



Government
Office for
Science

 **Foresight**

Foresight Project on Global Food and Farming Futures

Science review: SR16B

Education, training and extension for food producers

Professor Christopher Garforth, University of Reading

This review has been commissioned as part of the UK Government's Foresight Project on Global Food and Farming Futures. The views expressed do not represent the policy of any Government

Contents

1 Introduction	3
2 Information and knowledge needs	4
3 Education and extension	5
4 Food producers' access and response to new ideas and technology	5
5 Current trends in provision.....	7
6 Challenges and opportunities	8
7 Learning and innovation	10
8 Conclusion	11
References	12

SR16B Education, training and extension for food producers

1 Introduction

Information and knowledge are key resources for food producers: they are factors of production that can be considered as vital as land, labour and capital. Innovation and change are constrained, and efficiency and sustainability compromised, if farmers cannot access the information they need. Even in our information-rich age, empirical research confirms that farmers' responses to a changing physical, economic, social and policy environment are critically limited not only by financial constraints but also by lack of information on adaptation options (Deressa et al. 2009).

Historically, food producers have received education, training and advice from five main sources. *Informal communication* and exchange of knowledge has always been the most significant. This has often been associated with exchange or transfer of genetic material, both between continents (witness the spread of novel species from regions of origin across the world through trade and travellers, to become modern staples in the host region (Kiple and Ornelas 2000) and more locally (such as the introduction of new crop varieties by returning seasonal migrant labourers (Gill 2003). *Individual innovators* who feel they have something useful to share have always been proactive in giving advice and passing on their knowledge and are often seen as key points of reference by farmers with a pressing information need or problem (Subedi and Garforth 1996). *Non-state organisations*, which include farmers' associations, scientific societies, universities and colleges, were active in Europe in the 18th century and have become increasingly important in both developed and developing countries over the past 30 years. Indeed, many government initiatives in extension have built on successful initiatives among farmers or within the non-state sector. *Commercial enterprises* are significant sources of information, both where information and advice are associated with the provision of an input (seeds, fertiliser, pesticides) or service (artificial insemination, equipment sale or hire), and where producers hire consultants and firms that specialise in knowledge services. *The state*, concerned with increasing tax revenue or maintaining food security and, more recently, combating social, economic and environmental problems in rural areas, has been involved to varying degrees in the provision of information and advice for over 3,000 years. These five overlap and interact: state and non-state organisations sometimes operate as commercial enterprises, while informal communication frequently complements the activities of all formal sources.

The relative significance of these sources varies over time and space. Although provision in the 20th century was dominated by the state, this was a relatively recent phenomenon. In modern times, the state began to be a major player in the latter half of the 19th century in response to economic and social crises of various kinds often

related to crop failure from drought, pests or disease. It continued to step in at times of crisis, or as a response to perceived sluggish development in the agricultural and rural sector and associated concerns over national food security (Jones and Garforth 1997).

In much of the developed world (though less so in the USA than in Europe and Australasia), the public sector is now diminishing. This is evident in the decrease in public funding (from both local and central government) for the former county agricultural colleges in England, though many have successfully reinvented themselves as independent colleges responding to the modern market for further and adult education; in the privatisation of public sector extension providers in some developed countries; and in the retreat from universal public sector extension in many developing countries. The 21st century began with widespread acceptance that pluralism in the provision of information and advisory services to food producers is the way forward (Chipeta et al. 2008).

2 Information and knowledge needs

Our understanding of what knowledge, information and advice food producers need has matured from seeing the issue in simple terms as ‘transfer of technology’ and ‘diffusion of innovations’ (Rogers 1962, 2003) towards recognition of five main areas. The first is an understanding of the basic systems that sustain food production. While ‘modern’ science has a lot to contribute here, local knowledge of ecosystems, microclimates, soils, social systems and markets is also invaluable. As the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) acknowledged (McIntyre et al. 2009), blending the insights of different knowledge systems offers a good basis for coping with current and future challenges. Secondly, if producers are to make sound decisions about future production strategies, they need information on current and new technology, and its performance in real farm settings. Often in the past, the promotion of new practices and technology has been isolated from any analysis of economic performance from the perspective of the farm and the household, with producers urged to take up new ideas for which there is little economic justification. This leads to the third and fourth areas: business management advice, and information on markets, including an ability to investigate market opportunities. ‘Farming as a business’ has now become a recurring motif in many national agricultural strategies, for example within Uganda’s Plan for Modernization of Agriculture (Government of Uganda 2001), Ethiopia’s Agriculture Development-Led Industrialisation (Gebreselassie et al. 2009) and several national poverty reduction strategies as well as in the EU’s rural development policy (European Commission 2008). Information on markets includes knowledge of how producers can link to markets, with associated information on national and (for export commodities) international regulations and consumers’ market requirements, as well as more immediate information on the often volatile prices in local and regional markets. Information on domestic policy and regulation, and what producers can or need to do in order to comply, is the fifth area and has

