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ADOPTION OF INFORMATION AND COMMUNICATION TECHNOLOGIES IN ENHANCING FOOD SECURITY AMONG SMALL-SCALE FARMERS IN DELTA STATE, NIGERIA

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ABSTRACT
The study examined adoption of Information Communication Technology in Enhancing Food Security among Small-Scale Farmers in Delta State, Nigeria. The objectives were analyzed with the use of descriptive statistics and Likert scale while hypothesis one and two were analyzed with multiple regression and Product Moment Correlation Coefficient (r) respectively. Sample size adopted through multi-stage random sampling was 88. The mean age, farming experience, farm size and household size were 43.05 years, 12.66 years, 3.79ha and 7 persons, respectively. Most (82.96%) of the farmers were aware of ICT use on farm production. The use of ICT was constraint by high cost of ICT tools, poor network coverage, lack of funds and poor infrastructure. Socio-economic characteristics of the farmers like gender (b = 3.081), age (b = -2.017), educational level (b = 2.315), farming experience (b = 3.001) and farm size (b = 0.986) played significant role in their perceived contribution of ICT to farmers production. Result also revealed that significant relationship exist between farmers with low and those with high level of ICT awareness in agricultural production. The study therefore recommended that government should make policies that should help to improve infrastructure that concerns roads, electricity supply and network coverage so that they can be encouraged to the use of ICT tools for improved agricultural production.

Keywords: Farms, Farmers, Agricultural production, ICT, Adoption, Perceived contribution, Awareness.

INTRODUCTION
The concern for the necessity to increase the quantity and quality of food production has led to a condition as to whether efforts should be targeted at either small scale or large-scale farmers. Adebayo and Sorungbe (2002) noted that small scale farmers dominated the agricultural production land scape and produce about 85% of the total production. In line with the foregoing, Okwuokenye and Akintoye (2015) opined that targeting at the small-scale farmers would help to improve the agricultural sector. Okwuokenye and Akintoye (2015) further stated that higher farm yields enough to meet up with the increased demand of food quality and quantity is assured if appropriate recommended scientific farming techniques and communication techniques are targeted at the small-scale farmers.

Information Communication Technology (ICT) plays significant roles in almost all human endeavor (agriculture inclusive) as at today (Ekweanya *et al.,* 2019). (Ekweanya *et al.* (2019) acknowledged that if farmers who are the key players in agriculture are able to use the technologies very well, it will go a long way in stressing the role of ICT in agricultural production. Information Communication Technology was defined by Michiels and Vancrowder (2001) as a range of electronic technologies which when converge in new configuration are flexible, adaptable, enabling and capable of transforming organizations and redefining social relations. This definition portrays ICTs as an expanding assembly of technologies that can be used to collect, store and share information between people using

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multiple devices and multiple media. The aforementioned accounts for why Arokoyo (2005) stated that ICT covers a wide range of equipment and services and this accounts for why it assists the farmers in meeting up with his/her potentials.

Ezike and Nwodo (2018) rightly pointed out that ICT in this 21st century has been seen as a valuable tool in the pursuit of ensuring and achieving the goal of food security, sufficiency and supporting rural development. As a result of this laudable benefits of use of ICT, there is therefore the need seek for strategies and policies that would promote the use of ICT by farmers in order to provide and meet up with the food need of the people in particular and food security of the nation in general. Against this background, the study seeks to under study adoption of ICT in enhancing food security among small scale farmers in Delta State, Nigeria. Specifically, the study seeks to;

i. Determine the socio-economic characteristics of the farmers being served by extension agents in Delta State.
ii. To ascertain the farmers awareness and frequency of use of ICT tools in farm production in the State.
iii. Examine the farmers' perceived contribution of ICT to agricultural production in the study area.
iv. Examine the perceived factors limiting farmers' effective use of ICT tools in the state.

The hypotheses of the study were stated in their null forms and these include:

H_{oi}: There is no significant relationship between farmers socio-economic characteristics and their perceived contribution of Information and Communication Technology to farmers production.

