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# Acceptance of ICT in Agricultural Sector in the Republic of North Macedonia

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*Abstract:* The agricultural industry is very important part of each economy. The main driver of global demand for agricultural products over the next decade will be increasing of population. The fact that the agriculture has to meet the growing needs of food production makes this sector very essential. However, intensifying of food production is more difficult nowadays because of the great impact of climate change, water scarcity and enlarging of land deficiency. The urgent need for increased farm production on less land with less water through further intensification is, therefore, very important. The research related to the acceptance of ICT in Agricultural Sector in Macedonia was done using literature review and semi structured interviews. A total of 40 (forty) Macedonian agricultural companies were invited to participate on this study. The results from this study revealed that three different components such as lack of awareness about the benefits, maturity of new technology including costs and lack of trainings and operational knowledge have been identified as challenges for the acceptance of ICT in Agriculture in Macedonia. For each component, the critical factors that are influencing the acceptance of ICT were identified. In conclusion, based on the research findings, a groundwork structure for ICT acceptance has been developed for Macedonian agricultural sector, which will help the agricultural stakeholders and ICT providers to determine the best way to move forward.

*Keywords:* ICT; agriculture; North Macedonia

*JEL classification:* L86, M11, M15

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# Uveljavljanje IKT v kmetijskem sektorju v Severni Makedoniji

*Povzetek:* Kmetijstvo je zelo pomemben del vsakega gospodarstva. Glavni dejavnik svetovnega povpraševanja po kmetijskih izdelkih v naslednjem desetletju bo povečanje prebivalstva. Dejstvo, da mora kmetijstvo zadovoljiti naraščajoče potrebe po proizvodnji hrane, je za ta sektor zelo ključnega pomena. Vendar je intenziviranje proizvodnje hrane danes težje zaradi velikega vpliva podnebnih sprememb, pomanjkanja vode in povečanja pomanjkanja zemljišč. Zato je nujna potreba po povečani kmetijski proizvodnji na manj zemljiščih z manj vode z nadaljnjim intenziviranjem zato zelo pomembna. Raziskava, povezana z uveljavljanjem IKT v kmetijskem sektorju v Makedoniji je bila opravljena s kritično analizo in pregledom

literature in polstrukturiranimi intervjuji. Skupno 40 (štirideset) makedonskih kmetijskih podjetij je bilo povabljenih k sodelovanju v tej študiji. Rezultati te študije so pokazali, da so trije različni sestavni deli, in sicer pomanjkanje ozaveščenosti o prednostih, zrelost nove tehnologije, vključno s stroški in pomanjkanjem usposabljanj ter operativna znanja, opredeljeni kot izzivi za uveljavljanje IKT v kmetijstvu v Makedoniji. Za vsako komponento so bili opredeljeni kritični dejavniki, ki vplivajo na sprejemanje IKT. Na podlagi ugotovitev raziskave je bila za makedonski kmetijski sektor razvita temeljna struktura za uveljavljanje IKT, ki bo deležnikom v kmetijstvu in ponudnikom IKT pomagala določiti najboljši način za nadaljnje uveljavljanje.

*Ključne besede:* IKT, kmetijstvo; Severna Makedonija

*JEL klasifikacija:* L86, M11, M15

## 1. Introduction

The main instigator of global demand for agricultural products over the next decade will be population growth. According to OECD-FAO (2016), the world's population is expected to increase from 7.4 billion in 2016 to 8.1 billion in 2025. The second determinant for growth in consumption is the increased income per capita. Growing income per capita is also related with a third factor such as process of changing consumer habits. Higher incomes are first translated into demand for more calories and then in demand for more protein (usually from animal sources), as well as for other nutrients coming from fruits and vegetables. This trend goes together with more consumption of sugar, oils, fats and processed food, OECD-FAO (2016).

The urgent need for increased farm production on less land with less water through further intensification is, therefore, very important. From this perspective, it is crucial to increase the level of agricultural productivity.

Comparing agriculture in different countries is not practicable taking into the account that it leans on local climate, land quality, economic development, products, and also the manufacturing process which is used. However, agriculture value added per worker is generally accepted standard for measurement of agricultural productivity level worldwide. In accordance with the World Bank (2018a), the definition for agriculture value added per worker is given below:

> "Agriculture value added per worker is a measure of agricultural productivity. Value added in agriculture measures the output of the agricultural sector less the value of intermediate inputs. Agriculture comprises value added from forestry, hunting, and fishing as well as cultivation of crops and livestock production."

World Bank regularly publishes reports in which Agriculture value added per worker and GDP per capita, for different regions are presented (World bank, 2018a). The results with special focus on Euro area, United States and Macedonia are given in the table below.

