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ICTs Adoption for Accessing Agricultural Information: Evidence from Indian Agriculture§

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Abstract

This paper has addressed two research questions, viz. do farm households use ICTs for accessing agriculture-related information? and what are the factors that influence households to choose between ICT and non-ICT sources of information? Limiting the ICTs to widely available sources, viz. radio, television and newspapers, the study has found that only 11.4 per cent of the farm households use at least one source of these ICTs, to access agricultural information. Using NSSO data, the paper has found radio to be a more important source of agricultural information compared to television and newspapers. In terms of farm-size, the large farmers use ICTs more to access agricultural information. The probability of using ICTs to access agricultural information increases with educational level of the household-head and formal training of a member of household engaged in agriculture. The study has emphasized on capacity building of farmers to use ICTs for agricultural development in the country.

Key words: Farm households, agricultural information, ICTs adoption

JEL Classification: Q12, Q16, O33

Introduction

Information and communication technologies play a crucial role in disseminating information to farmers enabling them to decide on the cropping pattern, use of high-yielding seeds, fertilizer application, pest management, marketing, etc. (Meera *et al*., 2004; Shalendra *et al*., 2011; Gandhi, 2011; Ali, 2011; Lio and Liu, 2006; Nazari and Hasbullah, 2008; Segrave, 2004, Mittal *et al*., 2010). Traditionally, Indian farmers have been following indigenous production methods and rely upon friends, relatives, fellow farmers and input dealers to get information regarding agriculture. With advancement of agricultural science and technology, multiple options to access modern technologies have become available. It is evident from the replacement of indigenous varieties of seeds by high-yielding varieties and traditional equipment and practices by power tillers, tractors and others machines.

With liberalization of economy in India from mid-1980s, along with government agencies, several cooperatives, NGOs and private business entities are disseminating agricultural information. In recent years, the spread of information and communication technologies[1] (ICTs) has raised the expectation that these technologies would deliver fast, reliable and

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[1] On the basis of the International Standard Industrial Classification (ISIC) and the definition used in National Telecom Policy (GOI, 1999; 2012), Government of India, ICTs could include those products that are able to store, retrieve, manipulate, transmit or receive information in digital form. It could be the rapidly changing communication technologies — mobile phone, internet, radio, television and fixed telephone. Further it could be computers and software for using these technologies.

accurate information in a user-friendly manner (Shalendra *et al*., 2011). In fact, it is argued that only old ICTs like radio, television, newspapers, etc. could play an important role in awareness generation about new agricultural technologies in the farming community across the world (Ali, 2011). In this study, we have considered radio, television and newspapers as ICTs and have analysed their role in disseminating agricultural information. The study has also examined the factors that determine the use of ICTs.

Data and Methodology

Data Sources

The study has used the data of National Sample Survey Organisation (NSSO) for analysis. NSSO had carried out a comprehensive survey on the assessment of farmers' situations in the country during 2003. Though it seems that the round is a bit old for the analysis, this is the single largest data source so far available. This round has covered three aspects of Indian farming and farmers: (i) debt and investment, (ii) land and livestock holding, and (iii) access to modern technology for farming. In the present study, data from the third aspect, viz. access to modern technology for farming have been used. The study is focused on rural area and has covered 51,770 farm households.

Model

The empirical model specified for the study is depicted in Equation (1).

$$L_{ij} = \beta_1 + \beta_2 Edu + \beta_3 Training_{Agr} + \beta_4 HHS_{Type} + \beta_5 MPCE + \beta_6 Demon + \beta_7 HHS_{Size} + \beta_8 Age + \beta_9 SF + \beta_{10} MF + \beta_{11} CP + \beta_{12} OS + \beta_{13} FV + \beta_{14} Quality + \beta_{15} Age^2 + \beta_{16} HHS^2_{Size} + U_i \quad \ldots(1)$$

where, L_{ij} represents the sources of information. We have considered four categories of information user-farmers: (i) farmers who use only ICTs' sources, (ii) farmers who use only non-ICTs' sources, (iii) farmers who use both ICTs' and non-ICTs' sources, and (iv) Non-users of information from any source. The variable 'Edu' denotes the level of schooling of household-head; '$Training_{Agr}$' signifies the formal training of household-member who is engaged in farming; 'HHS_{Type}' depicts the households involved in agriculture as cultivators and non-cultivators; 'MPCE' symbolises monthly per capita consumption expenditure of the household; 'Demon' indicates 'Demonstration Effect' that takes into account the effect of the presence of users of any source; 'HHS_{size}' and 'age' signify the total members of the household and household head's age, respectively; 'SF' and 'MF' denote small farmers and medium farmers, respectively. 'CP', 'OS' and 'FV' are households who cultivate cereals and pulses; oilseeds and spices; and fruits and vegetables, respectively; 'Quality' indicates quality of information received from different sources; and Age and HHS_{Size} take into account the quadratic relation of the variables age and HHS_{Size}.

