

KRZYSZTOF JANC

University of Wrocław

KONRAD Ł. CZAPIEWSKI

Institute of Geography and Spatial Organization,

Polish Academy of Sciences in Warsaw

**THE INTERNET AS A DEVELOPMENT FACTOR
OF RURAL AREAS AND AGRICULTURE
– THEORY VS. PRACTICE¹**

Abstract: The main aim of the article is to show the role of ICT, especially the Internet, with regard to the development of rural areas. An analysis of both the literature and data referring to Polish rural areas has been conducted. ICT are an essential factor of social and economic development. They mean the possibility of equal development chances between country and city inhabitants. From the perspective of rural areas, access to the Internet means the availability of work (telework), office, education and services offered on-line that are impossible to obtain elsewhere, of different kinds of databases, entertainment as well as contact with other users. With reference to the access or use of the Internet, all available statistics point out the occurring disproportions between rural and urban areas. It is worth emphasizing that the distance between cities and rural areas continuously decreases. According to data about farmers (surveys conducted among farmers in 20 selected communes in the Mazowieckie Voivodeship), we could state that nowadays Internet utilization in obtaining information is common and the fastest means, one should notice polarization in agriculture in the use of new technologies. On one hand, well-educated farmers use the Internet most frequently obtaining various information (also in matters connected with agriculture), whereas poorly-educated farmers use this source of information less intensively. It is worth emphasizing that the advantages resulting from access and use of ICT (mainly the Internet) are not available to everyone. In the case of rural areas, accessibility is not as important as the possibility of using the resources of the net. In this context, education, understanding of the needs (and possibilities) connected with the use of ICT are essential.

Key words: ICT, Internet, rural areas, agriculture, Poland, Mazowieckie Voivodeship.

¹ Publication prepared under the research projects: N 306 058637, *Information and Communication Technologies as an element of modernization and multifunctioning of agriculture. Spatial diagnosis and assessment of the use of ICT in agriculture*, financed by the Ministry of Science and Higher Education and 2011/01/D/HS4/03295, *Models of knowledge transfer in agriculture and its influence on agricultural productivity - spatial analysis*, financed by the National Centre of Science.

Introduction

Information and Communication Technologies (ICT) carry serious implications for the development possibilities in the contemporary world. They are a factor which enables the transfer of data, services and people. The Internet and other systems of telecommunication are not only tools used in the economy and society but they also highly contribute to the development. ICT is an umbrella term that includes any communication device or application, encompassing: radio, television, cellular phones, computer and network hardware and software, satellite systems and so on, as well as the various services and applications associated with them. ICT have changed our way of thinking about the planet by transforming almost every field of human activity, from agriculture to entertainment, and from government to education [Rennie 2007].

The role of ICT in rural areas is, and what is more important, may become great in the nearest future. Any changes in the scope of the function and improvement of the social and economic situation of particular areas are not possible without the use of the infrastructure of the XXI century – the Internet. The Internet as an exact technical notion is a form of access to the deposits of abundant stores of data all over the world, independent of their location in space, and also it enables communication.

Taking into account the above mentioned advantages, this article aims at presenting the role of ICT with regard to the development of rural areas. Simultaneously, Polish rural areas have been characterized as far as access to and the use of the Internet are concerned. With regard to the fact that it is the Internet that constitutes a key component of all considerations of ICT, it is also the focus of the hitherto article. An analysis of both the literature and data referring to the Polish rural areas has been conducted globally, for all of the rural areas, despite their diversity. Some of the analyses which refer to the use of ICT by farmers are based on the data collected during the realization of the detailed survey analysis.

1. Internet: rural vs. urban

1.1. Factors influencing use of ICT

At present, the statement that the level of development of Information and Communication Technologies is closely dependent on the level of economic development is almost axiomatic. According to the data for OECD countries, as well as for developing countries, in the period of time from 1995 to 2000 a number of the Internet hosts (one of the most popular estimation methods of Internet development

level) was dependent on the Gross Domestic Product per citizen and Internet access costs [Kiiski, Pohjola 2001]. Chin and Fairlie [2006] confirmed these findings on the basis of data for developing countries regarding ICT (the Internet users among others). Thus, the higher the level of wealth of a given country, the higher the level of development of Information and Communication Technologies². This dependence constitutes the occurrence of a significant phenomenon: *digital divide* – that is the irregular distribution of access, that means the use of ICT on an urban–rural scale or between regions, countries [see Chakraborty, Bosman 2005; Grubestic 2006; Grubestic, Murray 2002; Whitacre, Mills 2007]. The relationship between wealth and access as well as the use of ICT takes place also on an individual level. The better-off, better educated feel a greater need and have more possibilities to take advantage of ICT. An important factor which affects the use of ICT is also age. Elderly people are less willing than the young to use ICT. There are also other additional factors influencing ICT usage [Selwyn, Facer 2007] such as disposable time budget, mental resources (knowledge, social and technological skills), social resources (social networks and relations at home and at work) and cultural resources. This leads to the conclusion that the appropriate use of ICT depends not only on the possibility of ‘logging on’ but on a group of factors like economic and social status, age, human, and social capital. An obvious implication of this fact is the occurrence of differences in the access and use of Information and Communication Technologies between rural and urban areas as these areas differ considerably with regard to the above mentioned factors.

It should be emphasized that technological developments intensively influence the economic aspects of existence in different territorial systems, especially the employment patterns. In production, an increase in the importance of information, communication, robotics, artificial intelligence, genetic engineering, and other fields strongly dependent on the applied technologies has been observed. Moreover, the importance of services, especially the ones connected with information processing, is rising, whereas the importance of production of objects, especially raw materials, is decreasing [Johnson 2001]. Technological developments have also influenced the relations between people and those between people and governments (the state, self-government, municipality). People are more mobile and flexible referring to their employment and residence choices and also they have better access to information. Information and Communication Technologies have changed the meaning and nature of physical distance. It has become less important thanks to technology, however, the same technology has increased the importance of ‘being connected’ and ‘being disconnected’ with appropriate places.

