thesis which is described as literature reviews. In this chapter, the readers may have some thorough knowledge about inventory management, such as: definitions, types of inventory, inventory cost, etc...

In chapter 3- Research on Inventory Management of Raw Materials at Famifarm Oy gives a brief view about the case company and shows how the inventory manage-



ment system is running. From that point, all the problems existing are also defined and analyzed. This chapter also leads readers to see how the research was implemented by observing and using qualitative interviews. At the final chapter - Recommendations and Conclusions, potential recommendations and summary will be given.

## **2 INVENTORY MANAGEMENT OF RAW MATERIALS**

In this chapter, the readers are able to learn all issues concerning inventory management of raw materials. There are also some discussions about definitions of inventory management along with the way it is classified. On the other hand, the thesis consults about stock rotation, physical inventory, inventory costs; or some calculation methods for when/how much to order. Finally, ending this chapter is lean manufacturing, Just-in-time inventory management and a general view on ERP system.

### **2.1 Inventory Management**

As a matter of fact, when there is a debate about a particular subject, the very first question comes to every one's minds is "What is it we are talking about?", or "Why do we have to debate about it?" Inventory's definition and its importance certainly without a doubt should be discussed beforehand in order to exploit deeper into the universe of inventory management.

#### **2.1.1 Definitions**

*"Many years ago, a firm's wealth was measured by its inventory"* (Daft, Kendrick & Vershinia 2010, 819), nowadays, that classic perception does not fit anymore since top managements have recognized the true meaning of inventory and inventory management. Every unnecessary stock held will cost extra electricity, extra labour, and in the end has an impact on the bottom-line cost (Rushton, Croucher & Baker 2007, 220). Meanwhile, if a proper launch for inventory is implemented, the extra cost will be saved for other production processes. Therefore, to understand thoroughly inventory and its function is an important step in order to achieve greater successes.

When people mention inventory, there have been many debates and discussions about the similarities and differences between inventory and stock. The two terms are closely related and can appear interchangeably in most cases. Still, it is necessary to understand stock beforehand.

Stocks are held in mostly every firm. They vary in many forms such as meat to produce hamburger, milk to produce cheese, or information for future researches. "Stock

*consists of all the goods and materials that are stored by an organization. It is a store of items that is kept for future use" (Waters 2003, 4).*

Inventory, in the other hand, *"is the list of items held in stock" (Waters 2003, 4)*; for a shop or a retailer, inventory is accessible to customers, but for wholesalers or factories, inventory is kept in warehouses. Inventory is the larger concept which includes stock and other assets of the firms. To manage well inventory will lead to a good start for every other steps in a production process. A good inventory management is the key component, a driver for other activities to connect to each other and achieve common purposes (Murphy & Wood 2011, 151-152).

Inventory management is one part of logistics, controls the stock levels in organizations. The basic and easiest way to understand the concept is: Inventory management includes batches of activities that differ from companies to companies. Its target is to control the stock levels of materials, goods in production, or finished goods in order to maintain a good flow of materials in and out of a company or a supply chain with the most efficient budget.

### **2.1.2 Importance of inventory management**

Long time ago when there was no computer, no modern technology, merchants at the time still wrote down on papers and documents number of goods sold per day, then tried their best to *"guess"* the future demand. Because experience and intuition was the only key for this method, the accuracy therefore was never high. Even though in those days, the biggest business could only be considered small compared to today's business standard, merchants still found controlling stock numbers, knowing when to buy new supplies and how much needed in stock for future demand, one of the biggest challenges in doing business. Alongside the rapid growth of business scale, management in every level, from family business, SMEs, to multinational groups got a new appreciation for inventory management, which is now one of the most important aspects of any business (How Stuff Works).

Without a proper inventory management, especially at the scale of a multinational business with hundreds of factories like Intel or Toyota, it is impossible for top management to maintain control and handle the needs of their customers. Whatever tools to use, or agent to hire, companies managers still need to know exactly where their inventory is and its situation at any time. *"Unless you can meet the needs of your*

*customers you will soon lose all of them to competitors who are able to meet their requirements, no matter how stringent"* (Southern Fulfillment Service (SFS)).

Nowadays, if you walk into a mall of a big retailer like Wal-Mart, you are witnessing the greatest triumph in logistics' history. Wal-Mart stocks items in more than 70 countries, while Bestbuy stocks about ten thousands of items from all over the world. Besides, the Arkansas-based retailer, at any given time manages an average of \$32 billion in inventory (How Stuff Works).

For such enterprises, inventory management is not only an aspect, but the rule, the principle that every employee should be aware of. Even though being slightly less important, it still takes an important role in smaller companies and firms. "*In order for suppliers to have the goods their customers need, it is necessary for them to maintain excellent and accurate inventory management"* (Southern Fulfillment Service (SFS)). Mistakes in inventory management means customers' disappointment, too much cash stuck in the warehouse and at the same time sales go down. Therefore, a suitable system will ensure that a factory will always have enough materials for production, or enough finished goods to provide to customers. Moreover, that system will always orient to maintain as little stock as possible so the organization could maximize profit.

## **2.2 Types of Inventory**

Inventory management is a big world of knowledge and information, as well as the number of ways to classify an inventory. However, among dozens of such ways, this report focuses on the basic knowledge that everyone researching inventory management needs to know. To understand these types is the basis to achieve higher level of understanding about inventory management. A whole inventory can be divided into different parts based on their roles like cycle stock, safety stock, or base on its demand like independent or dependent.

### **2.2.1 Major inventory categories**

Inventory can be divided into various systems for different management purposes. The most major and important categories often divided are:

- 1. Cycle stock or base stock:** This is the basic and major stock for production in a common warehouse, usually related to the batch sizes of the whole producing process. Logisticians usually refer this flow of inward supply and outward demand for a particular product as the classic "saw-tooth". The reason lies in its nature of ordering in lot sizes, decrease of stock and replenished before out of stock (Murphy & Wood 2011, 152).
- 2. Safety stock:** In order to prevent stock-out, which represents the uncertainty in demand and lead times of order, logisticians usually have additional stock called safety stock or buffer stock. Safety stock is basically an extra inventory, prepared to cover the demand in case demand increases unexpectedly. Another case usually occurs which require the existence of safety stocks is unexpectedly exceeded lead time; the supplies ordered would come later than scheduled. This is the time when safety stocks prove their comfortable usage, the reasons why they were created. However, everything got its own good and bad sides, and so do safety stocks. To prevent stock-out costs increase, which is very challenging to calculate as mentioned above, logisticians prepare a number of safety stocks in their warehouse facilities and plants. Unfortunately, at the same time stock-out costs decreased, logisticians have to spend more money on holding the extra stocks, which leads to the increase of inventory holding costs. The most important point here is logisticians need to take into consideration and calculate the best balance between these costs. Figure 1 shows the basic idea of Cycle stock and Safety stock. The thin "saw-tooth" line represents the ideal flow of cycle stock, decreasing, replenished in batches before out of stock and going on a loop. The thick "saw-tooth" line represents the regular flow of cycle stock in reality, which fluctuates unexpectedly because of many uncertainties in demand, lead time, or forecast... Because of the existence of many uncertainties that led to the creation of safety stock which is the darker coloured part. As being seen in the figure, safety stock has proved its advantages in saving a logistician from a shortage in his inventory (Rushton, et al. 2007, 200).

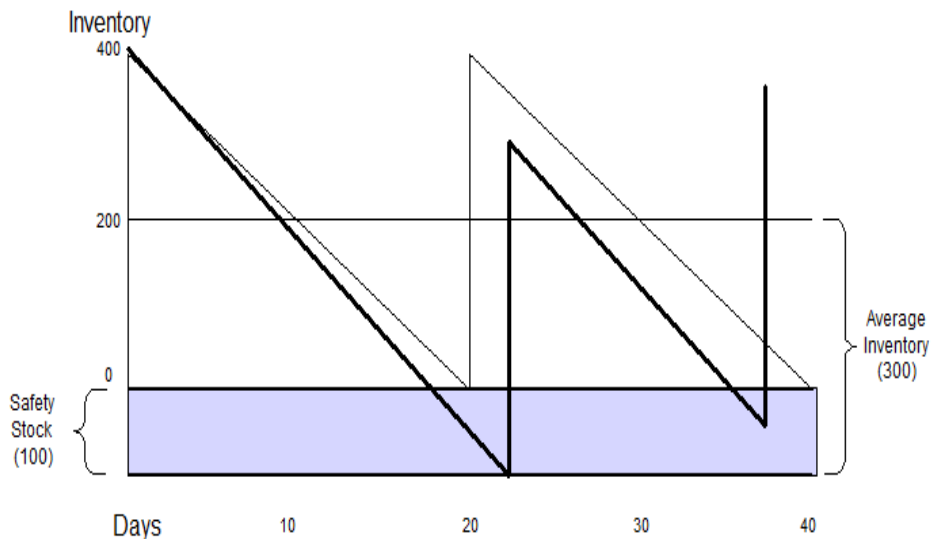


FIGURE 1. Cycle stock and Safety stock (Resource system consulting)

3. **Speculative stock:** This stock refers to other kinds of inventory which are held for special reasons, including seasonal demand, preparation for future demand... For example a chicken farm is preparing a big amount of eggs for incoming Easter, or a Finnish meat company prepares a special amount of "kinkku" –ham for Christmas... (Murphy & Wood 2011, 152).
4. **Psychic stock:** The most extraordinary kind of inventory. Usually inventory is created to satisfy demands, but in this case, some stock is prepared to stimulate demand, which is called psychic stock. Commonly being used in retail stores, psychic stock can be great amount of goods purposely shown in customers' eyes to stimulate purchases (Murphy & Wood 2011, 152).

### 2.2.2 Independent demand and dependent demand

One important base to divide inventory is demand. Judging on the nature of the items, logisticians can separate their inventory into two kinds: Independent Demand and Dependent Demand. To understand the difference between them is one of the most essential conditions to control inventory.

*"Demand is considered independent when no relationship exists between it and the demand for any other item"* (Tersine 1994, 337). Basically items with independent demands are not produced in another item's production schedule but on their own. The most comprehensive example for this concept is finished goods from a factory. The factors that affect an independent demand item's production include market trends, customers' orders, historical data which leads to forecasts and estimations.

Companies usually base on these factors to create schedule for independent items. Even though the item doesn't depend on other items, its production still makes a very challenging mission to top managements since the affecting factors always fluctuate. Nowadays, each product category is filled with thousands of brand names. The competition is getting tougher and tougher with new products, new functions, and new services every day. Not to mention hundreds of new technologies applied in latest products are also changing ending customers' behaviour rapidly. Thus, in order to avoid inventory tragedies such as over supply or stock-out, logisticians have to consider carefully demand for these independent items (Tersine 1994, 337).

Certainly, when there is independent demand, there will be dependent demand. Items classified as dependent demand are items produced based on other items' production schedule. For example, an Audi car factory just finished manufacturing 300 new cars for sales. The cars are independent items since they don't have to depend on any other product. But the subordinate items such as wheels, brakes, bodies, are dependent. The schedules for ordering from suppliers or manufacturing these subordinate items totally stick with the schedule of the cars. Based on the number of new cars needed to produce which are 300, Audi managers can make the calculation that they will purchase, or produce themselves 1200 wheels, 300 brake parts, and 300 car bodies. All of them must be ready at the factory before the production time of 300 cars. Basically, top managers need to forecast and estimate demand for independent items, then base on the requirement, calculate the demand for dependent items (Tersine 1994, 337).

### **2.3 Inventory Classification Methods**

To be successful in every area of business, an enterprise always need an inventory control system; even it is the simplest or most automated system to make business runs smoothly. Nowadays, most organizations use selective inventory classification methods based on Pareto 80-20 principle, which states that "*there are a critical few and trivial many*" (Roy 2005, 105). This stand rule 80-20 suggests that 20% of inventory items need 80% of the attention, conversely 80% of items need only 20% of the attention (Waters 2009, 362). Some of the popular inventory classification methods are as followed:

- ABC classification
- FSN classification
- VED classification

### 2.3.1 ABC classification

ABC classification, popularly known as "Always Better Control", is a method of classifying stock items into groups based on the total annual expenditure, or total stock-holding costs of each item. The items on hand are classified into A, B and C types on basis of value in terms of capital or annual euro usage (i.e., euro value per unit multiplied by annual usage rate), which also defined as follow (Waters 2009, 362)

- A items as high value and need special care
- B items as ordinary ones need standard care
- C items as low value and need little care

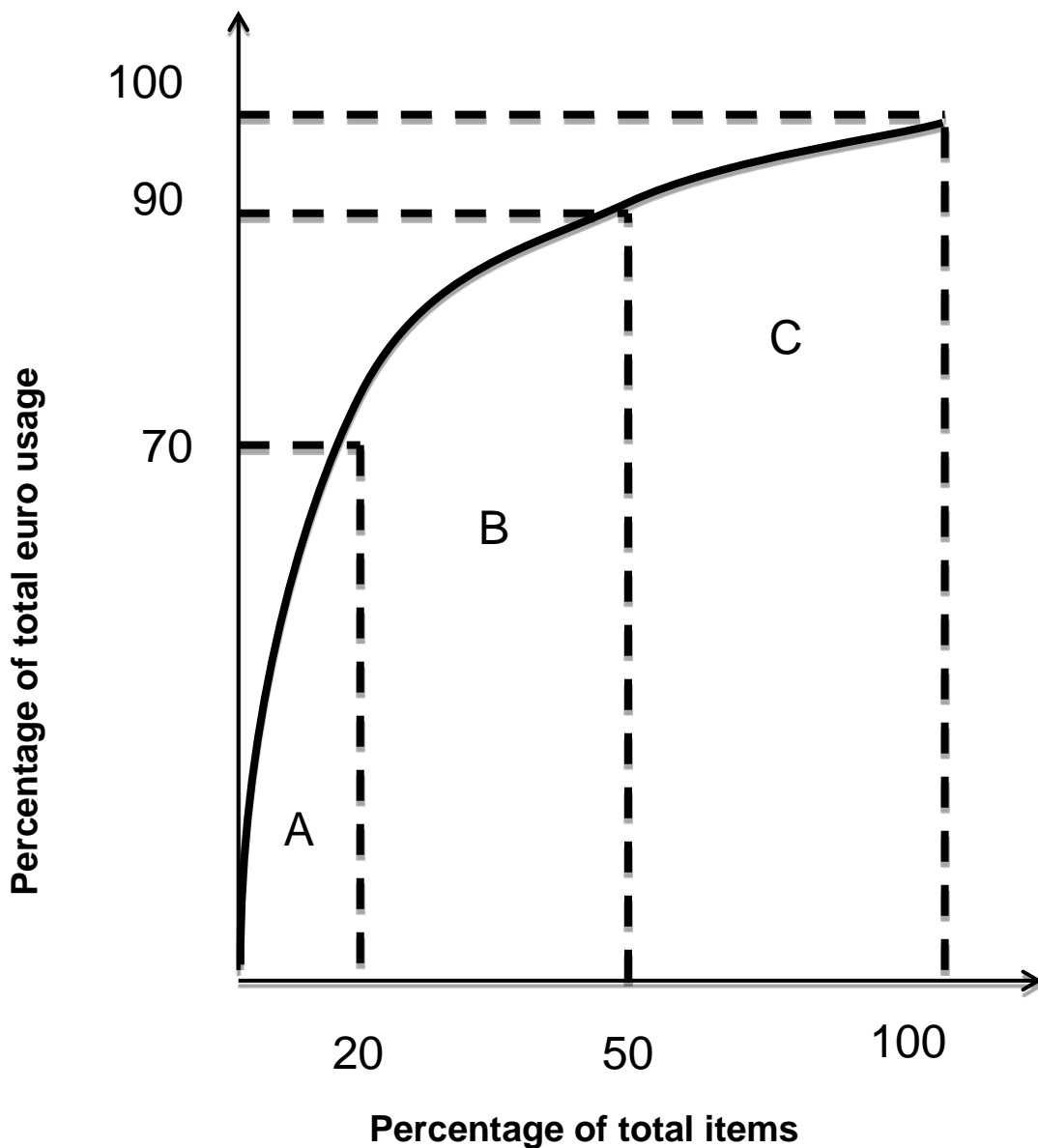


FIGURE 2. ABC classification of items (Roy 2005, 105)



Figure 2 shows the distribution of these three types. That means, the actual number categories varies from organization to organization, depending on the extent to which a firm wants to differentiate the control efforts. Suppose there are 3 types of items A, B, C, with percentage of total items and percentage of euro usage of item C are 100%. Numbers of item B are 50% compared to C but require 90% of item C's euro usage. Being the most expensive and need special care, even though numbers of item A are only 20% but require 75% euro usage compared to item C (Roy 2005, 105).

The number of categories from an organization is defined in terms of the value of annual demand, so an ABC analysis starts by calculating the annual usage by value of each item. That means it multiplies the number of units used in a year by the unit cost. However, a few expensive items account for a lot of use, while many cheap ones account for little. Therefore, listing the items in order of decreasing annual usage by value put A items at the top of list, B items in the middle and C items at the bottom, as shown in Table 1 below (Waters 2009, 363):

TABLE 1. ABC categories of items classification (Waters 2009, 363)

<i>Category</i>	<i>% of items</i>	<i>Cumulative % of items</i>	<i>% of use by value</i>	<i>Cumulative % of use by value</i>
A	10	10	70	70
B	30	40	20	90
C	60	100	10	100

However, a manager should note that C type items are not necessarily unimportant, due to the low annual dollar volume of C items, there may not be much incurred by ordering large quantities of some items, or ordering them a bit earlier (Roy 2005, 107).

When applying ABC classification in inventory management, some rules must be taken into consideration:

- A items: need high priority, tight control including complete accurate records, regular and frequent review by manager, frequent review on demand forecasts, and close flow-up and expediting to reduce lead time.
- B items: need medium priority, normal controls with good records, regular attention, and normal processing.

- C items: need lowest priority, simplest possible controls - make sure there are plenty. Simple or no records, perhaps use periodic review system. Order large quantities and carry safety stock.

On the other hand, using ABC classification could determine cycle counting for materials in inventory. Different categories (A, B, C) have different cycles (periods/times) for inventory counting.

- Category A items are counted most frequently, perhaps monthly
- Category B items are counted less frequently, perhaps quarterly
- Category C items are counted least frequently, perhaps once a year.

### **2.3.2 FSN classification**

In this method, the items are classified according to the rate of consumption. So FSN stands for Fast moving, Slow moving and Non-moving items. This form of classification identifies the items frequently used, less frequently used and the items which are not used for a long period. For example, applying this concept on a kitchen with different items in our home as: rice, salt, sugar, tea, vegetables, fruits, dry fruits, medicines, cosmetics, shaving blades and wound plasters, according to FSN they can be classified as below (Roy 2005, 107):

- F: rice, salt, sugar, tea and cosmetics are mostly used daily at relatively faster speed and they need more attention.
- S: Fruits, dry fruits are used moderately and need moderate attention
- N: Medicines, shaving blades, wound plasters are not used frequently and need less attention.

### **2.3.3 VED classification**

This method is classified according to its criticality in the production system. Thus VED stands for vital (V), essential (E) and desirable (D). Managers should pay maximum attention to the procurement and control of vital items and less to desirable ones. Lacking vital items can bring the plant of production down and the plant will run into losses (Roy 2005, 107).

For example, if 1000 items of steel planted and based on VED classification, it could be identified:

- V = 200 (much attention is given to vital items)
- E = 300 (moderate attention is given to those items)

- D = 500 (less attention is given to these items)

Moreover, the VED classification helps in focusing the attention of management on vital items and ensures their availability by frequent reviews and reports. Therefore, the downtime losses could be minimized to a considerable extent.

In conclusion, by using inventory classifications above, managers can achieve success in controlling all inventory items. Again, it is essential to analyze inventory items based on various characteristics such as frequency of issues, annual consumption value, critical priority, lead time and unit price.

## 2.4 Stock Rotation

Another important factor in inventory management is stock rotation. The term defines how merchandises and goods should flow in and flow out of stock in the most organized ways. There are several of methods to control stock rotation, depends on different and specific environment conditions.

The most important point here is not to keep the goods too long in stock. Why? Because the longer the goods stay in stock, the higher holding cost is. More than that, there will be higher chances for obsolescence as mentioned in chapter 2.6.1, especially when it comes to food category products such as milk or vegetables. These products have one of the earliest expiry dates, usually from 1-2 weeks at maximum after production. That is why logisticians have to understand the importance of stock rotation.

The idea of stock rotation is to always use or take the oldest units of a particular item first. Oldest here means the units stay in stock the longest time, still in good condition and undamaged. Many researches and methods have been taken into practice in order to make the goods flow more smoothly and never have too old and damaged products in stock. One of the current approaches is FIFO (First in, First out) according to which, "*products received first and/or with the closest expiration date on the label are shipped, displayed and sold first.*" (Tijskens, Hertog & Nicolai 2001, 422) and figure 3 below shows the idea of how a FIFO system works.

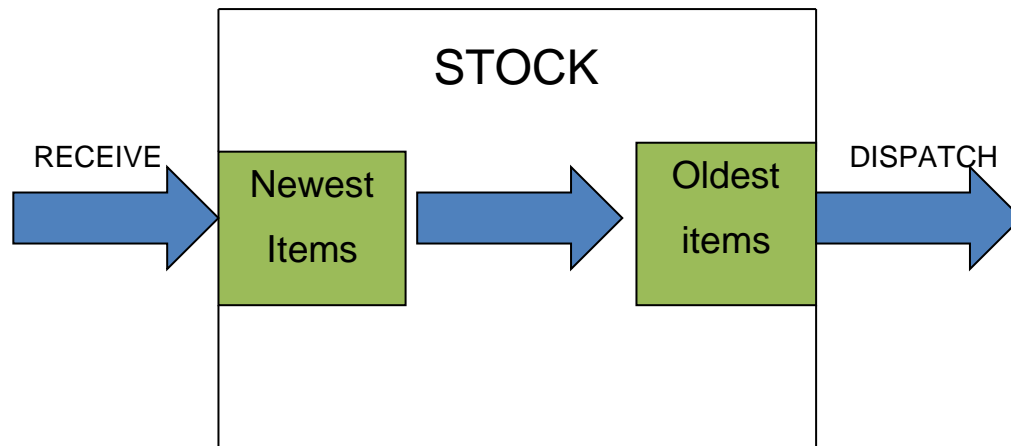


FIGURE 3. FIFO system

The fundamental point of using FIFO system is to make sure that units, which recorded first in stock, must be the first units to be recorded out. For a single item in stock, it is easy to understand in figure that the oldest units will be dispatched first. Even though in a multiple-item stock, with different expiration dates, it will become more complicated to control but the main principle is still applied to all items.

