Exploring the ICT Preferences of Personnel from Agricultural Extension Organizations in the Northeastern Region of India

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ABSTRACT

Although the public extension system in India is known to be one of the largest in the world, it still lacks coordinated effort in managing the links between research, extension, and farmers, resulting in non-uniform distribution of agricultural knowledge and technology. A vast majority of the population earning their livelihood through agriculture remain small and marginal farmers. Lack of computerized networks in agricultural extension departments, inadequate skilled manpower for disseminating agricultural information, and increasingly diverse needs of farmers across the Indian sub-continent pose hurdles in effective information transfer to the farming community. The use of information and communication technology (ICT) tools exerts a positive impact on agriculture worldwide by aiding speedy and effective dissemination of agricultural information. An increased awareness of modern ICT tools and their usage will contribute substantially to strengthening the extension network and expand its scope. This study explored the ICT preferences of personnel from agricultural extension organizations employed in public extension organizations in the north-eastern region of India. It found that electronic media is ranked below the conventional extension contact modes of print media and personalized contact regarding its use for disseminating agricultural information by the extension personnel. Demographic characteristics of the personnel from agricultural extension organizations such as sex, age, education, specialization, designation, and work experience were significantly associated with the pattern of ICT use specifically experience with ICT, frequency of use, training, and voluntary use.

Keywords: agricultural extension, extension personnel, information and communication technologies, ICT, northeastern India, electronic media

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INTRODUCTION

The agricultural sector provides employment to over 50 percent of the Indian population (MHA 2011), a vast majority of which are small and marginal farmers. Only by empowering them can the nation's agricultural productivity be augmented. Factors such as inadequate markets, credit access, unskilled labor, access to extension services, poor access to public goods (e.g., irrigation and electricity), and negative externalities from meager natural resources management are among those that impede the performance of small or marginal farmers (Dev 2012; Kameswari, Kishore, and Gupta 2011). Despite rapid progress in the availability of quality inputs and modern technologies, small and marginal farming population are unable to reap the benefits, largely due to a lag in receiving timely, reliable, and adequate information (Dev 2012).

Although the public extension system in India is known to be one of the largest in the world, it still lacks coordinated effort in managing the links between research, extension, and farmers, resulting in non-uniform distribution of agricultural knowledge and technology (Byerlee et al. 2008; Mukherjee and Maity 2015). The gap between the information rich and the information poor continues to grow and feed the impediments already plaguing the disadvantaged farmers, resulting in a lag in the extension contact of such farmers (Abura, Gikunda, and Nato 2013). Illiteracy, economic disparities, and digital divide further widen this information gap, posing hurdles to effective information transfer to the farming community (Malhan and Rao 2007).

Information and Communication Technology (ICT)

Information and communication technology (ICT) refers to all information and communication systems ranging from print media to electronic media such as radio, television, and digital media such as internet or World Wide Web (Flor and Hazelman 2004 as cited in Agwu and Chah 2007). In the context of this study, the term ICT refers to modern ICTs including but not limited to electronic/digital devices and the software used for procuring, storing, retrieving, and disseminating agricultural information. Employment of increasingly popular ICT tools, such as mobile phones, can enhance connectivity between extension personnel and farmers, which will enhance the quality of services delivered (Ferroni and Zhou 2012).

ICT emerges as a strong linking tool for two reasons. First, it is an effectual means for improving service provision as well as governance through the transparency and accountability it provides. Second, it encourages active participation of the service users, the farmers (Raabe 2008). The transfer of agricultural information to small and marginal farmers is challenging, especially in the remote regions of the Indian sub-continent. This is because of various factors such as diverse agro-ecology, culture, socioeconomic conditions, and political affiliations. Presently, the country's agricultural research infrastructure[1] follows three extension methods namely, individual contact methods (home and farm visits by extension functionaries); group contact methods (training and demonstration to a group of farmers through self-help groups, farmer forums, etc.); and mass contact methods (ICTs comprising of print media and e-media), which is considered the best due to time-effectiveness, cost-effectiveness, and real-time delivery of information (DAC and FW 2017).

ICT in Agricultural Extension in India

A comprehensive review of agricultural extension services in India reveals that majority of farmers lack access to reliable sources of information, limiting their productivity and income (Glendenning, Babu, and Asenso-Okyere 2010). A national survey found a very low coverage of government extension programs and public

[1] This is comprised of the Indian Council of Agricultural Research (ICAR) institutes, Central Agricultural Universities (CAUs) and state agricultural universities (SAUs).

[2] *Krishi vigyan kendras* means "farm science centers"; these are agricultural extension centers that provide vocational training to farmers and are usually associated with local agricultural universities.

extension services (NSSO 2005). A later survey found that public extension agencies, including *krishi vigyan kendras*[2] (KVK) and state agricultural universities, were able to transmit information to a meager 10 percent of farming households (NSSO 2014). Further, only 4.8 percent of small farmers consider extension services as their primary source of information (Adhiguru, Birthal, and Kumar 2009). This is a matter of great concern for future agricultural growth as 85.01 percent of farmers in India are small or marginal (DAC 2014). Thus, their response to public policies and government investments in agricultural research and development as well as public infrastructure will contribute substantially to determining the agricultural productivity of the country. Despite the development of agricultural technologies and innovation, information reaches only a fraction of small farmers. Hence, the role of agricultural extension officers as means of disseminating agricultural knowledge to farmers is crucial. However, the inadequate number of extension personnel and the weak link between research and extension prove to be deterrents in the flow of agricultural information from the lab to the field (Parikh, Patel, and Schwartzman 2007; Sicilima 2003).