² Perkins and Neumayer [2010] indicate that in the case of diffusion of new telecommunication solutions (on the scale of countries) not only affluence is significant but also certain specific qualities of given communities, that is the level of education, and commercial openness.

1.2. The role of the Internet in rural areas

In view of development possibilities, rural areas have a lower potential when compared to cities and towns. This disadvantage is caused mainly by the smaller population densities, greater distances from urban markets as well as information, work, education, and most other resources. In the case of Information and Communication Technologies, the difference between rural and urban areas means higher costs of infrastructure creation and access to ICT. Moreover, it should be emphasized that in rural areas there are considerably fewer large-scale users of these technologies, therefore expected investment profitability is decidedly longer than in the city. It is related to the so-called *'last mile'* problem. It refers to the costs of the last connection – the individual connection of a recipient with the net, whose costs belong to the highest in the final clearing of accounts. Not accidentally, as Poncet and Ripert [2007] noticed, ICT are naturally attributed to cities, connected with townspeople, the exchange of information between burghers or urban lifestyle. In the context of the *'last mile' problem*, for rural areas opportunities are supposed to appear in providing access to broad-band Internet by wireless Internet (Wi-Fi), which is available through a so-called hotspot [see Johnson, Snider 2003; Puel *et al.* 2007]. Unlike the traditional connection (cable system), the installation cost of a hotspot is very low.

However, as Johnston and Snider [2003, p. 1] notice, due to the low population density „...*Wi-Fi only breaks the chains on the last hundred feet of the telecommunications network. The rest of the last mile is still in chains*”. It is indicated, however, that this alternative option of technology versus “physical wiring” may influence the redefinition of the traditional (also in the case of the Internet – *e.g.* Houzet 2007) core-periphery system [Kwan 2006]. Park (2004) draws attention to the possibility of a reduction of differences between the cores and the peripheries owing to the Internet access. By stressing the importance of knowledge and creativity in the development processes, he indicates that the Internet can additionally reduce the feeling of isolation, not only the geographic but also psychological (*e.g.* alienation). Nowadays, it should be noticed that there is an even greater chance of breaking the monopoly of the city for Internet access and it is offered by the technologies connected with the fourth generation of wireless telecommunications (so-called 4G) standards.

In the case of running a private business in rural areas, two features, which were pointed out earlier, the distance from urban centres and low population density are the major significant challenges. As Malecki and Moriset [2008] notice, the distance from the city means a more difficult access to markets, production factors, and costly and time-consuming business trips. The lower the density, besides the factors mentioned earlier, the bigger the dispersal of local resources, mostly important human resources (human capital) as well as outlets.

The rate of Internet diffusion in rural areas is considerably slower than in cities. According to the theory of urban density, adoption costs decrease along with an in-

crease in population density. It is connected with [Forman *et al.* 2005] the availability of infrastructure, suitable labour markets, and knowledge transfer. The necessity of Internet ownership is greater in urban areas because technologically advanced enterprises (these often require the latest Information and Communication Technologies) are usually situated in cities. It should be emphasized, though, that the advantages of the adoption of Information and Communication Technologies for enterprises may be greater in sparsely populated areas. It relates to the fact that the ICT in the case of enterprises situated in less urbanized areas suppress bigger barriers between organizations as well as individuals (employees and clients) than in cities. Thus, despite higher costs of the adoption of the Internet and other Information and Communication Technologies, the expected advantages may be much greater.

What do Information and Communication Technologies mean for rural areas? Above all, they mean the possibility of equal development chances between the country and city inhabitants. Access to ICT means the availability of work (telework), office, education, services offered on-line that are impossible to obtain elsewhere, of different kinds of databases, entertainment as well as contact with other users. Thus, both the social and economic aspects can be differentiated. Both of them are conditions for development possibilities like the transformation of rural areas. It is essential in the context of the fact that besides the obvious advantages of “logging on” and using the resources of the global net in rural areas, the drawbacks for the “unconnected” people are immense. By drawing attention to this fact, Warren [2007] notices that in the nearest future a considerable number of people living in rural areas will be deprived of the benefits of the Internet.

Among the above mentioned advantages, a very important one is the possibility of working over the Internet. Telework brings obvious benefits to enterprises like an increase in employee productivity, a reduction in office overhead, greater flexibility of the organization structures, a decrease in absenteeism and late-coming, and more efficient use of tele-information links. For employees, the main benefits are: the opportunity to work in stress-free conditions, the possibility of better concentration, flexible working hours, an increase of work availability for people beyond a normal work mode (*e.g.* mothers minding their children, the disabled). Telework is a big chance for the inhabitants of rural areas. A very important benefit is the possibility of a well-paid, prestigious job without the necessity of leaving for the city. Retaining and even winning over the most talented, entrepreneurial parts of the rural community may bear long-term advantages for the development of rural areas. This part of the community decides about the looks of local communities, most frequently it is involved in the activities of the third sector (non-governmental organizations), and creates the appropriate conditions for social and economic activities.

While examining a wider context and considering the benefits offered by ICT (especially the Internet) to rural areas, one should look at Fig. 1. Interestingly, ICT, may be or is essential in the transformation processes of rural areas on many planes.

For they are not only directly connected with the mentioned possibilities of e-work but also useful in obtaining the knowledge necessary for farming or the activities which enable people to exist in the economic world (advertising, relations with offices). ICT make it possible for people to use local resources and knowledge [Park 2004]. They can be particularly useful in these rural areas where specialized crops (*e.g.* herbs) are grown, traditionally bound with research institutions, universities, and companies by modern technologies in order to transfer the knowledge and to use it for the creation of new products (*e.g.* medicines).

