

Identification and Relevance of E-readiness Assessment Tools for ICT Use in Agriculture

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Authors' contributions

This work was carried out in collaboration among all authors. Authors AP and DS designed the study. Author AP wrote the first draft of the study and collected the literature searches. Authors DS and RKD helped in final refinement of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Information and Communication Technology is an indispensable part of modern society. As with everything else, it has a profound impact on various activities in the agriculture sector like research, cyber-extension, marketing and transfer of technologies leading to its sustainable development. The concept of E-readiness provides a unified framework to evaluate ICT infrastructure and the ability of its consumers, businesses, and governments to use ICT to their benefit. E-readiness is a state of preparedness to comply and participate in a networked world, and its assessment is a novel concept that aims to understand the E-skill towards using ICT tools. Analysis of the past researches through journals, book chapters, Research Gate and relevant papers reveals various E-readiness assessment initiatives viz. E-commerce readiness assessment guide, Readiness for the networked world, E-readiness rankings, Ready Net Go, Network Readiness Index, Negotiating the digital divide. The paper aptly identifies and evaluates various tools available for assessing the E-readiness at macro and agricultural extension system. The kind of result tool will provide depends upon the researcher's goal and comprehensive definition of E-readiness adopted by the user. Hence, the paper helps in understanding the importance of measurement tools of E-readiness so that it can leverage ICT integration in agriculture development and improves the exchange of information between the stakeholders of agriculture by using limited resources wisely.

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1. INTRODUCTION

Effective communication between various stakeholders of the extension system is essential for increasing agricultural productivity [1], for which information is a critical input in realizing the goals of sustainable agriculture development [2]. Information and Communication Technology (ICT) is concerned with the technology used in acquiring, handling, processing, disseminating, and storing information [3,4]. ICT has a significant role in information dissemination and knowledge management in agriculture [5]. Information technology can improve the linkages between research, farmers, and extension systems. E-readiness of ICT users determines the skillful use of electronic resources and maximizes the benefits of ICT [6].

The concept of E-readiness is concerned with the rate of internet penetration among the communities for the use of ICT [7]. The concept of E-readiness originated as the result of an attempt to provide a unified framework to evaluate the extent and depth of the digital divide between the developed and developing countries during the latter part of 1990 [8]. The earlier efforts in conceptualizing E-readiness were undertaken by the Computer Systems Policy by defining E-readiness concerning a community [9]. Asian Pacific Economic Cooperation defined E-readiness as the degree to which an economy or community is prepared to participate in the digital world [10]. It was also defined by Zaied et al. [11] as the degree to which a community is prepared to participate in the information age i.e. the networked world. E-readiness was also defined in terms of Network Readiness Index [12]. Meaning of E-readiness was specified by Oreku [13] as the ability of a country to use ICTs to develop one's economy, to foster one's welfare and better participate in the global socio-economic value chains.

E-readiness is the sign of development for a country as it is concerned with the improvement of the national economy, human capital and government performances [14,15,16]. Mutula and Brakel [8] stated that E-readiness measured the level of infrastructure development, connectivity, internet access, applications and services, network speed, quality of network access, ICT policy, ICT training programs, human resources, and computer literacy. E-

readiness assessment is vital for judging the impact of ICT in the development of a country [17]. Many electronic resources viz. E-mail, E-journal, Facebook, WhatsApp, YouTube, Twitter, Online databases, Wikipedia etc. are available in modern society that helps to create a web of connection and information. With the continuous use of ICTs in the agricultural extension system, it has become necessary to assess the E-readiness of the agriculture system for understanding the status of its readiness for using ICT. Measurement of E-readiness in agriculture is also necessary to check the extent of ICT use, as it can contribute to agriculture development by providing better coordination of the information facilities developed in government and various institutions. It can improve and increase the exchange of information between the institutions and provide better means of access to the information. Further, it will fulfill the need of sensitized institutions to continuously update information on their activities. Thus, it will contribute to development of information, its sharing, and improvement of communication skills among workers and users.

