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## The use of ICT in Mazovian agriculture<sup>1</sup>

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**Abstract:** *The main objective of this paper is the diagnosis and evaluation of ICT use in farming. The area of research presented in the study covers the region of Mazovia, which represents different types of rural areas and diverse forms of agriculture. Mazovia region is characterised, on the one hand, by the highest value of GDP per capita indicator in Poland and, on the other, the biggest internal differentiation.*

*In our analyses, a variety of research methods were used as well as data sources - both commonly available (secondary source), as well as data from own studies. For detailed identification of farm equipment level in ICT and its use by farmers, primary research was conducted among farmers and local authorities in 20 deliberately selected municipalities. In each municipality, individual in-depth interviews were conducted with representatives of local government. The second research method was a survey aimed to be completed by individual farmers – almost 1300 were completely filled by farmers.*

*Own research carried out among farmers in Mazovia showed that nowadays infrastructural determinants still remain the crucial problem in access to the Internet – a significant majority of farmers does not have the possibility of choosing the Internet services provider or is forced to use the forms of access that do not ensure a stable connection and high-speed data transmission. Most farmers use a computer and the Internet, if the household is equipped in them. However,*

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*there are used primarily in a passive way - mainly to obtain information. Active forms of computer and Internet use, requiring user interaction, are much less common. Education is a very strong factor in differentiating the level of ICT use by farmers - poorly educated farmers are less able to acquire information from the Internet, while the transfer of knowledge with the use of ICT to best educated farmers is facilitated. Other characteristics of the economic situation of farms, the dominant production profile, size and location do not differentiate the levels of computer and Internet use by farmers as clearly as education, although these factors are important regulators of the frequency of Internet use for strictly occupational purposes.*

**Keywords:** *Internet, rural areas, agriculture, Mazovia, Poland*

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## Introduction

Information and Communication Technologies (ICT) are an important development factor in the modern world, supporting the flow of data, services and people. The role of ICT in rural areas is significant but, more importantly, may in the near future become crucial. Any changes in the function, improvement in social and economic situation of particular areas are not possible without the use of the Internet, the infrastructure of the 21st century, which is a form of access to infinite resources of data deposited around the world (regardless of location in space) and enables communication.

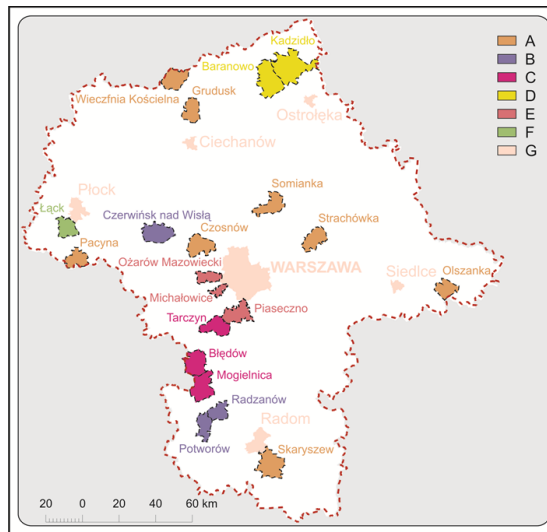
The main objective of this paper is the diagnosis and evaluation of ICT use in farming. The area of research presented in the study covers the region of Mazovia, which represents different types of rural areas and diverse forms of agriculture. Mazovia region is characterised, on the one hand, by the highest value of GDP per capita indicator in Poland and, on the other, the biggest internal differentiation. The central city of the region, Warszawa, is surrounded by the vast territory of the agglomeration, which has a multi-functional character, while the peripheral borderland areas display a mono-functional (agricultural) character, and are much more sparsely populated.

In our analyses, a variety of research methods were used as well as data sources - both commonly available (secondary source), as well as data from own studies. Various data from secondary sources allow for the general characteristics of diversity of ICT use and equipment in different spatial scales, referring to conducted development policy and providing the opportunity to evaluate web resources. However, in official statistics there is limited information on the equipment of households of diversified occupational groups in ICT, the use of ICT by different social and occupational groups, purposes, frequency and time span of using the Internet or causes for digital exclusion. For detailed identification of farm equipment level in ICT and its use by farmers, primary research was conducted among farmers and local authorities in 20 deliberately selected

municipalities (figure 1). These units differ in terms of location in relation to Warszawa, leading functions as well as level and orientations of specialisation in agriculture.

