EFFECTS OF INFORMATION AND COMMUNICATION TECHNOLOGIES USE ON TECHNICAL EFFICIENCY OF POULTRY EGG PRODUCTION IN IBADAN, OYO STATE, NIGERIA

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ABSTRACT
Information and Communication Technologies **(**ICTs) play numerous direct and supporting roles in agricultural production, but this critical essence has been largely under-researched. To this end, this study assessed the effects of ICTs use on the TE of poultry egg farmers. Primary data were collected from 180 poultry egg farmers in Ibadan, Oyo State with the aid of questionnaire. The study sample was selected using a four-stage sampling procedure. Descriptive statistics, Data Envelopment Analysis (DEA) and Tobit regression were the tools utilised for analyses. Results indicate that the level of ICTs use was low among the poultry egg farmers (mean=42.0±0.12). The TE of the poultry egg farmers was also found to be low, averaging 42.6 percent. Membership of Poultry Association of Nigeria (PAN) affected TE negatively (β= -0.112; ρ=0.05), while education (secondary: β=0.176, ρ=0.05; tertiary: β=0.135, ρ=0.10) and phone use index (β=0.165; ρ=0.10) affected it positively. Thus, there is potential in ICTs use to increase the technical efficiency and productivity of poultry egg production. However, there is need for improved capacity building for the egg farmers and regulation of the professional association for better inclusion.
Keywords: Information and Communication Technologies, Agricultural technology, Egg production, Technical Efficiency, Smallholder Farmers.

INTRODUCTION

Poultry are domesticated birds which are kept for the various benefits they present to humankind such as meat, egg and other items from the poultry by-products. Poultry birds include turkey, geese, ducks, chickens, quails, and guinea fowl. The chickens, otherwise known as fowls, include the meat-producing birds such as broilers, cockerels, and the egg-producing birds such as layers and the indigenous fowls. Poultry production has the potential for enhancing food security and resilience due to its short production cycle and ability to convert household waste into feed (Mottet and Tempio, 2016), especially for resource-poor households. Poultry is one of the most important sources of protein globally with meat and egg production estimates of approximately 100 million and 73 million tonnes, respectively (FAO, 2017). It is particularly important in a developing country like Nigeria where malnutrition is a source of concern due to low level of animal protein consumption, which has brought consensus that developing the poultry industry is the fastest means of bridging the protein deficiency gap prevailing in the country (Ikpi, Akinwumi and Adeyeye, 1979; Obasi and Amaechi, 2013).

Poultry egg production is particularly important in Africa as the region has not been left out of the gains in egg production (75%) noticed between 1961 and 2013 which was higher than that of Western Europe (59%) and compares favourably with that of East Asia (108%) (FAOSTAT, 2016 in Mottet and Tempio, 2016). Sub-Saharan Africa (SSA) was responsible for 1.3% of global egg production from layers (FAO, 2017) and 750 kilotonnes (protein equivalent) increase in egg production was projected for the sub-region for 2025 with 70% of this to come from Eastern and Western Africa at growth rates of 4% and 3%, respectively (OECD/FAO, 2016).

Information and Communication Technologies (ICTs) refer to series of stand-alone media that integrate and incorporate technologies/infrastructure required to store, manipulate, transmit and deliver information ultimately assisting the innovation processes (Samuel, 2007). The list of ICTs includes telephone and mobile telephony, radio, television, video, tele-text, voice-information systems and fax, as well as computer-mediated networks that link a personal computer to the internet. They also include computers, CD-ROM, email, video cameras and digital cameras (Kwadwo and Daniel, 2012). With the abilities of ICT tools to supply the right information at the right time through channels that are accessible to all the stakeholders, general life improvement for players in poultry production and marketing sectors are facilitated (Olaniyi, 2013).

Despite the realisation of the importance of poultry production in Nigeria, the sector has been grappling with challenges of low productivity and inefficiency in resource allocation and utilisation (Onyenweaku and Effiong, 2006). Thus, there is need to provide present and intending poultry farmers in Nigeria with useful information that will assist them set up and sustain poultry industry in the country (Ezeh, Anyiro and Chukwu, 2012). This useful information may come from several sources including Information and Communication Technology (ICT) tools since the explosion of ICTs is rapidly changing different facets of life with special reference to information delivery.