H_{oii}: There is no significant difference between farmers with high level and those with low level awareness of use of ICT in agricultural production

MATERIALS AND METHODS

The Study Area

The study was conducted in Delta State. It is an oil rich state and one of the six South-South States (NAEC, 2008). NAEC (2008) report had it that Delta State was carved out of former Bendel State on the 27th August, 1991. Its land area is approximately 17,698Km^2 and accommodating 25 local government areas with its capital seat at Asaba. As at today, the National Population Commission of Nigeria puts the state's population at 5,663,400 (NPC, 2018). Delta State is bounded on the north by Edo State, on the east by Anambra and Rivers States, on the south by Bayelsa State and on the west by Ondo State and the Bight of Benin of the Atlantic Ocean. The state lies within $5^0$00' and $6^0$30'N, and Longitudes $5^0$00' and $6^0$45'E. Its towns known for their characteristic diverse ethnic and tribal groups which include Isoko, Ika, Izon, Itsekiri, Urhobo, etc. and the major occupation of the indigenes include farming, civil service, oil prospecting, trade and commerce. (AWC, 2006). They are also known for mining and prospecting of gas and solid minerals. Due to the environmentally friendly nature of the area, the state is rich in agricultural activity like growing of crops, rearing of animals and fishes.

Sampling Techniques

The respondents of the study were selected through the use of multi-stage random sampling method. The first stage has to do with the random selection of two agricultural zones out of the three that exist in the state. The agricultural zones were Delta North and Delta South. This was followed by the second stage which involved the random selection of five local government areas (LGAs) from each of the zones and this brought the number of LGAs used for the study to ten. Those LGAs randomly chosen from Delta North include; Ika North-East, Ika South, Ukwuani, Ndokwa West and Aniocha South LGAs. While Isoko North, Isoko South,

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Bomadi, Patani and Warri South LGAs were chosen from Delta South Agricultural zone. The next stage involved the random selection of ten farmers being served by the agricultural agency in the LGAs. This brought the total number of farmers used for the study to one hundred (100). Efforts were made to be sure that the farmers were active and in contact with the extension agents servicing the area. The list of registered farmers was obtained from the State's Ministry of Agriculture. It was this group that was administered with the question instrument (questionnaire and interview schedule). Out of the returned question instrument, eighty-eight (88) (i.e. 88%) of them suitable for analysis were used for the study.

Data Analytical Techniques

Descriptive and inferential statistics were used to analyze the data of the study. Descriptive statistics involved frequency count, tables and percentages and means and they were used to analyze such objectives like socio-economic characteristics of the farmers, awareness and frequency of use of ICT tools in farm production. Likert scale was used to examine the farmers perceived contribution of ICT to agricultural production and the perceived factors limiting farmers effective use of ICT in farm production. The scale ranged from "Strongly Agree" (coded 4), "Agree" (coded 3), Disagree (coded 2) and Strongly Disagree (coded 1). A weighted mean score of 2.50 was obtained ({4 + 3 + 2 + 1 = 10} / 4 = 2.50). The value of ≥ 2.50 was considered as important in agreeing to perceived contribution of use of ICT to agricultural production. Values less than 2.50 were considered contrary. The same scale and condition applied to the perceived factors limiting effective use of ICT in farm production. Multiple regression was used to determine relationship between farmers socio-economic characteristics and their perceived contribution of ICT to farmers production (hypothesis one). Linear equation was adopted as the lead equation. The reason for the selection of the Linear equation was based on the number of significant variables, the *apriori* sign and the coefficient of determination (R^2) (Okwuokenye and Ovharhe, 2017). The explicit form of the equation is shown below as:

$Y = a + b_1X_1 + b_2X_2 + b_3X_3, \text{---} , b_nX_n + e$ …(1)

However, the variables in the model are defined as:

Y = Perceived contribution of ICT to farmers production
X_1 = Gender ((dummy: male = 1; female = 2)
X_2 = Age (years)
X_3 = Educational level (Pri. educ. = 1; Sec. educ. = 2; Post Sec. educ. = 3)
X_4 = Marital status (single = 1, Married = 2, Divorced = 3, Widow(er) = 4)
X_5 = Farming experience (years)
X_6 = Farm size (ha.)
X_7 = Household size (number of people living and feeding together)