India's extension personnel is a mere one-sixth of that of China, which shows the lack of adequate manpower in India's public extension field. Thus, most of the extension personnel are over-burdened with multiple roles to fulfill (Glendenning, Babu, and Asenso-Okyere 2010). To address this inherent complexity, it is imperative to ensure that the extension personnel employ ICT as the major tool in delivering extension services. Leveraging ICT for efficient agricultural extension services will not only enhance the outreach of the extension services, but also allow localization and customization of agricultural information being shared with farmers. A study on utilizing ICT in agricultural extension indicated a seven-fold increase in the adoption of improved agricultural practices when compared with traditional extension approaches. It enabled the transmission of requisite information to the farmers in a timely and reliable manner (DAC and FW 2017).

One of the generic issues identified in choosing agricultural extension models that developing countries should pursue is "scale and intensity". This includes factors such as geographical dispersion, illiteracy of smallholder farmers, and limited use of mass media (Feder, Willet, and Zijp 2001). The National Commission on Farmers noted that agricultural productivity in India is constrained by knowledge insufficiency, highlighting the use of ICTs in agricultural extension delivery for addressing information needs of farmers, thereby creating a demand-driven, knowledge-intensive, and diversified system to drive agricultural growth (Zijp 1994). The government's strategic plans on integrating ICT with agricultural information delivery has led to the emergence of e-services such as MKisan and Farmers' Portal and mobile apps such as Kisan Suvidha and Pusa Krishi. These aim at driving agricultural development through the use of ICT for timely, adequate, and reliable transmission of agricultural information (DAC and FW 2019). The existing strong institutional infrastructure in India can be leveraged in developing technologies for ICT extension in rural areas and in improving the information dissemination infrastructure through innovations. These include the "wireless in local loop" technology by the Indian Institute of Technology Chennai, which transformed the rural information delivery scenario (Gaur 2003).

Adoption of ICT for disseminating and communicating agricultural information is seen to have a positive impact on agriculture worldwide. ICTs have proven useful in facilitating agricultural extension and advisory services to reach family farmers (FAO 2017). ICTs help with speedy and effective dissemination of agricultural knowledge. Prior studies have pointed out that the enhancement of human capital is the best remedy for addressing the problem of low rate of ICT adoption and its effective implementation in agricultural knowledge dissemination. Additionally, it ensures the participation of farmers, which is a missing link in the ICT penetration process (Patil et al. 2008; Gelb et al. 2008).

In this regard, an investigation into the ICT preferences by extension professionals and

their adoption and use of modern ICTs will help identify the extent to which ICT is being used in their interaction with farmers.

ICT Usage by Agricultural Extension Personnel

The efforts to integrate ICT in agriculture have not been uniform or pervasive (Romero and Adolph 2009; Zhou 2010). When it comes to the use of ICT in agricultural and rural development, extension workers are important stakeholders and play a crucial role in extension development (Martin, Stewart, and Hillison 2001). The use of ICT in agricultural extension is largely delimited to a few aspects of the extension officer's job. Earlier studies show that ICT was used primarily for administrative tasks and in communicating with colleagues and other extension workers (Agwu and Chah 2007). In the delta state of Nigeria, agricultural extension agents said they do not commonly use ICTs for disseminating information to farmers (Ovwigho et al. 2009). Majority of women public extension staff in the same country used ICTs for gathering job related information to enhance professional efficiency (Agwu and Ogbonnah 2013). Caribbean extension officers, on the other hand, primarily used ICT to enhance personal knowledge and professional productivity. But when it came to communicating agricultural knowledge to farmers, they prefered traditional methods over modern technology (Strong et al. 2014). Extension officers in the Isfahan province of Iran used ICT for preparing and protecting files on agricultural and rural information, accessing latest agricultural news and information, and upgrading their professional competencies (Hashemi et al. 2014). As with the Caribbean extensionists, Sudanese agricultural extension functionaries still favor traditional ICTs agricultural information dissemination (e.g., television, radio, and mobile phone), compared to modern ICTs (e.g., computers, smart phones, and the World Wide Web) (Rahman and Fadol 2015). As with the Nigerian workers, majority of Bangladesh agricultural extension officers reported low level of utilization of ICTs for providing extension services (Islam et al. 2017).

Personal characteristics such as sex, age, education, and experience influence the adoption and use of ICT by extension personnel. Personal characteristics such as age, sex, education, and work experience were significantly associated with the level of use of ICTs by Nigerian extension functionaries (Adetumbi et al. 2013). Further, education and work experience significantly affected the level of ICT use by researchers and extension workers in Nasarawa state, Nigeria (Salau and Saingbe 2008).

OBJECTIVES OF THE STUDY

This study attempts to assess the pattern of ICT adoption and usage by personnel who are providing agricultural extension services to farmers in the northeastern region (NER) of India. It seeks to:

- identify the personal characteristics and indicators of ICT usage of the personnel from agricultural extension organizations (i.e., experience with ICT, frequency of ICT use, and training in ICT and voluntariness of ICT use);
- describe the personnel from agricultural extension organizations' pattern of ICT media use in agricultural information dissemination; and
- determine any association between personal characteristics of the extension personnel, such as sex, age, education, specialization, designation and work experience, and their pattern of ICT usage (i.e., experience with ICT, frequency of ICT use, training in ICT, and voluntary use of ICT).

METHODOLOGY

The study is descriptive in nature, based purely on primary data collected by administering an interview schedule to 395 personnel from agricultural extension organizations. These include extension officers, scientists, and faculty overing

eight northeastern states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura. Three types of public extension organizations were used as the sample frame. Research institutions such as the ICARs/ Regional Research Centers that are involved in agricultural research and extension, agricultural universities such as CAUs/SAUs that are involved in agricultural education and extension, and KVK that are involved in agricultural research and extension. The respondents were approached at their workplace and at venues of training programs conducted for extension personnel. For the purpose of the study, the extension officers, scientists, and faculty are categorized as extension personnel because they are all involved, as part of their duty, in extension work with farmers.

