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The Influence of ICT Usage in Sharing Information on Fish Farming Productivity in the Southern Highlands of Tanzania

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Abstract:
The use of ICTs in sharing information is very important in enhancing fish farming productivity among fish farmers. However, little is known on the linkage that exists between the use of ICTs and fish farming productivity in southern highlands of Tanzania. This study was conducted in three regions namely; Ruvuma, Mbeya and Iringa and involved twelve divisions purposively selected from six districts. The study involved 240 fish farmers who were randomly selected; it employed a cross section research design. The study used both quantitative and qualitative approaches in collecting data. Questionnaires, Focus Group Discussion (FGD), observation and key informants interview were used to collect data. Both descriptive and inferential statistics were used to analyze quantitative data while content analysis was used to analyze qualitative data. Findings indicate that mobile phone, radio and television were the most used ICTs tools among fish farmers for sharing agricultural information. In addition, the study revealed a higher fish farming productivity in Mbinga and Mufindi districts as compared to Iringa District. Moreover, the use of ICTs (radio, mobile phones and television) for sharing agricultural information was found to influence fish productivity. Furthermore, other factors including income, family size, use of poultry manure as pond fertilizer and pond size had a statistical significant and positive relationship with farmer's productivity. Thus, it is recommended that the media owners and other information providers should disseminate more agricultural programmes related to fish farming practices and make sure that such information is disseminated during appropriate and convenient time for farmers.

Keywords: *Agricultural information, information and communication technologies, information accessibility, fisheries, fish farming productivity, fish farming, fish farmers, Tanzania*

1. Introduction

Agriculture is the backbone of most African countries. In Tanzania, the sector employs about 80% of the total population (World Bank, 2014), contributes about 25.7% to the Gross Domestic Product (GDP) and 30.6% the foreign exchange (URT, 2010). Fish farming serves as a means of livelihoods to millions of people worldwide (FAO, 2016). In Tanzania, fish farming plays a significant role in building and strengthening a strong national economy by increasing household income, food security and employment opportunities. In 2014 the Tanzania fish farming sub-sector employed 183,800 full time fishermen and about 4.0 million people earned their livelihoods from fish farming related activities (URT, 2015). In addition, the sector contributed about 2.4 percent to the GDP (URT, 2016).

Tanzania has the greatest fish farming potential in Africa with suitable land and water bodies' resources. It has a total of 21,300 grow-out earthen ponds and nine raceway systems which are in operation (URT, 2015). These ponds can contribute to poverty reduction and enhance food security in the country. Despite of the existing potentials of fishery sector, fish farming in Tanzania is constrained by inadequate aquaculture extension, unavailability of quality fish seeds and feeds, inadequate aquaculture information and knowledge, poor transport infrastructure, unreliable markets, limited accessibility of capital and low incentives to aqua-farmer investors (URT 2010; Shoko et al., 2011; Ogello et al., 2013; Chenyambuga et al., 2014).

For rapid growth of fish farming, efficient flow of information and knowledge to the fish farmer on pond management practices is important. The sector depends on continuous flow of information and knowledge from local, regional and world markets (Rutger, 2000; Akinpelu *et al*., 2013). Like other agricultural sub-sectors, information in fish farming practices is very important for increasing productivity (Opara, 2008). Rational decisions on fish farming depend much on the availability of

timely and reliable information. Such information helps fish farmers decide on how to allocate inputs, find appropriate markets for products or produce, and decide on the best post-harvest storage of products (Demiryurek *et al*., 2008). According to Riesenberg (1989), Aphunu and Atoma (2011), optimal fish farming production depends on having an edge on information related to the market, efficient allocation of available resources and use of new or innovative farming practices. Mudukuti and Miller (2002) emphasized that in the information age, dissemination of agriculture information and applying this information in the process of fish farming production will play a substantial role in the development and improvement of fish farming. When acquired and effectively utilized by the fish farmers, such information helps to increase fish production and hence increase income and improve farmers' standard of living. A study from Nigeria found that fish farmers need to have access to agricultural information in order to improve their aquaculture production (Adomi *et al*., 2003). Thus, adoption of improved fish farming practices requires adequate access to information. Such information should be effectively disseminated to the famers and other stakeholders.