Product Moment Correlation Coefficient (r) was used to analyze farmers with high level and those with low level awareness of use of ICT in agricultural production (hypothesis 2). Ajayi (2005) established that the Correlation Coefficient measures linear association between interval variables. The Product Moment Correlation Coefficient (r) usually assumes a value between -1 to +1. When "r" = +1, it means that the relationship between X and Y are linear and perfect. Contrarily, when "r" = -1, it means that there is an inverse relationship between X and Y. Again, when "r" = 0, it means there is no relationship at all between X and Y. Product Moment Correlation Coefficient formular is as shown as:

$$r = \frac{n\sum XY - (\sum X)(\sum Y)}{\sqrt{[n\sum X2 - (\sum X)^2][n\sum Y2 - (\sum Y)^2]}} \quad \ldots(2)$$

The decision rule: We reject the null hypothesis when the estimate of the independent variable is statistically significant and when half of the parameter estimate of the variable is greater/bigger than the standard error of the variable (X), otherwise we accept the null hypothesis.

RESULTS AND DISCUSSION

Socio-economic Characteristics of the Respondents

The socio-economic characteristics of the respondents (farmers) is shown in Table 1. It revealed that farming in the area of study is gender friendly, although it was dominated by males (70.45%). The dominance of males in the farming business may be attributed to their more access to land in the area. This result is supported by findings of Okwuokenye and Okoh (2018) which noted that males dominated the Growth Enhancement Support Programme in 12 States (including Delta State) of Nigeria. Majority (38.64%) of the farmers sampled belonged to the age bracket of 35 – 44 years. The mean was 43.05 years. This shows a significant presence of young and active farmers in the business of farming who can work with ICT tools for improved farm yields. This result corresponds with that of Sobalaje and Adigun (2013) which reported similar age bracket of yam farmers in Osun State of Nigeria.

Farmers educational status revealed that all the farmers are literate though at different levels with majority (42.04%) of them having NCE/OND/Diploma qualification. Their educational level indicates that they can understand and use appropriately apply farm innovations. A similar result on farmers education level was obtained by Erie (2009). The marital status of the farmers revealed that most (64.64%) of them were married people. The dominance of married people in the farming business is an indication that such activity is to generate income to cater for their families. This study is in consonance with the results of Okwuokenye and Okoh (2018) that reported the dominance of married people in farming in Delta State. The modal farm experience of the farmers (37.50%) was between 10 – 14 years and their mean were 12.66 years. The result indicates that the farmers are experienced and would be able to apply farm innovations for improved farm yield. This result concurs with findings of Okwuokenye (2020) that expressed similar range (10 – 14 years) in farming experience of cucumber in NOUN farmers, Kaduna, Kaduna State.

The average farm size of the farmers was 3.79ha with a majority (44.32%) of them owning between 2.1 – 4 ha. By implication, the farmers are small-scale in nature since they are farming acreage was less than 4ha. Ovharhe (2014) reported similar result regarding farm size in Delta State and so confirms them as small-scale farmers. The respondents' household size revealed their average household size to be seven persons and majority (38.64%) of them had household size to be between 4 – 6 persons. The relationship implies that the farmers have dependants to cater for from their farm proceeds. The result is in consonance with that of Mohammad (2011) who reported similar household size and range for Nigerian farmers.

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Table 1: Socio-economic characteristics of respondents (n = 88)

Socio-economic variables	Categories	Frequency	Percentage	Mean
Gender	Male	62	70.45	
	Female	26	29.55	
Age range (years)	< 25	6	6.82	
	25 – 34	13	14.77	
	35 – 44	34	38.64	
	45 – 54	16	18.18	
	55 – 64	11	12.50	
	≥ 65	8	9.09	43.05
Educational status	Primary Educ.	9	10.23	
	Sec. Educ.	23	26.14	
	NCE/OND/Dip.	37	42.04	
	HND/Degree	15	17.04	
	Higher Degrees	4	4.55	
Marital status	Single	28	20.45	
	Married	56	64.64	
	Divorced	9	10.23	
	Widowed	5	5.68	
Farming experience (years)	< 5	8	9.09	
	5 – 9	19	21.59	
	10 – 14	33	37.50	
	15 – 19	11	12.50	
	≥ 20	17	19.32	12.66
Farm Size	≤ 2	18	20.45	
	2.1 – 4	39	44.32	
	4.1 – 6	15	17.05	
	6.1 – 8	11	12.50	
	≥ 8.1	5	5.68	3.79
Household size (years)	1 – 3	14	15.91	
	4 – 6	34	38.64	
	7 – 9	27	30.68	
	10 – 12	8	9.09	
	≥ 13	5	5.56	6.5 = 6