There are many benefits come from using FIFO system in inventory management. First of all, average quality of goods in stock is maintained high because no item has to stay too long in the warehouse. In many warehouses, when receiving new products, without a proper control system, warehouse workers usually put newer items in front while older items are still stuck behind, therefore when there are needs for taking goods to ship, dispatching workers cannot take older items even if they want to. Using FIFO can help avoid this kind of trouble. Besides, FIFO system helps inventory managers decrease the complication of difference between prices at the time receiving goods and issuing goods, keep goods' value in line with their "book" value. At most, it helps decrease the chance of obsolescence, there will be no expired products to throw away, which reduces an amount of waste and increase profit to organizations (Johnson & Everson 2003, 27).

In order to implement a good rotation stock system like FIFO, it is necessary to have tools such as barcode, scanners and computers, especially important to gigantic warehouses in multinational organizations. The main target is to be able to record exactly numbers and dates of products received as well as products issued. For some small factories, there might be no need for barcode, only dates and stickers are enough for dispatchers, as long as products are arranged in the most sufficient order (newest inside, oldest outside).

## 2.5 Physical Inventory

Assuming there was 10000 units recorded receiving in stock at the beginning of the year. The consumption after each month was 500 units, correspondent to which the final consumption for the whole year is 6000 units, therefore the remaining number of units should be 4000. But is it really the actual number of units in stock at the end of the year? In fact, without a usual check, there might be a very high chance more or less than 4000 units in stock. The reasons might varies from errors in receiving record, damages, theft, and loss,...that's why organizations and firms have to conduct physical inventories usually.

Physical inventories have been defined by many researchers and expressed in different ways, but there is always one important core point in its definition, which is "actual count". It means there must be someone, or a team to go and physically count the number of items in stock at the time (Goetz 2011, 2).

Afterwards, people questioned about the reasons and purpose of this action of actual counting, which led to multiple answers. Physical inventory certainly has proved its importance in organizations' inventory management. Knowing exactly how many units in stock is absolutely fundamental to high managers. From a general view, highest managers always want to know where their capital is located, which is here expressed in terms of units. From the point of production side, physical inventories help in verifying the availability of materials needed. By maintaining a proper and often physical inventory, logisticians can maintain the integrity and accuracy in their inventory control (Goetz 2011, 2).

There are also various types of physical inventories but the most major types are periodic and cyclic. When using periodic physical inventories, logisticians perform counting after a set period of time. The period, certainly varies from stock to stock, could be daily, weekly, monthly or annually. The start and stop date of counting is established beforehand and in each time, all inventory will be counted. Besides, in periodic physical inventory, it is also divided into open and closed stores process. Easily to understand, when a store or a factory performs closed stores process, they shut off production or selling operation and try to spend as little time as possible to perform counting. Because of its particular character, closed stores process isn't used for factories and stores which need to do physical inventories daily or weekly. In contrast to it, open stores process is performed while all operations and stock rooms re-

main open. One common point is in both cases, there is always a set period of time for performing physical inventory (Goetz 2011, 2).

Similar to that, cyclic physical inventories also have set forth start and stop date, during which inventory will be checked, but not all. Using cyclic physical inventories, the whole inventory are divided into manageable groups as mentioned in chapter 2.3 Inventory Classifications Methods, with each group has different start and stop date for counting, as well as different regularities. High value group A can be counted once a week, normal value group B can be counted once a month, while low value group C only needs counting annually. Items can also be divided by consuming speed like fast-consuming group, medium-consuming group and slow-consuming group (Goetz 2011, 5-6).

Performing a proper physical inventory requires not only human resources or set forth schedules but also step-by-step planning and many paper works included. With its essential importance to the accuracy of inventory control, even though it would takes a lot of attentions and supervisions, physical inventories performed properly will become a great tool for high level managers to minimize unnecessary wastes and maximize profit.

## **2.6 Inventory Costs**

According to Tersine (1994), "*the objective of inventory management is to have the appropriate amounts of materials in the right place, at the right time, and at low cost*". As a matter of fact, like every other aspect in a business, inventory costs money. It not only appears as an asset on the balance sheets of a company, but also tends to be in the top largest assets in terms of money value. To understand inventory costs therefore becomes an important task to logisticians (Tersine 1994, 13).

Inventory costs include not just the essential holding cost, but there are also ordering cost and stock-out cost, which is shown in Figure 4 below. It is critical to have a deep comprehension of each cost's nature and the trade-offs among them (Murphy & Wood 2011, 153).

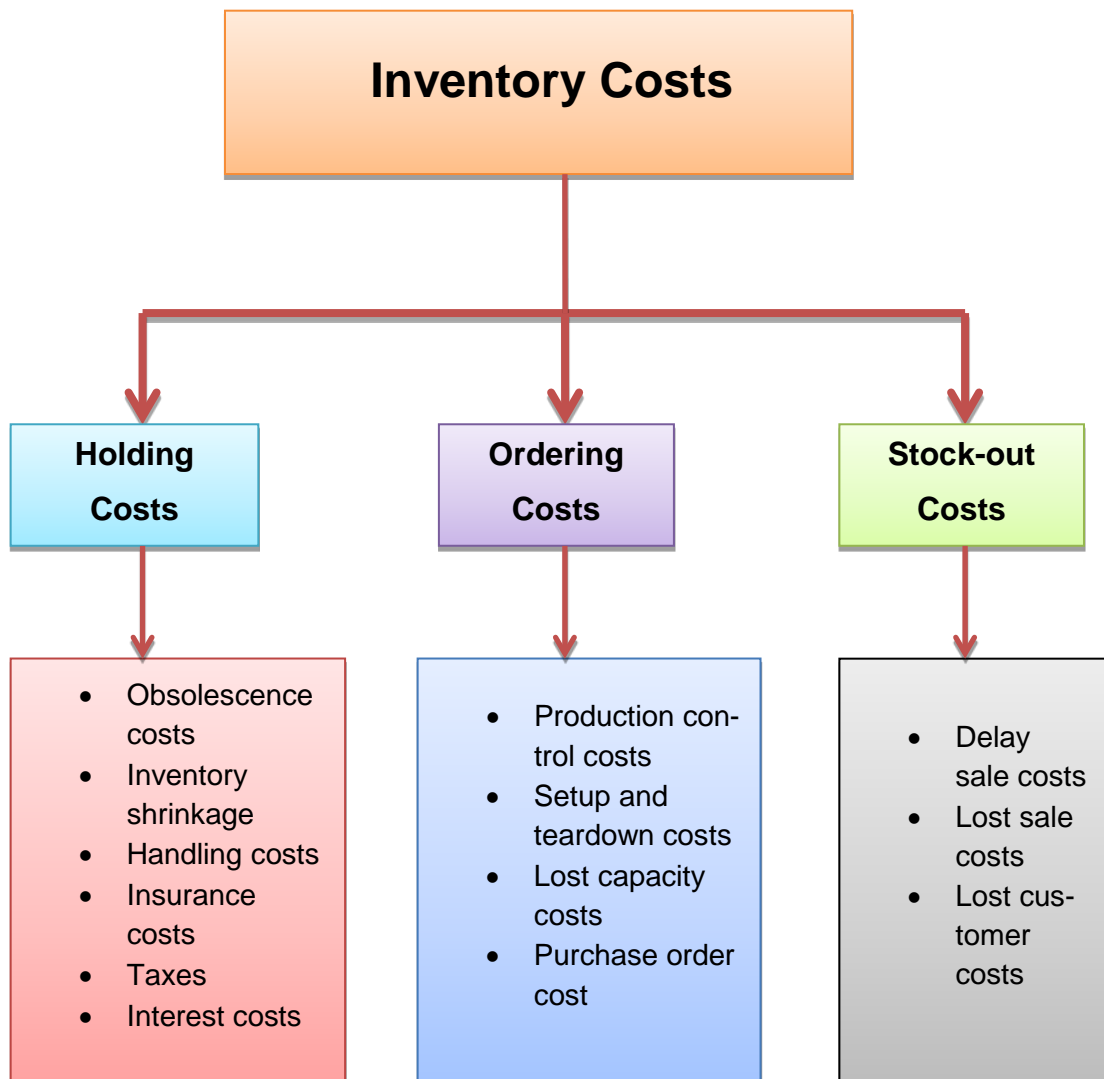


FIGURE 4. Inventory Costs

### 2.6.1 Holding cost

Usually being the first idea comes to mind when people mention inventory costs, holding costs include expenses associated with holding stock. Many people might think that if we minimize this cost also means minimizing the stock. However, the thought is not totally true. When a factory holds no stock, it certainly costs nothing for inventory, but at the same time has nothing for sales, leads to losing customers which means costs anyway. Basically, it is not ideal to hold no stock because companies will gain nothing while losing customers, rather should they try finding the best balance between holding stock and making sales (Waters 2009, 341).

Generally, inventory holding cost is shown in percentage terms, which is multiplied by the inventory's total value. There is a rule of thumb from the dates of mid-1950s says that the total cost for holding stock should be about 25% of its total value per year. In a recent study, more than 50% of the surveyed companies had established inventory holding cost, while mostly 20% of study respondents neither knew nor had access to their company's inventory holding cost. This fact led to the common use of inventory holding cost today is estimated the very same percentage as half-century ago. The components of holding cost are:

- Obsolescence costs
- Inventory shrinkage
- Handling costs
- Insurance costs
- Taxes
- Interest costs

Inventory holding costs include various numbers of different factors such as: capital, taxes, insurance, obsolescence, storage...Each component in these costs occur with but at the same time varies from product to product. To illustrate the component "obsolescence", it can be seen in this example. With quickly perishable items such as vegetables, meat, milk, fish, there is usually a short time before their expiration dates after which the products' value will become little or even zero. While for items such as erasers or pens, their values can stay still for a very long period. The bottom line in this example of obsolescence is products lose their value through time, some loses slowly, and some loses fast. If logisticians don't take it into account, there will be great financial losses (Murphy & Wood 2011, 153-154).

Certainly, money is required to maintain the investment in an inventory. That is where interest costs take into account. There is logic for using the prime interest rate said that cash to replace capital invested in inventory is viable to acquire in the money markets at that rate. There is always confusion from logisticians in establishing clear-cut policy for interest costs because it will have a big impact on performance and overall system design (Bowersox, Closs & Cooper 2010, 162).

One important factor belonged to inventory holding cost is storage. This expense refers to holding products, to occupying space in a warehouse or plant. According to Bowersox et al. (2010), the annual occupancy cost for a product can be calculated by multiplying average daily physical space occupied by the standard cost factor for a particular period of time. After that, logisticians divide the figure by the total number of



products flowing through the facility; they can achieve average storage cost per unit. As mentioned above, storage cost also varies from product to product. Some items only require dry space at normal temperature while some requires specialized warehouse facilities. Good examples of these items can be imported seafood or ice-cream which is usually stored at -20 degrees Celsius. As a result, such items will take much more storage cost than others (Bowersox et al. 2010, 162-163).

Another one closely related to storage cost is handling cost. While companies invest money on plants, warehouse facilities to hold stock, it is certainly necessary to expend on hiring employees to receive, store, and move inventory in and out of the facility. In many cases these two costs can be considered as one storage costs.

Essential and unavoidable, insurance and taxes are important entries in calculating inventory holding costs. Insurance, as a matter of fact, becomes a critical problem nowadays. It is an issue that nobody wants but everybody needs. The demand of ensuring economic protection in case of unwanted events is the reason behind, and so do logisticians. Loss, theft, damages are becoming harder to control since the scales of facility growing bigger, the speed of moving stock growing faster. To spend money on insurance is now an essential part of inventory control. However, like every other factors, it varies among various kinds of products. Rubies, sapphires, gold are stored with extremely high insurance cost while cheap products for everyday use require cheaper cost. Besides, insurance cost is also different between high security and low security facilities. Besides, in many regions taxes are assessed based on inventory held in warehouses. Location difference determines differences in tax rates and assessment methods (Bowersox et al. 2010, 162).

Another important issue needed to take into account when dealing with inventory holding cost is inventory shrinkage. It took logisticians a long time to understand why there was a fact that more items recorded entering than items recorded leaving storing facilities. Generally the reasons are damages, loss, and theft. Still, the solution for this issue is not easy. The contradiction here is when companies want to reduce inventory shrinkage; usually they change to better packages, increase facility securities... which increase other costs. The best balance for each facility will be quite different (Murphy & Wood 2011, 154).

### 2.6.2 Ordering cost

Besides holding cost, ordering cost also takes an important role in the whole picture of inventory cost management. Ordering cost refers to placing an order to another factory or supplier. It does not depend on the number of units in an order, but rather the number of orders placed in a period of time.

Ordering cost doesn't include only one but a few costs associated with the ordering inventory, which can be divided as follow:

- **Production control costs:** such as issuing and closing orders, scheduling, loading, dispatching and expediting. This is the cost for the efforts expended in production
- **Setup and teardown costs:** Whenever there is an issued order, it is essential to setup to run the order, and tear down the setup when the order is done.
- **Lost capacity cost:** It always costs time to setup an issued order, and this time is called productive output time. It is considered a loss of capacity is particularly important to those factories with bottleneck work centers.
- **Purchase order costs:** Every time a company issues an order, there is always cost for placing it. "*These costs include order preparation, follow-up, expediting, receiving, authorizing payment, and the accounting cost of receiving and paying the invoice*" (Management & Development Center).

### 2.6.3 Trade-off between holding and ordering costs

The trade-off between holding costs and ordering costs is basically a balance method for logisticians. If logisticians want to decrease ordering cost, it is unavoidable for them to increase holding cost and conversely.

Ordering cost is calculated by multiplying number of orders per year times the cost per order. Also, assuming even outward flow of goods, we can apply inventory holding cost to one-half of the order size, which represents average inventory. Average inventory is then multiplied by holding cost per unit. Suppose the total demand is the same in both cases, one case got high number of orders and small orders size, while the other one got low number of orders but bigger orders size. The example below will explain the trade-off.

Weekly demand is 200 units, value of a unit is 20 €, each order costs 50 €, holding cost is 25% of an item.

- **Case 1:** If we order one order per year

$$\text{Ordering cost} = \text{Cost per order} \times \text{Number of orders}$$

$$= 50 \times 1$$

$$= 50 \text{ €}$$

$$\text{Holding cost} = \text{average inventory} \times \text{holding cost per unit}$$

$$= [(\text{weekly demand} \times \text{number of weeks per year})/2]$$

$$\times [\text{value of an unit} \times \text{holding cost (\%)}]$$

$$= [(200 \times 52) / 2] \times (20 \times 0.25)$$

$$= 5200 \times 5$$

$$= 26000 \text{ €}$$

- **Case 2:** If we place an order every week

$$\text{Ordering cost} = 52 \text{ orders} \times 50 \text{ €}$$

$$= 2600 \text{ €}$$

$$\text{Holding cost} = \text{average inventory} (200/2) \times \text{holding cost per unit}$$

$$(20 \times 0.25)$$

$$= 100 \times 5$$

$$= 500 \text{ €}$$

(Murphy & Wood 2011, 155).

#### 2.6.4 Stock-out cost

Stock-out, as the word itself, is the case when there is out of stock, not enough for supply. Stock-out cost is related to all economic consequences of stock-out, which could happen from external shortage or internal shortage.

An internal shortage happens among departments in an organization, when a department cannot supply materials for another department. Usually in these cases, an organization has to use substitute materials which either cost higher or has worse quality. If the cost for substitute materials is higher than normal, production cost will increase. If the quality is lower, damages on the company's credit is unavoidable. In both ways, having to use substitute materials already means a decrease in company's profit. However, having substitute materials is still not the worst in stock-out. What if there is no substitute material? In that case, it is called lost production, there-

fore leads to the same situation for external shortage described below (Tersine 1994, 14).

An external shortage happens when a company doesn't have enough finished goods in stock to provide to customers. Calculating the exact stock-out cost is usually very challenging that many organizations ignore it and focus on calculating safety stock. Unfortunately, it is impossible to have exact inventory costs without the determination of stock-out costs, which brings a lot of benefits in calculating other factors of inventory control like how much to hold... (Murphy & Wood 2011, 156).

Clearly, there will be reactions from customers when there is a stock-out, and these reactions can be used to calculate stock-out costs. Even though there are various types of reactions from customers, but we can basically divide them into three categories:

1. Delayed sale (brand loyalty)
2. Lost sale (switched and comes back)
3. Lost customer.

With the first reaction, the estimated loss can be nearly zero since the sale is only slightly delayed, and mostly no future damages. The situation becomes worse in the second case when customers switch to other competitors for this instance. Even though they will still come back for future purchase, the current sale is already lost. The worst case happens when a company totally lost a customer. Being unsatisfied, customer changes to buy from competitors for good, and the company has to invest from the beginning to acquire a new customer to replace which usually cost five times than retaining an exist one.

Suppose there was a stock-out and 1000 customers experienced with different reactions divided in three categories as mentioned above. Among the customers, 15% gave back orders (delayed sale), 30% switched and come back later (lost sale) and 55% totally changed to purchase from other competitors (lost customer). Each probability is then multiplied by the respective loss in order to calculate the average stock-out cost. Assuming that a delayed sale doesn't cost anything since the sales will still be finished when available and customers are brand loyal. However, customers who switched and come back made the sale lost which led to a loss in profit. Lastly, lost customers' cost is related to a new customer developing cost. Table 2 shows the calculation for average stock-out costs.

TABLE 2. Determination of average stock-out cost, case 1 (Murphy & Wood 2011, 156).

<i>Alternative</i>	<i>Loss</i>	<i>Probability</i>	<i>Average cost</i>
1. Loyal customer	0	<b>0.15</b>	0
2. Switches and come back	50	0.3	15
3. Lost customer	900	<b>0.55</b>	495
Average cost of a stock-out	<b>510</b>		

The probabilities of the reactions also have an impact on the average cost of a stock-out. A better comprehension can be described through the table below. In Table 3 we switch the probability of reaction 1 and reaction 3 which leads to a different result in the average stock-out cost.

TABLE 3. Determination of average stock-out cost, case 2 (Murphy & Wood 2011, 156).

<i>Alternative</i>	<i>Loss</i>	<i>Probability</i>	<i>Average cost</i>
1. Loyal customer	0	<b>0.55</b>	0
2. Switches and come back	50	0.3	15
3. Lost customer	900	<b>0.15</b>	135
Average cost of a stock-out	<b>150</b>		

According to the results above, we can see the impact on the cost of a company when there is a stock-out. The more customers lost, the more new customers need to be developed in order to replace which takes a lot of time, efforts, and capitals. In the opposite way, the more brand loyal customers a company has, the better chance for them to reduce stock-out costs and have a better profit report (Murphy & Wood 2011, 156).

### 2.6.5 Trade-off between stock-out and holding costs

Similar to the trade-off between holding cost and ordering cost mentioned above, there is also a trade-off between holding cost and stock-out cost, as one cost moves higher or lower, the other will move in the opposite direction. An easy way to understand this issue is looking at the trade-off between number of stock-outs prevented and number of units in safety stock. Assuming in an inventory, products can only be ordered in batch of 10 units per time, with each unit values 480€. The holding cost is

assumed at 25%, which leads to the incremental holding cost of moving 10 units in safety stock are  $10 \times 480\text{€} \times 0.25 = 1200\text{€}$ . The purpose of this example is to show that various levels of safety stock can prevent a number of stock-outs. For example if holding 10 units in safety stock can prevent 20 additional stock-outs, then moving from 10-20 units in safety stock can prevent 16 stock-outs more. Suppose the average cost of a stock-out calculated at 400€, a safety stock with 10 units can avoid  $400\text{€} \times 20 = 8000\text{€}$  stock-out cost, comparing to the additional holding cost 1200€, logisticians can easily see the advantages of having a safety stock. But how many units in the stock should be optimal? Continuing the calculation, we can see at 70 units in safety stock, the stock-out cost avoided is equal to additional holding cost 1200€ and this should be the optimal amount to hold in safety stock for this firm (Murphy & Wood 2011, 157).

TABLE 4. Determination of safety stock level (Murphy & Wood 2011, 157).

<b>Number of Units in Safety Stock</b>	<b>Additional Safety Stock (480€ per unit)</b>	<b>25% Annual holding cost</b>	<b>Total value of Incremental Safety stock</b>	<b>Additional Orders filled</b>	<b>Stock-out Costs Avoided</b>
10	€ 4,800.00	€ 1,200.00	€ 1,200.00	20	€ 8,000.00
20	€ 9,600.00	€ 2,400.00	€ 1,200.00	16	€ 6,400.00
30	€ 14,400.00	€ 3,600.00	€ 1,200.00	12	€ 4,800.00
40	€ 19,200.00	€ 4,800.00	€ 1,200.00	8	€ 3,200.00
50	€ 24,000.00	€ 6,000.00	€ 1,200.00	6	€ 2,400.00
60	€ 28,800.00	€ 7,200.00	€ 1,200.00	4	€ 1,600.00
70	€ 33,600.00	€ 8,400.00	€ 1,200.00	3	€ 1,200.00

## 2.7 Order Time

When to order and How much to order is supposedly the two most fundamental questions for every logisticians. The answers for these questions depend on the nature of each inventory system, which varies in both time and quantity factors. It is necessary to understand the basic two inventory replenishment systems before knowing when and how much to order.

### 2.7.1 Fixed order quantity system

In an inventory using fixed order quantity system, basically the order quantity is constant, which means each and every time managers place an order for replenishing inventory, the number of units ordered are unchanged. However, demand from cus-

tomers are not constant, instead they vary from season to season, from month to month, or week to week. So how can logisticians manage their customer's fluctuating demand with the constant order quantity? The answer lies in the fluctuation of time interval. For example in a low demand season, the time length between 2 orders could be a month, but in a high demand season, it could be shortened to a few days per order. Thus, the key point here is represented by reorder point, which defines at which level of inventory; a replenishment order should be placed. Figure 5 shows the illustration of reorder point.

