

Automatic Washing System

Analysis of Problems and Evaluation of Possible Solutions

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<p>Abstract</p> <p>The thesis explains the meaning of automation and automated machines used in agriculture. It analyzes the operation principles of automation machine and technical specifications of the equipment using the example of the washing system in Fami Farm Oy. The productivity analysis is calculated. Also possible problems and mistakes which happen to the machine and the ways how to avoid or improve them are described. The following topics are discussed in the thesis: the ways how to reduce the damage and how to increase the productivity of the machine and of Fami Farm production, how to reduce time and money loses. Possible ways to automate manual work and improving machine efficiency operations are also described. All those aspects are contained in different parts of the thesis, main five of which are Theoretical inspection, Experimental part, Results of work, Marketing viewpoint, Practical usefulness. Also Introduction, Conclusion, table of Contents, References and Appendices are included.</p> <p>For those purposes the following methods are used: data collecting, analysis, induction, deduction, calculating. The results of the thesis are improved construction of the washing system.</p>			
<p>Keywords Automation, Fami Farm Oy</p>			

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1 INTRODUCTION

The aim in this thesis was to make an analysis of operation principles of automation machine using the example of the washing system in Fami Farm Oy. The thesis describes possible problems and mistakes and the ways how to avoid or improve them, how to reduce the damage occurred, how to increase the productivity of the machine. Also, the thesis analyzes the marketing viewpoint of the question – how to increase the efficiency of the machine from of the viewpoint of the delivery company; and, as a result, how it can affect the quality of the production of Fami Farm.

As far as nowadays quite a lot of work is automated, anyway factories and production lines face different problems with machinery. The machinery cannot work ideally; it breaks down or doesn't work properly from time to time. To analyze those kinds of problems, to find out possible solutions is quite important in the production process to increase the productivity which depends somehow on the quality of the machinery.

The thesis itself and its results can lead to a practical implementation at Fami Farm Oy and other factories which face some problems with automation systems. As no machinery can work ideally, there are always some troubles with it, and this system has to be improved. So, finding solutions can bring practical help. Also, the results of the thesis can help to find ways to automate any other manual work where it is necessary and possible.

The thesis consists of five main parts: Theoretical inspection, Experimental part, Results, Marketing viewpoint, Practical utility. Also Introduction and Conclusion are included.

In Theoretical inspection part there is theoretical view about automation, its advantages and disadvantages, the use of automation in agriculture; theoretical checkup of washing system types, using the example of Fami Farm Oy. Also, the principal operation of it is described.

In the Experimental part the automation – such as sensors in use, measurements, technical specifications of the equipment are dealt with. Using the example of the washing system of Fami Farm, the automation system in this application, and productivity analysis (operation time/hour) are analyzed.

In the Results it is explained how automation can improve the production system, how productivity can be increased, and how time and money can be saved in the production process. Then, after evaluating possible mistakes and problems, the ways how they can be solved will be found. Besides, maybe there can be also possibilities to automate manual work.

Marketing viewpoint part is dedicated to efficiency of the machine (advices to delivery company of the machine), how to achieve better quality of the production of Fami Farm and to reduce damage.

Practical utility part is about what was found in general and how the results of the thesis can help in the future.

2 THEORETICAL INSPECTION

In the Theoretical inspection part automation, its advantages and disadvantages, the use of automation in agriculture, theoretical checkup of washing system types are discussed using the example of Fami Farm. Also, the principal operation of it is described.

2.1 Definition of automation systems and agriculture

Automation can be defined as the control of industrial processes by automatic rather than manual means. Automation is widely spread in the chemical, electric power, paper, automobile, and steel industries, and in many others. The concept of automation is central in the modern industrial society. Automatic machines are used to increase the production of a factory per worker, and at the same time compensate rising wages and inflationary costs. Thereby industries are connected with the productivity per worker of their site. (Dorf & Bishop 2001, 8)

Automation is the automatic operation or control of a process, device, or system, which helps to improve productivity and obtain high-quality products. The automatic control of machines and processes is used to produce a product within special tolerances and features and to achieve high accuracy. (Dorf & Bishop 2001, 9)

In the 2000s, a need for flexible automation and robots is growing, with the demand for flexible, custom production emerging. (Dorf & Bishop 2001, 9)

The automation has a lot of advantages. It helps to increase the productivity, improve the quality of the production, improve the control and management processes, save time and money and remove a worker from doing dangerous for health and life jobs in a production process. (Payne 2013)

At the same time it has some disadvantages such as big cost of the equipment, breakage of it, high volumes and masses which can cause to serious injuries of personnel or even death. Also, using of automated equipment leads to pollution of environment and growth of unemployment. (Payne 2013)

The automation devices are widely used around the world in different spheres of production. In agriculture, as in the oldest humankind's but still very important economic

activity, they use automated systems to produce food, feed, fiber and fuel. The role of agriculture is important, as all the time growing population consume food and bio-energy. Especially nowadays agriculture faces to a big challenge. By 2050, the population is expected to reach 9 billion, so agriculture must increase its productivity by 25% to meet the requirements, while at the same time it must reduce the growing pressure on the environment. That seems to be quite a difficult task, so the role of agriculture in the whole world should be taken into consideration carefully, and the effort to increase its efficiency should be made by the humankind. (IEEE robotics & automation society, 2015)

In past twenty years, in agriculture automation has started to play a fundamental role in increasing the efficiency and reducing the cost of industrial production and products. Automation can play a significant role in society meeting the future needs. The mission of automation is to implement research, development, innovation, and standardization in production to enable safe, efficient, and economical agricultural production. (IEEE robotics & automation society, 2015)

Washing systems are very widely used in industry and agriculture. Such automated mechanisms simplify the production process substantially. There is a big variety of such machines nowadays in market. They can be classified for example according to their mobility, i.e. they can be static or mobile. Also they can be classified by the sector of industry where they are used. Here are some examples of them: sand washer, beverage processing machinery, pet bottle washing line, waste washing plant, gold washing plant, plastic film recycling and washing plant. (Made-in-China.com)

The washing machine which is used in Fami Farm Oy is intended for washing agricultural benches after growing seedlings. It is quite a massive static construction which takes a lot of space in the farm. It consists not only of the washing machine itself, but also of the crane, driving stations, machine control and other smaller details with work as one unit.

2.2 Delivery company of the automatic washing system

Benches are used in big quantities in Fami Farm to grow seedlings in a greenhouse. After plants are seeded into pots, they have to stay for some time in a steam room, after which Fami Farm staff puts them on the top of benches. Then benches with seedlings are put to the greenhouse where they are regularly watered. Some time

pasts, and the seedlings are put to troughs to a warmer part of the greenhouse where they pass the whole cycle from small size to big and are sent to market.

After replacing seedlings from benches to troughs each bench in its turn is sent to the crane to be lifted, and further to the washing machine and to stock. Each bench runs through this cycle hundred times constantly. Before starting a new one it's washed, dried up and is ready to be used again. That provides reliable and continuous lifetime of benches and stabile growing cycle of plants.

