RESEARCH ARTICLE

Fish farming technology change management in river bank communities of Delta state, Nigeria: The fish cage culture

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The study was carried out with the view to examine fish farming technology change management in river communities of Delta state, Nigeria. A sample size of 166 fish farmers were used for the study. Questionnaire and interview schedule were used to collect data from the respondents. Descriptive and inferential statistics were used to analyze the data. Most of the farmers were young people with (93.37%) of them. Majority of them had tertiary education. Majority of the farmers were intrinsically motivated to embark on change from earth pond and surface tank management system to the fish cage management system. Average household size was 5 persons. Majority (68.07%) of them embarked on the change slowly. The fish cage technology had relative advantages of being not complex to use, triable, being easily observed and less cost of procurement over surface and earth pond. Majority of the fish farmers were adjudged to be efficient in the management of change from the earth and surface pond to floating fish cage. Relative advantage, relevance, capacity to change, change in management experience, motivation and formal education had significant and positive relationship on change in management efficiency. Complexity and cost had significant and negative relationship on change in management efficiency. Challenges of floating fish cage management included poaching, predators and biofouling. Government should provide access to credits for farm fishers at low interest rates. The usage of floating fish cage technology management system should be encouraged and sustained. The fish farmer's clusters should hire the services of local security men to solve the problem of poaching. Traps should be placed around cages to discourage predators anti-fouling preventive measures and treatments are required to counteract biofouling problems. Technology usage training is recommended.

Keywords: Fish farming; Floating fish cage; Technology change; Change management; Fish management system; River communities

INTRODUCTION

The position of fishery sub-sector stands to be an available one in the economy of Nigeria. a large part of Nigeria population recline on the fishery sub-sector, particularly culture fishery or fish farming. Fish is a very important source of protein needed by humans. FAO asserts that fish flesh has high digestibility and immediate utility by human body. This quality is why it is recommended for consumption in various parts of the world that experience high carbohydrate diet, such as Africa [1].

Fish farming is a business that people like to venture into. Fish farming entails rearing fish commercially or on subsistent level in an enclosure such as surface tank or earth pond. There are diverse species of fish that are raised commercially and on small scale by fish farmers. The ones mostly reared in Nigeria include cat fish, carp, salmon and tilapia.

Out of the 4 million hectares of inland water in Nigeria surface, 1.75 million hectares have been found to be suitable for fish rising or rearing. Aquaculture is majorly land based system and it is carried out at subsistence and commercial scale in fresh water areas [2].

Delta agriculture and rural development authority gave an estimate 170 to 190 people involved in Delta state. The environmental conditions in the states encourage fish farming and there is a large market for fish and fish products. The common fish species reared in Delta state is the cat fish, while the Tilapia specie takes the second position. In Delta state, there is a high level of move at demand for the catfish and its low mortality rate. According to Akerede citing Mbarviso there is urgently in the need to raise the level of protein intake. Change management as a process is often discontinuous and temporary in general, and there is a factual rate of the neighborhood of 70% out of all the programmes of change initiated [3]. The performance of farmer after change from an existing innovation to a new one is most times not easy to manage. For instance, the transition phase, during the change period does not get reasonable level of focus in the planning and decision-making stages [4]. This weak point is bound to impact negatively on the farm and farmer. In their classic change curve, Elrod and Tippett gave a clear picture of the time duration in situations of low performance and despair. It is always the expectation that successful management of change will consequently lead to an enhanced level of performance after change is executed.

At the operational level, an important challenge is the commencement of change while operations are sustained simultaneously daily [5]. The magnitude of changes is one variable that is capable of influencing the ability to successfully manage change [6]. In a context in which farms operate while change has not occurred and numerous investments are not done for a long period of time, enhanced necessity for massive changes is required. When there is disruption instead of progressive output, change in technology is required by the farmers. Contrastingly, gradual or slow expansion or gradual positive response to new innovation is change that only needs adjustment of extent process of operation or a complete detion from an old technology to a new one. The fish farmer has the liberty to utilize existing knowledge or innovation. On the other hand, major changes in technology and organization necessitate a transformation of technology, operation and management. Balogun, et al. describes transformation as entailing a change in the way things are regularly done and the routine there. It is not enough to recline only on extant competence and skills anymore. This resembles the numerous changes that vegetable farmers experienced while changing innovations or technologies as found by Ofuoku and Ogisi. However, the process of change from the use of an old innovation and ideas to the use of a new one requires more than decision to use the new one [7]; there has always existed, the need for a prioritized change management in fish farming that has led to the development of improved packages on aqua cultural production. These have been found to be inadequately used by farmers. For instance, there is the problem of massive loss of fish stock in earthen ponds, especially in the farms

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established along river plains [8]. This researcher occasioned low productivity of aquaculture in Nigeria and has been found to be more severe in Delta state.