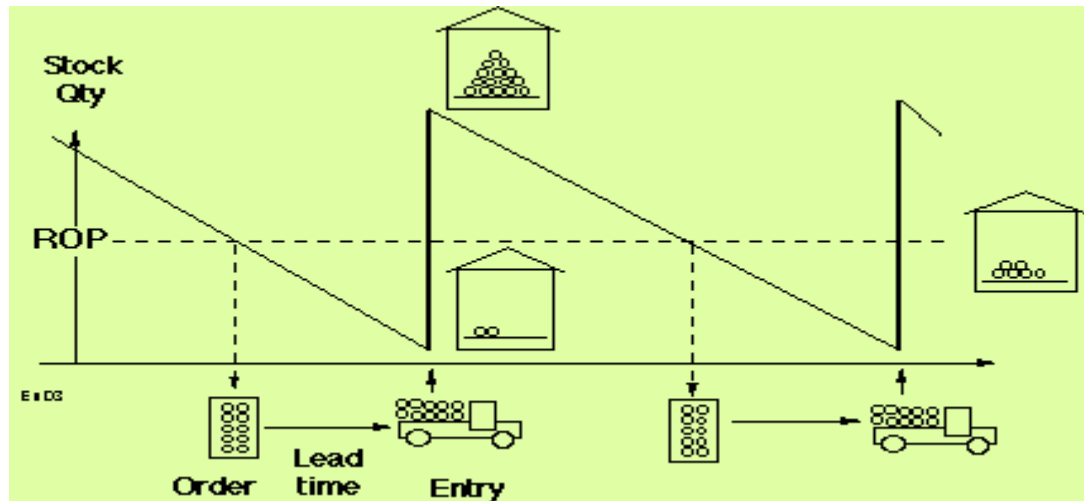


FIGURE 5. Reorder point (Administrative Information Service 2004).

Under certain conditions, the term reorder point (ROP) can be calculated easily by multiplying average daily demand (DD) by the length of the replenishment cycle (RC):

$$\text{ROP} = \text{DD} \times \text{RC}$$

Assuming a case when average DD is 30 units, and RC, which represents the length of time from the order is placed until merchandises are received in stock, is 7 days. As a result, ROP will be  $30 \times 7 = 210$  units, which means when the remaining number of units in inventory is 210; an order for replenishment should be placed.

However, just as mentioned above, that formulation for ROP can only be applied in certain conditions, but in reality it is mostly impossible. Because of the fluctuations of various factors affecting demand, delivery time...safety stock (SS) was born and was added for a more proper formulation of ROP

$$\text{ROP} = (\text{DD} \times \text{RC}) + \text{SS}$$

Suppose in the example above, the company decided to have 60 units in safety stock, then ROP would be  $210 + 60 = 270$  units. Uncertainties are the reasons why fixed order quantity inventory systems should be monitored regularly. Predetermined ROP, level of inventory should all be checked frequently for a next better and exact ROP calculation (Murphy & Wood 2011, 157-158).

### 2.7.2 Fixed order interval system

Like a reverse of fixed order quantity, fixed order interval inventory systems usually have fluctuating order quantities, while time intervals are constant. The time interval can be short like 5 days, or long like 6 months, but as long as an interval is applied, it will be constant. However, the order quantity is variable and dependent on the usage (demand) between the two ordering times.

In a fixed order interval inventory, there are some factors which must be take into account in order to maintain a smooth flow of goods through the system. With a maximum inventory level predetermined  $E$ , the stock condition is usually checked after a fixed period of time  $T$ . After that, an order of a proper number of units will be placed to make the inventory reach the maximum level again. Between intervals, the differences lie in the situation of the stock and ordering size. The advantage of this system is shown when there is mostly no uncertainty and the firm wants to check inventory and order for multiple items. Even if there are still many remaining for item A and a few for item B, after a fixed time, inventory will be checked and orders will be placed to replenish all items to their own maximum level (Tersine 1994, 133-134).

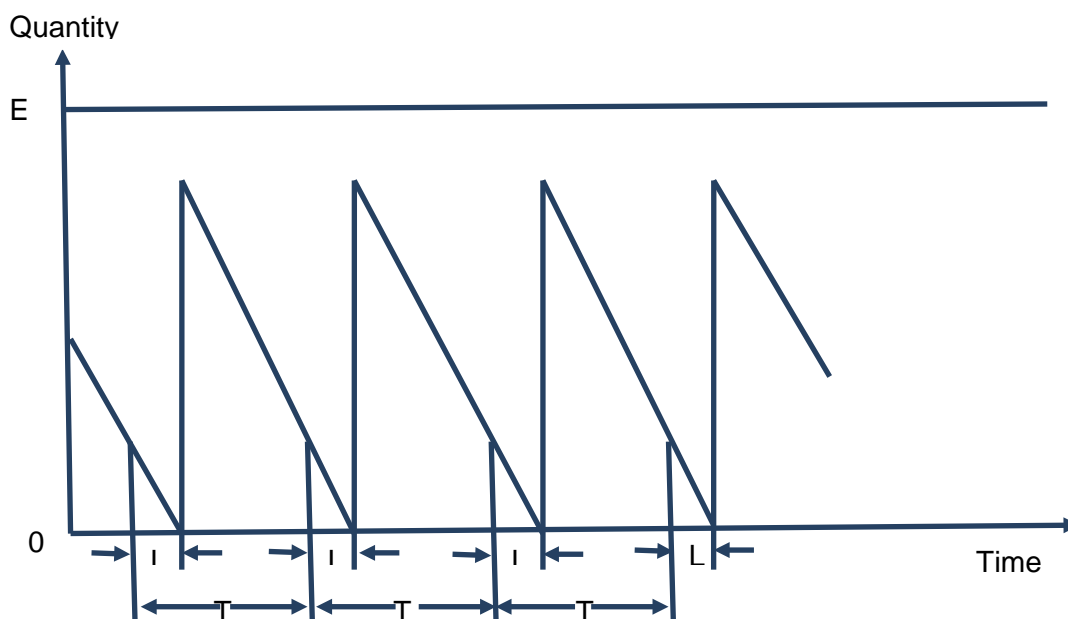


FIGURE 6. Fixed Order Interval System (Tersine 1994, 135).



Clearly, we can see the biggest advantage of using a fixed order interval system is simplicity. Logisticians don't have to put a lot of efforts into dividing their inventories into groups, or placing too many orders for different items at different times. Instead, they only have to perform monitoring once after a set period of time and place combined orders for groups of items right after. As a result, fixed order interval became a very economical choice for logisticians.

## 2.8 Order Quantities

Like "When to order?" the question of the number of units to order each time is an extremely critical issue that needs high level of effort. The core point here lies in the relationship between holding cost and ordering cost. As mentioned in chapter 2.4, there is a trade-off between these two costs. Basically, average inventory is equal to one half of order quantity, the larger the order quantity, the more cost will be added to annual holding cost. At the same time, a bigger order size also means fewer orders placed which helps decreasing the annual ordering cost. The question at the moment can be fully described as: "How many units / How much in euros should be ordered each time that helps minimizing the total combination of holding and ordering cost?"

### 2.8.1 Economic order quantity (EOQ)

The above issue of how much to order led to the formulation of Economic Order Quantity (EOQ). It is a model created to calculate the order quantity point at which minimizes the total of holding cost and ordering cost, or also means holding cost equals ordering cost.

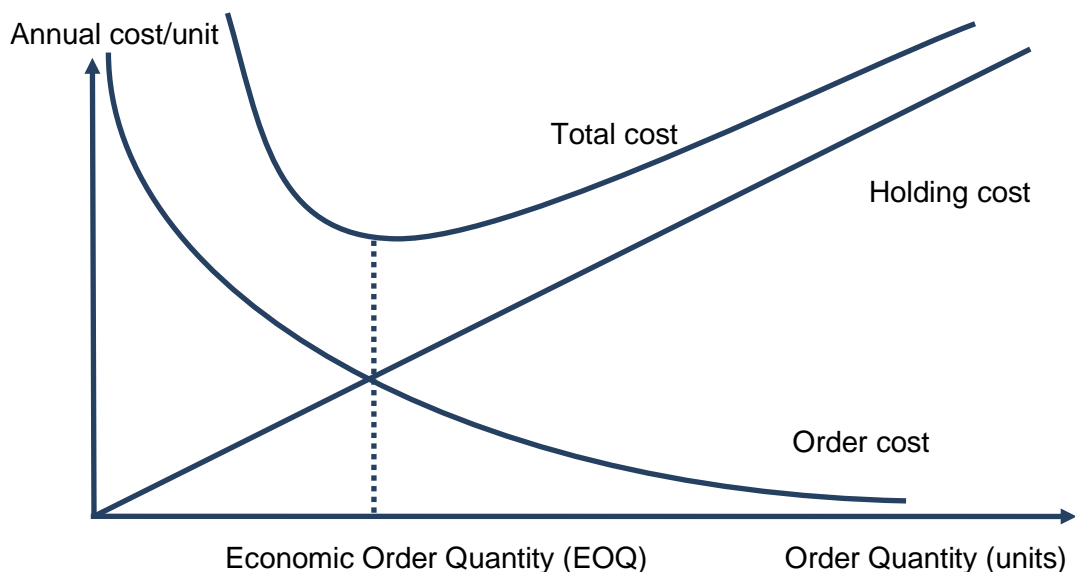


FIGURE 7. Economic order quantity (Murphy & Wood 2011, 158-160).

Figure 7 shows the idea of economic order quantity, which is the crossed point between ordering cost line and holding cost line. According to Murphy & Wood (2011) one important notice in calculating EOQ is that the model must be grounded in the assumptions below:

- A continuous, constant, and known rate of demand
- A constant and known replenishment or lead time
- A constant purchase price that is independent of the order quantity
- All demand is satisfied (no stock-out is allowed)
- No inventory in transit
- Only one item in inventory or no interaction between inventory items
- An infinite planning horizon
- Unlimited capital availability

(Murphy & Wood 2011, 158-160).

Satisfying these conditions, a standard formulation of EOQ can be expressed as:

$$\mathbf{EOQ = \sqrt{(2AB/C)}}$$

where

EOQ = the most efficient order size, in €

A = Annual usage of the inventory, in €

B = Cost per order, in €

C = Inventory holding cost, in percentage

This formulation is calculated in term of euros, for example: Assuming 2000€ of a product is used annually, cost per order is 10€, inventory holding cost is 25%, then

$$EOQ = \sqrt{(2 \times 2000 \times 10 / 0.25)} = \sqrt{160000} = 400€$$

Which means the most economic amount for each order should be equal to 400€.

Besides, another similar formulation is also applied in terms of units:

$$\mathbf{EOQ = \sqrt{(2DB/IC)}}$$

where

EOQ = Economic order quantity

B = Cost per order, in €

D = Annual demand, in units

C = Inventory holding cost, in percentage

I = Cost per unit, in €

Continue with the above example, adding cost per unit 5€. Thus, annual demand D is now equal to  $A/I = 2000 / 5 = 400$  units.

$$EOQ = \sqrt{[(2 \times 400 \times 10) / (5 \times 0.25)]} = \sqrt{6400} = 80 \text{ units}$$

As calculated, the EOQ is 80 units or 400€, but now it raises a new question of the liability of the result. How do we know this is the best number? A quick calculation test will be useful. 80 units per order which means there are  $400/80=5$  orders per year, which leads to ordering cost is equal to  $5 \times 10 = 50$  €. On the other side, each order size 400€ leads to average inventory 200€, therefore inventory holding cost will be  $200 \times 0.25 = 50$ €. The fact that holding cost and ordering cost are equal is the firm evidence to prove the exact of EOQ formulation. But as mentioned above, it can only be calculated exactly under all those assumptions, which is impossible because if there are something certain in modern business, it can only be uncertainties. (Murphy & Wood 2011, 158-160).

### **2.8.2 Important EOQ factors**

Beside such many assumptions, in order to execute a good calculation of EOQ, it is essential to take these following factors into consideration.

#### ***Volume transportation rate***

Transportation cost, as a matter of fact, is paid by nobody else but supply chain participants. No matter how well EOQ is formulated, if transportation cost isn't taken into consideration, there is still a big waste impacting inventory budget. Therefore, cooperation among participants is fundamental to reduce transportation cost.

There is an unwritten rule that the more units you order in one delivery, the more you are saving. As freight rate decreases, order size increases, and the order size for optimum freight-rate might be more than EOQ calculated. For example, EOQ calculated in units was 100 units, however the optimum quantity for each order should be 150 units, so what should logisticians do? The answer is to do the calculation, compare and decide. A good logistician can clearly see that when choosing an order quantity that makes transportation rates the lowest, order size will be larger than EOQ, which leads to higher average inventory, equally to higher holding cost. At the same time, in reverse, order size increasing leads to two advances: decrease in total number of orders per year or ordering cost, plus cheaper freight-rates. Whether choosing the method of ordering based on EOQ or based on volume transportation rates, there will be advantages and disadvantages. As mentioned above, making the calculation for both methods on visual images, logisticians can have a better comparison; know which method or which point of order size can lead to the lowest total cost (Bowersox et al. 2010, 165-166).

**Quantity discount**

Another issue needed to take into consideration when implementing purchase is quantity discounts. All suppliers, for the purpose of higher sales volume, higher profit, always offer several of purchase options with quantity discounts for bigger order sizes. But just like transportation rates, higher order quantity for discounts would also lead to higher inventory holding costs, but also lower ordering costs. The same solution would be applied that logisticians should carefully make the comparisons to decide the most suitable combination of these factors.

**Other EOQ adjustments**

According to Bowersox et al. (2010), beside the two factors above, there are various other factors that can also affect the adjustments of EOQ:

- Production lot size: related to the most economical production batch size
- Multiple-item purchase: this is usually the case in many companies, more than one items are bought at the same time if not taken carefully will lead to uneconomical costs.
- Limited capital: not all companies at all time can have enough capital resource to follow inventory budget plans.
- Dedicated trucking: with its fixed cost, a dedicated transport party can bring more benefits, especially if the trucks are taken to the last advantage in capacity.
- Unitization: cases and pallets are becoming the standard sizes for transportation. Always try to make full pallets in transporting goods are necessary to reduce waste.

(Bowersox et al. 2010, 165-166).

**2.9 Lean Manufacturing and Just-in-time Inventory Management**

To understand inventory is not enough to manage inventory properly. That's why there have been many researches about approaches to inventory management in the recent decades, one such approach is lean manufacturing.

A given question is: What is lean manufacturing? Strictly speaking, lean manufacturing focuses on the elimination of waste and the increase of speed and flow. The core idea is to maximize customer value and minimizing waste. Lean simply means creating more value for customers with fewer resources. However, another question is: What are customers willing to pay for? Customers themselves want value, and they

are paying for what they need. They don't pay for defects, or for extra cost of having large inventories. In other words, they shouldn't pay for the waste from any organizations.

Waste is any activity that does not add value to the product or services. Waste can be viewed as the single hurdle that can limit a business over time. In lean manufacturing, there are seven categories of waste which is shown in Figure 8 below (Lean Manufacturing Tools)



FIGURE 8. The 7 waste types of lean manufacturing

- **Overproduction:** taking time to produce more parts than demand. Overproduction leads to high levels of inventory which mask many of the problems within an organization.
- **Inventory:** costs money from businesspeople, every piece of product tied up in raw materials, work in progress or the finished goods has a cost and until it is actually sold, it still belongs to managers. In addition, the pure costs of an inventory add extra costs that mean inventory feeds many other wastes. Inventory has to be stored and it needs space, packaging, or to be transported around. As a result, it has the chance of being damaged during transport and being obsolete. Broadly speaking, the waste of inventory hides many of other wastes in an organization.
- **Waiting:** is an obvious waste not only in business lives but also in personal lives too. The waiting waste disrupts flow, too many motions in last process but waiting in next process.
- **Motion:** all unnecessary motions are those movements of a man to handling bad design process/machine. The operator needs to move or turn himself

around and around to handling the process/machine. All these waste motions obviously cost money and time and that cause stress on employees and machines.

- **Transportation:** all material cannot move itself from one location to another without any transportation, and it adds zero value to the product. Why would customer want to pay for an operation that adds no value? Transportation costs more money while it makes nothing for manager. One transportation process can be very high cost to a business, because it needs people to operate and equipment such as trucks or fork trucks to undertake materials.
- **Rework:** this waste happens when it meets defective items. It requires rework or replacement, it wastes resources and materials, and it can lead to lost customers. Broadly speaking, it obviously cost more money than expected.
- **Over-processing:** using inappropriate techniques, oversize equipment or working to tolerances that are too tight, perform processes that are not required by customers, all things lead to this waste of over-processing. And it also costs money and time from operators. For example, some company calls itself "mega machine" can do an operation faster than other. However, every process flows have to be routed through it causing scheduling complications, delays and so on. In lean, using small appropriate machines where they needed in the flow, not break the flow to route through highly expensive monstrosity that accountants insist is kept busy (Lean Manufacturing Tools).

However, only the waste of inventory is discussed due to this thesis' scope and just-in-time (JIT) is the best known lean inventory management. From paragraphs above readers may still keep in mind what the waste of inventory is; it costs money from organizations, every piece of product tied up in raw materials, work in progress or the finished goods has a cost and until it is actually sold, it still belongs to managers. In addition, the pure costs of an inventory add extra costs that mean inventory feeds many other wastes. Inventory has to be stored and it needs space, packaging, or to be transported around. As a result, it has the chance of being damaged during transport and being obsolete. Broadly speaking, the waste of inventory hides many of other wastes in an organization.

JIT is a movement and idea that has gained wide acceptance in the business community over the past decades. From an inventory perspective, the JIT approach seeks to minimize inventory by reducing safety stock as well as have the supplies at exact moment that they are needed. In order to accomplish this goal a company must constantly seek ways to reduce waste and enhance value. JIT is one way to achieve

that end result. The JIT approach has a number of important implications for logistics efficiency, one of which is that suppliers must deliver high quality materials to the production line because the emphasis of JIT is low safety stock, and defective materials result in a production line shutdown. By looking at suppliers as partners to improve product quality from them and that are essential to make JIT truly work (Murphy & Wood 2011, 165).

Incorporating JIT lean manufacturing in a company makes production operation more efficient, cost effective and customer responsive. JIT allows manufactures purchase and receive raw materials just before they're needed on production line, thus relieving manufacturers of the cost, burden of housing and managing idle parts. On the other hand, JIT manufacturing can be a real money saver for a company. Companies are not only responsive to their customers but also have less capital tied up in raw materials and finished goods inventory, allowing companies to optimize their transportation and logistics operations (Murphy & Wood 2011, 165).

Overall, JIT manufacturing not only results in lower total system costs and improved product quality, but also reducing waste. With JIT, some plants have reduced inventory more than 50% and lead time more than 80%. Indeed, JIT helps companies lowering costs in inventory, reducing wastes and raising the quality of products (Murphy & Wood 2011, 165).

## **2.10 Enterprise Resource Planning (ERP)**

In today's business world, most of enterprises encompass the use of computers and telecommunications equipment to store, retrieve, transmit and manipulate data, in other words, it is called IT system (information technology). However, there are major of software to help business people running business efficiently and effectively in this brutally competitive and rapidly changing business environment. Each department in one company almost has its own computer system to handle their jobs. It is difficult to build a single software program to serve the needs of different management of employee in Finance and Accounting department as well as administrative department and warehousing or personnel department, and so on. However, ERP systems could integrate all departments and all of the general functions of company in a single computer system that can meet all the different manager needs of each department, and it has been adopted by numerous companies across globe (Leon 2008, 30).

But what is ERP? ERP stands for enterprise resource planning, is a computer network system that use a database of information which is company- wide accessible. ERP is designed to replace paper- based system by analyzing data from all areas of a company resource. Moreover, ERP covers all functions of a business, which is shown in figure 9, as:

- Financial management
- Purchase management
- Inventory management
- Manufacturing management
- Quality testing and control
- Sales management
- Human resource management.

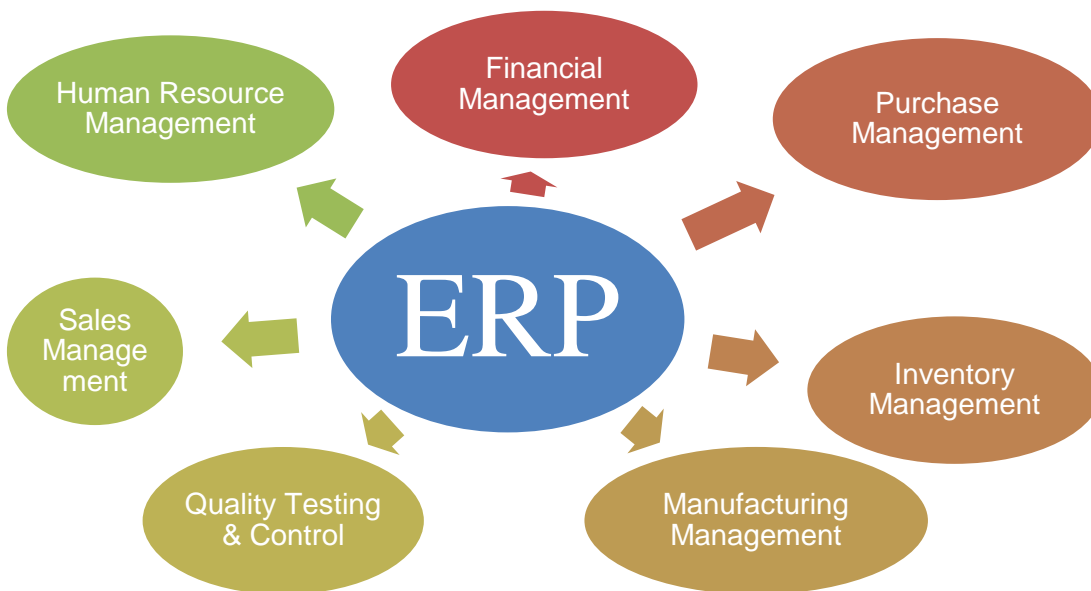


FIGURE 9. ERP system's functions

However, due to this thesis's scope, only inventory management function of ERP system is taking consideration. ERP inventory management could handle everything from ordering, physical inventory count, and scheduling, shipping, receiving, purchasing, and supply chain planning. By using an ERP management system, an inventory of a company is stored on a database that is comprised of physical stock, costs, vendor accounts and lead time for reordering stock. On the other hand, ERP system can improve costs, productivity, reduce time lag, reduce waste and improve overall efficiently. ERP system uses bar codes to keep up with inventory items. This makes tracking stock much easier. As the bar-coded items leave inventory, they get scanned and their product information is entered into the ERP inventory management system.



Placing bar code labels on stock helps companies save money because it keeps the list of stock updated. Employees can easily see when certain quantities are low and need to be re-stocked (General Solutions).

The main advantage of using ERP system for a company is that ERP system is company-wide and involves only one software system. On the other hand, follow Brinlee, ERP system brings some advantages as below:

- Proper communication between different areas
- Tracking of orders from the time the order was received to its delivery
- Keeping up with revenue cycle from when the invoice is issue through when the payment is received
- No longer have to keep up with changes in different software systems. The one system is tied together.
- Provides a 'top down' overview on the workings of a company.
- Reduces the risk of loss of information
- Sets up a form of security to protect against theft from outside or within a company.

