BASELINE SURVEY REPORT

A SUITABILITY STUDY FOR ESTABLISHMENT OF AQUA PARKS IN BUKOBA RURAL AND BUNDA DISTRICTS

PRO-POOR ECONOMIC GROWTH AND ENVIRONMENTALLY SUSTAINABLE DEVELOPMENT – POVERTY ENVIRONMENT INITIATIVE

2015

A SUITABILITY STUDY FOR ESTABLISHMENT OF AQUA PARKS IN BUKOBA RURAL AND BUNDA DISTRICTS (BASELINE SURVEY REPORT

PRO-POOR ECONOMIC GROWTH AND ENVIRONMENTALLY SUSTAINABLE DEVELOPMENT – POVERTY ENVIRONMENT INITIATIVE

Economic and Social Research Foundation
51 Uporoto Street (Off, Ali Hassan Mwinyi Rd.) Ursino Estate
P.O. Box 31226 Dar-es-Salaam
Tel +255 22 2760260, Fax +255 22 2760062
Web: www.esrftz.org

United Nations Development Programme

Government of Tanzania

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND ACRONYMS

BMUs	Beach Management Unit
BOD	Biological Oxygen Demand
BXW	Banana Xanthomonas Wilt
CED	Community Economic Development
DO	Dissolved Oxygen
EU	European Union
FAO	Food and Agriculture Organization
FETA	Fisheries Education and Training Agency
FGD	Focus Group Discussion
GPS	Global Positioning System
JKT	Jeshi la Kujenga Taifa
NaFIRRI	National Fisheries Resources and Research Institute
NEMC	National Environmental Management Council
TAFIRI	Tanzania Fisheries research Institute
TPA	Tanzania Port Authority
UNDAP	United Nations Development Assistance Plan
URT	United republic of Tanzania
WRCB	Water Resources Control Board

ACKNOWLEDGEMENT

Mr. Moses Mbiru from Fisheries Education and Training Agency (FETA), Mwanza and Mr. K. Rushoke a private consultant carried out this assignment. A baseline survey team included; Mr. V. Marco from Water laboratory in Bukoba, Mr. Raphael Emmanuel and Mr. Reginald Shirima District Fisheries Officers from Bukoba Rural and Bunda districts respectively. Other members are Mrs. Margareth Nzuki and Mr. Abdallah Hassan from Economic and Social Research Foundation, who apart from conducting interviews and FGDs coordinated and organized logistics for the survey.

We acknowledge the assistance, data and information contributions from different persons in Bukoba Rural and Bunda districts; Village leaders, BMU leaders and members of community from Karukekere, Sikiro in Bunda district and Kemondo and Rubafu in Bukoba Rural district.

Lastly we gratefully acknowledge the Economic and Social Research Foundation, The United Nations Development Programme and the Government of Tanzania for the financial support to conduct this suitability study.

EXECUTIVE SUMMARY

The Government of the United Republic of Tanzania through President's Office-Planning Commission and ESRF (The Economic and Social Research Foundation) through **Pro-Poor Economic Growth And Environmentally Sustainable Development Project** under the United Nations Development Assistance Plan (UNDAP) provided funds to carry out a feasibility study for identification of suitable sites for the establishment of Aquaculture parks in Lake Victoria particularly Bukoba Rural and Bunda districts for the purpose of encouraging individuals and business people to participate into cage culture business.

The physical, chemical, and microbiological data were obtained from in-situ (direct measure) and ex-situ (laboratory) analysis. The water samples were taken from two stations in each site, one from shallow water and the other from deep water. Observation of some topographical and physical criteria i.e. shelter and calmness of an area were also done. Furthermore, interview and group discussion with fisheries officers, village leaders, BMUs, fishermen, fish farmers and other stakeholders who were ready to give relevant information were done. Results of physical, chemical and biological parameters of the water from Kemondo, Rubafu, Karukekere and Sikiro bays were within acceptable ranges and no critical values were recorded throughout the survey. The values of water temperature, depth, dissolved oxygen (DO), suspended sold, biological oxygen demand (BOD), and bacteria count (E-coli) were recorded from all sites (Table 3, Appendix 1). The criteria and parameters recorded are both within recommended standards of cage farm and tilapia culture.

Finally, the current study has revealed that, cage culture is an ideal cultural system for commercial production of tilapia as compared to pond culture, with successful implementation of this project, the cage culture will promote expansion of tilapia farming at a commercial scale and thus will contribute significantly to the increased economic growth and reduce pressure of capture fisheries in Lake Victoria.