Several traditional approaches have been used by fisheries officers in delivering and disseminating information and knowledge to fish farmers in Tanzania. These approaches include public awareness creation, training such as Farmer Field School (FFS), demonstration and farmer visit (Kimaro *et al.,* 2010; NAP, 2012). However, these approaches have been constrained by inadequate extension capacity. Presently, there are 436 fisheries extension officers out of 16,000 who are required in the country to meet information and knowledge needs of fish farmers (URT, 2015) such a constraint decreases the dissemination of information and knowledge to fish farmers (Yaseen *et al.,* 2015). In addition, some of those fishery officers do not have adequate and relevant knowledge on fish farming, because some of them have been trained on livestock or crop production, a situation that makes it difficult for farmer to acquire the right information and consequently lead to poor fish farming productivity. Due to low capacity and/or limited understanding of fish farming environment by the fishery extension officers, extension services have therefore not led to significant increase in production (CUTS International, 2011). ICT use (Radio, TV and mobile phones) can play a critical role in this regard.

ICTs are sets of technologies that facilitate the capturing, storage, processing, and disseminating information by electronic means (Akinbile & Alabi, 2010). The range of technologies is growing all the time and there is convergence between the new and old media. The new media are computers, mobile phones and the internet, while the old media include radio, television, telephone and fax, among others.

The revolution of ICTs globally has opened larger opportunities for efficient information sharing in many sectors including fish farming sub-sector. ICT can play a key role in providing extensionists and fish farmers with vital information needed for fish farming activities (Munyua *et al*., 2008). ICTs enable interactive communication among farmers unconstrained by location/distance, volume, medium, or time as compared to traditional technology dissemination methods, such as field demonstrations, printed material, group meetings, or face-to-face (Joel and Adigun, 2013; Samansiri and Wanigasundera, 2014). Thus, a farmer can make use of various ICTs tools such as radio, television, mobile phones to access and share relevant and timely agricultural information for improved fish farming. Fish farmers can apply ICTs to increase fish farm productivity by providing farmers with access to information which enables them in matching fish farming practices to climatic trends, use inputs and resources optimally, and ensure good fish farming practices through improved fish breeds, disease control, market access, and pond management (Donovan 2011). Success in any fish farming enterprise is largely determined by the amount of information related to fish pond management practices provided and used by farmers (Soyemi, 2014), Chenyambuga et al. (2014), (Mwaijande and Lugendo, 2015).

1.1. Problem Statement and Justification

Fish farmers in the Southern Highlands of Tanzania lack vital agricultural information, leading to inefficiencies, inequity, poor productivity and post-harvest losses (Mwaijande and Lugendo, 2015). Inadequate access to knowledge on inputs and pond management among fish farmers has dwarfed the growth of the sub-sector in in the Southern Highlands of Tanzania (Wetengere 2011; Chenyambuga *et al.* 2014). Lack of information leads to poor pond management practices which in turn lead to poor fish farming productivity. When fish farmers put into use information related to pond management practices productivity goes to about 10,000 kg/ha/year (Eknath and Acosta 1998; Hussain et al 2000). Under poor access to information on how to manage ponds fish productivity ranges from 2089 kg/ha/year to 4,704kg/ha/year (Shoko et *al.,* 2011; Kaliba *et al.,* 2006). Due to limited usage of fishery production information fish production among small holders in Mbeya is estimated to be 5,312 kg/ha/year (Chenyambuga *et al.* 2014). This situation could be improved by making use of ICTs to timely share the required information, hence solve some of the information related challenges that Southern Highlands farmers face in fish farming. Moreover, the extent to which ICTs have been used in sharing of fishery information for improved fish farming productivity in Tanzania particularly in Southern Highlands is not known. Most studies done so far in the country have either analyzed the usage of the ICTs in accessing agricultural information and other information services (Lwoga 2010; Mwakaje 2010; Mtega 2011; Mtega and Benard 2013), or use of mobiles phones in communicating agricultural information (Nyamba 2011; Churi *et al.,* 2012), or the socio-economic impact of ICTs (Chilimo, 2008; and Nyakisinda, 2009). All these studies have explained ICTs usage without linking it with farmer's productivity especially fish farmers and none of them has been specific to fish farming. In addition, many studies in Tanzania addressing poor yield or low yield on fish farming have concentrated on production-based innovations while none has investigated the impact of ICTs on fish farming productivity.

Thus, this study intended to analyze how these ICTs are used in sharing agricultural information and consequently improving the fish farming productivity in Southern Highlands of Tanzania. Specifically, the study intended to: evaluate the extent of ICTs use in accessing agricultural information by fish farmers in the study area; to examine the productivity level and fish management practices of fish farmers in the study area and to determine the influence of ICTs use on fish farming productivity. The ICT considered in this study comprised the mobile phones, radio, and Television, this is because are the only ICTs tools which are easily available, accessible, affordable and most used by farmers in most areas of Tanzania.