Hypothesis and Variable Construction

To understand the dynamics among farmers in opting ICTs as a source of information, it is hypothesized that the 'use of ICTs is broadly influenced by farm households' characteristics, farm characteristics and performance characteristics of the technology'.

Household Characteristics

The diffusion theories explicate that heterogeneity in adopters' characteristics influence the diffusion of any technology (Rogers and Shoemaker, 1971; Brown, 1981). In the present study, farm households were the potential adopters, and it was assumed that household characteristics could influence the pattern of diffusion. The heterogeneity in age, education, income, etc. is more likely to influence adoption of ICTs as a source of information.

In the present study, education of the household-head was clubbed into three groups: (i) illiterates or below primary, (ii) primary or middle, and (iii) secondary and above level. We have created two dummy variables: (i) household-heads with primary or middle level of education coded as 1 and 0 otherwise; (ii) household-heads with secondary or above level of education, coded as 1 and 0 otherwise. The household-heads who were illiterates or had below primary level of education were considered as the reference category. It was hypothesized that the higher education influences ICTs adoption positively.

If a member of the farm-household has formal training in agriculture, it implies household's potential in adopting new technologies. These households are

expected to use more ICTs for accessing information. Hence, it is hypothesized that the 'adoption would be more among the farmers who are formally trained than the untrained farmers'. The variable has entered into the model as a dummy variable (formal training =1, otherwise 0).

The type of households indicates whether the household is engaged in farming as cultivator or agricultural labour. It is anticipated that cultivators would adopt more ICTs, since they need more information on cultivation. The National Sample Survey classifies households into five[2] categories, which we have clubbed into cultivators and non-cultivators. Households self-employed in agriculture were counted as cultivators =1 and others were considered non-cultivators=0.

The household-size gives the actual and potential workers in the family (Swamy, 1976) and it is expected that the household-size would have positive impact on any kind of decision- making. It is expected that household size will have a non-linear relation with ICTs adoption. To capture that the quadratic form of variable was included.

It is hypothesised that the age of household-head will have a positive influence on adoption of different sources of information. It is also assumed that the age of household-head will have a non-linear relationship and therefore the quadratic form of the variable was included.

Since NSS data don't provide information on monthly income of farm-household, the monthly per capita expenditure (MPCE) of household was taken as the proxy for income. It is hypothesized that higher MPCE will positively influence the choice pattern of households in adoption of ICTs.

It was also hypothesized that social category will have a positive relationship with the choice pattern of the households in adoption of ICTs. The social groups were categorised as: (i) schedule castes and schedule tribes, (ii) other backward castes, and (iii) others. For these three categories, two dummies were included in the equation where SC/ST was considered a base category.

[2] Self-employed in non-agriculture, agricultural labour, other labour, self-employed in agriculture, and others.

The epidemic approach of technology diffusion suggests that through interaction with users, non-users can become users. In the present analysis, it was considered that the presence of users would induce the non-users for using different ICTs. Here, we have taken the presence of households adopting any one of the sources of information per every hundred households in the state. The study hypothesizes that one unit increase in the share of users would increase the probability of the households' adoption of any source of information.

Technology Characteristics

The success of a particular innovation or technology depends on whether the technology satisfies the needs of its users (Freeman, 1987). This implies that diffusion is the outcome of the feedback given by the users. Other than this, diffusion is also the upshot of a process of competitive selection across different technologies (Metcalfe, 1988). Under technology characteristics, we have included the feedback given by users for different sources.