Various studies have been carried out on ICTs and agriculture. Ali, Jabeen and Nikhitha (2016) studied the impact of ICTs on agricultural productivity in Zambia and the result showed positive impact of ICTs on agricultural productivity. Fu and Akter (2012) examined the impact of mobile technology enhanced services on agricultural extension services delivery system in India. The

number, quality and speed of services delivery were significantly improved because of ICTs intervention. Also, Malsha, Jayasinghe and Wijeratne (2011) dwelt on the effect of ICTs on agricultural production in Sri Lanka with the results showing farmers' improvement in crop cultivation and management. In Nigeria, Chikaire, Anyoha, Anaeto and Orusha (2017) examined the effect of use of Information and Communication Technologies (ICTs) on farmers' agricultural practices and welfare in Orlu Agricultural Zone, Imo State using mainly descriptive statistics. Nwagwu and Soremi (2015) examined ICTs awareness and use in innovation chain by livestock farmers in Ibadan. Positive correlational relationship was observed among ICTs awareness, their usage and marketing of livestock in the study area. Oladele (2011) also noted significant difference in the level of extension agents' and farmers' perception of the effect of ICTs for agricultural information access. This study, on the other hand focused on the different ICT tools in the light of information access for efficient poultry egg production in Oyo State, Nigeria. There is paucity of research on the effect of ICT use on the technical efficiency of poultry egg production in the study area despite being a highly urbanised city and an important centre of commercial egg production in the Southwest and Nigeria at large. An attempt to fill this void provides the ground for this study. Therefore, the specific objectives of this study were to:

a. profile the poultry egg farmers by their socioeconomic characteristics,
b. assess the level of ICTs use in the production process,
c. estimate the technical efficiency of the poultry egg farmers, and
d. determine the effects of ICTs use on technical efficiency of poultry egg farmers in the study area.

METHODOLOGY

The study was conducted in Ibadan, which is the capital city of Oyo State, Nigeria. Ibadan is the third largest city in Nigeria with a population of 3,565,108 people coming only after Lagos (9.0 million) and Kano (3.63 million) in population (Statista, 2020). It is on Latitude 7°23′47″N and Longitude 3°55′0″E with an approximate surface area of 3,080 square kilometre. Ibadan consists of 11 LGAs out of the 33 LGAs that are in Oyo State. Five (5) of the LGAs (namely: Ibadan North, Ibadan North-East, Ibadan North-West, Ibadan South-East and Ibadan South-West) are in the metropolis while six (6) (Akinyele, Egbeda, Ido, Lagelu, Ona Ara and Oluyole) are in the less city. Ibadan was considered for this study because of its size, huge commercial activities, presence of large number of poultry farmers and extensive use of ICTs.

Multi-stage sampling procedure was used to select poultry egg producers for this study. The LGAs in Ibadan were first stratified into urban and semi-urban. Semi-urban LGAs were then focused because most of the poultry houses were in the less-city where there is low population to minimise air pollution risk to humans. Three LGAs were selected from the 6 semi-urban LGAs based on concentration of commercial egg production. These are Ido, Lagelu and Egbeda. The last stage involved purposive selection of production enclaves in each of the selected local government areas. Questionnaires were distributed to poultry egg producers in Ido, Lalupon, Folasade/Egbeda, Old-Ife Road, Wema Bank (New Gbagi) area, among others. Snowball technique was also used to complement the sample selection procedure at this stage. Primary data on socio-economic and demographic characteristics, quantity of inputs used in the production process and the quantity of output were collected from about 200 poultry egg farmers. However, only 180 instruments were finally used for analysis because of incomplete data. Each of the sampled poultry egg farmers used at least one type of ICT for poultry farming activities.

Two types of variables were involved in the study: dependent and independent variables. The dependent variable is the Technical Efficiency (TE) of the poultry egg farmers. The TE was generated from the inputs and output of the egg production process. The independent variables are as follows:

***Sex*:** The respondents were asked if they were males or females. Females were assigned 1 while males were assigned 0.

***Age*:** The age of the poultry egg farmers was measured in years.

Marital status: The farmers were asked if single, married, divorced or widowed.