The benches are washed under high pressure. The process mainly runs automatically, but some trouble happens to the machinery and it needs the operator's intervention. And, as no machinery can work perfectly without any problems and disadvantages in construction, this machine also faces some problems – from time to time. (User manual Automatic Washing plant, 2009)

The delivery company of this automatic washing system is VDT (VD-Technique ApS) which is located in Denmark. It manufactures different machines for the commercial greenhouse industry. It focuses especially on internal transportation equipment, such as cranes and other conveying systems. In Fami Farm, all automated work is done by such equipment. (User manual Automatic Washing plant, 2009)

The following picture below presents the washing machine's inside mechanism (see FIGURE 1. Inside mechanism of the washing machine)



FIGURE 1. Inside mechanism of the washing machine (Fedotova 22.10.2015)

The delivery company states that in washing system they use the newest technology and the best and most reliable products which help to manufacture a machine with high capacity, operational reliability, easy servicing and a high safety level. (User manual Automatic Washing plant, 2009)

2.3 Description the work principles of the washing system

The entire machine system consists of the following parts: crane, washing machine, driving stations for pulling the benches, machine control. (User manual Automatic Washing plant, 2009)

Each part performs its own functions separately, and in complex they compose one mechanism of well-working interrelated tasks according to the programmed construction and Fami Farm's needs. Mostly they all work properly, but like each mechanism they suffer from breaking down.

The figure below (see FIGURE 2. Positions for benches) presents different positions: P1, P2, P3, P4, P5, P6, P7, P8, P14, P33 where the benches can be placed, and the wash. From P1, P33 and P8 benches are delivered to the wash. Positions P2-P7 are used as bench stock positions. (User manual Automatic Washing plant, 2009)

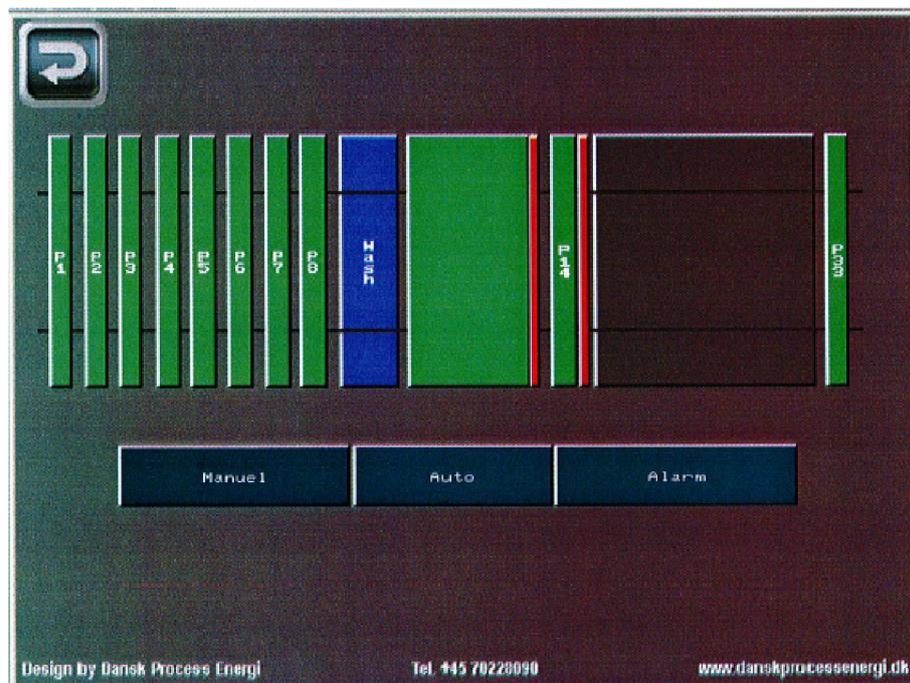


FIGURE 2. Positions for benches (User manual Automatic Washing plant, 2009)

The crane brings empty benches from different positions (P1, P2-P7, P33) to the push-in position P8 after which a bench will be put inside the washing machine. Normally a bench is taken directly to the position P8 and then to the Wash. If the P14 is full, the rest of benches are delivered to stocks.

Suhonen (2015) tells that when the bench is put to the push-in position P8 in front of the sensor, it is ready to be washed (see FIGURE 3. Push-in position P8). If the color of the sensor is orange it means there is empty space in front of the sensor, what gives order to the crane to take a new bench. When the color of it is green then it means there is a bench waiting for being placed inside the washing machine. Benches are taken automatically from positions P1-P7, usually from the nearest one. One position or even several positions can be chosen manually by using the program.



FIGURE 3. Push-in position P8 (Fedotova 29.03.2016)

So when a bench goes inside the washing machine, it is coming in the middle between two sensors. The sensors are sensible to the correct position of the bench. When two lights disappear, the locking mechanism turns and sticks the bench inside. The doors close down and the machine starts. All the process runs automatically. There are options to run it manually.

After the bench is washed, the doors are opened, the stocking mechanism comes down. If the position P14 is free, the clean bench is put there, after which the bench is used further for new grown plants (see FIGURE 4. Clean bench position P14). The washing process continues. If the position P14 is full, the washing process stops.



FIGURE 4. Clean bench position P14 (Fedotova 29.03.2016)

For the process they never use any detergent, only high pressure water is needed. The time to wash one bench is typically one minute. There are options to choose any other time just by inserting the necessary number of minutes.

The programs to operate the machine manually have variety from Crane to Washer. Crane can be used completely manually. Settings for Washer can be also done manually. (Suhonen 2015)

The crane device uses a measurement tool to provide feedback as it checks which positions are free and which are full. This component of the machinery represents a close-loop control system (see FIGURE 5. A diagram of a close-loop system).

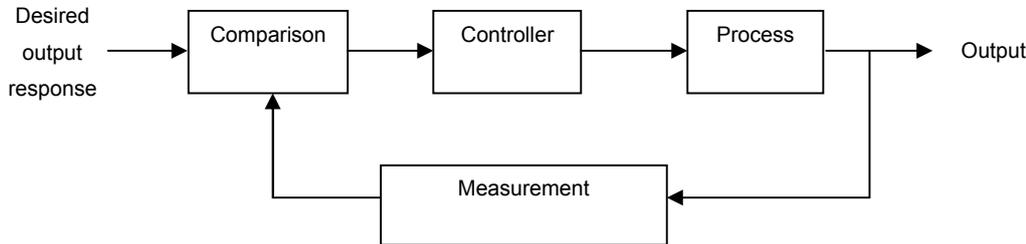


FIGURE 5. A diagram of a close-loop system. (Dorf & Bishop 2001, 3)

A close-loop system uses an additional measure of the actual output to compare it with the desired output response. The measure of the output is a feedback signal. This control system tends to save a prescribed relationship of one system variable to another by comparing functions of these variables. The difference is used as a means of control. (Dorf & Bishop 2001, 3)

As the washing machine during its working process doesn't use any feedback and only utilizes an actuating device to control the process directly it can be determined as an open-loop control system (see FIGURE 6. A diagram of an open-loop system).

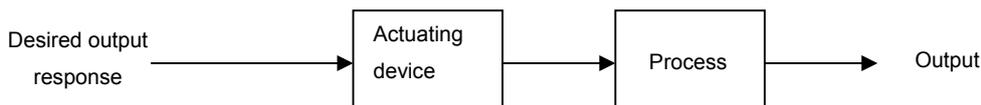


FIGURE 6. A diagram of an open-loop system. (Dorf & Bishop 2001, 2)

An open-loop system is an interconnection of different components of a machine which form a system configuration. Basic understanding of an open-loop system is linear system, which assumes a cause-effect relationship for the components. Thus, input and output represent the cause-and-effect relationship of the process. In turn that represents a process of the input signal to provide output signal variable. An open-loop control system utilizes a controller or control actuator to achieve a desired response. Feedback of the process is not used. (Dorf & Bishop 2001, 2)

After putting a bench into position P1 or P33 sensors actuate the device, and the crane is ready to lift up a bench. Then the crane puts it to a stock or to position P8. After a bench is inside the Wash, it is washed and pushed to the position for clean benches P14. (Suhonen 2015)

3 EXPERIMENTAL PART

In the Experimental part the automation – such as sensors in use, measurements, technical specifications of the equipment are discussed. Using the example of the washing system of Fami Farm, the automation system in this application, and productivity analysis (operation time/hour) are analyzed.