become increasingly important for farmers in developed economies who have seen fundamental shifts in policy with regard to environmental regulation and the role of food production in sustainable rural development.

These needs range from knowledge that remains relatively stable over time, through information and advice that inform strategic choices, to information for immediate decisions. It is hardly surprising that food producers seek and use multiple sources of advice and information.

A challenge to those wanting to design a national comprehensive system is the diversity within each country's food production sector. Many farms are small enterprises, often contributing only a modest proportion of the income or livelihood of the households that operate them. Part-time farming is a well-established trend in sub-Saharan Africa (Ellis 2000), which affects information-seeking behaviour and motivation to develop the farm business. In an EU setting, very small farm enterprises, with a single operator, are a common feature of the more remote parts of Finland and have become a particular target for programmes to support rural economic and social development, for example through training courses aimed to develop entrepreneurial attitudes and skills (Mäkinen et al. 2007).

3 Education and extension

Well-educated food producers are a good starting point for a strong, adaptable food production sector. Jamison's research from the 1980s has shown a clear trade-off between investment in basic education and in advisory services (Jamison and Lau 1982). As the basic education level of the farming population rises, advisory service needs change. A more highly educated farming population needs a more diverse set of more specialised sources of information and advice, from which they can access and adapt knowledge for their own circumstances.

A challenge here is that school science and agriculture curricula in developing countries are usually based on global science, with little recognition of local knowledge, a situation which perpetuates negative attitudes towards knowledge based on local experience and observation. At the same time, formal education supports an aspirational shift away from agriculture, with school qualifications seen as a passport to a life away from the drudgery of farming. While it is a normal feature of economic development for the relative size of the workforce in primary production to fall, it is essential that those who choose to work in, or have little option but to remain in, the farming sector are well prepared through appropriate basic education that will enable them to adapt sensibly to the changing context in which they work.

4 Food producers' access and response to new ideas and technology

Globally, most research on farmers' access to information and advice on new technology points to 'other farmers' within the locality as their most proximate source, particularly at the point of decision on whether or not to make a change in

their food production system. This reality underpins the theory of 'diffusion of innovations' formalised by Everett Rogers (1962). In information-rich societies, other sources – agricultural biotechnology companies, mass media, professional advisers, input suppliers, buyers for supermarkets, publicly funded research institutes – are relevant sources of initial awareness and background information on novel technology or practices; while new communication technology such as the internet extends the range of farmers' search for experiences of their peers beyond their local network of face-to-face contacts. But the role of producers who make the first step in introducing and adapting new ideas in the wider processes of technology change in food production systems is significant in all contexts.

However, advisory systems that try to build on and accelerate the 'natural' diffusion of new ideas within a food production system have not always been particularly successful. The World Bank promoted the 'Training and Visit' system for over 20 years in Asia and Africa, before recognising its conceptual flaws and operational inefficiencies in the mid-1990s (Anderson and Feder 2004), mirroring on a large scale the fate of national pupil farmer and master farmer schemes of earlier colonial and post-independence states in Southern Africa. Food producers are now recognised as active seekers of advice, information and opportunities to learn how to improve their production systems and livelihoods rather than a set of traditional producers who need to be persuaded to take on board new ideas in the interests of the wider public. Systems that have recognised and responded to this search for good ideas have been more successful in accelerating the spread of new ideas and practices than those operating a supply driven model of telling farmers what they should be doing: the diffusion of farm management practices that encourage biodiversity on UK farms, through lead farmers identified and supported by the Farming and Wildlife Advisory Group, is one example among many (Cox et al. 1991).

