Bangladesh Journal of Extension Education *ISSN 1011-3916*
Volume 28, No. 1&2, 2016: 37-48 *Research Article*
Journal website: bjee.com.bd
Published by: Bangladesh Agricultural Extension Society

Impact of Using Information and Communication Technologies by the Farmers of Sadar Upazila under Gazipur District

Syeda Tasnim Jannat[1], Md. Shadat Ulla[2], Md. Rafiquel Islam[3] and Mohummed Shofi Ullah Mazumder[4]

[1]PhD student, Department of Agricultural Extension and Rural Development, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur, [2&3]Professor and [4]Associate Professor, Department of Agricultural Extension and Information System, Sher-e-Bangla Agricultural University, Dhaka

Correspondence: Syeda Tasnim Jannat (tasnimj@gmail.com)

Abstract

The study was conducted to assess the impact of using ICT in agriculture. Impact was measured using Difference-in-Difference method minimizing spill-over effect. Data were collected from 96 and 32 respondents, from study and control groups, respectively. Changes in yield of cereal crop (Boro rice), vegetables yield, agricultural income and number of adopted new varieties of agricultural crops by the respondents were measured from 2012 to 2014. Although boro rice yield increase was higher in study group (6.58%) than control group (3.32%), difference was insignificant as a hailstorm took place before its harvest. Increases in vegetables yield, agricultural income and number of adopted new varieties of agricultural crops were significantly higher in the study group (vegetables yield: 5.15%, agricultural income: 13.15%, number of adopted new varieties: 182.58%) than the control group (vegetables yield: 4.24%, agricultural income: 10.63%, number of adopted new varieties: 78.63%). Respondents' age, level of education, effective farm size, use of ICT media in agriculture, farming experience, agricultural knowledge and problems faced in using ICT in agriculture had significant contribution to the impact of using ICT. It may be concluded that by ensuring market price and minimizing natural disaster affect, use of ICT in agriculture may play a significant role in increasing Boro rice yield, vegetables yield, agricultural income and adoption of new varieties of agricultural crops.

Keywords: Impact assessment, ICT, study group, control group, spill-over effect

Introduction

The economy of Bangladesh hugely depends on agriculture. The contribution of agriculture sector to the GDP in 2014-15 fiscal year at current prices is 15.59 per cent (BBS, 2016). Contribution of GDP in Bangladesh economy is prone to fluctuation and utilization of ICT to overcome the existing challenges may bring sustainable solution to feed the huge population. Utilization of all available technologies including ICT will be helpful to face the challenges of supplying agricultural information towards increasing production and marketing and distribution of these products to the increasing population when land resources are diminishing continuously. The use of ICT for disseminating agricultural technologies has been proved to be useful for enhancing agricultural production (Asenso-Okyere and Mekonnen, 2012). Keeping this view in consideration the government of Bangladesh already adopted the strategy of creating Digital Bangladesh within Vision 2021. Although ICT has an enormous effect and potential on agricultural development little research has been conducted regarding the impact of ICT in agriculture particularly in Bangladesh. Therefore, on the basis of the above considerations this research was carried out to assess the impact of using ICT in agriculture.

