Effectiveness and Constraints of ICT Enablers Used by the Farmers in Northern Bangladesh

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Abstract

The main purposes of the study were to determine the extent of effectiveness of ICT enablers used by the farmers in agricultural activities. Data were collected from the farmers of Agriculture Information and Communication Centers (AICCs) during September 2017 to April 2018. The sample size of the study was 200 farmers involved with AICCs of DAE in Northern Bangladesh which was drawn from a population of approximately 2000 AICC farmers using multistage random sampling technique. Data was collected with structured interview schedule. Eight characteristics of the farmers were selected as the factors for explaining effectiveness of ICT enablers and were measured by standard techniques. Correlation test was used to ascertain the relationships between the focus issue and the selected characteristics. It was found that 84.0 percent of the farmers perceived that the ICT enablers were medium effective. The respondents had high effectiveness is in the dimension of 'perceived importance of using ICT enablers', followed by 'maintenance and operational cost', 'ease to use' and 'frequency of use'. Farmers' characteristics i.e. education, annual family income, farming experience, ICT training received, use of ICTs in agricultural activities and attitude towards ICTs had significant positive relationships with the effectiveness of ICTs. It was found that 60.0 percent of the farmers had medium constraints. Among the twelve selected constraints "high cost of ICT enablers" is the top most ranked constraint faced by the farmers and "not enough time to spend on ICT use" had the last position in the rank. It may be concluded that, there is an ample scope of increasing effectiveness of ICTs in the study area since the farmers faced high maintenance and operational cost and felt difficulties in using the ICTs which intrigued them to use it in a less frequency.

Keywords: Effectiveness, constraints, ICT based extension services, ICT enablers

Introduction

The traditional public-sector extension services use a variety of extension programs to overcome barriers to technological adoption without much success (Anderson and Feder, 2004; Anandajayasekeram *et al.*, 2008; Aker, 2010). Historically, agricultural service delivery in developing countries started with production-oriented limited extension services for export crops compared to subsistence agriculture. The attention was diverted in the fifties to food production and improved farming techniques (Anandajayasekeram *et al.*, 2008). In the 1960s US-led 'technology transfer model' employed a large number of extension agents to provide extension services. Since then, with the rise in the demand for agricultural services, many variants of approaches, models and methods have been evolved to connect researchers, extension agents, producers and consumers (Feder *et al.*, 1986; Axinn, 1988; Anderson and Feder, 2004). Recent trend of Information and Communication Technologies (ICTs) in agriculture allows efficient and transparent storage, processing and communication of information and that entrepreneurial innovation in agricultural

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sector which may affect economic and social changes (Kaushik and Singh, 2004). Growth in ICT investment is found to be positively associated with growth in both GDP and productivity (Kraemer and Dedrick, 1994). Jensen (2007) demonstrated that the ICT linkages agricultural products with markets where as Chowdhury (2006) demonstrated that there is a linkage with ICT investment and the labor productivity. From service delivery point, ICT would enable extension workers to gather, store, retrieve and disseminate a broad range of information needed by farmers (Raabe, 2008). It is increasingly recognized that ICT is necessary for accessing required information and knowledge (Chapman *et al*., 2004; McNamara, 2009; Aker, 2010). But, balanced growth is needed and deep structural problems must be solved to make ICT-induced development more inclusive in agricultural sector (Parayil, 2005). Moreover, ICT is not fully utilized in agriculture, scaling up of delivery still remains at experimental stage (Heeks and Molla, 2009).

