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ICT and Farming

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Abstract

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The thesis focuses on integration of information and communication technology (ICT) and farming. The terms which connect both spheres are smart farming and e-farming. Big data, internet of things, global positioning system, robotics and many other technologies are used by smart farming.

The theoretical framework chapter includes information about concept of Smart Farming. Moreover, chapter presents interesting ICT solutions for efficient and profitable farming. Pictures of those ICT solutions are available in the same chapter.

The research chapter describes survey conducted with two Finnish and two Russian farmers to answer main research questions and reach research objectives. Results chapter demonstrates answers for the survey question list. Discussion chapter presents conclusion, suggestions and development ideas for future research.

In the end thesis should answer the questions:

- How does ICT help Russian and Finnish farmers to manage their business?
- Does usage of ICT solve a lot of problems?
- How hard is it to introduce ICT to the farm business?

Keywords
Smart Farming, ICT solutions, Efficient farming, e-farming, Farm management systems, e-agriculture.

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1 Introduction

Smart farming demonstrates the integration of information and communication technologies (ICT) with agriculture. Together ICT and farming lead to what can be called a Third Green Revolution. (Smart AKIS. 2018.)

Same as plant growing and genetics revolutions, the Third Green Revolution occupies the agricultural world with the set of ICT solutions. Those solutions include the internet of things (IoT), robotics, big data, sensors, actuators, global positioning system (GPS), unmanned aerial vehicles (UAVs and drones), etc. (Smart AKIS. 2018.)

By using more accurate and resource-efficient approach, smart farming gets big potential to bring better way of performing agriculture. In farmers' opinion smart farming should help them in the form of better decision making, more efficient maintenance operations and farm management. (Smart AKIS. 2018.)

Figure 1. What can farmers do by using Internet of Things (IoT) (ISOfocus. 2017)

Figure 1 present what farmers can actually do by using IoT. Functions include:

- Smart Irrigation
- Livestock monitoring
- Weather monitoring and forecasting
- Sensor-based precision agriculture
- Remote crop monitoring
- Remote monitoring of soil quality
- Smart warehousing, logistics and distribution
- Remote asset monitoring
- Wine quality enhancement

The level of integration between information and communication technologies is growing really fast. Our population is growing fast as well. The facts are connected due to need to feed all people. In 20-30 years our population will be close to ten billions and there is a problem because people are colonizing big part of lands by building cities, factories, hypermarket etc. those lands could be used / were used for farming. The question is: how to feed more people with fewer amount of resources and save environment at the same time? Here Smart farming comes to solve the problem. By using technologies as big data, internet of things, global positioning system, drones etc. smart farming allows to use full potential of resources and save environments at the same time, examples are available in theoretical framework chapter. (Max v. Schönfeld, Reinhard Heil and Laura Bittner. 2018)

Thesis objectives are available in next chapter for review. Detailed information about research is available in Research chapter where all question and answers from the survey are presented. The chapter theoretical framework demonstrates information which is found in thesis sources. Companies which develop ICT solution for farmers and their products are described in theoretical framework chapter.

1.1 Thesis objectives

The thesis objective is to study the topic with reliable internet sources and books to gather valuable information. Next objective is survey conduction with Finnish and Russian farmers via MonkeySurvey internet website with prepared list of questions. Then interviews are going to be conducted with same list of questions but discussed in more detail. Based on survey and interviews research results are going to be analysed and presented.

1.2 Background of the Thesis

The main reasons to start this project are to make the research on topic of ICT in farming, to check out the situations with ICT in some farms of Russia and Finland and use search engines to discover some top solutions for farmers.

The interviews are going to be conducted with couple of big farms in Republic of Karelia, Russia. Finnish farmers will be interviewed via social network and survey is going to be conducted via Survey Monkey website for both Russian and Finnish farmers.

There are advantages will be reached during the research: Meeting with new agricultural specialists, having look at new technologies (software used by farmers, milking technologies etc.), discovering the list of best ICT solutions for farming.

The report have to answer the main research questions. The list of research questions:

- How does IT help Russian and Finnish farmers to manage their business?
- Does usage of IT solve a lot of problems?
- How hard is it to introduce IT to the farm business?

1.3 The scope of the Thesis

The scope of this thesis covers all those things between ICT and farming. Nowadays, farmers get used to use at least some information and communication technologies e.g. forecast checking but this is one of the simplest things connecting farming and ICT. Smart green farms which do not need human labour to grow up crops because farm management system already knows everything or smart milk farms where robots feed cows, clean up manure, monitor animals' health, cow brushes scratch cows' backs and robots milk cows by themselves (ISOfocus. 2017). On such kind of farms people needed only to check out that everything works well and animals are relaxed/ crops are fresh and har-

vested in time. Those examples demonstrate how ICT and farming can be close to each other. Moreover, the scope of this thesis covers some really interesting solutions for farming.

1.4 Thesis structure

The structure consists of 5 chapters. First chapter is introduction where thesis topic, objectives, background, scope and structure of the thesis are discussed. Second chapter is theoretical framework where topics of ICT and farming are defined separately and as unite, modern ICT solutions for farming are presented and also couple of innovative farms of Russia and Finland are demonstrated. The third chapter is presenting the objectives and methods of the research. Moreover, the ways how interviews and survey are conducted are discussed in this chapter. The fourth chapter demonstrates the research results in detail and describes research problems which author faced. Fifth chapter discuss development ideas and suggestions for future research. Then work process is evaluated and by the end conclusions are done.

2 Theoretical framework

This chapter firstly focuses on defining terms of ICT and farming separately and then as united term e-farming. Secondly, chapter presents innovative ICT solutions for efficient farming and describes their characteristics, functionalities and field of application.