2. Methodology

This study was conducted in 2016 in three regions of the Southern Highlands of Tanzania namely Iringa, Mbeya and Ruvuma. These regions were selected because they have relatively large number of fish farms, long history of fish farming compared to other regions in the country and relatively well-developed ICTs infrastructure (FAO, 2012). According to URT (2013a) Ruvuma, Iringa and Mbeya regions have more numbers of fish ponds as compared to other regions in the country like Arusha, Kilimanjaro, Morogoro, Dar es Salaam. There are 4,942 fish ponds in Ruvuma Region, 3,137 in Iringa Region and 1,176 Mbeya Region (URT ,2013b).

2.1. Sampling procedure and sample size

The sampling frame comprised of all fish farmers in twelve divisions, in six districts namely, Mbeya, Mbarali, Iringa, Mufindi, Mbinga and Songea. The districts were chosen basing on the number of fish farms and presence of ICTs infrastructures like electricity, radio, television cables and mobile networks. Basing on these criteria two districts from each region namely: Mbinga and Songea districts in Ruvuma Region, Mbeya and Mbarali districts in Mbeya Region, and Iringa and Mufindi districts in Iringa Region were selected for this study. From each District, two divisions with at least twenty (20) fish farmers and good ICTs infrastructures were purposefully selected. Twenty fish farmers were randomly selected from each division basing on ownership of at least one type of ICT, and making a sample size of 240 respondents. Bailey (1994) argued that a sample or sub sample of 30 respondents is the bare minimum for studies in which statistical data analysis can be done. In addition, Saunders *et al.* (2007) argued that a sample size of 30 or more will usually result in a sampling distribution that is very close to the normal distribution and the larger the absolute size of a sample, the closer its distribution will be the normal distribution.

2.2 Data Collection Approaches and Methods

The study employed both quantitative and qualitative approaches. Both primary and secondary data were collected. It employed a cross-sectional research design in collecting primary data where data were collected once from individual fish farmers who were the sampling units of the study. Quantitative data were mainly collected using a structured questionnaire while qualitative data were collected from key informant interview and focus group discussions. A prepared interview guide was used for the interview with 6 key informants (one fishery officer in each of the six districts were selected purposefully); and a focus group discussion guide was used during discussions to gather information from 48 fish farmers who had an experience of at least five years in fish farming. One group discussion (eight participants in each of the districts) was conducted in each of selected district. Barbour (2011) recommends that eight participants per session is an adequate number for Focus Group Discussion (FGD). In addition, direct observation was done as method of data collection.

2.3. Data Analysis

With the aid of Statistical Package for Social Sciences (SPSS) Version 20, quantitative data collected through structured questionnaire were statistically analyzed both descriptively and inferentially, while qualitative data were analyzed using content analysis as follows; -

2.3.1. The Extent of ICT Uses In Accessing Agricultural Information By Fish Farmers In The Study Area

To ascertain the extent of ICT, use among the respondents a list of available ICTs was compiled and rated on 4-point Likert type scale, with response options of used very frequently = 4, Frequently =3, occasional = 2, Rarely = 1, Never=, 0. The mean cut off point is 2.00. This implies that any mean score that is equal to or higher than 2.00 is most often used by the respondents while those that are less than 2.00 are categorized as not often used.

2.3.2. To Extent of Productivity Level of Fish Farmers in the Study Area

Fish farming productivity was measured in terms of total kilograms of fish produced by farmer per hectare per year (Kgs/ha/year). One-way analysis of variance (ANOVA) was used to evaluate significant differences of the mean yield among the districts, and Duncan multiple range test were used to detect significant differences between the means. Significant differences were judged at a probability level of $P<0.05$.

2.3.3. The influence of ICTs uses on fish farming productivity

The multiple linear regression equation used for analysis was as follows

The multiple regression equation used for analysis was as follows:

$Y = \beta_0+\beta_1X_1+ \beta_2X_2+...+\beta_nX_n + \varepsilon,$
Where;
Y= Productivity (yield in kg per hectare)
β= Regression Coefficients
β_0= Intercept.
X_1 ...X_n are explanatory variables

ICTs use; (Mobile phone Radio , and Television), 4= Very frequently, 3= Frequently, 2=, Occasionally, 1= Rarely, 0= Never), Feed type: Grains, vegetables , fish me), kitchen waste, Brains, Cakes, Natural food in ponds (Use=1, Do not use =0), type of fertilizer used; Pig manure, Poultry manure, Goat /sheep manure, compost manure, Cattle manure and compost manure coded as Use=1, Do not use =0, Access to extension services (1= have access, 0=do not have access), Source of fingerling (1=official, 0=fellow farmers), Member of farmer group (1=Member, 0 not member), Annual income (Tshs), Family size (Number of household members)**,** Experience in fish farming (in years), (Sex (0=Female, 1=Male), Age (0=Up to 35, 1=more than 35), Marital status (0=Single, 1=Married), Education level (0=No formal education, 1=Primary, 2=Secondary . On the other hands, Variance Inflation Factor (VIF) was used to determine multicollinearity among independent variables while, the Durbin-Watson's d test was used to test for auto-correlations.

