Adoption of ICT in agricultural management in the United Kingdom: the intra-rural digital divide

Uplatnění ITC v zemědělském managementu ve Velké Británii: intrarurální digitální předěl

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Abstract: The benefits arising from adoption of information and communication technology by farming businesses are explored, and the prospect of a digital divide appearing in the UK agricultural sector is discussed, drawing on results of research at the University of Plymouth. It is proposed that countries in Central and Eastern Europe will be subject to the same phenomenon, and that the potential disadvantage suffered by non-adopters of this technology will be sufficiently severe to justify both policy intervention and further research.

Key word: information and communication technology, digital devide, adoption and diffusion ICT, farm management, Great Britain

Abstrakt: Příspěvek se zabývá užitkem plynoucím z uplatnění informačních a komunikačních technologií v zemědělství. Na základě výzkumu Univerzity v Plymouthu je zde diskutováno vytváření tzv. digitálního předělu v zemědělském sektoru Velké Británie. Příspěvek se dále zabývá pravděpodobností vzniku téhož fenoménu v zemích střední a východní Evropy a potenciálními nevýhodami pro ty, kdo tyto technologie neuplatní, a jejich řešením jak v rámci ekonomické politiky, tak dalšího výzkumu.

Klíčová slova: informační a komunikační technologie, digitální předěl, uplatnění a rozšíření ITC, management zemědělství, Velká Británie

INTRODUCTION

The term 'information and communication technologies' (ICT) can be used to embrace a multitude of standalone media, including telephone, television, video, teletext, voice information systems and fax, as well as those requiring the use of a personal computer fitted with a modem. The latter can include direct dial-up services such as electronic banking, file exchange and closed information services. This article tends to concentrate on the more ubiquitous internet and its associated services, including electronic mail (email), electronic bulletin boards and the World-Wide Web (WWW).

LITERATURE REVIEW

The academic literature is full of studies of ICT in a rural context, ranging from enterprise management information systems, through personal computers and internet technology, to new processes such as 'e-commerce' and 'e-government' which rely on the new technology (for instance Gibbon and Warren 1992; Woodburn, Ortmann et al. 1994; Amponsah 1995; Ortmann and Stockil 1998; Kenny 1999; Premkumar and Roberts 1999; Rosskopf 1999; Taragola, van Lierde et al. 2001). But why is so much time and effort devoted to the adoption of ICT? Surely the computer, with its offshoots such as internet, is just another innovation in a long line of innovations? There exists a voluminous and distinguished literature on the diffusion and adoption of innovations, dominated by the work of the American Everett M. Rogers (Rogers 1995). Development of alternative models has been heavily influenced by work in agricultural development and extension (Röling 1987; van der Ploeg 1993; Jiggins and Baker 1995; Ison and Russell 2000). In this context, the intensity of study of ICT diffusion and adoption in recent years could be regarded as either perverse or trivial. What do we learn from this multitude of research that we could not have anticipated from previous work on adoption of new crop varieties, potato harvesters, or milking routines?

Although there is some truth in this challenge, it is possible to make a special case for ICT adoption. Firstly, the base technology is universal, rather than being specific to agriculture. This makes for an unparalleled complexity of influences and information sources: the farmer's child could be as effective a change agent as an extension worker, another farmer, or a trade journal. Secondly, adoption of the basic technology, the computer itself, rarely evolves incrementally from existing practices, as many farm production innovations do (such as the

improved crop variety or the more sophisticated potato harvester). It is more likely to involve a quantum leap, requiring radically different skills and even attitudes in the user. Connected with this is the idea of a 'chasm' between innovators/early adopters and the rest (Moore 1995). The theory here is that whereas in 'normal' diffusion the prime influence on the later adopters is the example of the early adopters – a peer influence rather than an exogenous influence – the characteristics of the two groups are so fundamentally different in ICT adoption that this link loses much of its efficacy. If true, this has implications for both the rate of diffusion, and the methods chosen to facilitate wider adoption. Thirdly, those forms of ICT which rely on communication with others (e.g. e-mail, bulletin boards, groupware) share with other interactive technologies the requirement for critical mass (Markus 1987; Rogers 1990). In other words, a communication technology only achieves its full potential when enough of those in the user's communication network also adopt the technology. The value to a business of having e-mail, for instance, is limited if none of its customers and suppliers themselves use email. In rural areas, where communities tend to be tight-knit, and communication by conventional methods very good, this can be a particular problem.

