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Adoption of Water Recirculation System Technology by Catfish Farmers in Lagos State, Nigeria

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Abstract
This study was carried out to determine the level of adoption of water recirculation system by catfish farmers in Lagos State, Nigeria. The research was carried out with the aid of well structured questionnaires using random sampling technique with a sample frame of 169 respondents. Data were analyzed using descriptive statistics, frequency counts, percentages, and likert scale. The results show that the average age of the respondents was 51.05 ±10.79. About 67.5% of the respondents were between 41-60 years of age and were mostly male (73.96%). About 96% of the adopters have post-secondary school attainment and most of the respondents were not aware of water recirculation system and this leads to the low level of adoption in the study area. The constraints encountered by fish farmers were analysed using likert scale and rank order method. The result shows that, power supply, inadequate support from government and inadequate input facilities were ranked 1st, 2nd and 3rd respectively. Therefore, awareness on information dissemination of the technology should be more intensified by government or research institutions to the farmers in order to boost food production and hence food security in the country.

Keywords: Recirculation system; Fish farmers; Adoption; Nigeria

Introduction
Fishery is an important sector in the economic development of many developed and developing countries (FAO 2006a). About 40 million people are employed directly in the fishery sub-sectors of artisanal, fish farming, processing, preservation and marketing worldwide. Fish is a source of high-quality protein that can be produced more cheaply than any other animal protein for human consumption. It is also medically recommended for pregnant women, children and adults because of its high-level of protein, digestibility and lack of cholesterols, preventive resource for heart attack, stroke and reduction in health risk (Kareem, 2011).

In 2002, the world's total fishery production was 133 million tons. The production from world capture fisheries was 93.2 million tons which represents a slight increase of 0.4 percent compared with 2001. About 74 percent of fish produced were used for direct human consumption (Vannuccini, 2004). However, as much as 5 percent of the global population in Africa are dependent wholly or partly on fisheries for their livelihoods (FAO, 2006). This also means that it is a source of revenue generating activity for several African nations. Fish is a basic food in Sub-Saharan Africa. It plays a key role as a supplier of a concentrated form of food energy and protein of high biological value that is often

complementary to the limiting amino acids in the plant foods eaten so heavily in the diet of people in the developing countries.

Nigeria requires approximately 1.5 million tonnes annually to meet fish demand, whereas domestic supply is estimated at about 0.5 tonnes. The difference led to the massive importation of frozen fish, which gulps over ₦20billion annually. However, the country has witnessed an unprecedented interest by entrepreneurs in fish farming, due to scarcity/high cost of fish in the local markets in addition to the large export potentials of our local tin and shellfish species in international markets (Kareem, 2011). The use of high technology in catfish farming is the latest in Aquaculture system that has attracted numerous investors due to its tremendous success in areas that initiated the system (Fagbenro, 2005). There are now concerted efforts to develop intensive fish farming technology to increase fish production.

The introduction of Water Recirculation System (WRS) has made it possible to produce fish all year round. WRS is a system in which water used for fish rearing units is partially or completely recirculated through water treatment unit and reconditioning for further use. This system rears fish at high densities with reduction in water usage. This is achieved by employing a water treatment unit, which includes mechanical filtration, biological filtration, solid waste removal, water sterilization and aeration. Water Recirculation System conserve both water and land, maximize production in a relatively small area of land and use a relatively small volume of water for example 50 tonnes of fish can be produced in 60m^3 building annually (Lymbery, 1999). It is very effective in the control of poaching which is prevalent in Nigerian agricultural investment profiles and could offer better environmental control for maximum fish growth and survival Almazán, 2004). The system requires continuous supply of water at a temperature and content that is optimum for growth of the cultured fish and as well a filtering (bio filter) system is required to purify the water and detoxify harmful water products and uneaten food. Average Cat fish intake of households in Nigeria range between 1-9 kg/year and the country ranks second to Egypt in terms of aquaculture production on the African continent but is the largest producer in Sub-Saharan Africa (SSA). Even an increase in yield from 30,664 metric tonnes to 85,087 metric tonnes between 2002 and 2007 (FDF, 2008), still suggests sub-optimal production levels in contrast to the existing vast and untapped physical potentials. It is widely believed that aquaculture could be one of viable options to guarantee food security and generate a chain of multipliers effects on the national economies in the region.