2. FRAMEWORK OF E-READINESS ASSESSMENT

Measurement of E-readiness requires assessing the electronic connectivity, knowledge, attitude, and skills to use ICT, including confidence in using ICT. National Council of Applied Economic Research has given a framework [18] in the report to assess E-readiness forwarded the following factors:

- There are three crucial stakeholders to consider in the development and use of ICT-environment, readiness and usage.
- The degree of usage of ICT by (and hence the impact of ICT on) the three stakeholders i.e. individual, business, and government, is linked to their degree of readiness (or capability) to use and benefit from ICT.
- There is a regulatory environment for ICT, in which the stakeholders play out their respective roles.

ICT is revolutionizing information-seeking behaviour and has increased the use of E-resources, which indicates that the level of E-

readiness is increasing. Information and Communication technology in agriculture provides excellent help to extension personnel for addressing various issues in agriculture and increasing efficiency in the system. Several organizations, academia, and researchers who have suggested various indicators in the form of measuring tools for checking the level of E-readiness. Jirli et al. [19] categorises three levels of E-readiness assessment for ICT use:

- Individual E-readiness is the degree to which an individual can access and use the ICT tools and has the necessary skills to get him/her updated with the technological developments.
- Institutional E-readiness is the degree to which an institution possesses infrastructure, network accessibility, policy support, and affordability to acquire and effectively utilise ICTs. Also, it should possess a sufficient skilled workforce that can efficiently and effectively utilise the available ICT.
- National E-readiness is the degree to which a nation possesses the necessary infrastructure, internetwork accessibility, affordability, policy support, and the human resource with the necessary skills to acquire access and utilise ICTs.

3. E-READINESS ASSESSMENT AT MACRO LEVEL

- **E-Commerce Readiness Assessment Guide:** This readiness tool was created in the year 2000 to assess the E-readiness capability of the economies, cities, and communities in taking part in the digital economy. There are six indicators - Basic Infrastructure and Technology, Access to Necessary Services, Current Level and Type of Use of the Internet, Promotion and Facilitation Activities, Skill and Human Resources, and Positioning for the Digital Economy.
- **Readiness for the Networked World:** The readiness model for the Networked World was developed by the Centre for International Development of Harvard University and IBM in 2001. It is a generic model that assesses the E-readiness capability of the community in developing

countries. There are 19 different categories of indicators grouped into five sections that are Network Access, Networked Learning, Networked Society, Networked Economy, and Network Policy.

- **Ready? Net. Go!:** The framework designed By McConnell International and Worlds Information Technology and Services Alliance (WITSA) in the year 2001, was used to assess a country's E-readiness, or capacity to participate in the global digital economy. Five dimensions were used in this framework in evaluating the country's E-readiness capability: Connectivity, E-leadership, information Security, human capital, and E-business climate were used in determining the country's E-readiness level.
- **E-Readiness rankings:** This model was created in the year 2002 to measure a country's ICT infrastructure as well as the capability of governments, consumers, and businesses to obtain benefits by implementing IT. Created by the Economist Intelligence Unit, this model consists of more than 100 different qualitative and quantitative criteria, which can be grouped into six main categories viz. Connectivity and Technology Infrastructure, Business Environment, Social and Cultural Environment, Legal Environment, Government Policy, and Vision and Consumer and Business Adoption.
- **Network Readiness Index:** Designed by the Center for International Development (CID) at Harvard University and the World Economic Forum, this model is used to assess society/community(of any size) E-readiness, to measure technological capabilities according to following criteria which are an environment for IT, the readiness of the community and the actual use of ICT.
- **Negotiating the Digital Divide:** Center for International Development and Conflict Management (CIDCM), University of Maryland, developed this model to measure E-readiness of a nation. The framework measures four categories of information for each country: Background and history, key players in Internet development, ICT policy over time and negotiations between players in developing the country's Internet.