1.0 INTRODUCTION

1.1 Background Information

Aquaculture is playing an increasingly important role in world fish production. Aquaculture is considered as an option for rural development because it can help to solve problems of poverty alleviation, protein malnutrition and provides part- and full-time employment. The economic studies have demonstrated that fish farming is a viable enterprise for African producers with high gains, but minimum costs (Molnar *et al*. 1991; Lightfoot *et al*., 1996). Although, small-scale aquaculture with commercial orientation can be a profitable economic activity, in Tanzania, aquaculture has a vast but as yet untapped potential. The contribution of the aquaculture sector to national food security and economic development in the country is still marginal. At present, aquaculture is still a subsistence activity practiced by poor households in the coastal and inland areas. Despite the level of farming and technicalities involved, the use of small fish ponds coupled with prolificacy and frequent breeding of tilapia are major constraints toward commercial and sustainable tilapia farming in the country.

Cage culture can be established in any suitable body of water, including lakes, ponds, mining pits, streams or rivers with proper water quality. This flexibility makes it possible to exploit underused water resources to produce fish. Relative to the cost of pond construction and its associated infrastructure (electricity, roads, water wells, etc.), cage culture in an existing body of water can be inexpensive (Masser, 2008). Cage culture offers several important advantages in tilapia culture. Tilapia can be cultured at high densities in mesh cages that maintain free circulation of water. The breeding cycle of tilapia is disrupted in cages, and therefore mixed-sex populations can be reared in cages without the problems of recruitment and stunting growth, which are major constraints in pond culture. Eggs fall through the cage bottom or do not develop if they are fertilized. However, the confinement of fish in cages should not hinder other uses of the water resource, such as fishing, boating, swimming, irrigation or livestock watering (McGinty AS and Rakocy JE, anonymous).

Research findings of recent years (LVFRP 2001; Muhoozi, 2003) show the decreasing trend of the fish stocks in Lake Victoria while the lake has continued to attract more people in fishing and other related activities. This has resulted to high fishing pressure and use of destructive or illegal fishing gears. LVFRP (2001) reported that the data on landings of Nile perch indicate a decline in total catch, although levels of fishing effort have grown from an estimated 12,041 boats in 1983 to 22,700 in 1990 and 42,548 in 2000. Given the current challenges of Lake Victoria fisheries, there is an urgent need to improve fish production to bridge the gap between supply and on growing demand for fish. When cage culture is implemented successfully, it will promote expansion of tilapia farming on a commercial

scale with more profit at minimum operational cost as envisaged in the national aquaculture development strategy (URT, 2009). With that, tilapia production in the country will contribute significantly to an increased economic growth and preserve the lake's biodiversity. In addition, incorporation of land based hatchery for fingerlings production will reduce pressure of wild collection of seeds from capture fisheries in natural water bodies.

1.2 Objectives of the Survey

The key objective of a baseline survey was to carry out a feasibility study to identify suitable sites for establishment of Aquaculture Parks in Lake Victoria especially in Bukoba Rural and Bunda districts, which will encourage individuals and business people into cage culture business. The study focused on gathering information together with environmental parameters to use on cage culture and social-economic considerations. Specifically, the tasks of this study were:-

(a) To analyze topographical, biological, physical and chemical baseline conditions from identified sites that would be key factor in launching a cage farm

(b) To assess social-economic status of community around

(c) To propose an area for establishment of land-based hatchery, nursery and juvenile units that could be incorporated into cage project

(d) To identify issues related to marketing and selling of produced fish and fish products.

2.0 SURVEY APPROACH AND METHODOLOGY

The methodology brought together several approaches that include focus group discussions, interviews, consultations with key stakeholders, the review of existing information (literatures), data from fisheries offices and site visits. The information provided at the local level i.e. from Kemondo, Rubafu, Karukekere and Sikiro bays established a reliable baseline for the survey. Considering the time and cost limitations, FGDs, and interview with all stakeholder; fisheries officers, fish farmers, fishermen, beach management units (BMU) leaders, village leaders and some group of women were conducted consecutively at each point. Interview of key stakeholders and four FGDs were held at village offices, two FGDs per district. The FGDs were conducted from 22nd to 26th, June 2014 where a two-hour presentation was made with open questions and discussions. Majority of FGD respondents in both districts were men (64% in Bukoba rural and 92% in Bunda). Queries and concerns raised were recorded.