Source: Field Survey, 2021

Level of Awareness of Information Communication Technology on Farm Production

Table 2 shows the respondents awareness level of use of Information and Communication Technology (ICT) on farm production. The result revealed that most (82.96%) of the farmers indicated that they were aware of the use of ICT on agricultural production. Only an insignificant proportion on them (17.04%) claimed not to be aware of ICT use in the regard of boosting agricultural production. The result of Sobalaje and Adigun (2013) confirmed this finding as they stated that majority of the yam farmers, they studied were aware of the use of ICT in disseminating agricultural information that bothers on improving crop production. In where length of time of their awareness of use of ICT in crop production is concerned, majority (52.27%) of the respondents indicated that they have been aware for about 5 – 6 years, thus implying that they have been aware using ICT tools for their production during this period which can be described as a long period. Through personal communication, the farmers acknowledged that the use of ICT tools on farm production has really helped to boost production level. The result is at variance with that of Sobalaje and Adigun (2013) who reported

that most of the farmers studied by them had short period, ranging between 1 – 2 years of awareness level of use of ICT tools on farm production.

In line with the aforementioned, most (44.32%) of the farmers indicated that they had a high level of awareness of the use of ICT tools for farm production. The result implies that the farmers have been using ICT tools in their farm production in their farm production and this may have contributed to their improved output level as expressed in Table 2.

Table 2: Distribution of respondents according to level of awareness of ICT on farm production

Farmers awareness of ICT on farm production	Frequency	Percentage
Aware of use of ICT on farm production	73	82.96
Not aware of use of ICT on farm production	15	17.04
If your answer to the above is yes, please indicate for how long you have been getting information through any of the ICT tools:		
< 1 year	4	4.54
1 -2 years	7	7.95
3 – 4 years	21	23.86
5 – 6 years	46	52.27
➢ 7 years	10	11.36
Rate your level of awareness of the use of ICT on agricultural production:		
Very high	23	26.14
High	39	44.32
Average	16	18.18
Low	7	7.95
Poor	3	3.41

Source: Field survey, 2021

Perceived contribution of ICT to agricultural production

The distribution of the respondents in line with their perceived contribution of ICT to agricultural production in shown in Table 3. According to the result as revealed, the order of most perceived contribution was that ICT tools has improved extension agents service delivery to the farmers (mean = 3.23) and this has led to improved production activity (mean = 3.14) consequently resulting to increased savings of the farmers (mean = 3.09). In addition, the use of ICT has led to improvement of the professionalism status of the farmers farming business (mean = 2.94) and has paved the way to reduction in the occurrence of fraudulent activities (mean = 2.90). Going further, the farmers agreed that use of ICT tools have increased access to finance assistance (mean = 2.83), improved their farm management activities (mean = 2.83), reduction of transaction cost (mean = 2.71), improved the marketing of agricultural products (mean = 2.68) and as well improved quality of financial information (mean = 2.56).

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Table 3: Farmers' according to perceived contribution of ICT to agricultural Production

Perceived ICT contribution	Mean	Standard Dev.	Ranking
Improved extension agents service delivery	3.23	0.58	1st
Improved production activities	3.14	0.63	2nd
Increased the savings of the farmers	3.09	0.61	3rd
Increased the professionalism of farming business	2.94	0.61	4th
Reduction in the occurrence of fraudulent activities	2.90	0.64	5th
Increased access to finance assistance	2.83	0.59	6th
Improved the farm management activities	2.83	0.72	6th
Reduction of transaction cost	2.71	0.68	8th
Improved the marketing of agricultural products	2.68	0.79	9th
Improved quality of financial information	2.56	0.66	10th
Increased extension – farmer satisfaction	2.43	0.81	11th

Agreed ≥ 2.50
Source: Field survey, 2021

In line with the aforementioned, results of Ezike and Nwodo (2018) found that ICT has contributed to the reduction in transaction cost of farmers, resulted to less fraud in farming activities, improved the quality of financial information and presented the farmers with more level of professionalism in farming activities. Ezike and Nwodo (2018) also found that the use of ICT has increased the savings of the farmers, improved their marketing performance, increased their access to more financial assistance and helped to improve service delivery of those saddled with such task.