ICT enablers are the tools or instruments used to facilitate the transfer of technologies and the communication process. In Bangladesh, the ICT based information is available by (Agriculture Information Service) AIS, (Soil Resource Development Institute) SRDI, (Bangladesh Agricultural Research Council) BARC, (Bangladesh Rice Research Institute) BRRI, and other public research institutions as generally credible but probably not sufficient (Malone *et al., 2012)*. Most of the service providers in extension depend on the government sources and private sector for reliable and latest information. The major limitations of the existing information platforms have multi dimension which includes lack of regular update, only text based (no animation or video) and readiness in digital

format as well as quality. Specially, most of the government contents are still in traditional format i.e. print version. However, Agriculture Information Service (AIS) of Department of Agricultural Extension (DAE) is working to digitize different contents. Access to government sources is free but official endorsement and partnership is still a big challenge for the non-government (both private and NGO) organizations to ensure proper validation. In addition, ICT fear (use of internet) among the farmers is very high which lead low usage of the contents. Another limitation of the existing information platform is the absence of business model; so many project-based donor driven initiatives are popping up and dying down or running at low scale when the project life is over. In addition, much of the material available is only of use by extension staff or other intermediaries. Many public, private sector and NGO initiatives have worked on a pilot scale, but most still have to scale up. Effectiveness of ICT enablers and the ICT based extension services as perceived by the utilization system (i.e., farmers) is crucial for success of this approach. Very few research works considering the above-mentioned issues have been undertaken in Bangladesh. Thus, the present study was undertaken to measure the effectiveness and constraints of ICT enablers used by the farmers in northern Bangladesh. The specific objectives of the research are: i) to determine the extent of effectiveness of the ICT enablers in agricultural activities, ii) to determine the relationship of the effectiveness of the ICT enablers with selected characteristics of the farmers and iii) to identify the constraints and the expectations of the farmers related to the use of ICT based agricultural extension services.

Methodology

Farmers under the Agriculture Information and Communication Centers (AICCs) in Rangpur region containing 20 upazilas of Panchagarh, Dinajpur, Nilphamari, Rangpur, Lalmonirhat and Kurigram districts constituted the population of this study. There are about 2000 farmers are members of the above mentions AICCs. Through multistage random sampling procedure, 20 AICCs were selected and from each center, ten AICC farmers were selected randomly resulting a total of 200 AICC farmers as the sample of the study. An interview schedule containing both open and closed form questions was prepared for collection of data and was pre-tested among 12 AICC farmers of Chirirbandar Upazila of the Dinajpur district. In addition, two focus group discussions (FGDs) (with AICC farmers) were performed for getting collective view on constraints and expectations of the respondents regarding ICT based agricultural extension services. Data were collected from September 2017 to April 2018. Eight characteristics of the respondents namely age, level of education, family size, annual income, farming experience, ICT training received, ICT utilization in agriculture, attitude towards ICTs constituted the selected characteristics and the effectiveness of ICT enablers as perceived by the farmers was the focus issue of the study.

The focus issue was measured by computing a composite effectiveness score based on each of the four dimensions, are: (i) frequency of use, (ii) importance of using in agriculture, (iii) ease to use and (iv) maintenance and operational cost. Each of the dimensions was measured against ten ICT enablers (such as mobile phone, computer, internet, multimedia projector, digital camera, CD/DVD player, TV, radio,

printer and public address system) and was put against a 4-point rating scale. For frequency dimension the scores against the enablers were 'not at all' is 0 'seldom' is 2, 'weekly' is 3, and 'monthly is 4. For importance dimension the scores against the enablers were 'not important' is 0 'moderately important' is 2, 'important' is 3, and 'highly important' is 4. For ease to use dimension the scores against the enablers were 'difficult' is 0 'moderately easy' is 2, 'easy' is 3, and 'very easy' is 4. For maintenance and operational cost dimension the scores against the enablers was 'very expensive' is 0 'average' is 2, 'cheap' is 3, and 'very cheap' is 4. Thus, the score of each dimension could range from 0 to 30. This possible range was divided into three categories for classification of each dimension. Finally, the composite effectiveness score was calculated by addition of the scores for all of the four dimensions of a respondent. The composite effectiveness score could range from 0 to 120. This possible range was divided into three equal categories for categorization of effectiveness.