Education status: The different categories under education were: no formal, informal (Qur'anic and adult education), primary, secondary and tertiary. The farmers were asked if they've undergone any of the education categories listed.

Experience in production: This refers to the number of years that the farmers had been engaged in raising birds for egg.

Credit access: This is indicative of access to formal credit. Those that had access to credit were required to answer Yes (=1) while those without access answered No (=0).

Association membership: This is also a Yes or No question on whether the farmer belonged to Poultry Association of Nigeria (PAN) or not. Yes was assigned 1 and No, 0.

Length of association membership: This variable showcased the number of years that the farmer had belonged to PAN.

Length of cooperative membership: This was measured by number of years the respondent had been in a cooperative society.

ICT tools use index: The farmers were asked if they made use of any of the ICTs in production. It is a multiple response question and the index of use was

calculated from individual responses with respect to each tool. The values were between 0 and 1. These responses were then aggregated to get the ICT use index. There was a follow-up question on the extent to which the egg farmers used the tools for different purposes using a Likert-type scale of Never=0; Rarely=1; Occasionally=2; and Regularly=3.

Data were analysed using descriptive statistics (frequency distribution and percentages), Data Envelopment Analysis (DEA) and Tobit model. The DEA was used to estimate the technical efficiency of the poultry farmers in the study area while Tobit regression was used to assess the effect of ICTs use on technical efficiency.

The Tobit regression model is given in terms of an index function as follows (Greene, 2003):

$y_i^* = x_i' + \varepsilon_i$ ... (1)

$y_i = 0$ if $y_i^* \leq 0$ ... (2)

$y_i = y_i^*$ if $y_i^* > 0$ ... (3)

where,

y_i^* is the latent variable, y_i is the observed, x_i is the vector of explanatory variables and ε_i is the error term. Considering the assumption of normally distributed errors and the censoring of the data at the upper and lower limit values of 1 and 0 respectively for technical efficiency, the observed dependent variable, *y* is given by,

$$y_i = \begin{cases} 0 & if\ y_i^* < 0 \\ y_i^* & if\ 0 \leq y_i^* \leq 1 \\ 1 & if\ 1 < y_i^* \end{cases} \ldots (4)$$

where

Yi = Technical efficiency of the poultry egg farmers

The independent variables are as follows,

X_1 = Sex of the poultry farmers (female=1, male=0);

X_2 = Age (years)

X_3 = Marital status; X_4 = Educational status;

X_5 = Experience in poultry production (years); X_6 = Credit access (Yes=1, No=0)

X_7= Poultry Association of Nigeria (PAN) membership (Yes=1, No=0)

X_8 = Length of PAN membership (years); X_9 = Length of cooperative membership (years)

X_{10} = Radio use index; X_{11} = TV use index; X_{12} = Print use index

X_{13} = Phone use index; X_{14} = Internet use index

RESULTS AND DISCUSSION

Socioeconomic characteristics

Table 1 shows the distribution of the poultry egg farmers by socio-economic characteristics. The results reveal that 71.6% of the poultry egg farmers were males, while 28.3% were females. More male poultry egg farmers were found in the poultry farm following the belief that a male is able to dedicate more time, focus and energy to the job. The table also reveals that majority of the poultry egg farmers were between the ages of 41 and 50years. The mean age of the poultry egg farmers was 45.1years. This shows that the poultry egg farmers were in their economically active age and as such will respond positively to any technological change aimed at improving their level of production.

The distribution of marital status of the poultry egg farmers shows that 68.3% were married while the rest were single, divorced or widowed. These results indicate that most of the poultry egg farmers possibly had extra hands to help out with the farm work. Furthermore, most of the poultry egg farmers (88.9%) had one form of formal education or the other. The table shows that majority of the farmers (75.0%) had approximately 9 years of experience. The years of experience of a farmer will have positive effect on his productivity (Gabdo, Mansor, Kamal and Ilmas, 2017; Yusuf and Malomo, 2007). This is because such farmer is expected to have gathered problem-solving knowledge over the years.