Perceived Factors Limiting Farmers, Effective Use of ICT in Agricultural Production

The perceived factors limiting farmers effective use of ICT in farm production were ranked according to their weighted mean (Table 4). Highest amongst the factors was poor or unavailability of mobile service network (mean = 3.88) followed by poor electricity supply (mean = 3.67), lack of funds (mean = 3.42) and high cost of ICT tools (mean = 3.25). Other perceived limiting factors to ICT use were low level of awareness (mean = 2.96), lack of infrastructure (mean = 2.73), lack of technical skills on ICT use (mean = 2.53) and low level of training (mean = 2.51).

Thus, the foregoing results are in agreement with Arokoya (2005) which linked major constraints to farmers ICT to erratic and unstable power supply, poor mobile network connectivity, high cost of ICT tools, high level of rural poverty (resulting from lack of funds). Results of Sobalaje and Adigun (2013) are in agreement with the findings that lack of infrastructure and technical skills which also share a relationship with low level of training as constraints plaguing effective use of ICT tools in agricultural production. Contrarily, the same result (Sobalaje and Adigun, 2013) disagreed with farmers' level of awareness as a constraint to effective use of ICT.

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Table 4: Perceived factors limiting farmers, effective use of ICT in agricultural production

Perceived ICT contribution	Mean	Standard Dev.	Ranking
Poor or unavailability of network	3.88	0.63	1st
Poor electricity supply	3.67	0.56	2nd
Lack of funds	3.42	0.61	3rd
High cost of ICT tools	3.25	0.59	4th
Low level of awareness	2.96	0.66	5th
Lack of infrastructure e.g. roads, schools	2.73	0.61	6th
Lack of technical skills	2.53	0.74	7th
Low level of training	2.51	0.71	8th
Low level of income earning	2.38	0.81	9th
Low level of farmers educational status	2.34	0.77	10th
Farmers bias for ICT device or tools	2.15	0.74	11th

Agreed ≥ 2.50
Source: Field survey, 2021

Farmers' Socio-Economic Characteristics and the Perceived Contribution of ICT to Agricultural Production

Multiple regression was used to assess how contribution of ICT to agricultural production is influenced by the socio-economic characteristics of the respondents (Table 5). The computed F-value (32.67) signify that the regression model is significant ($P < 0.01$) while the explanatory variables (socio-economic characteristics) explained 62.1% variation in contribution of use of ICT to agricultural production (adjusted $R^2 = 0.621$). Five out of the seven explanatory variables have a significant effect on the contribution of ICT to agricultural production.

Gender has a beta coefficient of 3.081 and a t-value of 2.11. It was positively signed and significant at the 5% level. By implication, since male dominated the farming business, it therefore means that the more participation of males in the farming business will result to more contribution of ICT to agricultural production. The odd ratio implies that the inclusion of more males in farming will lead to three times more contribution of ICT to agricultural production. This assertion is supported by the results of Joyous and Paul (2016) which noted that more participation of males in the ICT tools will consequently lead to more contribution to farm production.

Age of the farmers respectively has a beta coefficient and t-value of -2.017 and 0.06. The variable was negatively signed and significant at the 5% level. The result implies that younger farmers had more perception of the contribution of ICT to agricultural production and vice versa. The odd ratio was approximately three and this by implication means that an increase in age of the farmers will result to three times less than proportionate perceived contribution of ICT to farm production. Negative relationship between farm workers use of ICT tools and their age was reported by Joyous and Paul (2016). The education level of the farmers (beta = 2.315; t-value = 0.98) was positive in relationship and significant (at the 1% level) to contribution of ICT to farm production. The result implies that the more educated farmers perception will be skewed towards more contribution of ICT to agricultural production. The odd ratio was 4.01 which indicates that an increase in the educational level of the farmers will earn about four times their perceived contribution of ICT to agricultural production. The findings of Strong *et al.* (2014) supported this result as they acknowledged that educational levels play significant role in the acceptance of technologies and innovations in farm operations.