Survey method was used to collect demographic data and ICT use-related information from the respondents. The questionnaire contained multiple choice questions as well as open-ended questions to collect information regarding the personal characteristics of respondents; their use of ICT (i.e., experience, frequency of use, training, and voluntary use); and agricultural information dissemination modes they used. Frequency analysis, ranking of means, and chi-square analysis were performed using the software SPSS to analyze data, interpret results, and fulfill the objectives.

RESULTS OF THE STUDY

Demographic Characteristics of the Personnel from Agricultural Extension Organizations

Table 1 characterizes the personnel from agricultural extension organizations of NER. Most personnel are male (70.9%); and 43.5 percent are aged 31–50 years, followed by those older than 50 years (37.2%), and those younger than 30 (19.2%). A majority (63.5%) are post-graduates,

Table 1. Demographic characteristics of personnel from agricultural extension organizations

	Profile	Frequency	% of Sample Population
Sex	Male	280	70.9
	Female	115	29.1
	Total	**395**	**100.0**
Age	Less than 30	76	19.2
	31–50	172	43.5
	50 and above	147	37.2
	Total	**395**	**100.0**
Education	Post-graduate	144	36.5
	PhD	251	63.5
	Total	**395**	**100.0**
Designation	Programme Coordinator	19	4.8
	Subject Matter Specialist	203	51.4
	Programme Assistant	12	3.0
	Scientist	2	0.5
	Senior Scientist	3	0.8
	Principal Scientist	93	23.5
	Assistant Professor	16	4.1
	Associate Professor	13	3.3
	Professor	34	8.6
	Total	**395**	**100.0**
Work Experience	Less than 5	43	10.9
	5–15	179	45.3
	15 and above	173	43.8
	Total	**395**	**100.0**

and the remaining are PhD holders. This trend has been expected as the respondents belong to central/state research organizations, central/state agricultural universities, and KVK. The 395 respondents possessed 35 different specializations, so this personal characteristic has been omitted from Table 1 to maintain parsimony.

Of the nine job designations presented, majority of the respondents are subject matter specialists (51.4%), followed by principal scientists (23.5%). All the other respondents are distributed among the other designations, with senior scientists being the least represented (0.8%). Most of the respondents (45.32%) had a work experience of 5–15 years, closely followed by 43.80 percent of respondents with 15 or more years of experience, and the remaining 10.88 percent with less than five years of work experience. It implies that majority of the respondents have spent a considerable number of years in the profession and hence, would be well-acquainted with the intricacies of the agricultural extension activities.

Pattern of ICT Usage of Personnel from Agricultural Extension Organizations

Table 2 describes the indicators of ICT usage of the respondents. Only less than 10 percent of the respondents have less than three years of familiarity with ICT. Most have been using ICT for more than three years, and about 43 percent for more than six years.

A total of 282 respondents have indicated that they use ICT daily, 82 use ICT 4–5 times a week, and 31 respondents use it 2–3 times a week. This suggests that agricultural extension staff are quite familiar with using ICT, so integrating ICT with agricultural extension services may be accomplished without much hindrance. It must be considered, however, that the extension workers do not prefer technology media for disseminating agriculture-related information to farmers. Furthermore, because only 78 personnel have attended more than three training programs, quality training programs tailor-made for providing agricultural extension services may help boost the usage of ICT in agricultural extension services. As suggested in several studies (Hosseini,

Table 2. Pattern of ICT usage of personnel from agricultural extension organizations

ICT Usage		Frequency	% of Sample Population
Experience with ICT	Less than 3	30	7.6
	3–6	195	49.4
	6 and above	170	43.0
	Total	**395**	**100.0**
Frequency of ICT use	2–3 times a week	31	7.8
	4–5 times a week	82	20.8
	Daily	282	71.4
	Total	**395**	**100.0**
ICT training	Nil	131	33.2
	1–3	186	47.1
	More than 3	78	19.7
	Total	395	100.0
Voluntariness of ICT use	No	29	7.3
	Yes	366	92.7
	Total	**395**	**100.0**

Niknami, and Chizari 2009; Adetumbi Olaniyi, and Adewale 2013; Hashemi et al. 2014; Rahman and Fadol 2015; Okeke et al. 2015), the provision of on-the-job training to personnel engaged in providing extension services might contribute significantly to the utilization of ICT. That 366 personnel are using ICT voluntarily shows that agricultural extension personnel are willing to use ICT and may only need the right kind of motivation and environment to best utilize it at the workplace. The personal interest displayed by extension workers in using ICT can be leveraged for aligning ICT infrastructure for the delivery of extension services efficiently and effectively, thus expanding reach of delivery.

Further, younger extension workers have been using ICT regularly for a long period and have attended more training programs in ICT; PhD holders use ICT less frequently than post-graduates. It can be surmised from these results that older and more experienced extension personnel with rich educational qualifications are reluctant to use ICT. However, earlier studies (Salau and Saingbe 2008; Meera and Sain 2010; Adetumbi et al. 2013; Samansiri and Wanigasundera 2014) show that with increase in age and decrease in educational qualifications, the use of ICT in the workplace diminishes.

Preferred ICT Mode by Personnel from Agricultural Extension Organizations to Disseminate Information

Table 3 describes the preferred mode of disseminating agriculture-related information by the personnel from agricultural extension organizations. The respondents ranked four modes of communication namely, (1) print media, (2) electronic media, (3) partnering with external institutions, and (4) personalized contact, in the order of regularity with which they use these modes in delivering their extension duties. "1" indicated frequent use and "4" indicated least frequent use.