Among the 20 selected municipalities:

- eight represent mixed farming type (Czosnów, Grudusk, Olszanka, Pacyna, Skaryszew, Somianka, Strachówka and Wieczfnia Kościelna);
- three represent specialised agriculture type (Czerwińsk nad Wisłą, Potworów and Radzanów);
- three represent suburban agriculture type (Michałowice, Piaseczno and Ożarów);
- three represent fruit-growing type (Błędów, Mogielnica and Tarczyn);
- two represent dairy production type (Baranowo and Kadzidło);
- one represents agritourism type (Łąck).



**Figure 1. Location of investigated municipalities by type of farming**

**A - mixed farming, B – specialised farming, C – fruit growing, D - dairying, E - suburban agriculture, F - agritourism, G - major cities.**

**Source: own elaboration**

In each municipality, individual in-depth interviews were conducted with representatives of local government. The second research method was a survey aimed to be completed by individual farmers. The standardised questionnaire consisted mainly of closed questions, which are best suited for surveys that are completed independently by the respondent. Of 5000 questionnaires sent in total, almost 1300 were completely filled by farmers (the response rate was 26%).

## Significance of ICT in rural development and agriculture

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Nowadays, possession of mobile phone and access to the Internet has become a requirement for functioning on the labour market and performing daily activities. Through the use of communication and information devices people can communicate and gain increasingly more, relevant information. ICT are also indispensable in modern agriculture. Because of them, a farmer acquires and broadens knowledge, establishes contacts with other producers, promotes products and services, orders necessary means of production and resolves official matters (Heilig, 2003).

Among all sources of knowledge, such as various institutions, agricultural consulting and traditional media, today the Internet is the fastest and richest source of information. Moreover, information and communication technologies can be used in almost any location. They can also be applied practically in every activity, of course with different significances - including the fundamental (such as information technology, banking, media, research and development) and complementary activities (e.g. gastronomy, services requiring personal contact). Information and communication technologies allow for improving efficiency, increasing sales, seeking new markets and supplies, and above all providing the most recent knowledge and information. The use of the Internet in rural areas primarily gives the possibility to align the level of development opportunities with inhabitants of cities. Access to information and communication technologies is the access to work (telecommuting), offices, education, services offered online that are impossible to be obtained at home, various databases, entertainment and contact with other users (Czapiewski, Janc, 2009). With access to the Internet it is possible to overcome some negative location-based determinants in rural areas related to difficult access to traditional educational institutions, accumulating knowledge and offering new technologies and information. The Internet is therefore an attractive and effective means of reaching the knowledge previously available solely from traditional resources.

Taking into account the broader context, it should be clearly noted that ICT may be important in the transformation processes of rural areas in many dimensions. The Internet brings the potential of telecommuting, it is also useful for acquiring necessary knowledge for management or actions enabling for functioning in the field of economy (advertising, contact with authorities). ICT also enables utilisation of resources and local knowledge (Park, 2004; Akca et al., 2007). This can be especially useful for those rural areas of specialised crops (e.g. herbs), traditions - can be bound with the use of new technologies with research institutes, universities, companies, for the purpose of knowledge transfer and its use to create new products (e.g. medicines).

The primary economic sector is spatially immobile, closely associated with a specific area, while taking up a modern industrial activity may depend on several factors, including simple and direct access to knowledge and inno-

vation (Fujita et al, 1999). Industrial activity can to a greater extent be located where there are most favourable factors and in agricultural production such opportunities are limited. Owing to the superficial nature of agriculture and the punctual focused nature of traditional sources of knowledge, farmers have limited access to them. With the development of modern information and communication technologies this spatial barrier can gradually be overcome (Johnson, 2001; Malecki, 2003).

Thus, considering changes in the functioning of the economy and society, the Internet is seen as one of the significant factors in allowing the socio-economic development of rural areas. It enables gaining knowledge and new skills or even acquiring certified education, at the same time helping to overcome adverse situations associated with the peripheral location of rural areas.