2.1 ICT and Farming

Information and communication technology (ICT) is usually defined as technology used to fulfil manipulations with data e.g. storing and processing. Those manipulations include e-mail, phone text messaging, video calls and social networks. Moreover, ICT includes hardware (computer devices, smartphones, tablets, smart watches and etc.) that perform a broad range of communication and information functions.
(Brian E., Perron Harry O., Taylor Joseph E. and Glass Jon Margerum-Leys 2010)

Most of the internet sources and dictionaries define farming as the activity or business of growing crops and raising livestock (Cambridge University Press 2019). In my opinion, definition is really common and empty. I am a part of farming since child age and I can define farming in more detail than one sentence. Once you become a farmer, farming starts to be your life or way of life because crops or animals need everyday care. Of course time spending depends on type of crops and animals, outdated or modern machinery and having or not having ICT technology. In my example, when I was kid our family had only small buildings with 1-2 milk cows, 1-2 meat calves, 2-3 meat pigs, 10-15 hens laying eggs and of course dog as security of farm. We did not sell meat, milk and eggs because of big family, so all of produces products were for ourselves. We did not have any machinery and ICT technology. All the crops grew were to feed animals and were transported mostly by wheelbarrows. Two times a day I was helping my family members to take care of animals while my coevals were playing on a street. At those days farming was not only activity or business it was way of live or way to survive. Our family farm still exists but now we have sheeps, pigs, hens and two dogs. Luckily, due to machinery and employees it became much easier. Nowadays, I can say it is not only way to survive but business as well.

There are diversity of terms defining the term uniting ICT and Farming. Smart farming, e-agriculture and precise agriculture are the most popular. E-farming designs, develops and applies innovative ways to use information and communication technologies in the rural area, primary focusing on agriculture. E-farming offers a wide range of solutions to some agricultural challenges. (FAO & ITU 2016, Foreword.)

2.2 ICT solutions for farmers

This chapter presents to readers ICT solutions for farmers. There is variety of really interesting solutions different from each other but their mission is mostly the same. They aim to help farmers to increase the harvest, milk and meat volume etc. In other words they help to improve efficiency of business and get full potential out of resources.

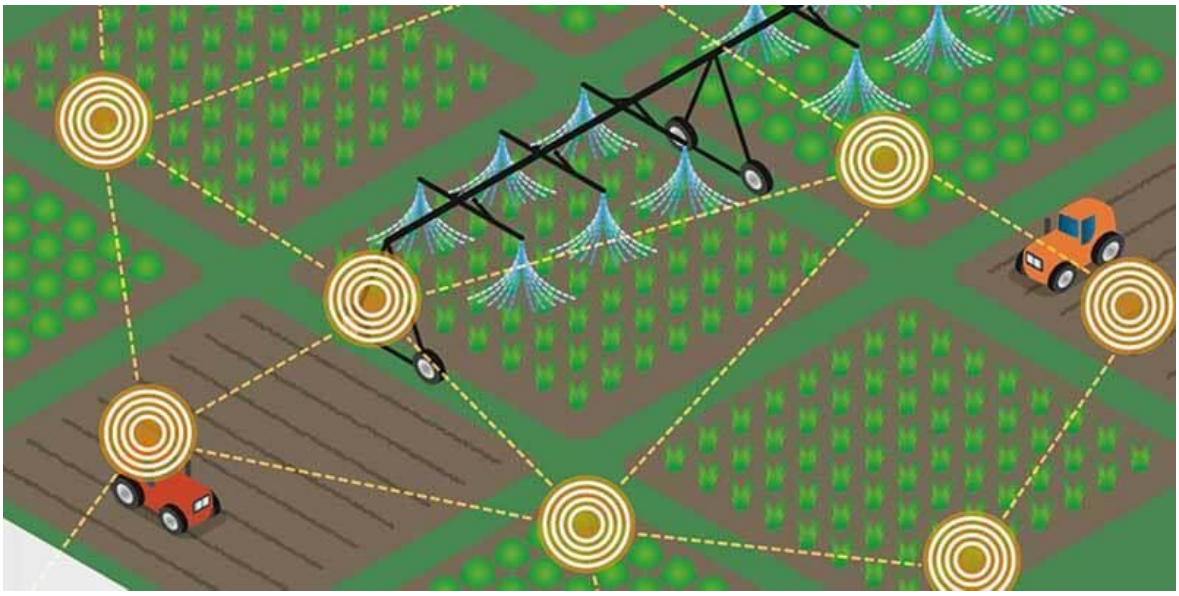

Figure 2 Smart Farming as Internet of Things (IoT) (Richard van Hooijdonk 2015)

Figure 2 demonstrates how smart farming as IoT looks like. All tractors, machines, irrigation system and other sensors are connected via wireless network to each other. Such systems allow farmers to view complete and clear picture. Moreover, based on picture farmers are able to make good decisions and predictions.

Farming as IoT presented by Figure 2 can be described as process. Sensors located on separate fields, measure the level of water, if there is luck of water irrigation system which is demonstrated as shower with wheels get alert that water is needed for particular field. By using global positioning system (GPS) technologies irrigation machine will find needed field and water it. Tractor drivers get order from farmer that some crops have to be planted, harvested or cultivated. Farmer makes those decisions based on knowledge and farm management system which keeps date when crops were planted, harvested or cultivated.

2.2.1 Farmobile solutions

Farmobile Company offers to farmers two platforms: FARMOBILE DataEngine and FARMOBILE DataStore. DataEngine is powerful tool which uses big data and cloud computing technology to collect and organize more data attributes on more machines. In that case farmers get more data visibility into operations much faster than before. To use this platform farmer need to install special Farmobile device called PUC (Figure 3.). PUC is a state-of-the-art collection device that streams geo-tagged data every second. Device can be connected with most machine and tractor brands. PUC collects data via cellular network. When PUC is installed to all farm machines and connected to the DataEngine platform farmers can view either they sowing, harvesting or water crops on fields just by using smart phone, tablet or computer. (Farmobile 2018.)

Second platform called DataStore allows farmers turn collected data to valuable information which is stored on this platform. Moreover, farmers can sell the particular reports or information to special buyers e.g. manufactures of farm machines and farm equipment, in that case farmers stay anonymous but they can see who wants to buy their information and farmers choose accept or reject transaction. (Farmobile 2018.)