Majority of extension personnel still prefer traditional modes of communication over modern methods as seen from the first and second place rankings of print media and personalized contact (Table 3). Electronic media and external institutions ranked lower with means of 2.53 and 3.19, respectively. These results indicate that the usage of modernized methods of ICT and pluralistic approach of delivering extension services is still in the infancy stage in the NER. This result aligns with the findings of studies done in the Caribbean, Bangladesh, and Iran. Strong et al. (2014) reported that Caribbean extension officers preferred conventional approaches to communicate agriculture-related information to farmers, while Islam et al. (2017) reported low utilization of ICT by Bangladeshi agricultural extension officers in rendering extension services. Hashemi et al. (2014) stressed that Iranian extension officers used ICT merely for preparing and protecting files on agricultural and rural information, accessing latest agricultural news and information, and upgrading their professional competencies and not so much in disseminating agriculture-related information to farmers.

Lack of sufficient personnel from agricultural extension organizations in public extension

Table 3. Agricultural information dissemination mode used by personnel from agricultural extension organizations

Serial Number	Mode of Communication	Mean Score
1	Print media (e.g., newspapers, magazines, brochures, pamphlets, package of practices)	2.11
2	Electronic media (e.g., TV, radio, digital camera, projector, video recorder, telephone, personal computer, mobile phones, smart phones)	2.53
3	External institutions (e.g., governmental agencies, private institutions, farmer's cooperatives, NGOs)	3.19
4	Personalized contact (e.g., farm visit, face-to-face meetings)	2.17

is a well-known concern in India (Tiwari 2008; Chandragowda 2011; Rasheed 2012; Bhattacharyya et al. 2018) as well as in the NER (Saravanan 2010; 2012). Nevertheless, it is imperative to popularize the usage of modern ICT tools among extension personnel to disseminate agriculture-related information to farmers. This can boost the efficiency and effectiveness of delivering agricultural extension services by fewer personnel to more farmers, which would largely contribute to the boosting of productivity and profitability of farmers, thereby bettering their livelihood.

Prevalence of Significant Association Between Demographic Characteristics of Personnel their Pattern of ICT Usage

Table 4 shows the prevalence of significant association between personal characteristics of personnel from agricultural extension organizations and the indicators of ICT. Table 5 presents the strength of association between the significantly associated groups. Tables 6–9 display the association of groups based on the chi-square post hoc analysis.

Results of chi-square analysis indicate that sex is significantly associated with frequency of ICT use, although the strength of such association is small. Male personnel from agricultural extension organizations use ICT 4–5 times a week while their female counterparts use ICT daily.

Age is significantly associated with experience of ICT use, frequency of ICT use, and training in ICT, and strength of this association is medium, large, and small, respectively. Agricultural extension officers aged less than 35 years use ICT daily and have rich experience of using ICT for a period of six or more years. They have also attended more training programs in ICT (>3 programs). Those personnel aged 35–50 years also use ICT daily while those aged 50 years and above largely use ICT 2–3 times a week, closely followed by 4–5 times a week and have been using ICT for 3–6 years. This indicates that younger personnel are more involved in ICT use.

Education is significantly associated with frequency of ICT use and the strength of this association is medium. Postgraduate agricultural personnel are using ICT 2–3 times a week followed by 4–5 times a week.

Specialization is significantly associated with experience of ICT use, frequency of ICT usage, and ICT training programs attended, with the strength of association being large in all cases. The association table has been excluded from the paper to maintain parsimony. Personnel who specialize in agribusiness, agriculture, home science extension, and veterinary microbiology have been using ICT

Table 4. Association between demographic characteristics of personnel from agricultural extension organizations and their ICT usage characteristics

Variable	Experience with ICT Use		Frequency of ICT Use		Training in ICT		Voluntariness of ICT Use	
	Chi-squared value	P-value	Chi-squared value	P-value	Chi-squared value	P-value	Chi-squared value	P-value
Sex	3.118	0.210	10.520	0.005*	0.736	0.692	0.035	0.851
Age	73.074	0.000*	259.581	0.000*	14.957	0.005*	1.422	0.491
Education	5.603	0.061	43.801	0.000*	5.335	0.069	0.029	0.864
Specialization	129.334	0.000*	110.864	0.001*	120.076	0.000*	29.376	0.694
Designation	72.871	0.000*	180.237	0.000*	47.272	0.000*	3.090	0.929
Work Experience	48.555	0.000*	172.728	0.000*	6.637	0.156	1.842	0.398

Note: * denotes prevalence of significant association

Table 5. Strength of association between demographic characteristics of personnel from agricultural extension organizations and their patterns of ICT usage

Variable	Experience with ICT Use		Frequency of ICT Use		Training in ICT		Voluntariness of ICT Use	
	Cramer's Value	df	Cramer's Value	df	Cramer's Value	df	Cramer's Value	df
Sex	0.089	1	0.163*	1	0.098	1	0.051	1
Age	0.304*	2	0.573*	2	0.138*	2	0.091	2
Education	0.057	1	0.333*	1	0.073	1	0.063	1
Specialization	0.418*	34	0.343*	34	0.390*	34	0.093	34
Designation	0.288*	8	0.470*	8	0.226*	8	0.028	8
Work Experience	0.248*	2	0.468*	2	0.156	2	0.089	2

Note: * denotes prevalence of significant association

Table 6. Nature of association between experience with ICT use and demographic characteristics of personnel from agricultural extension organizations