### **The use of ICT in Mazovian agriculture**

The most common ICT device in surveyed farms is the mobile phone, followed by the computer and subsequently the Internet, for which 65% of households are equipped. However, the most interesting phenomenon is the sequential appearance of various ICT elements - about 80-90% of households were equipped with a mobile phone as early as 2006, computer in 2009, and in the case of the Internet such values have not yet been reached. Taking into account the dynamics of mobile phones and computers dissemination among farmers, a further gradual increase in the incidence of Internet connections in the farms of Mazovia is expected.

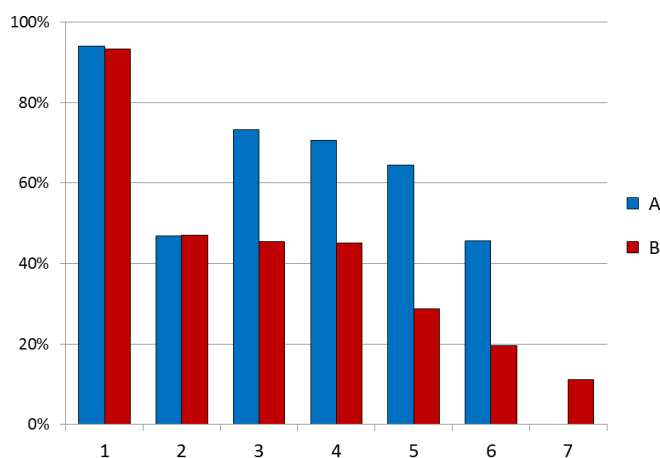
The Internet access to half of the examined farms is provided by the Polish Telecom (TP) - mainly in form of Neostrada services and in a small percentage as a dial-up access (via a modem). In 36% of cases, access to the Internet is provided through a radio or cellular network. Only a minor share is represented by fixed connections of other operators than TP or via mobile phone. Almost 90% of farms were using a single form of access to the Internet; in cases with more than one type of connection, the modem and Neostrada were mainly mentioned.

One of the greatest barrier to the full use of some websites is a low speed data transfer. Among the surveyed farmers 78% had Internet access with data transfer rates of less than 2 Mb/s. In 2010, i.e. at the time of the study, these values were low.

The most common activity performed on the computer by farmers was to use a search engine - 93% of Internet users pointed to that skill. Around 45% of farmers using the computer perform such activities as installation of external devices, copying or moving a file or folder and using e-mail and sending an e-mail (figure 2). Less than 20% of surveyed farmers used a spreadsheet and 10% performed a multimedia presentation. Some of these activities were also

the subject of the Central Statistical Office (CSO) analyses conducted on a larger population, representing different social and occupational groups in Poland. Although the results of the CSO cannot be directly compared with the outcome of surveys conducted in Mazovia, in general it can be stated that the level of computer and Internet skills among farmers is lower than in society overall.

It should however be noted that the levels of computer and Internet skills among farmers increase with the duration and frequency of using the above. Farmers using computers on a regular basis for more than seven years have the full range of skills necessary for proper and basic handling of the computer and Internet. The key step in the widespread use of computer and Internet among farmers is to convince them to start using ICT. In the next stages, with the time span and regularity of computer and Internet use, their skills level increases and these devices can become one of the primary tools used on the farm.



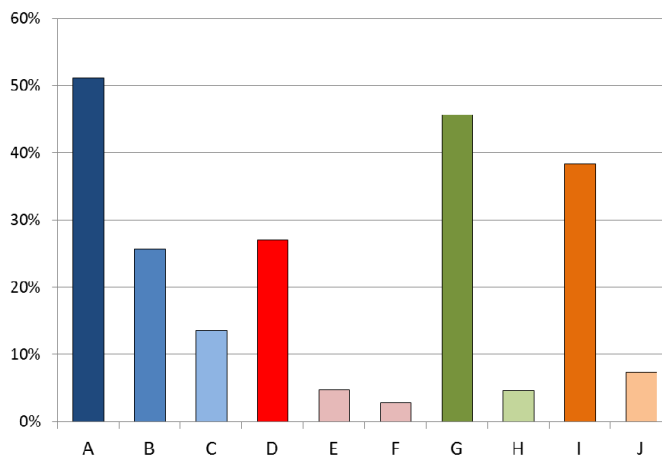
**Figure 2. Percentage of Internet users (in the case of web search engine) and computer (in other cases) able to perform activities mentioned among respondents surveyed by the CSO (A) and farmers surveyed in this study (B)**

1 – Using a web search engine, 2 – installing external devices, 3 – Copying a file, 4 – Using e-mail, 5 – copying an extract of text, 6 – Handling a spreadsheet, 7 – Creating a multimedia presentation.