As a result of this, federal departments of fisheries recommended that fish farmers, especially the ones along river plains in river communities should change from usage of earth pond to fish cage management system in the rivers or streams. Other reasons the fish cage management system was recommended is the rigours involved in bailing of water during harvest, rigours involved in changing water, weekly in surface tanks and the slow growth rate of cultured fishes in surface/concrete tanks. So many farmers embraced the technology; get fish remain inadequate in markets. This may not be unconnected with the way the change in fish management system was managed or being managed among fish farmers in the study area. This therefore necessitated this study which sought to examine the management of fish management system in Delta state. Specifically, the study was designed to describe the socio-economic features of fish farmers in the study area; determine the change management patterns and the experience among the fish farmers; ascertain the characteristics of floating fish cage technology; determine the level of fish output before, during and after change to fish cage management system; determine efficiency of change as evaluated by extension agents and identify factors that contributed to efficient management of the change. It was therefore hypothesized that the characteristics of floating fish cage technology and selected characteristics of fish farmers do not significantly influence the efficiency of change management.

MATERIALS AND METHODS

The study area

This study was executed in river communities of Delta state, Nigeria to evaluate change management among fish farmers. Delta state is located in the Niger delta zone of Nigeria. Delta state, the study area lies between latitude 5°00' and 6°30' and longitude 5°00' and 6°45'. The State is located in the Niger delta region of Nigeria and lies within mangrove swamp fresh water swamp forests and derived savannah vegetation belts. The state is well irrigated naturally by many rivers, rivulets and streams.

The state is shared into three agricultural zones-delta south, delta central and delta north agricultural zones by Delta state Agricultural Development Programme (DTADP) now known as Delta Agricultural and Rural Development Agency (DARDA). DARDA has zonal offices in each of the zones.

Population of the study

The study population comprises of all fish farmers in river communities who are registered with DARDA in Delta state, Nigeria. The study population.

Sampling and sample size

Multistage sampling procedure was used for the study. At the first stage, 2 local governments were selected from each agricultural zone randomly. The second stage witnessed the selection of two of the river communities where fish farmers abound. The third stage was the selection of 20% of fish farmers from the list of registered fish farmers operating in the selected communities. At the end, Aniocha North and Ndokwa East in Delta North, Ethiope East and Okpe in Delta Central and Burutu and Bomadi in Delta South were the areas elected from the Agricultural zones. From Delta North agricultural zone, 46 fish farmers were selected, Delta Central agricultural zone 59 and Delta South 61 fish farmers were finally selected totalling 166 fish farmers. The extension agents responsible for covering the fish farmers were also selected, this led to selection of 25 extension agents to rate the farmers.

Data collection

The data for the study was collected with the use of structured interview schedule was administered to the fish farmers who have little or no formal education, while the questionnaire was administered to those with reasonable level of formal education [9].

Data analysis

The socioeconomic attributes of the respondents were measured by percentages. The change management patterns of the farmers were also measured in the same way. The level of output before and after change was measured by dividing the total by the number of fish farmers in kilogram and represented in a tray. The factors that contributed to efficient change management will be measured through the use of Tobit regression model. Efficiency of change management was measured by extension agents who rated them as not efficient (0-2), fairly efficient (3-5), efficient (6-9) and very efficient (10-12). That means that frequency counts and percentages were used to achieve objectives i, ii, iii and v. Objective iv was met with bar graph while objective vi was achieved with the use of Tobit regression model. To bit model is as follows:

Y=Change management efficiency (efficient=i, not efficient=0)

X_1=Relative advantage (yes=1, no=0)

X_2=Relevance (yes=1, no=0)

X_3=Complexity (not complete=1, complex=0)

X_4=Cost (not costly=1, costly=0)

X_5=Capacity to change (Farm income, N)

X_6=Change management experience (manage change before=1, otherwise=0)

X_7=Motivation of farmers (intrinsic =1; extrinsic=0)

X_8=Formal education (years of schooling)

RESULTS AND DISCUSSION

Socioeconomic characteristics of fish farmers

Most (63.86%) of the fish farmers were in the age bracket of 30-49 years of age (Table 1) indicating massive engagement of youths in fish farming. Majority (93.37%) were married, implying that they had responsibilities to their respective families. Many of them had level of formal education or the other with those who had tertiary education forming the model class. The involvement of many of those who had tertiary education in fish farming was occasioned by the quest for those farmers to become self employed as a result of unemployment syndrome that has plagued the Nigerian society for many decades.