3.1 The washing machine parts and their specifications

As it was already mentioned before, the machine system consists of crane, washing machine, driving stations for pulling the benches, machine control. Now each part is described in more detailed.

3.1.1 The crane

The crane is the part of a full-automatic system used to handle the benches. It includes power rail communication with help of which it operates and which is situated on the top of the greenhouse, the height is about 4,5 m. The crane runs on 4 wheels which provide optimal safety. (User manual Automatic Washing plant 2009)

The wheels are moved by a differential gear, which ensures optimal distribution of the tractive force. So, the traction is spread on 4 wheels. (User manual Automatic Washing plant 2009)

The crane is built of modules which provide easy and quick maintenance. All motors and wheels are of the same type. (User manual Automatic Washing plant 2009)

The picture below shows the crane construction in Fami Farm Oy. (see FIGURE 7. The crane)



FIGURE 7. The crane (Fedotova 09.04.2016)

The following picture shows the crane picking up a bench from the position P1 (see FIGURE 8. The crane lifts a bench)



FIGURE 8. The crane lifts a bench (Fedotova 29.03.2016)

The crane handles the following type of bench:

- Bench type: mobile bench
- Dimensions: 837x5920 mm
- Edge profile: DRI 3244 (User manual Automatic Washing plant 2009)

The crane performs different tasks, main of which is to bring empty benches from different positions (P1, P2-P7, P33) to the push-in position (P8) after which a bench is put inside the washing machine (Wash) and the stock (P2-P7). P14 is the position for clean benches; they are put there after washing. (see FIGURE 2. Positions for benches) (User manual Automatic Washing plan 2009)

Positions P1 and P33 are provided with pneumatic carrier pipes to move the benches crosswise the lanes if necessary. (User manual Automatic Washing plant 2009)

The crane has an acoustic sound and a blinking warning light; they are activated when the crane is running. (User manual Automatic Washing plant 2009)

The SRO system which operates the processes of lifting and bringing the benches to different positions automatically updates all of them in the working area and the quantity of benches in the stacks. (User manual Automatic Washing plant 2009)

The crane is made of lacquered steel, and the rails are made of galvanized steel. The crane is controlled by a PLC. Its signals are received through the power rail. That provides quick communication between the crane and the crane control. (User manual Automatic Washing plant 2009)

The crane is provided with rack, encoders and positioning detectors. (User manual Automatic Washing plant 2009)

It is controlled via a SRO system which communicates with the crane through a power rail. The crane updates automatically all positions in the working area.

The PLC control includes a modem which makes it possible to operate the system by remote control and the program and monitor the system from overseas. (User manual Automatic Washing plant 2009)

The rail is made of square profiles; dimensions are 100x50x3 mm. It is supported by suspension brackets. (User manual Automatic Washing plant 2009)

The crane has some technical specifications (see Appendix 1. The specifications of the crane and TABLE 1. Specifications of the crane, TABLE 2. Technical specifications of the crane).

3.1.2 The washing machine

The following figure below (see FIGURE 9. Inside mechanism of the washing machine) shows mechanism of the washing machine from inside. A bench is ready to be washed under high pressure between two sensors.



FIGURE 9. Inside mechanism of the washing machine (Fedotova 22.10.2015)

The washing machine is provided with 2 pieces 5,5 kW high-pressure pumps and fitted with high pressure nozzles with approximately 70 bar. That provides optimal and quick washing. (User manual Automatic Washing plant 2009)

The machine is protected on all sides by a noise shielding which is manufactured in galvanized steel plates and coated with PVC. The machine consists of wash room with disinfection. When the benches are washed, high pressure water is applied and then they are disinfected. (User manual Automatic Washing plant 2009)

The washing machine construction demands the following bench types:

- Bench type: container bench
- Dimensions: 837x5920 mm
- Edge profile: DRI 3244 (User manual Automatic Washing plant 2009)

The entry and exit of the machine is provided with lifting / lowering gates driven by a gear motor with a wire haul. There is also a sliding door on one side of the cabinet to service and clean the machine. (User manual Automatic Washing plant 2009)

The benches are transported to the push-in position (P8) automatically. (User manual Automatic Washing plant 2009)

The push device is used to bring a new bench into the washing machine. It is a profile with tiling catches, where the profile is drawn back and forth by a linear drawing device. In the washing machine the bench is pushed into a drawing unit. When the push device reaches the front position, the bench inside the washing machine simultaneously locks onto the drawing unit. (User manual Automatic Washing plant 2009)

The dirty bench in the washing machine is locked by a rotating stop what prevents the bench from moving. It protects the bench during the whole washing process. The push device is now drawn back to the starting position and ready to receive a new bench. (User manual Automatic Washing plant 2009)

The washing machine is built for automatic operations and is driven by a SRO control system. There is also a possibility to control the machine manually or semi-automatically, and this action must take place from the control terminal. (User manual Automatic Washing plant 2009)

The water supply is 70 l/min (2 Bar). The power supply is 3x400 V 50 Hz. (User manual Automatic Washing plant 2009)

The materials used in washing machine construction is galvanized steel for the machine itself and galvanized plate PVC coated with noise absorbing material for the cabinet. The washing machine is controlled by a PLC and receives its control signals via radio signals. It is controlled via a SRO system which communicates with the washing machine via radio signals. (User manual Automatic Washing plant 2009)

The washing machine has some specifications (see Appendix 2. The specifications of the washing machine and TABLE 3. Specifications of the washing machine, TABLE 4. Technical specifications of the washing machine).

3.1.3 Roller pipes

There are also some various parts included in entire machine system, such as roller pipes lifting / lowering. They are used when the benches are transported in the transverse direction. It lifts the bench after clearing of the conveyor wheels. (User manual Automatic Washing plant 2009)

The mechanism is automatically controlled, but also can be manually driven. (User manual Automatic Washing plant 2009)

Correct positioning is registered by photoelectric sensors when it is controlled by the SRO system. (User manual Automatic Washing plant 2009)

The roller pipes have the following technical specifications: power - 6 bar dry air, drive – pneumatic cylinder Ø 50. (User manual Automatic Washing plant 2009)

3.2 Sensors in use

There are two pairs of sensors in the washing machine mechanism and two sensors for the crane on positions P1 and P33.

3.2.1 Sensor used for the crane

A sensor used for lifting a bench is photoelectric sensor (see FIGURE 10. Photoelectric sensor for the crane). A bench is put to positions P1 or P33 to end so that the

orange light goes out, and the crane lifts a bench to stock P2-P7 or to push-in position P8.



FIGURE 10. Photoelectric sensor for the crane (Fedotova 09.04.2016)

A photoelectric sensor is a device that detects a change in light intensity. Photoelectric sensors consist of a light source (LED), a receiver (phototransistor), a signal converter, and an amplifier. The phototransistor analyzes incoming light, verifies that it is from the LED, and appropriately triggers an output (see FIGURE 11. Photoelectric sensor work principle).