Freeman (1987) has emphasized on the feedback of a particular innovation in order to increase its diffusion and the epidemic approach assumes that the interaction of non-users with users will have positive impact on the diffusion. Feedback can be given only by the users and we are assuming that this feedback of users will have positive influence on the non-users. On that basis, the variable quality of information was included in the analysis. To capture this factor in the analysis, a variable was constructed by taking the share of users who had given the feedback on various sources per hundred households. In NSSO data, the quality of information has been classified as good, satisfactory, and poor. In our analysis, we have considered the households who had given the feedback good or satisfactory. It is hypothesised that the increase in percentage of households who experience the good or satisfactory quality of information, increases the probability of adoption of that particular source of information.

Farm Characteristics

Apart from farmers' and technological characteristics, it was presumed that farm characteristics like holding size, cropping pattern, etc. may also influence their choice pattern in adopting

various sources of information. The farm-size refers to the total land possessed by a household, which includes the land owned, leased-in, neither owned nor leased-in and leased-out. The landholdings were categorised as: small (≤ 2 ha), medium (> 2 ha but ≤ 10 ha) and large (> 10 ha) farmers. Two dummies were included for small and medium farmers and large farmers were considered as the base category.

The cropping pattern is expected to have an influence on the choice pattern of households in accessing agriculture-related information (Ali, 2011). The information requirement may vary for different crops and hence the choice of sources. The NSSO data provided a list of 153 crops which were clubbed into four categories: cereals and pulses, fruits and vegetables, oilseeds and spices, and other non-food crops. Three dummy variables were entered in the model for first three crop groups and the non-food crop group was considered as the base category.

Use of ICTs and Information Dissemination: A Descriptive Analysis

A household was considered to be ICTs-user if it used at least any one of the three sources, namely, radio, television or newspaper, The non-ICTs sources included information through training programmes, Krishi Vigyan Kendra, extension workers, village fairs, government demonstrations, input dealers, other progressive farmers, farmers' study tours, private agency or NGOs, primary cooperative society, output buyers, credit agencies and others. If the household used at least one of the non-ICT sources, it was considered as non-ICTs user. The third category, viz. users of both ICTs and non-ICTs was generated using the above two categories which implied that the household used at least one ICT source and one non-ICT source.

Table 1 presents the proportion of households using three ICTs separately across major Indian states. At

Table 1. State-wise proportion of farm households using ICTs for obtaining agricultural information

(in per cent)

State	Television	Radio	Newspaper	ICTs
Andhra Pradesh	12.0	3.9	6.4	14.1
Assam	9.3	29.0	10.3	32.7
Bihar	3.5	17.4	5.7	18.1
Chhattisgarh	4.2	3.5	1.6	6.1
Gujarat	10.4	6.2	6.8	15.4
Haryana	9.0	11.2	8.0	18.5
Jammu & Kashmir	30.0	36.3	1.9	45.0
Jharkhand	2.4	15.6	4.7	16.8
Karnataka	12.0	14.2	9.8	21.3
Kerala	22.6	30.6	37.9	47.3
Madhya Pradesh	6.7	8.4	3.4	12.2
Maharashtra	20.9	12.6	14.6	27.5
Odisha	6.1	6.0	3.9	10.0
Punjab	16.6	5.4	8.1	18.2
Rajasthan	2.1	2.8	2.1	4.3
Tamil Nadu	19.7	16.4	14.4	27.7
Uttarakhand	4.5	2.3	0.2	6.1
Uttar Pradesh	6.5	15.0	4.0	17.9
West Bengal	6.7	21.1	5.7	24.9
All India	9.3	13.0	7.0	18.7

Source: NSSO 59th Round unit level data

all-India level, radio had the vital role in disseminating agricultural information (13.0%), followed by television (9.3%) and newspapers (7.0%). State-wise, the farm-households in Jammu & Kashmir were better placed in using radio, followed by Kerala and Assam. Similarly, a substantial proportion of farm-households in the states of Jammu & Kashmir, Kerala and Maharashtra were using television for obtaining information on modern agricultural technologies. In accessing information through newspaper, Kerala (38%) was at top, followed by Maharashtra (14.6%) and Tamil Nadu (14.4%). This figure can be read in the line that Kerala with highest literacy rate and educated households, will have more access to newspapers. If we consider the single indicator, i.e. the proportion of farm-households that used at least one of the ICTs, Kerala ranked first (47.6%), followed by Jammu & Kashmir (45.0%) and Assam (32.7%).