Using Poultry Association of Nigeria (PAN) classification, the results presented in Table 1 show that 62.2 % of the sampled poultry egg farmers were medium-scale farmers. The number of birds owned by farmers affects productivity: the higher the number of birds, the higher the efficiency of production since inputs/resources can be used much more efficiently. Furthermore, various kinds of housing systems were used by the poultry farmers, however, most poultry egg farmers (62.8%) preferred battery cage system since it eases process of egg collection.

Furthermore, Table 1 shows the various sources from which the farmers get information on inputs and output. From the Table, ICTs (68.3%), personal experience (55.6%) and fellow farmers (41.7%) were the most important sources of information used by the sampled poultry egg farmers, in decreasing order of importance. The Table also reflects the moribund nature of the extension system in the study area as only 2.2% of the farmers get information from extension agents. Similarly, the poultry association served approximately a third of the farmers as source of information while cooperative had very little significance (3.3%). The association seemed to be less important as source of information because of large presence of ICTs. The farmers also resorted to self-help (personal experience and fellow farmers) as alternatives since these were close-by and thus required little effort to utilise.

From the results, less than half of the poultry egg farmers in the study area (38.9%) belonged to poultry association. This implies that more than half of the poultry egg farmers did not have access to some of the benefits usually enjoyed by being members of the association which would have contributed positively to their productivity.

Table 1. Distribution of poultry egg farmers by their socio-economic characteristics

Variables	Categories	Frequency	Percentage (%)
Sex	Male	129	71.7
	Female	51	28.3
Age (years)	21-30	20	11.1
	31-40	49	27.2
	41-50	57	31.7
	51-60	39	21.7
	>60	15	8.3
Marital status	Single	48	26.7
	Married	123	68.3
	Divorced	5	2.8
	Widowed	4	2.2
Level of Education	No formal education	20	11.1
	Koranic education	1	0.6
	Adult literacy training	4	2.2
	Primary education	9	5.0
	Secondary education	28	15.6
	Tertiary education	118	65.5
Farming experience (years)	2-10	135	75.0
	11-20	36	20.0
	>20	9	5.0
Number of birds	1-500	55	30.6
	501-10,000	112	62.2
	>10,000	13	7.2
Housing system	Battery cage	113	62.8
	Deep litter	54	30.0
	Both	13	7.2
Information sources	Friends and family	42	23.3
	Extension agents	4	2.2
	Personal experience	100	55.6
	Poultry association	61	33.9
	ICTs	123	68.3
	Fellow farmers	75	41.7
	Cooperative society	6	3.3
Membership of poultry association	No	110	61.1
	Yes	70	38.9

Source: Field survey, 2017

Information and Communication Technologies (ICTs) use among poultry egg farmers

Table 2 shows the distribution of the poultry egg farmers by the type of ICT used in the production process. Highest number of respondents made use of the phone, then the internet. The index of ICT use is shown in Table 3. The phone has the highest level of use (0.567), followed by the radio (0.425). This is corroborated by responses to the Likert-type question on the extent to which egg farmers made use of ICTs to access information on subsidies, stocks, equipment, weather condition, new technology, credit facilities, market trends, health, animal feeding and nutrition, government policies, among others. The scores (see table in the appendix) show that phone was the mostly used ICT, followed by the radio while prints was the least used. The egg farmers used phone to access information mostly on marketing and feeds, while radio was used to get information on the environment and government policies/plans.

Table 2: Distribution of respondents based on ICTs used in production

ICT type	Frequency*	Percentage
Radio	65	36.1
Television	27	15.0
Prints	33	18.3
Phone	171	95.0
Computer	49	27.2
Internet	73	40.6

Source: Field Survey, 2017
* Multiple responses

Table 3: Summary statistics of ICTs use indices

ICT type	Mean	Std. dev.	Min.	Max.
Radio	0.425	0.177	0.25	1
Television	0.371	0.167	0.25	1
Prints	0.347	0.150	0.25	0.854
Phone	0.567	0.187	0.25	1
Computer	0.397	0.208	0.25	1
Internet	0.412	0.918	0.25	1

The ICTs use indices for individual farmers were aggregated to get the ICT index. The distribution of this aggregate index is shown in Table 4. From the table, it can be seen that the level of ICTs use was low as high percentage distribution of ICTs use index was found within the 0.15-10.55 indices mark. The mean ICTs use index was also below average at 42%.