Source: own elaboration based on data from the Central Statistical Office (Społeczeństwo informacyjne..., 2010) and surveys.

Farmers surveyed indicated that the main purpose of their Internet use is to obtain information – such an answer was given by 83% of respondents. Further down were: career goals (agricultural) and entertainment. All three of these objectives can be classified as passive forms of Internet use - the user only acquires information on websites. Significantly fewer respondents mentioned more active forms of the Internet use - contacting other people, shopping, e-banking, official matters disposal - requiring interaction from the user.

Respondents most often seek information via the Internet concerning new technologies and means of production (51%), EU subsidies (46%), sales of their products (27%) and purchase of means of production (26%); viewing websites related to agriculture is also quite common (38%). All of these activities can be classified as a passive form of Internet use - farmers are only recipients of web pages content (figure 3). A small percentage of respondents was featured by the active form of Internet use - every other farmer looking for information on new technologies and means of production and one in four is interested in purchasing these devices and materials, whereas only one in eight eventually purchases such items via the Internet. Similarly, one in six farmers who seeks information about the possibilities of selling their own products ultimately makes the transaction through the Internet. Just over 2% of farmers advertise and promote own products via the Internet. Also, a small group of respondents is involved in e-training courses for farmers and participates in online forums related to agriculture.



**Figure 3. Main occupational purposes of using the Internet by surveyed farmers**

**A – acquiring information about technology; B – acquiring information on purchasing the means of production, C – purchasing the means of production online, D – acquiring information about the sales of agricultural products; E – selling agricultural products via Internet, F – promoting agricultural products; G – acquiring information on EU subsidies, H – participation in training for farmers via Internet, I – reviewing agricultural web-pages, J – taking part in online forums.**

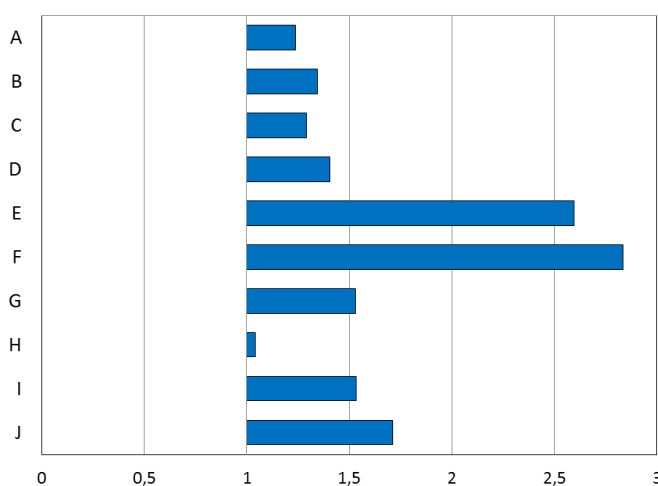
Source: own elaboration.

As shown in the survey, only 2% of Mazovia's farmers use the Internet to promote and advertise their services, and an online resources review identifies only very few entities with their own websites. In this regard, there is still a lot to do, and the primary causes for such a low popularity of this form of Internet use among farmers are probably financial reasons and lack of skills, as well as failing to perceive the benefits from this form of raising the business. Promoting own services via the Internet is a factor of increasing the competitiveness of agricultural producers. It is to be hoped, therefore, that the number of such



sites will increase and thus the use of ICT in agriculture will rise and bring benefits to farmers.