(Brinlee, ERP inventory management)

### 3 RESEARCH ON INVENTORY MANAGEMENT OF RAW MATERIALS AT FAMIFARM OY

In this chapter, readers are able to have a general view about Famifarm Oy, some information about its history, its products,... Moreover, research objectives and methods are introduced afterward. In the last part, this research not only gives some discussions about the current model of materials control at Famifarm Oy but also mentions all issues concerning problems existing.

#### 3.1 Case Company Introduction

Producing a development project for a company includes many steps in which general information of that company is compulsory. Many new managers coming to a new company have achieved success because they spend a lot of time on researching and finding out as much knowledge of the company as possible. General information here means the whole business environment, its history, its current process and future plans.

##### *History of Famifarm Oy*

On this Järvikylä area, planting traditional vegetables such as cabbages, cauliflowers, radishes, carrots, has been a main business activity for hundreds of years, since its origin in 1674. Along with the rapid development of twentieth-century technologies, in 1987 the first greenhouse was built on the field of Järvikylä. A company was established in the same year, called Famifarm Oy, the brand name used since then has been Järvikylä, printed on every box and package. The idea of establishing Famifarm was to become a supplier for the whole Finland with its special products: potted vegetables. Famifarm changed from cabbages and radishes planted on field to planting potted vegetables on gutters, keeping the vegetables clean at all times. The main products at first were lettuce, Ice Salad, and Romaine (Famifarm Oy).

##### *Scale of business*

After its foundation, Famifarm has been growing gradually. Fulfilling its main mission from the beginning, Famifarm now is the biggest potted vegetables supplier in Finland. Figure 10 shows the total net sales of Famifarm Oy in the last five years, with its value steadily increased and reached over 15 million Euros in 2011 (Famifarm Oy).

## Famifarm Oy's Net Sales 2007-2011



FIGURE 10. Famifarm's net sales 2007-2011

Providing 28 kinds of herbs and 11 kinds of salads, Famifarm's products now can be seen in almost every supermarket all over Finland, in addition a small amount is exported to Estonia. Some brands have become pretty popular to consumers such as Ice Salad, lettuce, Lollo Rosso for salads and Basil, Red Vein Sorrel, and Dill for herbs. Among those, the three products with highest sales quantity are Ice Salad, Basil, and Dill, which are now essential not just for families but also restaurants and cafeterias.

In today's Finnish open market, thousands of foreign vegetable brands have been struggling to approach but still, Famifarm products are the first choice for consumers. Why is that? Consumers in Finland are getting stricter and stricter, good and fresh looks are not enough for quality vegetables anymore, but cleanliness and quality are more important. More than everything, high managers of Famifarm are aware of the situation and always try to provide 100% safe vegetables, even if they are eaten right from the bag. Achieving many qualification standards such as quality standard from BUREAUVERITAS 2007, guidelines for Quality Garden (Global GAP) and ISO 9001:2008 are the best proofs of Famifarm's efforts to become number one (Famifarm Oy).

Famifarm's main office is located in Järvikylä, Joroinen, Finland, along with its main greenhouse facility. In the main facility, 90% of all salads and some main kinds of herbs such as Basil, Dill, Red Vein Sorrel, Thyme, and Parsley are produced. It is

divided into 9 different small greenhouses with different water and temperature conditions, suitable for various kinds of salads and herbs. All the greenhouses are connected to each other, and environmental conditions can easily be adjusted. For example, Ice Salad is planted in house 3A to 3D but before it was Oak Leaf and lettuce planted here.

Besides, Famifarm has a small subsidiary greenhouse located in Juva, just about 20 kilometres to the South from Joroinen for easy contact and transportation. The small subsidiary greenhouse was bought from another company to support the production of two main salads: Ice Salad and lettuce. Even with these two facilities, Famifarm's production capacity is not enough to manufacture every kinds of herbs, and that's why they have another subcontractor also located in Juva specifically used for producing various kinds of herbs which don't have high demands at the moment. Every product from subsidiary and subcontractor are transported to the main facility right after packaging for freshness. As said before, Famifarm Oy provides about 28 kinds of herbs and 11 kinds of salads to the market, however, in main facility at Joroinen, there are only 7 kinds of herbs and 10 kinds of salads produced which are shown in table 5 below:

TABLE 5. Products in main facility of Famifarm (Famifam Oy).

<i><b>Herbs</b></i>	<i><b>Salads</b></i>
Basil	Frisee
Coriander	Ice Salad
Parsley	Ice Saladin bag
Chives	Multi-leaf green
Dill	Lollo Rosso
Thyme	Red Salanova
Red Vein Sorrel	Romaine
	Lettuce
	Oak Leaf
	Rucola
	Frisee in bag

The main facility and subsidiary run at average 12 hours every day from 6am to 6pm. There are total 170 employees, including office employees, permanent workers, long-term workers, and part-time workers. Mostly all Famifarm employees live in nearby areas such as Varkaus, Kuvansi, Joroinen, and Juva. The age of workers also varies, from 16 to even more than 60. There are many permanent workers over 50

years old but still performing well in production and have given great contributions to Famifarm's successes. Certainly, young students starting at 16 are always welcomed to work as part-timers or if performing well, they can become long-term or permanent workers. Except for office jobs which require higher education levels, various jobs in production process can be quickly learned and performed well, especially with young people, that's why many important jobs in this process are controlled and supervised by Finnish and foreign young workers.

Already being the biggest supplier for potted vegetables, Famifarm is well aware that there are many potential competitors, from both Finland and foreign countries trying to break its success with more attractive and quality products. That's why high managers at Famifarm never satisfy with current accomplishments and always focus on research and development. The product list will gradually grow bigger in the near future. Expanding facilities, expanding product ranges, expanding list of qualification and customers' satisfaction are what Famifarm is always aiming at.

### **3.2 Research Objectives and Methods**

The empirical of this thesis process was carried out by researching Famifarm Oy's inventory management of raw materials and also included interviews with people incharge such as Managing Director, Production Director, Operaton Manager, Cultivation Manager and Sowing Manager.

The objective of the interviews was to gather necessary information and build up an image of the current model inventory management of raw materials. First level questions were focused on building the big picture about the way materials are being organized. After every step is clear, second level questions concentrate on personal ideas about the reasons for mistakes in inventory control.

The aim of this research is to make improvements in materials management at Famifarm Oy, giving a better control of in-stock materials, from monitoring to forecasting, therefore reduce stock-out, late orderings, and so on.

The main research methods used for this thesis is observation and qualitative interview. Direct observation is useful for detailed description of production process as well as stock-outs consequences. Because of the subject's characteristics only relate to manager-level, individual interviews with open-ended questions were mainly

used for gathering information. Questions are structured in two levels, from building the big picture of current management model to personal ideas of mistake reasons.

### 3.2.1 Observation

In both normal daily life and academic or scientific studies, observation is an important method when it relates to behaviors. The basic idea is researchers implement direct observations without asking from respondents. Even though there are many limits and restrictions to this kind of research method, if done properly, observation can be helpful in collect data without facing one critical problem: subjective bias (Kothari 2006, 96).

Observation methods sometimes can be divided into participant and non-participant. The chosen one for this case of Famifarm Oy is participant observation. Researchers are also workers at Famifarm, therefore enabled to observe the natural behaviors of other workers and team captains when there is a stock-out such as "How they reacted when there was no material?", "How much time was wasted?",... A Famifarm worker can have the opportunities to experience different positions in the whole production process, thus a better detailed insight can be gained. All these information would be very difficult to achieve by merely interviewing managers. Besides, by being a member of the researched group, researchers can also verify the dependability of answers from managers in qualitative interviews (Kothari 2006, 97).

### 3.2.2 Interview

Qualitative research nowadays has become one of the most popular research types in our social life. Tons of debates about whether qualitative or quantitative is the better method have been made and there is no definite winner here. These two are technically different and if applied in suitable contexts, their true advantages can be brought out. While quantitative research normally uses a large number of participants to question on a limit and standard with numbers and graphs as foundation for analysis, qualitative researchers rather focus on "*understanding how people interpret their experiences, how they construct their worlds, and what meaning they attribute to their experiences*" (Merriam 2009, 5). And as a matter of fact, among many methods being used in qualitative research, interviewing is the most commonly one for data collection. The success of a qualitative interview doesn't depend only on how good the questions are or how well we analysis data. Actually the first stage where we

made decisions on designing a study has the biggest impact on the outcomes of the research (King & Horrocks 2010, 1 and 41).

Generally a qualitative interview is semi-structured. Even though there are other options such as group interviews, completely unstructured interviews,... semi-structured interview is still the major method nowadays. When using semi-structured interviews, researchers make a broad plan about the topic, but there will be no compulsory specific way to word these questions, or a fixed order for them to be placed. Questions are mostly open-ended, makes no limit for interviewees to answer. They can choose the way to answer the questions, as well as the length of the answers or the topics to discuss. The biggest advantage of this method is to achieve the first-person account. No limitation encourages longer responses, therefore help building up a more perfect first-person's point of view (Packer 2011, 43).

Because of the nature of thesis topic and the advantages of qualitative research, interview was chosen as the most important method for data collection. Certainly mostly all workers directly use materials everyday at Famifarm for production, however the topic is about how those materials are being organized and controlled in stock, which relates to only a few managers who manage and order them. As the number of potential participants are already so few, it encourages an approach by qualitative research. Besides, in order to have a deeply understanding about the whole production process, how materials going at Famifarm, information cannot just be on the surface but has to go deeper in detailed descriptions. Some shallow questions in a standard therefore cannot afford to achieve such depth of details. As a result, qualitative interview is taken into account as the workhorse of this research.

Based on the results of interviews, researchers use the findings, insight for descriptions, thus giving suggests for improvements and all details are expressed in a long written research report. The report includes detailed attachments of documentations about what was done and how the research was implemented, therefore encourages and provide helpful information for other researches about inventory management.

The limitations and restrictions of this research were due to the timeframe and scope of the bachelor thesis - 15 credits. According to the supervisor agreement, the thesis is supposed to be finished between beginning of September 2012 and the end of January 2013. Five months can be considered a short time compared to the level of

detailed information needed. At some points, choosing whether to dig deeper or leave it for other researches was a difficult task.

### **3.2.3 Interviews at Famifarm Oy**

Fortunately, with the low number of participants, all at Famifarm headquarter, making direct contacts and planning interviews were smoothly done. However, most participants can only be available at work time for some day because of their hectic work schedules, researchers weren't able to conduct the whole research by direct interviews, but rather parts of it by emails.

The research process started with the direct discussion with Managing Director and Production Manager about the content and purpose of it. History, general information about company's business were provided then as well as the decentralized management hierachy. From this information, identities of other participants were revealed. Operation Manager, Cultivation Manager, and Sowing Manager are contacted afterward for later direct interviews as well as through emails. First level questions were carried out to each manager in order to define their main jobs, and their methods in managing materials. Second level questions, conducted after the first level were about some records of stock-outs and late orders as well as each manager's opinion about the reasons.

Every interview and email were promised to be carried out individually and confidentially. After being gathered, answers, adding data and figures were looked into carefully for a deep comprehension. They were also organized, placed in order, unnecessary and duplicate details were removed. The whole empirical part of this research is a scientific presentation based on the results of interviews. In the end, the results of interviews led to reasons of mistakes, therefore led to suggests for potential solutions and improments.

### **3.3 Current Model of Raw Materials Control at Famifarm Oy**

In such an orgnization, raw materials and products have a close relationship to each other. This chapter therefore describes in detail the production process at Famifarm, the decentralized management, as well as methods in managing materials.



### 3.3.1 Current process of production at Famifarm Oy

Nowadays in Finland, picking up Järvikylä's vegetables in supermarkets seems to be the easiest job among the variety of daily works. Why? Because everything is ready for customers to cook; besides, all Järvikylä products are finished in the same standard for quality and weight, therefore difference between two random units of the same salad or herb is mostly unrecognizable.

However, in order to provide such great potted vegetables to consumers, Famifarm Oy has to conduct a manufacturing process which is not only smooth, quick enough for catching up with a tight schedule of mass production but also strict in production standards to assure that all products of the same kind are alike. A simple looking vegetable pot we see in stores is the result of combining many materials and manufacturing, storing, and transportation stages. This chapter introduces how a finished vegetable box is made at Famifarm from raw seeds. Since Famifarm's direct customers are supermarkets, resellers, who always order in large quantity, Famifarm doesn't sell individual vegetable bags but full boxes. The boxes might be different in quantity depending on what kind of vegetable and box sizes, for example: one box of Dill 6, one box of Dill 12, and one box of Frisee 9 are different in the name of vegetable and number of bags inside the box, which could be 6 or 9 or 12 correspondent to whatever printed outside the boxes. Figure 11 below shows exactly all stages of production.

Basically all kinds of vegetables go through the same stages as mentioned in figure 11, the only difference lies in number of seeds in a pot, different kinds of sleeves and boxes. Figure 11 demonstrates the production process chain at Famifarm from the first step of sowing seeds to finished boxes storing to be shipped.

#### **Sowing**

In figure 11, the example seed is Ice Salad seed for producing Ice Salad in bag, with each pot includes only one seed. The first stage of production is sowing. All kind of seeds are one by one going through sowing machine system. This machine's main job is to create the initial product: the vegetable pot, full peat and sowed.

The sowing stage can be described in six steps. First, empty pots are distributed into slots in carrying trays. After that, peat which was already mixed with water and other ingredients is dispersed into every pots of each tray. Holes then will be dug by a suitable dibbler on the surface of each pot, with sizes and number of holes varies among vegetable kinds. The fourth step in this stage is the main one, sowing. One or two

sowing rollers will equally put seeds into each pot as the trays pass. Certainly, each roller is designed specifically for one particular kind of seed, thus there are several rollers used. More water will be sprayed to dampen the seeds before they are slowly laid on a carrier for easy movement afterward. After each kind of seed is finished, sowed amount is input in the computer.

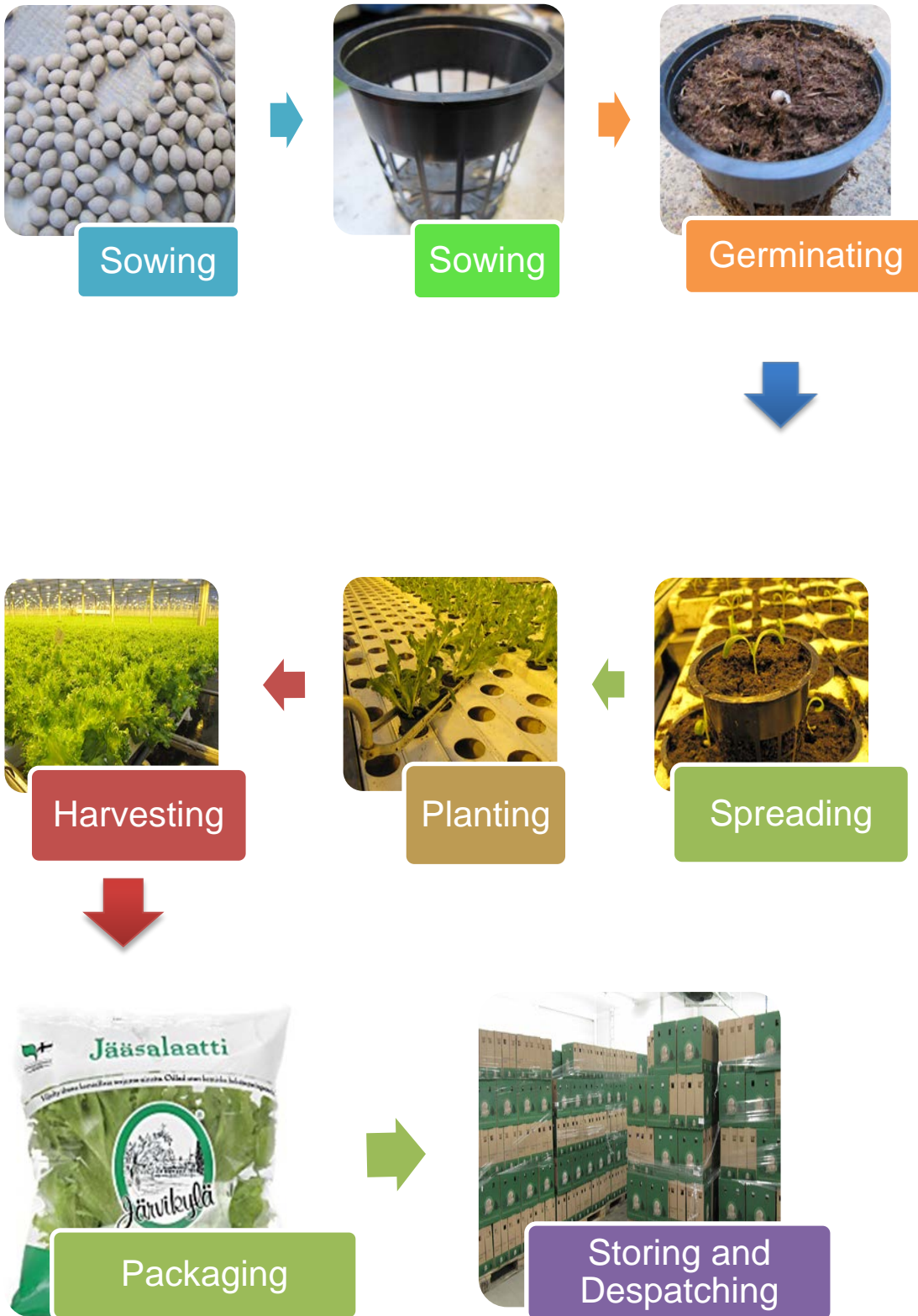


FIGURE 11. Stages of production process

The quality of finished product from this stage has an impact over all other stages, especially the quality of vegetables at the time of harvesting. If there are mistakes in sowing, many bad examples of results can happen such as: pots with no seed, too many or too few seeds in a pot comparing to standard, not enough peat or water sprayed... Each problem of this sowing stage will lead to different problems of plants. Ice Salad in bag product requires exactly one seed in each pot, if there are more than one seeds inside the pot then at harvesting time, each seed will not have enough water, nutrition therefore not big enough for cutting. In case there's not enough peat, the foundation of the plants become too fragile to hold them firmly and plants can easily fall down to one side. Not to mention less peat will supply less nutrition and make the plants smaller than expected. The same results can also happen if there is not enough water sprayed to dampen the pots. And if there is no seed in pots, nothing can grow up on it later. Certainly with this high level of complication, the sowing machine system always have small troubles occur somewhere, some times. The most important point is to make as many efforts as possible to maintain the smooth flow. Only then, quality and quantity of sowed pots can catch up to plans and expectations.

Schedules for sowing varies through the year, depend on many factors. Consumer demand changes, plans for new kinds of seed, boosting plan for a particular plant can change schedule of sowing. Thus, sowing schedule is made in weekly term and coming week schedule is always made at the end of the week before. Table 6 shows an example extracted from a sowing schedule on week 47.2012, unit is tray, with each big-pot tray consists of 35 pots, while this number is 54 for a small-pot tray.

In table 6, only Romaine uses small pots, while others use big pots. At the moment mostly all salad types use small size pots except for Lollo Rosso and Salanova, while all herbs go with big pots. Because of tight schedule with some amount of seeds waiting to be sowed every day, the machine system always has to run at full speed nearly 12 hours. Work time is divided in two shifts with each shift includes one person in charge. The person in charge must have the basic knowledge to understand everything running in the process, which usually takes at least 2 weeks of training. He also needs to be very careful, fast and exact since each mistake can cost thousands of Euros for the company. Long-time training, high responsibility are the reasons why Famifarm have around ten people capable of doing this job, and also only train new employees when necessary. What the job requires from employees is quality, not quantity.

TABLE 6. Sowing plan for week 47/ 2012 (Famifarm Oy Operation Manager, November 2012).



### ***Spreading***

After trays of sowed pots are put layer by layer on carriers for easy moving, they are immediately delivered into germination room for sometimes before being spread. This stage of production process includes two small steps. In the first step connected to sowing, the person in charge of sowing usually take carriers of newly sowed pots into germination room and leaves them there for some time. The room is designed to be near and closed all the time, only open for delivery in and out. It's extremely high humidity helps increase the germinating speed of the seeds. After the germination, at the second step, there will be employees who take carriers out to spread on tables. The mission is to make every individual pot exposed to light and able to receive fertilization. The spreading area is designed with many wheels for easy movements of tables back and forth or from side to side. Therefore, tables of the each vegetable kind will be delivered to their right destinations. Concentrating lights and spraying system help germinated plants grow stronger before planting them. In the end of the

day, spreading employees need to put insect traps, exact date tags and also make an initial water spray for newly spread tables.

Even though this second stage can be done without numbers input in computers, and for first look it only seems like moving things around. But actually, this is the most critical time of the production process. Firstly, each kind of seed has its own germinating time which can vary from 1 day to 6 days while there are dozens of carriers going in and out of germination room every day. Even with their name and date tags, too many carriers can lead to some troubles such as taking out the wrong kind to spread, or forget and leave a carrier inside for too long...all lead to significant consequences. When spreading employees take the wrong stuff, for example Lollo Rosso put in Dill area, the differences of fertilizing spray system and lights in Dill area will create a whole new and bad version of Lollo Rosso. They will not be in standard size and quality anymore but could be either bigger or smaller or totally spoiled. Besides, if a carrier stays in germination room longer than its optimal time, the plants trunk would grow too long that they will not fit the sleeves anymore, and easy to fall down to one side, easy to break in other processes. More than that, pots can be too dry without the initial water spray and cannot grow quickly enough, or they can be eaten and damaged by insects without enough traps. Figure 12 below shows an example of spreading process.