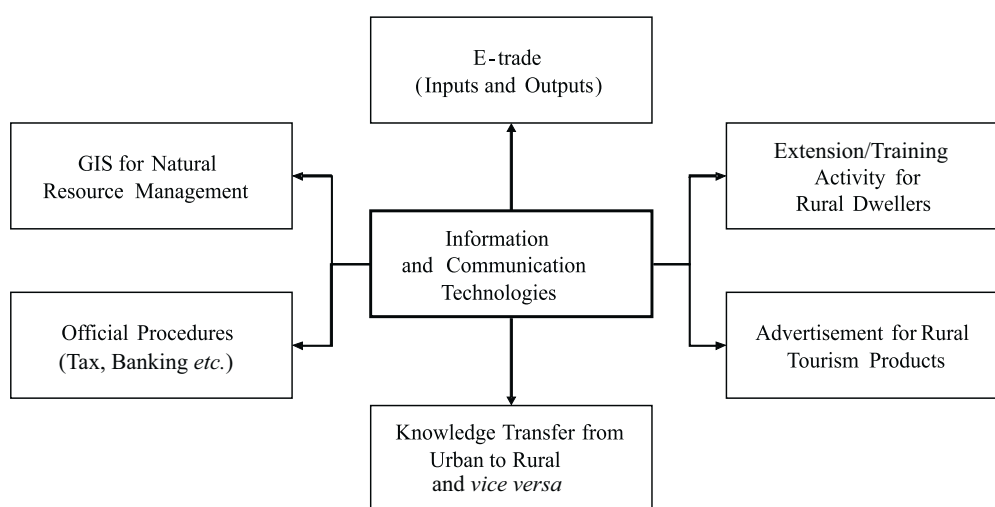


Figure 1. Advantages of ICT for rural areas with regard to economic activity.

Source: [Akca *et al.* 2007].

It is worth emphasizing the contribution of ICT in the development of the agricultural sector of the economy prevailing in rural areas. With regard to the areal character of agriculture and the ‘spot and focus’ character of traditional sources of knowledge, farmers have a hindered access to them. Thanks to the development of ICT this spatial barrier can be gradually removed [Johnson 2001; Malecki 2003].

What is significant, the role of ICT technologies is emphasized in the knowledge, innovation and information transfer models. In the three models of knowledge elaborated by Floriańczyk *et al.* [2007] – the horizontal one, the global model and the one directly from the supplier – ICT constitutes the basis of two of them. In the horizontal model the uncoded knowledge is passed on to farmers, and obtained from an agricultural advisor in a traditional way. On the other hand, in the other two models (the global one and directly from the supplier), the incentive to search for and apply new technologies comes from the information stored in the Internet services (electronic editions of newspapers, specialized websites, news sites for farmers as well as go-

vernmental and non-governmental institutions). According to the presented models of knowledge transfer, the information accessible *via* the Internet is verified in the next stage and extended by specialized agricultural counselling or directly by the supplier of equipment, production resources, and by the producer of machines and technologies.

The reference to the knowledge transfer is important because, nowadays, knowledge constitutes one of the basic factors influencing production efficiency in all sectors of the economy and agriculture. Due to the developments of the political, technological surroundings and socio-economic agriculture, it is important for farmers to continually improve their knowledge and raise qualifications. The dispersed character of agricultural production and farmers' living places causes their peripheral disadvantage with regard to the access to traditional sources of knowledge (educational institutions and resources gathered in libraries, *etc.*). ICT, most of all access and the ability to benefit from the resources stored on the global net, enables us to broaden the already possessed knowledge and to obtain indispensable new information and, simultaneously, to overcome the problem of adverse location (spatial isolation).

2. The Internet in rural areas – the case of Poland

With reference to the access or use of ICT, all available statistics point out the occurring disproportions between rural and urban areas in Poland [*Spoleczeństwo informacyjne...* 2012]. It is worth emphasizing that the distance between cities and rural areas continuously decreases (Fig. 2). In order to illustrate this problem, a simple measure has been assumed. It is the relation of the quality for a given feature in rural areas to the quality in towns (both in big ones over 100,000 inhabitants and smaller ones – under 100,000 inhabitants) in the same year³. The higher the value of the so calculated measure, the smaller the distance from rural areas to towns (the perfect situation is the value equal to 1 – that is the same level in all areas).

A period of several years has allowed for a considerable reduction of the delay of rural areas with respect to towns in the scope of access and utilization of selected elements of ICT. In the case of computer ownership, rural areas are nowadays at the same level as towns (cities– 0.89, towns – 0.94). The biggest reduction in the *digital divide* took place in the case of the access to broadband Internet – as refers to cities: from 0.07 to 0.79; regarding towns: from 0.11 to 0.86. An interesting phenomenon is conspicuous: the elimination of the digital gap happens earlier within the scope of basic problems like computer ownership; later, in the range of more sophisticated problems (requiring bigger knowledge and abilities) from using the Internet to purchasing selected goods. Partially, such a dependence should be recognized as an expected cause-effect consequence because, first and foremost, a basic infrastructure is necessary (that is a computer

³ Types of place of residence are strictly depended on data published by Central Statistical Office of Poland.

and the Internet) in order to afterwards, by their means, perform different activities (e.g. purchasing products). However, on the other hand, it is also connected with the priorities of the regional and domestic policies as regards to innovation and the development of telecommunications. In the scope of the Regional Operations Programmes (for the years 2007–2013), the projects regarding the information society are backed up in the range of 5 intervention categories. The biggest expenditures are and will be dedicated to the building and modernizing of the telecommunications infrastructure (in Poland on average 45%) and further for services and application for citizens (28%) as well as other activities [Bilans otwarcia... 2008]. Also, in other programmes subsidized from UE resources, projects are directed to the development of the information infrastructure to a larger extent than to the upgrading of the competence of citizens in this field.