Having discussed the use of ICT by famers, we proceed to discuss about the use of ICTs, non-ICT, both ICT and non-ICT sources by farm households and the proportion of households without any source of information. The state-wise proportion of households using only ICTs, only non-ICTs, and none of these sources for accessing agricultural information is presented in Table 2. At the all-India level, 40.04 per cent of the households were using one or the other kind of source to access agricultural information. Out of that about 11 per cent of households were using ICTs sources; around 22 per cent of households were relying on non-ICTs sources, and about 7 per cent of the households were using both ICTs and non-ICTs sources. Almost 60 per cent of the households were not using any source to access agricultural information. The states that depicted a higher proportion of households using ICTs sources than the national average are Assam, Bihar, Haryana, Jammu & Kashmir, Jharkhand, Karnataka, Kerala, Maharashtra, Punjab, Tamil Nadu, Uttar Pradesh and West Bengal.

To assess the nature of information dissemination, the information on cultivation was grouped under four categories: production-related, market-related, allied,

Table 2. Proportion of households using different sources for accessing agricultural information across states of India

State	Only ICTs	Only Non-ICTs	Both ICTs & Non-ICTs	Non-users
Andhra Pradesh	6.22	48.92	7.22	37.64
Assam	21.69	13.22	10.79	54.30
Bihar	11.44	13.90	6.54	68.12
Chhattisgarh	3.20	19.05	2.73	75.02
Gujarat	4.22	41.50	9.25	45.03
Haryana	14.43	18.73	3.58	63.26
Jammu & Kashmir	41.43	2.95	3.60	52.02
Jharkhand	12.87	11.49	3.35	72.30
Karnataka	11.57	23.08	8.98	56.36
Kerala	31.60	13.88	11.89	42.63
Madhya Pradesh	7.13	29.56	4.73	58.58
Maharashtra	12.83	19.79	13.28	54.10
Odisha	6.73	15.65	3.01	74.61
Punjab	11.72	8.71	6.26	73.31
Rajasthan	2.62	10.44	1.42	85.51
Tamil Nadu	14.45	23.07	11.94	50.53
Uttarakhand	4.93	24.27	1.07	69.72
Uttar Pradesh	12.10	15.81	5.39	66.70
West Bengal	12.15	35.96	11.76	40.12
All India	11.04	21.98	7.01	59.96

Source: NSSO 59th Unit Level

and others. The NSSO data broadly provide information on three sub-sections, viz. cultivation, animal husbandry and fisheries. Again, it provides six types of information under cultivation, 5 types under animal husbandry and 4 types under fisheries. For the analysis, information on cultivation was clubbed into three categories and termed as production-related information, market-related information and other information on cultivation. The production-related information included information on agricultural inputs, viz. improved seed, fertilizers, pesticides and farm machinery. The market-related information included information on harvesting and marketing and the third category included other information on cultivation. The NSS did not provide any specific information under 'other information on cultivation'. Information on other than cultivation, i.e. animal husbandry and fishery was categorized as information on allied activities.

Table 3 shows that farmers in general receive production-related information from all sources. A comparison of three sources of ICTs reveals that farm households in all the states receive information on harvesting or marketing more from newspapers than from television or radio. The farmers in economically-backward states like Chhattisgarh, Uttar Pradesh, Uttarakhand, Rajasthan and Madhya Pradesh, receive production-related information more from television than the relatively better-off states like Punjab, Kerala and Gujarat. The farm-households in Chhattisgarh, Madhya Pradesh, and Uttar Pradesh, receive production-related information more from radio than in Punjab or Kerala. A similar trend has been observed in the case of newspapers. Therefore, it was inferred that backward regions use these sources more for receiving production-related information than the developed region. The proportion of households receiving information on post-harvesting or marketing is less than that for production-related information from all the sources.

Factors Determining Adoption of ICTs as a Source of Information vis-à-vis other Sources

To identify the determinants of ICTs adoption as a source of information vis-à-vis other sources, multinomial logit regression analysis has been carried out and the results are presented in Table 4.