Farmobile is independent farm Data Company located in Kansas City, USA. They believe that data is most valuable thing for farmers to grow their crop. Their strategy called collect-share-monetize strategy. (Farmobile 2018.)

Actually, in Russia we have same kind of ICT solutions for farmers, I think in Finland there are same solutions as well. For Russian farmers it is really good way to control fuel consumption, working time, breaks time, work volume. Such solutions are suitable for Russian farmers due to frequent fuel stealing, long breaks taken by drivers and other problems with employees caused by Russian mentality.

Figure 3. Farmobile device PUC (Farmobile 2018)

2.2.2 CropX solutions

CropX Inc. is agro Analytics Company developing ICT solutions for farming based on cloud computing and wireless sensors (Figure 4.). This technology helps farmers to raise harvest of crops, lower water and energy consumption and save the environment. The company also creates maps for irrigation and automatically applies the right amount of water to different parts of the same field. (CropX Inc. 2018.)

Farmers buy CropX sensors and by using irrigation maps in application, system will show where to place the sensors. After placing farmer scan QR code on sensor and after that all information automatically goes to cloud platform. Application will alert when fields need more or less water. That is perfect because farmers can seat at home or go somewhere and control the irrigation of the crops just by opening the application and set needed level of irrigation even on the same field. (CropX Inc. 2018.)

CropX Inc. was founded in 2014. Headquarters located in Tel Aviv, Israel but they have additional office in San Francisco, USA. (CropX Inc. 2018.)

In my opinion such solutions is perfect for crop farmers only from one side which is irrigation control. Farmer can seat at home and control irrigation, nevertheless still have to visit fields to check if there any crop diseases or insect attacks. It would be really nice to have system controlling all aspects of crop growing.

Figure 4. CropX sensor (CropX Inc 2018)

2.2.3 Moocall solutions

Moocall Ltd develops Moocall Calving Sensor (Figure 5.), Moocall Heat (Figure 6.) and Moocall Breed manager App (Figure 7.). Those solutions are appropriate for farmers breeding cattle. (Moocall Ltd. 2018.)

Moocall Calving Sensor is device need to be attached to cow's tail. Device is connected to Moocall Breed manager Application and based on special movements of cow's tail, sensor sends the alert one hour before calve will be born. Usually farmers need to be near

the cows to see which one is going to calve and due to live situations some of calves are missed. With that device they can do their own things and be sure that since alert appears they got one hour to come to cow and help to calve. Each saved and healthy born calve is saved money for farmers, so that is really nice device. (Moocall Ltd. 2018.)

Moocall Heat is device needed to detect that cow is in heat. It includes rechargeable collar to be worn by bull and 50 Moocall ear tags attached to cows' and heifers' ear. The collar then uses cow/bull closeness, measuring behaviour and bull activity levels to determine to an extremely high level of accuracy when a cow or a heifer is in heat. Application alerts farmer when closeness between cow and bull happened and it shows cows number in the app, so that also really help farmers to know which cows already had closeness with a bull. (Moocall Ltd. 2018.)

Moocall Ltd locates in Dublin, Ireland (Moocall Ltd. 2018.). Company produces really interesting products for farmers. I am currently working on farm breeding milk cows and I can surely say that moocall calving sensor together with moocall breed manager application would really help to save all calves. Nowadays, we only have workers changing each other three times a day to keep eyes on pregnant cows and trying to be in time when calve is going to born. Of course accidents happen and some calves are missed. Such kind ICT solution can change the situation on same kind of farms as I am working.

Figure 5. Moocall Calving Sensor (Moocall Ltd 2018)

Figure 6. Moocall Heat (Moocall Ltd 2018)

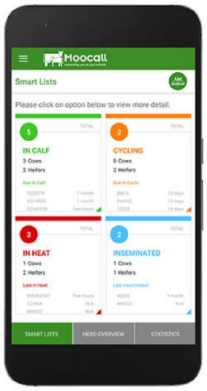

Figure 7. Moocall Breed Manager App (Moocall Ltd 2018)

2.2.4 Vence solutions

The product which Vence provide is awesome. Founders of the company have noticed the problems that traditional fencing face, those are time and money consumption, requirement of maintenance time after time and harm of environment. Moreover, it control and limit animals' motion range which is not good for them, it is better to let nature decide where animals should graze. (Vence Corporation. 2018.)

Vence started 10 years ago as a group of farmers and engineers. The idea was no fence, in other words they wanted to develop virtual fence for animals. So, they developed collar (Figure 8.) which has GPA, mobile phone networking, sound amplifier and electric shock. (NoFence AS 2017.)

By using application farmers draw the boundaries on the map and boundaries can be moved every time. If the animals cross the boundary collar make a sound which supposed to scare animals and make them go back to allowed area, if sound does not help and animal continues to go farther, weak but effective electric shock is used as last resort. (NoFence AS 2017.)

That technology allows farmers to use full potential of land and animals and to control the borders of grazing by using smart phone, tablet or computer. Animals allowed grazing without visible fences. Moreover, if anything unexpected happened farmers will get a notification and will be able to come and solve the problem. (NoFence AS 2017.)

Vence Corporation located in Can Diego, USA (Vence Corporation. 2018.). In my opininon, Vence ICT solution is suitable for my family farm. We have almost 250 sheeps and we use only one employee to graze the herd. As soon as there is human factor some problems may occur: loose of one sheep because animal was eating in bushes and worker simply missed it or sheeps somehow decides to run away from one field to another and etc.

Figure 8. Vence collar (NoFence AS 2017)

2.2.5 LeLy solutions

Lely is one of the world leaders in the niche of milking. They have really broad list of products and services. One of the most interesting things they develop is fully automated milking farms with free cow traffic. Robots feed cows according to setting, so actually cows eat when they want, robots milk cows when cows want to, automated drinking system, air conditioning and etc.