Demographic Characteristics		Experience with ICT Use (Column % Age)			
		< 3 years	3–6 years	>6 years	Total
Sex	Male	70.00	74.90	66.50	70.90
	Female	30.00	25.10	33.50	29.10
Age	<35 years	0.00	7.20	36.50	19.20
	35–50 years	40.00	43.60	44.10	43.50
	>50 years	60.00	49.20	19.40	37.20
Education	Postgraduate	23.30	33.30	42.40	36.50
	PhD	76.70	66.70	57.60	63.50
Designation	Program Coordinator	0.00	1.50	9.40	4.80
	Subject Matter Specialist	46.70	46.70	57.60	51.40
	Program Assistant	10.00	3.10	1.80	3.00
	Scientist	0.00	0.50	0.60	0.50
	Senior Scientist	0.00	1.00	0.60	0.80
	Principal Scientist	43.30	32.80	9.40	23.50
	Assistant Professor	0.00	1.00	8.20	4.10
	Associate Professor	0.00	3.60	3.50	3.30
	Professor	0.00	9.70	8.80	8.60
Work Experience	<5 years	0.00	4.60	20.00	10.90
	5–15 years	36.70	39.50	53.50	45.30
	>15 years	63.30	55.90	26.50	43.80

Table 7. Nature of association between frequency of ICT use and demographic characteristics of personnel from agricultural extension organizations

Demographic Characteristics		Frequency of ICT Use (Column % Age)			
		2–3times/ week	4–5times/ week	Daily	Total
Sex	Male	67.70	85.40	67.00	70.90
	Female	32.30	14.60	33.00	29.10
Age	<35 years	0.00	0.00	27.00	19.20
	35–50 years	0.00	1.20	60.60	43.50
	>50 years	100.00	98.80	12.40	37.20
Education	Postgraduate	3.20	14.60	46.50	36.50
	PhD	96.80	85.40	53.50	63.50
Designation	Program Coordinator	0.00	2.40	6.00	4.80
	Subject Matter Specialist	6.50	20.70	65.20	51.40
	Program Assistant	0.00	0.00	4.30	3.00
	Scientist	0.00	0.00	0.70	0.50
	Senior Scientist	0.00	0.00	1.10	0.80
	Principal Scientist	74.20	58.50	7.80	23.50
	Assistant Professor	0.00	0.00	5.70	4.10
	Associate Professor	3.20	1.20	3.90	3.30
	Professor	16.10	17.10	5.30	8.60
Work Experience	<5 years	0.00	1.20	14.90	10.90
	5–15 years	0.00	4.90	62.10	45.30
	>15 years	100.00	93.90	23.00	43.80

for less than three years. On the other hand, those specialized in agricultural extension, biostatistics, plant breeding and genetics, plant biotechnology, and soil fertility have been using ICT for more than six years. Those whose specialize in entomology, fisheries, and horticulture are using ICT daily, while those specialized in agribusiness, agronomy, and animal nutrition are using ICT 4–5 times a week. Those specialized in agricultural economics and home science have not attended any training programs on ICT usage, while those specialized in agriculture have attended 1–3 training programs. Those who specialize in fisheries, fruit science, medicinal and aromatic plants, plant protection, plant virology, and technology extension have participated in more than three training programs on ICT.

Designation is significantly associated with the period of ICT usage, frequency of ICT usage, and ICT training programs attended, with the strength of association being medium, large, and medium, respectively. Program assistants have been using ICT for less than three years, while for principal scientists it is 3–6 year, and for subject matter experts it is six years. Subject matter specialists, program assistants, and assistant professors use ICT daily, while principal scientists and professors use ICT 4–5 times a week. Assistant professors have not attended any ICT training programs, while program coordinators have with three trainings.

The years of work experience is significantly associated with experience of ICT usage and frequency of ICT usage, with the strength of association being medium and large, respectively. Extension personnel with more than 15-year work experience have been using ICT for less than three years, followed by 3–6 years. Those with

Table 8. Nature of association between training in ICT use and demographic characteristics of personnel from agricultural extension organizations

Demographic Characteristics		Training in ICT Use (Column % Age)			
		Nil	1–3	>3	Total
Sex	Male	72.50	68.80	73.10	70.90
	Female	27.50	31.20	26.90	29.10
Age	<35 years	19.10	15.60	28.20	19.20
	35–50 years	39.70	42.50	52.60	43.50
	>50 years	41.20	41.90	19.20	37.20
Education	Postgraduate	32.10	34.90	47.40	36.50
	PhD	67.90	65.10	52.60	63.50
Designation	Program Coordinator	2.30	3.20	12.80	4.80
	Subject Matter Specialist	54.20	50.50	48.70	51.40
	Program Assistant	0.00	4.30	5.10	3.00
	Scientist	0.00	0.50	1.30	0.50
	Senior Scientist	0.00	1.10	1.30	0.80
	Principal Scientist	23.70	22.00	26.90	23.50
	Assistant Professor	8.40	2.70	0.00	4.10
	Associate Professor	3.10	4.80	0.00	3.30
	Professor	8.40	10.80	3.80	8.60
WorkExperience	<5 years	15.30	7.50	11.50	10.90
	5–15 years	40.50	46.20	51.30	45.30
	>15 years	44.30	46.20	37.20	43.80

Table 9. Nature of association between voluntariness of ICT use and demographic characteristics of personnel from agricultural extension organizations

Demographic Characteristics		Voluntariness of ICT Use (Column % Age)		
		No	Yes	Total
Sex	Male	72.40	70.80	70.90
	Female	27.60	29.20	29.10
Age	<35 years	27.60	18.60	19.20
	35–50 years	37.90	44.00	43.50
	>50 years	34.50	37.40	37.20
Education	Postgraduate	37.90	36.30	36.50
	PhD	62.10	63.70	63.50

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Table 9 continued

Demographic Characteristics		Voluntariness of ICT Use (Column % Age)		
		No	Yes	Total
Designation	Program Coordinator	3.40	4.90	4.80
	Subject Matter Specialist	58.60	50.80	51.40
	Program Assistant	3.40	3.00	3.00
	Scientist	0.00	0.50	0.50
	Senior Scientist	0.00	0.80	0.80
	Principal Scientist	20.70	23.80	23.50
	Assistant Professor	6.90	3.80	4.10
	Associate Professor	3.40	3.30	3.30
	Professor	3.40	9.00	8.60
Work Experience	<5 years	17.20	10.40	10.90
	5–15 years	48.30	45.10	45.30
	>15 years	34.50	44.50	43.80

less than five years' experience and 5–15 years of experience have been using ICT for more than six years. Extension personnel with more than 15 years of work experience have been using ICT for 2–3 times a week, followed by 4–5 times a week. On the other hand, personnel with less than five years and 5–15 years of experiences are using ICT daily. As with age, it can be inferred that personnel with lesser experience (assumed to be younger) have more inclination toward using ICT than the more experienced (older) ones.