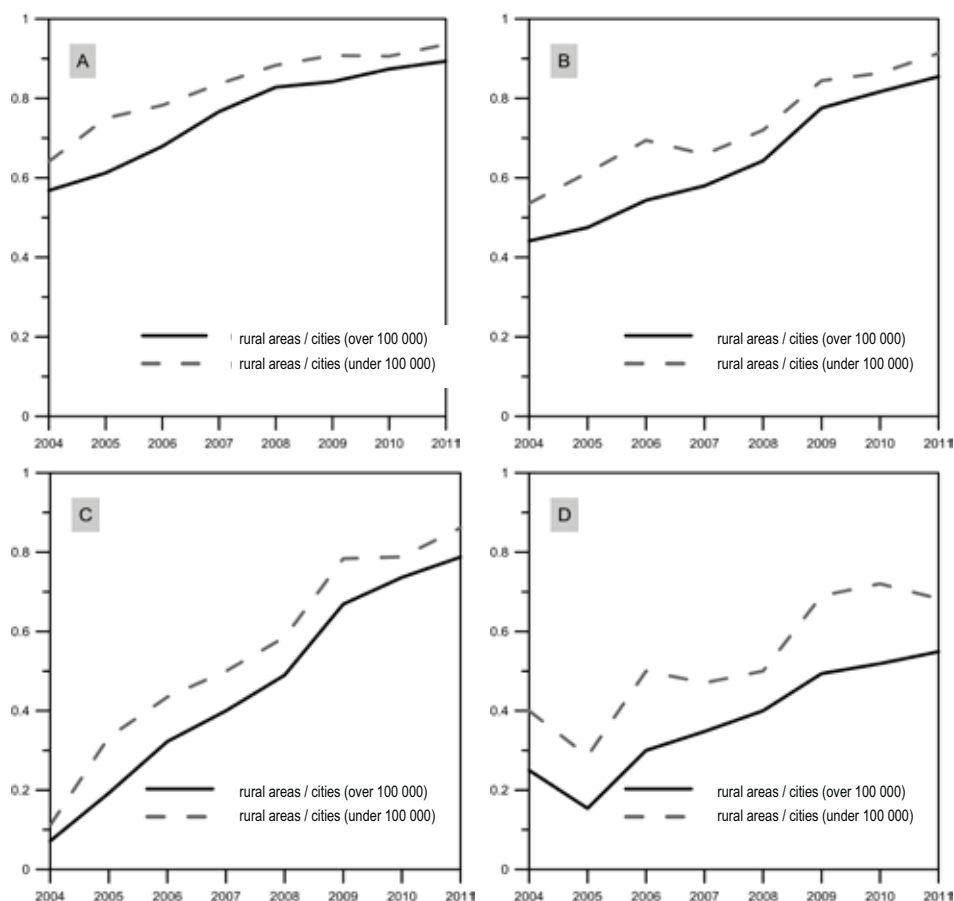


Figure 2. The comparison of rural areas with towns and cities in the scope of selected features in the years 2004–2011 in Poland: A – computer ownership; B – the Internet accessibility; C – access to the broadband Internet, D – purchasing over the Internet.

Source: The authors' study on the basis of GUS data.

The kind of Internet connection in a household (Fig. 3) explicitly indicates the dissimilarity between the city (town) and the country. When considering only the broadband connection, the domination of the country regarding DSL or the wireless Internet seems to be expected. DSL is connected mainly with delivering the Internet by traditional operators who mostly use telephone lines. In rural areas the use of telephone lines is a natural process – the lack of extended cable telephone networks or optical fiber nets causes the “traditional net” to be the most important. According to the specificity presented in the considerations above, wireless access to the net is more popular in rural areas than in cities (towns) in Poland. It shows the importance of wireless forms of access to the net in rural areas.

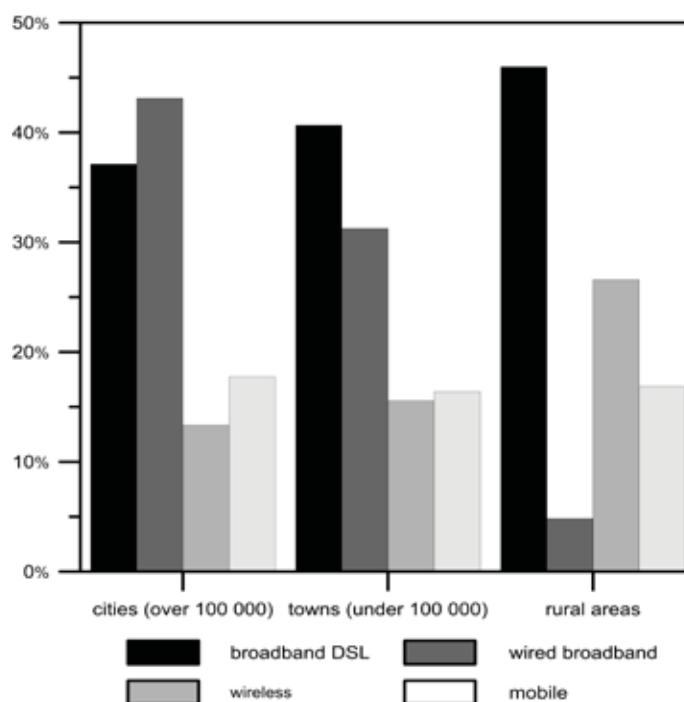


Figure 3. The comparison of rural areas with cities (towns) in the scope of connecting to the Internet by mobile devices in the year 2011 in Poland.