The constraints faced by the farmers in using ICTs in agricultural activates was measured by using four-point rating scale such as high, medium, low and not at all with a score of 3, 2, 1, and 0, respectively. The scale contained 12 constraint items related to use of ICTs in agricultural activates by the farmers which were identified during pre-testing of the interview schedule. Comparative severity of the constraints was determined by item-wise ranking of constraints through computation of the Constraint Facing Index using the following formula:

$$CFI = (C_h \times 3) + (C_m \times 2) + (C_l \times 1) + (C_n \times 0)$$

Where,

CFI = Constraints Facing Index,

C_h = Percentage of respondents having high constraints,

C_m = Percentage of respondents having medium constraints,

C_l = Percentage of respondents having low constraints and

C_n= Percentage of respondents having no constraints.

Attempts were also made to find out suggestions from the respondents to overcome the identified constraints. Ranking of the suggestions based on percentage of citations for each suggestion was done in this regard. Moreover, various descriptive statistical measures were used for categorization and describing the variables. Pearson's Product Moment Correlation Coefficient was used for testing the relationships between the concerned variables. SPSS computer package was used for analysis of data.

Results and Discussion

Effectiveness of ICT enablers

The effectiveness of ICT enablers is measured based on dimension wise effectiveness score and overall effectiveness score. The results are given and discussed as follows:

Dimension-wise effectiveness

Four dimensions of effectiveness were considered for determination of overall effectiveness of ICT enablers along with ten ICT enablers. The dimensions are: frequency of use, importance of using in agriculture, ease to use, maintenance and operational cost. The findings of these four dimensions of ICT enablers are presented in Table 1.

Table 1 Dimension wise distribution of the effectiveness (n=200)

Dimensions	Possible range (observed)	Respondents Categories (scores)	%	Mean	SD
Frequency of use	0-30 (0-30)	Low (up to 10)	74.0	9.13	5.76
		Medium (11-20)	20.0		
		High (above 20)	6.0		
Perceived importance of using in agriculture	0-30 (4-28)	Low (up to 10)	3.5	18.08	4.74
		Medium (11-20)	67.0		
		High (above 20)	29.5		
Ease to use	0-30 (0-30)	Difficult (up to 10)	26.5	13.66	6.21
		Moderately ease (11-20)	66.5		
		Easy (above 20)	7.0		
Maintenance and operational cost	0-30 (2-30)	Low (up to 10)	13.5	17.83	6.45
		Medium (11-20)	45.5		
		High (above 20)	41.0		

The frequency of use of ICT enablers score mean is 9.13 and standard deviation is 5.76.

About three-fourth (74.0 percent) of the respondents had low frequency of use of

ICT enablers followed by 20.0 percent had medium frequency of use and 6.0 percent had high frequency of use of ICT enablers in agriculture. The perceived importance of using ICT enablers in agriculture score mean is 18.08 and standard deviation is 4.74. The highest proportion (67.0 percent) of the respondents had medium perceived importance of using ICT enablers in agriculture followed by 29.5 percent had high perceived importance and 3.5 percent had low perceived importance of using ICT enablers in agriculture. The ease to use of the ICT enablers score mean is 13.66 and standard deviation is 6.21. The highest proportion (66.5 percent) of the respondents were found under the moderately ease category followed by 26.5 percent under difficult and 7.0 percent under easy to use category. The maintenance and operational cost score mean is 17.83 and standard deviation is 6.45. The highest proportion (45.5 percent) of the respondents had mentioned medium maintenance and operational cost followed by 13.5 percent had low cost and 41.0 percent had mentioned high maintenance and operational cost of the ICT enablers.

Overall effectiveness
The scores of overall effectiveness of ICT enablers ranged from 0 to 120 while observed range was 18 to 98 with a mean of 58.71 and standard deviation of 15.43. Based on their effectiveness scores the respondents were classified into three categories as shown in Table 2 namely 'low effectiveness' (up to 40), 'medium effectiveness' (41 to 80) and 'high effectiveness' (above 80).