Their farm income level is encouraging as those of them earned net income of between N51,000 above N110,000 (US $1=N460) monthly. Most (75.90%) had previous change experience that was encouraging. This is because they no longer changed water from ponds weekly and during harvest, they did not have to spend time and energy draining off water from Earth ponds and surface tanks as well as the growth rate of the fish as a result of abundant oxygen supply from the water body (rivers and streams). Hamsen and Jervell state that change experiences are encouraging when a new technology yields expected results.

Most (75.90%) of the fish farmers were intrinsically motivated to embark on the change from earth pond and surface tank management system to the floating fish cage management system. This motivation may have been triggered by their need to adopt a management system that reduces the drudgery involved in fish farming. Zimmermann and Campillo stressed the fact that intrinsic motivation is needed to sustain management of change in technology [10].

They had an average household size of 5 persons. This implies medium household sized among the farmers. This is at variance with the findings of Ofuoku, et al. who formed that most fisher folk households were at an average of 7 persons implying large household sizes (Table 1).

TABLE 1
Socioeconomic characteristics of fish farmers (n=166)

Variables	Frequency	Percentage (%)
Age (Years)		
Below 30	11	6.63
30-34	26	15.66
35-39	28	16.87
45-49	19	11.45
40-44	33	19.88
50-55	28	16.87
Above 55	21	12.65
Marital status		
Married	155	93.37
Single	11	6.63
Level of formal education		
No formal education	21	12.65
Primary	33	19.88
Secondary	46	27.71
Tertiary	66	39.76
Farm income (Monthly #)		
20,000-50,000	8	4.82
51,000-80,000	32	19.28
81,000-110,000	54	32.53
Above 110,000	72	43.37
Change management experience		
Encouraging	126	75.9
Discouraging	40	24.1
Motivation to change		
Intrinsic	126	75.9
Extrinsic	40	24.1
Household size (persons)		
1-2	11	6.63
3-4	33	19.28
5-6	48	28.92
7-8	33	19.88
Above 8	42	25.3

Change management pattern

The change type among many of (68.07%) the fish farmers took place slowly over a long period before they totally changed to the use of fish cages (Table 2). However, few (29.51%) went about the change transformational way, that is, they immediately changed to the fish cage management system completely. The gradual change in fish management system is attributed to the financial implications involved in the procurement of fish cage and canoes used in the farming operation.

In the midst of the financial constraint, many of them (56.02%) embarked on expansion as a result of the abundant water in the natural aquatic habitat where the cages are submerged and did not require frequent change of water as the water flows steadily. More (63.98%) had restricted expansion because of the financial involvement in the purchase or construction of fish cages and servicing canoes. Majority (83.13%) of them had strained capacity to change from earth and surface ponds to cage management system, but the change was sufficiently after the change to cage management system.

Many (87.35%) of them experienced increased yield and production. This implies that they experienced increased yield in the size and weight of their products and low mortality. These were experienced because of the abundant oxygen supply and dilation of natural feeds to their feed supply. The cage system also discouraged cannibalism among the fish reared in the cage system. The low yield experienced by few of them was occasioned by the inability of the farmers to supply them with adequate amount of the required compounded feeds. This inability on the part of the farmers was a consequence of the amount of money they spent in the procurement of the fish cages and canoes [11].

As for post charge performance of the fish, most (92.17%) of them experienced enhanced performances in terms of growth within a short period of months than they expected. However, very few (7.83%) of them did not experience enhanced growth in within a short period of months. This was prompted by inadequate feeding of the fishes with compounded feeds. These change experiences by the farmers confirm the findings of Schei, et al. Hansen and Jervell as similar results were formed by them in their earlier studies on farmers who experienced change in agricultural technologies [12].