Methodology

The study was carried out in Baria union of the Sadar upazila under Gazipur district of Bangladesh. Three villages namely Khundia, Digdha and Shukhundi were purposively selected from Baria union as intervention area as a more ICT exposed area due to presence of Agricultural Information and Communication Centre (AICC). Baldha village from the same union was selected as control village as less ICT exposed area. The number of farmers in the selected three villages Shukhundi, Digdha and Khundia were 48, 71, and 144, respectively which constituted the population of the study group. Sample size was determined using Yamane (1967) formula. From 263 test population 96 (37%) study group respondents (farmers had been using at least one of the six selected ICT media in agriculture for two years or more) were selected proportionately using purposive sampling procedure. The selected six ICT media were radio agricultural programs, TV agricultural programs, mobile phone/ smart phone/ telephone, computer/ laptop / tablet/ multimedia/ Internet (with the help of media supplied in AICC), Krishi Call Centre/Farmers help Line and agricultural assistance services of mobile phone companies (Banglalink Krishi Jigyasha/ Banglalink Krishibazaar/ GrameenPhone Krishi Tatthya Sheba/ Robi Haat-bazaar). Thirty two (32) control group respondents (non-ICT media users) were selected following two-way stratified random sampling where education and annual income were the strata (Mazumder and Lu, 2015; Haque, 2002). In control village non-ICT user farmers (farmers using none of the selected six ICT media in agriculture) were selected in purposive sampling procedure Data were collected using a semi-structured interview schedule during October to December 2015. Data were collected once for two different years (2012 and 2014) based on recall data (Schröder and Börsch-Supan, 2008). To reduce spill-over effect i.e. to avoid the problem of information flow from ICT user farmers to non-ICT user farmers, study group and control group were selected from separate villages maintaining a remarkable distance of about 3-5 km (Mazumder and Lu, 2015; Hulme, 2000). Impact of using ICT by the farmers of Sadar upazila under Gazipur district was the dependent variable of the study. The impact of ICT use on the farmers was measured in four dimensions: a) change in yield of cereal crop (Boro rice), b) changes in yield of vegetables, c) changes in income from agriculture and d) changes in number of adopted new varieties of agricultural crops. In each case, the impact was measured in difference-in-difference method. Difference between 2012 and 2014 was measured both for study and control group respondents. Finally, the study group was compared with the control group based on difference between 2012 and 2014 data record (Mazumder and Lu, 2015). Twelve selected characteristics of the respondents viz. age, level of education, purpose of farming, family size, effective farm size, annual income, training exposure, use of ICT media in agriculture, service taking from agricultural service centre, farming experience, agricultural knowledge and problems faced in using ICT media in agriculture were independent variables of the study. Data were coded, compiled and tabulated according to the objectives of the study. Various descriptive statistical measures like number and percentage distribution, mean, standard deviation, coefficient of variation (CV) etc. were calculated for describing selected variables. Difference between means of each changed variable was measured employing t-test. Multiple regression analysis was used to examine the contribution of the respondents' selected characteristics to the impact of using ICT

Findings and Discussion

The agricultural development was measured by changes in yield of cereal crop (Boro rice), yield of vegetables, agricultural income and number of adopted new varieties of agricultural crops by the respondents from 2012 to 2014.

Change in Yield of Cereal Crop (Boro rice)

Results shown in Table 1 indicate that the average change in yield of the respondents experiencing positive change in Boro rice yield was slightly higher than those of the control group but the difference was insignificant. Again, the average change in yield of the respondents experiencing negative change in Boro rice yield was slightly higher than those of the control group and the difference was insignificant. It might have happened due to the natural disaster (hailstorm) which took place before the harvesting period of Boro rice in 2014 fiscal year.

Information presented in Table 2 show that the average yield of Boro rice was higher in 2014 than the year of 2012, but the change was non-significant in both cases (study group and control group). A hailstorm took place in 2014 fiscal year before the harvesting period of Boro rice that might have influence for non-remarkable changes where the change of yield was higher in study group than the control group respondents. Therefore, it may be concluded that, ICT media might had a significant yield difference in the study group which was absent due to affect by natural disaster. Alia et al. (2013) also observed that the indirect effect of rural radio rice programs through adoption of modern varieties on rice farmers' yield was significantly positive.

Table 1: Distribution of the respondents according to their change in yield of cereal crop (Boro rice)

(Kg/Decimal)

Types of Changes	Study Group			Control Group			t-value
	No. of respondents	Mean	SD	No. of respondents	Mean	SD	
Positive change	53	9.11	4.36	17	9.00	1.78	0.101^{NS}
Negative change	39	-9.23	8.35	14	-9.49	2.46	0.115^{NS}
No change	4	-	-	1	-	-	-
Total	96	1.28	9.43	32	0.63	10.86	0.303^{NS}

SD= Standard deviation; NS = Non significant

Changes in Yield of Vegetables

Results shown in Table 3 indicate that the average change in yield of the respondents experiencing positive change in vegetables yield was much higher than those of the control group and the difference between the study and control group was significant.