3. Results and Discussion

3.1. Social Economic Characteristic Of The Respondents

Table 1 summarizes the findings of the research study on social economic characteristics of the respondents. The study findings revealed that (80%) of the respondents in the study area were males while 20% were females These findings are similar to those of Chenyambuga *et al*., (2012), Chenyambuga (2014), Mwaijande and Lugendo (2015) who also reported that almost all fish ponds surveyed in Morogoro, Ruvuma, Kilimanjaro, Njombe, Mbeya and Dar es salaam regions in Tanzania were owned and managed by male farmers. This perhaps is due to tedious nature of fish farming particularly on pond management practices. This was also noted by Ofuoku *et al. (*2008) from Nigeria who reported that the male dominance in fish farming suggests the laborious nature of farming operations which their female counterparts cannot.

Similarly, findings reveal that nearly half (47.1%) of the respondents were in the age group of 47 to 56 (Table 1). This means that most of the respondents were within the economically active age group and this could have a positive influence on information accessibility and fish farming productivity in the study area. Olaoye *et al.* (2014) revealed that ages between forty and fifty are considered highly productive and active to undergo energetic task associated with fish farming activities. Respondents above the age of 56 in the study area were few in fish farming. In addition, results show that majority (67.9%) of the respondents had attained primary education.

Similarly, study findings show that 58.8% of the respondents had family size of 1-4 members while the remaining 38.3% and 2.9% had members of 5-8 and more than 8 members respectively. Further analysis of the research findings showed that (45.4%) of the respondents had income level of more than Tsh. 1500,000/= per year. This suggests that income level of the fish farmers in the study area was below the per capital income of Tanzanian which is Tsh. 2,100,000/= per year (TNBS, 2016). Income level can have positive or negative consequences on information accessibility and use and influence the level of fish farm productivity. This is because the success or the failure of agricultural productivity depends on household income (Urgessa**,** 2015).

Factors	**N**	**%**
Sex		
Male	192	80.0
Female	48	20.0
Education level		
No formal education	15	6.3
Primary education	163	67.9
Secondary education	39	16.3
Tertiary education	23	9.6
Age		
18 – 35	40	16.7
36 – 46	71	29.6
Factors	**N**	**%**
47 – 56	113	47.1
57 – 66	16	6.7
Marital status		
Married	211	87.9

Factors	N	%
Not married	29	12.1
Household income		
Less than 500,0000	38	15.8
500,001- 1000 000	60	25.0
1000 001 – 1500,000	33	13.8
More than 1500,000	109	45.4

Table 1: Social Economic Characteristic of the Respondents (N= 240)

3.2. Fish Management Practices in Southern High Lands

Table 2 shows fish management practices of fish farming in the study area. It was observed that, most of the ponds were small with an average size of less than 250 m^2. According to FAO (2012), most small-scale fish farmers own small ponds of an average size of 150 m^2. Majority (60%) of the respondents claimed that they got their fish seeds from their colleagues/neighbors while 20.8% claimed that they got fish seeds from Government farms. This means that farmers rely on local produced seeds from their colleagues that might lead to poor productivity and this is partly caused by low information accessibility. During FGD with the farmers it was reported that some of the farmers were not aware on the existence of some of the fingering production unit, for instance Luwila production center in Songea, Kingolwira in Morogoro and other units. Most of the respondents were feeding their fish either once (37.5%) or twice per day (34.6%) respectively. In fish feeding, especially tilapia farming the recommended optimum feeding interval is between 4 – 5 hours depending on the energy and composition of the diet (Riche et al 2004). This means that there is inadequate information/knowledge on feeding practices among fish farmers in the study area. In supporting this, during FGD, for example one respondents in Isagati narrated that, "I always feed once per day my fish as it advised by my neighbor that frequent feeding makes fish not to reproduce well"

Also, the study revealed that fish farmers provided maize bran (85%), kitchen wastes (29.6%) and fish meals (18.8%) as supplementary feeds to their fish. This is due to the fact that these materials are readily available and low in price. Moreover, these supplementary feeds could be of poor quality since they may lack protein concentrates which are very important in fish growth. Chenyambuga et al. (2014) pointed out that fish reared in ponds need to be supplemented with high protein concentrates. Based on the field observations, it was noted that protein concentrates such as fish meal, soybean meal and oil cakes were not used for feeding fish; this probably could be due to the lack of information and knowledge on feed formulation, their irregular supply, and high expense for farmers to afford it. For instance, during FGD one farmer in Pawaga pointed that: "I always feed my fish with only bran as it contains high nutrients compared to other feed staffs." Likewise, most fish farmers used cattle manure (87.5%) to fertilize their fish ponds while (12.1%) fertilized their fish ponds using poultry manure. Chenyambuga et al. (2014) reported the similar findings on type of fertilizer used by fish farmers in pond fertilization in Mbarali District, Tanzania. This could be due to lack of information on the use of other manure for pond fertilization and easy availability of cattle manure in the study area. Poultry manure was not used by majority of the respondents, since during FGD, for example one farmer in Kalenga commented: "it was my first time to hear from you that poultry manure can be used to fertilize fish ponds too". On the other hands, some fish farmers complained on unavailability of such manure in the study area.