Table 4. Aggregated ICTs use indices among poultry egg farmers

ICTs index range	Frequency	Percentage
0.15-0.35	72	40.0
0.36-0.55	82	45.5
0.56-0.75	23	12.8
0.76-0.95	3	1.7
Total	180	100.0
Maximum ICT index = 0.8090		
Minimum ICT index = 0.2604		
Mean ICT index = 0.4196		
Standard deviation = 0.1232		

Source: Field survey, 2017

Analysis of technical efficiency (TE) of the poultry egg farmers

The summary statistics of the variables used in calculating the technical efficiency and other important production data are presented in Table 5. The results of the assessment of the level of technical efficiency of the poultry egg farmers are also presented in Table 6. The mean efficiency of the poultry egg farmers was 0.43, implying that on average, sampled poultry egg farmers are 42.6% technically efficient and 57.4% technically inefficient. In other words, poultry farmers could reduce their input units by 57.4 percent to achieve the same unit of output. The mean technical efficiency of the poultry farmers was 0.43 (43%), implying that the poultry egg farmers were not efficient as the observed output was 57% less than the maximum output. This may be due to management issues as many of the farmers complained about the cost of feed and therefore tried to reduce the quantity of feed given to the birds.

Also, from the table, it could be seen that there were variations among the poultry egg farmers in terms of technical efficiency. The frequencies of occurrence of the technical efficiency between 0.05 and 0.45 representing about 67.8% of the sampled poultry farmers, indicate that majority of the farmers were not technically efficient in producing given maximum level of output with the given combination of inputs.

Table 5: Summary statistics of TE (and associated) variables

Item	Mean	Std. dev.	Min.	Max.
Price of birds (chicks) (N)	155.3	41.3	100	250
Price of birds (POL) (N)	1,316.7	200.2	500	2,100
Feed intake (bags)	385.9	705.4	15	4,600
Price of feed/bag (N)	3,043.8	454.3	1,700	4,700
Cost of drugs (N)	4,700.0	4,423.2	1,000	15,000
Labour (manday)	28.1	32.7	3.5	208.3
Labour wage /manday (N)	716.0	318.4	119	2,000
Egg output (crates)	83.4	135.5	4	800
Price of egg/crate (N)	784.5	37.8	700	850

POL: Point-of-Lay

Table 6. Distribution of the TE indices of the poultry egg farmers in Ibadan, Oyo State

Technical efficiency (TE) range	Frequency	Percentage
0.05-0.25	54	30.0
0.26-0.45	68	37.8
0.46-0.65	26	14.4
0.66-0.85	14	7.8
0.86-1.00	18	10.0
Total	180	100.0

Maximum Technical Efficiency = 1.00
Minimum Technical Efficiency = 0.1388
Mean Efficiency = 0.4264
Standard deviation = 0.2491

Effects of ICTs use on technical efficiency of poultry egg production

The effects of ICTs use on technical efficiency of poultry egg production is presented in Table 7. Four variables were found to significantly influence technical efficiency of egg production in the study area. Three of the variables were found to have positive effects on the technical efficiency: secondary education, tertiary education, and phone use index, while only membership of poultry association had negative relationship with the technical efficiency. The coefficients of secondary and tertiary education were 0.176 and 0.135 with levels of significance of 5% and 10%, respectively. The results show that the more educated a poultry egg farmer is, the higher the technical efficiency relative to a farmer with no formal education. This is in agreement with the result of Malsha *et al*. (2011) who noted that investment on learning and improvement in ways of getting knowledge and information will improve the technical efficiency in the production process. Results from Table 7 also show that the use of phone, as an ICT tool, increased technical efficiency by 16.6% with a significant level of 10%. Some studies (Malsha *et al*., 2011; Ali *et al.*, 2016) have found similar positive relationship between ICTs use and efficiency. In contrast, belonging to poultry association reduced the technical efficiency of the egg farmers by 11.2% at 5% significant level. Although Adedeji, Kazeem, Ogunniyi and Otekunrin (2013), Sanusi and Olagunju (2013) and Adesiyan (2014) stated that belonging to poultry association affects the efficiency of a poultry farmer positively, the negative effect of PAN membership on technical efficiency of the egg farmers might not be unconnected with huge amount being paid for membership subscription (farmers complained about this during data collection) which might have deprived them of the inputs necessary to improve technical efficiency.