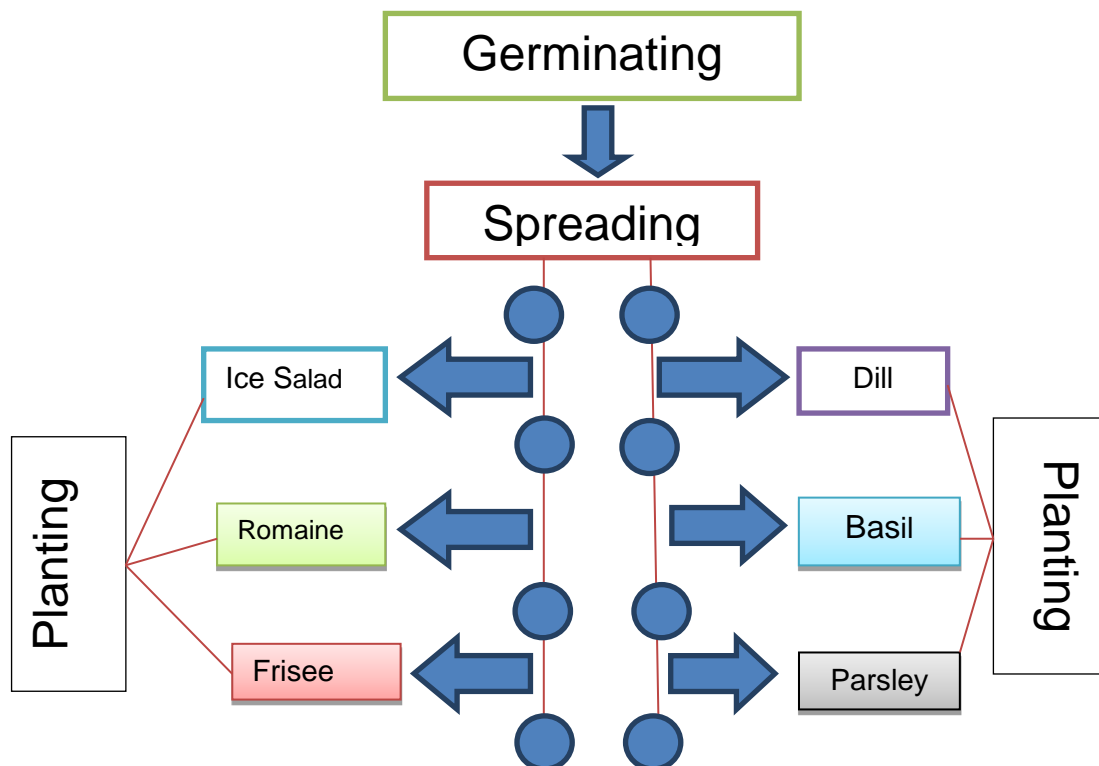


FIGURE 12. Spreading process

Due to the reasons mentioned above, people in charge of spreading need a lot of experiences before he/she can manage this job well. The job is usually done in morning shift with two people required. There are basically two employees working here in weekdays with both of them have at least ten years experiences. Only on Saturday when primary employees not at work, a few trained younger employees can be in charge. It takes a lot of time to remember everything necessary to do in this job since there are too many details, from optimal germinating time of each kind of seed, good spreading technique so that trays won't easily fall off the tables, to distributing skill to well arrange tables in places which sometimes can be a real challenge, spreading employees are usually trained in at least 1 month before they can remember everything. Since each detail forgotten always lead to tragic consequences, there requires many qualities from an employee in charge of spreading such as: hard-working and fast enough to spread hundreds of trays per day; highly organized since the arrangement of tables into their own areas are quite difficult in busy times of the year, with many salads don't have enough space and need to be put temporarily somewhere else before taken back on another day; always careful and detailed enough to remember every steps needed. After all, spreading is an extremely important part of production process that needs to be taken care of carefully since it affects all other production steps after.

### ***Planting***

As mentioned in figure 12, tables full of germinated seeds are arranged in line waiting to be planted. In the next stage, Famifarm workers take the trays from spread tables, using hands or tools removing the pots and then put them on many slots on long gutters. These actions combined are called planting. The mission of planting is to put pots on gutters where there is space inside that let water flow through. Then all plants can keep growing up with lights and water supplied through gutters while gutters moving slowly to harvesting side. There is a moving bar system designed to push the gutters planted forward, and then leave enough space for another batch of 6-7 empty gutters to fit in. After each time, planting employees need to clean gutters with water before planting in order to keep gutters clean, setup insect traps and in the end input numbers of planted vegetables into computer.

Despite its simple technique, planting is still very important to the result of harvesting. Usually there are quite many pots with inexact number of seeds inside and can lead to different results, mostly unexpected. Therefore, planting employees must check every individual pot before putting them into gutter slots. Too many seeds, too few

seeds, or no seed pots are all considered faulty and need throwing away. Only by doing this carefully, all planted pots are in good condition enough for harvesting later.

Planting and harvesting are connected closely to each other, like a duo. In each individual greenhouse, people harvest when there's no planting, and vice versa. The reason behind this lies in the moving bar systems designed only to do one task at a time. Anyway, based on that fact, managers usually arrange planting group to work right before or after the harvesting group finish their jobs. Number of gutters planted in each greenhouse varies, depended on how many gutters were harvested before that. Besides, depending on the quality of germinated pots, planting time can stretch or shrink compared to normal condition. Therefore there is no actual standard for timing, especially when the speed and self-discipline of different employees also fluctuate.

### ***Harvesting***

Harvesting is the step taken right after planting. Harvesting is required every day, its main target is to clean the fully grown salads and herbs, cut them or putting them in sleeves and deliver to packaging stage. Harvesting groups use an individual harvesting carrier which is basically a mobile stand for holding sleeves and trash buckets. The simple technique of harvesting includes lifting plants from gutters, removing bad leaves and long roots before putting them in sleeves and put on the lines moving toward packaging room. If it is cutting, instead of keeping the pots, harvesting employees cut them off totally before putting them on moving lines or plastic boxes carried toward packaging stage. In the end, numbers must be input; empty gutters after harvesting must be delivered into steamer for cleaning in at least 4-6 hours before they can be ready to be planted again.

Being the last stage deciding the quality of products before they go into boxes and stored for shipping, harvesting even though is a simple job, still requires a lot of determination. If harvesting employees leave bad leaves, long roots or dirt on the salad and herb sleeves, both consumers and resellers will have complains for bad products received which could lead to tragic consequences like lost customers and cost a lot more efforts, time, and capital to build up new customer relationships. Harvesting then can be described in two words: simple, but important.

As mentioned above, planting is connected closely to harvesting in terms of quantity, time, and quality. In terms of time, they can't be done at the same time because of moving bar systems, but always right after or before each other, usually one time of planting and harvesting for each greenhouse per day. In term of quantity, the more

gutters harvested, the more empty gutters for planting, and vice versa. For quality, a bad planting with too many pots which don't have enough seeds or too many seeds both lead to a bad harvesting. Employees again need to carefully check and throw away bad plants before putting them on the lines. The more mistakes decreased in the previous stage would help decreasing mistakes happen in the stage after. Carefulness and speed are both required in a harvesting employee. He/she must be careful to not leave any bad leaves or roots but also must be quick enough in speed to finish the scheduled quantity. However, comparing to other stages in the whole production process, planting and harvesting are still the simplest ones. That's why when there are brand new workers, they are arranged to work in these two stages at first.

### ***Packaging***

No matter which kind of salads or herbs, no matter from which greenhouse, all harvested plants are put on the lines moving toward the packaging room. This is a big room placed in the centre of the facility, near the storage and dispatching room. Packaging room includes different smaller packaging areas connected to different lines from all the greenhouses. The main job here is to get every product from the lines into much different kind of boxes depending on demand. Each packaging area has its own spinning table designed to receive harvested plants, then they are picked up by hands into boxes before put on to pallets and moved into storage. Badly harvested products must be taken out and notice of carefulness must be delivered to harvesting groups. Boxes are automatically folded and moved into positions by three complex folding and distributing systems. Certainly before moving into separate lines, all the empty boxes have to pass by a printing machine which can input exactly name and date of the contents inside the boxes. After packaging one kind of vegetable finishes, packaging employees must input exact number into computers.

Even though this stage doesn't really affect directly to the quality of products anymore, they can still affect the total cost of production. Many mistakes can happen in this packaging room which require constant watch. Forgetting to put new boxes for folding into the machine, for example, can lead to the situation of overloaded packaging tables, therefore, all products lie underneath will be crushed, damaged to the level that can't be used anymore and need throwing away. The same results also happen from a mistake of the folding machine when a box gets stuck and makes a traffic jam inside, or a stuck of harvested products on the way to packaging room that needs immediate care before too many products got damaged. Printing machine might get ink stuck and nothing printed outside the boxes which could lead to mistaken product deliveries. For Ice Salad in bag, their packaging area includes one wrapping machine



designed to wrap the cut salads before they move to the spinning table. The high complexity level of this machine also leads to many troubles through the day and affect the smooth flow of production.

Beside Ice Salad in bag packaging area which specially requires three employees, every other packaging area only requires one employee for normal speed and two in case of large amounts coming. Every morning packaging employees come at the same time with harvesting employees and take some time to prepare necessary things such as printing machine, folding machine, spinning table, pallets,...Packaging employees must have experiences in both planting and harvesting, can do both jobs very quickly since packaging requires higher speed. To manage a packaging area alone well normally requires one week of training. The job is busy and always going at fast pace, therefore there are many employees at Famifarm already trained and be ready to come work there any time. Indeed, a busy day in packaging room can be funnily compared to a small battle field.

### ***Storing***

After pallets are fulfilled with boxes, they are cooled down to 3°C before delivered into storage. There is usually one person in charge of this job. He wraps plastic around each pallet for better steadiness and easier movement, using pumpers to put them into the container of vacuum cooler. The machine is designed to fit five pallets inside, after starting; it sucks out all the air inside and at the same time decrease the temperature of products down to the optimal 3°C. This step usually takes half an hour before all pallets are ready to go into storage. The storage is placed at the output of the vacuum cooler, with constant temperature at 4°C, it assures the longest lasting possible for almost all vegetables, except Basil types which require normal room temperature. Receiving pallets from vacuum cooler, the person in charge of storing uses pumpers to move those pallets into different marked empty lines with each line is wide enough for 1 pallet and long enough to contain 3-4 pallets. Since almost all vegetables of Famifarm come to storage before shipping, the number of pallets going in storage every day is greatly large.

Storing is not only about putting pallets in empty places but also about organizing them. Normally there is one person in charge of this job in a shift, and totally about ten people trained for this job already. Training new employees will take place when there is a shortage in human resource. Usually, an irresponsible storing employee would just put pallets wherever suitable for him and doesn't care about how difficult it is for dispatchers to take what they need after that. While a highly skilled employee

would take some time to organizing the pallets in the order and positions based on theory FIFO (First in, first out) with newer pallets behind and older pallets in front of the lines. Therefore, when dispatchers need to take some vegetables for shipping, they would find no difficulty in finding what they need because it's certain that they would take the oldest first. Speed is also another important character required from storing employee as he needs to organize well all incoming pallets in storage in time, not to mention many small accidents such as boxes falling out could happen all the time. This step is the bridge connect all the efforts of production to the last step: dispatching.

### ***Dispatching***

Every effort mentioned above would just become a waste if finished products are not taken to customers in time, and this is the stage where dispatchers are needed. The dispatching room is connected directly to storage, with temperature constantly at 8°C. Receiving orders from the main office, dispatchers take whatever needed in the orders, put them on a pallet or more if it's a large amount and hand them over to transporters. Usually, the room is divided in many different lines with each line correspondent to one kind of vegetable. Dispatchers or storing employee often try to fulfil the lines as soon as they have free time. For the rest of the time, dispatchers holding orders, go around; pick necessary finished goods from storage if it runs out in dispatching room. Using all the numbers input in previous stages, dispatchers could know exactly how many finished products in storage. After the pallets for customers are fulfilled, dispatchers carefully wrap the goods by using a special wrapping machine or by hands if the machine is busy, noting important information on sides of the pallets about what are inside, for what customers, in what order...before leaving them in waiting places for transportation.

Unlike storing, dispatching goods according to orders require much more time and there are usually at least five people in a shift. One thing in common is that since both dispatchers and storing employees need to work under cold condition, they are provided warm outfits for their jobs. Dispatchers must be at least tall enough to put boxes on high levels; they are often not shorter than 1m65. Besides, working with orders requires at least intermediate Finnish level, while mostly all foreign employees at the moment are not qualified enough, thus only Finnish employees are working in dispatching room. Speed is not the highest priority in here but accuracy and carefulness are what needed, a mistake in dispatching is mostly unfixable. Like storing, new employees will be trained only when there are needs for them.

Described above are the seven stages of production process at Famifarm main facility. For the subsidiary in Juva, they basically have the same spreading, planting, harvesting and packaging stages except they receive goods from sowing stage transported from the main facility, and transport finished goods after packaging back to main facility for storing and dispatching. Each stage in the whole process has its own challenges, difficulties that not so many employees can work in the whole process. Sowing and spreading only require very few employees but they all must be trained carefully after a long time since these stages are the initial ones, affecting every other stage afterward. Planting and harvesting are the simplest ones that need little training. But still, there are large amount of works in these two stages which require the biggest number of employees. After mastering planting and harvesting, a good employee can be trained for packaging, which needs faster speed and is slightly more complicated. Accuracy, organizing skill are necessarily added when an employee works in storing and dispatching rooms. The high level of complication in these two stages can easily leads to mistakes that can both reduce profit and credit of Famifarm.

### **3.3.2 Decentralized management model of raw materials**

At Famifarm, materials management is a big amount of work and is divided like the hierarchy shown in figure 13. All department managers in charge of managing different kinds of materials report to Production Manager. Then, important information is reported to the highest position Managing Director.

#### ***Managing Director's role***

It is the job title called at Famifarm, but in many other organizations, the same position is called Chief Executive Officer (or CEO). He's the highest position responsible for making major decisions in the company. In some big organizations, CEO is often only in charge of high-level strategies, connecting the board of director to the corporations. Usually he is also a member of the board, sometimes even the chairman. But here at Famifarm, since the scale of organization isn't big, the CEO, or Managing Director gets concerned to more hands-on activities like hiring office employees. Certainly, his main job is still the captain of the Famifarm ship, and deciding which way to go and so on. In controlling materials, Managing Director doesn't directly concern with the practical activities since there are too many details and he already got the Production Manager for the job. Receiving updated information about materials situation from Production Manager, Managing Director would know that everything is running smoothly or not (Famifarm Oy Managing Director, November 2012).

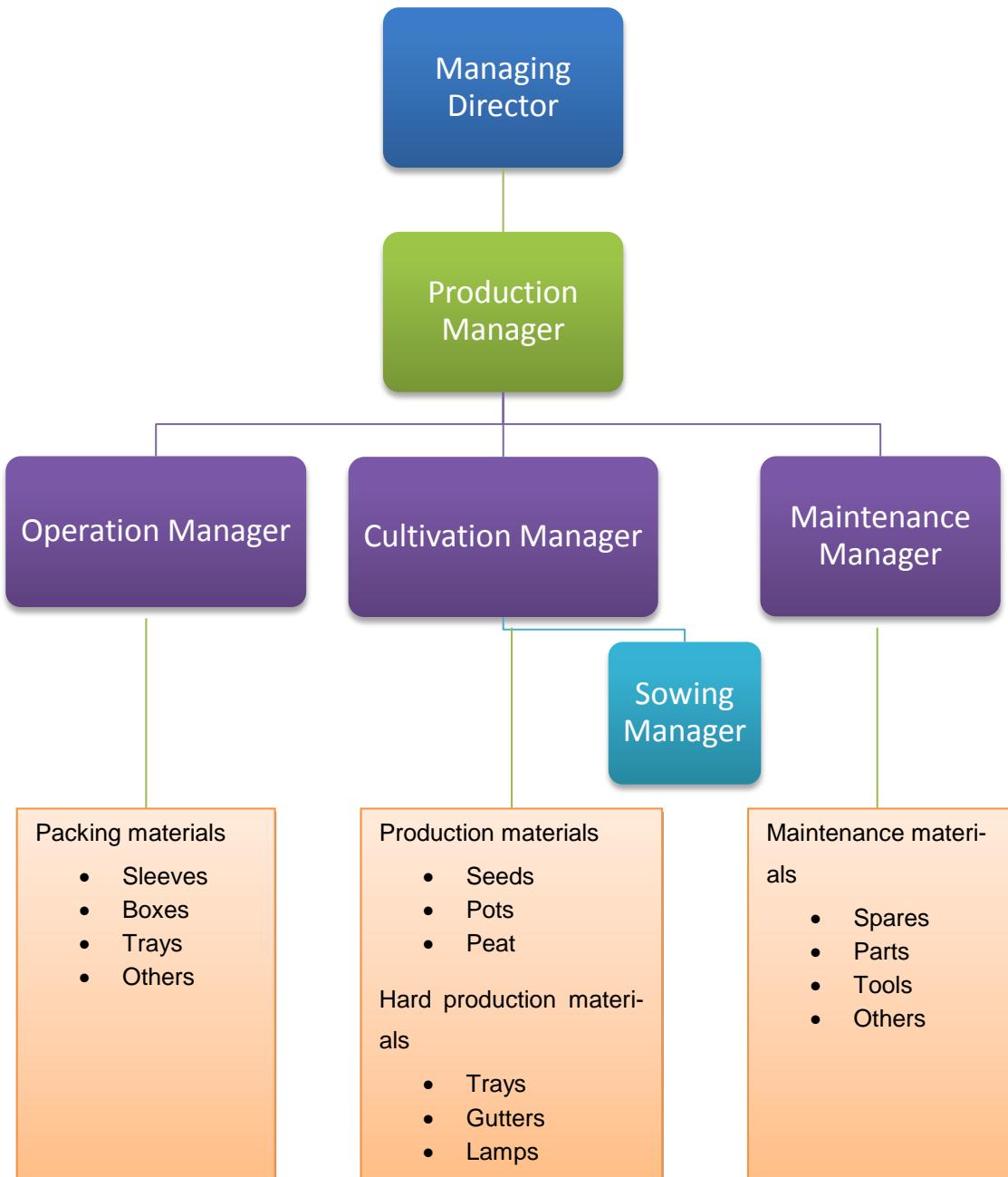


FIGURE 13. Decentralized management model of raw material

He also often takes some times to quickly go around the facility and check if production is running in schedules, employees are working enthusiastically... In case of changes needed, he will be the one to decide. As a matter of fact, since Managing Director only concerns about high-level decisions and strategies, he will need suggestions, advices from lower managers, who know more in detail.

### ***Production Manager's role***

As a matter of fact, the person that Managing Director will ask for information the most is Production Manager, the one who is responsible for managing every main

activity in production process. Changing personnel in production department, rearranging the teams and their works...are all controlled by Production Manager. There is a close connection between Production Manager and Managing Director. The one making the biggest decisions is Managing Director, but the one knows more in detail is Production Manager. Production Manager creates new plans; presents the plans, and asks Managing Director if it is available. In reverse, when Managing Director wants to change something in production, makes new plans, he must need advices from Production Manager (Famifarm Oy Production Manager, November 2012).

Being a Production Manager in a company like Famifarm is totally a challenging job. Only concerning about materials, there are already three people below him; they often report tons of information, and ask for dozens of decisions every month. With a change in production plan can affect the net sales of total 15 million Euros per year, Production Manager must be highly responsible. Certainly, being the boss always has its own advantages. Managing and reporting to Director is his job, but Production Manager doesn't have to do everything alone. In the current model at Famifarm, about more than 10 kinds of materials are being in used. Physical inventory, preparing budget for next year, placing and managing orders to suppliers... those tasks mean a lot of work every day. That's why Production Manager has distributed these works equally to lower managers: Operation Manager, Cultivation Manager, and Maintenance Manager (Famifarm Oy Production Manager, November 2012).

### ***Maintenance Manager's role***

Basically an engineer, Maintenance Manager concerns about the technical side of production process. Anything related to technical problem happens during production can be assisted by the engineer team working under the instructions of Maintenance Manager. Since the facility includes many greenhouses connected to each other, with each greenhouse contains thousands of metal parts, automatic machines, bar moving systems...engineers' jobs are really a big amount. In order to maintain the smoothest flow of production possible, engineers always come to where there's problem and fix them as soon as possible. Not to mention when there is a new greenhouse built-up which happens in every few years, engineer teams are also in charge of designing and creating the working system in that greenhouse. By mentioning all these engineer works, it is quite easy to understand how hard it is to be Maintenance Manager at Famifarm. Besides, because of so many metal parts needed to change and replace, he also has to deal with a lot of material managing works such as physical inventory, ordering new spare parts, and report to Production Manager (Famifarm Oy Maintenance Manager, November 2012).

### ***Cultivation Manager's role***

The second manager needed to mention here is Cultivation Manager. He is the one in charge of directing the way plants grow at Famifarm, an expert in fields of Biology, Agriculture,...As we all know, human have been growing things from land for thousands of years, but have we really ever totally controlled what was growing up and how well it was growing compared to what we wanted? No. And the answer is still true nowadays, too many objective and subjective factors can happen to affect the size and quality of matured plants. The idea of creating Famifarm was also to bring plants production to a higher level in which we can control as many factors as we can, more than what we used to do long time ago.

Cultivation Manager is the one to record the growing progress of plants, noting problems, unexpected results, and then research for reasons and solutions. In a funny way, Cultivation Manager is the scientist of Famifarm. Besides, he also has to calculate how many ingredients needed to mix for the fertilization, how much water for different kinds of vegetables, how bright and hot the lamps should be, and the frequency of them. Because of Cultivation Manager and his team, Famifarm has managed to increase the successful rate of production a lot, bringing greater profit reports every year. However, beside his original job, Cultivation Manager at Famifarm also supports in materials management. The important advantage from researching many greenhouse models from foreign countries is that he could understand languages and contacts from these countries, and in this case it is Sweden and Netherland, the origin of current greenhouse model. At the moment, Cultivation Manager is in charge of ordering two types of materials:

- Production materials: seeds, pots, and peat
- Hard Production materials: trays, gutters, lamps which don't need to change usually.

However, as mentioned above, his main job is still cultivation which takes up a lot of time, therefore, the job is entrusted to Sowing Manager. Sowing Manager is basically the main person in charge of the sowing area. Working there mostly every day, he can easily manage materials and report to Cultivation Manager when needed (Famifarm Oy Cultivation Manager, November 2012).

### ***Operation Manager's role***

The last important person needed to mention in this hierarchy is Operation Manager. He is the one closest to Production Manager in term of job characteristics. He's in charge in many parts in production process such as human resources, production

quantity management, and support in diplomacy... Operation Manager takes the main role in recruitment. Certainly, this recruitment only belongs to production side, since office employee is hired directly by Managing Director. Every new employee intends to work in production is introduced and guided by Operation Manager, not to mention that promoting long-term contract employees to permanent employees is also decided by him (Famifarm Oy Operation Manager, November 2012).