INTRINSIC AND INSTRUMENTAL BENEFITS

Thus the *process* of ICT diffusion and adoption has special characteristics which make it particularly interesting as an area of study. Another factor is the *potential benefit* arising from adoption: far greater than the average farm innovation, and offering the promise of faster, easier access to records and accounts; help with complex decisions through decision-support systems (Parker 1999; Cooke and Park 2001); faster (relatively) and cheaper (in running costs) communication with others; rapid access to a vast store of information through the WWW. Moreover, in addition to such *intrinsic* benefits, ICT has considerable *instrumental* value for other, related innovations. Within the boundaries of ICT itself, this can be seen in the 'nested' nature of the different technologies. Adopting the innovation of online trading, or 'e-commerce'(Wilson 2000), requires the adoption of internet technology, which in turn requires adoption of the personal computer (or possibly interactive televisions and wireless telephones in the future). This implies an adoption process of significant complexity for those wishing to engage (or being forced to engage) in e-commerce or electronic bureaucracy, but who have not previously identified sufficient intrinsic value in the use of a computer in their business management to warrant a purchase.

The motives for firms developing e-commerce, whether business-to-business (B2B) or business-to-customer (B2C) are various: as well as trying to increase market share, they include the potential for reducing transaction costs, cutting down on clerical staff, speeding response times, and making access to information easier and cheaper. Government departments, for instance the UK Department for Environment, Food and Rural Affair (DEFRA, formerly MAFF), are not immune to the attractions. They increasingly look to online completion of grant submissions, census returns and the like in order to make the task easier for both farmers and their own office staff ('e-government'). Publications are produced in downloadable electronic form instead of in paper format, allowing access to information which heretofore involved a trip to a specialist library. (MAFF 2000b; 2000a). Internet can provide opportunity to access to education and training at a distance, overcoming some of the problems of location and lack of time in family-run small businesses (Bryden, Fuller et al. 1996; Albrigo, Valiente *et al.* 1998; Cook 1998; Jones, Cain et al. 1998).

This instrumental role of ICT, coupled with the apparent complexity of its diffusion process, makes its adoption of considerable interest to researchers. It also makes the threat of its *non*-adoption one of greater public concern than most farm innovations. At the least, the non-adopter will be at a *relative* disadvantage, unable to access the additional knowledge and services, and losing opportunity to increase trade and cut costs. As time goes on, the non-adopter may increasingly be at an *absolute* disadvantage, losing what he or she has now: publications in hard copy; extension services using conventional communications; paper application forms, face-to-face or telephone-based trading.

That non-adopters will be increasingly disenfranchised, and their businesses disadvantaged, could be regarded as a problem of their own making, and for them to bear the consequences. If, however, there are factors that inhibit significant sectors of the farm business population from adopting ICT, there will be consequences for the competitiveness of those sectors, and consequently of the agricultural industry in general. If those sectors are geographically concentrated, there is a risk of creating pockets of relative and even absolute deprivation which could exacerbate existing trends in rural poverty. If the internet is the gateway to knowledge, and access to knowledge is one of the key factors in innovation in general (Feder and Slade 1984), the ability of an industry to adapt to increasingly turbulent economic circumstances could be compromised by a significant proportion of its members being off-line.