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Farming experience of the respondents had a beta coefficient of 3.001 and t-value of 0.29. The relationship was positive and significant at the 5% level, this indicate that increasing farm experience will be skewed to double increase (since odd ratio is 2.25) in the farmers perceived contribution of use of ICT to agricultural production. Farm size of the respondents had positive and significant relationship (at the 5% level) with perceived contribution of use of ICT to agricultural production. The beta coefficient and t-value were 0.986 and 0.39 respectively. The positive relationship implies that an increase in farm size will result to a proportionate (odd ratio is one) perceived contribution of use of ICT to agricultural production. This result corresponds with Mwombe *et al.* (2014) findings that farm size has an influence on the intensity of use of ICT tools as a source of agricultural information for small holder farmer in Gatanga District, Kenya.

Table 5: Relationship of farmers' socio-economic characteristics and perceived contribution of ICT to agricultural production

Variables	Coefficient (b)	Standard Error	t – values	Prob. Level	Odd ratio
Constant	8.286	2.017	1.59	0.149	
Gender	3.081**	1.368	2.11	0.012	3.31
Age	-2.017*	-0.006	0.04	0.001	2.87
Educational level	2.315**	1.027	0.98	0.009	4.01
Marital status	1.109	0.914	0.75	0.382	0.44
Farming exp.	3.001*	1.466	0.29	0.081	2.25
Farm size	0.986*	0.016	0.39	0.173	1.08
Household size	1.637	1.239	0.288	0.226	2.41

** = significant at the 1 % level; * = significant at the 5% level
Chi-square = 41.52; df = 6; $p < 0.05$ (This indicates that the model is significant at 5% level). Goodness-of-fit Chi-square = 54.21; df; = 6; $p < 0.05$; Coefficient of determination = 0.621 (62.1%)

Relationship between Farmers' Level of Awareness of Use of ICT and Agricultural Production

The relationship between farmers with high level and those with low level awareness of use of ICT in agricultural production was analyzed using the Product Moment Correlation Coefficient. Hypothesis 2 expresses thus: There is no significant difference between farmers with high and those with low level of use of ICT in agricultural production. Product Moment Correlation (r) was used to determine the statistical significance in difference between respondents with high and those with low level of awareness of use of ICT in agricultural production. The Results is shown as: parameter Estimate = 0.5721; standard Error = 0.1218 and R^2 = 0.5923. In conclusion, half of the parameter estimate of level of use of ICT in agricultural production was 0.2861, obtained as 0.5721 / 2 = 0.2861. The half of the parameter estimate is greater than the standard error (0.1218) of the estimate. This is an indication that the estimate or equation was significant. It therefore goes to say that there is a significant difference between farmers with high level and those with low level of use of ICT in agricultural production. The result led to the rejection of the null hypothesis and the acceptance of the alternative hypothesis. This result is in agreement with that of Sobalaje and Adigun (2013) which established that farmers who were aware and using farm book ICT derived more benefits in terms of production and marketing from their farm activities than those farmers who did not use the ICT application in their farming activities.

CONCLUSION AND RECOMMENDATIONS

Farming in the area of study was gender friendly, though male dominated with most of them rated as small-scale farmer, being married, in their active age group, with good level of education and farming experience backed with having a household size of that is within their economic carrying capacity. The study revealed that the use of ICT has really contributed and played significant role to agricultural production and development. However, the roles played by ICT were not without some challenges that actually distorted the effective use of ICT by the farmers.

Based on findings, the study recommended that:

1. To ameliorate the problem of low level of training and poor technical skills in other to improve farm production, farmers need to be trained and their capacity built in the use of ICT on farm practices and activities by the Ministry of Agriculture and or any related organization.
2. Government should make policies that should help to improve infrastructure that concerns roads, electricity supply and mobile network coverage in the rural areas. Such policies will help to encourage the farmers on the use of ICT in farm operations and then increase the farmers' output.
3. The government need to increase farmers awareness level on ICTs and still create synergy between farmers and extension personnel to support further ICT development and application.
4. There is need to provide ICT tools to the farmers at subsidized rates so that the poor rural farmers can be able to afford the tools.

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