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INFORMATION AND COMMUNICATION TECHNOLOGIES' USE PROFICIENCY AND THE POULTRY WASTE MANAGEMENT PRACTICES OF FARMERS IN NIGERIA

[*1]Olanrewaju, K.O., [1]Idris-Adeniyi K.M., [1]Adebayo, S., [2]Famakinwa M. and [1]Adeyemo I.A.
[1]Department of Agricultural Extension and Rural Development, Osun State University, Osogbo, Nigeria
[2]Department of Agricultural Extension and Rural Development, Obafemi Awolowo University, Ile-Ife, Nigeria
**Corresponding Author's e-mail: khadijat.olanrewaju@uniosun.edu.ng*

Abstract
Information and communication technologies (ICT) represent a veritable tool for developing farmers' capacities in resource optimization and sanitation for environmental protection. Poultry farmers' proficiency in ICT use for facilitating eco-friendly waste management in line with the sustainable development goal of clean water and sanitation was evaluated. A random survey (n = 113) of the members of four major poultry farmers' groups in Ibadan metropolis was done for data collection. A validated interview schedule was used for data collection. Data analysis entailed descriptive and regression analyses for hypothesis testing. Results show that the poultry farmers, predominantly males, were more proficient in using social media and online videos. Only one-fifth of them explored ICT for waste management purposes, while 15.4% and 15.9% used it for learning safe disposal and handling methods. An average of 17% and 16.6% of the respondents disposed of their poultry wastes through open dumping and dug pits, respectively. Farmers' exploration of ICT for learning about waste management purposes was significantly related to their proficiency in ICT usage ($F = 63.4$ at $P \leqslant 0.001$). Low level of ICT use proficiency is responsible for its limited exploration as a transformative panacea to the continued use of objectionable waste management practices in Nigeria. Specialized training sessions aimed at improving poultry farmers' ICT knowledge and skills, thus enhancing their ICT use proficiency, should be implemented by the state Agricultural Development Program or any intervention initiative.

Keywords: Clean Water and Sanitation, ICT, Sustainable Development Goals, Poultry Wastes, Waste Disposal

Introduction

Poultry is a crucial source of protein for human consumption, as it has provided a huge quantity of animal protein for human consumption. Given its extraordinary acceptability, the global consumption of poultry products soared tremendously in the past few decades. Poultry has now surpassed other meat types in terms of its quota of total meat production in the world (Schierhorn et al., 2019; Zhang et al., 2023). In Nigeria, the contribution of poultry production to economic growth, income generation, and food security cannot be overemphasized (Odumosu et al., 2020). The monumental production expansion is however trailed with attendant issues, particularly the menace of managing the gamut of generated wastes.

Through widespread improper treatment of the constantly generated poultry wastes, the industry contributes a lion's share to environmental problems (Qian et al., 2018). These wastes come from the by-products of hatcheries, poultry droppings or litter, slaughter and processing especially feathers, routine management wastes like feed remnants, dead birds etc. These wastes have the potential of releasing a large volume of greenhouse gases, thereby contributing to environmental degradation underlining climate change (Adegbeye et al., 2020; Chiarelotto et al., 2021). Moreover, poultry wastes may be hazardous to human health by enabling the spread of pathogens and diseases (Hu et al., 2017). However, research and development have generated technologies that enable the recycling and reuse of the wasting resources to produce other valuable products. Evidently, poultry wastes are utilized as raw materials for the production of agrochemicals, textiles, biodiesel and wood adhesives among many others (Zhang et al., 2023).

Specifically, it is established that poultry litter consists of essential plant and animal nutrients given its high crude protein and minerals levels (Adekiya et al., 2019; Begum et al., 2023). This underscores its wide usage as effective organic fertilizer for supplementing soil nutrients and organic matter improvement for crops production for human consumption as well as livestock feed production (Modak et al., 2019). This use drastically limits the associated negative impact of open dumping of poultry litter especially in its pollution of water bodies with released nitrate and phosphate and air pollution from ammonia and hydrogen sulfide gas (Dai et al., 2015). Also, the open dumping offers substrate for pathogens growth, thereby posing a critical menace for public health (Kyakuwaire et al., 2019). This aesthetically substandard disposal mechanism is equally destructive to the environment. Thus, a standardized transformation of the wastes' disposal portends a valuable strategy for alleviating environmental and health hazards related to poultry wastes (Koul et al., 2022). As such, proper waste management by poultry farmers is necessitated in adherence to the stipulations of the Sustainable Development Goals (SDG) of promoting a clean environment and sanitation, as highlighted in the SDG Goal 7: clean water and sanitation.