Farmers with no less than secondary education more often than the surveyed group with at most vocational education use the Internet for occupational purposes. The differences in activity between the two groups were observed in all actions indicated by the respondents. However, the most noticeable is the disparity in active forms of Internet use - farmers with no less than secondary education are almost three times more likely to advertise their own products and to sell them online compared to less educated respondents. Increased frequency of selected occupational activities on the Internet is also characteristic for respondents with agricultural education but in this case the absolute differences are smaller compared to the analyses of general level of education.



**Figure 4. Frequency of performing various activities on the Internet by surveyed farmers with at least secondary education (farmers with at most vocational education = 1)**

\*Designation as in Figure 3.

Source: own elaboration.

Education is a strongly differentiating factor concerning the level of ICT use by farmers. Our results suggest that poorly educated farmers have a low possibility of absorbing new technologies, new solutions and knowledge transferred via the Internet. On the other hand, the transfer of knowledge with the use of ICT to the best educated farmers is facilitated and taking into account their skills in the field of information technology it may seem to be effective (at least in the utility aspect). Assuming that nowadays the use of ICT in obtaining information is the most common and fastest way, there should emerge polarisation in their use in agriculture. The best educated farmers mostly use the Internet for acquiring different types of information (also for agriculture related matters), whereas the less educated farmers do not use this source of information as often.

Farm size to some extent differentiates the level of Internet use for occupational purposes. The group of 25% of farmers with the largest farms (over 15 ha) views agricultural websites and participates in online forums twice as often in comparison to the group of 25% of farmers with the smallest farms (less than 5 ha) and about one and a half times more often searches for different kinds of information on new technologies, EU subsidies and sales of agricultural products. Despite of the lack of differences in the level of equipment and the use of ICT by farmers of diverse farm sizes, in the case of occupational (agricultural) use of the Internet, discrepancies in this field are apparent. Farmers running larger farms often use the Internet for occupational purposes, looking for information.

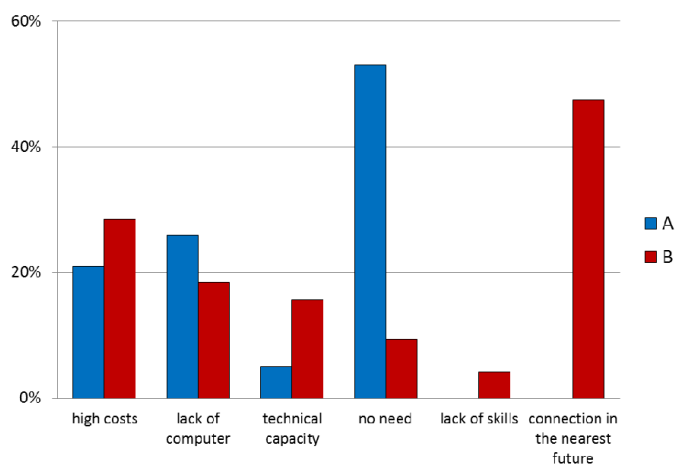
The share of income from agriculture in total household income of examined farms was also a differentiating factor concerning the frequency of using the Internet for agricultural purposes. With the decrease in the share of income from agriculture in total household income (from over 75% to below 25%) there is a gradual decline in the frequency of using the Internet to obtain information concerning agricultural issues.

Farmers of fruit growing and animal production profile more frequently use the Internet for business purposes. Almost half of the farmers managing horticultural holdings and 55% of those in predominantly animal production use the Internet for seeking information in the field of agriculture. This share does not exceed 40% among farmers managing holdings with a dominance of plant production. Farmers keeping horticultural holdings or with a dominance of animal production more frequently than others search the Internet looking for various items of information (about new technologies, marketing opportunities for agricultural products and the purchase of means of production, EU subsidies, or general information posted on websites), make purchases via the Internet (especially animal production) and advertise their products (horticultural holdings in particular). The results are closely related with the level of investment in farm technology and the level of intensity of agricultural production. Horticultural holdings and entities with predominance of animal production are characterised by a higher level of investment in the means of production and technology used as well as a greater intensification of production compared to the often extensive farms with a predominance of plant production. Farmers running horticultural holdings and with a predominance of animal production must use more advanced technologies (for example, in terms of using and starting the spraying, fruit storing, animal feeding methods) and require detailed current information (e.g. weather forecast, especially important in horticulture), therefore the use of ICT for agricultural purposes among these farmers is at a higher level.