Information presented in Table 4 indicates that the average yield of vegetables in 2014 was higher than the year of 2012 and the changes were significant in both cases (study group and control group). The increases in vegetables yield were higher in study group than the control group respondents. It can be concluded that use of ICT in study group had a potential influence. Ozaki et al. (2013) reported that yield amount of the vegetables was increased smoothly at Kapasia and Ekhlaspur in Bangladesh due to participation of the farmers in the Income Generation Project for Farmers using ICT except the yield amount of 2012 Kharif-1 at Kapasia which was damaged due to huge rain which supports the findings of the present study.

Changes in Income from Agriculture

Results presented in Table 5 indicate that respondents' average agricultural income in 2014 was higher than the year of 2012 and the changes were significant at 1 percent level of significance in both cases (study group and control group). The findings also reveal that increases in agricultural income were higher in study group than the control group which might be due to the use of ICT by the study group respondents. However, the increases in agricultural income might be even much higher than the present finding if there were reasonable market price of rice and no natural disaster resulting in heavy loss in Boro rice production.

Table 2: Yield difference in cereal crop (Boro rice) within study group and control group in the year of 2012 and 2014

(Kg/Decimal)

	Category of Yield	2012		Category of Yield	2014		% Change	t-value (df = 95)
		Number (%)	Mean		Number (%)	Mean		
Study Group	Low yield (up to 16.02)	22 (23.2)	19.46	Low yield (up to 15.78)	27 (28.1)	20.74	6.58	1.154^{NS}
	Medium yield (16.03-22.90)	43 (45.3)		Medium yield (15.79-25.70)	28 (29.2)			
	High yield (>22.90)	30 (31.6)		High yield (>25.70)	41 (42.7)			
	SD	6.88		SD	9.92			
	CV (%)	35.36		CV (%)	47.81			
	Category of Yield	2012		Category of Yield	2014		% Change	t-value (df = 31)
		Number (%)	Mean		Number (%)	Mean		
Control Group	Low yield (up to 16.53)	9 (28.1)	19.00	Low yield (up to 15.11)	11 (34.4)	19.63	3.32	0.377^{NS}
	Medium yield (16.54-21.47)	8 (25.0)		Medium yield (15.12-24.15)	7 (21.9)			
	High yield (>21.47)	15 (46.9)		High yield (> 24.15)	14 (43.8)			
	SD	4.94		SD	9.04			
	CV (%)	26.02		CV (%)	46.04			

NS= Non significant

Table 3: Distribution of study group and control group respondents according to their changes in yield of vegetables

(Kg/Decimal)

Types of Changes	Study Group			Control Group			t-value
	No. of respondents	Mean	SD	No. of respondents	Mean	SD	
Positive change	93	4.67	1.63	30	3.85	0.74	2.646**
No change	3	-	-	2	-	-	-
Total	96	4.52	1.80	32	3.61	1.19	2.669**

** Significant at .01 level
SD= Standard deviation

Table 4: Yield difference in vegetables within study group and control group in the year of 2012 and 2014

(Kg/Decimal)