To this end, Information and Communication Technologies (ICTs) are relevant for empowering the pursuit of environmental sustainability in poultry production. ICT simply includes hard and soft computer related tools used for the collection, storage, processing, facilitation, presentation and transmission of information for various uses (Aceto et al., 2019). These tools are crucial to farmers for facilitating easier accessibility to input usage in the right quality and quantity, thereby limiting waste, as well as offering learning platforms for informing farmers with optimum waste handling techniques, alternative uses, and eco-friendly management, among others. The alternative offered with ICT overturns the limitations of the traditional agricultural communication involving scheduled visits of extension agents to farmers, which is gradually fading away in Nigeria due to high shortage of extension personnel and many systemic problems. This highlights the imperative of ICT deployment in order to enhance agricultural productivity and resource optimization, including waste management capacities of farmers (Oladipo & Olaniyi, 2020; Amidu et al., 2021).

The highlighted need for sustainable poultry farming in Nigeria requires a facility for adequate information access by the farmers (Kalio, 2020). ICT is proven in this regard as a mechanism for bridging the information divide and enabling farmer capacity development (Bhattacharjee & Raj, 2018; Chauhan et al., 2016). Therefore, ICT deployment can be an effective panacea to the reduction of massive poultry waste generation, limit environmental impact, and inculcate the utilization of poultry wastes in Nigeria. To this end, this study was conceived to assess farmers proficiency in ICT utilization for poultry waste management uses. As such, this study examined poultry farmers' level of proficiency in ICT use, identified the waste management practices employed by the poultry farmers, and assessed poultry farmers' level of exploration of ICTs for poultry waste management in the study area.

Materials and Methods

Study Area

The study was conducted in Ibadan metropolis, the capital of Oyo State, Nigeria. The state has an estimated total population of 3,649,000 people for the year 2021 and Ibadan occupies a strategic location in terms of linkage of many Yoruba towns to the most populous and industrialized Lagos State in Nigeria.

Study Population and sampling

The study population was the poultry farmers in Ibadan, Oyo State. The members of organized poultry farmers' groups in Ibadan were targeted and sampled for data collection. Adopting Yamane sample size calculation based on an aggregated total population (N) of 153 farmers from 5 groups identified, the required sample size (n) of 110 farmers was increased to 120 respondents during the field survey. The respondents' selection was done using proportionate random sampling technique. However, a total of 113 sufficient responses were recorded and eventually processed for analysis.

Data collection and analysis

The instrument used for the data collection was a validated interview schedule, while the collected data were analyzed using descriptive tools including frequency counts and percentages, and regression analysis was conducted for inferential analysis. Poultry farmers' literacy of ICT was adjudged based on their level of proficiency in the use of ICT, and this was measured using Olatoye *et al.* (2021) 5-point rating scale of ICT use expertise.

Results and Discussions

Socio-Economic Characteristics of Farmers

Results in Table 1 show a good representation (34.51% and 31.85%) of young (below 40 years), respectively and middle-aged (40–50 years) people among the poultry farmers, and this is depicted with a mean age of 44.5±12.5 years. This affirms that the poultry farming sector is operated by people within the most productive age range who have the capability to invest the requisite energy in the production activities as reflected in the findings of Owolade et al. (2016). More than half (58.41%) were males, and the females constituted 41.59%. Despite the reflection of male dominance, the substantial proportion of females indicates the current trend of increasing females' involvement in entrepreneurial livelihoods. Over fifty percent (51.33%) of the farmers had households with five to eight people, and the mean household size was about five people. One-third (34.82%)

of the farmers had not more than six years of formal education; 39.29% had seven to twelve years of education; and the remaining one-quarter had more than twelve years of education. This reflects that the majority of the farmers had post-primary school education, which can be equated to the expectation of a high level of literacy among the poultry farmers. This corroborates the finding of Olanrewaju et al. (2021) which exemplified high level of literacy in poultry farmers' groups in Nigeria.