## Digital exclusion among farmers

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Among the factors affecting the level of equipment and the use of ICT, the weakness of rural areas should be emphasised in terms of capacity and cost-effectiveness of a large part of the initiatives related to the provision of access to the Internet. A lack of large, innovative companies operating in the field of advanced technologies that could become initiators of creating a network based on fibre optics or other solutions enabling broadband access to the Internet, and the lower density of conventional telephony and satellite television are the obstacles in developing an information society in rural areas that would be equivalent to the urban one. Therefore, it is clear that the rate of Internet diffusion in rural areas is much lower compared to urban areas (Czapiewski, Janc, 2009). This is due to: accessibility to infrastructure, and appropriate labour market and knowledge transfer (Forman et al, 2005). If, however, the infrastructural and financial difficulties are overcome, ensuring full access to Internet service in rural areas, then the socio-demographic factors will largely determine the level of information society development. In terms of demographic and social conditions it can be expected that in the future the disparities will consolidate at the disadvantage of rural areas. The process of migration of young, enterprising and educated people from peripheries to the areas of economic success will strengthen depopulation and population aging in rural areas. Therefore, it should be clearly stressed that of all factors analysed above influencing the development and use of ICT, in the future the most important will be the socio-demographic factors such as level of education, age, and the so-called mental, social and cultural resources.



**Figure 5. Causes for the lack of access to the Internet of respondents surveyed by the Polish Central Statistical Office (A) and farmers surveyed in this study (B)**

Source: own elaboration based on data from the Central Statistical Office (Społeczeństwo informacyjne..., 2010) and surveys.

Among the farmers surveyed in Mazovia the significant causes of the lack of Internet connection were more often technical and economic conditions than those resulting from desire and needs (figure 5). It is worth noting that the vast majority of farmers surveyed use a dedicated line access to the Internet, and only 13% indicated a connection to the Internet via landline phone (modem, the so-called dial-up connection). This would imply that technical reasons for households with Internet are not a serious limitation in the use of the Web. However, among the responses on the speed of Internet connections as many as 78% concerned the values not exceeding 2 Mb/s, which in the current context of increasing the capacity and richness of sites and the commonness of services requiring high bandwidth services (e.g. television) is a very slow transfer rate. The financial aspect is also a significant cause for the lack of Internet access among farmers - this group is characterised by an average income of about a dozen to several dozen per cent lower compared to the mean value for the country. However, with the introduction of new technology, legal conditions and increased demand from the providers of data services, a further decrease in Internet access is anticipated and thereby the financial cause should be increasingly irrelevant in the future.

When it comes to the socio-demographic determinants, elderly and poorly educated inhabitants of rural areas are most vulnerable to digital exclusion. Such people generally do not have sufficient skills to use the Internet and knowledge concerning opportunities and benefits of using the Internet.

## Conclusions

Information and communication technologies are an important factor in social and economic development. It should be noted, however, that the benefits of ICT are not available for all – in the case of rural areas, the equipment is not as important (diagnosed using such elements as cost, speed, quality and bandwidth) as the possibility of using existing resources in the Internet. A significant aspect in this context is the level of education, understanding the needs, benefits and skills. It is worth noting that the full equipment in ICT is not a development factor itself, however the lack of such equipment is certainly a serious barrier. First of all, appropriate skills are required in order to make effective use of the existing infrastructure (Malecki, 2003).

The studies conducted at a general level showed that the spatial distribution of ICT equipment in Mazovia and the levels of its exploitation and utilisation by residents are similar. Both features determining the level of information society development reach top values in highly urbanised areas, whereas the lowest are noted in rural areas of peripheral location with low population density. It should be emphasised, however, that the first aspect of information society, meaning the level of infrastructure accessibility will slowly lose its significance – gradually the broadband service will be commonly accessible across the Mazovia region. Analyses concerning the level of schools' equipment in computers with Internet access are an example of such a process. Therefore,

it is expected that the socio-cultural aspects related to the use of ICT in the future will to the greatest extent differentiate the level of information society development in the region. Currently, the diversification in this respect refers to the clearly dichotomous division on the “core-periphery” line. The most advanced information society is concentrated in Warszawa and surrounding districts with sub-regional centres. All other districts attain low and very low values in this regard.