Free cow traffic means that cows are free to do everything they want according to the six factors of freedom: feed, water, air, light, rest and space. Cows can eat when they want, they can be milked when needed and they free to drink rest and walk. Moreover, there are automated cows' back brushes which are also really good for cows. All cows in such kind of farms wear special collar consisting of different sensors which allows controlling health and milking statuses. During milking in robot, system analyzes the data from collar and displays it on computer so that farmer can see all information about the cows. (LeLy. 2018.)

In addition, LeLy provide such services as building new farm from scratch, they can help farmers to renovate old farms and totally rebuild everything inside of the building and they can complement your farm with new robots for feeding and milking. Actually, they can help farmers with everything in milking sphere. (LeLy. 2018.)

LeLy is a family company started in 1948 in Netherlands and headquarters are still there. Now it is worldwide company working in farming/agriculture sector with clients in more than 40 countries. (LeLy. 2018.)

Actually, I have never seen how Lely solutions work. I have kind of dream to visit fully automated Lely milk farm. In the area where I from there are only some Lely products bought by other farms. As I researched there is couple of Lely farms in Finland. Probably, one day I will go and visit them.

2.2.6 GEA solutions

GEA Company develops ICT solutions for farmers as well as for many other sectors (logistics, pharmaceutics, chemistry, sea equipment etc.). Dairylan C21 is good example of ICT solution for farmers. DairyPlan C21 is herd-controlling software with module architecture, which can be adapted to farm of any size. (GEA 2018.)

The list of advantages of using DairyPlan C21:

- Centralization of herd management with full set of data on animals and their performance indicators.
- Functions to control milking, reproduction, feeding and animal health.
- Milking control system allows seeing clear picture of milking volume even for particular cow.
- Automated feeding system
- Automated heat detection
- Separate module automatically control animals' health and allows detecting diseases on early stages. Moreover, system keeps the list of medications, which have been already used for particular cow.
- Information can be presented via tables, graphs and reports for better analyzing. (GEA 2018.)

Actually, software is core of farm connected to everything. Firstly, DairyPlan C21 connected with cows via special GEA collar, placed to cows' neck, which allows getting full information on cow's health status, movements and heat status. Secondly, software is connected with milk hall where cows usually milked and this function allows gathering all information about milk volume from one cow separately and from all cows together. Moreover, if cow is sick and cannot be milked to the same capacity as other cows, system will alert so that dairyman will not mistake. Thirdly, software is connected to feed system and it allows controlling the volume of feed eaten by each cow and the volume of feed left in the storage. Finally, if farm specialists need statistics about milk volume for example, software can generate it via tables or graphs. In my opinion, there is only couple of disadvantages of system, quite long period of teaching staff how to use it, time while cows will get used to milk system, feed system and etc. and of course price of software and needed modules. There are DairyPlan C21 screenshots presented below with explanations.

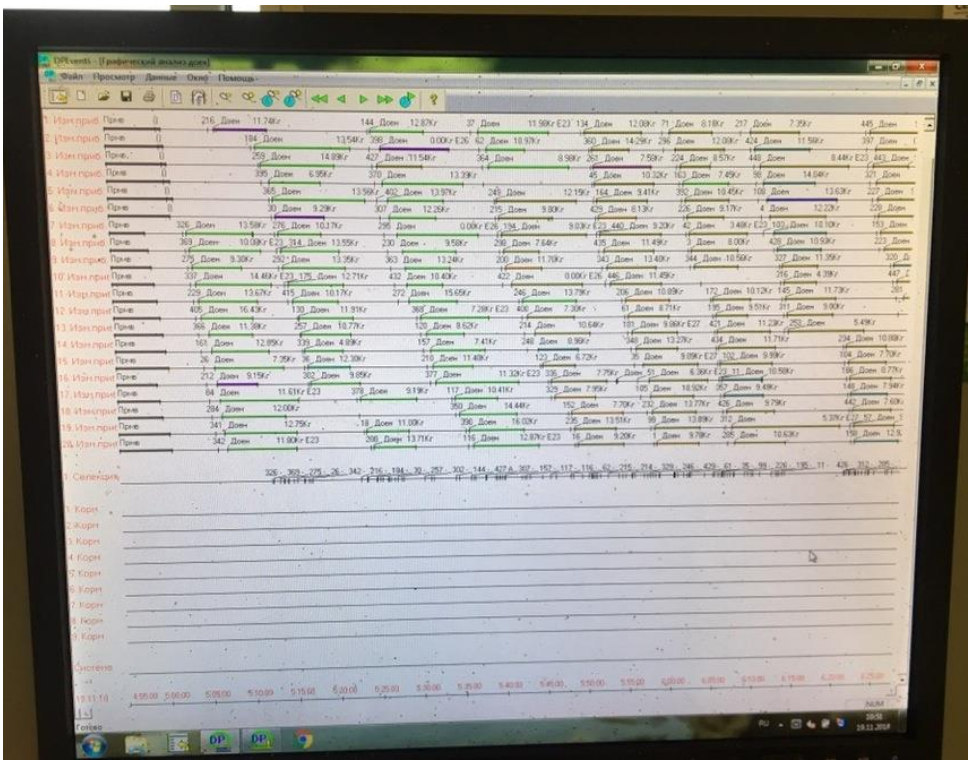

Figure 9. Dairyplan C21. Volume of milk for each cow.

Figure 9 presents screenshot from DairyPlan C21 software. Above each colored line which is showing particular cow there are cow number, milk status (milked or not) and milk volume. Each sector within the farm have special color, so colors mean from which sector of farm cow comes from.