Table 1. Important e-readiness assessment parameters identified by the researchers

S. no	Assessment criteria	Aspect covered	Researchers
1.	Access to ICT	<ul style="list-style-type: none"> • Proportion of internet activities undertaken in households and by individuals with radio, television, fixed-line telephone, mobile, computer • Availability of electricity • Connectivity of internet • Affordability to internet • Easy availability of internet • Network speed • Quality of internet • Bandwidth • Capacity of internet • Availability of ICT tools and various applications 	[20,21,22,23,17,24,25,26,27,28,29,30,31,32,33,34,8,35,7]
2.	Infrastructure availability	Computers, internet subscribers, building, telecommunications infrastructure, mobile cellular subscriber, presence of public access points, broadband internet subscribers	[36,37,38,39,40,41,42,43,44,45,46,31,8,7]
3.	E-Governance	Regulation of government offices and employees with internet access and website, availability of technical infrastructure in every department, sharing of public administration services online	[9,40,22,17,24,47,48,31,44,7,49]
4.	Human capital	ICT skills, Vocational training, literacy, motivation, and willingness to learn ICT, computer/internet self-efficacy, technical competencies	[50,22,17,51,52,53,31,32,8,54,55,56]
5.	ICT policy	Telecommunications policy, trade policy, E-commerce taxation, consumer protection, privacy, information security, universal service provider, the content available online, consumer control	[57,58,38,22,59,51,60,31,55,61,62,49]
6.	E-business	E-education, E-commerce, E-government	[9,10,22,63,26,64,65]
7.	Demographic indicators	Age of the user, literacy rate, gender, income, culture, community, the population of the locality, employment status, location of internet use	[25,27,26,66,67,35,7,49]

Source: Modified after Hanafizadeh et al. (2009)

4. E-READINESS INDICES FOR AGRICULTURE

- ArunBabu [68] assessed E-readiness level of farmers using a tool developed for the study that covered indicators like E-access, E-learning, E-society, E-business, E-governance, E-willingness.

Table 2. Indicators to measure E-readiness of farmers as suggested by ArunBabu

Indicators	Aspect covered
E-access	Connectedness, internet availability, internet usage, and internet affordability
E-learning	E-literacy, E-experience, E-training
E-society	People and organisations online in society and ICT usage by the society members
E-business	Awareness and usage of online business
E-governance	Awareness and usage regarding E-governance program
E-willingness	Willingness to access ICT

- Agwu et al. [69] assessed the E-readiness level of extension personnel based on major indicators i.e. resources available, access to ICT, perceived quality of ICT, the importance of ICT, adherence to policies, and regulations.
- Purnomoi and Lee [70] used the E-LRS four-factor model in assessing the readiness of agricultural extension officers in Indonesia towards ICT program implementation. This model was based on farmer readiness, personal readiness, infrastructure readiness, and management readiness.
- Alavion and Allahyari [71] assessed the E-readiness of rural ICT offices for rice E-marketing using the following index.
 2. E-awareness: Related to the state of being aware of various ICT tools
 3. E-ownership: The number of ICT tools possessed by an individual
 4. E-accessibility: Defined as the availability of resources
 5. E-frequency of use: Measurement of the frequency of ICT usage
 6. E-willingness: Willingness of the individual to continue with ICT tools.
- Raksha et al. [72] developed an index to measure E-readiness of agricultural extension personnel of Andhra Pradesh, where extension personnel were selected from both public and private sectors. E-readiness was calculated by measuring three main domains of the index viz. technology accessibility, ability to use ICT and motivation towards ICT usage in agricultural extension. Technology accessibility was measured through two sub sections; availability and ability to use ICTs at individual level. Ability to use ICTs was measured under two sub heads; internet skills and software literacy skills. The results of the study showed that both private and public sector extension personnel have e-readiness towards use of ICTs. However, public sector extension personnel had less e-readiness as compared to private sector extension personnel which can be improved by proper training, awareness, policy matters and infrastructural development. The e-readiness index of the study was also adopted by Koyu et al. [73] to measure E-readiness of farmers towards the use of ICTs in agricultural extension system. This index has the following indicators:

Table 3. Alavion and Allahyari’s E-readiness index for E- marketing

Dimension	Sub-dimension
Socio-cultural	Adoption of ICT Internet Skill
Legal	E-commerce education
Backup services	Post services E-banking education Technical services

- Vankudothu and Padaria [5] developed a composite E-readiness index to assess E-readiness of farmers covering six indicators:
 1. E-skill: Defined as the confidence of farmers in trying and adopting various ICT based tools.