Table 2 Distribution of the respondents according to their overall effectiveness scores (n=200)

Categories (scores)	Percent	Mean	SD
Low effective (up to 40)	10.5		
Medium effective (41-80)	84.0	58.71	15.43
Highly effective (above 80)	5.5		
Total =	100.0		

Results of Table 2 indicate that more than four-fifth (84.0 percent) of the respondents had mentioned medium effectiveness of the ICT enablers in agriculture followed by 10.5 percent had mentioned low effectiveness and 5.5 percent mentioned high effectiveness. The findings implied that most of the respondents were clustered around the category of medium effectiveness. Thus, there is ample opportunity to increase the effectiveness of the ICT enablers in agricultural activities. ICT enablers are recently very popular in Bangladesh thus the opportunities need to be considered by the concerned authorities.

Selected Characteristics of the AICC farmers
Eight selected characteristics of the AICC farmers were considered to describe the socio-economic profile of the AICC farmers. The characteristics are: age, education, family size, annual income, farming experience, ICT training received, ICT utilization in agriculture and attitude towards ICTs. The findings related to the selected characteristics of the AICC farmers are presented in Table 3.

Table 3 Distribution of selected characteristics of the AICC farmers (n=200)

Characteristics	Scoring method	Possible range (observed)	Categories	Respon-dents (%)	Mean	SD
Age	No. of year	Unknown (16-55)	Young (up to 35)	80.0	29.48	9.27
			Middle age (36-50)	17.0		
			Old (>50)	3.0		
Education	Year of schooling	Unknown (0-15)	Illiterate (0)	8.5	7.32	3.44
			Primary (1 to 5)	26.0		
			Secondary (6 - 10)	54.0		
			Above secondary (>10)	11.5		
Family size	No. of member	Unknown (3-8)	Small (up to 4)	40.0	4.85	1.29
			Medium (5 - 6)	48.5		
			Large (above 6)	11.5		
Annual income	('000' Tk.)	Unknown (10-360)	Low (up to 120)	70.5	107.01	77.01
			Medium (121 - 240)	21.0		
			High (above 240)	8.5		
Farming experience	Year	Unknown (2-39)	Low (up to 12)	64.0	14.11	9.40
			Medium (13 - 24)	23.0		
			High (above 24)	13.0		
ICT training received	Day	Unknown (0-180)	No training (0)	77.0	9.18	28.70
			Short duration (1-7)	9.5		
			Mid duration (8-30)	5.0		
			Long duration (above 30)	8.5		
ICT utilization in agriculture	Score	Unknown (0-27)	Low (≤9)	19.0	16.22	6.36
			Medium (10-18)	52.5		
			High (≥19)	28.5		
Attitude towards ICTs	Score	9-45 (9-45)	Less favorable attitude (up to 21)	12.5	29.93	6.05
			Neutral attitude (22 to 33)	4.5		
			Highly favorable attitude (above 33)	83.0		

Age of the farmers ranged from 16 to 55 years with mean of 29.48 years and the standard deviation of 9.27 years. It was found that four-fifth of the AICC farmers (80.0 percent) was young aged compared to 17.0 percent were middle aged and 3.0 percent under old aged category. The education score ranged from 0 to 15, the mean was 7.32 and the standard deviation was 3.44. It was found that 8.5 percent of the AICC farmers were illiterate, 26.0 percent had primary level of education, 54.0 percent had secondary level of education and 11.5 percent had above secondary level