	Category of Yield	2012		Category of Yield	2014		% Changes	t-value (df = 95)
		Number (%)	Mean		Number (%)	Mean		
Study Group	Low yield (79.79)	3 (3.1)	87.79	Low yield (up to 83.88)	3 (3.1)	92.31	5.15	24.639**
	Medium yield (79.80-85)	93 (96.9)		Medium yield (83.89-100.73)	93 (96.9)			
	High yield (>85)	0 (0)		High yield (>100.73)	0 (0)			
	SD	15.98		SD	16.85			
	CV(%)	18.21		CV(%)	18.25			
	Category of Yield	2012		Category of Yield	2014		% Changes	t-value (df = 31)
		Number (%)	Mean		Number (%)	Mean		
Control Group	Low yield (up to 73.95)	2 (6.3)	85.21	Low yield (up to 77.29)	2 (6.3)	88.82	4.24	17.212**
	Medium yield (73.96-96.46)	30 (93.8)		Medium yield (77.30-100.54)	30 (93.8)			
	High yield (>96.46)	0 (0)		High yield (>100.54)	0 (0)			
	SD	22.51		SD	23.44			
	CV(%)	26.42		CV(%)	26.39			

** Significant at 0.01 level
SD= Standard deviation

Okello (2010) observed that much higher margin (86%) was earned by the farmers after joining the ICT-based market information service project DrumNet project. Raj et al. (2011) also revealed that a mobile phone service providing information on the correct use of nutrients in the Nagapattinam district of India led to 15% higher income of the intervention farmers than the control group through cost reduction due to application of appropriate (i.e. lower) amounts of seeds and nutrients. These literatures strongly support the findings of the present study.

Changes in Number of Adopted New Varieties of Agricultural Crops

Results presented in Table 6 indicate that the average change of the respondents experiencing positive change in number of adopted new varieties of agricultural crops was much higher than those of the control group and the difference between the study and control group was significant at 1 percent level of probability.

Results shown in Table 7 indicate that average number of adopted new varieties of agricultural crops by the respondents in 2014 was higher than the year of 2012 and the changes were significant at 1 percent level of probability in both cases (study group and control group). Increases in number of adopted new varieties were higher in study group than control group. It can be concluded that use of ICT by the study group respondents might have influenced the remarkable change. Alia *et al.* (2013) also observed that adoption of modern varieties of

Impact of ICTs by the farmers

Table 5: Difference in income from agriculture within study group and control group in the year of 2012 and 2014 ('000' taka)

	Category	2012		Category	2014		% Changes	t-value (df = 95)
		Number (%)	Mean		Number (%)	Mean		
Study Group	Low (up to 138.72)	31 (32.3)	238.75	Low (up to 167.55)	35 (36.5)	270.15	13.15	25.787**
	Medium (138.73-338.78	44 (45.8)		Medium (167.56-372.75)	41 (42.7)			
	High (>338.78)	21 (21.9)		High (>372.75)	20 (20.8)			
	SD	200.06		SD	205.20			
	CV(%)	83.79		CV(%)	75.96			
	Category	2012		Category	2014		% Changes	t-value (df = 31)
		Number (%)	Mean		Number (%)	Mean		
Control Group	Low (up to 150.00)	11 (34.4)	238.72	Low (up to 176.22)	11 (34.4)	264.10	10.63	18.653**
	Medium (150.01-327.44)	13 (40.6)		Medium (176.23-351.97)	13 (40.6)			
	High (>327.44)	8 (25.0)		High (>351.98)	8 (25.0)			
	SD	177.43		SD	175.76			
	CV(%)	74.33		CV(%)	66.55			

** Significant at .01 level

Table 6: Distribution of study group and control group respondents according to their changes in number of adopted new varieties of agricultural crops

Types of Changes	Study Group			Control Group			t-value
	Number of respondents	Mean	SD	Number of respondents	Mean	SD	
Positive change	86	2.69	0.87	28	1.18	0.39	8.851**
No change	10	-	-	4	-	-	-
Total	96	2.41	1.17	32	1.03	0.54	6.434**

** Significant at .01 level

rice was significantly higher by the farmers who listened to radio programs of rice before 2008 than those who had not.

It was also revealed that the farmers in rural Nigeria got a new variety of maize through interactions with scientists made possible by the internet (Adekunle and Alluri, 2006). The above literatures vividly corroborate the findings of the present study.