The physical, chemical, and microbiological data were obtained from in-situ (direct measure) and ex-situ (laboratory) analysis. The water samples were taken from two stations in each site, one from shallow water and the other from deep water (Table 2). Each water sample in each station was collected from two columns of water, i.e., the thermo cline layer, and the lake base. The sampling method was conducted compositely which was by mixing the samples. The total depth was measured using special tape hanged with heavy object while wave height was estimated using visual observations. A Global Positioning System (GPS) tool (GARMIN) was used to take the GPS coordinates and height above sea level (Elevation) of the surveyed sites. In addition, the methodology used considered the application of a standard matrix approach which takes into account the issues of site selection criteria (Table 3, Appendix 2).

The following are criteria guideline for standard value, range and conditions that were adopted and considered for site selection during a baseline survey:-

(a) Sheltered and calmness areas protected from strong wind and wave. Strong winds will destroy any structure projecting above the water while waves will bear on any object on and under the water.

(b) BA depth range of 4 - 8 m and 5 - 20 m are recommended for stationary and floating cage respectively. Sufficient depth in cage culture is necessary in order to maximize water exchange and avoid oxygen depletion.

(c) A bottom of a firm substrate for better water exchange rate.

(d) An area with no strong current.

(e) High turbid water which is normally caused organic and inorganic solids resulted from soil erosion is not suitable for cage culture. These sediments act as a substrate for the growth of fouling organisms, which prevent proper water circulation.

(f) The water temperature for tilapia culture should range from 25 to 32 °C.

(g) pH and Suspended solids for cage culture should be within a recommended standards (pH-6.5-8.5 and Suspended solids <10 mg/l)

(h) Dissolved oxygen concentration should preferably be above 4 mg/L, but operating levels of between 5.0 and 7.5 mg/L is recommended.

(i) Bacteria count (E-coli) should be less than 3000 cell/ml.

(j) The cage farm site should be near a shore and other infrastructural services.

(k) Security is an important consideration anywhere. Since cage culture farm are sited in public waters, farm should be sited in a safe place and watched carefully to prevent poaching.

2.1 Baseline Survey Team

A baseline survey team and their roles are described below (Table 1).

Table 1: Survey Team

Name	Qualification	Institution	Role
Survey Team			
Mr. M. Mbiru	BSc. Aquaculture M.Sc. Biodiversity conservation	Fisheries Education and Training Agency-Mwanza	**TEAM LEADER** Aquaculture issues: FGDs, Interviews, Literature review, Data analysis and Report writing.
Mr. K. Rushoke	MA – Business Administration	Private	Market and marketing issues: FGDs, interviews and report writing
Mr. V. Marco	Laboratory Technician	Water Laboratory-Bukoba	Water testing – Sample analysis and presentation
Mr. H. Emmanuel	Fisheries Sciences	Fisheries officer-Bukoba	Fisheries issues; sites recommendation, organisation of FGDs and interviews
Mr. E. Shirima	B.Sc. Fisheries Sciences	Fisheries officer-Bunda	Fisheries issues - sites recommendation, organisation of FGDs and interviews
Mr. A. Hassan	Msc. Community Economic Development (CED)	Researcher-ESRF Dar es Salaam	Project introduction; FGDs, interviews and logistics organisation

3.0 FINDINGS FROM THE BASELINE SURVEY

3.1 Topographical Conditions of an Area

3.1.1 Exposure and Wave Actions

To avoid damage of the cage structures, cages farming system should be allocated in sheltered areas protected from strong wind and wave (FAO, 1989). Observations from the field survey showed that all identified sites at Bukoba Rural district (Kemondo and Rubafu bays) and Bunda (Karukekere and Sikiro bays) were well sheltered with mountains projected from almost three different sides. This makes the water to be calm with no strong wind and wave. Also, the information from local people, fishermen and fisheries officer proved that the identified sites do not experience strong winds and waves as compared to other disclosure parts of the lake. The survey team also experienced the calmness and rough conditions from sheltered and disclosure sites respectively while travelling from one point to another. However, strong wind and wave in Lake Victoria occur between May to September each year, this is within the time when the survey was conducted and it was advantage to researchers to observe the wind and accurately judge the sites. Though all identified sites bear similar characteristics in wind and wave actions, large area of Rubafu and Karukekere bays are well covered compared to Sikiro and Kemomondo bays.