While most (71.69%) of them were intrinsically motivated to embark on the change to fish cage management system, very few (28.31%) of them were extrinsically motivated. The ones who were intrinsically motivated changed not because of their inner desires to achieve their production goals to their advantages. Those extrinsically motivated had their motivation to change their management systems because of the material motives of award of prize to the best fish farmers of each year by the department of fisheries. It is known that intrinsic motivation is stronger than extrinsic motivation. These findings are congruent with those of Zimmermann and Campillo. Hansen and Jervell are of the opinion that farmers who embark on changes by transformation changes require a strong inner interest and an enhanced degree of motivation to gain success.

sMost (67.47%) of them consulted frequently with fisheries extension agents. Their frequent level of consultation with extension agents was as a result of the fact that their clusters formed respective fish farmer's groups or associations in their various communities [13].

TABLE 2

Technology change management pattern (n=166)

Variables	Agricultural zone			
	Delta North (n=46)	Delta Central (n=59)	Delta South (n=61)	Total
Change type				
Gradual	31 (67.39)	39 (66.10)	43 (70.49)	113 (68.07)
Transformational	15 (32.61)	20 (33.90)	18 (29.51)	53 (31.93)
Change experience				
Expansion	25 (54.35)	31 (52.58)	37 (60.66)	93 (56.02)
Restricted	21 (45.65)	28 (47.46)	24 (39.34)	73 (63.98)
Capacity				
Strained but sufficient	37 (80.43)	49 (83.05)	52 (85.25)	138 (83.13)
Strained, prolonged transition	9 (19.56)	10 (16.95)	9 (14.75)	28 (16.87)
Outcome of change				
Increased yields and production	39 (84.73)	51 (86.44)	55 (90.16)	145 (87.35)
Low yield and production	7 (15.22)	8 (13.56)	6 (9.84)	21 (12.65)
Change performance				
Better than expected	41 (89.13)	54 (91.53)	58 (95.08)	153 (92.17)
Does not meet expectation	5 (10.87)	5 (8.47)	3 (4.92)	13 (7.83)
Motivation				
Intrinsic	33 (71.74)	41 (69.49)	45 (73.77)	119 (71.69)
Extrinsic	13 (28.26)	18 (30.51)	16 (26.23)	47 (28.31)
Frequent use of extension workers				
Yes	26 (56.52)	40 (67.80)	46 (75.41)	112 (67.47)
No	20 (43.48)	19 (32.20)	15 (24.57)	54 (32.53)

Characteristics of the fish cage technology as observed by the fish farmers

The characteristics of the fish cage technology included relevance to the fish farmer's situation (85.54%), the relative advantage it had over surface and earth pond (100%), being less complex to use (89.76%) (Table 3). Other characteristics that made them to change to the fish cage technology were its friability (100%), capability of being easily observed (100%) and its less cost of procurement (85.06%) relative to surface and earth ponds.

The relevance to the fish farmer's situation is based on the problem of loss of fish stock during flood incidents, which is always at the colossal level and the drudgery involved in frequent changing of water as a result of pollution from both feeds and droppings. With the floating fish cage technology, the fish hardly escape from the water body during flood incidents as the cages are anchored to discourage movement from its location in the water body [14]. In their study in Uganda, Mbowa, et al. found that the loss of fish which frequently occurred during flood incidents was discouraged with the change from earth and surface ponds to floating fish cage technology.

The fish cage technology to them was easier to use as the cages are purchased at low prices, depending on the size instead of spending money and time on the construction of earth and surface ponds. As the cage is placed in a natural water body, the fishes are in their natural environment which has implications for their growth. This factor also removes the burden of having to change pond water frequently. Rakocy and McGinty listed the advantages of fish cage to include: Management flexibility ease and low cost of harvesting, close observation of fish feeding response and health case and economical treatment of parasites and diseases, relatively low capital investment compared to ponds.

TABLE 3

Characteristics of the fish cage technology (n=166)

Variables	Frequency	Percentage (%)
Relevant to farmer's situation	142	85.54
Has relative advantage	166	100
Less complex	149	89.76
Cost of less	108	65.06
Triable	166	100
Observable	166	100

Efficiency of change management

The efficiency with which the fish farmers managed the change process was measured by extension agents responsible for working with the selected fish farmers. The extension agents measured the efficiency of the change process thus on the basis of each farmer on the continuum of 0-2 (not efficient), 3-5 (fairly efficient); 6-9 (efficient) and 10-12 (very efficient).

Table 4 shows that overall, 68.67% of the fish farmers were adjudged to be efficient in the management of change from the earth and surface pond to floating fish cage. However, the fish farmers in delta south agricultural zone were found to be most efficient than those in the other two agricultural zones. Farmers in delta central were more efficient in the management of the change than those in Delta North agricultural zone. This is attributable to their familiarity of the fish farmers in Delta North and Central agricultural zone with the aquatic terrain. During the narratives, it was found that most of the farmers in Delta South and Central agricultural zones were once fished folks catching fishes from the wild. To these farmers, the change represented a compromise between artisanal fisheries and cultural fisheries.