A perusal of Table 4 reveals that the households whose head had basic or secondary level education, are more likely to adopt ICTs as a source of information relative to no sources than the households-heads with no education. If a household-head had basic education, then the chances to opt ICTs sources relative to no sources increased by 2.07-times (107%) vis-à-vis illiterate heads. The chances of choosing ICT as a source of information relative to no sources increased by 3.40-times (nearly 240%), if a household-head had education up to higher secondary level. Similar results were found for both ICT and non-ICTs sources. The household-heads with basic and secondary education depicted higher inclination to choose ICT and non-ICT sources relative to no sources. However, education did not have any significant impact on opting non-ICT sources relative to no sources.

If any member of the household engaged in farming had received any kind of formal training, then the probability of its opting for ICT, non-ICT and both ICT and non-ICT as a source of information relative to no sources was 1.42-, 2.58- and 5.91-times higher, respectively. If a household was self-employed in agriculture rather than working as a farm labourer or employed in some other activities, then its chances of choosing ICTs, non-ICTs and both ICT & non-ICTs sources relative to no sources were higher by 45 per cent, 36 per cent and 74 per cent, respectively. Regarding demonstration effect, it was observed that one unit increase in adoption of ICTs, non-ICTs and both ICTs and non-ICTs relative to no sources increased the probability of adoption of all the indicators by 1.03-, 1.04- and 1.05-times, respectively. The results for landholding size showed that large farmers were more likely to adopt ICTs sources relative to no sources than the small farmers. Similar results have been found for non-ICT and both ICT and non-ICT sources. In the case of small farmers, the chances of opting ICT, non-ICT and both ICT & non-ICT sources relative to no sources were lower by 0.23-, 0.37- and 0.65-times, respectively compared to large farmers.

Regarding crop category it was observed that the farmers cultivating cereals and pulses, oilseeds and spices and fruits and vegetables were more likely to adopt ICTs than the households that grew non-food crops. It could be due to the fact that non-food crops being mostly long-duration crops, the farmers don't need information frequently, whereas for seasonal

Table 3. State-wise proportion of farm households accessing agriculture-related information through ICTs

State	Television				Radio				Newspapers			
	Production	Market	Other	Allied	Production	Market	Other	Allied	Production	Market	Other	Allied
Andhra Pradesh	85.2	2.4	6.1	6.3	87.7	.8	6.9	4.6	71.7	10.4	11.3	6.6
Assam	69.2	5.2	16.6	9.0	86.4	1.3	7.7	4.6	68.6	14.4	7.4	9.6
Bihar	74.7	4.1	11.6	9.6	84.2	2.9	8.3	4.6	78.3	4.8	12.1	4.8
Chhattisgarh	95.1	1.6	3.3	0.0	90.9	2.3	6.8	.0	82.8	3.4	13.8	.0
Gujarat	79.1	2.0	0.0	19.0	77.9	10.3	5.9	5.9	66.4	12.7	8.2	12.7
Haryana	80.0	3.2	8.4	8.4	76.1	5.4	12.0	6.5	65.8	17.8	11.0	5.5
Jammu & Kashmir	92.9	0.3	1.5	5.4	87.8	2.5	2.1	7.6	78.1	.0	12.5	9.4
Jharkhand	75.9	0.0	18.5	5.6	81.0	.9	10.8	7.3	68.8	1.6	21.9	7.8
Karnataka	81.2	6.0	7.6	5.2	81.0	5.3	9.5	4.2	71.6	10.9	11.4	6.0
Kerala	73.0	5.2	9.8	12.1	65.3	6.1	9.6	19.1	60.7	12.7	9.4	17.2
Madhya Pradesh	90.9	1.1	2.7	5.3	91.9	1.4	3.6	3.2	85.6	5.8	4.8	3.8
Maharashtra	86.3	5.8	3.6	4.3	83.1	6.7	5.5	4.6	76.2	13.6	5.6	4.5
Odisha	78.8	2.6	15.2	3.3	84.3	3.0	6.7	6.0	67.4	7.6	17.4	7.6
Punjab	73.2	7.1	2.7	16.9	72.5	7.8	2.0	17.6	62.6	27.5	.0	9.9
Rajasthan	95.1	0.0	2.5	2.5	76.2	1.9	12.4	9.5	70.9	7.6	13.9	7.6
Tamil Nadu	75.2	4.7	6.8	13.3	73.4	4.2	5.5	16.9	65.3	17.4	5.7	11.7
Uttarakhand	90.0	0.0	10.0	0.0	66.7	22.2	11.1	.0	100.0	.0	.0	.0
Uttar Pradesh	90.4	1.9	5.2	2.5	91.2	1.2	2.5	5.1	74.2	8.0	11.1	6.7
West Bengal	75.6	1.4	13.1	10.0	88.3	.9	7.2	3.5	75.1	4.4	15.3	5.2
All India	81.7	3.6	6.8	7.8	83.1	3.0	6.5	7.5	69.8	11.5	9.4	9.3