Most Nigeria fish farmers operate small-scale farms ranging from homestead concrete ponds (25-40 metres) to small earthen ponds (0.02-0.2 hectares). The development of aquaculture can only be enhanced by the introduction of water recirculation system which either in good combination or serve as complement, help to bridge the gap between supply and demand, increase the level of fish production and ensuring food security within the country (FAO, 2006a). While there have been instances of successful introduction of water recirculation system to enhance production in Bangladesh

(Thompson *et al*, 2005) and Ghana (WFC, 2005). The major challenge in Nigeria has been the lack of appropriate technology in meeting the current levels of consumption (Gupta *et al.*, 2004; Mwangi and Kariki, 2015).

This study is therefore poised to determine the level of adoption of water recirculation system technology by cat-fish farmers in the eastern part of Lagos State. Specifically, the study was designed to: assess the level of awareness and adoption of this technology in the study area and examine the constraints experienced from the adoption of this technology.

Methodology

Study Area

This study was conducted in Lagos State Nigeria. The State lies extensively within the Southern rain forest zone of the humid tropics. It lies between latitude 6˚ and 7˚ of North of the equator and longitudes 3˚ and 4˚ East of the Greenwich Meridian. Lagos State has a total area of about 4000km^2, out of which 3277km^2 (78%) is land. The state is bounded in the North and the East by Ogun State, in the West by the Republic of Benin and in theSouth by the Atlantic Ocean. The topography which is undulating plain, in the northern area is interspersed with swamps in the flood plains of the rivers that run through the state. The coastal belt of sandy ridges is interspersed by lagoons and creeks. This makes the state rich in water resources for fishing and aquaculture activities. The state experiences annual rainfall of 1312mm – 1726mm. The ambient temperature is fairly high (32˚C) though moderated by the Cool Coastal wind. The relative humidity is on the average over 60% throughout the year. The state has an estimated population of 10million (National Population Commission 2006). The State comprises of 20 local government areas.

Lagos state is divided into two Agricultural Development programme (ADP) zones, East and West by Lagos State Agricultural Development Authority (LASADA). The Eastern zone is made up of two divisions consisting of three local government councils namely Epe, Ibeju-Lekki and Ikorodu while the Western zone consists of three divisions consisting of 12 local government councils which are Agege, Alimosho, Eti-Osa Badagry, Ojo, Lagos Island, Lagos Mainland, Mushin, Oshodi-Isolo, Ikeja, Surulere and Shomolu. For the purpose of administrative convenience, the two zones were further stratified into sixteen blocks. Each block was being managed by a block extension Agent.

Sampling Procedure and Data Collection

Multi stage sampling procedure was employed. Lagos State was purposively selected based on *a priori* expectation knowledge. That the state was prevalent of fish farmers (old age, middle age and young) in the western part of the country. In the first stage, eastern ADP zone was selected since Lagos state is made up of two ADP zones based on the information that they are the leading fish farmers producing local government areas. The second stage was the selection of three Local Government areas in the eastern ADP. These are Epe, Ikorodu and Ibeju-

lekki Local Government areas. The third stage was the random selection of 70 respondents from Epe, 70 respondents from Ikorodu and 60 respondents from Ibeju-lekki local government areas, making a sample frame of 200 respondents. A total number of 169 questionnaires were found useful after cleaning of the data. Data collection was carried out using participatory approach with the aid of structured questionnaires.

2.4. Analytical Framework

The study employed the use of descriptive analysis which includes: frequency distribution tables, percentages and mean. Adoption scores were calculated using; adopters = 1 and non adopters = 0. A 5 point likert scale was developed to measure respondents' perception of individual in respect to their views on WRST and the constraints hindering them from adopting this technology. The mean ranking for the perception statements was calculated from the perception index generated and the degrees of unfavourable and favourable disposal determined by the mean score above and below the benchmark respectively (Likert, 1932).

The 5 point likert scale has a critical advantage over every other type or method in that it does not expect a simple 'yes' or 'no' answer from the respondents, but rather allow for degrees of opinion, and even no opinion at all (i.e., it allows individual respondent to express how much they agree or disagree to a particular statement, with the neutral point being neither agree, disagree or undecided).