Table 1: Distribution of Poultry Farmers by their Socio-Economic Characteristics

Socio-economic variables	Frequency	Percentage	Mean±sd
Age (years)			44.5±12.5
Below 40	39	34.51	
40-50	36	31.85	
Above 50	38	33.63	
Gender			
Male	66	58.41	
Female	47	41.59	
Household sizes			
0-4	46	40.71	4.9±2.5
5-8	58	51.33	
9 and above	9	7.96	
Years of education			8.9±6.3
1-6	39	34.82	
7-12	44	39.29	
Above 12	29	25.89	
Types of birds raised*			
Broilers	83	73.45	
Layers	42	37.17	
Turkeys	29	25.66	
Quails	2	1.77	
Undergone any training on poultry production	34	21.24	
Participated in ICT training	33	29.2	
Participated in CBO	72	63.72	

*Multiple responses

Source: *Field Survey (2022).*

The majority (73.45%) of them were raising broiler birds for chicken production, while 37.17% were raising layers for egg production. Also, one-quarter of the farmers indicated that they were into turkey production. This reveals that poultry production was mostly for meat and egg production. Furthermore, about one-fifth (21.24%) were privileged to be technically trained on poultry production. Such participation in any form of formal training on

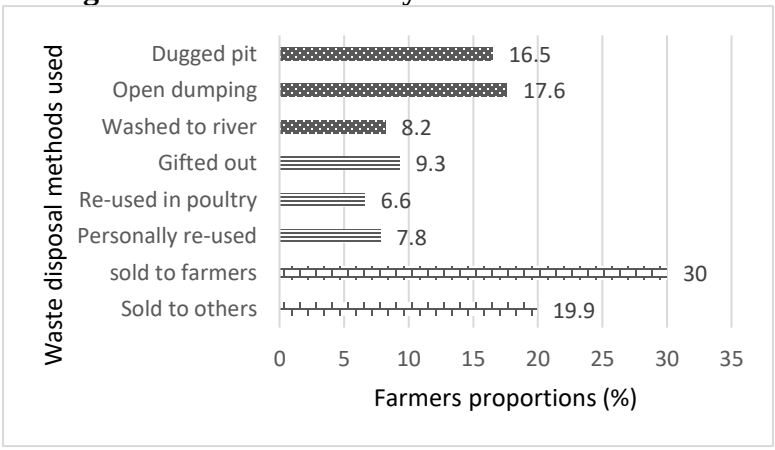
poultry production could inform their exposition and consequent adoption of sanitation practices in poultry waste management. Similarly, 29.2% had undergone training on ICT use. This has the potential to underpin improved proficiency in resourceful utilization of ICT for capacity development on waste management and disposal choices. Also, many of the farmers (63.7%) were participating in community-based organizations. The dimension of their participation in the CBOs is of high potentials as being active members in community development organisations may likely enhance the drive to explore available means like ICT to learn and implement proper sanitation in poultry waste disposal.

Poultry Waste Management Techniques

Results in Figure 1 show the various techniques employed by farmers for disposing their farm waste. It shows that sizable proportions of the farmers (17.6% and 16.5%) employed open dumping and pits, respectively, for disposing the poultry wastes, and 8.2% washed the wastes into rivers. This shows the incidence of unwholesome waste management methods, especially dumping in open spaces, pits, and pollution of water bodies with waste piles. This reiterates the substantial contribution of the poultry industry to environmental pollution due to the persistence of improper disposal constituting a menace to the environment (Adegbeye et al., 2020; Chiarelotto et al., 2021; Qian et al., 2018). This finding signifies an urgent need for a pragmatic redress to the menace of open dumping of wastes and the need to protect water-related ecosystems, which are critical targets of SDG Goal 6 (Clean Water and Sanitation).

Furthermore, about one-tenth (9.3%) of respondents gave out their poultry waste as gifts to crop farmers, while close to one-third (30%) sold the wastes to farmers for manuring. The results reveal the gradual evolution of poultry wastes recycling as a source of manure for crop production purposes. This reflects the increasing grass-roots recognition of the potentials of poultry wastes, especially the litter, which forms a larger portion of the generated waste. As such, the innumerable potentials of the wastes, especially for crop fertilization, as highlighted by Modak et al. (2019), among other scholars, could be adjudged to be becoming popular among rural farmers. Improved sensitization on this and logistical support could ameliorate the highlighted persistence of land and water pollution, which are major drawbacks to the 2030 SDG targets.