On the other hand, our own research carried out among farmers in Mazovia showed that nowadays infrastructural determinants still remain the crucial problem in access to the Internet – a significant majority of farmers does not have the possibility of choosing the Internet services provider or is forced to use the forms of access that do not ensure a stable connection and high-speed data transmission. Most farmers use a computer and the Internet, if the household is equipped in them. However, there are used primarily in a passive way - mainly to obtain information. Active forms of computer and Internet use, requiring user interaction, are much less common. Education is a very strong factor in differentiating the level of ICT use by farmers - poorly educated farmers are less able to acquire information from the Internet, while the transfer of knowledge with the use of ICT to best educated farmers is facilitated. Other characteristics of the economic situation of farms, the dominant production profile, size and location do not differentiate the levels of computer and Internet use by farmers as clearly as education, although these factors are important regulators of the frequency of Internet use for strictly occupational purposes.

Based on the conducted analyses it can be stated that the farmers surveyed are at the initial stage of developing their Internet skills. There may be two reasons for such a situation: (1) low levels of knowledge and computer skills do not allow farmers to actively exploit the opportunities offered by information and communication technologies, and (2) farmers do not see the benefits of using more advanced Internet tools for purchasing or selling agricultural products and consequently do not use them. Taking into account the experience of farmers from Western Europe and the growth of e-services (including e-commerce) in Poland among all users, it can be assumed that the first of the presented explanations is the more probable.

The percentage of digitally excluded inhabitants, including farmers, will gradually decrease. Currently, however, special attention is to be paid to the adverse situation in terms of equipment and the use of ICT in peripherally located areas with a predominance of low levels commercial production. There is a coincidence of several reasons for the low levels of investment and Internet use - these are both factors related to location and infrastructure as well as of economic nature but above all, the socio-demographic factors.

Assuming that the Internet plays a major role in agricultural production (and more importantly - in the near future may be even more significant, as evi-

denced by the wide range of agricultural support institutions websites) and the main factor affecting the intensity and effectiveness of the Internet use are skills (quantified inter alia, by level of education) a recommendation can be specified for targeting more action on education. A lack of adequate knowledge and skills to use ICT results in fewer opportunities for agricultural development. Comprehensive solutions leading to the development of a system of oriented and specialised offer of training and support for farmers (instead of self-dependent, one-off initiatives), should contribute to an increase in Internet use by farmers and to perceive it as a basic tool or even means of production in agriculture.

## Literature

- Akca H., Sayil M., Esengun K. (2007). *Challenge of rural people to reduce digital divide in the globalized world: Theory and practice*. Government Information Quarterly, 24, p. 404-413.
- Czapiewski K., Janc K. (2009). *Kapitał ludzki a rozwój obszarów wiejskich – współwystępowanie przestrzenne*. IERiGŻ-PIB. Warsaw. (manuscript in Polish).
- Forman C., Goldfarb A., Greenstein S. (2005). *Geographical Location and the Diffusion of Internet Technology*. Electronic Commerce Research and Applications 4, p. 1-13.
- Fujita M., Krugman P., Venables A. J. (1999). *The Spatial Economy. Cities, Regions and International Trade*. The MIT Press. Cambridge.
- Heilig G. (2003). *Information society and the countryside: can internet-based system bring income alternatives to rural areas?*, (in:) J. Bański, Owsieński J. (eds.), *Alternatives for European Rural Areas*. Rural Areas and Development. 1. ERDN. Warszawa, p. 65-79.
- Johnson T. G. (2001). *The Rural Economy in a New Century*. International Regional Science Review, 24, p. 21-37.
- Malecki E. J. (2003). *Digital Development in Rural Areas: Potentials and Pitfalls*, Journal of Rural Studies, 19, p. 201-214.
- Park S. O. (2004) *Knowledge, networks and regional development in the periphery in the internet era*. Progress in Human Geography, 28, p. 283-286.
- Spółeczeństwo informacyjne w Polsce. Wyniki badań statystycznych z lat 2006-2010*. (2010). GUS. Szczecin. (statistical publication in Polish).