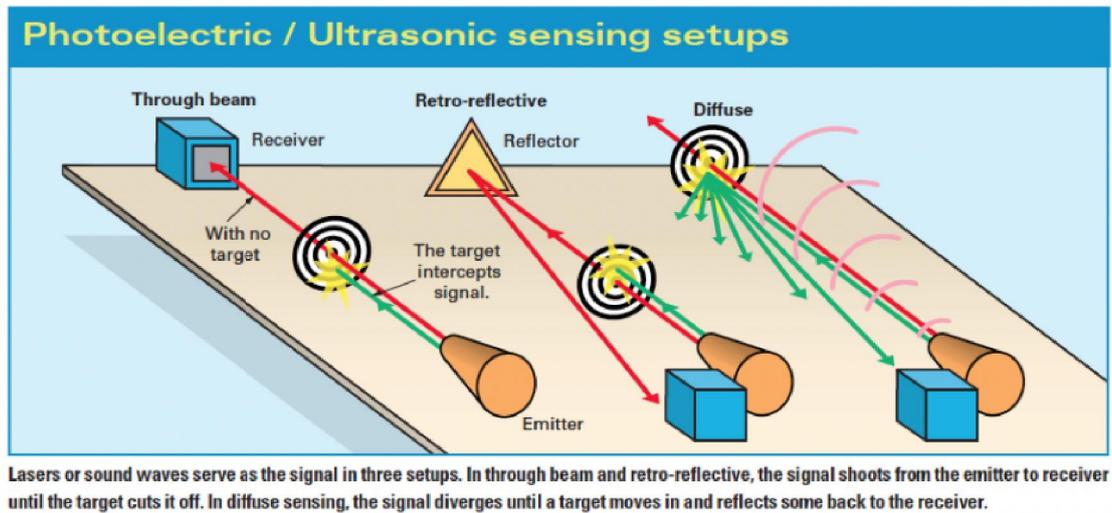


FIGURE 11. Photoelectric sensor work principle (Machine design 2016)

Photoelectric sensors have many advantages when compared to other sensors. Photoelectric sensors have much bigger sensing ranges than the inductive, capacitive, magnetic, and ultrasonic ones. Their small size versus sensing range and a unique variety of housings makes them a perfect choice for any application. Besides, photoelectric sensors are price competitive in comparison with other sensing technologies.

Photoelectric sensors provide three main methods of object detection: diffused, retro-reflective and thru-beam, with variations of each. (Automation.com)

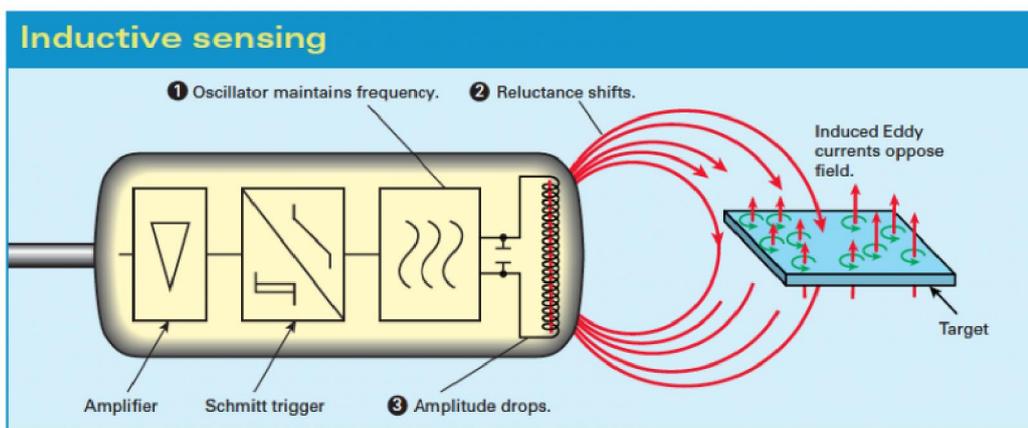
3.2.2 Sensor in the washing machine

The washing device uses inductive proximity sensors to detect the presence of metallic objects (see FIGURE 12. Inductive sensor which is used inside the washing machine). Such sensor consists of a ferrite core with coils, an oscillator, a Schmitt trigger, and an output amplifier.



FIGURE 12. Inductive sensor which is used inside the washing machine (Fedotova 09.04.2016)

The oscillator creates a symmetrical, oscillating magnetic field that is radiated from the ferrite core and coil array at the sensitive face. When a metal object enters this field, small independent electrical currents (or eddy currents) are induced on the object. This changes the natural frequency of the magnetic circuit, which reduces the oscillation amplitude. As the metal object enters the sensing field, the oscillation amplitude shrinks. The Schmitt trigger responds to the amplitude changes, and adjusts sensor output. When the object moves from the sensor's range, the circuit begins to oscillate again, and the Schmitt trigger returns the sensor to its previous output (see FIGURE 13. Inductive proximity sensor work principle). (Machine design 2016)



Ferrous targets change the reluctance of the magnetic circuit; system oscillation frequency, which gets left behind when the natural frequency shifts, then loses amplitude.

FIGURE 13. Inductive proximity sensor work principle (Machine design 2016)

Inductive proximity sensors are designed for detecting metal objects. The most popular shape is tubular, with the diameter of 3-40 mm. The sensing range for such sensors is between 4 and 40 mm. It detects any close-range ferrous materials. (Machine design 2016)

The range of the sensor is the maximum and minimum values of applied parameter that can be measured. (National instruments 2013)

Inductive sensors are typically rated by frequency, or on/off cycles per second. Their speeds range from 10 to 20 Hz in ac or 500 Hz to 5 kHz in dc. Because the magnetic field is limited, inductive sensors have a relatively narrow sensing range – from fractions of millimeters to 60 mm on average. But longer-range specialty products can be available. (Machine design 2016)

Typically inductive sensor is made of nickel-plated brass, stainless steel, or PBT plastic. Special designs with IP ratings of 67 and higher are capable to withstand the build-up of contaminants in the air and on the sensor. Proper setup guarantees long life of a sensor. Disadvantage is that they lack in range. (Machine design 2016)

It was already mentioned that in the washing machine mechanism, a dirty bench is additionally locked by a rotating stop. That prevents the bench from moving and protects the bench during the whole washing process. Anyway, benches are sometimes placed askew.

3.3 The productivity analysis

The productivity ratio is a fraction of output over input (see FIGURE 14. Productivity ratio)

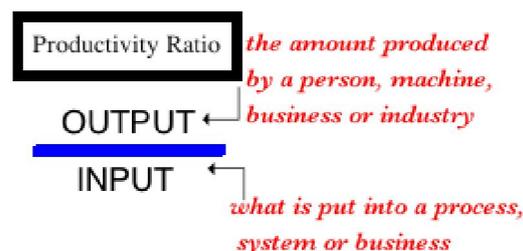


FIGURE 14. Productivity ratio (Study.com)

Input is what a business puts in to turn a profit, and this profit is output. The most common input is measured in hours and the most common output is measured by money. This is calculated when business owners try to decide if their business is profitable and efficient.

Input can be measured not only by hours but also by for example raw materials used, energy, amount of land, etc. Output can be also measured by amount of products produced, number of sales, etc. (Study.com)

In this case, if the productivity ratio for the washing machine used in Fami Farm Oy has to be calculated, for example energy consumed per one hour is taken as input. And for output value number of benches washed during the same period of time is chosen. This number is going to be average, as it can never be said exactly how many benches are washed per each hour; their number depends on the volume of work which needs to be done.

From technical specifications (see Appendix 2. The specifications of the washing machine) power supply of 12 kW per hour is taken as input. The average number of washed benches taken for calculation is 6. This number represents output. Then, using the formula (see FIGURE 14. Productivity ratio), the following is calculated:

$$\text{Productivity ratio} = \frac{6 \text{ benches}}{12 \text{ kW per hour}} = 0,5 \text{ kW per bench}$$

So, as a result, the productivity ratio for the washing machine is 0,5 kW for one bench per hour.