Figure 1: Summary of Poultry Waste Management methods used by Farmers



Source: *Field Survey (2022).*

Level of Proficiency/Expertise of ICT Use

Results in Table 2 show that the majority of the farmers were highly proficient in the use of social media messaging (WMS = 3.81), online video and audio lectures (WMS = 3.50), e-

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mails (WMS = 3.49), and web documents (WMS = 3.18). On the contrary, the farmers were least proficient in accessing online archives (WMS = 1.96) and repositories of agricultural organizations (WMS = 2.26). The results depict that the farmers were most conversant with online social media messaging and the use of emails. This could be expected given the popularity of social media pages for social networking and entertainment purposes. This finding corroborates that of Bolarinwa et al. (2021), which affirmed livestock farmers' use of social media in various dimensions.

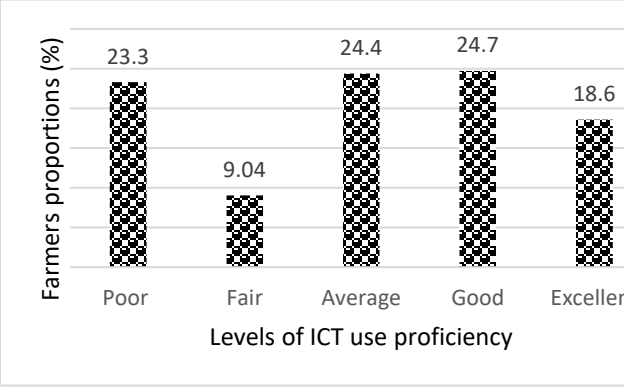
Overall, the evidence in Figure 2 shows a summary of farmers aggregate level of expertise in the use of ICTs. It shows that about one quarter each (24.4% and 24.7%) had average and good expertise in ICT usage, respectively. Less than one fifth (18.6%) were excellent in ICT use proficiency, while 9.04% and 23.3% had fair and poor levels of ICT use proficiency, respectively. Based on these results, it is evident that the majority of the poultry farmers were not yet proficient users of ICT, but rather at an average level. This could be underlined by the predominant poor technical knowledge of farmers in operating many ICT tools (Kalio, 2020; Olayiwola et al., 2023) Thus, the competence of the poultry farmers in exploring the diverse ICT potentials for optimizing their production processes needs to be capacitated to ensure maximum benefits to the farmers. Indicated foremost literacy of social media usage by the farmers could be leveraged as basis for purposeful sensitization on eco-friendly waste management.

Table 2: Expertise of ICT media use

ICTs	Poor	Fair	Average	Good	Excellent	Weighted Mean Score
Online/social media messages	4.42	4.42	27.43	31.86	31.86	3.81
Online video and audio lectures/	7.96	708	27.43	37.17	20.35	3.50
Electronic mail (e-mail)	2.65	14.16	31.86	32.74	18.58	3.49
World wide web-based documents	14.16	8.85	30.97	27.43	18.58	3.18
Digital electronic media	29.20	11.50	18.58	22.12	18.58	2.62
Search engines for accessing sites and links	32.74	7.08	20.35	17.70	22.12	2.59
Electronic/online library resources	38.05	7.96	17.70	20.35	15.93	2.35
Online repositories of international agricultural organizations	35.40	10.62	23.89	20.35	9.73	2.26
Online archives	45.13	9.73	21.24	12.39	11.50	1.96