These results echo findings from studies conducted by Salau and Saingbe (2008); Meera and Sain (2010); Adetumbi, Olaniyi, and Adewale (2013); and Samansiri and Wanigasundera (2014). These revealed significant association between sex, age, education, and work experience of the personnel from agricultural extension organizations and their ICT usage characteristics.

CONCLUSION

Due to the use of ICT, agriculturists need not come to the agricultural extension centers nor is it needed for the agricultural extension personnel to physically contact the agriculturists to disseminate agriculture-related information. The virtual space thus facilitated can be used to reach a larger number of agriculturists with a lesser number of extension personnel through ICT. Agriculturists can use ICT for interacting, connecting, communicating, and collaborating with co-agriculturists and the agricultural extension personnel. E-content can also be created, providing updated information about good agricultural practices and shared with a huge number of agriculturists, ultimately benefitting their livelihoods. With the extensive use of ICT, all stakeholders become acquainted with more digital apps. For instance, the YouTube app can be used to host videos pertaining to best agricultural practices and research findings, which will effectively reach more agriculturists. Hence, ICT will go a long way in revolutionizing agriculture in the backward NER India. It will make available the services of a few agricultural extension personnel to reach the maximum number of agriculturists. Equally important, an increasing awareness and use of modern ICTs to link extension personnel and farmers will help to strengthen the extension network and play a significant role in expanding its scope.

Although the findings of this study cannot be generalized beyond the study population, it provides an insight into the current usage pattern of ICT by the agricultural extension personnel

in NER India. It also reveals the pattern of technology utilization by agricultural extension personnel to educate clientele.

RECOMMENDATIONS

Short message service (better known as SMS) and WhatsApp can be best utilized by agriculturists to interact with their colleagues and extension personnel to gain useful information pertaining to all aspects of agriculture. This could cover the areas of availability of quality inputs up to marketing, which will immensely benefit them with the involvement of a minimum number of extension personnel.

The benefits of ICT in agriculture can be fully reaped only when there is an increased understanding, acceptance, and use of ICT in agricultural knowledge dissemination, especially by extension personnel in remote areas of the country such as the NER. The use of technology by extension officers will emerge as a vital requirement for their future work. Awareness and knowledge about ICT usage are imperative to the adoption and usage of ICTs by the study population. Thus, ICT training and skills development could be the focal point of integrating ICT into agricultural extension services. Regular on-the-job training regarding ICT usage may facilitate effective delivery of extension services. As personal characteristics impact the use of ICT, these factors should be considered when designing such training programs for the extension personnel. Programs and policies regarding agricultural extension services could aim at motivating extension personnel to use ICT for communicating with farmers by educating both groups about the benefits of ICT in agriculture.

Future studies can look into the constraints that limit the usage of ICT for agricultural information dissemination. Limited ICT usage for communicating with clientele may arise due to factors other than lack of knowledge about technology or lack of interest of extension personnel.

REFERENCES

Abura, Gilbert Odilla, Raphael Mwiti Gikunda, and Godffrey Nyongesa Nato. 2013. "Technical Knowledge and Information Gaps among Smallholder Farmers in the Production of Sugarcane in Kakamega County, Kenya." *International Journal of Agricultural Science, Research and Technology in Extension and Education Systems* 3(3): 199–207.

Adhiguru, P., Pratap Singh Birthal, and B. Ganesh Kumar. 2009. "Strengthening Pluralistic Agricultural Information Delivery Systems in India." *Agricultural Economics Research Review* 22(347-2016-16740): 71–80.

Adetumbi, Saheed Ige, Olumuyiwa Akin Olaniyi, and Jacob Adewale. 2013. "Assessment of Use of Selected Information Communication Technologies (ICTs) for Extension Service Delivery: Implication for Agricultural Development in Nigeria." *International Journal of Agricultural Management and Development* 3(2): 1–9.

Agwu, A. E. and Chah, J. M. 2007. "Access and Utilization of Modern Information Communication Technologies among Extension Personnel in Benue State of Nigeria." In *Proceedings of the 12th Annual Conference of the Agricultural Extension Society of Nigeria (AESON)*. Maiduguri, 4–7 July 2007.

Agwu, Agwu Ekwe, and Elizabeth Ene Ogbonnah. 2013. "Access and Use of Information Communication Technologies by Women Staff of Public Extension Service in the North Central Zone of Nigeria." *Agricultural Information Worldwide* 6: 18–24.

Agwu, Ekwe, and Nwokorie Uchechi. 2019. "Challenges and Opportunities for ICT Adoption in Agricultural Extension." *ICT Update* (92). https://hdl.handle.net/10568/105780

Bhattacharyya, Tapas, Vinayak Krishna Patil, S. G. Bhave, and Parag M. Haldankar. 2018. "E-Extension Services of SAUs in Indian Agriculture: Challenges and Management Strategies." *Advanced Agricultural Research & Technology Journal* 2(2): 119–25.

Byerlee, Derek, Alain De Janvry, Elisabeth Sadoulet, Robert Townsend, and Irina Klytchnikova. 2008. *World Development Report 2008: Agriculture for Development* no. 41455. The World Bank.