Table 4. E-readiness index for agricultural extension personnel

Indicators	Aspect covered
Access and Availability at an individual level	Ability to use the internet, computer, smartphone
Elementary ICT expertise	Capability to take part in the online program, ready to use computers, MS Windows
Internet expertise	Understanding of online technology, emails, chatting tools, file sharing, knowledge of social networking
Software literacy expertise	Know-how about file compression or zip, curiosity to learn more ICT courses
Motivational dynamics	Overcoming physical and psychological commotions. Motivation to learn without proper training, speed of ICTs.

Table 5. Comparison of selected E-readiness assessment tools for agriculture

Tool	Developer	Focus	Assessment criteria	Purpose	Strength
E-readiness index for farmers (2005)	ArunBabu	E-agriculture	E-access, E-learning, E-society, E-business, E-governance	Developed to measure the level of E-readiness of farmers	Easy to use and covers major aspects of accessing ICT
E-readiness index for extension personnel (2008)	Agwu et al.	E-agriculture	Resources available, access to ICT, perceived quality of ICT, the importance of ICT, policy, and regulations	measures the status of E-readiness of extension personnel	Provides an analysis of E-readiness at the infrastructural level and individual level
E-readiness index (2011)	Alavion and Allahyari	E-marketing	Socio-cultural, legal, backup services	Measures the level of E-marketing skills of farmers	Provides an analysis at both individual and infrastructural level
Composite E-readiness index (2014)	Vankudothu and Padaria	E-agriculture	E-skill, E-awareness, E-ownership, E-accessibility, E-frequency of use, E-willingness	Measures the level of E-readiness of farmers	Provides in-depth analysis of the status of an individual state of being E-ready
E-readiness of farmers (2018)	Koyu et al.	E-agriculture	Ability to use the internet, computer, smartphone, understanding of online technology, emails, chatting tools, file sharing, knowledge of social networking, speed of ICT.	Measures ability of farmers to utilize ICT at the infrastructural level	It is an in-depth analysis of identifying the status of E-readiness of farmers

Utilizing Information and Communication Technology effectively by stakeholders of the agricultural extension system for sustainable growth of agriculture will increase the level of E-readiness in the system. ICT is revolutionizing the information-seeking behavior and has increased the use of E-resources, which indicates that the level of E-readiness is increasing, and the agricultural extension system is becoming E-ready. The concept of E-readiness provides a unified framework to evaluate ICT infrastructure and the ability of its consumers, businesses, and governments to use ICT to their benefit. Measurement of E-readiness is vital because it helps to plan for ICT integration in the crucial development areas of the country by identifying the opportunities and constraints of ICT.

5. CONCLUSION

Since ICT is an indispensable part of modern information society and it has a profound impact on various agriculture sectors, especially research activities, cyber extension, marketing, and transfer of technologies towards its sustainable development. To better harness the full potential of ICT in developing countries, its users have to be E-ready. E-readiness is a state of preparedness to participate in a networked world, and its assessment is a novel concept that aims to understand the E-skill towards using ICT tools and has the potential to create linkages among stakeholders of agriculture. Analysis of the past researches reveals the various E-readiness assessment initiatives viz. E-commerce readiness assessment guide, Readiness for the networked world, E-readiness

rankings, Ready Net Go, Network Readiness Index, Negotiating the digital divide. These have been created and launched by the government, development agencies, research organizations, academia, business enterprises, and individuals to help developing countries in analyzing various aspects of ICT, society, and the economy. The main goal of this paper is to study various tools available for assessing the E-readiness focusing on the agriculture sector. From past studies, various parameters have been identified that are important in developing a framework for measuring E-readiness viz—access to ICT, infrastructure availability, human capital, ICT policy, E-business, demographic indicators. The vital point to conclude from various studies is that every tool may not be used in all situations and in turn depends upon the researcher's goal and comprehensive definition of E-readiness adopted by the user. There is always an underlying limitation of method and the kind of result it will provide. Henceforth the user of the tool should be thorough about the purpose of the study and the method of using the tool. Hence, the paper helps in understanding the importance of measurement tools of E-readiness so that it can leverage ICT integration in agriculture development and improving the exchange of information between the stakeholders of agriculture by using limited resources wisely.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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