of education. The family size of the farmers ranged from 3 to 8 with a mean of 4.85 and a standard deviation of 1.29. Findings indicated that majority of the AICC farmers (48.5 percent) have medium sized family. On the other hand, 40.0 percent had small family and 11.5 percent had large family. The annual income of the farmers ranged from 10 to 360 thousand Taka with a mean of 107.01 thousand Taka and standard deviation of 77.01 thousand Taka. It was found that the highest proportion (70.5 percent) of the farmers had low annual income compared to 21.0 percent had medium and 8.5 percent had high annual income. The farming experience score of the respondents ranged from 2 to 39 years with a mean of 14.11 years and standard deviation of 9.40 years. It was found that the highest proportion (64.0 percent) of the respondents had low farming experience while 23.0 percent had medium farming experience and 13.0 percent having high farming experience. Score of ICT training received of the AICC farmers ranged from 0 to 180 days with a mean of 9.18 days and standard deviation of 28.70 days. It was found that more than three-fourth of the respondents (77.0 percent) had no ICT training reception while 9.5 percent had short term duration of ICT training reception, 8.5 percent had long term duration of ICT training reception and 5.0 percent had mid duration of ICT training reception. ICT utilization in agriculture score of the respondents ranged from 0 to 27 with a mean of 16.22 and standard deviation of 6.36. It was found that the highest proportion of the respondents (52.5 percent) had medium utilization of ICT while 28.5 percent had high utilization and 19.0 percent had low ICT utilization in agriculture. The score of the AICC farmers' attitude towards ICTs ranged from 9 to 45 with a mean of 29.93 and standard deviation of 6.05. It was found that the highest proportion of the respondents (83.0 percent) had highly favorable attitude while 12.5 percent had less favorable attitude and 4.5 percent had neutral attitude towards ICTs.

Relationships between effectiveness of ICT enablers and the selected characteristics

Pearson's Product Moment Correlation Co-efficient (r) was estimated to examine the relationships of the selected characteristics of the AICC farmers and the focus issue (effectiveness of ICT enablers). A summary of the correlation analysis is presented in Table 4.

Table 4 Relationships between the focus issue and selected characteristics

Focus issue	Selected characteristics	Computed values of 'r' with 198 *df*	Tabulated value of 'r'	
			0.05 level	0.01 level
Effectiveness of ICT enablers	Age	0.156		
	Education	0.316**		
	Family size	0.033		
	Annual income	0.275**	±0.139	±0.182
	Farming experience	0.203*		
	ICT training received	0.365**		
	ICT utilization in agriculture	0.162*		
	Attitude towards ICTs	0.680**		

** Correlation is significant at the 0.01 level (2-tailed) and * Correlation is significant at the 0.05 level (2-tailed).

Out of eight selected characteristics, education, annual income, farming experience, ICT training received, ICT utilization in agriculture and attitude towards ICTs found significantly and positively related with effectiveness of ICT enablers. Education broadens the horizon of outlook of an individual and this might help to positively perceive the effectiveness of ICT enablers by an individual. Thus it might be the reason of the positive significant relationship between education and effectiveness of ICT enablers. High annual income helps an individual farmer more access to the ICT enablers. Thus the farmers having high annual income might perceive the ICT enablers highly effective and this might be the reason of positive significant relationship between the annual income and effectiveness of ICT enablers. Farming experience might help an individual farmer to broaden his/her outlook and analytical capability related to farming. Thus, he/she can analyze the effectiveness of the ICT enablers more intensively. This might be the reason of the positive relationship between farming experience and effectiveness of ICT enablers. ICT training improves the skill of an individual farmer to utilize the ICT enabler effectively. Thus an individual having training might perceive the ICT enabler more effective. More utilization of ICT enablers in agricultural activities might bring more effectiveness of the same to a farmer. This might be reason of the positive significant relationship between utilization of ICT in agricultural activities and effectiveness of ICT enablers. Attitude towards ICTs determines the predisposition of an individual farmer towards the ICTs. Thus positive attitude towards ICTs might influence positive perception towards effectiveness of the ICT enablers. These selected characteristics are needed to be considered for launching any ICT based extension activities. Age and family size did not show any relationship with the effectiveness of ICT enablers.