The word 'if' – starting each of the three preceding sentences – raises questions which are difficult to answer with any certainty given the present state of knowledge. Most work on ICT adoption in agriculture skates over the surface. We know little about the parameters of the adoption curve, since few studies have included the time dimension, and/or have given a fully comprehensive and representative picture of the whole range of agricultural businesses in any country (to a large extent because of the rapid pace of adoption). We know little about the true costs and benefits, either to individual businesses or to society as a whole: this in turn makes it impossible to quantify an appropriate target level of adoption for a

particular sector, as we cannot be sure of the point at which the marginal cost of stimulating innovation begins to exceed its marginal benefit. We know little about the complex web of influence that leads to adoption of PC, then internet, then 'e-business'. There is much scope for rigorous research here – though the rapidly-changing conditions will not make it easy. The one 'if' that we *can* address through existing research is that relating to sectoral and geographical concentration. Since 1995, research has been conducted by the University of Plymouth, using two contrasting areas in the United Kingdom in investigating the adoption of ICT by farmers.

THE UNIVERSITY OF PLYMOUTH STUDY: METHOD

Full details of the methodology are given in the project report (Warren 2000b), downloadable from http://sh.plym.ac.uk/LearningResources/Telematics.html. Telephone surveys were made of farmers in two contrasting areas of England – the far South West, dominated by small-scale pastoral farming, and the East of England, characterized by larger-scale arable production – in order to test the degree of awareness and use of electronic media. These surveys were conducted during 1996 and 1997, with 277 farmers being interviewed (81% of eligible contacts in the sample). Comparison with Ministry of Agriculture, Fisheries and Food (MAFF) data suggests that the survey samples fit closely in the East with respect to farm type, while in the South West sample dairying is slightly over-represented at the expense of mixed farms. In both regions the smaller categories of farms are under-represented: a known consequence of using classified telephone directories as the sampling frame (Errington 1985; Burton and Wilson 1999). This survey was repeated in December 1999 and January 2000 with the original 277 survey respondents, though usable responses were obtained from only 177. Tests suggest no significant difference between regions with respect to non-response, or to reason for non-response. While the surveys gave some insight into computer adoption, the very unfamiliarity of internet based media to many respondents made it difficult to test the potential for that adoption. The methodology therefore included a number of focus group sessions, incorporating some demonstration of internet technology. These groups, seven in all, were convened in the South West region only, in the Spring of 1996 and were used to provide qualitative depth to the interpretation of the original survey results. The methodology also involved the establishment of a one-year trial (1997–1998) within a farmers' potato production/marketing group in Devon, South West England. Of the 22 members of the group, eight agreed to be supplied with subsidised internet facilities (modems were supplied free of charge: members agreed to pay for the running costs of service provider fees and telephone charges for a minimum period of six months). Participants were involved in meetings which included elements of both training and research on their attitudes to ICT: at the end of the 12 months they were interviewed in depth in their workplace.

RESULTS

Some of the results of the surveys are summarised in Figures 1 to 5. Figure 1 gives some indication of the rate of growth in use of ICT such as personal computers (apparently slowing) and internet technologies (showing