These farmers were already used to the streams and rivers during their fishing experience, thus their efficient management of the change. The efficient management of the change is as well a consequence of the ease with which fishes were fed and their health managed on daily basis and the absence of regular flushing of ponds because of pollution or feeds and fish droppings. While studying the information needs of fish farmers, Agbamu and Ofuoku found that one of the information desired by fish farmers in Delta state was information on alternative fish management system, particularly, floating fish cage. With their high level of desire for this management system, their level of efficiency of change becomes influenced by their intrinsic motivation on having opportunity to the floating fish cage management system.

TABLE 4

Efficiency of change management process as evaluated by extension agents

Agricultural zones	Not efficient	Fairly efficient	Efficient	Very efficient
Delta North (n=46)	2 (4.35)	8 (17.39)	21 (45.65)	15 (32.61)
Delta Central (n=59)	7 (11.86)	11 (18.64)	24 (40.68)	17 (28.81)
Delta South (n=61)	11 (18.03)	13 (21.31)	17 (27.87)	20 (32.79)
Total (n=166)	20 (12.05)	32 (19.28)	62 (37.35)	52 (31.33)

Level of output before and after change

The mean fish yield kept on increasing right from the year of change through the first and second years after change (Figures 1 and 2). This increase in output is attributed to the flexibility of expansion and the weight gain of fishes that is influenced by the natural water body that has abundant oxygen supply ad libitum and some natural feeds that the fishes also pick up from the water bodies to supplement the formulated feeds fed to them regularly. Hansen and Jervell; Ofuoku and Ogisi found similar trends in their studies on their studies on change management in dairy and vegetable farming respectively. The superior yield in output is a consequence of the superiority of floating fish cage technology over Earth and surface ponds. The floating fish cage has advantages to both the fishes and farmers. To the fishes, they are comfortable in their natural habitat and had abundant supply of oxygen and clean water. The farmers no longer had to change pond water every 1-2 weeks to clear off polluted water previously supplied to keep the fishes alive. Harvesting became easier for the farmers likewise.

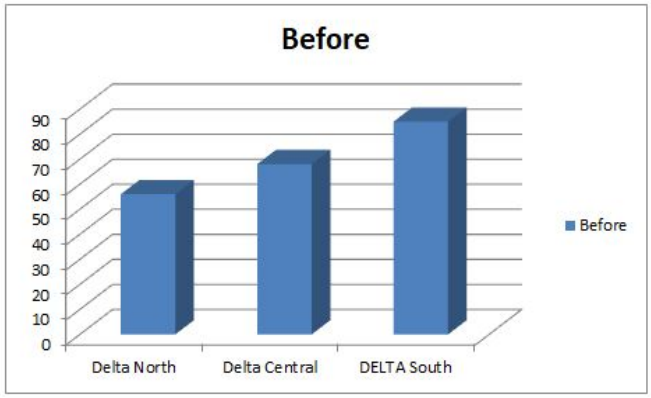

Figure 1: The mean fish yield kept on increasing right from the year of change through the first and second years before change.

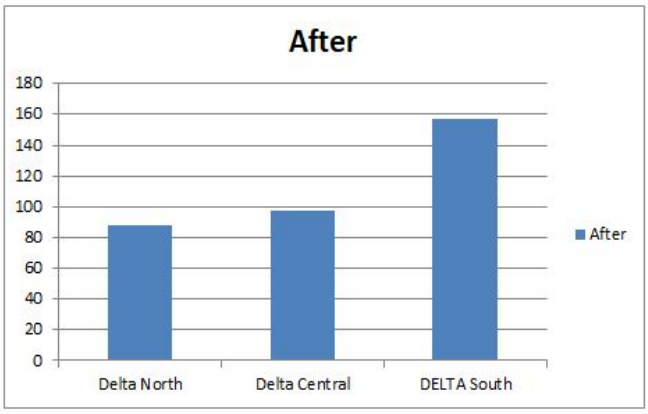

Figure 2: The mean fish yield kept on increasing right from the year of change through the first and second years after change.