Figure 1: Rubafu bay

Fig: 1 Rubafu bay

Figure 2: Karukekere bay

Fig: 2 Karukekere bay

Fig: 3 Calmness and rough conditions at Rubafu bay

Figure 3: Calmess and raugh conditions at Rubafu bay

3.1.2 Size of the Area and Depth

During the study the area size estimation was done. The result showed that all sites have enough area for establishment of cage culture. Although, all sites have enough area for cage culture, Karukekere and Rubafu bays have big and potential area for the project expansion as well as establishment of both stationary and floating cage compared to Kemondo and Sikiro bays. Size of an area treated per each surveyed site is summarized in Table: 2.

The maximum depth of a stationary cage should not be less than 4m and should not exceed 8 m this is, due to the fact that, it is difficult to find sufficient strong supporting posts longer than 8 m, while 5-20m depth is recommended for floating cage. The usual depth from 4m deep is necessary to allow sufficient depth under the cage in order to maximize water exchange, avoid oxygen depletion, accumulation of uneaten food, faeces and debris, disease infection, and build up of some noxious gases such as Hydrogen sulfide (H_2S) generated by decomposition of the deposited wastes. The measurement of water depth during a survey showed that the depth of all identified sites follow within recommended standards for both stationary and floating cage as shown in Table 2. Additionally, Rubafu and Karukekere bay had a wide range of area that follow within a recommended depth unlike to a narrow area of Sikiro and Kemondo bays. The data for depth treated per each surveyed site are summarized in Table 2.

Table 2: Estimated area and depth of all sites beyond 500m in shore

Table 2. Estimated area and depth of all sites beyond 500m in shore

District	Site (Area m²)	Station	Depth (m)	GPS coordinates
Bukoba rural	Kemondo bay (41,300m²)	1	4.7	S01.46368° E031.76816°
		2	8.0	S01.46786° E031.77088°
	Rubafu bay (121,500m²)	1	3.8	S01.06247° E031.79204°
		2	8.2	S01.033701° E031.81169°
Bunda	Karukekere bay (133,650m²)	1	4.0	S02.01393° E033.53330°
		2	4.8	S01.99950° E033.51892°
	Sikiro bay (36,450m²)	1	4.5	S02.03955° E033.39075°
		2	7.2	S02.02786° E033.38476°

3.1.3 Bottom Condition

The design of the cage is directly influenced by the type of substrate present at any given site. A firm substrate, with a combination of fine gravel, sand and clay presents an ideal site for cage culture. For example, floating cages over rocky substrates require more expensive anchoring blocks, but have better water exchange rate. On the other hand, stationary cages are easily set up in a muddy substrate with the use of cheaper poles but are not suitable for

high stocking density due to their low water exchange rate. Sampling from three identified sites namely, Sikiro, Karukekere and Kemondo bays indicated presence of sand substrate from different sampling points while Rubafu bay showed the presence of soft muddy substrate at the bottom in some sampling points, in fact, this might be due to presence of water hyacinth and some aquatic plants that were seen along the lake's shore.

Figure 4: Depth Measurement

Fig.4 Depth measurement

Figure 5: Sampling of a bottom substrate

Fig: 5 Sampling of a bottom substrate

3.2 Physical Criteria

3.2.1 Suspended Solids

Suspended solids in the lake are normally caused by water run-off from rivers or streams during rainy season; an area with suspended solids that exceed 10 mg/l is not suitable for cage culture. Organic and inorganic solids are suspended in the water column as a result of soil erosion. Run-off also brings some heavy metals leached from the catchment area as well as other agricultural and industrial effluents. Laboratory analysis of suspended solids in all identified sites showed a very low concentration of less than 0.1ml/L. This means that, all identified areas are not accumulated with either suspended solids of agricultural wastes or soil erosion.

3.2.2 Current Movement

The strength and direction of current are major criteria to be followed when positioning a cage on a grid line or raft. The survey from all sites showed that no strong current from river or stream entrance. With the exception of Karukekere and Rubafu bays, there were shallow drainage systems at Sikiro and Kemondo bays, although the currents are not strong to cause damage to the nets and cage structures or fixed poles. However, the water currents bring fresh oxygenated water to and remove waste from cage.