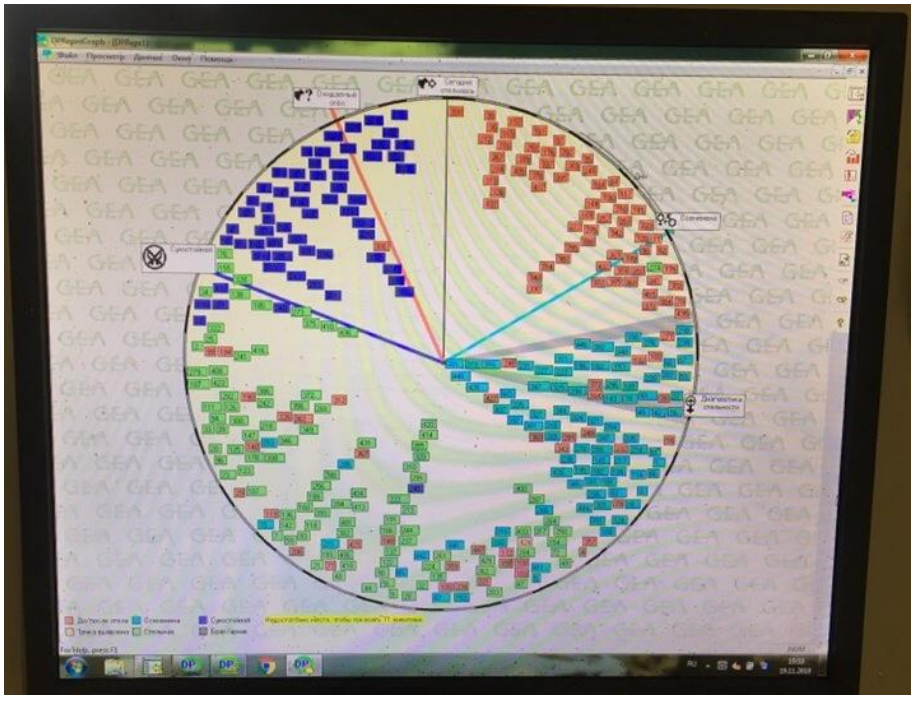

Figure 10. Dairyplan C21. Cows' status.

Figure 10 presents pie where each square showing particular cow. Colours mean cows status: pregnant, cows which have already born calve and cows which are ready to be pregnant.

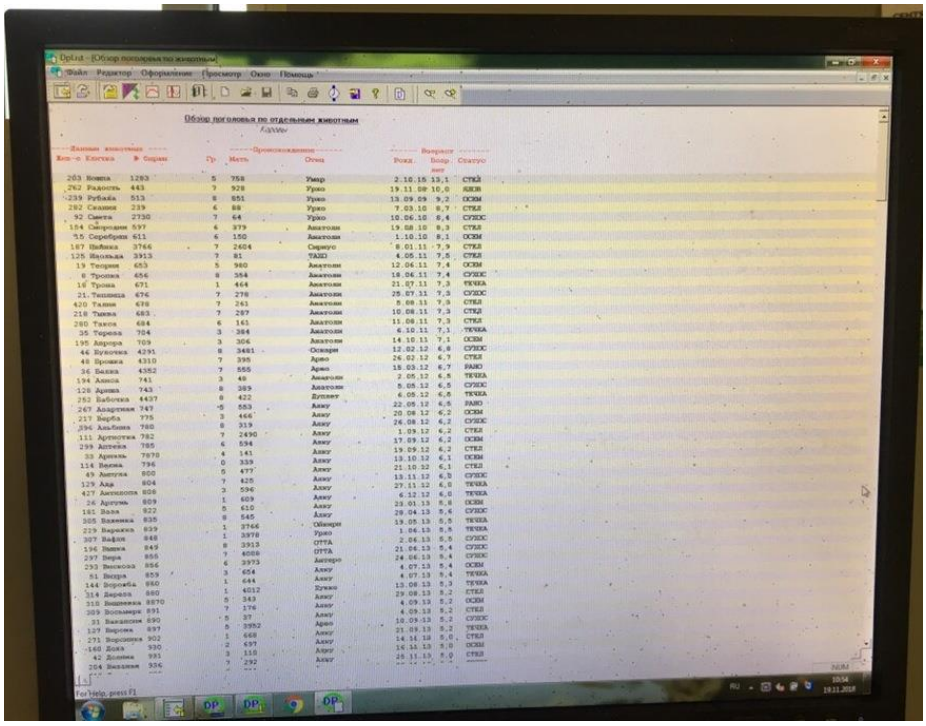

Figure 11. Dairyplan C21. Detailed info about each cow.

Figure 11 presents the list of cows with detailed information. Information include: personal number, name, mother, father, age, kinds, and pregnancy status.

2.2.7 WebWisu solution

WebWisu is online crop production tool for crop planning. In Finland it is first multifunctional online tool for crop farmers available in the market. (Mtech Digital Solutions Oy 2018.)

The list of advantages of WebWisu:

- Real time backup of files.
- Automatic update of software version.
- Versatile map service.
- MobiWisu is application for smartphone and tablets. It is addition to Web-Wisu.
- SMS and email service for better crop planning. (Mtech Digital Solutions Oy 2018.)

Crop farmers and experts can create crop and fertilization plan with WebWisu. Secondly, farmers can make section-specific notes. Finally, farmers can apply for subsidies and also have possibility to transfer data to/from different systems e.g. subsidy application system or productivity data service. (Mtech Digital Solutions Oy 2018.)

2.2.8 Plinor solutions

Selex Dairy Cattle is program which allows farmers to create kind of cows' profiles. These profiles contains all information about cow life cycle e.g. origin, genotype, development, full evaluation of animal, all lactations performance, udder estimation, events – calving, insemination, dry off etc. all that information is kept in database. (Plinor 2018.)

Firstly, Selex Dairy Cattle allows farmers to fulfill fast process of initial data to keep the records. Secondly, program allows successfully manage farm, selection process, animal assessment, milk equipment and milk volume for particular farm. Thirdly, by buying separate modules farmers can predict animal produce, manage calve growing, have card-file structure, analyze economics and statistics of farm. Finally, program support Excel and Open Office. There are screenshots of Selex Dairy Cattle presented below with explanations. (Plinor.2018.)