Table 1: Agriculture value added per worker and GDP per capita for different regions

| | Agricultural vale added per worker 2016 (constant 2010 USD) | GDP per capita 2016 (constant 2010 USD) |
|---|---|---|
| United States | 83,736 | 52,319 |
| Euro area | 39,260 | 40,471 |
| Macedonia | 7,658 | 5.246 |

Source: World Bank (2018b)

When the Agricultural vale added per worker and GDP per capita in Macedonia is compared with other countries in Europe and the United States, the level of informal employment in Macedonia should be taken into the consideration. According to the report from the World Bank (2017), informal sector employment in Macedonia in 2015 was 19.9 percent. Tevdoski (2011), Stankovic and Stankovic (2012) argue that a certain share in all economic sectors goes undeclared, but this phenomenon is particularly prevalent in labour-intensive, low-earning jobs in construction,

transport, catering, the textile industry, domestic services, agriculture and trade. Novkovska (2013) highlights that the share of informal employment in agriculture in Macedonia, for the period of 2008-2012 is between 86.1% and 82.4% of all agricultural employment. If GDP per capita is treated as an expression of the degree of productivity of the worker, taking into the account the level of undeclared work in the Agriculture, the productivity per worker in Macedonia is significantly lower in agriculture than in the rest of the economy. In comparison, Agricultural value added per worker in Euro area is almost on the same level with GDP per capita, while in the United States, productivity of the worker is much higher in Agriculture in comparison with the productivity in other sectors.

According to research made by Fuentes and Mies (2012), the productivity is directly connected with the level of adoption of technology. The power of absorption of technology depends on many factors. The main factors are:

- Human capital determined by the quantity of education and the quality of the educational system.
- Institutional environment (barriers, law, property rights) that favors or set barriers for introduction of the new technologies.
- Microeconomic flexibility which enables the entry of firms with high productivity and exit in case of low productivity.

The less developed countries are faced with problems in all areas (human capital, institutional environment and microeconomic flexibility). For that reason, there is a difference in productivity of employees in developing countries compared with the employees in economies in more developed countries overall in all economic branches, including the Agriculture. In accordance with Restuccia *et al.* (2003), barriers for use of modern intermediate inputs[1], are main reason for low productivity in agriculture in less developed countries. However, this quantitative study does not provide any reason for existence of the mentioned barriers and recommendations to go beyond.

In a study prepared by Holster *et al.* (2012), adoption of ICT in Agriculture in Europe is highly related to local challenges. In more economically active agricultural countries (like Denmark and The Netherlands) the standardization of ICT is a big issue, while in East or South of Europe, the costs, connectivity and demographical issues (aging of farmers) are often mentioned as a key inhibitor for ICT adoption in Agriculture.

In addition to this EU study, there are other country-based case studies which are reviewing in more details the specific barriers for adoption of ICT in Agriculture. In pilot study for prefecture Kilkis (northern Greece), the aspects of incorporation of ICT in the Greek agricultural enterprises was investigated by Botsiou and Dagdilelisa (2013). As it appears from the results of this research, the use of ICT in the rural enterprises depends from the farmer proficiency but also from the attitudes that they developed toward the ICT. In accordance with the Indian Case study prepared by Patil *et al.* (2008), illiteracy, cost and lack of awareness are the major barrieres in India for adoption of ICT in agriculture. Human capital enhancement was understood to be the main remedial factor to change the low rate of ICT adoption and its effectiveness.

From the literature review, we can notice that there is gap between requirement for research of drivers and barriers for adoption of ICT in agriculture in non EU countries and number of published research papers on this topic. The purpose of this case study is to reduce the gap and to provide conceptual framework for deep investigation of specific contributions of ICT to agriculture improvement and specific problems in ICT implementation and use in the North Macedonia.

Research question that guided to this study are:

1. How ICT contributes to the agribusiness development?
2. What are the main drivers for embracing the ICT technology in agriculture?
3. What are the main barriers for embracing the ICT technology in agriculture?

[1] Intermediate inputs in agriculture refer to those factors that are provided outside the agricultural sector, such as chemical fertilizers, pesticides, machine services, processed seeds, fuel, and energy.

## 2. Methodology

This section covers the objectives, the methodology, and the design of the research.

### 2.1 Research objectives

The farm productivity is directly connected with the level of adoption of Information and Communication technology (Fuentes and Mies, 2012). The aim of this research is to find out to what extent digital technologies contribute to the development of agribusiness, which are the main elements of the implementation of digital technologies in agriculture, and what are the main barriers that farmers face in the implementation of such technologies. In addition, the level of awareness and interest in investing in digital technologies in managing the agricultural business is also in scope.This research does not aim at a measurement of the degree of ICT penetration in agriculture.