Source: GUS data. (Figs 3-5).

Concerning the use of mobile devices (Fig. 4) the comparison of rural areas with towns looks interesting when compared to the previously discussed data. Although it can be stated that the wireless Internet is important in rural areas, its use by mobile devices is much less popular than in towns. It leads to a relevant conclusion: hierarchic diffusion of innovations (with regard to the use of the newer ways of connecting to the net) indicates that the appearance of new solutions in the scope of the wireless Internet

use confirms the urban character of the Internet. New technologies as ways of the net utilization first will be present in towns and then will come into common use in rural areas. What can be perceived as a panacea for the weaknesses of the Internet access in rural areas, is of a naturally urban character - towns, while adopting these solutions earlier, do not lose the edge over the rural areas.

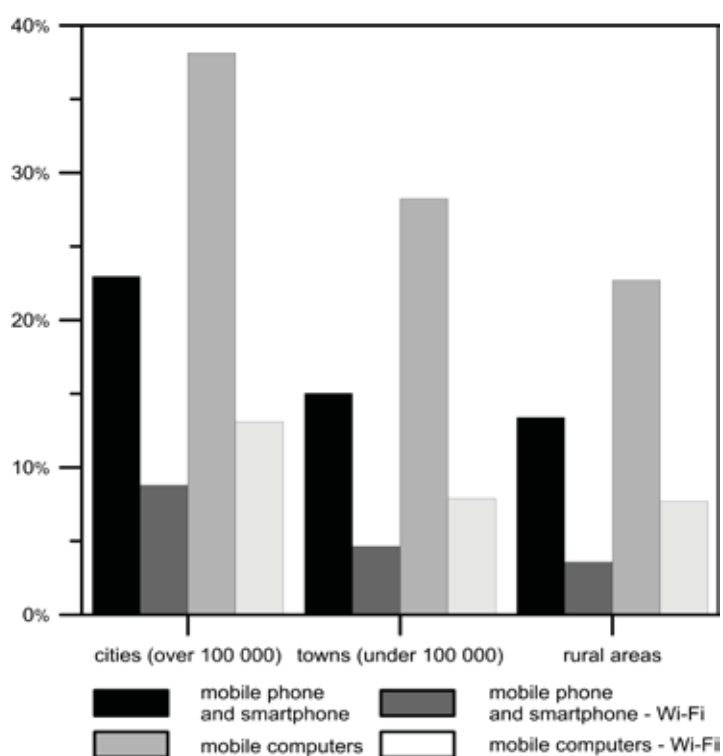


Figure 4. A comparison of rural areas with cities (towns) in the scope of the kinds of Internet connection in a household in Poland.

Another essential element of consideration referring to ICT utilization is the purpose of connecting to the net (Fig. 5). While the basic forms which are generally associated with the benefits from the net do not differentiate particular communities and are common (communicating in cities – 95%; in rural areas – 90%), the more advanced forms distinctly indicate the existing divisions. Especially, the utilization of electronic services show that ICT are not really the factor equalizing “the city” with the “country” at least in the current conditions. In the case of approaching the use of resources of the global net by the inhabitants of a village similarly as the people in cities use them, there is still a problem of the access to the resources impossible to digitalize (human interactions, tradition, specific character of places).

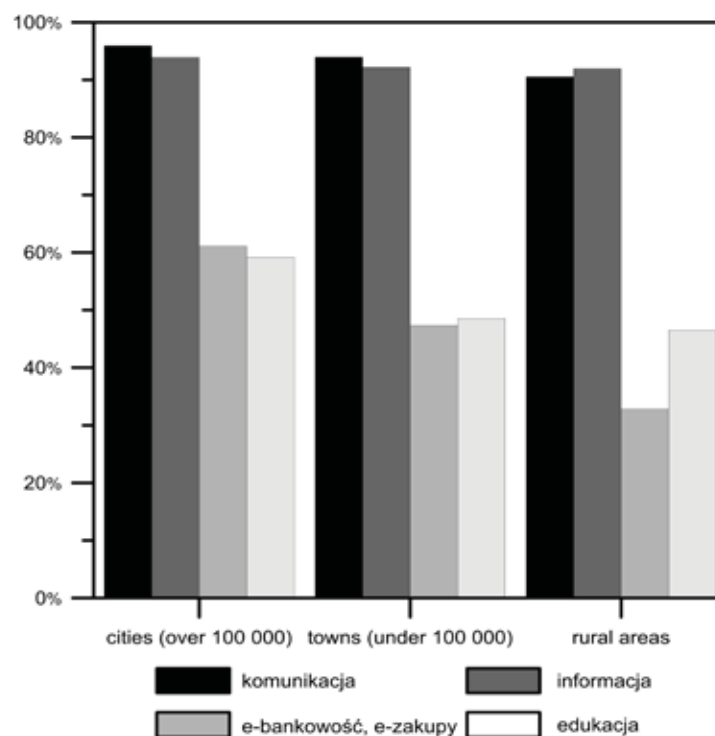


Figure 5. The comparison of rural areas and cities (towns) in the scope of purpose of Internet use in the year 2011 in Poland

3. The Internet in agriculture – the case of the Mazowieckie Voivodeship

Technical infrastructure is frequently indicated as an essential element of local development and agriculture [e.g. Borcz 2000; Chudy-Hyski 2004; Ciekanowski, Milewski 2009; Dolata 2005]. However, these analyses do not usually consider ICT due to the low level of development in rural areas. In the hitherto study, the findings of surveys conducted among farmers in 20 selected communes in the Mazovia region⁴ have been used – 1,283 questionnaires were completed [Czapiewski *et al.* 2012]. It is worth emphasizing that the examined sample is younger than the whole of the population, better educated and their farms are of a bigger area and higher level of productivity.