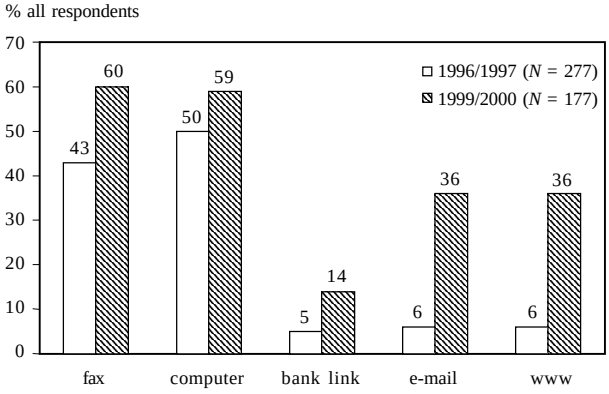

Figure 1. Use of ICT as management aids

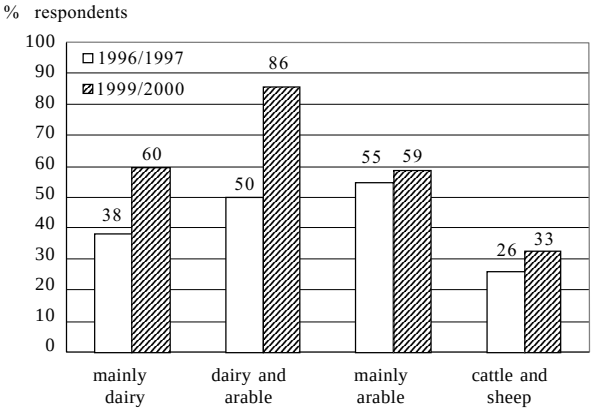

Figure 2. Use of PC as a management aid by type of farm (*N* = 177)

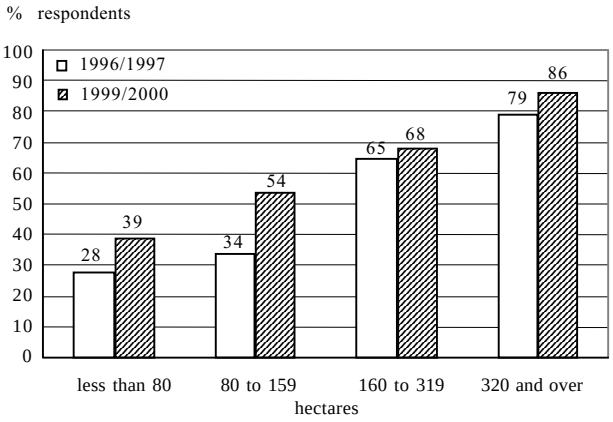

Figure 3. Use of PC as management aid by size of farm (*N* = 177)

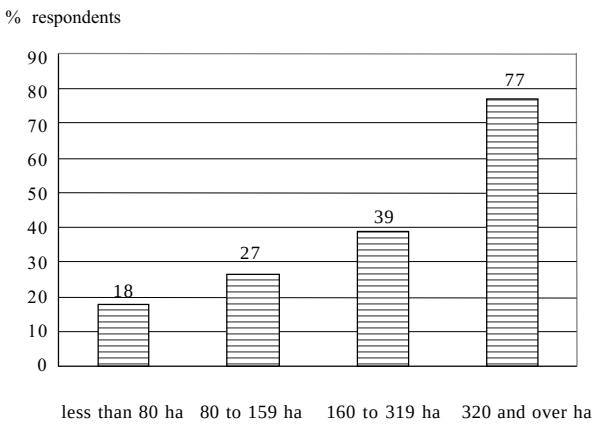

Figure 4. Use of e-mail/WWW in the business by size of farm (hectares, 1999/2000) ($N = 177$)

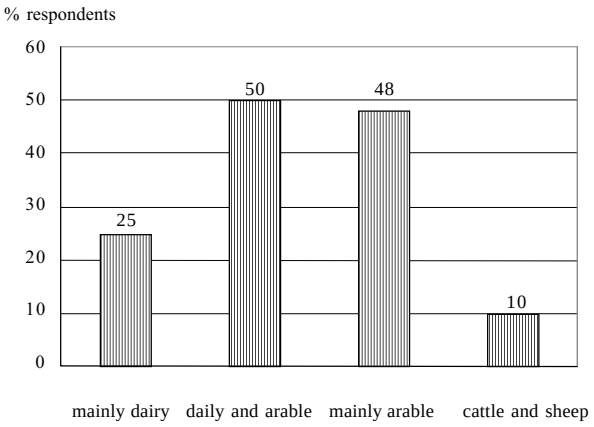

Figure 5. Use of e-mail/WWW in the business by type of farm (1999, $N = 177$)

substantial growth). For the argument in this article, however, the key results are those shown in Figures 2 to 5 (using only those respondents who participated in both the 1996/7 and the 1999/2000 surveys). Responses indicate highly significant differences in management use of personal computers (PC) between categories, with cattle and sheep farms, and smaller farms, lagging far behind arable-dominated, larger counterparts. Differences in internet use are even more extreme. Older farmers, and those with no education beyond secondary school, are likewise more likely to be laggards than innovators.