Table 7: Difference in number of adopted new varieties of agricultural crops within study group and control group in the year of 2012 and 2014

	Category	2012		Category	2014		%Changes	t-value (df = 95)
		Number (%)	Mean		Number (%)	Mean		
Study Group	Low (up to 1)	48 (50)	1.32	Low (up to 3)	39 (40.6)	3.73	182.58	20.220**
	Medium (2-3)	48 (50)		Medium (4-5)	46 (47.9)			
	High (>3)	0 (0)		High (>5)	11 (11.5)			
	SD	1.02		SD	1.71			
	CV(%)	77.35		CV(%)	45.76			
	Category	2012		Category	2014		%Changes	t-value (df = 31)
		Number (%)	Mean		Number (%)	Mean		
Control Group	Low (up to 1)	13 (40.6)	1.31	Low (up to 2)	14 (43.8)	2.34	78.63	10.846**
	Medium (2-3)	19 (59.4)		Medium (3-4)	18 (56.3)			
	High (>3)	0 (0)		High (>4)	0 (0)			
	SD	0.90		SD	1.15			
	CV(%)	68.40		CV(%)	49.27			

** Significant at .01 level

Summary of Impact of Using ICT

Information presented in Table 8 indicate that there were significant positive differences in each component of total changes within study and control groups except in case of yield of cereal crop (Boro rice) as a natural disaster (hailstorm) took place before the harvesting period of Boro rice which might have an influence on the non-remarkable change. The differences within the study and control groups in case of other three components were highly significant. The differences might be even much higher than the present condition if there were reasonable market price of rice and no natural disaster occurring excessive loss in Boro rice production.

Impact of ICTs by the farmers

Table 8: Component based total changes within study group and control group

Sl. No.	Components	Study Group	Control Group	% Changes	t-value (df = 126)
1	Difference in yield of cereal crop (Boro rice)	1.28	0.63	103.17	0.303^{NS}
2	Differences in yield of vegetables	4.52	3.61	25.21	2.669**
3	Differences in income from agriculture	31.40	25.38	23.72	2.673**
4	Differences in number of adopted new varieties of agricultural crops	2.41	1.03	133.98	6.434**

** Significant at .01 level; NS= Non Significant

Contribution of selected characteristics of the respondents to the impact of using ICT as perceived by the farmers

In order to assess the factors contributing to the level of contribution in improving the agricultural conditions of the respondents, multiple regression analysis was conducted. Information presented in Table 9 show that there is a significant contribution of respondents' age, level of education, use of ICT media in agriculture, agricultural knowledge and problems faced in using ICT media in agriculture to changing the respondents' yield of cereal crop (Boro rice). Of these, age was the most important contributing factor and level of education, use of ICT media in agriculture, agricultural knowledge and problems faced in using ICT media in agriculture were the second most important contributing factors.

Age, use of ICT media in agriculture and agricultural knowledge are related to increase knowledge regarding Boro rice cultivation and adoption of improved practices in cultivation might have an influence on the change in Boro rice yield. Level of education had negative impact on the change in respondents' Boro rice yield which indicates that the more educated the respondents the less they were inclined to Boro rice cultivation as it is a losing concern because of high investment in cultivation and no profit or even sometimes loss. Van Hout (2013) also revealed that price for paddy rice has declined significantly over the last five years while costs for labour and external inputs for irrigated Boro rice continue to rise. Problems faced in using ICT also had a negative impact on the change in the respondents' Boro rice yield which indicates that the respondents facing problems in using ICT might not feel free to utilize ICT to a great extent and thus were reserved from adoption of improved practices in Boro rice cultivation. Results shown in Table 9 also indicate that except the problems faced in using ICT media in agriculture all the previously mentioned predictor variables also had significant contributions to the changes in the respondents' vegetables yield, but the level of significance of the contributions differed from one model to another. In this model, the most important contributing factor was the use of ICT media in agriculture and the second most important contributing factors were the respondents' age, level of education and agricultural knowledge. The predictor variables such as age, level of education, use of ICT media in agriculture and agricultural knowledge might have influenced the respondents' greater knowledge regarding vegetable cultivation and adoption of improved practices. Lio and Liu (2006) also found significant positive impact of ICT on agricultural productivity. Information presented in Table 9 reveal that the respondents' effective farm size, use of ICT media in agriculture, farming experience and agricultural knowledge significantly contributed to the changes in their agricultural income. Of the predictor variables, effective farm size and use of ICT media in agriculture were the most important contributing factors and the second most important contributing factors were farming experience and agricultural knowledge. The respondents' effective farm size is concerned with their economic strength which might have influenced changes in their agricultural income.