Source: NSSO 59th Unit Level

Note: Production: Information on agricultural inputs, Market: Information on output (harvesting/marketing), Other: Other information on cultivation, Allied: Information on animal husbandry and fisheries

Table 4. Determinants of ICTs adoption as a source of information vis-à-vis other sources: Results of the multinomial logit model

Independent variables	Dependent variable: Sources of information					
	ICTs source relative to no sources		Non-ICTs source relative to no sources		ICTs & Non-ICTs sources relative to no sources	
	Coefficient	Relative risk ratio	Coefficient	Relative risk ratio	Coefficient	Relative risk ratio
Basic education	0.731***	2.078	-0.027	0.972	0.764***	2.147
	(0.000)		(0.322)		(0.000)	
Higher secondary education	1.225***	3.405	0.009	1.009	1.34***	3.821
	(0.000)		(0.873)		(0.000)	
Training	0.356***	1.428	0.950***	2.586	1.778***	5.919
	(0.001)		(0.000)		(0.000)	
Household type	0.375***	1.455	0.307***	1.360	0.555***	1.741
	(0.000)		(0.000)		(0.000)	
MPCE	0.000***	1.000	0.000***	1.000	0.000***	1.000
	(0.000)		(0.000)		(0.000)	
Demonstration effect	0.035***	1.036	0.048***	1.049	0.051***	1.052
	(0.000)		(0.000)		(0.000)	
Household size	0.176***	1.193	0.069***	1.071	0.142***	1.153
	(0.000)		(0.000)		(0.000)	
Age	0.033***	1.033	0.014**	1.014	0.026***	1.026
	(0.000)		(0.011)		(0.003)	
Small farmers	-0.263*	0.768	-0.460***	0.630	-1.06***	0.344
	(0.095)		(0.002)		(0.000)	
Medium farmers	-0.069	0.933	-0.051	0.949	-0.373**	0.688
	(0.663)		(0.734)		(0.016)	
Cereals & pulses	0.325***	1.384	0.476***	1.610	0.207***	1.23
	(0.000)		(0.000)		(0.000)	
Oilseeds	0.427***	1.534	0.387***	1.473	0.244***	1.27
	(0.000)		(0.000)		(0.000)	
Fruits & vegetables	0.874***	2.397	.164***	1.179	0.404***	1.49
	(0.000)		(0.001)		(0.000)	
Quality of information	0.021***	1.021	0.016***	1.016	-0.044***	0.956
	(0.002)		(0.003)		(0.000)	
General castes	0.475***	1.608	0.012	1.012	0.383***	1.468
	(0.000)		(0.709)		(0.000)	
OBCs	0.355***	1.426	-0.000	0.999	0.323***	1.382
	(0.000)		(0.995)		(0.000)	
Age	-0.000**	0.999	-0.000***	0.999	-0.000	0.999
	(0.012)		(0.004)		(0.103)	
Household-size	-0.006***	0.993	-0.002***	0.997	-0.004***	0.995
	(.000)		(0.002)		(0.000)	
log likelihood				-44815.717		
LR $\chi^2_{(54)}$				8663.28		
Pseudo R^2				0.088		
Total observations (No.)				45242		

Note: ***,** and * denote statistically significant difference means at the 1 per cent, 5 per cent and 10 per cent levels, respectively. P values are within the brackets.

crops, the farmers need information at regular intervals. For the households that grow cereals and pulses, the probability of opting for ICTs as a source of information relative to no sources was found 1.38-times higher; it was 1.61-times higher for adopting non-ICTs sources. For oilseeds and spices farmers, the chances of opting ICTs relative to no sources were higher by 53 per cent, while these were 47 per cent higher for choosing a non-ICT source. For the households that cultivate fruits and vegetables, the probability of adopting ICTs relative to no sources was more; it was 2.39-times for ICT and 1.17-times for non-ICT sources. A similar trend was observed for the cropping pattern for adoption of both ICT and non-ICT sources. With respect to the quality of information it was found that every one unit increase in the share of households who experienced the quality of information as good or satisfactory, the probability of households opting for ICT and non-ICT sources relative to no sources increased by 1.02- and 1.01-times, respectively.