Constraints and the expectations related to the use of ICTs

For determining constraints related to the use of ICT based agricultural extension services, overall constraints scores was calculated and comparative severity of the constraints was determined by item-wise ranking of constraints. AICC farmers expectations related to ICT based agricultural extension services are also explored. The findings related to constraints and expectations are discussed in this sub-section.

Overall constraints related to the use of ICTs

The score of overall constraints faced by the AICC farmers in using ICTs in agricultural activities ranged from 5 to 29 with a possible range of 0 to 36 and the mean score and standard deviation was 18.76 and 6.29, respectively. The farmers were divided into three equal categories based on their possible overall constraints scores are: low constraints (up to 12), medium constraints (13 to 24) and high constraints (above 24). The distribution of the farmers according to the constraints categories are shown in Table 5.

Table 5 Distribution of the respondents according to overall constraints scores (n=200)

Categories (scores)	Percent	Mean	SD
Low constraints (up to 12)	18.5		
Medium constraints (13-24)	60.0	18.76	6.29
High constraints (above 24)	21.5		
Total =	100.0		

Results of Table 5 indicates that (60.0 percent) of the farmers faced medium constraints as compared to 21.5 percent faced high constraints and 18.5 percent faced low constraints in using ICTs in agricultural activities. Therefore, it could be concluded that the overwhelming majority of the farmers are facing constraints in using ICTs in agricultural activities which needed to be addressed and resolved for the improvement of ICT based extension services.

Comparative severity of constraints related to the use of ICTs

The comparative severity of constraints related to the use of ICTs in agricultural activities was computed by computation of Constraint Facing Index (CFI) of the 12 constraints which ranged from 110.5 to 228.5 against a possible range from 0 to 300 and the rank order according to their CFI are shown in Table 6.

Table 6 Rank order of the constraints faced by the farmers in using ICTs

Constraint items	Extension of severity (percentage)				CFI	Rank
	Very high (3)	High (2)	Less (1)	Not at all (0)		
Lack of ICT Knowledge	18.5	30.5	51.0	0	167.5	5th
Too hard to use ICTs	3.0	47.0	32.5	17.5	141.5	8th
Lack of Access to ICT enablers	17.0	35.0	42.0	6.0	163.0	6th
Do not understand the value of ICT	13.0	24.0	55.0	8.0	142.0	7th
Lack of technological infrastructure (like mobile tower etc.)	15.0	43.0	39.0	3.0	170.0	4th
High cost of ICT enablers	53.0	22.5	24.5	0	228.5	1st
Not enough time to spend on ICTs	11.0	23.5	30.5	35.0	110.5	12th
No interest in ICTs use	11.0	24.5	37.0	27.5	119.0	11th
Fear of technology	32.5	30.5	33.0	4.0	191.5	2nd
Unavailability of better alternatives	6.0	28.0	58.0	8.0	132.0	10th
Farm size is too small to use ICTs	4.0	34.0	58.0	4.0	138.0	9th
Personal impediments e.g. age, knowledge, English, motivation etc.	9.0	67.0	20.0	4.0	172.0	3rd

CFI = Constraints Facing Index

Farmers of the study area faced 12 selected constraints while they were using ICTs in agricultural activities. Among those constraints, it is found that "high cost of ICT enablers" was the top ranked constraint followed by "fear of technology" and "personal impediments" are the 2nd and 3rd ranked constraints faced by the farmers. The commonly used ICT enablers are high in price in Bangladesh. The price of the ICT enablers is a bit high for the farmers. This might be the reason of ranked the problem

"high cost of ICT enablers" in the first position. The training on ICT enablers is not sufficient at farm level. This might cause the fear of the technology by the farmers. Different personal impediments like old age, low level of knowledge, language barrier, personal motivation, lack of time, family restriction etc. might hinder the farmers of using ICT enablers. Whereas "unavailability of better alternatives", "no interest in ICT use" and "not enough time to spend on ICTs" ranked 10th, 11th and 12th position in the rank order, respectively.