However, 42.9 % of the respondents claimed that they were seldom visited by extension officers. Further, 38.8% reported that they have never been visited by an extension officer. This suggests that fish farmers lack the necessary technical agricultural information. This is explained by low numbers of fisheries officers in the surveyed districts, also during interview it was informed that lack of funds to facilitate their movements in their districts as the other reasons for low frequency of visiting farmers. To confirm this problem, this study established that there was only one extension officer in each district for serving the whole district. These findings are in line with Mwaijande and Lugendo (2015), Chenyambuga *et al.* (2014) from Tanzania, and Njagi *et al*. (2013) from Kenya who also found poor extension visit and inadequate numbers of extension officers to be among the factors limiting fish farming development.

Fish management practices	n	%
Pond size(m2)		
Less than 251	104	43.3
251 – 500	63	26.2
501 – 750	28	11.7
751 - 1000	18	7.5
More than 1000	27	11.2
Feeding frequency		
Once a day	90	37.5
Twice a day	83	34.6
Thrice a day	29	12.1
Twice per week	38	15.8

Fish management practices	n	%
Feed type		
Grains	21	8.8
Fish	39	16.3
Kitchen waste	71	29.6
Brans	204	85.0
Natural food in pond	29	12.1
Fertilizer used		
Pig manure	15	6.3
Poultry manure	29	12.1
Goat/sheep manure	2	0.8
Composite manure	1	0.4
Cattle manure	210	87.5
Sources of labor		
Hired	39	16.3
Self	120	50.0
Family members	75	31.3
Frequency of extension visit		
Frequently	44	18.3
Seldom	103	42.9
Never	93	38.8

Table: 2 Fish Management Practices in the Southern High Lands

3.3. The Extent of Icts Uses in Accessing Agricultural Information by Fish Farmers

This study evaluated the most common ICT tools used for accessing agricultural information. These were radio, television and mobile phones**.** Aboh (2008), Sousa *et al*. (2016) opined that radio, television, mobile phone are ICT tools that have great potential for use by farmers in sharing agricultural information. The most frequently consulted ICT tools by fish farmers in sharing agricultural information were mobile phones, radio and television respectively (Table 3).

Mobile phones were mostly used because they are easily accessible, available and cheap, and facilitate a two-way communication, that is a farmer can seek more clarification and get instantly answers. This was confirmed during Focus Group Discussions and Key informant interviews where it was pointed out that most fish farmers prefer to use of mobile phones because they are convenient to use. For example, during FGD one farmer from Sadani pointed out that,

"With a mobile phone I can communicate with fishery officers asking for some information related to weather, market, credits, fish pond construction, fish feeding, source of fingerings and other information without necessarily traveling a long distance to meet them".

Likewise, some fishery officers pointed out that they use mobile phones more frequently because they help them to overcome problems of transport. With mobile phones, they do not need to travel to visit farmers located far away. They can just call them when there is new knowledge or information. The findings of this study are similar with those of Chavula (2014) and Eucharia (2016) which also found that mobile phones are the most used ICTs tools among fish farmers because of their availability, wide coverage, and being accessed at a modest cost. In addition, findings from a study conducted by Masuki et al (2010) in Nigeria revealed that use of mobile phones was appreciated by rural farmers because of their easy, fast and convenient way to share and get prompt answers of respective problems.

Likewise, radio was another ICT tool that is utilized by fish farmers in accessing and sharing agricultural information. The high level of usage of radio is explained by its affordability, flexibility, ease language comprehension and its credibility in communicating timely, and relevant agricultural information to farmers. In addition, during focus group discussion it was informed that radio programmes aired to farmers were useful and enriched them with credible information on how to improve their fish farming activities. For example, during FGDs in Kigonsera in Mbinga District one farmer pointed out that 'listening to radio programmes related to fish farming has helped me to construct fish pond with acceptable dimensions'. The use of radio is also supported by Njoku (2016) who confirmed that radio is very effective and credible medium in agricultural technology transfer to rural farmers. Moreover, Nyareza and Dick (2012) opined that while other communication media like television remain in the hands of a small percentage of people, low-cost transistor radios run on batteries are now affordable for the poorer sections of the population.