Table 9: Multiple regression coefficients of contributing factors related to impact of using ICT on the farmers by changing their yield of cereal crop (Boro rice), yield of vegetables, agricultural income and number of adopted new varieties of agricultural crops

Independent variables	B	p	R^2	Adjusted R^2	F	p
Age (years)	0.423	0.003**	0.398	0.319	5.053	0.000**
Level of education (years of schooling)	-0.230	0.035*				
Family size	-0.063	0.508				
Effective farm size (decimal)	0.006	0.950				
Annual income ('000' Taka)	-0.098	0.432				
Training exposure (days)	-0.080	0.433				
Use of ICT media in agriculture (score)	0.311	0.031*				
Service taking from agricultural service centre (score)	0.166	0.288				
Farming experience (years)	-0.224	0.113				
Agricultural knowledge (score)	0.221	0.032*				
Problems faced in using ICT media in agriculture (score)	-0.254	0.028*				
Age (years)	0.281	0.020*	0.560	0.502	9.714	0.000**
Level of education (years of schooling)	0.183	0.049*				
Family size	-0.029	0.718				
Effective farm size (decimal)	0.105	0.241				
Annual income ('000' Taka)	0.020	0.853				
Training exposure (days)	0.019	0.822				
Use of ICT media in agriculture (score)	0.330	0.008**				
Service taking from agricultural service centre (score)	0.060	0.652				
Farming experience (years)	0.186	0.125				
Agricultural knowledge (score)	0.177	0.044*				
Problems faced in using ICT media in agriculture (score)	0.000	0.998				
Age (years)	-0.003	0.980	0.531	0.469	8.629	0.000**
Level of education (years of schooling)	-0.012	0.900				

Independent variables	B	p	R^2	Adjusted R^2	F	p
Family size	0.014	0.871				
Effective farm size (decimal)	0.384	.000**				
Annual income ('000' Taka)	-0.005	0.964				
Training exposure (days)	-0.087	0.332				
Use of ICT media in agriculture (score)	0.408	0.002**				
Service taking from agricultural service centre (score)	-0.060	0.664				
Farming experience (years)	0.269	0.032*				
Agricultural Knowledge (score)	0.179	0.049*				
Problems faced in using ICT media in agriculture (score)	-0.012	0.906				
Age (years)	-0.222	0.042*	0.638	0.591	13.47	0.000**
Level of education (years of schooling)	0.064	0.446				
Family size	0.063	0.392				
Effective farm size (Decimal)	0.210	0.011*				
Annual income ('000' Taka)	-0.006	0.948				
Training exposure (days)	0.066	0.406				
Use of ICT media in agriculture (score)	0.777	0.000**				
Service taking from agricultural service centre (score)	-0.182	0.133				
Farming experience (years)	0.237	0.032*				
Agricultural knowledge (score)	-0.045	0.570				
Problems faced in using ICT media in agriculture (score)	-0.120	0.176				