4 RESULTS

In the Results the central question is how automation can help to improve the production system, how productivity can be increased, and how time and money can be saved in the production process. Then, after evaluating possible mistakes and problems, the ways how they can be solved are found. Besides, maybe there are also possibilities to automate manual work.

4.1 Recommendations of the Danish company VDT

As the Danish company VDT claims, before implementing any check-ups or cleaning procedures all the mechanisms must be switched off and locked and connections to the mains must be disconnected for safety reasons. That is logical and important if accident prevention is considered. (User manual Automatic Washing plant 2009)

Functionality and safety devices must be checked before daily actuation. Also, it must always be remembered to be careful with the control of the lifting and braking devices. (User manual Automatic Washing plant 2009)

The washing system should be cleaned regularly as needed. During the cleaning, special attention should be paid to the following points:

- Sensors and switches
- Carrier pipes and wheels
- Power rails and current collectors
- Connecting devices

The Danish Working Environment Service designates the following definitions of a skilled person:

- Knowledge of the technical structure and function of the machine
- Necessary education and training in service and maintenance
- Knowledge of the manual of the machine
- Knowledge of the safety demands of the machine, especially regarding, reporting, test loads and keeping record
- Knowledge of possible demands on the machine stipulated by other authorities

- Knowledge of possible demands on authorization / certification of different special tasks, e.g. welding or electric installations. (User manual Automatic Washing plant 2009)

Besides, the company suggests performing load tests for the crane, when the load must be 125% compared to the allowed maximum load. It must consist of loose weights and must maximum vary +/- 1%. The test time is at least 10 minutes. (User manual Automatic Washing plant 2009)

When performing load tests, special attention must be paid to:

- Supporting beams, suspension brackets
- Crane frame
- Wheels and shafts
- Stability
- Joints

Test loads must be carried out by skilled staff. (User manual Automatic Washing plant 2009)

Also, service reports can be used where all the items are listed. The checklist consists of the column of the items and a column for the machine part, "Control methods", "Frequency", the column "Checked" to cross when checked, and the column "Comments" for remarks. Finally, the document must be signed by the responsible person (see Appendix 3. The service report. Checklist). (User manual Automatic Washing plant 2009)

The Service report documentation is used as a log book for changes made on the machine. It includes a "Date" column, "Work performed", "Replaced components", and a column "Signature" (see Appendix 4. The service report. Documentation). (User manual Automatic Washing plant 2009)

The mentioned service reports are not the only ones to be used in Fami Farm to control service and maintenance that are taking place there. Just two examples are shown but quite a great variety of reports exists in Fami Farm.

Different service reports help to control the condition of the machinery and its components, and the quality of work performed. They can also inform the operator about any changes and defects in the construction.

The machine manufacturer has to ensure that the products have adequate transmission guard security fencing the shafts, gears, belts, chains, etc. Both the employer and the employees have to ensure that the guards are kept in a good condition. Also, the employer has to ensure that the machines are provided with proper cutter, chuck and splash guards which are fitted and used correctly. The employee's duty is to use the guards properly. (Timings 1998, 281-282)

4.2 Problems with the crane and possible solutions for them

The crane doesn't work properly all the time. (see TABLE 5. Problems with the crane and possible solutions for them)

TABLE 5. Problems with the crane and possible solutions for them. (Suhonen 2015)

The problems with the crane	Solutions for those problems
The biggest issues are somehow damaged benches. Also if a bench is askew or its wheels are not in a straight enough position, the crane's sensors cannot work properly.	If benches get damaged quite often, solution for that is constant monitoring of their condition. That is what they actually do in Fami Farm every day before they put trays on them.
For instance last summer the crane had serious problems with stopping points for washer. Then the only thing that could be done is calling to service of washer maker.	Besides, service could have more inspections about the machinery and the crane to control their normal working conditions. Everything must be kept in accurate order, cleaned and checked regularly.
Another problem is users' error. Only few employees have enough knowledge to operate the machine, the majority doesn't know exactly what to do in problem situations, so they just cause the problems to those machines. That doesn't bring any positive effect on the crane's working properties.	People who don't have special ability to fix the machinery in problem situations should not intervene in order not to bring any extra damage. One way is to teach more people how to operate the machinery if it fails to work. But this way for Fami Farm is problematic, as there are so many employees working there. It's impossible to teach every person those things. So the solution could be forbidding strictly using the machinery without supervising.

<p>If all stock positions P2-P7 are full, the crane cannot deliver a bench anywhere (see FIGURE 2. Position of benches). That usually happens in the evening. Thus the process stops and the crane doesn't react to a bench put in positions P1 and P33. Normally clean benches are taken to put new seedlings in the morning, so in this case benches have to be put manually by employees to the after-wash position P14, to a free space between positions P14 and P33, or to free space in the field, where are bench with growing seedlings. That is sometimes problematic, because, if benches are many and the space is small, employees have to put one bench on the top of the other one by hand, and thus three levels. Benches are heavy, and such job is a bit physically hard.</p>	<p>This event is not exactly breakage as it is quite normal, but this happens quite often and could be simplified. This is an example of how work, which employee has to do manually instead of the machinery, can be automated. The solution for that would be in building one or two more sections for stock positions. They could be built next to the position P33, to its left side (see FIGURE 2. Position of benches).</p>
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4.3 Problems with the washing machine and possible solutions for them

During the using of the washing system, the staff always faces some problems which cause operational problems, worse efficiency of the working equipment and, as a result, of products. Here are some of the most typical problems with the washing machine in Fami Farm. Problems can be different. (see TABLE 6. Problems with the washing machine and possible solutions for them)

TABLE 6. Problems with the washing machine and possible solutions for them. (Su-honen 2015)

The problems with the washing machine	Solutions for those problems
<p>Often faced problem is not correct position of the bench when it is put inside the washing machine. In other words, the bench can be askew, stay not straight, in that case the sensors don't work – for</p>	<p>Probably the sensors which are used inside the washing machine could be replaced from inductive to photoelectric. Photoelectric sensors are versatile and can detect an object 60 mm away.(see</p>

<p>example one is on, the other is off – then the machine will not start. (see FIGURE 15 and FIGURE 16. Bench is askew)</p>	<p>FIGURE 17. Proximity sensor comparison). Because that sensor has to be used under water, it is possible to use E32-series optical fiber photoelectric sensors, which have no electric components. Usage, however, is limited by the model. Only models with IP67 protection can be used. Depending on the light source (red light or infrared light), further attenuation may occur if for example dirt is attached to a branch surface. (Omron)</p>
<p>Besides that, different components of the machine from time to time get dirty or rusty, what also brings troubles to the working of the machine. The water is full of rust, and nozzles get stuck because of that. Bearings also get rusted; and when it happens, the machine doesn't work properly. Bearings should be changed regularly or otherwise there will be stuck somewhere. Filters get dirty; they need to be cleaned couple of times.</p>	<p>First of all, regular cleaning and – if necessary – replacing of the components in the machine should take place: nozzles, bearings, filters.</p>
<p>As about benches, quite commonly they are not cleaned well enough. Very often some moss can be seen on the surface of not-new benches, because after washing no drying mechanism is used. Moss is not totally washed off from the benches inside the washing machine. As it is known, mosses can collect some radioactive materials. Of course there are not such big quantities to bring serious damage to the production, but still they can contain some if the moss spreads from the bench to the pots with plants. Also, mosses are said to worsen the productivity of agricultural soils by water-logging them. Because of this reason, it</p>	<p>The benches can be cleaned from moss form time to time by employees. Flies are liquidated in Fami Farm by sticky tags. Against other insects they use special means. Anyway, some disinfection measures should take place from time to time, not only moss but also weeds should be removed regularly to prevent wider spreading of them.</p>