Moreover, the study findings show that, even though television programmes are credible and key sources of information to farmers, they were least consulted by fish farmers in the study area as compared to radio and mobile phones (Table 3). However, this observation contradicts the results by Aphunu and Atoma (2011) and Eucharia *et al*. (2016) who reported that majority of the fish farmers used television more frequently in accessing fisheries information. Based on findings accessed through FGDs, this disparity is explained by the high cost of purchasing television sets, lack of electricity in most rural areas and in appropriate time for broadcasting agricultural programmes related to fish farming.

ICTs	Mobile phone		Radio		TV	
	n	%	N	%	n	%
Never	19	7.9	32	13.3	95	39.6
Rarely	70	29.2	135	56.2	71	29.6
Occasionally	56	23.3	45	18.8	25	10.4
Frequently	86	35.8	27	11.2	46	19.2
Very frequently	9	3.8	1	.4	3	1.2
Total	240	100.0	240	100.0	240	100.0

Table 3: The Extent of ICTs Uses in Accessing Agricultural Information by Fish Farmers

3.4. Productivity Level of Fish Farmers in the Study Area

Table 4 summarizes the ANOVA results on the productivity level of fish farmers in the study area. The study revealed that among the six districts surveyed Mbinga, Mufindi, Mbeya DC, Mbarali, and Songea had higher productivity levels (no significant differences in their productivity levels) while Iringa district had lowest fish productivity level (productivity level of Iringa differs significant from the rest of other districts i.e. *at P≤0.05*) (Table 4). The differences in productivity could be attributed mainly by the differences in fish pond management practices, information accessibility, social economic characteristics as well as to lack of extension officer's visits to farmers in Iringa District. The differences in productivity was observed during FGDs and KI interviews whereby farmers from Iringa DC complained that they were never visited by fisheries extension officer that makes them to have inadequate knowledge on fish farming, also they complained about poor stunted fish growth due to poor fish seeds acquired from other farmers or from the wild (rivers), lack of supplementary feeds like protein concentrates and about lack of knowledge on the construction of modern fish ponds. For instance, it was observed that there was an abnormal fish pond dimensions and stocking density from some of the fish farms in Iringa DC. One farmer from Kalenga Division in Iringa had a pond with 10 m x 15 m which was three metres deep and was stocked with 1100 fingerings; this can have a negative impact on productivity. According to Carballo *et al*. (2008) the recommended pond depth should be 0.5m to 1m in at shallow end and slopping of 1.5m to 2.0m at the drain end and also the recommended stocking density should be 2 to 3 fingerings per meter square. The other reason attributing to variations in productivity was the presence of a number of ongoing projects on fish farming in some districts. Mufindi District for example, had a project on different aspects of fish farming practices implemented by Sokoine University of Agriculture. These projects offered some training that imparted farmers with some information, knowledge and skills that helped farmers to improve their fish farming practices and consequently improving their productivity. FAO (2012) and Chenyambuga *et al*., (2014) confirmed that poor productivity among fish farmers in Tanzania is due to the unavailability of fingerlings, long interval from stocking to harvesting lack of concentrate feeds, inadequate information/knowledge on fish farming, and small pond size. Findings indicate that the overall mean productivity observed in this study (1810.78 kg/ha/year) is lower than the productivity of 5,312 kg/ha/year and 4,704 kg/ha/year reported by Chenyambuga *et al.,* (2014) and Shoko *et al* (2011) respectively. The mean productivity is also low compared to the productivity of 10,000 kg/ha/year, which can be attained when improved breeds and pond management are used in Tanzania (Eknath and Acosta 1998; Hussain *et al*., 2000).

District	Mean + sem	P - value
Mufindi	1991.70 ± 287.97a	0.015
Iringa DC	1153.20 ±194.69b	
Mbeya DC	1878.90± 299.25ab	
Mbarali	1835.20±278.10ab	
Songea district	1757.60±250.75ab	
Mbinga	2208.10± 110.42a	
Overall	1810.78 +110.42	

Table 4: Productivity (Kg per Hectare) Level of Fish Farmers in the Study Area
Mean In the Same Column with Different Superscript Are Significant Different At P≤0.05