Therefore,

$$\text{Weighted scores} = \Sigma \text{requency (strongly agreed to strongly disagreed)}$$

$$\text{Weighted means} = \frac{\Sigma \text{ of weighted scores}}{\text{Total number of respondents}}$$

$$\text{Percentage} = \frac{\text{Weighted means}}{\text{Total weighted mean}} \times 100\%$$

Results and Discussions

Table 1 presents the awareness and household demographic characteristics of fish farmers in the study area. The results reveal that 58.8% of the respondents fall within the age bracket of 41-60 years were aware of WRST while 70.73% of the respondents within the age of 21-40 were not aware of WRST. Furthermore, majority of the respondents were male (73.96%) out of which 71.74% were aware of WRST. This is in accordance with Brummett *et al.,* (2010) that fisheries activities are mostly dominated by men and this is likely because men are more conversant with their environment and do have first hand information which they relate to their female counterparts. The result also shows that more males were involved in fish farming than females and majority (71.7%) of the respondents in terms of gender awareness were more prominent in male while about (28%) recorded in the female might not be unconnected to the activities of female respondents such as processing and marketing of produce. Majority (84.78%) of the respondents were married and have highest awareness in WRST in the study area while 2.2% and 10.9% were single and divorced respectively. WRST while average family size was 5 persons per household which indicates that as the family size increases, the level of awareness increases due to their involvement and interest in the job in order to improve the living standard and

livelihood of the family.

Awareness and Household Economics Characteristics

Results in Table 2 below shows that half (51.48%) of the respondents owned land through purchase and therefore had full right on their land and 56.52% of them were aware of WRST while 1.18% of the respondents possessed land through squatting out of which none was aware of WRST. About (93%) of the fish farmers have less than 1 hectare of land and 82.61% were aware of WRST while 1.20% had less than 2 hectares of land. It implies that most of the farmers in the study area are small holders and had little or no fund to invest in WRST. Also, 78.11% of the respondents make use of both hired and family labor and about 91% were aware of WRST. Majority (77.52%) of the respondents were involved in farming association. About 85% were aware of WRST while 74.79% were not aware of the technology. However, 22.48% of the respondents were not involved in farming association but

Table 1: Awareness Profile of Fish Farmers

Demographics characteristics	Aware (N=46)	Not Aware (N=123)	ALL (N=169)
Age			
21-40	6.52	17.89	14.79
41-60	58.68	70.73	67.46
=60	34.78	11.38	17.75
Total	100	100	100
Average Age	51.05		
Gender			
Male	71.74	74.79	73.96
Female	28.26	25.20	26.04
Total	100	100	100
Marital Status			
Single	2.17	13.82	10.65
Married	84.78	78.86	80.47
Divorced	2.17	0.81	1.18
Widow	10.87	6.50	7.69
Total	100	100	100
Family Size			
1 – 3	10.87	18.70	16.57
4 – 7	82.61	73.98	76.33
8 – 10	6.52	7.32	7.10
Total	100	100	100

Source: Field Survey 2014

15% of them were aware of the technology. The higher percentage recorded in the awareness of the technology might not be unconnected to their participation in the farming association. Occupation remains valid in our society as individual engages in more than one occupation which gives them satisfactions and belonging in the society (Ashley-Dejo *et al.,* 2012). Results showed that (43.79%) of the respondents were involved in fish farming and about 40% were aware of WRST. Also, 41.42%, 16% and 8.3% of the respondents sourced their capital from personal saving, relatives/friends and bank loan respectively while 34.3% sourced capital from cooperative society. This indicates that awareness of a technology and adoption would invariably improve an enterprise because agricultural technology had been associated with higher earnings, improve nutritional status and improve employment opportunities and earnings for landless labourers (Kariyasa and Dewi, 2011). Access to credit has been reported to stimulate technology awareness and adoption (Muhammed and Temu, 2008).

Furthermore, a largest proportion (83.43%) of the respondents had 1–10 years of fish farming experience and 65.23% were aware while 90.24% were not aware of WRST. In addition, the results show that nearly all the respondents in the area of study were educated. Less than half (34.78%) of the respondents with BSC were aware while 30.89% were not aware of WRST. Also, 4.35% of the respondents with SSCE were aware while 4.88% were not aware of WRST. The level of awareness might be due to the standard of education in the study area which is in tandem with Ashley-Dejo *et al.*, (2012) that as education increases the level of awareness of technology also increases.