Table 7. Parameter estimates of the effects of ICTs use on technical efficiency of poultry egg farmers

Dependent Variable: Technical Efficiency (TE)	Tobit Regression		
	Coefficients	Standard error	t-statistics
Sex: Female	0.011	0.044	0.25
Age	0.002	0.002	0.78
Marital status			
Married	0.038	0.048	0.80
Divorced	0.047	0.111	0.43
Widowed	0.100	0.131	0.77
Education			
Koranic education	-0.059	0.239	-0.25
Adult literacy education	-0.053	0.132	-0.40
Primary education	0.030	0.093	0.32
Secondary education	0.176**	0.076	2.32
Tertiary education	0.135*	0.069	1.96
Experience in poultry production	-0.006	0.004	-1.59
Credit access	-0.031	0.039	-0.80
Membership poultry association	-0.112**	0.052	-2.14
Length of PAN membership	0.008	0.006	1.27
Length of cooperative membership	-0.003	0.006	-0.61
Radio use index	-0.157	0.123	-1.28
TV use index	0.010	0.172	0.06
Print use index	-0.187	0.170	-1.10
Phone use index	0.165*	0.098	1.69
Internet use index	0.016	0.108	0.15
Constant	0.323***	0.116	2.77
/Sigma	0.225	0.012	
Number of obs = 180; Log likelihood= 12.20; Pseudo R^2: 2.84			
LR $chi^2(20)$ = 37.64; Prob > chi^2=0.0098			

Significance level: *** 1%; **5% and *10%.

CONCLUSION AND RECOMMENDATION

Egg farmers in the study area have the opportunity of improving efficiency of production through the deployment of ICT tools and other inputs. To achieve this, however, the capacity of the farmers needs to be enhanced through trainings in egg production and in the use of various ICT tools. Ability to use the tools will improve productive capacities of the egg farmers thereby increasing their technical efficiency. The poultry association should also be better regulated to ensure inclusion of their members.

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APPENDIX

Table A1: Respondents' scores from Likert scale measurement of ICTs use for information access

	Reason for accessing information	Information and Communication Technologies (ICTs)					
		Radio	**Television**	**Prints**	**Phone**	**Computer**	**Internet**
1.	Subsidies	97 (0.54)	66 (0.37)	77 (0.43)	168 (0.93)	95 (0.53)	98 (0.54)
2.	Stocks	93 (0.52)	79 (0.44)	79 (0.44)	284 (1.58)	137 (0.76)	105 (0.58)
3.	Equipment	109 (0.61)	70 (0.39)	69 (0.38)	176 (0.98)	115 (0.64)	93 (0.52)
4.	Weather condition	154 (0.86)	110 (0.61)	46 (0.26)	129 (0.72)	95 (0.53)	145 (0.81)
5.	Adoption of new technology	81 (0.45)	79 (0.44)	54 (0.30)	266 (1.48)	109 (0.61)	163 (0.91)
6.	Credit facilities	110 (0.61)	79 (0.44)	65 (0.36)	161 (0.89)	96 (0.53)	95 (0.53)
7.	Marketing	84 (0.47)	68 (0.38)	63 (0.35)	404 (2.24)	110 (0.61)	106 (0.59)
8.	Health	117 (0.65)	84 (0.47)	78 (0.43)	330 (1.83)	107 (0.59)	156 (0.87)
9.	Feed	124 (0.69)	94 (0.52)	87 (0.48)	359 (1.99)	124 (0.69)	155 (0.86)
10.	Government policies and plan	184 (1.02)	127 (0.71)	71 (0.39)	115 (0.64)	91 (0.51)	94 (0.52)
11.	Business and trade	167 (0.93)	95 (0.53)	84 (0.47)	212 (1.18)	102 (0.57)	92 (0.51)
12.	Environment	192 (1.07)	90 (0.50)	62 (0.34)	133 (0.74)	86 (0.48)	99 (0.55)
	Total	**1512**	**1041**	**835**	**2737**	**1267**	**1401**

Likert scale: *Never=0; Rarely=1; Occasionally=2; Regularly=3*. Averages are in parenthesis