Among adopters' characteristics, the age, social category and income were found to affect the adoption of different sources of information. A positive likelihood was observed for age in adopting ICTs, non-ICTs and both ICT & non-ICT sources relative to no sources. The MPCE which was included in the model as proxy for the income of households, showed that it had a negligible effect on the source choice pattern of households. For the social category, it was observed that households belonging to higher classes were more likely to use ICT and both ICT & non-ICT sources of information relative to no sources.

Conclusions

To sum-up, the paper has made an effort to comprehend how ICTs facilitate the dissemination of agricultural information. Although farmers use various sources to get agricultural information, this study has analysed information dissemination by radio, television and newspapers as ICTs and the factors that determine the adoption of these ICTs as information source. The study has found that farmers mostly rely on ICTs sources for accessing production-related information. The estimated multinomial logit model has indicated that the factors 'education' and 'training' have a positive bearing on the adoption of ICTs as a source of information, highlighting the relevance of capacity building initiatives for enhancing the use of ICTs in Indian agriculture. The study has concluded that the extent of confinement of ICTs adoption to households with literacy, formal training and large holdings is likely to widen the knowledge-gap. In this context, the role of information disseminating agencies and institutions becomes more important in facilitating the use of ICTs for agricultural development.

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References

Ali, J. (2011) Adoption of mass media information for decision-making among vegetable growers in Uttar Pradesh. *Indian Journal of Agricultural Economics*, **66**(2): 241-254.

Brown, L.A. (1981) *Innovation Diffusion: A New Perspective*. Methuen Publications, London.

Freeman, C. (1987) *Technology Policy and Economic Performance: Lessons from Japan*. Pinter Publishers Ltd, London.

Gandhi, V. P. (2011) ICT based knowledge and information system for brand-variety selection by farmers: Study and design using the crop-cutting survey system in cotton. *Indian Journal of Agricultural Economics*, **66**(3): 498-512.

GOI (Government of India) (1999) *National Telecom Policy*, New Delhi.

GOI (Government of India) (2012) *National Telecom Policy*, New Delhi.

Lio, M. and Liu, M.C. (2006) ICT and agricultural productivity: Evidence from cross country data. *Agricultural Economics*, **34**: 221-228.

Maddala, G.S. (1983) *Limited Dependent and Qualitative Variables in Econometrics*. Cambridge University Press, UK.

Meera, S.N., Jhamantani, A. and Rao, D.U.M (2004) *Information and Communication Technology in Agricultural Development: A Comparative Analysis of Three Projects from India*, Network Paper No. 135, Agricultural Research and Extension Network.

Metcalfe, J.S. (1988) The diffusion of innovation: An interpretative survey. In: *Technical Change and Economic Theory*, Eds: Dosi *et al*. Pinter Publishers Ltd., London.

Mittal, S., Gandhi, S. and Tripathi, G. (2010) *Socio-Economic Impact of Mobile Phones on Indian Agriculture*. Working Paper No. 246, ICRIER.

Nazari, M.R. and Hasbullah, A.H. (2008) Farmers' approach and access to information and communication technology in the efficient use of modern irrigation methods. *European Journal of Scientific Research*, **21**(1): 37-44.

Peng, C.Y.J. and Nichols, R.N. (2003) Using multinomial logistic model to predict adolescent behavioural risk. *Journal of Modern Applied Statistical Methods*, **2**(1): 1-13.

Rogers, E.M. and Shoemaker, F.F. (1971) *Communication of Innovations: A Cross Cultural Approach*. The Free Press, New York.

Segrave, R. (2004) Communication technologies and knowledge building in agriculture. *Australian Journal of Adult Learning*, **44**(1): 27-43.

Shalendra, Gummagolmath, K.C. and Sharma, P. (2011) ICT initiatives in Indian agriculture – An overview, *Indian Journal of Agricultural Economics*, **66**(3): 489-497.

Swamy, D.S. (1976) Differentiation of peasantry in India. *Economic and Political Weekly*, **11**(50): 1933-1939.

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