Chandragowda, M.J. 2011. "Extension Planning and Management in Agriculture and Allied Sector." Presentation to the Third Meeting of the Sub-Group on Extension Planning and Management, New Delhi, India, 16 July 2011. The Planning Commission.

Chapman, Robert, and Tom Slaymaker. 2002. "ICTs and Rural Development: Review of the Literature, Current Interventions and Opportunities for Action." *Working Paper* 192: Results of the ODI research presented in preliminary form for discussion and critical comment. London: Overseas Development Institute (ODI).

DAC (Department of Agriculture and Cooperation). 2014. "All India Report on Number and Area of Operational Holdings." *Ministry of Agriculture, Govt. of India, New Delhi, Agriculture Census 2010–11*. Accessed 30 June 2020. http://agcensus.nic.in/document/ac1011/reports/air2010-11complete.pdf

DAC and FW (Farmers Welfare). 2017. "Report of the Committee on Doubling Farmers' Income: Volume XI - Empowering the Farmers through Extension and Knowledge Dissemination." Department of Agriculture, Cooperation and Farmers' Welfare, Ministry of Agriculture & Farmers' Welfare. Accessed 30 June 2019. http://agricoop.gov.in/sites/default/files/DFI%20Volume%2011.pdf

———. 2019. "Annual Report 2018–19." Accessed 30 June 2019. http://agricoop.nic.in/sites/default/files/AR_2018-19_Final_for_Print.pdf

Dev, S. Mahendra. 2012. "Small Farmers in India: Challenges and Opportunities." Indira Gandhi Institute of Development Research, Mumbai. http://www.igidr.ac.in/pdf/publication/WP-2012-014.pdf

FAO (Food and Agriculture Organization of the United Nations). 2017. "ICTs and agricultural extension services." *e-agriculture*. Accessed 30 June 2019. http://www.fao.org/e-agriculture/blog/icts-and-agricultural-extension-services

Feder, G., A. Willett, and W. Zijp. 2001. "Generic Challenges and the Ingredients for Solutions. Knowledge Generation and Technical Change: Institutional Innovation in Agriculture." *The World Bank*. DOI:10.1007/978-1-4615-1499-2_15

Ferroni, Marco, and Yuan Zhou. 2012. "Achievements and challenges in agricultural extension in India." Global Journal of Emerging Market Economies 4, no. 3 (2012): 319–346.

Gaur, Ramesh C. 2003. "Rethinking the Indian digital divide: The present state of digitization in Indian management libraries." *The International Information & Library Review* 35(2–4): 189–203.

Gelb, E., A. Maru, J. Brodgen, E. Dodsworth, R. Samii, and V. Pesce. 2008. "Adoption of ICT Enabled Information Systems for Agricultural Development and Rural Viability." In ICT adoption workshop at the IAALD-AFITA-WCCA conference,1–26.

Glendenning, Claire J., Suresh Babu, and Kwadwo Asenso-Okyere. 2010. "Review of Agricultural Extension in India: Are Farmers' Information Needs Being Met?" No. 1048. International Food Policy Research Institute (IFPRI).

Hashemi, Haji, Zahra Rad, Pezeshki Rad, Gholamreza Mohammad, and Chizari Mohammad. 2014. "Factors Influencing the Use of and Attitude of Using Information and Communication Technologies (ICTs) in Agricultural Extension, a Study in the Isfahan Province of Iran." *International Journal of Agricultural Management and Development* 4(1): 1–10. DOI: 10.22004/ag.econ.210358

Hampson, Karen, and Blythe McKay. 2019. "The Enduring Power of Radio for Agricultural Extension in Africa." *ICT Update*, 5 September 2019. https://ictupdate.cta.int/en/article/the-enduring-power-of-radio-for-agricultural-extension-in-africa-sid0b44967f7-8e1d-4461-b4d7-3c8b23934ba2

Hosseini, Seyed Jamal F., Mehrdad Niknami, and Mohammad Chizari. 2009. "To Determine the Challenges in the Application of ICTs by the Agricultural Extension Service in Iran." *Journal of Agricultural Extension and Rural Development* 1(1): 27–30.

Islam, M.S., M.E. Haque, M.S.I. Afrad, H.M. Abdullah, and M.Z. Hoque. 2017. "Utilization of ICTs in Agricultural Extension Services of Bangladesh." *Asian Journal of Agricultural Extension, Economics & Sociology* 16(1): 1–11. DOI:10.9734/AJAEES/2017/31207

Kaaya, Janet. 1999. "Role of Information Technology in Agriculture." In *Proceedings of FoA conference*, Vol. 4, 315–328. Accessed 30 June 2019. http://www.tzonline.org/pdf/roleofinformatontechnologyinagriculture.pdf

Kameswari, Vyakaranam L.V., Devash Kishore, and Vinita Gupta. "ICTs for Agricultural Extension: A Study in the Indian Himalayan Region." *The Electronic Journal of Information Systems in Developing Countries* 48(1): 1–12.

Kariuki, Benson K. 2014. "Use of Modern Communication Technologies among Rural Personnel from Agricultural Extension Organisations to Disseminate Agricultural Information: Case Study of Machakos County." PhD diss., University of Nairobi.

Malhan, I.V., and Shivarama Rao. 2007. "Impact of Globalization and Emerging Information Communication Technologies on Agricultural Knowledge Transfer to Small Farmers in India." Presented at the World Library and Information Congress: 73rd IFLA General Conference and Council, 19-23 August 2007, Durban, South Africa..

Martin, Brenda L., Daisy L. Stewart, and John Hillison. 2001. "Computer Anxiety Levels of Virginia Extension Personnel." *Journal of Extension* 39(1): 1–11.

Meera, Shaik N., and Mangal Sain. 2010. "Critical Analysis of E-learning Opportunities and E-readiness in the Public Extension System: Empirical Evidence from Tamil Nadu." *Journal of Global Communication* 3(2): 11–18.