<p>leads in its turn to spreading of small flies which are attracted by smell of plants. Those small flies are very widely spread in Fami Farm greenhouse. (see FIGURE 18. Moss on a bench)</p>	
<p>If employees forget a thing on the bench and put it to the positions P1 or P33, it can cause to dropping of the mechanism. If this thing is flat, if it fits inside the washing machine easily and doesn't fall down on the floor under the high pressure, nothing happen, it will stay on the bench till the end of the operation. But if it is quite massive and doesn't fit inside, the washer will stop.</p>	<p>Employees have to be careful and always check if there is some extra thing on the benches.</p>
<p>If working pressure is overloaded in the electric system, it will not burn anything, but the mechanism will stop automatically. It doesn't happen often, and it demands interruption of working process and using of this equipment and intervention of a specialist to fix.</p>	<p>Employees cannot anyhow affect this process, but if that happens they should inform maintenance specialists and stop the using of the machine.</p>



FIGURE 15. Bench is askew (Fedotova 29.03.2016)

As can be seen in the picture, a bench doesn't exactly suit between two sensors, and so because of this they cannot work properly.



FIGURE 16. Bench is askew (Fedotova 29.03.2016)

Proximity sensors represent four different types with one common principle but different characteristics: sensing range, applications and target materials. For the washing plant they can be compared by those characteristics. (see FIGURE 17. Proximity sensor comparison)

Proximity sensor comparison			
Technology	Sensing range	Applications	Target materials
Inductive 	<4-40 mm	Any close-range detection of ferrous material	Iron Steel Aluminum Copper etc. 
Capacitive 	<3-60 mm	Close-range detection of non-ferrous material	Liquids Wood Granulates Plastic Glass etc. 
Photoelectric 	<1mm- 60 mm	Long-range, small or large target detection	Silicon Plastic Paper Metal etc. 
Ultrasonic 	<30 mm- 3 mm	Long-range detection of targets with difficult surface properties. Color/reflectivity insensitive.	Cellophane Foam Glass Liquid Powder etc. 

FIGURE 17. Proximity sensor comparison (Machine design 2016)

First after appearing moss is wet, and in length of time it is becoming dry and ramous. Wet environment is an ideal condition for their growth and reproduction (see FIGURE 18. Moss on a bench)



FIGURE 18. Moss on a bench (Fedotova 29.03.2016)

4.4 Advantages and disadvantages of the machine construction

Cleaning benches under high pressure helps to remove soil and other dirt from its surface which prevents spreading of harmful bacteria. That way is very environmentally friendly as only pure water and no detergent is used, and as there is no bad emission into atmosphere after each cleaning procedure. (Falch World of water jetting)

Furthermore, cleaning under high pressure is economic. Water pressure and water amount can be adjusted which makes that process flexible. (Falch World of water jetting)

In any case, from time to time benches get dirty and need to be washed more thoroughly by hand, or even replaced – if too polluted. On the other hand, washing benches by hand can cause damages surface, like scratching.

The material which is used in the inside constructing the washing machine and in rails is galvanized steel. It is widely used in automotive and agricultural equipment. In the process galvanizing steel and iron are hot dipped in molten zinc that provides electrochemical protection against the elements. The surface is then bright, which over time becomes dull and gray. (Thompson 2007, 368)

This kind of steel has chemical processing in order to provide better protection against corrosion. It is coated with layers of zinc oxide which can protect the metal from rusting and make it more durable. (IQS Newsroom)

That material has lots of benefits. First of all, price is quite low in combination with good quality. Combination of zinc and iron produces a very effective alloy which increases the lifetime of a steelwork. Galvanized metalwork is protected from the elements and in this way retains its structural integrity. (Thompson 2007, 368)

Galvanizing proves to provide long-lasting, tough and low-maintenance coating. Galvanized steel can be recycled. It is stable to aggressive handling. (Thompson 2007, 368)

Steelwork coating is tough; it protects the base material against corrosion from oxygen, water and carbon dioxide. Levels of corrosion can vary from 0, 1 microns (0, 000039 in.) for indoor uses to 4-8 microns (0, 00015 -0, 00031 in.) for outdoor uses per year, depending on various conditions. A typical coating is between 50 and 150 microns (0, 0020 - 0, 0059 in.) thick; it depends on the application technique. Thus the zinc coating protects the steel, even if it is penetrated. The zinc reacts with atmospheric elements easily what forms a deposit over the open area which protects the base material from further corrosion. (Thompson 2007, 368-367)

Likewise, coating is toughest. The structure of it is unique; it gives outstanding resistance to mechanical damage in transportation and service. It has an automatic protection for damaged areas, which provides cathode or sacrificial protection to small areas of steel exposed through damage. Generally galvanized steel has complete protection – of every part, even inaccessible. (Galvanizers Association of Australia 2011)

Galvanizing increases the durability of steelworks and reduces their environmental impact. This process uses zinc to protect the surface of steelwork. Zinc can be indefinitely recycled without any loss of its physical and chemical properties. (Thompson 2007, 367)

It is very easy to inspect – even by eye, or simple non-destructive thickness testing methods can be applied. When galvanized steels are received, they already are ready for use. No time is needed on-site in surface preparation, painting or inspec-

tion. Thus after assembly of the structure it is immediately ready for use. (Galvanizers Association of Australia 2011)

At the same time, nothing can exist without disadvantages. Galvanized steel should not be mixed with some other elements, for instance yellow brass, what causes to dezincification and, as a result, electrolytic action with non ferrous metals, such as copper and brass. Actually galvanized steel and copper cannot be connected together at all, because they produce a chemical reaction which weakens the construction. (eHow)

Another disadvantage can occur in processing. If work is done incorrectly, for example if surface is cooled too quickly, it could be possible that zinc peel or chip off. (IQS Newsroom)

Like all metals and materials, zinc has no eternal lifetime. It can become shorter especially faster in situations where it might be exposed to the elements frequently. High pressure water flow is one of those situations. That's why it should be regularly checked on. When done right, and applied in the right way, galvanized steel is the perfect option in many industries, as well as in food industry. (IQS Newsroom)

Aside from regular check-on, from time to time – with difference in several years – those galvanized steel plates should be cleaned, and eventually replaced.

As it was already mentioned, for crane such material as lacquered steel is used. Lacquered is defined as that kind of steel that has a protective coating consisting of a resin, cellulose ester, or both, dissolved in a volatile solvent, sometimes with pigment added. That protects the lacquered surface from extra damages and harmful influences. (Dictionary.com 2016)

Inductive sensors which are used inside the washing machine are made of nickel plated brass and PBT-plastic.

Nickel plated brass is regular brass covered by a thin layer of nickel through electroplating. The advantages of this material is that it is quite corrosion resistant, that tarnishing is reduced, and a hard ware surface is provided, especially for such products as gears, bearings, and plumbing fixtures. (Machine design 2009)

What about PBT plastic, it is a synthetic semi-crystalline engineered thermoplastic. It is a high performance material which is often characterized as a strong and stiff plastic. PBT is widely used in electrical and automotive components. The major advantages of this material are excellent machining characteristics, high strength, good toughness, excellent stiffness-to-weight ratio. Aside from, it has dimensional stability and high electrical insulation properties. Also, PBT is stain resistant and resistant to hot and cold water without deforming or warping. It withstands abuse and holds shape. Disadvantages are that it is prone to warp when glass is used as filler, and that it has lower rigidity than other plastic resins. (Johnson 2016)

In general, the materials for sensors are quite a fine choice.