Besides, Famifarm is usually visited by many different social organizations and groups, like a school trip for students or job guidance for immigrants. In such cases, Operation Manager who knows in most details the production process take the lead and help visitors to understand what is going on under the giant glass roof by a trip around the facility. Besides, in other business visits from many interest groups such as other greenhouses' representatives asking for good examples, experts in greenhouse production models giving suggests for improvements, Operation Manager also supports Managing Director a lot in showing visitors around. But the most important task of being an Operation Manager at Famifarm is calculating, preparing production plans. He is the one giving instructions to team leaders the production quantity needed from each greenhouse every day. Receiving budget plan from head office, he balances with the production capacity and decide the optimal production quantity plans, thus based on that to make in-detailed instructions to lower production employees. The numbers and methods in detail will be discussed in the following chapter (Famifarm Oy Operation Manager, November 2012).

### **3.3.3 Management methods in inventory management**

As mentioned above, the total number of materials related to Famifarm's business is a great amount and it is impossible to discuss about them all in such a scale of the thesis. Therefore, the main subject focused here are three production materials managed by Cultivation Manager: peat, pots, and seeds, and three main packaging materials managed by Operation Manager: sleeves, trays, and boxes. Basically, Cultivation Manager doesn't actually manage his materials, but Sowing Manager. He is the one directly manages, calculates, and orders all material from Finnish suppliers. Operation Manager does the same job with his materials and orders whatever comes from Finnish suppliers. With materials from foreign suppliers, Operation Manager and Sowing Manager both ask for support from Cultivation Manager, who has the contacts and relationships, directly orders those materials. The details and list of materials from Finland and from other countries will be listed in table 7 below:

TABLE 7. List of suppliers of Famifarm Oy (Famifarm Oy Sowing Manager, November 2012).

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### ***Physical Inventory***

Meanwhile, it is necessary to mention another important activity performed monthly, which is physical inventory. As said above, seeds, peat, and pots are all managed directly by Sowing Manager and he always performs physical inventory when he comes into storage every day to take necessary materials. For sleeves, trays, and boxes which take large spaces, in order to know exactly how much of material is still left in stock, Famifarm performs physical inventory periodically once a month on the 1<sup>st</sup>. There are about four to five employees trained to perform this activity and each physical inventory performed requires one employee. The employee must go to all locations in the whole facility where materials are stored and count them. At the moment there are four such locations to check: the outside main stock where all materials come into first before distribution and three small storages inside the facility. Except for the main storage, all the other 3 material storages are purposely small, usually enough for only 1-2 pallets of each material. Replenishment for these small storages is performed when the material is about to run out. After being informed about the shortage of a material in near future, team leaders will call a transporter of Famifarm mainly in charge of transporting materials inside the company's area. Since main storage is built right next to the main facility, it takes almost no time for the transporter to bring 1-2 pallets into the main facility. Besides, there is also a small number of sleeves, trays already taken to harvesting places. However, only one box of each material is taken to harvesting places when necessary, the actual number of these opened boxes is really small thus it is available not to count them into inventory. After performing counting of all material in all four storages, the employees calculate to get the total number in stock for each kind of material and make a monthly inventory re-

port before giving it to Operation Manager (Famifarm Oy Operation Manager, November, 2012).

***Operation Manager's management method***

The beginning of each month is also a busy time for Operation Manager. Receiving Physical Inventory report, he needs to input data into his own inventory managing tool using Excel. The file is created in Excel and uses basic tables and formulas to control usage, in stock materials, time and quantity to order...

For controlling sleeves, Operation Manager creates continuous tables like table 8, certainly with full details for every kind of sleeves being used at Famifarm. Content of table 8 is the extracted and translated information of some certain sleeves from the original tables.

TABLE 8. Sleeves storage in 2011 at Famifarm Oy (Famifarm Oy Operation Manager, November 2012).

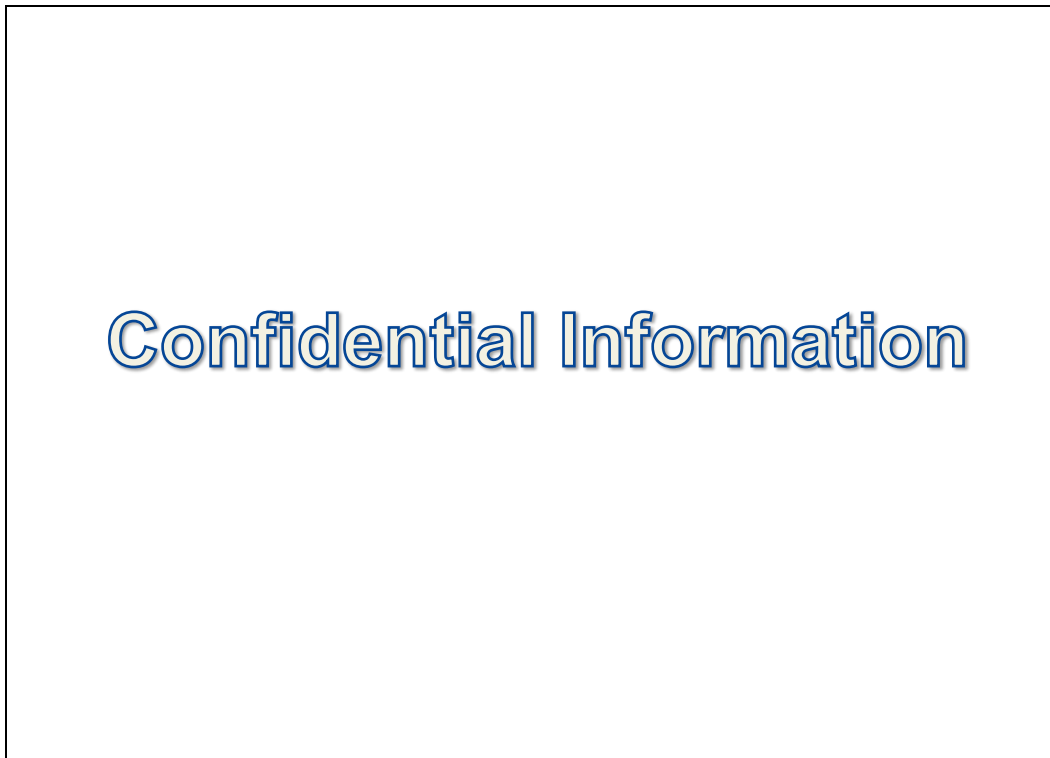


Table 8 includes the inventory numbers of four vegetables: Rucola, Dill, Basil, and Parsley from week 1 to week 15 in 2011. The most fundamental formula applied to calculate in-stock amount for a particular week is very simple: in-stock amount of previous week plus delivery if available, minus usage. For example, the calculation of in-stock amount of week 12 for Rucola is described as below:

$$\text{In-stock week 11} + \text{Delivery} - \text{Usage} = \text{In-stock week 12}$$

$$199350 + 780000 - 25000 = 954350$$

The usage amount for correspondent weeks and vegetables are shown in table 9:

TABLE 9. Sleeves consumption in 2011 at Famifarm Oy (Famifarm Oy Operation Manager, November 2012).

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However, there isn't such a table in reality, but Operation Manager inputs these data directly into his formulas in Excel. According to Operation Manager of Famifarm, the expected usage is based on historical records and they have shown that usage of a particular week between two consecutive years' only changes at an extremely small rate. Therefore, the dependability of these expected usage numbers are considerably high.

As mentioned above, there is always physical inventory for these materials performed periodically on 1<sup>st</sup> of every month, after which report is given to Operation Manager. And on table 8, marked red weeks are the first weeks of each month. Before receiving the physical inventory report, these red weeks weren't marked red and they were calculated in the same formula as other weeks. However, after receiving the report, Operation Manager uses the expected numbers as the base to consider the dependability of report numbers. As mentioned above, with much storage around the facility, difficulties when moving and counting in storages can lead to mistakes in physical

inventory. Since the dependability of expected numbers are high, only slightly different from exact numbers, if the report numbers are too higher or too lower than expected numbers, they are considered wrong and need to be counted again. If report numbers are not so different from expected numbers, they are considered dependable and therefore used to replace expected numbers in data tables. As a result, numbers in red weeks are physical inventory numbers input after checking dependability, not calculated by a formula (Famifarm Oy Operation Manager, November 2012).

After physical inventory numbers are input and marked red, next weeks' numbers automatically change correspondent to new data added. Using data from the latest physical inventory as the base, next weeks' inventory numbers of sleeves have come nearer to reality than before. The routine is repeated at the beginning of each month, or after 4-5 weeks. Not just physical inventory numbers, but expected usage of each sleeve in near future is also updated and informed by the head office. As a result, new data are often input in the table at least once a month.

Using this tool for sleeves, Operation Manager can predict until what week, a particular material will run out of stock. Certainly, to make sure that there will be safety stock to use for production even in case there are problems with suppliers or transport companies and deliveries come later than expected, Operation Manager always aims for deliveries to come at least some weeks before the materials run out of stock. Orders would be placed based on normal lead times from suppliers (Famifarm Oy Operation Manager, November 2012).

With both trays and boxes are calculated in separate tabs, the same formula is applied for in-stock amounts which is:

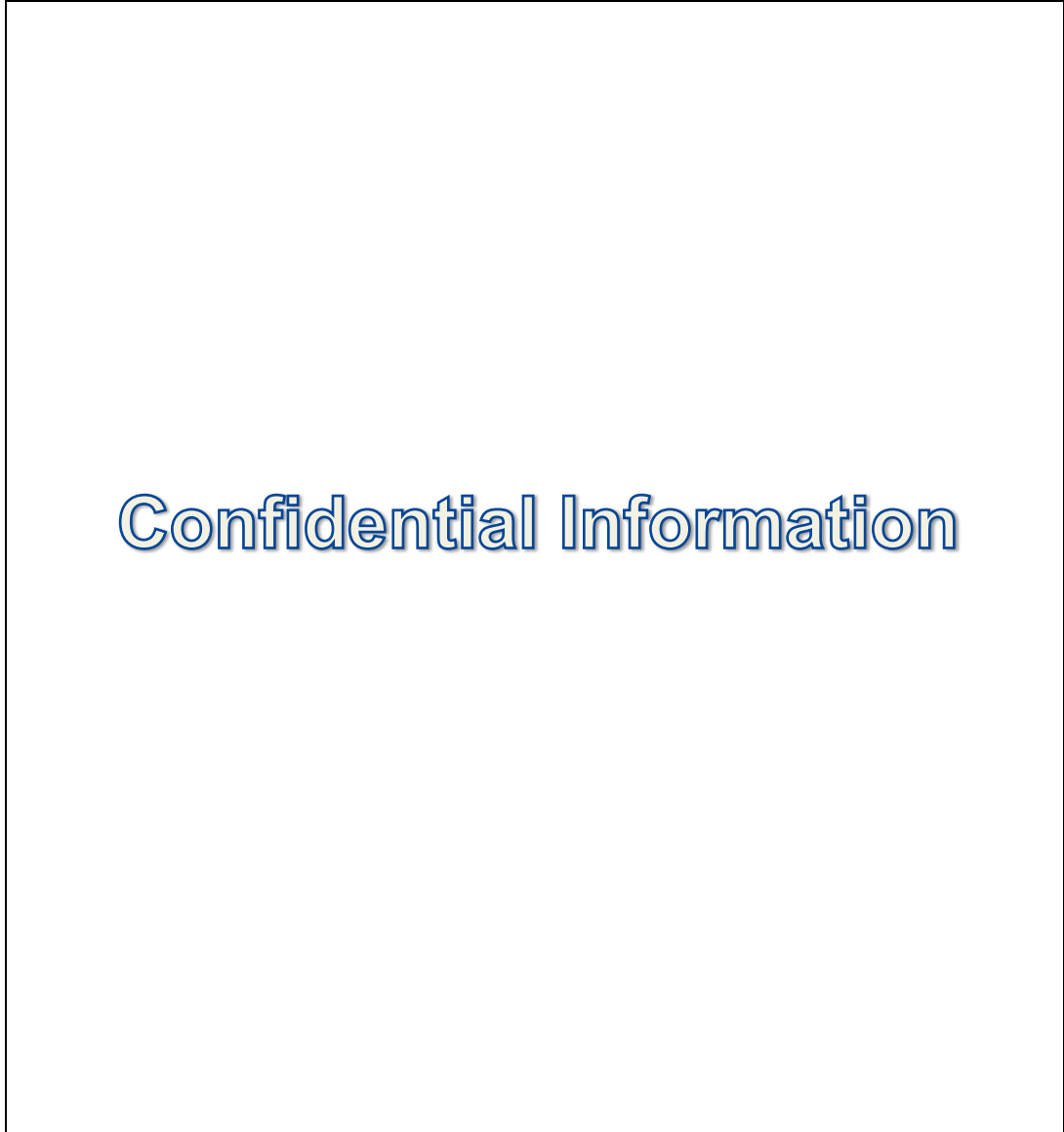
$$\text{Previous In-stock} + \text{Delivery (if available)} - \text{Usage} = \text{Current In-stock}$$

The biggest difference from sleeves needed to take into consideration is that there are only two kinds of trays and total six kinds of boxes used for nearly twenty kinds of sleeves. Therefore, Operation Manager makes a separate tab in the same Excel file to calculate the usage for each kind of tray and box before using those results for inventory tables for all trays and boxes.

Table 10 below shows the average consumption of boxes per week at Famifarm. Columns are divided by six kinds of boxes in used and rows are divided by products. The first column presents the average weekly production volume of each product.

Using this figure, Operation Manager divides them by the number of sleeves in each particular kind of box, thus gets the results for weekly consumptions.

TABLE 10. Box consumption at Famifarm Oy (Famifarm Oy Operation Manager, November 2012).



A big box usually consists of 12 sleeves, except for Ice Salad with 9 sleeves and Salanova with 8 sleeves. This type ranks second with average 14150 boxes used per week. They are used mostly for salads type such as Lollo Rosso, Romaine, Salanova...planted from greenhouse 1 to 6. Medium size is consumed the most as all herbs like Basil, Coriander, Dill, Parsley,... with high production volumes use this type as the main box. Not to mention some kinds of salads also use this type such as Lollo, Multi-leaf green, Romaine, Rucola, Frisee and Oak Leaf.

As a result, the average consumption of medium size boxes reaches nearly 22500 per week. Beside these main two types of boxes, Famifarm is also using some other box types for different purposes, certainly with a much smaller amount. Small boxes are folded at the average of 2000 boxes per week for Dill and Parsley with each box contains 6 sleeves. Since Famifarm also produces Dill in small size as a contractor for another brand Pirkka, the average usage per week of this type also reaches 600. Last but not least, along with being put directly into sleeves, Ice Salad and Frisee are also being harvested by cutting in standard of 100 grams for one package. These packages are then put into their specific box type before going into storage or shipping. The usage of this box type is often about 4750 per week but tends to increase in the future as these Ice Salads in bag sales are increasing more quickly than others. Table 11 below shows the main tab for controlling inventory of boxes at Famifarm.

TABLE 11. Box storage at Famifarm Oy (Famifarm Oy Operation Manager, November 2012).

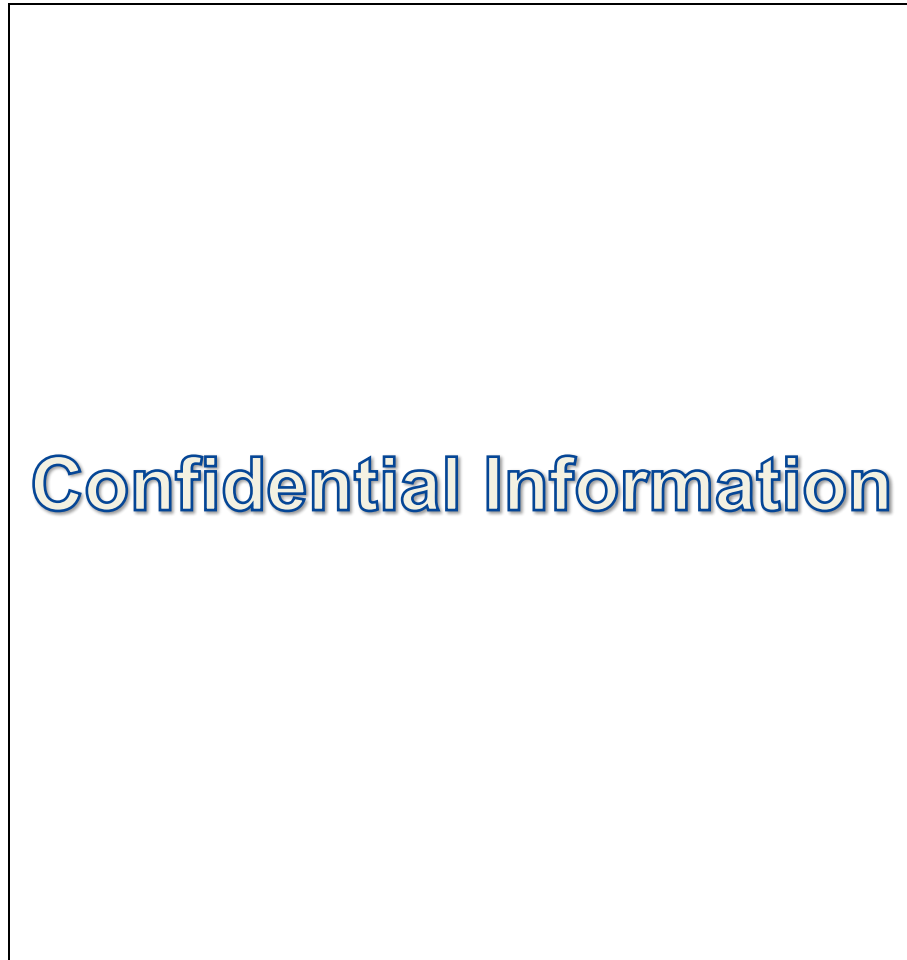


Using the same method as sleeves, Operation Manager deducts these results of average consumption, therefore calculates the in-stock amount of boxes for coming weeks. Certainly, after monthly physical inventory, these numbers are updated, marked red after Operation Manager checks the dependability of report numbers.

As mentioned above, Operation Manager also calculates in-stock trays in a separate Excel tab with the same formula as sleeves and boxes. Certainly, his job has become

a lot easier here since there are only two kinds of trays in use. Table 12 shows an example of inventory management for trays in 2011.

TABLE 12. Tray storage in 2011 at Famifarm Oy (Famifarm Oy Operation Manager, November 2012).

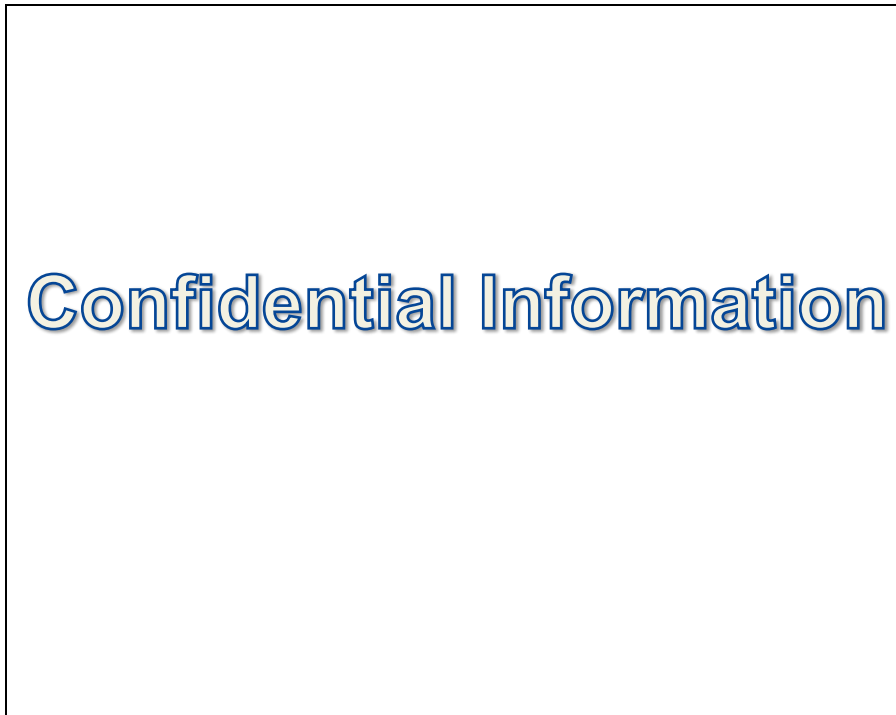


However, it is necessary to mention here that not every product needs tray before put into boxes, the only products using trays at the moment at Famifarm are listed in table 13. Because only Dill 12 and Parsley 12 needs twelve-slot trays, the average consumption of this type only takes about 5200 per week. On the other side, seven other kinds of herbs are using 6 slot trays as their base for more secure transportation with Basil as the leader. As a result, more than 20000 six-slot trays are being put into production every week. Phone and email are the two main communication tools for Operation Manager when placing orders. The usual suppliers are Stora Enso and Muovijaloste, whose products are mentioned above in table 7.

### ***Sowing Manager's management method***

For the other three materials: seeds, pots, and peat, as mentioned above their management are entrusted to Sowing Manager who works directly with these materials every day. Storage is considered very important for a faster sowing process. To finish the large amount of work in this stage, the machine must be maintained running all the time, with only slight idle time allowed.

TABLE 13. Tray consumption at Famifarm Oy (Famifarm Oy Operation Manager, November 2012).



After finishing one vegetable, Sowing Manager and other sowing employees have to change many parts such as seed, suitable roller, suitable dibbler...as fast as possible in order to minimize idle time between two seeds. Because of that, storage for pots, peat and seeds are located pretty near the machine. Being so fragile and needs careful handling, seeds are stored in a small cold storage usually at 4<sup>0</sup> Celsius. In the room, there are some shelves divided into separate levels with particular name tags to prevent confusion.

Different kinds of seeds are thus arranged into their right spaces. Salads seeds are bigger, always stored in cans, while herbs seeds, mostly very small, usually come to Famifarm in big bags. Secondly, pots are neatly packaged in boxes on pallets and stored near the sowing machine. There are always two pallets of pots, one for small and one for big pots put right next to the machine for quick input. Meanwhile, other pallets of pots are stored in the storage near there, and can easily be moved into po-



sition whenever needed. However, different from seeds and pots, peat is produced and packed in a big mass covered by plastic on pallets, thus they require extremely careful handling when being input or else the mass could fall off which leads to a large waste of time. The only comfortable point about handling peat is that once a pallet is input, it takes a long time to run off. One day's work often requires two to three pallets of peat only. Since Sowing Manager come and change seeds, pots, peat many times per day, he can always see how many materials left; therefore have an easy time preparing for next replenishments.