Factors that contributed to change management efficiency

The results on Table 5 indicate that the fish cage technology characteristics, as well as selected fish farmer's characteristics contributed to efficiency of the change management process. Relevance of the flouting fish cage technology to the situation of the farmers contributed significantly to the efficiency of the change management. The coefficient bore a positive sign, which implies that efficiency was enhanced as the level of relevance increased. The farmers were more serious with change as a result of its relevance to their situation, hence improved efficiency.

Relative advantage as well, significantly contributed to efficiency of change management. The positive sign borne by the coefficient shows that the more advantageous the fish cage was over the surface and Earth ponds, the more efficient the farmers become while managing the change in fish housing management. They became more dedicated to the change process when they realized the advantages of the cage management system over the surface tank and earth pond management systems.

Complexity of the technology also contributed significantly to efficiency of change management, but the coefficient bore a negative sign indicating that the less complex the technology is, the more efficient the change management process will be by the farmers. This connotes that they found the fish cage management system easier to operate than the previous management technology they used.

Cost of the technology also contributed to efficiency of the change management, though the coefficient lore a negative sign. This is indicative of the fact that the lower the cost of the fish cage technology the higher the efficiency of the change management. Ray asserts that all the technology characteristics captured here enhance efficiency of change.

Other variables that contributed to efficiency of change management included the farmers' characteristics such as capacity to change (farm income), previous change management experience motivation and formal education. Capacity to change bore a positive sign indication that the higher the farm income the level of the fish farmers, the more the likelihood of efficiency in managing the change. Change management requires funding. Availability of fund promotes the process of change management.

Previous change management experience was brought to bear in the management of the current change. The more the experience carried in previous change management the higher the level of efficiency in the management of the change. This is articulated by the surging that experience is the best teacher. Motivation which its coefficient bore a positive sign means that intrinsic motivation which is stronger has the likelihood of enhancing efficiency in the change management. Hansen and Jervell, Ofuoku and Ogisi found that intrinsic motivation enhances change management that extrinsic motivation. This means that the farmers were efficient in managing the change because of their high level or inner motivation which is stronger.

Formal education positively contributed to efficiency in change management. A merit increase in the level of formal education has the likelihood of enhancing the level of efficiency by one unit as well. Education acquired is applied in every activity, hence the positive influence of formal education on efficiency of the farmers in fish housing change management. Education forms one crucial factor that promotes change management efficiency.

TABLE 5

To bit model estimation of factors that contributed to change management efficiency

Variables	Coefficient	Z-statistics
Intercept	10.346	4.47
X_1 (Relative advantage)	0.526	2.52**
X_2 (Relevance)	0.71	2.17**
X_3 (complexity)	-1.178	-2.33**
X_4 (cost)	-0.061	-1.78*
X_5 (capacity to change)	1.567	2.11**
X_6 (change-management experience)	0	0.01***
X_7 (motivation)	0	0.11***
X_8 (formal education)	0.161	2.19**
Log likelihood	85.534	

Challenges of floating fish cage management

Table 6 shows that the important challenges to change management of fish cage technology included poaching, predators and bio-fouling. The cages are susceptible to poaching by humans, who are not even fish farmers. This reduces the profits of the farmers.

Predators abound in the water and will always attack the fishes in cages. Bio-fouling is when algae grow on the edges and bottom of cages. When this happens, the flow of water and oxygen across the cage for fishes to

access becomes inhibited. Masser, et al. Slutote found the same challenges in both the USA and Kenya.

TABLE 6

Challenges of fish cage management

Challenges	Frequency	Percentage (%)
Poaching	106	63.86
Diseases	61	36.75
Pests	58	34.94
Bio-fouling	101	60.84
Predators	102	61.45

CONCLUSIONS

Based on findings in the study, it was concluded that fish farmers were efficient in the management of process of change. The use of fish improved technology had positively influenced fish production output of fish farmers in the study area. The variables that influenced efficient management of the change includes relative advantage, relevance, capacity to change, change in management experience, motivation and formal education. However, inadequate capital, complexity and high cost were found to be the major factors affecting the change in technology.

Based on the findings of this study, the following recommendations are proposed:

- Association of fish farmers in the study area should focus its training, workshops and seminars more on the use of new technologies.
- Government should provide access to credits for farm fishers at low interest rates.
- The usage of floating fish cage technology management system should be encouraged and sustained.
- The fish farmer's clusters should hire the services of local security men to solve the problem of poaching.
- Traps should be placed around cages to discourage predators
- Antifouling preventive measures and treatments are required to counteract bio fouling problems. These preventive and treatment measures can be known and used by contacting extension agents and the fisheries department of the extension agency.

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