Source: *Field Survey (2022).*

Figure 2: Levels of ICT Use Expertise of poultry farmers



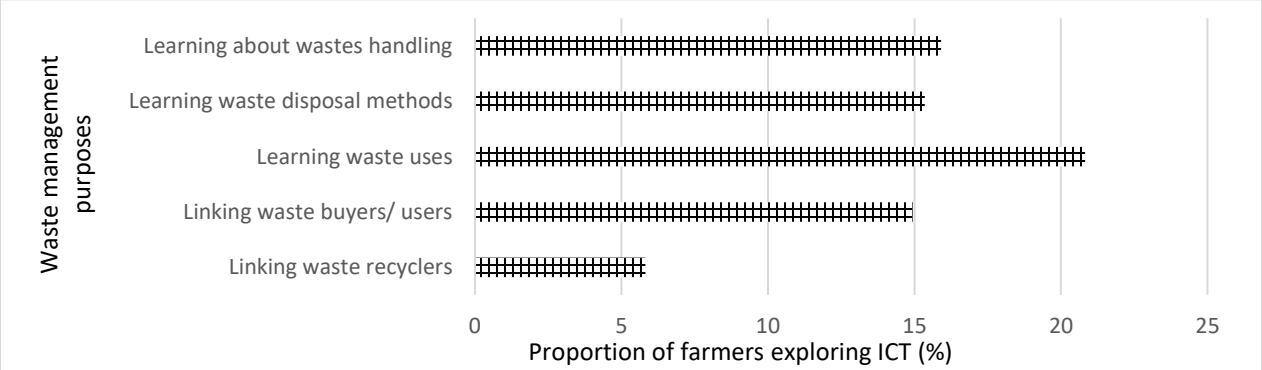
Source: *Field Survey (2022).*

Exploration of ICT for Waste Management Purposes

Exploration of ICT for waste management purposes results in Figure 3 shows that ICT was mostly employed by farmers for learning about poultry waste use (20.83%), followed by learning about environmentally friendly waste disposal methods (15.35%) and techniques for waste handling (15.95%). A smaller proportion (14.94%) indicated their ICT exploration for linking up with potential buyers of their poultry wastes, while only 5.82% explored ICT to access waste recyclers. This result reveals farmers' use of ICT for learning about effective and more sustainable waste management methods. As such, the potential of ICT for bridging the information gap for farmers is highlighted. The limited exploration of ICT for various purposes, however, earmarks the need for greater sensitization of the farmers to these possibilities.

These findings entrench the role of ICT as an important tool in addressing poor waste management in poultry farming. Through ICT, farmers have the opportunity to be sensitized, learn, and develop capacity for eco-friendly poultry waste management. Due recognition of the potentials of ICT, especially social media usage, is necessitated in the national strategies towards achieving SDG goal 6: clean water and sanitation in Nigeria.

Figure 3: ICTs Exploration for Poultry Waste Management Purposes



Source: *Field Survey (2022).*

Proficiency in use of ICT and extent of exploration for waste management

Results in Table 3 show that farmers' ICT use proficiency significantly influences the depth of exploration of ICT for learning about sustainable waste management practices. As such, farmers' improved expertise in using ICT would translate into substantial use of ICT for waste management purposes. This means that a limited proportion of proficient ICT users among the farmers underpins less popularity of ICT exploration for deepening farmers' knowledge and practice of effective options for environmental-friendly poultry waste management. Inadvertently, the literacy level of poultry farmers determines the extent to which they explore ICTs for learning about waste management.

Table 3: Results of Relationship between Farmers' ICT Use Proficiency and Exploration for Waste Management

	Unstandardized coefficient	**Standard error**	**T**	**P value**
ICT use proficiency	0.146	0.018	7.96	0.00
Constant	2.535	0.510	4.97	0.00

F= 63.40; R^2= 36.78

Source: *Field Survey (2022).*

Conclusion and Recommendations

The study affirms the perpetuation of traditional and environmentally hazardous poultry waste disposal practices including open dumping, piling in pits and washing into water bodies and thereby highlights the notion that SDG 6 target of ending open dumping and protecting water-related ecosystems is yet to be achieved in Nigeria. The poultry farmers were largely inept in the use of ICT, and this is indicated as underscoring the limited exploration of ICT for learning and linking up for safe waste management practices. It was concluded that low level of ICT use proficiency is responsible for its limited exploration as a transformative panacea to the continued use of objectionable waste management practices in Nigeria. It is recommended that specialized training sessions aimed at improving poultry farmers' ICT knowledge and skills, thus enhancing their ICT use proficiency, be prioritized by poultry farmers groups in Nigeria. Recognition and support of ICT for pragmatic usage by farmers needs to be urgently incorporated into national strategies in the strive towards the attainment of SDG goal 6—clean water and sanitation in Nigeria.

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