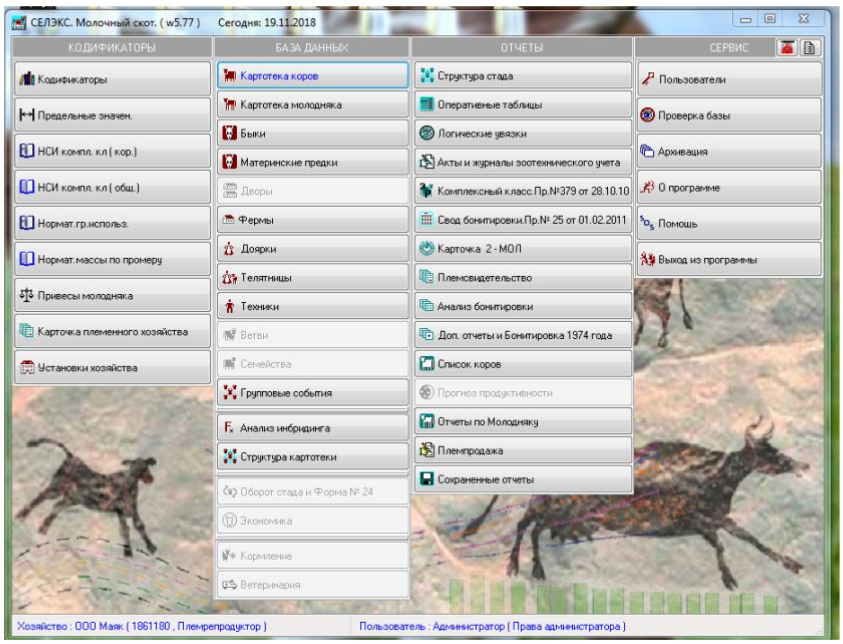

Figure 12. Selex Dairy Cattle. Start screen.

Figure 12 presents the start screen of the Selex Dairy Cattle. Start screen contains all the functions mentioned before together with system update and other system settings.

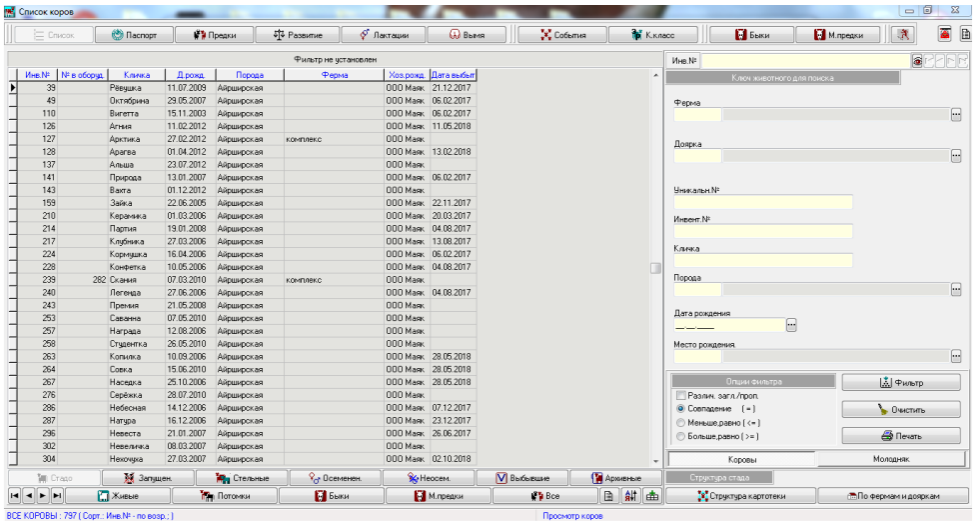

Figure 13. Selex Dairy Cattle. Detailed info about cows.

Figure 13 present the page with detailed information about the herd. Information contains personal number and name of the cow, date of birth, breed and name of the farm.

Plinor has second really interesting product called Selex Beef Cattle. Actually, program has almost same list of functionalities as Selex Dairy Cattle but has some special functions needed for beef producers. Those functions are evaluations of animal genetic potential, creation of young growth genotype, their lines and branches and others.

2.3 Farms of Russia and Finland

This chapter presents some innovative Finnish and Russian farms found in the internet. ICT solutions presented below are manufactured by world leaders but not all of them were presented before.

2.3.1 Russian farm

One of the good examples of innovative farm in Russia is Krol-Korol which can be translated to English as Rabbit-King. Farm is located in area of Smolensk city, Gagarinskiy district, Klushinka village. Farm keeps approximately 12000 rabbits for meat production. Farm is fully automated and uses modern and innovative technology which includes:

- Automated feeding system
- Automated water system
- Automated system of manure removing
- Automated ventilation system
- Automated air conditioning system
- Automated heating system

(Krol and K. 2018)

All the equipment and system is developed by Italian company Meneghin. Farm produces 75 tonnes of meat per month. Moreover, company manufacture feed for rabbits on own plant equipped by German brand Himel which develops feed production equipment. (Krol and K. 2018)

This is really good example of smart farming. Farm is fully automated and does not require much human labour. Moreover, farm produces feeds by themselves. Surely, company uses full potential of ICT.

Figure 3 Krol-Korol automated rabbit farm (Krol and K. 2018)

Figure 3 presents how automated rabbit farm looks inside. All rabbits are in separate cells where they live, eat, drink etc. Manure goes through cell on the floor and then will be automatically removed from farm.

2.3.2 Finnish farm

Juntti brothers are Finnish farmers. They are good example of farmers using modern technologies to make business more efficient. Juntti brothers are milk manufactures. Their farm includes such innovatives:

- Automated milk system
- Automated feed system
- Atomated water system
- Automated manure removing system
- Automated air conditioning system
- Helath controll system

(Valio. 2017)

Juntti brothers use GEA Company as ICT solution provider. They are really good example of small Finnish farmers using ICT to make business more profitable and efficient. GEA ICT solution and its functions were mentions before.

3 The research

The research aims to conduct surveys and interviews with farmers from Russia and Finland to discover integration level of ICT into farming sphere. The project focuses on farmers from different sectors of agriculture e.g. milk production and crop growing.