Such patterns are reflected (after discounting for sample bias and differences in question phrasing) in another, contemporary survey in England (Brown, Anaman et al. 2000). Given that the South West region of England has high concentrations of livestock farms, and its average farm size is lower than the country as a whole, this implies a geographical concentration of slow adopters. Still further concentration is possible within regions: within the South West of England there are substantial areas where the farming is almost entirely represented by cattle and sheep production and small farms. The same is true for many other regions of Europe. In the Plymouth survey at least, there was a highly significant association ($p < 0.01$) between low educational attainment of the business principal and both small farm size and beef/sheep production.

Typical barriers to adoption were identified through the surveys, focus groups, and group trial, and are echoed in other studies (e.g. (Brown, Anaman et al. 2000; Oftel 2000)). They include lack of funds and perceived cost; time demand; technological barriers (old hardware, poor rural telecommunications infrastructure); good alternative communication media (eg print, fax); lack of confidence and skills; off-putting medium. Perhaps most significant is that for farmers who work full-time on manual farm work (a high proportion in many areas of Europe) the pattern of use required by internet technologies does not fit the pattern of the working day (Warren 2000b). Staring at a computer screen is not an attractive proposition after a long and hard day's work outside.

DISCUSSION

The digital divide

These results, and more specifically the disparity in adoption between different sizes and types of farm, lend weight to our primary hypothesis: that rapid adoption by governments, corporations and public agencies of electronic communication as the default mechanism for knowledge transfer will result in sizeable pockets of relative, if not absolute, disadvantage, unless the barriers that are inhibiting adoption in these areas are identified and attacked. This phenomenon has been termed, in other contexts, the 'digital divide'

The most comprehensive studies of digital divides are probably those conducted by the US Department of Commerce studies (US Department of Commerce 1995; 1998; 2000). The 1995 and 1998 reports found that the most affected groups were rural poor, rural and city ethnic minorities; young households; and female-headed households. By 2000, rapid growth had taken place in household internet access, and some 'divides', such as the urban-rural gap, had narrowed. Some showed no decline or a slight increase, such as those related to people with disabilities; ethnic minorities; and single-parent families. The report suggests that people who lack access to internet-based tools are at a growing disadvantage, and its recommendations include improving public access in schools, libraries, etc.

Specific studies of similar scale are lacking in Europe, but the presence of digital divides (by virtue of income, and gender for instance) is reflected in smaller surveys such as the Pan-European Internet Monitor run by Pro-Active International (Dilenge 2000). It is furthermore implicit in publications such as the European Commission report '*e*Europe: An Information Society For All' (European Commission 2000) with its aim of 'bringing the benefits of the Information Society to all Europeans'. Various studies in the US and UK (Parker 2000) (Clark, Ilbery et al. 1995; Ilbery and Clark 1995; Berkeley, Clark et al. 1996; Grimes 2000) indicate differences in adoption rates be-

tween urban and rural households and/or businesses, suggesting an urban-rural divide. Hindman, in reporting on an empirical study in the US, measured an increasing difference between rural and metropolitan areas in an 'Information Technology Index' between 1995 and 1998. His analysis shows factors such as high age, low income, and low educational attainment, to be better explanatory variables than rural or urban location in itself (Hindman 2000). If such characteristics are themselves geographically concentrated, however, their effect will still be one of a digital divide by virtue of location. And if an urban-rural divide, why not an intra-rural divide?

Reducing the divide

Reducing the divide (i.e. eliminating the barriers to adoption listed above) means addressing a closely-woven web of technological, economic and human factors. For a technology enthusiast, it can be a lot easier to recognise and deal with technological limitations than the difficulties faced by the end-user (for instance lack of confidence and skills, particularly in the older and less well-educated, and reconciling the amount and pattern of time needed with the demands of working on the farm). Hence the tendency to focus on improving website design, providing web portals, creating facilities for completing 'e-forms' and obtaining online advice.