⁴ Mazovia region is characterized, on the one hand, by the highest value of the GDP *per capita* indicator in Poland, and on the other – the biggest internal differentiation. The central city of the region, Warsaw, is surrounded by a vast territory of the agglomeration, having multi-functional character, while the peripheral borderland areas display a mono-functional (agricultural) character, and are much more sparsely populated.

The Internet is provided to half of the agricultural farms by the Polish Telecommunication (Telekomunikacja Polska - TP) mostly in the form of the Neostrada⁵ service (DSL) and a small participation of the dial-up access (by a modem). In 36% of cases the access to the Web is provided by mobile networks or by Wi-Fi (Fig. 6). A small participation belongs to the connection through fixed broadband connections of other operators than TP and by mobile phones. Almost 90% of farms used one of the forms of Internet access – in the cases when it was more than one kind of connection, mostly a modem or Neostrada were indicated.

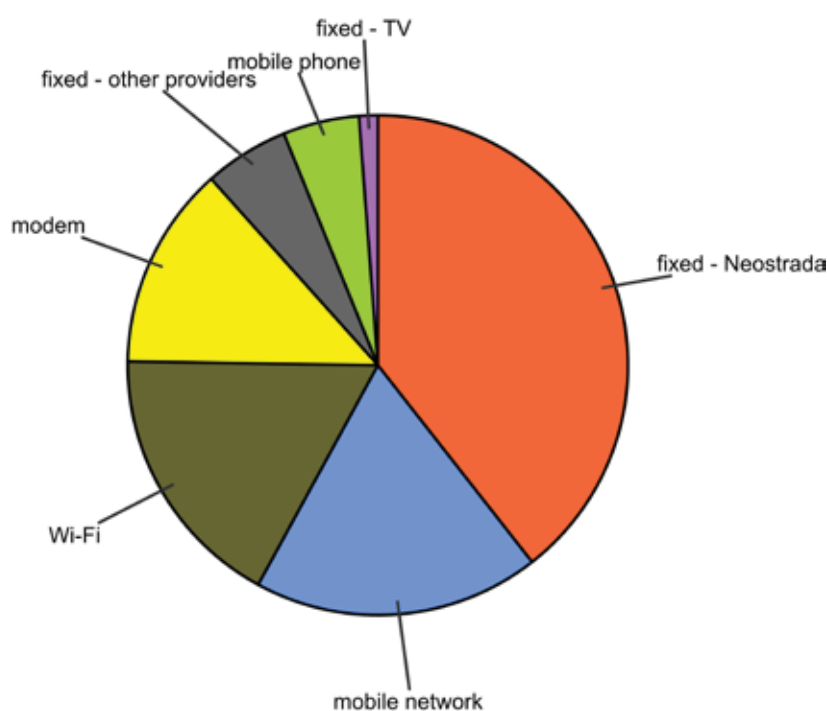


Figure 6. Type of Internet access used on a surveyed farm – Mazowieckie Voivodeship

Source: Own materials. (Figs 6-8).

The respondents indicated that the main purpose of Internet use for them is obtaining information (83%). E-learning rated second, followed by professional (agricultural) aims, and entertainment. All four purposes can be characterized as passive forms of Internet use as the user only obtains information stored in the Internet bulletins. On the other hand, the more active forms of Internet use, like contact with others, e-shopping, e-banking, making arrangements, dealing with administrative matters

⁵ *Neostrada* is a service based on ADSL technology and standard requesting using compatible modem for Internet access. It is the most popular DSL service in Poland. This service allows fixed Internet access only over analog phone line.

(requiring interaction on the part of the user), are definitely less popular. The most common activity done by farmers on the Web is searching for information on new technologies and means of production (51%), opportunities to become subsidized by the EU (46%), possibilities of finding markets for their products (27%), possibilities of the purchase of farming equipment or general browsing of websites with agricultural topics (38%). A small percentage of farmers choose an active form of Internet use (Fig. 7). Every second farmer searches for information on new technologies and means of production but only every fourth farmer is interested in how to purchase these machines and materials, and only every eighth one finally purchases them over the Internet. Similarly, every sixth farmer who is looking for information concerning the possibilities of finding markets for his products finally accomplishes such a transaction on the Internet. Slightly over 2% of farmers advertise their products on the Internet. Few farmers participate in e-training for farmers or join and take active part in forums connected with agriculture.

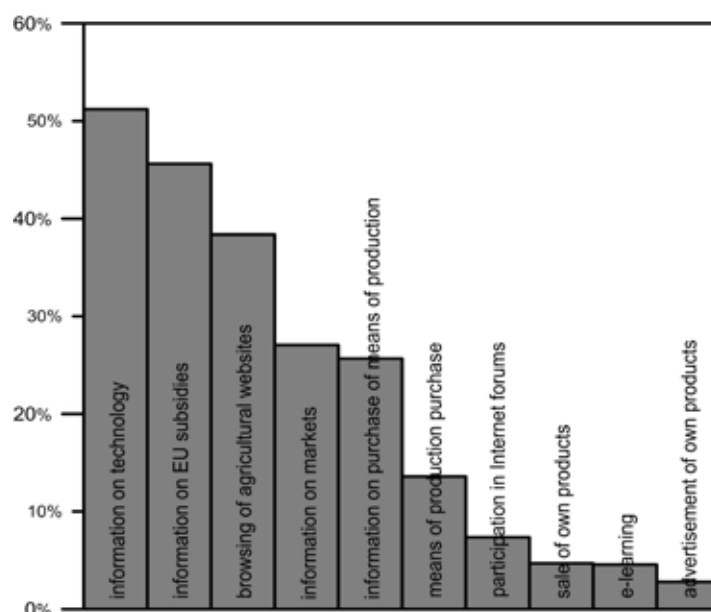


Figure 7. Main professional (agricultural) purposes for Internet utilization by surveyed farmers – Mazovian Voivodeship

It can be concluded that farmers are at the entry level of Internet skills. Such a matter of fact may be a result of two causes: firstly, a low level of IT knowledge and abilities is a reason for not taking advantage actively of the possibilities offered by Information and Communication Technologies by farmers. Secondly, farmers cannot notice the advantages arising from the application of more advanced Internet tools for

e-shopping or the sale of farm products, and as a result, they do not use them. Taking into consideration the experience of farmers from Western Europe and the high participation of the users of e-services (also e-commerce) in the biggest cities in Poland, one should assume that the former of the presented explanations is more probable.