Survey is conducted via Monkey Survey website and all information is collected from there. Interviews are conducted via personal meetings with participants. Participants are two farmers from Finland and two farmers from Russia. The research mainly focuses on:

- How does IT help Russian and Finnish farmers to manage their business?
- Does usage of IT solve a lot of problems?
- How hard is it to introduce IT to the farm business?

3.1 Research methods

The researcher is going to use qualitative and quantitative research methods. In this project research methods consist of seven parts:

1) Building of question list
2) Survey creation (via MonkeySurvey)
3) Selection of participants
4) Interviews and survey conduction
5) Data collection and presenting
6) Data analysis
7) Conclusion

Building of question list is significant part for every research. Actually, success of the research and value of collected information depend on correctly stated questions. The author should really pay attention to the question list. The question list is available for reading in next chapter.

Survey creation is important part as well since survey is part of research. All the question need to be written correctly and in logical order. Good survey website, platform or service will allow analyzing and presenting collected data in a good way. Survey website should be user friendly so that participants feel comfortable while answering questions. Researcher uses SurveyMonkey website as platform for Survey.

Selection of participants will have influence on the final result of research. Value of information depends on careful selection of participants otherwise information is going to be unreliable and ineffective. The participants should play important role in a company e.g. farm owner or chief livestock specialist because we have important information in hands.

Interviews and survey conduction is stage where researcher starts collecting information. Interviews conducted as eye to eye discussion between researcher and participant there researcher uses the list of questions to ensure that all needed information collected in a good way. Survey is conducted via special website Survey Monkey there participants answer all the questions by themselves. Properly stated questions guarantee good research results.

On data collection stage researcher gathers all information from interviews and survey. After that all valuable information is presented for reading and analyzing. Readers can have their own opinions on presented information.

On data analysis stage researcher analyzes the collected information and thoughts, suggestions and development ideas are presented. In order to do that researcher has to clearly express the analysis so that reader understands the point.

Last stage is conclusion stage. Conclusion includes project results which can be used to analyze the level of integration of ICT into farming in Russia and Finland.

3.2 Survey and interviews

Survey is going to be conducted via Survey Monkey platform with all participants. There two participants from Russia which have cow farms and two farmers from Finland growing crops. Unfortunately, interviews are going to be conducted only with 50% of participants due to long distance and other reasons. The reasons for the survey are to find an answer for research questions and personal interest.

The survey questions:

1. Before you answer all questions please give your full name and write down the location of your farm.
2. Which crops do you have and how many ha. of each? Which animals do you have and how many?
3. Which Farm Management System do you use for your farm?

4. Which role does the Farm Management System play? Does it play the key role in your business?
5. Does the Farm Management System save time and money? Please, give some examples.
6. How hard was it to introduce the Farm Management System to your farm? Did it take a long period?
7. How hard was it to learn how to use the Farm Management System and to teach the employees (if you have them) how to use it?
8. Does the implementation of FMS to your farm business make your life easier than before you started to use special technologies?
9. Would you like to add/delete any functions to/from your current Farm Management System? Would you install any other system(s)? For which purpose?
10. How do the animals or plants react to the FMS which you use? (if system interacts with animals or plants)

There are 10 questions used in the survey. In my opinion the answer will help to understand how high the level of integration of ICT into farming is. Some of the answers are in Finnish I will translate them in English in brackets.

4 Research results

Chapter presents the answers of all participants. The survey is really interesting results prove that. Unfortunately, researcher not able to download the results from MonkeySurvey platform because of free subscription therefore author have just copied the results form web page. Interviews results are combined with survey results to make picture complete. The web link of author's survey is available in references chapter.

1. Before you answer all questions please give your full name and write down the location of your farm.

Farmer №1: Answer was given by farm owner, location: Eura, Finland.

Farmer №2: Answer was given by farmer owner, location: Virolahti, Finland.

Farmer №3: Answer was given by chief zoo technician / chief livestock specialist, location: Ladva, Republic of Karelia, Russia.

Farmer №4: Answer was given by farm director, location: Shuya, Republic of Karelia, Russia.

2. Which crops do you have and how many ha. of each? Which animals do you have and how many?

Farmer №1: 25 ha kevätvehnä ja 30 ha suurimokaura (25 ha of spring wheat and 30 ha of large oats).

Farmer №2: Oats 40 ha and wheat 30 ha.

Farmer №3: We have 1024 cows including calves.

Farmer №4: We got 985 cows including calves.

3. Which Farm Management System do you use for your farm?

Farmer №1: WebWisu.

Farmer №2: WebWisu.

Farmer №3: Dairyplan C21 and Selex Dairy Cattle.

Farmer №4: Selex Dairy Cattle.

4. Which role does the Farm Management System play? Does it play the key role in your business?

Farmer №1: Not really, but it is a convenient way to process crop notes.

Farmer №2: The main platform to plan crop management process.

Farmer №3: Yes. FMSs play the key role.

Farmer №4: It really helps us to keep all needed info about cattle on computer, so it plays the key role.

5. Does the Farm Management System save time and money? Please, give some examples.

Farmer №1: In a way, at least it saves time.
Farmer №2: Easier to plan and execute farm level actions compare to Excels or other software.
Farmer №3: For sure, it saves time and money. Before we start using FMSs, we were keeping all information in notebooks and it was hard to find information about particular cow. Now it is easy because all information kept on computer.
Farmer №4: Of course, FMS saves time and money. Now we can easily find information about particular cow by writing name or number in search line. Before we would need to check it in paper journals and spend a lot of time.

6. How hard was it to introduce the Farm Management System to your farm? Did it take a long period?

Farmer №1: So, I have used WebWisu so long time, that I am quite familiar with it, but it is complicated system.
Farmer №2: No, easy and convenient.
Farmer №3: It took approximately 2-3 weeks to install the FMSs and it was quite hard.
Farmer №4: It was hard to install the FMS. It took 2-3 weeks to get the result.