Adoption Profile of Water Recirculation System

Household's characteristics are usually used as a measure of wealth of the farming households and reveal a lot about the living condition of the farming households as seen in Table 3 below. A well-endowed household could better adopt an improved agricultural technology than otherwise (Awotide *et al.,* 2012). Table 3 shows that about two-third (66.86%) of fish farmers fall between the age representing 4.44% WRST adopters which indicates that very few young and old adults are involved in fish farming. Majority (73.96%) of the respondents were male, out of which 68.89% were WRST adopters, while 26.04% were female. This implies that a male fish farmer were quicker to adopt WRST than their female counterpart because women are mostly involved in processing and other post harvest activities Rauf *et al.,* (2009). Also, majority (80.47%) of the respondents were married out of which 86.87% were WRST adopters.

A larger proportion (86.67%) of the family size within 4 – 7 persons per household adopts WRST, while others adopts at lower percentages. From the results obtained it can be observed that family size has no significance effect on both awareness and adoption of WRST. This suggests that family size has nothing to do with adopting WRST, but the ability and capacity of the farmer's family. Moreover, a large household size could hinders adoption of farming technology particularly if it is composed of a large number of dependants, which means the

Table 2: Awareness and Household Economics Characteristics

Economic characteristics	Aware (N= 46)	Not Aware (N=123)	ALL (N=169)
Land Ownership			
Inherited	32.61	23.58	26.04
Purchased	56.52	49.59	51.48
Leased	10.87	25.20	21.30
Squatting	0	1.63	1.18
Land Size			
<1hectare	82.61	96.75	92.89
1 – 2 hectares	15.22	2.44	5.92
> 2 hectares	2.17	0.81	1.18
Source of labor			
Family labor	6.52	19.51	15.98
Hired labor	2.17	5.92	5.92
Both	91.30	78.11	78.11
Farming association			
Yes	84.78	74.79	77.52
No	15.22	25.20	22.48
Primary occupation			
Farming	36.96	46.34	43.79
Artisan	4.35	1.63	2.37
Civil service	39.13	30.08	32.54
Private employee	8.69	16.26	14.20
Others	10.87	5.69	7.10
Source of capital			
Relative and friends	8.69	18.69	15.98
Personal savings	58.69	34.96	41.42
Bank loan	8.68	8.03	8.29
Cooperative Society	23.91	38.21	34.32
Years of Farming Experience			
1 – 10	65.23	90.24	83.43
11 – 20	30.44	8.94	14.79
21 – 30	4.34	0.81	1.78

Source: Field Survey 2014

family has more mouth to feed (Awotide *et al.,* 2012).

Furthermore, it was observed that the civil servants (32.54%) in the area who were into fish farming adopted WRST than those who were primarily into fish farming (37.78%). Less than half (40%) of the respondents who were civil servant adopts WRST of which 29.84% were non - adopters while 11.11% of other respondents who engaged in others activities apart from fish farming adopt WRST of which 7.10% were non - adopters. This is likely because civil servants who were into farming activities had other means of income generation and this will enable them to adopt WRST thus investing more than those who do not have other source of income apart from fish farming activities.

Perceptions of Respondents on Fish Cultured in Water Recirculation System

Table 4 contains the percentages, weighted scores and means of the respondents based on the questions assessed. The Likert scale values were used in conjunction with farmer's perceptions to calculate the weighted scores and means. These values are ranked and then used to determine the severity of the questions asked. Majority (24.26%) indicated that fish cultured in WRST grows faster than other culture systems. This is the most important question that ranked first followed by the survival rate (21.89%), profitability (20.7), easy to manage (19.53%), water quality (13.6%), and mortality rate (17.8%) were strongly agreed by the respondent that WRST is higher than other culture systems respectively. However, the weighted score was calculated by summation of all the frequencies across the row while weighted mean is the summations of all weighted scored across the column divided by the total number of the respondents.

Individual Perception Index towards Adoption of Water Recirculation System

Table 5 shows that more than half of the respondents (56.52%) perceived adoption of WRST as highly unfavorable, thus affecting the level of adoption while 43.48% were highly favored through adoption of WRST. This result shows that adoption of WRST is a challenge encountered by farmers in the study area, thus awareness and enlightenment should be a concern in the area so as to increase the level of adoption of WRST thereby increasing fish production.