An analysis of the level of ICT utilization confirms it's depending on the education level of the farming respondents (Fig. 8). The participation of farmers using the Internet increases significantly depending on their education level. 26% of the questioned farmers with primary education uses the Internet, 57% of respondents with vocational education, 71% of farmers with secondary education, and 81% with tertiary education. Similarly, the higher the level of education, the longer the period they have been using the computer and Internet.

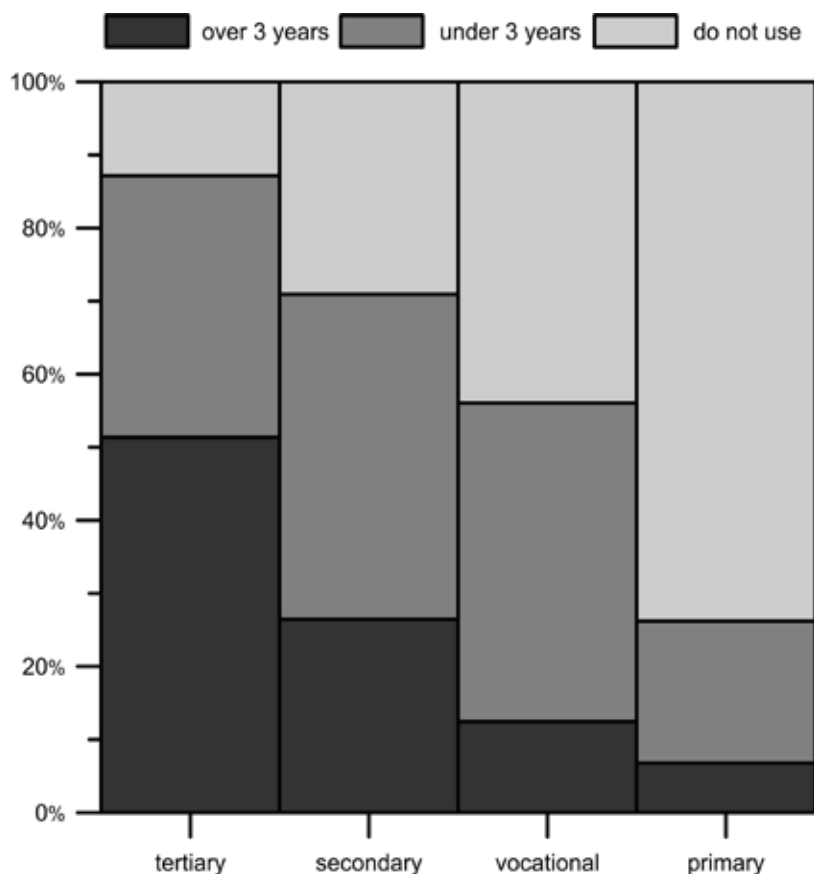


Figure 8. Time span of Internet utilization by surveyed farmers depending on level of education (in the year 2010)

Farmers with at least a secondary education used the Internet for professional purposes more often than the group only with a professional education. The most distinct is the disproportion in the active forms of Internet utilization – farmers holding at least a secondary level of education advertised their farm products and sold them over the Internet nearly three times more often than farmers with a lower level of education. Also, farmers with an agricultural education show a greater frequency in performing selected professional activities on the Internet in comparison with the group which does not have such an education. Poorly educated farmers have low possibilities of absorption of new technologies, new solutions or knowledge through the Internet. On the other hand, knowledge transfer with ICT use is more available for well-educated farmers. Taking into account their IT abilities, it may seem more effective (at least when tools are concerned). Assuming that nowadays ICT utilization in obtaining information is common and the fastest means, one should notice the polarization in agriculture in the use of new technologies. On one hand, well-educated farmers use the Internet most frequently obtaining various information (also in matters connected with agriculture), whereas poorly-educated farmers use this source of information less intensively.

Conclusions

ICT undoubtedly significantly influences the development possibilities in rural areas. The level of infrastructure accessibility will not be such a big issue with time as gradually Web accessibility will become more common in rural areas. It is evident in the light of the analysis related to the divide between rural areas and cities in the case of access to ICT. But it should be remembered that infrastructure (access) is only one aspect of a multifaceted phenomenon. As we pointed out, diffusion of ICT usage is deeply rooted into types of places of residence. On account of this, it should be expected that the socio-cultural aspect will differentiate ICT utilization levels in the future. Consolidation (or even an increase) in the existing differences can be expected as a disadvantage for rural areas. Out of the factors influencing ICT development and utilization level, socio-demographic factors such as education level, age, and social and cultural resources will have the greatest importance in the future.

To summarize our findings, we should look at the connections between the empirical results and the theoretical background. First of all, there is a strong tendency to use ICT as an important source of information for farmers. From the perspective of knowledge creation, we should emphasise that the Internet among Polish farmers plays rather a role of traditional information (a way to obtain a codified knowledge), rather than a basis for social interactions (a way to obtain an informal knowledge). This is related to the character of the knowledge types.