5 MARKETING VIEWPOINT

Marketing viewpoint part is dedicated to efficiency of the machine (advices to delivery company of the machine), how to achieve better quality of the production of Fami Farm and to reduce damage.

5.1 Definition of marketing

Marketing is a social and managerial process. By this process individuals and groups get what they want and need through the creating and exchanging of products and services of value with others. (Kotler, Hayes & Bloom 2002, 91)

Marketing is basically a research option. A market research is very important to any company, as well as willing and ability to understand the need to change. A market research plays a vital role in the development of products. It has some responsibilities such as:

- Ensuring the company being up-to-date data of market trends and customer requirements
- Ensuring the company with information about the product development, marketing strategies and pricing strategies of its competitors
- Ensuring the company with information about the life cycle of its existing products so that new products can be developed before the existing products cause to be marketable and profitable
- Making a preliminary assessment of ideas for new products
- Making a detailed study of the viability of a new product before large sums are spent on research and development, capital equipment and tooling
- Softening up the ground for the sales force by planning the publicity surrounding the launch of a new product. (Timings 1998, 356-357)

Marketing research is defined as the systematic design, collection, analysis, and reporting of data relevant to a specific marketing situation facing an organization. (Kotler, Hayes & Bloom 2002, 91)

Organizations face quite various situations and challenges. Aside from, during last few years there have been some changes in the world which affect professionals in marketing. For instance, rapidly developing technologies dictate terms and force to

change and adapt. Likewise dissatisfaction with professionals increases as boundaries among them are blurring. (Kotler, Hayes & Bloom 2002, 91)

All that demands raising the level of qualification by courses and training, ability and willingness to change and develop, and more concrete knowledge that is necessary on the concrete site at the concrete time and in the concrete situation.

All of those targets seem to be complicated. At the same time, the changing conditions in the world and trade in particular demand changes from the side of professionals and all who are involved in the process of production, of marketing strategies, and in the process of the interaction with customers. Marketing should be client oriented to stay effective and successful. It should provide satisfaction to clients via developing of relationship with them. (Kotler, Hayes & Bloom 2002, 91)

5.2 How to achieve better quality of Fami Farm products

In general, there are some basic practices of hygiene and sanitation rules which should be taken into consideration in a greenhouse:

- Exploring
- Knowing pest and disease problem
- Good agricultural practices within the harvest
- Sanitization of water
- Clean seedlings
- Weed and moss control
- Succeeding planting
- Controlling plant debris and finished crops (Primary industries Agriculture 2010)

Except all the practices as cleaning and replacing of the components inside the machine, deleting mosses and getting rid of flies and insects which were mentioned earlier, it is very important to keep the greenhouse, the working environment and equipment generally in a clean condition, organize clear-out. That is so important, if food industry is considered. For producing food, there must always be clean conditions and surroundings.

To increase the quality of Fami Farm Oy's production, the negative effects must be reduced. Those negative effects happen in different areas of the farm; and they cannot be removed totally – so that there would be zero problems and everything would work perfectly without problems, breakages, pests, etc. But in a good measure those

effects and their outcomes can be reduced to make the production's lifecycle in a greenhouse better.

As marketing is basically a research option that means that employees in Fami Farm should always check different kind of information – each of them in their own field. Thus, biologists should enrich their knowledge in biology; consider new events happening in the farm in the field of biology, new plants and new pests or diseases if such appear. They should bring innovative ideas about using some new means against negative cases and outcomes after them. For this purpose the employer should send them to advanced training courses. As for instance pests always adapt to some means which were long time in use, some other must be used. To reduce negative effect from pests, we have to get rid of them effectively and properly quickly.

Likewise biologists, maintenance specialists should be trained well in their field, in using concrete equipment, so that they could become more effective in working with it and in fixing it. Some advanced training courses could be organized also for them.

Of course, besides, there are some processes which cannot be controlled. Breakages of the equipment are predictable in most cases, but there can be exceptions. Sales are not the same high all the year – sometimes Fami Farm grows more than sends to the market. Thus, sales cannot be predicted in advance with ideal accuracy so that they don't lose time, products and money. In food industry, this question is one of the most critical, as food is spoiled in a short time. That's why the time in storage is limited, and the supply chain from a greenhouse to a customer is short. Anyway, it is impossible to predict and calculate all those details to get zero losses.

Not absolutely everything can be taken under control and absolutely each detail cannot be considered – that is physically impossible. But if more attention is paid to some things, the damages of production and losses of time and money can be reduced.

5.3 Recommendations to the delivery company for improving the machine efficiency

The Danish company VDT, when designing similar mechanisms, could take into consideration first of all sensors. They could be replaced from inductive to photoelectric.

After sensors, the delivery company can pay attention to the bench drying question. Probably the configuration of the washing system could be redesigned so that there

is added a drying component. It could be one more section after the washing system with a drying system or just a drying mechanism inside the washing system.

It was already mentioned before the extra sections for bench stock which could be built in Fami Farm Oy. So the delivery company could take into consideration that next time in similar cases they should build more sections for stock. Clients always have to inform exactly what elements in such constructions they need, how many of them have to be built. Clients also have to make sure they have enough space in their plant for building.

6 PRACTICAL UTILITY

The results of the thesis could be useful for Fami Farm Oy as some recommendations on how to improve the equipment running operations, how to avoid breakages and how to increase the productivity are given.

Those recommendations are collected from previous parts Results of work and Marketing viewpoint as a result of research and analysis. They are going to help in future exploitation and maintenance of the machinery, in increasing productivity and in avoiding problems in the future.

As a result, all the recommendations about the automated washing system machinery can be summarized as the following:

- All the mechanisms must be switched off and locked before any check-ups or cleaning procedures for safety reasons
- Functionality and safety devices must be checked before daily actuation
- The staff should always remember to be careful with the equipment, especially with the control of the lifting and braking devices
- Regular cleanings are required
- To work with the equipment, the staff must know the technical structure and functions of the machine, have special education and training, have knowledge of the manual of the machine and its safety demands
- It is recommended to perform different load tests and service reports
- Employees have to ensure that the guards are kept in good condition had to use the guards properly
- The components of the washing machine must be regularly cleaned and – if necessary – replaced
- Moss and weeds should be removed from the benches' surface from time to time
- Before sending a bench under the crane, employees should always check if there is something on the top of the benches
- Some disinfection measures should be taken from time to time
- The sensors inside the washing machine could be replaced from inductive to photoelectric
- Benches' condition should be monitored daily
- Regular inspections of the machinery and the crane should be done

- Training more people to operate with the crane – or instructing them not to interact with the equipment
- The galvanized steel surface should be always checked on – if zinc exposes to the elements frequently
- Galvanized steel inside the washing machine should be regularly cleaned and – when necessary – replaced
- Specialists working in different fields should explore new ways to increase the efficiency and reduce damages (for instance as I mentioned about biologists, maintenance specialists and all the others who are involved in the production process in Fami Farm Oy)
- Specialists must know pest and disease problems
- Good agricultural practices should always be followed
- Sanitization measures should take place
- It is important to control plant debris and finished crops
- Advanced training courses can be organized for specialists from time to time

And, finally, some recommendations to the delivery company DVT:

- The sensors inside the washing machine could be replaced from inductive to photoelectric
- A drying component could be added into the configuration of the washing machine
- More sections for stock could be added

Not absolutely everything can be taken under control and absolutely each detail cannot be considered, time and money losses cannot be totally avoided. It is impossible to remove all those negative effects, all things cannot be predicted and controlled.