At the same time, motivation for change varies between farmers: economic factors are important, but not necessarily the dominant drivers, particularly in situations of livelihood diversity and competing opportunities. A small but significant number of dairy farmers in New Zealand has moved to milking their cows once instead of twice a day: motives for this change range from shortages or high prices of feed to a lifestyle choice for the farm family and its hired labour force (Bewsell et al. 2008). Producers' motivation for moving into or staying in farming varies with their values and objectives and with their family and business circumstances: it cannot be reduced to a simple 'profit maximisation' construct. This is seen in all kinds of decisions, from responses to policy changes that affect the farm-level economics of food production (Garforth et al. 2006) to decisions of whether or not to take up new ideas that have been shown to offer an economic benefit (Rehman et al. 2007).

There is clear evidence that the way in which information and advice services are provided has an effect on equity of access to and use of services. Women, who in many systems are the main producers of food crops and managers of livestock, are particularly disadvantaged through, for example, the inbuilt bias of services

dominated by male professionals and their inability to participate in events that take place away from their home community because of childcare and other responsibilities (McIntyre et al. 2009). Culture may also make it difficult for them to seek advice from male extension agents. Other sources of inequity include group membership and poverty: where services are provided through existing farmer groups or cooperatives, non-members lose out; while elite capture of available services is well documented, for example in recent research on the National Agricultural Advisory Services in Uganda (Bukenya 2009).

5 Current trends in provision

Throughout the second half of the 20th century, it was widely assumed that the state should both fund and deliver services. It is now recognised that funding and delivery can be separated. There are two sets of arguments behind this separation. First, since the 1980s and the rise of neoliberal economics in policy-making, many have argued that delivery of services by government departments and agencies is inherently inefficient and that bringing in elements of market competition will enhance quality and efficiency. In developing countries, this argument was bolstered by the widespread perception that government extension services were overstuffed and lacked incentives to deliver advice in response to the expressed needs of food producers. Second, others have pointed to fundamental market failures in respect of information and advice (Beynon et al. 1998). Some types of information and delivery have strong public good characteristics limiting the potential of their being funded adequately by the private sector alone. At the same time extension services often deal with advice and information that is in the wider public interest (Röling 1988): farmers' production practices and land management decisions create externalities, both positive (including landscape and biodiversity benefits) and negative (pollution and health hazards). So there is a strong argument that the state should provide some funding for services where knowledge and information markets fail, but contract private sector service providers to do so (Garforth et al. 2003). This, though, should be done with caution because it is also now recognised that public funding can damage emerging commercial provision of knowledge and information services, for example public information centres providing services free of charge to users can undermine commercial internet cafes and other private sector services in developing countries.

These same arguments have led, in the first decade of the 21st century, to renewed enthusiasm for putting public funds into ensuring food producers have access to appropriate advice, information and knowledge services. In the EU, this is driven by concerns over food security, environmental externalities, rural economic development and social exclusion and most recently the levels of greenhouse gas (GHG) emissions from food production. Since the privatisation of the public sector Agricultural Development and Advisory Service (ADAS) in England and Wales in the late 1990s – a process that began in 1986 with ADAS being required to recoup part of their costs through fees from farmers and ended with its formal sale in 1997

(Garforth 2004) – increasing amounts of public funding have gone into advisory campaigns around the ‘stewardship’ agenda and subsidising access to business advice for farmers and other rural enterprises. In developing countries, after a sharp decline in international grants and loans to support extension services, donors are now helping to finance initiatives that build both demand and supply within pluralistic systems. New policy frameworks have been put in place at national (e.g. India: Raabe 2008) and international levels (Chipeta et al. 2008) to guide future investment.

Increasing pluralism is seen by some as a positive development that meets the diversity of demand from food producers and stimulates quality and efficiency through competition (Garforth et al. 2003). Others see it as creating new inefficiencies through duplication and confusion in a fragmented market where producers have insufficient information on which to base a choice of supplier and where significant gaps in provision remain (The Curry Report: Policy Commission on the Future of Farming and Food 2002). One specific concern particularly in developing countries is over quality assurance and the related issue of continuing professional development for service providers who are no longer employees of a government department or agency. This has led to proposals for registers of approved service providers and a professional code of conduct to ensure that farmers can be confident in the quality of services for which they are expected to pay at least part of the cost.