ICT is an essential factor of social and economic development. It is worth emphasizing that the advantages resulting from the access and use of ICT are not available for everyone. In the case of rural areas, accessibility is not as important as the possibility of using the resources of the World Wide Web. In this context, education, an understanding of the needs (and possibilities) connected with the use of ICT are essential. It should be remembered that even in the case of the equalization of ICT in rural and urban areas, the development potential will still be unevenly distributed. Especially because "telecommunications is only one piece in the more complex puzzle of rural development" [Malecki 2003, p. 212].

References

- 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, Vol. 24, pp. 404-413.
- Bilans otwarcia programów operacyjnych realizowanych w latach 2007-2013 – perspektywa regionalna*, 2008, MRR, Warsaw.
- Borc Z., 2000, *Infrastruktura terenów wiejskich*. Akademia Rolnicza, Wrocław.
- Chakraborty J., Bosman M. M., 2005, *Measuring the Digital Divide in the United States: Race, Income, and Personal Computer Ownership*. The Professional Geographer, Vol. 57, No. 3, pp. 395-410.
- Chinn M. D., Fairlie R. W., 2006, *ICT Use in the Developing World: an Analysis of Differences in Computer and Internet*. NBER Working Paper No. 12382, NBER, Cambridge.
- Chudy-Hyski D., 2004, *Analiza przestrzennego zróżnicowania infrastruktury technicznej w województwie śląskim*. Inżynieria Rolnicza, 2, pp. 103-111.
- Ciekanowski Z., Milewski L. (Eds.), 2009, *Rola infrastruktury w społeczno-ekonomicznym rozwoju Mazowsza*. Wyższa Szkoła Zarządzania i Prawa, Warsaw.
- Czapiewski K., Kulikowski R., Bański J., Bednarek-Szczepańska M., Mazur M., Ferenc M., 2012, *Wykorzystanie ICT w rolnictwie Mazowsza. Ujęcie przestrzenne*. Studia Obszarów Wiejskich, 30, PTG, IGiPZ PAN, Warsaw.
- Dolata M., 2005, *Stan i kierunki rozwoju infrastruktury gospodarczej obszarów wiejskich Wielkopolski*. Akademia Rolnicza, Poznań.
- Floriańczyk Z., Czapiewski K., Stawicka E., 2007, *Rural Technology Transfer in Transition Economies in Poland*. Report for CEEC AGRI POLICY project, AgriPolicy.net.
- Forman C., Goldfarb A., Greenstein S., 2005, *Geographical Location and the Diffusion of Internet Technology*. Electronic Commerce Research and Applications, Vol. 4, pp. 1-13.
- Grubestic T. H., 2006, *A Spatial Taxonomy of Broadband Regions in the United States*. Information Economics and Policy, Vol. 18, No. 4, pp. 423-448.
- Grubestic T. H., Murray A. T., 2002, *Constructing the Divide: Spatial Disparities in Broadband Access*. Papers in Regional Science, Vol. 81, No. 2, pp. 197-221.
- Houzet S., 2007, *The Diffusion of ICT in France: Infrastructures, Services, and Uses*. GoeJournal, Vol. 68, pp. 5-17.

- Johnson T. G., 2001, *The Rural Economy in a New Century*. International Regional Science Review, Vol. 24, No. 1, pp. 21-37.
- Johnston J. H., Snider J. H., 2003, *Breaking the Chains: Unlicensed Spectrum as a Last-Mile Broadband Solution*. New America Foundation, Spectrum Series Working Paper, No.7.
- Kiiski S., Pohjola M., 2001, *Cross-country Diffusion of the Internet*. WIDER Discussion Paper, No. 2001/11.
- Kwan M., 2006, *Transport Geography in the Age of Mobile Communications*. Journal of Transport Geography, Vol. 14, pp. 384-385.
- Malecki E. J., 2003, *Digital Development in Rural Areas: Potentials and Pitfalls*. Journal of Rural Studies, Vol.19, pp. 201-214.
- Malecki E. J., Moriset B., 2008, *The Digital Economy. Business Organization, Production Processes, and Regional Development*. Routledge, Oxon.
- Park S. O., 2004, *Knowledge, Networks and Regional Development in the Periphery in the Internet Era*. Progress in Human Geography, Vol. 28, pp. 283-286.
- Perkins R., Neumayer E., 2010, *Is the Internet Really New After All? The Determinants of Telecommunications Diffusion in Historical Perspective*. The Professional Geographer, Vol. 63, pp. 55-72.
- Poncet P., Ripert B., 2007, *Fractured Space: a Geographical Reflection on the Digital Divide*. GeoJournal, Vol. 68, pp. 19-29.
- Puel G., Fernandez V., Fautrero V., 2007, *Alternative Technologies for Rural Areas – What about the ‘Alternative’ Dimension of Wi-Fi?*. GeoJournal, Vol. 64, pp. 41-53.
- Rennie J. J., 2007, *ICTs and Educational Benefits in Regional Development*, [in:] *Information and Communication Technologies for Economic and Regional Developments*, H. Rahman [Ed.]. Idea Group Publishing, London, pp. 1-21.
- Selwyn N., Facer K., 2007, *Beyond the Digital Divide. Rethinking Digital Inclusion for the 21st Century*. Futurelab, Bristol.
- Społeczeństwo informacyjne w Polsce. Wynik badań statystycznych z lat 2007-2011*, 2012, GUS, Warsaw.
- Warren M., 2007, *The Digital Vicious Cycle: Links between Social Disadvantage and Digital Exclusion in Rural Areas*. Telecommunications Policy, Vol. 31, pp. 374-388.
- Whitacre B. E., Mills B. F., 2007, *Infrastructure and the Rural-urban Divide in High-speed Residential Internet Access*. International Regional Science Review, Vol. 30, no. 3, pp. 249-273.