Expectations of the AICC farmers related to the use of ICTs

The expectations of the AICC farmers to overcome the constraints faced regarding use of ICTs in agricultural activities are given in Table 7 with their citations and rank order.

Table 7 Rank order of the expectations of the farmers related to the use of ICTs

Expectations	Percent of citations	Rank order
Increase opportunity of ICT training for the farmers	86.5	1st
Season based SMS services to the farmers in Bengali language	71.0	2nd
Government support to increase the ICT tools at community level	69.5	3rd
Forecasting about weather vulnerabilities through ICT tools	62.5	4th

The findings revealed that the highest expectation of the farmers (86.5 percent-1st ranked) was found on "increase opportunity of ICT training for the farmers". Training on ICTs will improve farmers' proficiency in utilization of ICTs in agricultural activities. This will also enlarge farmers' horizon of outlook regarding ICTs. The lowest ranked expectation (62.5 percent-4th ranked) was found "forecasting about weather vulnerabilities through ICT tools".

Findings of FGDs

Focus Group Discussions (FGDs) was conducted with the AICC farmers to get community level expectations. Some issues are identified through discussions with the focus groups are discussed as follows: the effectiveness of ICTs will be high if the ICT tools will be available in their community (in AICCs). Government should take initiative to make available the ICT tools in the AICCs. The farmers also need to effective user of the tools in this regard and appropriate non-formal education like training, workshops need to be emphasized in different agricultural extension programs. All kinds of farmers (like landless, marginal, small etc.) should be included in such kind of non-formal educations. Mass awareness programs (like campaign, use of public address system, poster etc.) are also needed to be incorporated to improve the effectiveness of ICT based agricultural extension services. The messages related to specific farm relation problems need to be structured in such a way that those can be easily used by the respective ICT enablers. Meanwhile, farmers' problem solution center using ICT enablers need to be established both at regional and national level.

Conclusions

There is an ample scope of increasing effectiveness of ICT enablers in the study area. In addition, AICC farmers feel important of using of ICT enablers and they faced high maintenance and operational cost in using ICT enablers as well as they feel difficult to use the enablers thus they might use the enablers in a less frequency. Without minimizing the constraints and increasing the use of ICTs in agricultural activities by the farmers, it may be restrict farmers to receive updated and modern agricultural information. The study also shows that education, farming experience annual income, ICT training received, utilization of ICTs in agricultural activities and attitude towards ICTs had significant positive relationships with the effectiveness of ICTs. So, it leads to the conclusion that, to formulate any program to improve the effectiveness of ICT enablers all of these characteristics should be considered. If any program implemented to improve the effectiveness of ICT enablers, the program must take attention on educational aspect of farmers as one of the key factors of effectiveness. The following recommendations of the study were made on the basis of major findings and conclusions for policy implications:

i.   Strategies like group discussion, innovation campaign, farmers' workshop, training should be taken to increase farmer's awareness about different agricultural services through ICTs.

ii. Strategies should be taken by the respective authorities like Agriculture Information Service of Department of Agricultural Extension and other related NGOs for strengthening agricultural extension services by arrangement of different non-formal education options like training and workshop on ICT and adult education to increase their ICT knowledge.

iii. Farmers should motivate in using the available ICT enablers to seek various agricultural information. They should motivate to use their mobile phones to communicate with extension staff, input dealers and other farmers. They should also motivate to listen/watch various agricultural programs on the radio and television. Radio broadcasting stations need to be established in places where radio signal is poor or absent.

iv. Improvement of farmers' knowledge and information delivery system should be developed. Need based ICT related information should be provided in this regard.

v.   Strengthening the linkage between GOs and NGOs for integrated ICT based extension services to the farmers needs to be ensured. In this regard, input, farm problem and market related information should be prioritized.

Acknowledgement

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