Growing pluralism and the move away from service delivery by the state raises questions over what role, if any, governments should play in relation to information and advisory services. Beyond providing funding to address market failure, the public interest and externalities, to what extent should they seek to ‘manage’ a pluralistic system? Possible roles include setting up a quality assurance and legal framework for private sector (commercial and not-for-profit) service provision to ensure food producers can hold service providers to account, and providing seed money to stimulate demand and overcome entry barriers to the service provision market.

6 Challenges and opportunities

The IAASTD summarised challenges that face food producers over the coming decades (McIntyre et al. 2009). These have significant implications for both demand and supply aspects of knowledge, information and advisory services.

Climate change will lead to acceleration of environmental change for many farmers, requiring in turn faster and more fundamental change in technology and adaptation of production systems. In developing countries, those systems facing decline in precipitation and increase in temperatures will need to become even more efficient in water use and switch to more drought-tolerant species and varieties. Developed economies are already recognising the need to reduce GHG emissions from agricultural production as part of their commitment to mitigation.

Food security concerns were stimulated by a spike in global food prices in 2007–08. While prices have subsequently fallen back, it is recognised that current demographic and socio-economic trends will increase demand for food faster than the rise in population and that, unless this demand is met by increasing supply, prices will rise and jeopardise access to food for poorer segments of the world's population. Increased production will have to come mainly from yield increases on existing productive land rather than expansion of production into new areas.

Livelihood concerns stem from the fact that food production is still a major source of income and security for many relatively poor and vulnerable households who face increasing competition in local markets from large-scale producers in their own country and from imported products. Larger scale producers are also better placed to take advantage of international trade opportunities because they can match the consistency in quality and quantity demands of purchasers, and cope with regulatory requirements more readily. New technology alone will not enable smaller producers to compete: institutional innovation is needed to facilitate aggregation, quality control and regulatory compliance.

Information and communication technologies (ICTs) represent a major opportunity for improving access and efficiency of knowledge and information services for food producers. The most significant current trend is the rapid spread of mobile telecommunication networks in rural areas in both developing and developed countries and the associated rise in the numbers of rural mobile phone users. This offers new opportunities for both one-way and interactive communication with and between food producers. There is interesting evidence of both demand- and supply-led service development here. Farmers are calling agricultural advisers for specific information or to arrange consultation, which represents a big reduction in transaction costs and consequent increase in efficiency. A wide range of organisations is using text messaging (SMS, short message service) to disseminate timely information on market prices. Little research has been done on the impact of these services, but one study in Niger found a significant reduction both in price fluctuations and in price variations between markets following the introduction of market price information services through mobile phones (Aker 2008). Another study found mobiles being used by farmers in India to access information in their efforts to increase farm productivity (Mittal et al. 2010). Public–private partnership models are being used by provincial governments and telecommunications companies in China to establish telephone information and advisory services for farmers (Yu et al. 2009). China Mobile, now the world's largest mobile phone carrier with over 530 million subscribers, has launched its own service for farmers, combining market information and technology advice (*The Guardian* 2010). Although the rural population lags behind urban areas in phone ownership, a familiar dimension of the digital divide across the globe, 37% of China's rural population already have mobile phones and the numbers continue to rise fast (*The Guardian* 2010).

Internet use is rising less quickly, and usage rates in rural areas lag a long way behind urban areas. In Europe, national and EU policy-makers see lack or slow speed of broadband in rural areas as a serious constraint on economic and social development, while small rural businesses including those in the food production sector are less likely to make use of the internet for accessing and exchanging information and for e-commerce than larger and urban businesses. In developing countries, lack of infrastructure, high cost of connections and the lack of locally relevant content restrict growth. However, convergence of technologies within new generations of mobile phones will make internet services increasingly accessible and we can expect demand to stimulate supply of internet products targeted at food producers.

Use of still and moving images in extension has a long history (Oakley and Garforth 1985). New generations of ICTs are increasing the scale and interactivity with which these can be used, from pest and disease diagnosis and surveillance through mobile phone images (Miller et al. 2009), to scaling up within and between regions the use of videos documenting local innovation processes (van Mele et al. 2010).

7 Learning and innovation

Information, education, knowledge and advice are essential ingredients for successful innovation among food producers, but they cannot do the job alone. Local success stories of innovation and new entrepreneurial activity have identified training in business skills, support to marketing, and strong partnerships between farmers' organisations and sources of new technology as key factors alongside information in farmers' building of successful agricultural enterprises (MATF 2007).