3.5. The Influence of ICT Uses on Fish Farming Productivity

Before running the regression model, the collinearity/multicollinearity diagnostics test was done in order to detect whether there is a correlation among the independent (X_i) variables. Results show that no variables had a tolerance value of VIF >10. Pallant (2011) suggests that a VIF above 10 indicate multicollinearity. This means that there was no violation of the multicollinearity assumption in this study. Further analysis, showed that the Durbin-Watson's was 1.99 which falls within the values of $1.5 < d < 2.5$, implying that there is no auto-correlation (Kutner et al., 2005). An analysis of the relationship between ICT use and the fish farming productivity is displayed in Table 4. From the regression analysis, the value of coefficient of multiple determinations (R^2) was 0.25 (Table 5) which implies that 25% of the variations in the fish farmers' productivity is explained by the independent variables in the model and it was significant at 0.05 level of probability. Results in Table 3 revealed that the use of ICTs (radio, mobile phones and televisions), family size, income, pond size, and application of pond

manure) were positive and statistically significant ($p<0.05$) with fish farming productivity. The positive correlation between the use of radio and fish farming productivity implies that the more the frequency farmers listen to agricultural information on fish farming technologies from radio, the more they can improve and increase their fish farming productivity. This is because radio is a powerful medium in sharing relevant, credible and timely agricultural information to farmers. Thus, being informed with timely and relevant information leads to improved fish farming practices hence an increase in fish farming productivity. This observation was also confirmed during focus group discussion, for, example one farmer from Hagati in Mbeya narrated that, "I usually listen to radio agricultural programs related to fish farming practices like how to measure fish pond water turbidity, how to carry out fish pond fertilization, and other practices which helped me a lot to improve productivity". The significant relationships between radio and farmer's productivity sustains the findings by Fabusoro (2003) who confirms that there is a positive significant relationship between respondents' level of production and the frequency of listening to radio agricultural programmmes.

On the other hand, the positive correlation between the use of mobile phones and fish farming productivity implies that the more frequent farmers communicate and share information regarding fish farming technologies, the more they will improve and increase their fish farming productivity. This was evidenced during interview by one of the fisheries officer in Songea who pointed out that, "farmers who frequently call or text me seeking for advice on different fish farming practices are those who do well in their fish farming". Supporting this, Jehan et al. (2014) reported that farmers who use mobile phone more than five hours per week to communicate with agriculture expert earn higher yield than those who use less than four hours. Likewise, Mwakaje (2010) in Tanzania revealed that the use of mobile phones by farmers in sharing and communicating information was significantly related to the quantity of agricultural produce. Moreover, a study by otter and Theuvsen (2014) confirmed that the use of a mobile phone to communicate with trading partners in Chile had a great positive impact on the productivity of the smallholder raspberry farms. This is explained by the fact that with mobile phone farmers can have ability to timely exchange relevant and credible information which can help them to make right decisions on fish production and hence improving and increasing their production. It is from this point of view that Masuki et al. (2010) argued that access to appropriate information and knowledge from the right source is known to be one of the biggest determinants of agricultural production. Therefore, farmers who adopt ICT technologies for sharing or exchanging agricultural information gain competitive advantages.

Findings also indicate that the use of television sets for sharing agricultural information had a positive significant relationship with fish farming productivity (Table 4). This suggests that the more the frequency the farmers watch television programmes related to agricultural information on fish farming technologies, the more they can be informed on those technologies, and thus improve and increase their fish farming productivity. This was confirmed during Focus group discussion, for example one farmer from Kigonsera in Mbinga District stated that, "by watching Citizen Television I learnt and improved a lot on different pond management practices especially on fish feeding, fingerling selection and pond fertilization". This revelation is supported by Ali et al. (2016) in Zambia, Mwakaje (2010) in Tanzania and Chavula in (2014) who found that there was a higher significant relationship between watching agricultural programmes on TV and increased farm productivity.

Other factors found to have a positive significant relationship with fish farming productivity at 0.05 level of probability were income, family size, pond size and application of poultry manure during pond fertilization (Table 4). The positive correlation between income and fish farming productivity infers that the more the income of the farmer the higher the productivity of the farmer. This could be explained by the fact that a higher income leads to higher capital investment in various improved fish farm inputs which invariably leads to higher productivity. Waithaka et al. (2007) validated this assertion when they noted that higher incomes mean that a farmer will be able to satisfy his/her basic requirements and have a surplus for productive activities such as buying farm inputs. Furthermore, the positive correction between family size and farmer's productivity indicates that, the bigger the family size the higher the fish farming productivity. Ukagwu et al. (2014) validated this assertion by noting that fish farmer's revenue increase with increase in household size. This could be attributed by the fact that a family and more members from the community provide cheap labor for the practising fish farming and consequently could increase the fish farming productivity. Iheke (2010) noted that fish farm households rely on more members of their households for doing different farming activities than hired workers for labor on their fish farms.