* Significant at 0.05 level; ** Significant at 0.01 level

Use of ICT media in agriculture, farming experience and agricultural knowledge might have influenced the respondents' greater knowledge and experience in agriculture and thus greater agricultural income. Forestier et al. (2002) also observed that the farmers received better prices for their crops with the help of rural telephony which led to significant increase in their earnings. Results shown in Table 9 also indicate that the respondents' age, effective farm size, use of ICT media in agriculture and farming experience had significantly contributed to the changes in their number of adopted new varieties of agricultural crops. In this model, effective farm size and use of ICT media in agriculture were the most important contributing factors and the second most important contributing factors were age and farming experience. Their effective farm size is associated with their economic power and hence, might have influenced the changes in their number of adopted new varieties. Other predictor variables such as the respondents' use of ICT media in agriculture and farming experience might have increased their agricultural knowledge and experience and thus influenced them to become innovative and adopt

new varieties. Akudugu et al. (2012) also reported that farm size significantly influenced technology adoption decisions of farm households in Ghana. Odoemenem and Obinne (2010) found that farmers' use of information sources had positive significant contribution on their level of adoption of improved cereal crop production technologies. Age had a negative contribution to the changes in their number of adopted new varieties of agricultural crops which implies that the younger the respondents were the more they were innovative and more likely to use ICT and adopt new varieties of agricultural crops. Okello et al. (2012) also noticed that the age of the farmers was a significant factor inversely influencing the use of ICT tools by them. It was observed in the study that the use of ICT tools for agricultural transactions was greater among the younger farmers. Ndag et al. (2008) also reported that younger farmers had more exposure to ICT usage and courses than older farmers.

In summary, the modeling proposes that the government should reconsider the problems faced by farmers in using ICT and find and implement the solutions. The government should also reconsider the pattern of Boro rice cultivation where the farmers invest highly but do not get profit and even loss. The government should also fix profitable price of rice for farmers so that they can get profit from rice production and thus continue rice cultivation in the country. The government should make more arrangements for using ICT so that farmers can spontaneously avail of digital facilities and increase their knowledge and improved practices in agriculture.

Conclusion

The research reveals that use of ICT in agriculture had significant impact on respondents' vegetables yield, agricultural income and number of adopted new varieties of agricultural crops. Farmers faced some problems in using ICT in agriculture, although use of ICT had a great influence on agriculture. The increases in respondents' Boro rice yield, vegetables yield, agricultural income and number of adopted new varieties of agricultural crops were likely to be influenced by their age, level of education, effective farm size, use of ICT media in agriculture, farming experience, agricultural knowledge and problems faced in using ICT in agriculture. The government should reconsider the problems faced by the farmers in using ICT and address appropriate solutions to these problems. The concerned authority should reconsider the pattern of Boro rice cultivation with minimum costing. The research institutes should develop more rice varieties that need minimum level of irrigation. The government should also ensure market price. It can also be recommended that the research institutes may return to develop strong rice varieties that can fight with any natural disaster like hailstorm, rain, flood etc.

References

Adekunle, A. and K. Alluri. 2006. Using ODL Aided by ICT and Internet to Increase Agricultural Productivity in Rural Nigeria. Paper presented by the Commonwealth of Learning and the Caribbean Consortium in The Fourth Pan Commonwealth Forum on Open Learning, Ocho Rios, Jamaica. Retrieved from pcf4.dec.uwi.edu.

Akudugu, M.A., E. Guo and S.K. Dadzie. 2012. Adoption of Modern Agricultural Production Technologies by Farm Households in Ghana: What Factors Influence their Decisions? *Journal of Biology, Agriculture and Healthcare*, 2(3):1-13.

Alia, D.Y., T. Nakelse, and A. Diagne. 2013. Rural Media, Agricultural Technology Adoption and Productivity: Evidences from Small Rice Farmers in Burkina Faso. In: 4th International Conference of the African Association of Agricultural Economists, Hammamet, Tunisia.

Asenso-Okyere, K. and D.A. Mekonnen, 2012. The Importance of ICTs in the Provision of

Information for Improving Agricultural Productivity and Rural Incomes in Africa. UNDP Working Paper WP 2012-015, January 2012. United Nations Development Programme (UNDP).