For each kind of seed, Sowing Manager usually uses at least once per day, which equally means a quick daily physical inventory. Moreover, lead time from Finnish seed suppliers is usually 2 days, thus Sowing Manager in theory can choose reorder point at minimum 2 days' work. However, being careful about sudden late deliveries and unexpected problems, he usually places orders when the remaining amount of a particular seed is still enough for around 10 days' usage. Ordering quantity is not calculated by any formula but aimed to fulfil the space for that seed in the shelves. With seeds being bought from foreign supply sources, Sowing Manager has to notice Cultivation Manager at least one month before running off because it takes about 2 weeks lead time at minimum (Famifarm Oy Sowing Manager, November 2012).

Similar to seeds, pots usage is very stable between years and only fluctuates a little between seasons. As a result, Famifarm doesn't need to store many pallets of pots at once. Easily seeing in-stock amount of pots, Sowing Manager also orders new batches when there are enough for 7 days' work left. In addition, he already got an agreement with PM Plast Oy, thus they always prepare a safety stock of pots for immediate delivery in case of emergency.

As mentioned above about peat usage, only 2-3 pallets are consumed per day, therefore Famifarm sees no need to put so much capital in this material's stock. However, as peat takes larger volume than other materials, most of its stock is kept in the main storage. Replenishment from main storage is implemented everyday by a transporter or Sowing Manager himself to maintain the number of pallets near the production area equal to at least 2-3 days' work. In that way, Sowing Manager could also perform physical inventory briefly with peat. Besides, replenishment from Kekkilä Oy usually comes in only 2 days, adding some safety stock; he often chooses reorder point at least 7 days (Famifarm Oy Sowing Manager, November 2012).

### ***Cultivation Manager's management method***

Just like Operation Manager, Cultivation Manager's role is very important to Famifarm. Not only in charge of cultivation, the quality of outcome products, he also takes care of ordering materials from foreign suppliers. Sowing Manager and Operation Manager often manage, calculate, and give notice to Cultivation Manager to order.

One advantage for Cultivation Manager when calculating ordering quantity is that usage of seeds and sleeves over the years only slightly fluctuate, therefore it is easy for him to forecast the usage in 1-2 years forward. Based on that, Cultivation Manager usually contacts with foreign suppliers, and makes oral agreements with them broadly about the quantity for the coming 1-2 years. After that, whenever Sowing Manager needs replenishment, Cultivation Manager just needs to make the call and tell exactly how many pallets needed to suppliers. Goods will come in normal lead times (Famifarm Oy Cultivation Manager, November 2012).

## **3.4 Problems Existing in Inventory Management at Famifarm Oy**

It is unrefuted that Famifarm's managers are trying very hard in controlling inventory with their current resources, from the decentralized management hierarchy, using computer tools like Excel to well being aware of safety stock when placing orders. The question is whether their current way of management enough to maintain a smooth rotation without any trouble? This chapter not only describes some stock-outs remembered in 2012 with their consequences but also indicates their potential causes.

### **3.4.1 Stock-outs and consequences**

According to Operation Manager of Famifarm, in the last few years, production process has usually been in the situation of stock-out at least once or twice a year. A stock-out of a particular material often leads to delays in its production, therefore costs the company more.

Even though managers at Famifarm can generally remember since stock-outs don't happen too often, there is actually no detailed written record of them at all as well as any calculation about consequences nor potential solutions. In 2012, there have been three stock-outs remembered. The first stock-out happened around the very first

week of 2012, with missing material was 6-slot trays. Table 14 is extracted from the original inventory calculation file by Operation Manager.

The duration of this stock-out wasn't remembered clearly by any manager, but according to table 14, it must have last at least one week. There was only around 17000 trays left in week 52 of 2011, with the weekly usage reached more than 20000, it was unavoidable that in week 1 of 2012, in-stock amount went down below zero. During that stock-out time, harvesting forces had to use the substitute trays that had been in stock for a long time. The substitutes were harder to use and took a longer time to harvest than usual. Eventhough there was no record, it was agreed that the effectiveness of harvesting was lower at that time than usual because of the substitute material.

TABLE 14. Stock-out of 6-slot trays (Famifarm Oy Operation Manager, November 2012).

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The second stock-out happened between week 20 and 30. Missing material was Chives sleeves. Table 15 below, extracted from Operation Manager's inventory file shows his calculation and record at that time, with a lack of data input for delivery in week 27.

According to Operation Manager, eventhough it looked like fourweeks of missing in the file, in reality it was only about one week. In that period, harvesting forces didn't have any Chives sleeves at all, which led to many confusions and wasted time. Especially on the first day of the stock-out, receiving information about a lack of sleeves, team captains had to go asking for directions from higher managers, waiting for an answer, then came back to inform the directions to workers, who were waiting. These steps even though sounds simple, wasted more than one hour with nearly ten workers didn't know what to do and waited for directions, team captains walking around asking for information while higher managers struggled to find a temporary solution. With one hour from each person, it was 15 hours wasted in terms of time,

and about two hundred euros in terms of salary. Not to mention this was just the first day.

TABLE 15. Stock-out of Chives sleeves (Famifarm Oy Operation Manager, November 2012).



A temporary solution was directed to everybody: using stickers on blank sleeves instead. Blank sleeves basically is a substitute material that is stored for just emergency cases like this, Famifarm doesn't use or buy it often therefore doesn't put it into any calculation. The stickers used here were special stickers with each kind consists information of a particular vegetable. Glueing the stickers on makes the blank sleeves become available to use for production interms of information. However, since there are only one kind of blank sleeve for all herbs and another one for all salads, its size is designed for multiple purposes. A general size certainly cannot fit perfectly every kind of vegetables, but there was no other option at the time. Stickers were glued to every single sleeves before being used for harvest. With an average consumption of 2500 sleeves per day, a lot of extra time was spent on this new job. A group of three workers were arranged, spent two hours fifteen minutes (a working day time is six hours forty-five minutes plus fifteen minutes break) every day to glue stickers on blank sleeves for the next day's usage. At the same time, the planned amount of work still had to be finished, thus required extra workers. As mentioned above, three workers did the job in one third of a working day's time is equal to one extra worker for the whole day and that was briefly the daily extra cost for Famifarm on that week.

Stock-out trouble at Famifarm wasn't stopped there and reappeared once again recently between week 49 and 51, in the beginning of December 2012. The trouble center this time was Romainee sleeves as shown in table 16.

Indeed, according to Operation Manager's calculation beforehand, the remaining stock should have been in control. The amount was supposed to be about 20000 in week 47 and down to 6000 in week 48 when a new deliver came. However, for some reasons, the delivery came a lot later than planned, in week 51, while the remaining stock had already run out after week 49. As a result, a stock-out situation continued in a period of one week with the missing item this time was Romainee sleeves.

TABLE 16. Stock-out of Romainee sleeves (without physical inventory update) (Famifarm Oy Operation Manager, November 2012).



During this whole stock-out time, instead of using the normal sleeves which was high quality, familiar, easy to shred when harvesting, Famifarm workers had to use the substitute blank sleeve for salad types, with Romainee stickers glued on. This substitute material was complained to be easily torn apart while harvesting and didn't totally fit the salad. Certainly, just like the last stock-out, stickers didn't glue themselves, but required some workers spending some extra time, approximately 2 hours per day. This is due to the slightly smaller daily usage of Romainee, 2300 compared to Chives, 2500 sleeves. However, with such a small difference, in the end, the total daily extra cost can still be considered one day's work of one worker.

#### **3.4.2 Potential causes**

It's true that Famifarm made "*hundreds, or even thousands of orders and deliveries a year and 99% of them are alright*", as a manager stated, however this last one

percent also did lead to many troubles and confusions, as mentioned above. Thus it becomes certain that looking for potential reasons of those mistakes can help solving them in the future.

In the whole process of physical inventory, managing, communicating, ordering, delivering,...running around materials at Famifarm, there are three main parties involved: suppliers, transport services, and Famifarm personnel. Mistakes can come from one or more of the three parties. And the more clearly we understand, the better solutions can be issued.

During the research process, one manager said that "*We shouldn't ever say that mistakes were because of suppliers or transport service*". According to Famifarm office, it's true that in the last few years, there haven't been any late deliveries from any transport service or suppliers. Most of these companies have performed well, in time when doing business with Famifarm, thus Famifarm hasn't changed any supplier nor transport service.

In an indirect way, Famifarm managers have agreed that in those cases of stock-out, it was no other than themselves who let small mistakes slip through and created confusion. But in such a long process, in which part mistakes lied? This question couldn't find a direct answer from any manager as it seemed inappropriate for them to point out each other's faults. Therefore, by analysing all direct potential causes in the whole material management process, it becomes possible to see which parts still need improving to prevent further problems.

### ***Physical inventory***

The first direct step relates to material management is physical inventory. As mentioned above, Famifarm performs periodic physical inventory once a month, with one employee in charge of directly counting in-stock amount of every material. This job usually takes up to a whole day for him/her to finish since there are at least four storages in and around the facility, not to mention the collection of material titles. Most of storages, especially the main one are large with many full high pallets put very closed to each other, thus it is a difficult task to see and count exactly everything. Besides, since there is no heating system in the main storage where takes up most of physical inventory time, counting in winter becomes a disaster, which can easily affect the employee's concentration and accuracy. As a result, after every time performing physical inventory, most employees in charge has to recheck once again in the next day since there are often some items not matched with Operation Manager's calculation. In the end, even if it were performed well without

any mistake, this kind of periodic physical inventory is only performed once a month, which also means that for the rest of the month, Famifarm can only guess how many left in stock, no matter how fast or slowly that material is being used. Certainly, after checking these points, it is not difficult to understand if a mistake comes from physical inventory.

#### ***Operation Manager's method***

After that, physical inventory is reported to Operation Manager for inputting figures into his Excel file for calculation. Basically, he is doing considerably well with his job of managing materials. Because of small fluctuated usage and his experiences, the average material usage can be acceptable for the moment. However, in the future when there might be a bigger fluctuation in demand, and business scale gets a lot bigger, bias will also be greater, and more stock-outs will certainly come about. In addition, during the research process, a small miscalculation was found in average usage of medium boxes, which is supposed to be around 22000, instead of more than 24000 per week. This issue indicates that lack of carefulness can happen all the time with anybody at any stage, especially with a hectic work environment. Moreover, as seen in the stock-out of Romainee sleeves, Operation Manager isn't putting enough effort in considering safety stock. His calculation in table 15 aimed for the delivery to come in week 48 when there was supposed to be only 6000 left, which wasn't enough for half a day usage. As a result, a late delivery happened, and there wasn't enough safety stock to use in the mean time.

#### ***Cultivation Manager's method***

Last but not least, Cultivation Manager also takes an important role in this process since he's in charge of ordering materials from foreign suppliers. After calculation, Operation Manager, as well as Sowing Manager, tells him to order a new batch of materials. At first, the work sounds simple enough, however, delivery time needs to be taken into consideration. There might be a chance that Operation Manager and Sowing Manager don't tell Cultivation Manager soon enough for material to come in time, but in this case of Famifarm, there is a higher rate for the reverse alternative that other two managers are in time but Cultivation Manager is late. It is necessary to remember that his main job is cultivation, which is also an important job and takes quite a lot of time and effort since it effects the outcome quality of products. Ordering is just another extra job which he certainly doesn't take as high priority his main job, therefore it is highly possible that Cultivation Manager tends to forget to place orders in time. Also, the only reason Cultivation Manager orders these materials is that he's got contacts, knows some Swedish and Dutch. However, this is totally inappropriate

and unnecessary, local language is good, but english can still be used when working internationally, while contacts can be transferred to other two managers without any trouble. Instead, Famifarm put an unnecessary extra stage in the process, makes it more complicated and confusing. Responsibilities are now unclear to divide, like a manager stated that he didn't really know exactly who was to blame, himself or the other manager.

### ***Conclusion***

Material management is truly a difficult and complex task, requires a lot of knowledge as well as experiences. Even if Famifarm performs 99% orders and deliveries well, the remaining 1% stock-out is already enough to give them some extra cost and efforts. In the current system at Famifarm, there are a lot of parts and details which could become reasons for stock-outs to occur such as physical inventory, inputting Excel file, forecasting average usage, and arranging orders in time... By putting effort into seeking out weaknesses, the whole material management system can be improved therefore prevent unnecessary problems in the future.

## **3.5 Research Results**

Conducting the research provided a quite clear and thorough insight of the biggest vegetables supplier in Finland. From how a product was produced in a long process, how materials are used and managed, the critical stock-outs as well as potential risks in the future.

### ***Purpose and use of materials in the whole production chain***

When doing business, there are products and services to provide. Famifarm supplies products to markets, therefore use materials as an extremely important element. Just a lack of one material, there will be no vegetable for selling to customers. A complete product of Famifarm Oy is the result of combining many kinds of material. Not to mention each material comes to Famifarm, put into production is also the result of researching, communicating, ordering, transporting, and handling.

A sold product that Famifarm provides to reseller includes a box, (tray), sleeves, seeds, pots, and peat. Moreover, these are only main materials which require high amount and rotate quickly, not to mention other low profile materials such as ink, stickers, maintenance shares and parts, hard production materials like gutters and hard trays, all that don't need replacing often.



### ***Current material management methods***

As mentioned by Production Manager, Famifarm Oy aims for flat organization type in which there are not too many levels of command, instead every manager are equal and all report to Production Manager. The outer level division seems to be clear and simple enough which helps a lot in minimizing unnecessary efforts. However, in this transition period from the old management system to new ones suitable for further development of Famifarm Oy, there are still many inadequacies in smaller management levels. Interaction among managers is considerably average. Tasks and responsibilities division aren't clear enough which lead to many confusions. When there is a mistake, it is difficult to find a person to blame since the one in charge might not be the one directly got something wrong.

Cheap cost is still the highest priority in choosing suppliers, leads to the fact that half of production materials are being imported from England, Sweden and Netherland. At the same time, it also increases the complexity in managing and ordering.

### ***Stock-out as a critical problem in inventory control***

Stock-out in this research indicates the state of lacking materials for production. It can happen for many reasons as mentioned in chapter 3.3.2. When there is a stock-out, confusion, even panic appears, workers and captains don't know what to do except for later directions from managers. Time and labor are wasted a lot more in a stock-out, and this is just in case there is a substitute material. What if in near future, designs change and the current substitutes can't be used anymore? There will be no production for that product line during the period, the company might lose even lose customers for good, then have to spend five times cost to build up new customer relationships to replace.

### ***Disadvantages of substitute materials***

Certainly, there are many reasons that substitute materials are considered to use only in cases of emergency when there are desperate needs and no main material to supply. Substitute materials are usually bought in quite a large amount and stored in the main storages of Famifarm facility, sometimes used in stock-out periods. As mentioned above about sleeves, there are one sub for all kind of herbs, and one sub for all kind of salads being stored. However, since there are too many different sizes vary among herbs and salads, it is impossible for the substitute sleeve to perfectly fit every product like their own specific sleeves do. While some vegetables might look too short in the sub, others might look too high, even higher than the sleeve's edge, which can also affect the quality of products in packaging and transportation.

As substitute sleeves are blank and put on stickers for different titles, the design therefore isn't as specific as main materials. The current design of main sleeves from Famifarm has changed a little in the last few years, with some additional information about health and certifications. As a matter of fact, these changes haven't been applied to substitute sleeves that bought a longer time ago. When these substitute sleeves come to the hand of ending customers, a negative image of the company would certainly stay in customers' minds.

From inappropriate size to bad looking, even worse quality than usual, substitute materials could never bring such high quality, positive image of Famifarm's products into customers mind. Because of that, minimizing the chance of stock-out emergencies from happening also means minimizing the usage rate of substitute materials, thus maintaining the company's credit in public.

### ***Risks increase as business scale increases***

With its production complication at average high level and annual net sales reached 15 million Euros, Famifarm's current material management is updating at a slower speed than production scale. Five years ago, there was mostly no such stock-out happened since the business scale was only as half as today's. At the moment, such problems did happen, even though not usual, but still critical and costly. If Famifarm's business is still growing at this speed with material management unchanged, sooner or later, there will be many production disasters come about in the next few years. Stock-out happens more often, workers will have more time standing still without knowing what to do, at the same time more workers will be needed to keep up with scheduled production plans... Comparing to current calculations, the extra cost will be double or even triple.

### ***Conclusion***

The research results can help many later researchers in understanding how things are running in a vegetables production facility, how materials are organized, stock-outs and their consequences as well as potential sources of problems. Firstly, Famifarm Oy, as the biggest vegetables supplier in Finland, is growing in such a steady safe speed, regards of many changes and crisis of the world economy in the last few years. They are organizing well a smooth flow of production process, whose net sales already reached 15 million Euros in 2011. Materials, as the source of their business are being bought from many suppliers, stored and used in every stage. Most of production materials are being managed directly by Operation Manager and Sowing Manager, with Cultivation Manager giving support in ordering from foreign

suppliers. This kind of division even though helped in hundreds of deliveries every year, still needs a lot of changes and improvements in order to prevent stock-outs that tend to occur in times of carelessness.

Whenever a stock-out occurs, not only it makes the production process run slower, but also comes with many other consequences. Time and effort are wasted for the confusing time as well as working with substitute materials. With many disadvantages along, substitute materials should only be stored in small amounts, while putting more efforts to minimizing the chances to use them as low as possible.

With such a big scale of business running, the current management method for materials seems to be unsuitable in the near future. Net sales will be greater; more greenhouses will be built, certainly as well as a lot more materials will be flowing through the process. Only by understanding weaknesses of the system and researching to improve can help maintain the smooth flow of production at Famifarm Oy.

## 4 RECOMMENDATIONS AND CONCLUSIONS

Stock-outs did happen and brought along many consequences to Famifarm's business. Inevitably, the current way of management needs changing, whether parts or the whole system. This chapter therefore discuss about some potential suggestions as well as conclusion for the whole research.

### 4.1 Recommendations

As a matter of fact, changes are absolutely necessary in not just one but in many parts, or even the whole system itself. The current way isn't bad, but it will be in the future. Constantly changing is the best way to always develop and be the leader in the modern business world.

#### ***Tasks division***

It is such an easy job to see the inadequacies in the current way of tasks division in material management at Famifarm Oy. Even though Operation Manager and Sowing Manager are the ones directly manage and control production materials, whenever they need to order some items from foreign suppliers, the job is transferred to Cultivation Manager. The only reason behind this, as mentioned by a manager is that Cultivation Manager knows some Swedish, Dutch, and he's got the contacts. In fact, the reasons are totally unconvincing; contacts can be transferred without any troubles, and certainly the other suppliers from Sweden and Netherland can communicate in English when working internationally. The extra Cultivation Manager certainly has proved that the ordering became more complicated and confusing in responsibilities. Because of that, letting Operation Manager and Sowing Manager be in charge of ordering their own materials are absolutely necessary, whether Famifarm still uses the current suppliers or not. Certainly at first, difficulties can be found when suppliers also have to change the way of communication and these two managers have to take care of more jobs. However, after a while when everyone gets used to the new way, the ordering process is going to be a lot easier and smoother. As the people directly control materials, Operation Manager and Sowing Manager know exactly when they need to place orders as well as the importance of the orders' time. They will consider placing orders as the highest priorities since that's one of their main jobs. Besides, as a manager stated that the same materials can also be bought from local Finnish suppliers with just a little higher price. Changing suppliers is also another highly recommended option for shorter lead times, cheaper delivery cost and more constant mate-

rial supplies. Surely everything's got its good and bad sides, purchase costs will be higher which might make an impact in the outcome price. Trying to create a balance between cost and other advantages from local suppliers is naturally the best option.

### ***Physical inventory***

With its collection of material items in stock, Famifarm is poorly performing a periodic physical inventory once a month. The specialties of storages and pallets bring a lot of difficulties when counting every single item, not to mention the freezing condition in winter when staying in the main storage for too long. Besides, reality has proved that the current method also lacks the necessary accuracy and the employee in charge often has to recount in the next day. Therefore, change is needed. If Famifarm insists in using the current periodic method because of other objective conditions, there should be a change in the period itself. One month isn't too long, but it has shown its inaccuracy level when choosing 1<sup>st</sup> as the physical inventory day. Regardless of whether 1<sup>st</sup> is the first or the last day of the week, physical inventory is always performed on this day, leads to the differences between real figures and Operation Manager's calculation. Since the calculation is based on terms of week, and there are total 52 weeks per year, a two-week-period seems to be a better choice for this method. Certainly, this means doubling the performing times, from once every 4-5 weeks to every 2 weeks. However, this also means doubling the accuracy level of physical inventory. Figures will be updated more often than before, with every single items counted on Monday once after 2 weeks. In exchange, this method will double the performance costs, therefore an experiment time and balancing calculations must be implemented in order to see whether this method is worthy or not.

Moreover, it might bring even better results when Famifarm totally changes the current method from periodic to cyclic physical inventory. The basic principle of this method is not to count every single item in one time; instead the portfolio is divided into different groups based on classification theory in chapter 2.3.1. The item group with high total usage in terms of Euros would be performed physical inventory more often, maybe even once a week. The medium group can be counted again after 2-3 weeks while it is 4-5 weeks for the low total usage group. Table 17 below is an example of group division for sleeves based on total usage in Euros.

TABLE 17. ABC classification for sleeves

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As seen in table above, sleeves are divided into three groups ABC based on total usage in Euros. Group A's got the highest value above 10%, group B is from 5 - 10 % while group C includes items below 5%. The table not only indicates which group requires more capital invested annually but also which group is being used more usual in terms of quantity since the unit cost among items don't really differ from each other. Based on this type of classification, group A with Dill, Ice Salad in bag, Ice Salad, and Lettuce sleeves requires highest care in physical inventory. Group B includes Basil, Rucola and Parsley sleeves while the rest of sleeves belong to group C. Certainly, when applying into reality, Famifarm also has to consider other factors such as size of spaces arranged for each kind of materials, or geographical arrangement of

storages. It's true that performing this cyclic physical inventory method requires higher costs and efforts compared to the current way. However, in exchange, the level of effectiveness and efficiency achieved will be much greater. Counting parts of inventory not only shortens the performing time but also increases the accuracy level. In the end, no matter how better it sounds in theory compared to the old way, calculations are needed to balance between cost and effectiveness before the implementation of this method.