Dealing with the 'human factor' is not just a matter of laying on training courses for farmers, but implies developing real or virtual communities where the learning is participatory, and relates to the whole family (spouses and children often have more opportunity and incentive to learn than the business principal). It means providing access to knowledge in a way that is geared to the needs of the learners rather than those of bureaucracy and commerce, or what a well-meaning but distant web-designer considers appropriate. In short, it should learn from the lessons of the last twenty years' work in extension and development theory, focussing on participatory, 'bottom-up' approaches. That this can be done is shown by many projects under the LEADER programme and EU Structural Funds. In South West England, the SWARD (South West Agricultural and Rural Development) project links self-selected 'cells' of rural business people via a personal computer and an ISDN line with a central information hub dedicated to supporting their specified projects (Warren 2000a). The Agrinet project takes minibuses equipped with PCs to farmyards, pub carparks and village halls, using peer tutoring to introduce novices to the more useful elements of the internet, with the aim of drawing them into more intensive use later. Early indications are that both projects have had a significant impact on ICT adoption rates among the participants.

Table 1. Internet users (source EITO 2001)

	1998	2010	Compound annual growth rate (%)
W. Europe	36 362	195 325	40.0
E. Europe	3 399	38 920	63.2
World	160 058	738 055	35.8
US	78 845	183 985	18.5
UK	8 552	33 850	31.7

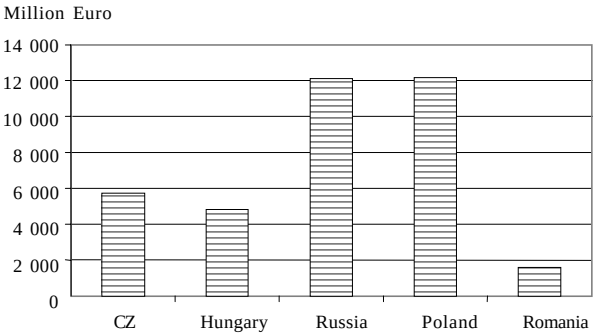

Figure 6. ICT spending, selected CEEC, 2000 (source EITO 2001)

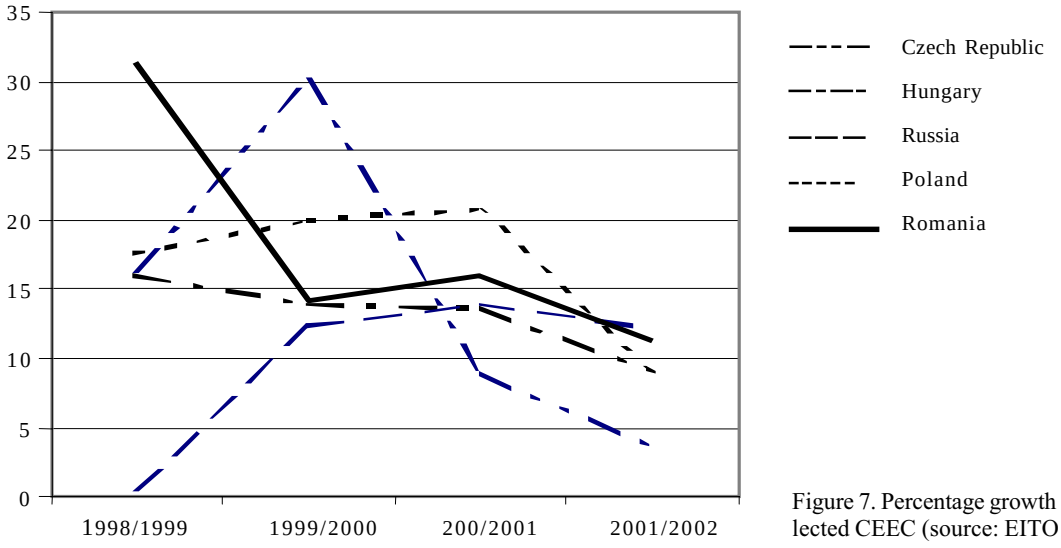

Figure 7. Percentage growth in ICT market, selected CEEC (source: EITO 2001)