BBS. 2016. Sectoral Share of GDP at Current Prices, 2010-11 to 2014-15(p) (Base: 2005-06). GDP of Bangladesh 2014-15(p) (Base: 2005-06). Bangladesh Bureau of Statistics, Dhaka. Retrieved from http://www.bbs.gov.bd.

Forestier, E., J. Grace, and C. Kenny. 2002. Can Information and Communication Technologies be Pro-poor? *Telecommunication Policy*, 26:623–646.

Haque, M.E. 2002. Performance of Rice IPM Farmers under Farmer Field School in the Department of Agricultural Extension (Unpublished doctoral dissertation), Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh.

Hulme, D. 2000. Impact Assessment Methodologies for Microfinance: Theory, Experience and Better Practice. *World Development,* 28:79-98.

Lio, M and M. Liu. 2006. ICT and Agricultural Productivity: Evidence from cross-country data. *Agricultural Economics*, 34: 221–228.

Mazumder, M.S.U. and W. Lu. 2015. What impact does microfinance have on rural livelihood? A comparison of governmental and non-governmental programs in Bangladesh. *World Development,* 68:336-354.

Ndag, I., R.A. Sanusi, and E.O. Aigbekaen. 2008. "Comparative Analysis of Information and Communication Technology (ICT) Use by Agricultural Extension Workers in South West and North-Central Nigeria", Paper presented at 19th Annual International Information Management Association, San Diego, California, United States of America. 13-15 October, 2008. U.K.

Odoemenem, I.U. and C.P.O. Obinne. 2010. Assessing the Factors Influencing the Utilization of Improved Cereal Crop Production Technologies by Small Scale Farmers in Nigeria. *Indian Journal of Science and Technology*, 3(1):180-183.

Okello, J.J. 2010. Does use of ICT-based market information services (MIS) improve welfare of smallholder farmers? Evidence from Kenya. Proceedings of the 4th ACORN-REDECOM Conference Brasilia, D.F., May 14-15th, 2010, pp. 1-10.

Okello, J.J., O.K. Kirui, G.W. Njiraini, and Z.M. Gitonga. 2012. Drivers of use of Information and Communication Technologies by Farm Households: the case of smallholder farmers in Kenya. *Journal of Agricultural Science*, 4(2):111-124.

Ozaki, A., M.A. Rahman, K. Ogata, A. Ahmed, I. Miyajima, T. Okayasu, T. Osugi, D.K., Choudhury, and N.A. Amin. 2013. Impact of ICT based Farming Knowledge Dissemination on Farmers' Income: experience of income generation project for farmers using ICT in Bangladesh. *Bulletin of the Institute of Tropical Agriculture*, 36:95-112.

Raj, D.A., A.V. Poo Murugesan, V.P.S. Aditya, S. Olaganathan, and K. Sasikumar. 2011. A crop nutrient management decision support system: India, In: Grimshaw, D.J. and S. Kala (Eds.), *Strengthening Rural Livelihoods: The Impact of Information and Communication Technologies in Asia* (pp. 33–52). Rugby and Ottawa: Practical Action and International Development Research Centre.

Schröder, M. and A. Börsch-Supan. 2008. *Retrospective data collection in Europe*. (Mannheim Research Institute for the Economics of Aging [MEA] Discussion Paper 08172). University of Mannheim.

Van Hout, R. 2013. Agricultural diversity in Bangladesh - how to promote and protect agricultural diversity in a country that is flooded by irrigated Boro rice? Discussion paper for the Conference on "Agrobiodiversity in Bangladesh", organized by BARCIK, ASD Bangladesh, Helvetas Swiss Intercooperation and Terre des hommes Lausanne, Dhaka, 28 January 2013. pp. 1-13.

Yamane, T. 1967. *Elementary Sampling Theory*. Englewood Cliffs, New Jersey, NJ: Prentice-Hall.