7. How hard was it to learn how to use the Farm Management System and to teach the employees (if you have them) how to use it?

Farmer №1: As I wrote above, it is complicated system and it is more learning by doing work.
Farmer №2: No employees.
Farmer №3: It was hard to learn how to use the systems but if you know how to use the system it’s quite easy to teach employees.
Farmer №4: It was not so hard to learn how to use the system. It's not so hard to teach how to use but still depends on employees how fast they can learn the all needed functions.

8. Does the implementation of FMS to your farm business make your life easier than before you started to use special technologies?

Farmer №1: Yes, now I have learnt how to use it, it does my life a bit easier.

Farmer №2: Of course.

Farmer №3: Of course! Now we can control milk volume and cows' health and it is all visible on our computer.

Farmer №4: Of course! Now it is much easier to check info about cows and milk.

9. Would you like to add/delete any functions to/from your current Farm Management System? Would you install any other system(s)? For which purpose?

Farmer №1: I would need a better nitrogen management tool.

Farmer №2: The interfaces within different systems make life more complicated and holistic platforms are more than welcome in the future.

Farmer №3: No.

Farmer №4: We would install something new but all of FMSs are expensive, so we did not plan anything yet.

10. How do the animals or plants react to the FMS which you use? (if system interacts with animals or plants)

Farmer №1: None.

Farmer №2: No.

Farmer №3: It took 2-3 months for cows to get used to the new system.

Farmer №4: System and cows do not interact with each other.

4.1 Research problems

The main problem of the research was to find Finnish and Russian farmers from same sector of farming e.g. milk sector, crop sector, meat sector etc. also problem was to find a contact of any farmer in Finland but luckily researcher found them. In the place there author from (Republic of Karelia, Russia) only two milk farms agreed to help with research. Unfortunately, author did not find contacts of milk farms in Finland or farmers did not reply. Anyway, Finnish crop farmers are found and they integrate ICT into farming. They agreed to help the author that is perfect for the research.

5 Discussion

The main objectives of this paper is to check out the level of integration of information and communication technologies into farming/ agriculture in Finland and Russia and search for modern ICT solutions for farming around the world. Second part is discussed in theoretical framework chapter. Answers to the first part are collected via survey and interviews with Russian and Finnish farmers. As a result objectives are reached.

Even small Finnish crop farmers use information and communication technologies to produce better product. WebWisu is not really difficult to introduce to farm business but can be difficult to learn how to use all the functions of the tool.

WebWisu help farmers to create better crop planning. Better planning helps to higher harvest and higher harvest will feed more people/ animals and increase the profit. In that case farmers earn more money and possibly can invest to own farm and integrate more ICT.

Russian milk farmers use such programs as Selex Dairy Cattle and Dairy Plan C21. These programs are quite complicated. It will be difficult to understand for people not familiar with farming, even for farmers it takes time to get familiar with such kind of information and communication technologies. Both programs are hard to introduce to business due to need to connect all hardware and equipment to the program and enter the animal information step by step. As survey demonstrates it takes weeks and even months for introducing, learning, teaching and for animals to get used to the system. Participants mentioned that once they learn how to use the system it is quite easy to teach other employees.

Researcher has tried both programs and thinks that Selex Dairy Cattle is easier to use than Dairy Plan C21 because of clear interface where all the buttons and information is understandable but by clicking one of the buttons e.g. herd info it is quite hard to understand all information there due to speciality of the sphere. To understand Dairy Plan C21 knowledge about farming needed. When this program is fully completed with all modules (milk, health, reproduction, heat detection and insemination) and connected with all equipment it becomes really powerful tool for farmers and their business. This program can control all stages of cow life cycle and detect all problems on early stages. In fact, both of the programs play key role in the business and really help their owners to make money and feed world population.

5.1 Development ideas and suggestions

Actually, author has no development ideas and suggestion for the developers of information and communication solutions for farmers due to huge diversity of the products on the market. Author has searched information about solutions for farmers and noticed that they have already gone out of borders of the mind.

For farmers which are already using some ICT solution researcher would suggest to learn integrated technology fully and to complement it with everything what is possible (of course if budget allows) to get full potential out of the product. Such kind of products reduces human labour and higher productivity of business.

For further research author suggest having more questions in the survey list for better understanding of particular farmer and technology used. Researcher suggest to divide farming into sectors e.g. milk sector, crops sector, meat sector etc. and research them separately due to huge volume of information. Moreover, in each sector there are different ICT solutions and all of them are interesting and unique.

5.2 Process evaluation

In my opinion thesis process was fluent, calm and interesting. The reason is that I really like the topic and have enjoyed empirical and theoretical part of the thesis. There were obstacles appearing in the beginning when I could not find Finnish farmers for my survey but luckily I have found them.

As said before if I would do same kind of research I would take one sector of farming e.g. milking and dig more deep into topic of integration with ICT. For this project goals are reached. Obviously, farmers are trying to make their business more efficient and profitable with ICT. ICT solutions help farmers to reach those goals.

5.3 Conclusion

To conclude this project, the integration of information and communication technologies and framing is growing fast. Even small farmers which got couple of field of crops use ICT solution to save time and money but increase efficiency, harvest and profit. Big farmers use complex of ICT solution containing systems there programs are connected to all equipment, animals, robotics etc. I would say that system is a soul of farm which controls everything. Some of ICT products are quite easy to introduce into business and some are really hard and could take months and probably years to be working correctly. There are

examples presented in survey Russian famers have spent months to get farm management system working but Finnish farmers use online tool and mobile application to support their business (information is only about those farmers which took part in the survey) but ICT helps both.

In my opinion, smart farming will help our population to survive in 2 – 3 decades. Internet full of articles and books there problem is discussed in more detail but I will write shortly. Our population now is 7.5 billion but by 2050 it is going to be 10 billion (according to someone calculations) and there is a problem to feed huge number of people with same or even less amount of resources. Here comes ICT to solve all problems. We will see in 20 – 30 years.

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