In this respect, extension theory is catching up with practice. Innovation is now less likely to be spoken of as something to be passed on to farmers, than as an autonomous process that can be nurtured and sustained through professional support (Leeuwis and van den Ban 2004). Innovation systems and innovation platforms are concepts that recognise the multiple factors that lead to farmers' developing, adapting and applying new ideas and the importance of linking all actors in the value chain to ensure producers can access appropriate information and advice for decision-making at all stages in the production process. Such concepts are central to new extension policies and strategies that are emerging across the world.

Similarly, while 'group approaches to extension' have been widely applied for many years through the application of theories drawn from social psychology and other disciplines, there is now a better understanding of why these can be so effective. Concepts of social learning, group development and solidarity, social capital, collective action and empowerment all help to explain and therefore to apply more effectively group approaches in the support of innovation among farmers.

'Discussion groups' have now become one of the main channels through which public sector advisers in Ireland interact with and support their farmer clients,

building on the New Zealand experience with Monitor Farms (Teagasc 2008). Two well-established applications of group approaches are Landcare and Farmer Field Schools.

Landcare began in Australia in the 1980s as an autonomous development of farmer groups concerned about local land degradation and now comprises over 4,000 groups that undertake local research, analysis and action co-funded by government, business and group members. Elements of social capital, including 'trust, norms, expectations of reciprocity, and linkages', are key to the success of Landcare groups (Sobels et al. 2001: 265).

Farmer Field Schools (FFS) originated in efforts to reduce rice farmers' dependence on chemicals to control insect and other pests in Indonesia, again in the 1980s. Supported by the Food and Agriculture Organization of the United Nations (FAO) and taken up by other international agencies and national organisations, FFS has become an international movement across all continents and a range of disciplines and enterprises. Although some have expressed scepticism about the cost-effectiveness of the FFS model (e.g. Feder et al. 2003), a review by van den Berg and Jiggins (2007) of available evaluations demonstrated that there are both immediate and longer-term benefits of farmers' participation in FFS, ranging from a reduction in pesticide use (representing savings for the farmers as well as an environmental benefit for the wider population) to increased capacity to make sound production decisions in the future. A key element of the FFS model is a process of local research and analysis by group members, supported by a trained facilitator, on the basis of which they decide on a course of action and then review the outcomes.

The FFS experience and other group approaches to supporting innovation highlight the need for appropriate knowledge and skills among those who facilitate these processes. Staff who were brought up in the 'technology transfer' tradition may need re-orientating towards a more participatory, interactive approach so that they can engage confidently in the co-production of knowledge with food producers and focus on the process of problem solving, learning and innovation. Recent research on the use of 'platforms' for social learning, collective action and negotiation between conflicting interests over management of natural resources shows a much richer role for professional 'change agents' than as the promoters of new practices to individual producers (Collins et al. 2009; Ison and Watson 2007; Ison et al. 2007).

8 Conclusion

It is clear that current and anticipated challenges facing food production systems will create new demands for education, training and advisory services, and linking these services to applied research will help to ensure that providers can access up-to-date knowledge. However, 20th century models dominated by public sector funding and delivery are no longer appropriate. Creating space for civil society and the private sector, with regulation and targeted public investment to overcome market failures, should be the main focus of state activity in the 21st century. We have sufficient

experience from the past 100 years to design systems that will support the supply of these services, while taking full advantage of rapid developments in ICT technology and infrastructure. The vitality of pioneering work in the non-government not-for-profit sector¹ continues to provide lessons and inspiration for the development of producer-focused support for innovation.