### ***Safety stock***

One good point in the current management method is that safety stock is already considered when placing orders. As mentioned by both Operation Manager and Sowing Manager, they always place orders to come when there is still one or two weeks of usage left in stock, varies among suppliers. However in fact, safety stock isn't always cared for enough all the time as seen in the stock-out of Romaine. At that time, in Operation Manager's calculation, the delivery was aimed to come on week 48 when there was only half a week usage left, which was too risky. And reality proved that carelessness had to pay the price of one week stock-out as delivery came later than usual, regardless of the reason why. To know preparing safety stock when ordering is naturally necessary, however it is truly difficult to optimize this figure. There are many suppliers doing business with Famifarm, each supplier has their own usual lead time and credit. But the hardest part in optimizing this figure belongs to the lack of necessary elements for calculation such as standard deviation in demand or lead times, which will be discussed after this. Without those elements, it is impossible to figure out exactly the reorder point of each material.

### ***Essential figures***

Not only reorder point but also holding cost, ordering cost, and even stock-out cost take important roles in a company's inventory management. However, in fact, there is no such figure calculated at Famifarm, as confirmed by an office employee. They know neither exactly how much it costs for an unit when holding it in stock, how much it costs for one order placed, nor how much it costs when there is a stock-out. Indeed, calculating these figures, preparing statistical numbers such as customers' reactions with stock-out, total cost for building a new customer relationship, etc....require some hard efforts. There is no certainty that Famifarm will never have a stock-out again, no matter how many parts changed or new systems applied. But a thorough preparation can help in minimizing the chance of production disasters to the lowest. In exchange of some times' effort, preparing necessary figures such as holding cost, ordering cost, stock-out cost will also bring a lot of advantages for Famifarm Oy in the future.

### ***ERP System***

Even though recommendations above can surely bring some new fresh air into the old rusty mechanism of material management at Famifarm, they could never change it totally. Coming along with the bright future of the company's business, it is required that a new kind of mechanism will be needed in order to adapt with a brand new level of complexity which will be a lot higher than now. There have been many researches and developments implemented in this field for the past few decades by businessmen and academies all over the world. Among those researches, a certain approach has been proved as the best choice for not just material management but also the whole organization. The system is called ERP (Enterprise Resource Planning). As mentioned in chapter 2.10, ERP systems could integrate all departments and all of the general functions of company in a single computer system that can meet all the different manager needs of each department, and it has been adopted by numerous companies across globe. Certainly material management will also be included in this system's function.

If applied into the current system at Famifarm Oy, ERP will bring a great fortune to its business outcomes. A whole IT-based system will be implemented everywhere in the company to replace the old paper-based one. Sowing Manager will not have to write down every serial code of seed cans he use, which will anyway become trash afterward. Instead, he can use simple but useful tools such as barcode and scanner, automatically input all information of materials used into ERP system, which can be approached and analyzed by any department in the company. An office employee when in need of current sowing plan can use this system to check rather than wasting time walking directly to meet Sowing Manager. Because of using barcodes and scanners, every goods and materials going in, being used, and going out of FamiFarm will be scanned and recorded into the ERP system. This amazing function allow the company to easily track how many pallets of goods received, therefore becomes a base for a more accurate physical inventory. Operation Manager can also use ERP system to approach forecasts from main office, and constantly automatically update them into his calculation. As a result, the average usage of materials will be more realistic. Moreover, using ERP system, Famifarm also gets more advantages than the current system when implementing calculation for essential figures like mentioned above. In conclusion, ERP system, even though costs many efforts and time to apply, will make a great boost for the management system at Famifarm, raise it to a whole new level of accuracy, departments communication, tracking stock, loss and stock-out,....



## 4.2 Conclusions

Famifarm is a typical model of manufacturing business, in which material management is the source to achieve great successes. With a collection of materials needed for production, Famifarm is dealing with a greatly difficult task. The current ways of organizing roles and responsibilities, of dividing tasks, performing physical inventory, paper-based system are put into questions because inadequacies have let mistakes slip through and created confusions as well as unnecessary extra costs. Stock-out was happened about 2-3 times annually in the last few years and is certainly going to increase if inventory management methods remain the same.

As seen in chapter 3.3.2, there are many flaws in the current system which could lead to stock-outs. Physical inventory is being performed poorly, meeting a lot of difficulties when trying to counting every single item in stock, not to mention the one month period is not helping with the accuracy at all. Operation Manager is trying hard to control inventory as well as possible, however because of the unsuitable task division, lack of department communication and statistical figures, he's finding it hard to forecast average usage properly. Besides, the unnecessary role of Cultivation Manager is also making the system more complicated, easier to make mistakes when timing for orders placement. Generally, changes are unavoidable, and must be researched immediately.

Indeed it is always easier to find improvements for known weaknesses. Physical inventory can shorten the period, or totally change to cyclic type, which was proved to be much more effective. Rearranging responsibilities by cutting off Cultivation Manager's role, transferring everything to Operation Manager and Sowing Manager is also an option to simplify the mechanism. Besides, in order to adapt with modern technologies and further business environments, some essential figures such as holding cost, ordering cost, stock-out cost must be calculated and prepared for many occasions. But moreover, without the application of modern ERP system, the mechanism will always be a rusty old one. By changing from paper-based to IT-based system with barcodes and scanners, Famifarm will not just be a group of many departments and individuals doing their own jobs, but utterly becomes an united organization in which the communication among departments are better, every information from different departments can be approached in a blink, which decreases a lot of waste time. Besides, it is also more effective in preventing production troubles such as stock-out, loss...

#### **4.2.1 Reflections on this thesis**

The idea of this thesis started from seeing the consequences of a stock-out in production at Famifarm. At the beginning, we didn't have much detailed knowledge about how a manufacturing company runs how materials are used and managed, as well as various inventory management concepts and methods. Not only this thesis brought a wonderful insight of a typical production organization like Famifarm, it was also a splendid study experience. No matter how you learn about business in school, everything will always be on theory and paper unless such a practical research comes about.

In addition, the research isn't just a mere theory report but a result of cooperation among researchers, supervisor, and Famifarm managers. Everyone was aiming and hoping to conduct a useful research for the company's business and expectedly it is. Famifarm managers have been very cooperative and tried to help us as much as possible despite their hectic work schedules.

#### **4.2.2 A suggest for future researches**

Because of the limitation in thesis scope and four months timing, our research didn't aim for too detailed numbers, instead exploring a real organization and inventory management image, stock-outs' consequences, their potential reasons as well as promising ideas for improvements.

If there is another research about inventory management at Famifarm in the near future, a figure-focused direction would be extremely practical. As Famifarm hasn't started calculating essential figures because of their tight schedule, it is totally recommended for a deep research in calculating figures such as holding cost, ordering cost, standard deviation in demand and lead time for reorder point, or even stock-out cost. Such figures if calculated exactly will become a great tool for Famifarm managers in the future.

## REFERENCES

Academic Mind

*Just-in-time inventory management strategy & Lean manufacturing*, [accessed on 13<sup>th</sup> November 2012], Available from:

<http://academicmind.com/unpublishedpapers/business/operationsmanagement/2005-04-000aaf-just-in-time-inventory-management.html>

Administrative Information Service 2004

*Preface* [accessed on 6<sup>th</sup> January 2013], Available from:

<http://ais.web.cern.ch/ais/apps/lms/EXCEPT~1convert.html>

Blurt It

*What is the importance of inventory management to a business*, [accessed on 6<sup>th</sup> November 2012], Available from: <http://management.blurtit.com/q143178.html>

Bowersox Donald J, Closs David J and Cooper M. Bixby 2010

*Supply Chain Logistics Management*, third edition. New York: McGraw-Hill Higher Education.

Brinlee Doug

*ERP inventory management*, [accessed on 24<sup>th</sup> November 2012], Available from:

<http://www.askdeb.com/inventory-management/erp/>

Council of Supply Chain Management Professionals

*CSCMP Supply Chain Management Definitions* [accessed on 5<sup>th</sup> November 2012]

Available from: <http://cscmp.org/aboutcscmp/definitions.asp>

CiteMan- Global Corporate Community Knowledgebase

*Classifications of inventory systems*, [accessed on 7<sup>th</sup> November 2012], Available from:

<http://www.citeman.com/7533-classification-of-inventory-systems.html>

Coyle John J, Langley C. John Jr., Gibson Brian J, Novack Robert A & Bardi Edward J. 2009

*Supply chain management A logistics perspective*, e-book, [accessed on 8<sup>th</sup> November 2012], Available from:

[http://books.google.fi/books?id=TbuZnzcXGysC&pg=PA339&dq=stock+out+costs+inventory&hl=en&sa=X&ei=3Z-bUP-kOfLR4QS2rIGICw&redir\\_esc=y#v=onepage&q=stock%20out%20costs%20inventory&f=false](http://books.google.fi/books?id=TbuZnzcXGysC&pg=PA339&dq=stock+out+costs+inventory&hl=en&sa=X&ei=3Z-bUP-kOfLR4QS2rIGICw&redir_esc=y#v=onepage&q=stock%20out%20costs%20inventory&f=false)

Difference Between

*Difference between inventory and stock*, [accessed on 6<sup>th</sup> November 2012], Available from:

<http://www.differencebetween.com/difference-between-inventory-and-vs-stock/>

Daft Richard L, Kendrick Martyn & Vershinia Natalia 2010

*Management-International Edition*, e-books, [accessed on 6<sup>th</sup> November 2012] Available from:

[http://books.google.fi/books?id=76mkYywwQA4C&pg=PA819&dq=importance+of+inventory&hl=fi&sa=X&ei=OOSYUNmjPOr-4QS7nYCoAg&redir\\_esc=y#v=onepage&q=importance%20of%20inventory&f=false](http://books.google.fi/books?id=76mkYywwQA4C&pg=PA819&dq=importance+of+inventory&hl=fi&sa=X&ei=OOSYUNmjPOr-4QS7nYCoAg&redir_esc=y#v=onepage&q=importance%20of%20inventory&f=false)

Roy Ram Naresh 2005

*A Modern Approach to Operations Management*, e-books, [accessed on 7<sup>th</sup> November 2012], Available from:

[http://books.google.fi/books?id=KkJp8jb8UzkC&pg=PA105&dq=inventory+classification+methods&hl=en&sa=X&ei=KZGaUPWKG6bU4QSV0YBq&redir\\_esc=y#v=onepage&q=inventory%20classification%20methods&f=false](http://books.google.fi/books?id=KkJp8jb8UzkC&pg=PA105&dq=inventory+classification+methods&hl=en&sa=X&ei=KZGaUPWKG6bU4QSV0YBq&redir_esc=y#v=onepage&q=inventory%20classification%20methods&f=false)

Ehow Money

*Importance of Inventory Management Systems*, [accessed on 6<sup>th</sup> November 2012], Available from:

[http://www.ehow.com/about\\_5518506\\_importance-inventory-management-systems.html](http://www.ehow.com/about_5518506_importance-inventory-management-systems.html)

Experts Mind

*Ordering costs*, [accessed on 23<sup>rd</sup> November 2012], Available from:

<http://www.expertsmind.com/learning/ordering-cost-assignment-help-7342872644.aspx>

Famifarm Oy

Official website, [accessed on 9<sup>th</sup> November 2012], Available from:

<http://www.jarvikyla.fi/>

### General Solutions

*Enterprise resource planning*, [accessed on 22<sup>nd</sup> November 2012], Available from:

<http://gscom.vn/portal/20091204402/chuyende-erp/10-dieu-can-biet-ve-erp.html>

Goetz Douglas N. 2011

*Physical Inventories-Process Requirements under the Federal Acquisition Regulation Government Property Clause*, e-book, [accessed on 22<sup>th</sup> November 2012] Available from:

<http://government-property.com/wp-content/uploads/2011/07/PHYSICAL-INVENTORIES.pdf>

### How Stuff Works

*How inventory management system works*, [accessed on 6<sup>th</sup> November 2012], Available from:

<http://money.howstuffworks.com/how-inventory-management-systems-work.htm>

### Institute of Management Services

*ABC analysis/Pareto analysis*, [accessed on 7<sup>th</sup> November 2012], Available from:

<http://www.ims-productivity.com/page.cfm/content/ABCPareto-analysis/>

### INWENT

*Logistics areas and logistics systems*, [accessed on 21<sup>st</sup> November 2012], Available from

[https://gc21.giz.de/ibt/en/opt/site/ilt/ibt/regionalportale/sadc/inhalt/logistics/module\\_02/economic\\_order\\_quantity.html](https://gc21.giz.de/ibt/en/opt/site/ilt/ibt/regionalportale/sadc/inhalt/logistics/module_02/economic_order_quantity.html)

Järvinen, Jorma 2012. Cultivation Manager. Famifarm Oy. Joroinen 29.11.2012. Email interview.

Johnson Joe & Everson Colin 2003

*Controlling physical resources*, fourth edition, e-book, [accessed on 22<sup>nd</sup> November 2012], Available from:

[http://books.google.fi/books?id=an0gwHsZdP4C&pg=PA27&dq=first+in+first+out+stock+rotation&hl=fi&sa=X&ei=E\\_2tUMK-EZD14QT-olH4CA&redir\\_esc=y#v=onepage&q=first%20in%20first%20out%20stock%20rotation&f=false](http://books.google.fi/books?id=an0gwHsZdP4C&pg=PA27&dq=first+in+first+out+stock+rotation&hl=fi&sa=X&ei=E_2tUMK-EZD14QT-olH4CA&redir_esc=y#v=onepage&q=first%20in%20first%20out%20stock%20rotation&f=false)

King Nigel & Horrocks Christine 2010

*Interviews in Qualitative Research*, first edition, e-book, [accessed on 24<sup>th</sup> December 2012], Available from:

[http://books.google.fi/books?id=iOsnITKC48gC&printsec=frontcover&dq=qualitative+research+interview&hl=fi&sa=X&ei=YWnYUInTlunw4QT4woHQAaw&redir\\_esc=y#v=onepage&q&f=false](http://books.google.fi/books?id=iOsnITKC48gC&printsec=frontcover&dq=qualitative+research+interview&hl=fi&sa=X&ei=YWnYUInTlunw4QT4woHQAaw&redir_esc=y#v=onepage&q&f=false)

Kothari C. R. 2006

*Research Methodology: Methods & Techniques*, second edition, e-book, [accessed on 23<sup>th</sup> January 2013], Available from:

[http://books.google.fi/books?id=8c6gkbKi-F4C&pg=PA96&dq=research+without+observation&hl=fi&sa=X&ei=x3X\\_UJ-YMc-Go4ATLi4GQBw&redir\\_esc=y#v=onepage&q=research%20without%20observation&f=false](http://books.google.fi/books?id=8c6gkbKi-F4C&pg=PA96&dq=research+without+observation&hl=fi&sa=X&ei=x3X_UJ-YMc-Go4ATLi4GQBw&redir_esc=y#v=onepage&q=research%20without%20observation&f=false)

Kärkkäinen, Jani 2012. Maintenance Manager. Famifarm Oy. Joroinen 14.11.2012. Interview

Lean Manufacturing Tools

*Lean manufacturing tools, principles, implementation*, [accessed on 11<sup>th</sup> November 2012], Available from:

<http://leanmanufacturingtools.org>

Lean Manufacturing Concepts

*Lean manufacturing- JIT (Just in time)*, [accessed on 11<sup>th</sup> November 2012], Available from:

[http://www.leanmanufacturingconcepts.com/LeanTool\\_JIT.htm](http://www.leanmanufacturingconcepts.com/LeanTool_JIT.htm)

Lean Sigma Supply Chain

*So, what's so wrong with EOQ*, [accessed on 18<sup>th</sup> January 2013], Available from:

[http://www.resourcesystemsconsulting.com/blog/so-whats-so-wrong-with-eoq/#.UPmLX\\_KZrls](http://www.resourcesystemsconsulting.com/blog/so-whats-so-wrong-with-eoq/#.UPmLX_KZrls)

Leon Alexis 2008

*Enterprise resource planning*, second edition, e-book, [accessed on 22<sup>nd</sup> November 2012], Available

from:[http://books.google.fi/books?id=pTGDy2GX\\_sUC&printsec=frontcover&dq=ERP&hl=en&sa=X&ei=HdWtUMjHI6j14QShjYCIBA&redir\\_esc=y](http://books.google.fi/books?id=pTGDy2GX_sUC&printsec=frontcover&dq=ERP&hl=en&sa=X&ei=HdWtUMjHI6j14QShjYCIBA&redir_esc=y)

Management & Development Center

*Inventory fundamental*, [accessed on 8<sup>th</sup> November 2012], Available from:

<http://mdcegypt.com/pages/purchasing/material%20management/Inventory%20Fundamentals.asp>

Merriam Sharan B. 2009

*Qualitative Research: A guide to design and implementation*, second edition, e-book, [accessed on 24<sup>th</sup> December 2012], Available from:

[http://books.google.fi/books?id=tvFICrgcuSIC&printsec=frontcover&dq=qualitative+research&hl=fi&sa=X&ei=VWnYUJHVIK-K4gST0IDgAg&redir\\_esc=y#v=onepage&q=qualitative%20research&f=false](http://books.google.fi/books?id=tvFICrgcuSIC&printsec=frontcover&dq=qualitative+research&hl=fi&sa=X&ei=VWnYUJHVIK-K4gST0IDgAg&redir_esc=y#v=onepage&q=qualitative%20research&f=false)

Murphy Paul R Jr. and Wood Donald F. 2011

*Contemporary Logistics*, International Edition. United State of America, John Carroll University and San Francisco University. Pearson Education, Inc.

Packer Martin 2011

*The Science of Qualitative Research*, first edition, e-book, [accessed on 25<sup>th</sup> December 2012], Available from:

[http://books.google.fi/books?id=fEPt0ePCQvUC&pg=PA43&dq=interview+qualitative&hl=fi&sa=X&ei=QFbZUIXzLo6k4ATI8YGACA&redir\\_esc=y#v=onepage&q=interview%20qualitative&f=false](http://books.google.fi/books?id=fEPt0ePCQvUC&pg=PA43&dq=interview+qualitative&hl=fi&sa=X&ei=QFbZUIXzLo6k4ATI8YGACA&redir_esc=y#v=onepage&q=interview%20qualitative&f=false)

Pehkonen, Jukka 2012. Managing Director. Famifarm Oy. Joroinen 13.11.2012. Interview.

Rushton Alan, Croucher Phil & Baker Peter 2007

*The handbook of Logistics and Distribution Management*, third edition. The Chartered Institute of Logistics and Transport (UK).

Resource Systems Consulting

*Safety Stock Calculation*, [accessed on November 12<sup>th</sup> 2012] Available from:

<http://www.resourcesystemsconsulting.com/blog/safety-stock-calculations/#.UKEQpYfrySo>

Soininen, Hannu 2012. Operation Manager. Famifarm Oy. Joroinen 21.11.2012. Interview.

Southern Fulfillment Service (SFS)

*The importance of inventory management*, [accessed on 6<sup>th</sup> November 2012], Available from:

[http://www.southernfulfillment.com/articles/order-fulfillment/inventory-management/the\\_importance\\_of\\_inventory\\_management.htm](http://www.southernfulfillment.com/articles/order-fulfillment/inventory-management/the_importance_of_inventory_management.htm)

Suhonen, Vesa 2012. Sowing Manager. Famifarm Oy. Joroinen 21.11.2012. Interview.

Tersine Richard J. 1994

*Principles of Inventory and Materials Management*, fourth edition. The University of Oklahoma. Prentice-Hall International, Inc.

Tijskens L.M.M, Hertog M.L.A.T.M. & Nicolai B.M. 2001

*Food Process Modelling*, first edition, e-book, [accessed on 22<sup>nd</sup> November 2012], Available from:

[http://books.google.fi/books?id=M9TWELaBBZQC&pg=PA422&dq=first+in+first+out+stock+rotation&hl=fi&sa=X&ei=E\\_2tUMK-EZD14QT-olH4CA&redir\\_esc=y#v=onepage&q=first%20in%20first%20out%20stock%20rotation&f=false](http://books.google.fi/books?id=M9TWELaBBZQC&pg=PA422&dq=first+in+first+out+stock+rotation&hl=fi&sa=X&ei=E_2tUMK-EZD14QT-olH4CA&redir_esc=y#v=onepage&q=first%20in%20first%20out%20stock%20rotation&f=false)

Waters Donald 2003

*Inventory Control and Management*, e-books, [accessed on 5<sup>th</sup> November 2012]

Available from:

[http://books.google.fi/books?id=gVISsYqpi4C&printsec=frontcover&dq=inventory+management&hl=en&sa=X&ei=GwKYUNfaJdH54QSCqIH4AQ&redir\\_esc=y](http://books.google.fi/books?id=gVISsYqpi4C&printsec=frontcover&dq=inventory+management&hl=en&sa=X&ei=GwKYUNfaJdH54QSCqIH4AQ&redir_esc=y)

Waters Donald 2009

*Supply chain management, an introduction to logistics*, second edition. Palgrave Macmillan.



**APPENDICE****Appendix 1:****Interview questions for Managing Director/ Producer Director**

1. How much kind of raw materials concerning production? Are they divided in groups? Please describe
2. Do you manage the ordering raw materials process? If not, who are in charge?
3. What is the current decentralized administration in managing raw materials? Why you must do that?
4. What is your own responsibility concerning manage raw materials?
5. What would happen if only you manage the whole ordering raw materials process?
6. What is the method in report? Timing? (Daily, weekly, monthly)
7. How does raw materials quality impact to products?

**Appendix 2:****Interview questions for Operation Manager**

1. What kind of materials you are in charge of ordering?
2. How many people checking inventory for these materials? They only report it to you or somebody else
3. After receiving inventory report from them, what do you do with those documents?
4. Is there any other step in this traditional inventory management that you can tell us more?
5. Is the timing wrong? Once a month on 1st is good enough, or we need to check more?
6. Is the employee system too complicated or too few people? Is that enough people checking inventory or too many?
7. The way numbers flow, is it smart? After counted, numbers will be on inventory documents, and they come to you; so do those numbers continue to be on paper and then saved in folders on the shelves, or input into computer at some steps?
8. So now you have pointed out the problems above, what do you think are the main reasons for those problems? Please describe in detail
9. In 2012 there was few times missing materials such as sleeves, tray, so what exactly time it happened? From which party the mistakes belong to, the transport service, suppliers or Famifarm ordered too late?
10. In case were from transport service or supplier? Does it happen usually and do you know why? Any solution yet?
11. In case mistakes were from us, please tell me who had mistaken, in which stage. I divide to 3 stages:

- Inventory once a month on 1st, mistakes belong to person checks inventory.
- You receive inventory, input numbers, and calculate the time to order wrong. Or you calculate right but tell Cultivation Manager to order too late, or you order yourself too late?
- You tell Cultivation Manager to order soon, but he is busy and forgot to order on time.