Reducing negative effects and their outcomes in different fields in Fami Farm, paying more attention to some important things, increasing one's own knowledge and skills for each employee are the ways to increase the quality of production.

7 CONCLUSION

We live in a constantly changing world; the progress never stops. Automation was created to reduce manpower, to make production process easier and increase its quantities several times. It helps nowadays to produce much bigger amounts of products and to reduce required time for that. Especially agriculture, as it is said to be the world's oldest humankind's activity, was very important field of production in past, it is so nowadays and will be in the future. It has its positive and negative sides as everything in the world, but of course it is demanded activity.

Even though the progress is developing, and machinery is being improved and becomes smarter, there are some problems related to working conditions, productivity and quality of doing work. New machinery is quite costly; old machinery which was bought many years ago breaks down from time to time, and is not that reliable as it was earlier. Old machinery needs more maintenance and is repaired more often. But for new machinery there is also no guarantee that it will work without any problems.

So, no machinery works perfectly because of different reasons. It can be users' errors, when employees lack of necessary knowledge on how to use the machinery. It can be not good enough maintenance. It can be also so that problems are not diagnosed at the right time. Components of machinery get dirty or rusty from time to time, and need regular cleaning or replacing, etc.

Solutions for the problems can be various. Employees have to be trained where it is possible, or at least instructed that it's for instance forbidden to use the machinery without supervision, and the only thing to do is calling Fami Farm maintenance specialists. Maintenance has to be done regularly enough according to the machinery manufacturer's recommendations; some actions are done daily, some of them weekly, monthly, etc. Inspection methods should be effective enough to keep attention to possible failures and breakdowns. Failures and any other problems should be noticed in advance, and measures to fix them should be taken immediately.

Even if we take all those actions, we can realize that it is anyway not enough. Machinery breaks because of so many reasons that we cannot predict and prevent absolutely each one. Aside from that, machinery has its lifetime; and using it after the lifetime is over can sometimes be not rational or even dangerous. In majority of cases it

is normal, but employer has to take into consideration that soon maintenance will be more intensive and costly.

Both manufacturer and user should be interested in machinery's long lifetime, both should find new ways to improve its productivity and increase its lifetime. The main task is probably to find better options for manufacturing, designing, maintenance and keeping the machinery in safe and clean conditions. As we cannot use any machinery eternally, we have to do everything to extend its time of using, and to achieve most effective result of its using in a safest way.

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APPENDICES

Appendix 1. The specifications of the crane

The crane has the following specifications. (see TABLE 1. Specifications of the crane and TABLE 2. Technical specifications of the crane)

TABLE 1. Specifications of the crane

Product name	crane – AC provided crab
Product ID	LA-AC-S-2008-P00227
Type	crane
Year	2008
Power supply	2x230V, 50 Hz
Maximum load	100 kg
Maximum speed	7 km/t
Weight	400 kg
Output-Lifting/Driving	3,0kW / 1,5kW

TABLE 2. Technical specifications of the crane

Motor	1 pc VEM AC-motor 1.5 kW 1400 rpm 230/400 Volt 50 Hz “byggeform B14F1” fitted with Mayr brake 12 Nm 104 V DC size 5 “BJ”
Gear	1 pc SW 063 07.5 140*24 25 U. “BJ”
Lifting motor	1 pc VEM AC-motor 3.00 kW 1400 rpm 230/400 Volt 50 Hz “byggeform B14F1” fitted with Mayr brake 26 Nm 104 V DC size 6 “BJ”
Lifting gear	1 pc SW 090 30.0 160*28 35 U. “BJ”
Grip-motor	1 pc ABB AC motor 0.09 kW 900 rpm. IMB14 / IM3601 ICLF IP55 “BJ”
Grip-gear	1 pc SW 040 100,0 090*11 18 U. “BJ”
Cable drum	2 pcs SKN 5/40-1 incl. 5 m cable. “Nord Tech” (User manual Automatic Washing plant)

(User manual Automatic Washing plant)

Appendix 2. The specifications of the washing machine

The washing machine has the following specifications. (see TABLE 3. Specifications of the washing machine and TABLE 4. Technical specifications of the washing machine)

TABLE 3. Specifications of the washing machine

Product name	washing machine – AC provided
Product ID	VA-2008-P00227
Type	automatic washing machine
Year	2008
Weight	1400 kg
Minimum water supply	70 l./Min.(2 Bar)
Working pressure	70 bar
Power supply	3x400V50 amp 50 Hz
Total effect	12 kW

TABLE 4. Technical specifications of the washing machine

Motor “nozzle device”	1 pc ABB AC motor 0,25 kW 1400 rpm. IMB14 / IM3601 ICLF IP55 EFF2 “BJ”
Gear “nozzle device”	1 pc BJ-worm gear Serie 42. 1 42 20511 1202 01 40 03. Type 2 0 511 12 02 01 40 0 3 11
High pressure pump	2 pcs WS 1630, incl. flange f. 5,5 kW “Kent high pressure”
High pressure motor	2 pcs 5,5 kW electric motor “Kent high pressure”
Bench lock motor	1 pc ABB AC motor 0,09 kW 900 rpm. IMB14 / IM3601 ICLF IP55 “BJ”
Bench lock gear	1 pc SW 040 100,0 090*11 18 U. “BJ”
Gate up / down motor	1 pc ABB AC motor 0,18 kW 1400 rpm. IMB / 14IM3601 ICLF IP55 EFF2 “BJ”
Gate up / down gear	1 pc BJ-worm gear Serie 42. 1 42 20511 1101 01 60 03. Type 2 0 511 11 01 01 60 03 11
Ratchet gear	2 pcs SW 063 40,0 120*19 25 U incl. gear fender 1:3. PC 071 Input: 160 / 14 (IEC71 B5) Output: 120 / 19 (IEC80 B14) “BJ”
Ratchet motor	2 pcs ABB AC motor 0,25 kW 1400 rpm. IMB5 / IM3001 ICLF IP55 EFF2 “BJ”

(User manual Automatic Washing plant)

Appendix 3. The service report.

Here are some examples of service reports. (see TABLE 7. Checklist)

TABLE 7. Checklist

No.	Machine part	Control method	Frequency	Checked	Comments
1	The entire machine	Cleaning – remove dirt from the machine	Daily		
2		Check for noises	Daily		
3		Check for functionality	Daily		
4		Check safety devices	Daily		
5	Push station	Check linear pull device for functionality	Quarterly		
6		Check linear pull device for noises	Quarterly		
7		Check the tipping ratchets	Quarterly		
8		Check the guide blocks for wear	Quarterly		
9	Guide and running wheels	Check the covering	Quarterly		
10		Check the bearings	Quarterly		
11		Check the fastening of the wheels	Quarterly		
12	Locking device	Check the actuators for wear and noises	Quarterly		
13		Check the fastening of the actuators	Quarterly		
14		Check the steering for the locking device	Quarterly		
15	Tipping frame	Check the gear motor for noises	Quarterly		
16		Check the gear for leakages	Quarterly		
17		Check tipping bearings for wear and slackness	Quarterly		
18		Check for correct positioning	Quarterly		

Date: _____ Signature: _____