MHA (Ministry of Home Affairs). 2011. "Primary Census Abstracts, Registrar General of India, Government of India." *Census 2011*. Accessed 30 June 2019. http://www.censusindia.gov

Mukherjee, Anirban, and Aniruddha Maity. 2015. "Public-Private Partnership for Convergence of Extension Services in Indian Agriculture." *Current Science* 109(9): 1557-1563. DOI:10.18520/v109/i9/1557-1563

NSSO (National Sample Survey Organisation). 2014. "Key Indicators of Situation of Agricultural Households in India, 70th Round (January–December 2013)." Ministry of Statistics and Programme Implementation, New Delhi.

NSSO (National Sample Survey Organisation). 2005. "Situation Assessment Survey of Farmers: Access to Modern Technology for Farming, 59th round (January–December 2003)." *Report* No. 499(59/33/2). Ministry of Statistics and Programme Implementation, New Delhi.

Okeke, M.N., Hyacinth U. Nwalieji, and C.O. Uzuegbunam. 2015. "Emerging Role of Information Communication Technologies in Extension Service Delivery in Nigeria: A Review." *Journal of Agricultural Extension* 19(1): 128–141.

Ovwigho, B.O., P.A. Ifie, R.T. Ajobo, and E.I. Akor. 2009. "The Availability and Use of Information Communication Technologies by Extension Agents in Delta Agricultural Development Project, Delta State Nigeria." *Journal of Human Ecology* 27(3): 185–188.

Parikh, Tapan S., Neil Patel, and Yael Schwartzman. 2007. "A Survey of Information Systems Reaching Small Producers in Global Agricultural Value Chains." In *2007 International Conference on Information and Communication Technologies and Development*, 1–11. Institute of Electrical and Electronics Engineers.

Patil, V.C., Ehud Gelb, Ajit Maru, N.T. Yadaraju, M. Moni, Harekrishna Misra, and S. Ninomiya. 2008. "Adoption of Information and Communication Technology (ICT) for Agriculture: An Indian Case Study." In *IAALD AFITA WCCA 2008: World Conference on Agricultural Information and IT.*

Raabe, K. 2008. "Reforming the Agricultural Extension System in India: What Do We Know About What Works Where and Why?" *IFPRI Discussion Paper* 775. IFPRI, Washington, DC.

Rahman, Ahmed M. Abdel, and Isam O. Fadol. 2015. "Use of ICTs in Agricultural Extension Services, Gezira State, Sudan." *International Journal of Agriculture Innovations and Research* 4(3): 518–522.

Rasheed, Sulaiman V. 2012. "Agricultural Extension in India: Current Status and Ways Forward." Background Paper for the Roundtable Consultation on Agricultural Extension, Beijing.

Romero, A. F., and M. Adolph. 2009. "ICTs and Food Security: ITU-T Technology Watch Report: International Telecommunication Union."

Salau, E.S., and N.D. Saingbe. 2008. "Access and Utilization of Information and Communication Technologies (ICTs) among Agricultural Researchers and Extension Workers in Selected Institutions in Nasarawa State of Nigeria." *Production Technology and Agriculture Journal* 4(2): 1–11.

Samansiri, B.A.D., and W.A.D.P. Wanigasundera. 2014. "Use of Information and Communication Technology (ICT) by Extension Officers of the Tea Small Holdings Development Authority of Sri Lanka." *Tropical Agricultural Research* 25(4): 360–375.

Sanga, Camilius Aloyce, Siza D. Tumbo, and Malongo RS Mlozi. 2014. "System Design and ICT Adoption in Agricultural Extension Services Delivery in Tanzania." In *Technology Development and Platform Enhancements for Successful Global E-government Design* 282–306. IGI Global.

Saravanan, R. (Ed.) 2010. *ICTs for Agricultural Extension: Global Experiments, Innovations and Experiences.* New India Publishing.

———. 2012. "E-Agriculture Prototype for Knowledge Facilitation among Tribal Farmers of North-East India: Innovations, Impact and Lessons." *The Journal of Agricultural Education and Extension* 19(2): 113–131. https://doi.org/10.1080/1389224X.2012.718247

Saravanan, R., C. Kathiresan, Narmi Darang, T. Indra Devi, Supriya Devi, and Lizamoni Chungkurang. 2010. "7 e-Village for Agriculture and Rural Development: Integrating ICTs with Traditional Agricultural Extension Methods in North-East India." In R. Saravanan (Ed.), *Information and Communication Technology for Agriculture and Rural Development* (pp. 110–115). Imphal, Manipur: New India Publishing Agency.

Sicilima, N. 2003. "Strengthening the Linkage Among Researchers, Farmers and Extension as a Means towards Enhancing Adoption of Agricultural Technologies." In *Proceedings of the Second Collaborative Research Workshop on Food Security.* TARP II-SUA.

Strong, Robert, Wayne Ganpat, Amy Harder, Travis L. Irby, and James R. Lindner. 2014. "Exploring the Use of Information Communication Technologies by Selected Caribbean Extension Officers." *The Journal of Agricultural Education and Extension* 20(5): 485–495.

Tiwari, R.K. 2008. "National Agricultural Extension System - Strategy for Revitalization." Paper presented at the National Conference on Agriculture, Kharif Campaign, New Delhi, India, 29 February 2008.

Zijp, Willem. 1994. *Improving the Transfer and Use of Agricultural Information: A Guide to Information Technology.* The World Bank.

Zhou, Yuan. 2010. "Smallholder Agriculture, Sustainability and the Syngenta Foundation." Syngenta Foundation for Sustainable Agriculture, 1–15. Accessed 30 June 2019. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.187.3595&rep=rep1&type=pdf