Pond size was found to be positively correlated with fish farming productivity. The positive sign infers that increase in size of ponds increases fish stocking rate and this would influence the increased use of other inputs which would result to increased profit and productivity. The result is in line with (Osondu and Ijioma (2014) who reported that an increase fish pond size leads to an increase fish farming output with sufficient and right inputs.

Likewise, the application of poultry manure in pond fertilization had a positive correlation with fish farming productivity. This suggests that farmers who utilize more poultry manure to fertilize their fish pond produce better results than farmers who utilize other animal manure. This is supported by Chauhan (2014), Kang'ombe *et al.* (2006), Ghaly and MacDonald (2014) who reported that total fish production increase with an increasing optimal loading of fishpond with poultry manure. This can be explained by the fact that poultry manure enriched with more nutrients stimulates production of fish natural food (phytoplankton and zooplankton) which in turn increase yield. Kang'ombe *et al.* (2006), Endebu *et al*. (2016) reported that poultry manure triggers more production of phytoplankton (natural food) in ponds than any organic fertilizers including cattle manure due to high percentages of potassium, nitrogen and phosphorous.

Variable	Unstandardized Coefficients		Standardized Coefficients	t	p-value
	B	Std. Error	Beta		
(Constant)	-1661.178	2993.865		-.555	.580
Sex	273.793	291.163	.066	.940	.348
Age of respondent (years)	-3.466	11.216	-.024	-.309	.758
Family size	168.542	53.164	.229	3.170	.002*
Marital status	-229.900	357.458	-.046	-.643	.521
Education level of respondent	183.327	168.763	.084	1.086	.279
Average income for the last 12 months (Tshs)	.100	.020	.188	2.163	.032*
Experience in fish farming (years)	15.926	32.477	.038	.490	.624
Member	-14.837	239.221	-.004	-.062	.951
Pond size (square metres)	.189	.058	-.256	-3.252	.001*
Feeding frequency	51.201	139.052	.028	.368	.713
Frequency of pond fertilization	-83.898	140.472	-.047	-.597	.551
Frequency of water quality maintenance	-30.751	103.677	-.022	-.297	.767
Frequency of weeding	-268.445	174.881	-.148	-1.535	.126
Frequency of liming	-44.641	148.594	-.024	-.300	.764
Frequency of cleaning	55.286	150.626	.036	.367	.714
Frequency of disease control	23.917	255.145	.008	.094	.925
Frequency of water flushing	.516	249.236	.00	.002	.998
Radio	304.230	143.555	.152	2.119	.035*
Mobile phone	251.386	119.716	.157	2.100	.037*
TV	18.931	115.152	.013	.164	.008*
Grain feed	-470.148	494.509	-.081	-.951	.343
Vegetable	-339.835	228.779	-.101	-1.485	.139
Fishmeal	-137.893	360.618	-.029	-.382	.703
Waste	-90.803	281.956	-.025	-.322	.748
Brans	-350.775	416.730	-.075	-.842	.401
Cake	412.237	518.454	.060	.795	.428
Natural food	141.338	351.043	.029	.403	.688
Pigmanure	698.301	523.253	.105	1.335	.184
Poultry manure	956.505	459.870	.168	2.080	.039*
Goat/sheep manure	-617.906	1376.117	-.035	-.449	.654
Cattle manure	495.441	422.914	.097	1.171	.243
Source of fingerling	392.732	305.022	.095	1.288	.200
If extension services are adequate	323.529	350.347	.072	.923	.357
Water status	96.132	383.994	.018	.250	.803

Table 5: The Significant Relationship between Utilization of ICTs an Productivity of Fish Farming among Fish Farmers
Source: R=0.251, p=0.007 Significant at 0.05

4. Conclusion and Recommendations

ICT tools (radio, television and mobile phones) have been found to be very important tools in sharing information to fish farmers and consequently improve and increase farming productivity in Tanzania particularly in the Southern Highlands. Therefore, to enhance ICT usage on fish farming productivity the following recommendations are made:

- The government through her ministry of Minerals and Energy should facilitate more rural electrification so that more fish farmers can use ICT tools such as television sets because few farmers consulted these tools due to problems of electricity in some areas.
- Media owners and other information providers should broadcast more agricultural programmes related to fish farming practices on both radio and television and should make sure that the programmes are broadcasted on appropriate and convenient times especially during evening hours as proposed by most farmers.

- Moreover, government through her ministry of Finance and Planning should consider granting incentives and support to the fish farming sub-sector and to fish farmers in form of credits or loans that they may use sustainable fish farming management practices like feeding and pond fertilization.
- Likewise, there is a need for the Government via Ministry of Information, Culture and sports, Non-Governmental Organizations, researchers and policy makers to consider establishing community FM radio station in the southern highland regions to encourage sharing of agricultural information on fish production and knowledge that is more relevant to the farmers.

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