Conclusion and Recommendation

Majority of the fish farmers were still in their active age within 41-60 years of age, mostly dominated by male, and married having 4-7 persons per household and were mainly into fish farming business, owned their personal land through purchased with less than 1hectare of land. It was also observed that virtually all the respondents were educated, make used of both family and hired labor on the farm, a larger percentage belong to farming association. Also it was seen that the level of awareness and adoption of WRST was low. This could likely be due to reduction in the number of extension agents, lack of incentive from the government to the extension agents and inadequate/lack means of transportation to extension agents which hinder them from getting to farmers when necessary as well as improper dissemination of information to farmers. Finally, the regression analysis shows that

Table 3: Adoption Profile of Water Recirculation System

Household characteristics	Adopters (N= 45) Percentage	Non adopters (N=124) Percentage	All (N=169)
Age			
21-40	4.44	18.55	14.79
41-60	60.00	69.35	66.86
=61	35.56	12.09	18.34
Total	100	100	100
Average age	51.05		
Gender			
Male	68.89	75.81	73.96
Female	31.11	24.19	26.04
Total	100	100	100
Marital status			
Single	0	14.52	10.65
Married	86.87	78.23	80.47
Widow	11.11	6.45	7.69
Total	100	100	100
Family size			
1 – 3	6.67	20.16	16.57
4 – 7	86.67	72.58	76.33
8 – 10	6.67	7.26	7.10
Total	100	100	100
Average Family size	4.87		
Primary occupation			
Farming	37.78	45.97	43.79
Artisan	2.22	2.42	2.37
Civil service	40.00	29.84	32.54
Private employee	8.89	16.13	14.20
Others	11.11	5.65	7.10
Total	100	100	100
Educational attainment			
MSC/MBA	20 .00	16.13	17.16
PGD	8.89	9.68	9.47
BSC	33.33	31.45	31.95
HND	17.78	25.81	23.67
ND	6.67	7.26	7.10
NCE	8.89	4.84	5.92
SSCE	4.44	4.84	4.73
Total	100	100	100

Source: Field survey 2014

Table 4: Distribution of Respondents showing their Perceptions, Weighted Scores and Means with their Rank Order

Perceptions	Strongly agreed (5)	Agreed (4)	Undecided (3)	Disagreed (2)	Strongly disagreed (1)
Fish culture in WRS grow faster than other systems	24.26%	1.78%	0	0	0
Survival rate in WRS is higher than other systems	21.89%	4.14%	0	0	0
WRS is more profitable than other culture systems	20.71%	4.73%	0.59%	0	0
WRS is easy to manage than other culture systems	19.53%	2.96%	1.18%	2.37%	0
Water quality in WRS is better than other systems	13.61%	10.65%	1.18%	0	0
WRS requires more time and attention than other systems	13.61%	7.69%	2.37%	2.37%	0
WRS reduces mortality rate than other systems	17.75%	2.96%	1.18%	4.14%	0
Perceptions	**Weighted scores**	**%**	**Weighted means**	**%**	**Rank order**
Fish culture in WRS grow faster than other systems	217	15.4	1.284	15.4	1St
Survival rate in WRS is higher than other systems	213	15.1	1.260	15.1	2nd
WRS is more profitable than other culture systems	210	14.9	1.243	14.9	3rd
WRS is easy to manage than other culture systems	199	14.1	1.178	14.1	4th
Water quality in WRS is better than other systems	193	13.7	1.142	13.7	5th
WRS requires more time and attention than other systems	187	13.3	1.107	13.3	7th
WRS reduces mortality rate than other systems	190	13.5	1.124	13.5	6th
Total	1409	100	8.338	100	

Source: Field survey 2014

Table 5: Individual Perception Index

Category of perception	Frequency	Percentage	Min	Max	Mean	SD
Low (Unfavorable disposed)	26	56.52	23.00	35.00	32.02	3.06586
High (Favorably disposed)	20	43.48				

Source: Field survey, 2014

there is a significant relationship between the level of awareness and adoption of WRST by cat fish farmers at 5% level of significant.

Based on the above results, it is recommended that all available channels of information by extension agents should be used to improve the awareness and adoption of WRST to farmers. Power supply and input facilities should be made available to the farmers in order to boost their productivity. Enlightment programme on the awareness and adoption of technology should be promoted in enhancing more productivity and improve farmers' standard of living.

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