### 2.2 Research methodology

This case study refers to modern trends in ICT management of agribusiness. The qualitative approach was used as the method since allows in-depth investigation of attitudes, perceptions, opinions and feelings of participants (Kincheloe and McLaren, 2005). Data were collected by using individual semi-structured interview using a questionnaire consist of 31 questions divided in two parts. The questions from the first part are structured and they referred to the demographics of the sample, identification of the capacity for accepting digital technologies from the aspect of infrastructure and human factor. The second part of the questionnaire is composed of open-ended questions. The aim of this section was to determine the correlation between the drivers and challenges in Agriculture and the applied technology.

For the analysis of these interviews, content study was used. The study of the transcribed material enabled better understanding and analysis of the material and reduction of the data. This method was chosen because it is considered ideal for the study of text (Krippendorff, 2004).

The interviews were carried out on 40 (forty) farms during November and December 2018 in the North Macedonia. They were randomly selected from 7 (seven) out of 8 (eight) different regions in Macedonia. The sample does not include the farms from Polog region, but given the size of Macedonia, we can presume that the indications that will be obtained from this research can be valid for the whole territory of Macedonia

## 3. Results and discussion

This section represents the results from the research. The data is managed and organized using word processing program.

### 3.1 Age distribution

Participants who are interviewed are between 25 to 64 years old (shown in Table 2). Statistical method was not taken in the ongoing analyse because of the small sample.

Table 2: Age distribution of farmers

| Age group | Frequency | Relative frequency (%) |
|---|---|---|
| 18-24 | 0 | 0 % |
| 25-34 | 2 | 5 % |
| 35-44 | 14 | 35 % |
| 45-54 | 16 | 40 % |
| 55-64 | 8 | 20 % |
| 65 and above | 0 | 0 % |



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Most of the responders were between 45-54 years old, 40 %, i.e. 16 (sixteen), followed by a group of responders aged between 35-44 years, 35 %, i.e. 14 (fourteen) and 20 %, i.e. 8 (eight) responders belonged to the group aged between 55-64 years, Only 5 %, i.e. 2 (two) responders belong to the group aged between 25-34 years old.

According to Stiakakis et al (2009), the age of the population is an important category for ICT adoption. In this research, the usage of 5 (five) different digital technologies (online ordering from suppliers, online payment to suppliers, online sales, online payment to consumers and software for precision farming) among different aged groups was investigated. It was found out that younger population use digital technologies at same level in comparison with the middle aged and older farmers (over 45 years old). The reason might be that general population is interested in ICT usage for entertainment, while the farmers are motivated to use ICT for their needs in agriculture.

### 3.2 Educational attainment levels of survey's farmers

In this research, educational levels of respondents are presented in Table 4. 15 % i.e. 6 (six) people are primary school graduates, 40 %, i.e. 16 (sixteen) persons are high school graduates and 45 % or 18 (eighteen) persons, are university graduates.

Table 4: Educational attainment levels of survey's farmers

| Educational level | Frequency | Relative frequency (%) |
|---|---|---|
| Primary school | 6 | 15 % |
| High school | 16 | 40 % |
| University | 18 | 45 % |

It was noticed that the education level of the respondents is related to the method of keeping records about everyday farm operations. Namely, 100 %, i.e. 18 (eighteen) people with university degree, 37.5 %, i.e. 6 (six) people with High school degree and 0 %, i.e. 0 (zero) people with Primary school degree are using electronic methods for keeping the data.

### 3.3 ICT training

Using ICT may give new impulse in agricultural life. It can be understood as life changing in rural areas. In the Table 5 below are shown the results from the questions connected with ICT trainings.

Table 5: ICT training from of survey respondents

| Training form | Frequency | Relative frequency (%) |
|---|---|---|
| Formal | 4 | 10 % |
| Informal | 18 | 45 % |
| No training in ICT | 18 | 45 % |

10 %, i.e. 4 (four) people received formal ICT education, 45 %, i.e. 18 (eighteen) people received informal training, while 45 %, i.e. 18 (eighteen) received no training at all. Usually, answers related with ICT training were connected with the basic ICT education on the university. Informal trainings were usually completed in private educational companies for which farmers had to pay by themselves or when someone from the family introduced them with some elemental digital knowledge. The trainings mainly were related to basic computer and internet knowledge.