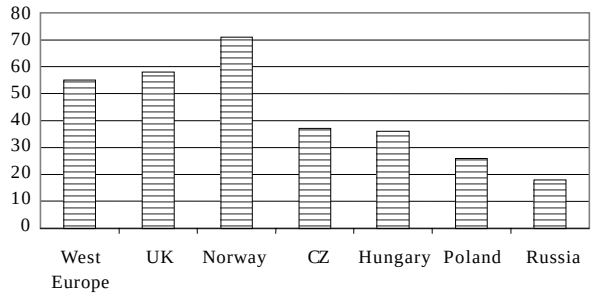

Figure 8. Main phone lines per 100 inhabitants (source EITO 2001)

Lessons for Central and Eastern Europe

The above discussion has focussed largely on a specific UK example, with some reference to experiences in Western Europe and the USA. Adoption of ICT in the Central and Eastern European Countries (CEEC) is less advanced, though growing rapidly (Table 1, Figures 6 and 7) (EITO 2001). Will the next few years see the emergence of an intra-rural digital divide in these countries?

To some extent, it will be inevitable, and it will be exacerbated by the 'divide' that is already growing between CEEC and the rest of Europe, and within the CEEC block. An analysis in February 2001 (Cohen 2001) noted that internet penetration rates in Slovenia, Estonia and the Czech Republic were significantly higher than the rest of the region, and correlated significantly with per capita income. Given that access to internet confers economic advantage, this suggests another scenario where the rich get richer and the poor get poorer. This then translates into further divides within countries. Given the often stark contrasts in economic prosperity between urban and rural populations even in relatively prosperous countries such as the Czech Republic, an urban-rural digital divide is unavoidable: where there are contrasts in agricultural prosperity within the rural sector, an intra-rural divide will surely follow. Contributing to this will be not only differences in disposable income, but also relative educational and skill levels, and access to telecommunication services. In many CEEC countries, access to telephone lines of any kind is a problem even in urban areas, let alone broad-band services (Stenberg and Bryden 1999) (see Figure 8). A 'profound language gap', given the dominance of English on the internet, adds further complication (Cohen 2001).

There is some hope. There are advantages in being a later adopter, in that one can learn from the experiences – and mistakes – of the innovators. There is, for instance the potential for 'leapfrogging' more developed economies through concentrating efforts on newer telecommunications technology (mobile and wireless) rather than struggling to provide a service through an ailing landline network. Services delivered through internet can avoid the worst mistakes made by early providers in Europe and the US, in designing a product that is genuinely easy to use and which is geared to the needs and abilities of normal human beings, rather than computer 'nerds'. Such developments do not come cheap, however. To realise the potential will need a degree of government commitment – for instance to infrastructure investment, whether terrestrial or satellite – and understanding of the needs of rural communities that has so far been little in evidence. Moreover, the 'people' issues noted in the UK study – acquisition of skills and confidence, life-styles and working practices – are equally relevant in the rural areas of the CEEC.

CONCLUSIONS

The intrinsic and instrumental importance of IT in agricultural management is such as to make it a significant factor in the future competitiveness of agriculture, and in exacerbating geographical and sectoral disparities in that competitiveness. Empirical study in the United Kingdom suggests the emergence of a 'digital divide' which will create pockets of relative or even absolute disadvantage within agricultural society. The empirical evidence is not yet complete or conclusive, however, and there remains a need for research which will test this conclusion more comprehensively, not just within one country, but across the wider Europe. When one excludes data from organisations with a vested interest in promoting ICT, there is very little rigorous research yet undertaken in this area, and yet reliable data is so crucial to effective policy decisions. Unfortunately, within national and European government research funding, there appears little scope for ICT research that is concerned with why people do not adopt, and the consequences, amid the overwhelming and relentless enthusiasm for promoting the new technologies.

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