References

- Aker, J. 2008 *Does digital divide or provide? The impact of cell phones on grain markets in Niger. Working Paper 177*. Durham NC: BREAD (Bureau for Research and Economic Analysis of Development), Duke University, USA.
- Anderson, J., and Feder, G. 2004 Agricultural Extension: good intentions and hard realities. *The World Bank Research Observer*, **19**: 41–60.
- Bewsell, D., Clark, D. A. and Dalley, D. E. 2008 Understanding motivations to adopt once-a-day milking amongst New Zealand Dairy Farmers. *Journal of Agricultural Education and Extension*, **14**: 69–80.
- Beynon, J., Akroyd, S., Duncan, A. and Jones, S. 1998 *Financing the future: Options for agricultural research and extension in sub-Saharan Africa*. Oxford: Oxford Policy Management.
- Bukenya, C. 2009 *Meeting farmer demand? An assessment of extension reform in Uganda*. Wageningen, the Netherlands: Wageningen University.
- Chipeta, S., Christoplos, I. and Katz, E. 2008 *Common Framework on Market-Oriented Agricultural Advisory Services*. Neuchâtel, Switzerland: Neuchâtel Group.
- Collins, K., Colvin, J. and Ison, R. 2009 Building ‘learning catchments’ for integrated catchment managing: designing learning systems based on experiences in the UK and South Africa. *Water Science and Technology*, **59**(4): 687–693.
- Cox, G., Lowe, P. and Winter, M. 1991 *The voluntary principles in conservation: The Farming and Wildlife Advisory Group*. Chichester: Packard Publishing.
- Deressa, T.T., Hassan, R.M., Ringler, C., Alemu, T. and Yesuf, M. 2009 Determinants of farmers’ choice of adaptation methods to climate change in the Nile Basin of Ethiopia. *Global Environmental Change*, **19**: 248–255.
- Ellis, F. 2000 *Rural Livelihoods and Diversity in Developing Countries*. Oxford: Oxford University Press.
- European Commission. 2008 (18 April). Rural Development Policy 2007–2013. Retrieved 21 March 2010, from http://ec.europa.eu/agriculture/rurdev/index_en.htm
- Feder, G., Murgai, R. and Quizon, J. B. 2003 The acquisition and diffusion of knowledge: the case of pest management training in farmer field schools, Indonesia. *Journal of Agricultural Economics*, **55**: 221–243.
- Garforth, C. 2004 United Kingdom: ADAS and the privatization of advisory services in England and Wales. In *Extension Reform for Rural Development Volume 2. Privatization of Extension Systems Case Studies of International Initiatives* (eds. W. Rivera and G. Alex), pp. 56–65. Washington: The World Bank.

¹ The global ‘Promoting Local Innovation’ network (<http://www.prolinnova.net/>) and Linking Local Learners in East Africa (<http://www.linkinglearners.net/>) are two among many examples.

- Garforth, C., Angell, B., Archer, J. and Green, K. 2003 Fragmentation or creative diversity? Options in the provision of land management advisory services. *Land Use Policy*, **20**: 323–333.
- Garforth, C., Rehman, T., McKemey, K., Yates, C.M., Rana, R.B., Green, K., et al. 2006 *Research to Understand and Model the Behaviour and Motivations of Farmers in Responding to Policy Changes (England)*. Reading: School of Agriculture, Policy and Development, University of Reading.
- Gebreselassie, S., Amdissa Teshome, Devereux, S., Scoones, I. and Sharp, K. 2009 *Pathways for Ethiopian Agriculture: Options and Scenarios*. Brighton, UK: Future Agricultures, Institute of Development Studies.
- Gill, G. 2003 *Seasonal Labour Migration in Rural Nepal: A Preliminary Overview*. ODI Working Paper 218. London: Overseas Development Institute.
- Government of Uganda. 2001 *Plan for Modernization of Agriculture*. Kampala: Government of Uganda.
- The Guardian* 2010 'State owned China Mobile is world's biggest mobile phone operator', *The Guardian*, 11 January 2010. Available at <http://www.guardian.co.uk/business/2010/jan/11/china-mobile-telecomms> (accessed 31 March 2010).
- Ison, R. and Watson, D. 2007 Illuminating the possibilities for social learning in the management of Scotland's water. *Ecology and Society*, **12**(1), Article No. 21.
- Ison, R., Röling, N. and Watson, D. 2007 Challenges to science and society in the sustainable management and use of water: investigating the role of social learning. *Environmental Science & Policy*, **10**(6): 499–511.
- Jamison, D. and Lau, L. 1982 *Farmer Education and Farm Efficiency*. Baltimore, MD: Johns Hopkins University Press.
- Jones, G. E. and Garforth, C. 1997 The history, development and future of agricultural extension. In *Improving agricultural extension: a reference manual* (eds. B. E. Swanson, R. P. Bentz and A. J. Sofranko), pp. 3–12. Rome: FAO.
- Kiple, K. F. and Ornelas, K. C. (eds.) 2000 *The Cambridge World History of Food*. Cambridge, UK: Cambridge University Press.
- Leeuwis, C. and van den Ban, A. 2004 *Communication for Rural Innovation: Rethinking Agricultural Extension*. Oxford, UK: Blackwell.
- McIntyre, B. D., Herren, H. R., Wakhungu, J. and Watson, R.T. (eds.) 2009 *Agriculture at a Crossroads. International assessment of agricultural knowledge, science and technology for development (IAASTD): global report*. Washington: Island Press.
- Mäkinen, S., Lemetyinen, T., Matilainen, A. and Kattelus, P. 2007 *Detailed descriptions on best practice case studies related to ICT-supported training targeted to SMEs, micro-entrepreneurs, self-employed and unemployed people: Finland*. Helsinki: Ruralia Institute, University of Helsinki.
- MATF 2007 *Improving livelihoods through innovative partnerships*. Nairobi: Maendeleo Agricultural Technology Fund and Farm Africa.
- Miller, S.A., Beed, F.D. and Harmon, C.L. 2009 Plant Disease Diagnostic Capabilities and Networks. *Annual Review of Phytopathology*, **47**: 15–38.
- Mittal, S., Gandhi, S. and Tripathi, G. 2010 *Socio-Economic Impact of Mobile Phones on Indian Agriculture*. New Delhi: Indian Council for Research on International Economic Relations.
- Oakley, P. and Garforth, C. J. 1985 *Guide to Extension Training*. Rome: Food and Agriculture Organisation of the United Nations.