### 3.4 Technological capabilities (infrastructure)

Agriculture is one of the backbones of Macedonian Economy holding a share of 9.42 % in Macedonia's gross domestic product in 2017 (Statista, 2018). It is encompassing all aspects of crop production, livestock farming, fisheries and forestry. In accordance with the research, there is a small level of modern technology absorption in Agriculture.

Table 6: Technological capabilities

| Digital technologies | Frequency | Relative frequency (%) |
|---|---|---|
| Irrigation system | 34 | 85 % |
| Soil analysis | 30 | 75 % |
| Analysis of irrigation water | 8 | 20 % |
| Measuring soil moisture | 6 | 15 % |
| Meteorological stations | 0 | 0 % |
| Electronic reporting | 0 | 0 % |

The main adopted technologies are irrigation systems and soil analysis, having in mind that 85 %, i.e. 34 (thirty-four) farms use some type of irrigation system, while 75 %, i.e. 30 (thirty) farms perform soil analysis. Analysis of irrigation water is used by 20 %, i.e. 8 (eight) farms and measuring soil moisture is performed by 15 %, i.e. 6 (six) farms.

Weather forecast information is generic, and it is related to the location of the nearest town. Weather stations are not used for providing current weather information at micro location. Bearing in mind that climate conditions significantly affect the costs that are incurred in agriculture (when and how much to irrigate, when to spray), there are probably a lot of rooms for improving the processes and for cost optimization in this domain, if appropriate products are available.

Agriculture in Euro zone and United States has reached a point where the methods and tools which farmers are using have to be improved even more; from tradition-based macro into automated data-driven micromanagement. The introduction of single decision support system, which will give the farmer a highly realistic image of their fields and their economy, nowadays, is slowly becoming a necessity.

At first glance, the Agriculture in Macedonia is not following the example from the Euro zone and United States. It seems that farmer's life in Macedonia is not complicated, despite the fact that farm management efficiency is not on a very high level. Ability to electronically report, i.e. electronically transfer data to national institutions is missing which is the reason for many paper works. As a result of the lack of implementation of ICT in Agriculture, the management of the farms is conducted at macro level based on theory, general instructions or prior experience. The decision on a farm is usually made on a daily basis coming from working experience not on extensive data analysis. *"Decisions are made by giving specific plans to the owner of the farm and they are usually based on best practice. Then together as a team, we decide what we are going to do next year" (M.M., 60).*

### 3.5 Challenges related to the usage of ICT

The level of acceptance of new technologies depends on a number of factors that we define in this paper as challenges. Based on the conducted interview, three different type of challenges have been identified (Table 7).

Table 7: Different types of acceptance of new technologies

| *Challenges related to the usage of ICT* | Frequency | Relative frequency (%) |
|---|---|---|
| Lack of awareness about the benefits | 20 | 50 % |
| Maturity of new technology, including costs | 14 | 35 % |
| Trainings and operational knowledge | 6 | 15 % |
| No need | 6 | 15 % |
| No barrier for ICT | 2 | 5 % |

Lack of awareness about the benefits

Lack of awareness about the benefits of ICT can be considers as a main challenge. Namely 50% i.e. 20 (twenty) farms have lack awareness of the future benefits that ICT can deliver. Information received in local language for new ICT technologies and benefits are insuficient. They are usually limited to individual visits from local ICT providers who are offering solutions that solely solve one segment of the overall farm work process. Most of the technologies from

different providers are not compatible with each other. Platform or product that is able to unite more technologies and provide turnkey solution that can connect the farm digitally to the Agriculture ecosystem (suppliers, customers, agricultural consultants and accountants) is missing. Presentations and public information about agricultural innovations are also missing. The only way to get comprehensive information about ICT is via hiring a consulting company. *"To be honest, we were not looking for this type of information directly. We were using consulting company services during last two years. Their knowledge helped us to understand the potentials and benefits of implementation of ICT technologies" (Z. M., 51).*

There is a need to increase information availability about innovations and new ICT technologies in Agriculture on country level free of charge. In this section, help and involvement of the local and central government is needed.

Maturity of new technology, including costs

ICT products in agriculture are usually based on new innovative technology and as such, this technology has often need to overcome some immature problems. As an example, the problem with the duration of the batteries of sensors placed in the soil can be given here. ICT is very promising, but the adoption of these technologies is not apparent in Macedonia due to lack of funds. This means that the price is likely to be a limiting factor for a large number of small and medium-sized farms. *"For bigger investments, money funds could be serious problem. I want to emphases that our manager is very interested in innovations and progressive ideas" (O.P., 47).*

Investment options are restricted in Macedonia but developing communications and practicing around a product may increase them. Running a pilot projects funded by local governments or EU funds and dissemination of the results might be the critical factors for success. Another option might be a creation of favourable credit lines subsidized by the central government dedicated for small and medium-sized farms that wants to invest in ICT.

Trainings and operational knowledge

The level of expert support in the sales process as well as in the implementation process is very low.

The companies that offer digital technologies do not have an appropriate approach to local mentality, and level of education. Furthermore, farmer's population in Macedonia is aging. Accepting new technologies is really difficult process taking into the account that the farmers finished their educational process for more than 30 years ago. The problem is not only in attitudes that they had developed toward the new technologies but also the low level of English language knowledge can be seen as an inhibitor. Most of the older farmers have learned Russian and French language during their education, which is barrier for being acquainted with new technologies and their benefits. Developments are not positive because of a lack of young people in agriculture; furthermore, the flow of people out of the rural area is an issue of increasing concern. Younger generations do not find attractive working on the farms. *"I belong to older generation and I do not feel comfortable using these technologies. That is the main obstacle! Additionally, language knowledge is a serious barrier. Our generations do not speak English, but some of my colleagues have advanced level knowledge in Russian and French language" (Z.M., 51).*

The implementation of ICT technology may replace labor in Macedonian farms, but also it can bring back younger generation. New technologies are something that attracts young people, but this is not a simple straightforward process since there are other factors that influence the demographic issues that should be investigated in another comprehensive study.

### 3.6 Drivers for acceptance of ICT

Based on the conducted interview, three different drivers for acceptance of ICT have been identified (Table 8).

Table 8: Drivers for acceptance of ICT

| *Drivers for acceptance of ICT* | Frequency | Relative frequency (%) |
|---|---|---|
| Reduce cost | 16 | 40 % |
| Increased competitiveness | 6 | 15 % |
| Increased yield | 6 | 15 % |
| Don't know | 12 | 30 % |

The majority of the respondents consider that the biggest driver for acceptance of ICT is reduce of the costs, 40% i.e. 16 (sixteen), while 15% i.e. 6 (six) farms consider increased competitiveness and increased yield as major driving factor. 30% i.e. 12 (twelve) farms cannot define the drivers for acceptance of ICT them because they do not have enough information.

Adoption of ICT in agriculture can lower farmers operational costs and can supports decision-making process. ICT enables direct data acquisition from a range of sensors, devices and machinery on the farm. Meteorological stations, earth analysers and pest controllers can provide direct link with the environment and can reduce cost. All this provides a good basis for sound decisions on a successful and profitable farm.

ICT can offer valuable solutions for improving the agricultural sector in Macedonia. In order to be competitive on the market, farms in Macedonia have to invest in ICT technology. There is a believe that he people that are investing in technologies and keep score are the ones that are going to do a farming 20 years from now. "Well, if farmers do not invest in modern technologies in general then they will lose their business. The small ones are already closed, or they are on the edge of surviving, whereas the big ones are not enough efficient, which enables a possibility for hostile takeover by bigger corporation. There is no future in agricultural business if we do not invest" *(T.D., 57).*

The main driver for adoption of ICT in agriculture is based on lowering the cost for production, modernizing processes and increasing farm profitability. With ICT, farms can be better positioned in terms of competition.

## 4. Conclusions

In this paper are presented results from the pilot study. The approach used in the paper is qualitative and based on semi structured interview and literature review. Taking into account that this paper is based on a sample of 40 (forty) farms, results from the research are not relevant for generalizing, although it might highlight the trends related to the penetration of ICT in Agricultural Sector in the Republic of Macedonia.

The rapid expansion of agricultural technology offers an opportunity to increase agricultural productivity in Macedonia. However, adoption of ICT is very limited. Lack of awareness about the benefits, maturity of new technology including costs and lack of trainings and operational knowledge are determent as challenges for greater acceptance of ICT. Individuals or groups of individuals cannot solve these challenges. There is a requirement for a common approach involving all stakeholders (ICT firms, Local and Central government and other members of agricultural value chain). There is also a need for further assessment of each of the challenges by all stakeholders, creating a collective framework with the sole purpose of facilitating the adoption of ICT in agriculture.

In this study are given indications for complementary priorities. Recommendations can be formulated such as follows:

- Running an ICT based pilot projects in agriculture funded by local governments or EU funds and supported by agricultural extension service;
- Dissemination of the information about novelties in Agriculture and the results from Pilot projects using Above the Line (ATL) and Below the Line (BTL) campaigns sponsored by central or local government;
- Creating favorable credit lines that will be subsidized by the central government dedicated for small and medium-sized farms that wants to invest in ICT;
- Introduction of projects that will be sponsored or guided by the central government that will stimulate migration of young people from city to rural areas.

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