- Policy Commission on the Future of Farming and Food. 2002 *Farming and Food: a sustainable future*. London: Cabinet Office.
- Raabe, K. 2008 *Reforming the agricultural extension system in India*. Washington: International Food Policy Research Institute.
- Rehman, T., McKemey, K., Yates, C.M., Cooke, R.J., Garforth, C.J., Tranter, R.B., et al. 2007 Identifying and understanding factors influencing the uptake of new technologies on dairy farms in SW England using the theory of reasoned action. *Agricultural Systems*, **94**(2): 281–293.
- Rogers, E. 1962 *Diffusion of Innovations*. New York: Free Press.
- Rogers, E. 2003 *Diffusion of Innovations (5th edition)*. New York: Free Press.
- Röling, N. 1988 *Extension science: information systems in agricultural development*. Cambridge, UK: Cambridge University Press.
- Sobels, J., Curtis, A. and Lockie, S. 2001 The role of Landcare group networks in rural Australia: exploring the contribution of social capital. *Journal of Rural Studies*, **17**: 265–276.
- Subedi, A. and Garforth, C. 1996 Gender, information and communication networks: implications for extension. *European Journal of Agricultural Education and Extension*, **3**(2): 63–74.
- Teagasc 2008 *Supporting science-based innovation in agriculture and food: Teagasc statement of strategy 2008–2010*. Dublin: Teagasc, Agriculture and Rural Development Authority.
- van den Berg, H. and Jiggins, J. 2007 Investing in farmers – the impacts of Farmer Field Schools in relation to integrated pest management. *World Development*, **35**(4): 663–686.
- van Mele, P., Wanvoeke, J., Akakpo, C., Maiga Dacko, R., Ceesay, M., Béavogui, L., et al. 2010 Videos bridging Asia and Africa: overcoming cultural and institutional barriers in technology-mediated rural learning. *Journal of Agricultural Education and Extension*, **16**: 75–87.
- Yu, F., Garforth, C. J. and Daoliang, L. 2009 *Study on ICT for Rural Development in China and EU*. Beijing: EU-China Information Society Project.

All the reports and papers produced by the Foresight Project on Global Food and Farming Futures may be downloaded from the Foresight website (<http://www.bis.gov.uk/Foresight>).

First published January 2011.

The Government Office for Science.

© Crown copyright 2011

You may re-use this information (not including logos) free of charge in any format or medium, under the terms of the Open Government Licence. To view this licence, visit

<http://www.nationalarchives.gov.uk/doc/open-government-licence/> or write to the Information Policy Team, The National Archives, Kew, London TW9 4DU, or e-mail: psi@nationalarchives.gsi.gov.uk.

Any enquiries regarding this publication should be sent to:

Foresight, Government Office for Science
Department for Business, Innovation and Skills
1 Victoria Street
London SW1H 0ET

If you require this publication in an alternative format, email enquiries@bis.gsi.gov.uk, or call 020 7215 5000.

URN 11/562