3.2.3 Water Temperature

The ideal water temperature for cage culture depends on the cultured species, the optimum temperatures for tilapia in cage are from 26.7 to 32°C, but good growth is maintained between 24 and 35°C. Death occurs at approximately 10 to 12.8°C depending on the species, and diseases become common below 15.6°C (Masser, 1997a). In the present study, results indicate that in all identified sites temperature values ranged from 24.3°C to 24.5°C with an average value of 24.4°C. However, temperature of water in the lake environments depends on time and season when sampling is done, in fact this low temperature from all identified sites is not permanent but it keeps on changing with time and season. Furthermore, the low temperature range recorded could have been influenced by land runoff which bringing up the colder water into the lake.

3.3 Chemical Parameters

Water quality management is a key ingredient for a successful fish operation. Normally, poor growth, disease and parasite outbreaks can be associated with water quality problems (Masser, 1997b). Water quality management is undoubtedly one of the most difficult problems facing a fish farmer. Water quality problems are even more difficult to predict and to manage. Various species of fish differ in their requirements with regard to water quality in terms of chemical parameters. Most chemical changes in the lake water along the littoral zone are affected by the discharge from rivers or steams. From this point of view, water sampling was conducted both at low and deep water.

3.3.1 Dissolved Oxygen (DO) and Biological Oxygen Demand (BOD)

The problem of dissolved oxygen for cage culture is not severe as compared to pond culture due to regular and permanent water movements in large water bodies. Dissolved oxygen recorded during a survey from all sites was above 4 mg/L (Table 3), that was found to be within the optimal range for tilapia growth (Phelps and Popma, 2000). Interestingly, biological oxygen demand (BOD) from laboratory analysis fell within standard values (Table 3, Appendix 3) for tilapia survival and growth.

3.3.2 Hydrogen ion index (pH) and Salinity

In fresh water, pH in the range of 6.5 to 8.5 supports most of aquatic organisms Although, the pH of freshwater may have great variation from 3 to 11 caused by acid rain or presence of limestone rocks. Extreme values of pH can directly damage fish gill surfaces and leading to death (WRCB, 2004). Tilapia can survive a wide range of pH, from 5 to 10, but do best in a pH range from 6 to 9 (Dennis *et al.,* 2009). The records from a survey from all identified sites showed that the pH values range from 7.8 to 8.5 which is within a recommended range for survival and growth of tilapia.

Table 3: Laboratory analysed results

Matrix of Criteria for Site Selection									
Parameter	**Chemical criteria**						**Physical criteria**		**Biological criteria**
	Dissolved oxygen	Biological Oxygen Demand (BOD)	Salinity	Hydrogen ion index (pH)	Phosphate	Nitrate (NO_2-N)	Suspended solid	Water temperature	Bacteria count (E. coli)
Acceptable Standard / **Sites**	> 4 ppm	< 5 mg/l	<5 ppt	6.0–9.0	< 70 mg/l	< 4 mg/l	> 10 mg/l	27-31 °C	< 3000 cell/ml
Kemondo 4.7m	9.09	6.6		8.5	-	-	<0.1 ml/L	24.5	3
Rubafu bay 3.8m	9.80	10.2		7.8	-	-	<0.1 ml/L	24.5	6
Karukekere 4.0m	8.69	13.2		7.9	-	-	<0.1 ml/L	24.3	6
Sikiro 4.5m	8.99	11.0		8.3	-	-	<0.1 ml/L	24.4	4
Note: Suspended solid are in ml/L, E. coli are in colonies/100ml matrix									

3.3.3 Pollutant from Other Sources

Apart from other factors, survey study also focused on different pollutants such as domestic sewage, agricultural wastes, animal waste and oil spills from fishing boats or navigation ships. These kinds of pollutants may have caused a number of problems to cage culture. The results from interview and physical observation indicated that no intensive application of agricultural chemicals, sewage systems and animal waste near the shore of all identified sites. However, there were a number of fishing and navigation activities at Kemondo bay, this scenario may indicate the presence of pollution in water although analysis of this kind of pollution was not carried out.

3.4 Biological Parameters

3.4.1 Bacteria Count (E. coli)

Many harmless or beneficial strains of *E. coli* occur widely in nature and several different types of *E. coli* are capable of causing disease. Results of laboratory analysis for bacteria count (E. coli) showed that Rubafu and Karukekere bay had highest count of *E. coli* in colonies/100ml compared to Sikiro and Kemondo bays (Table 3, Appendix 1). Although, Rubafu and Karukekere bays were shown to have high count, the concentrations of *E. coli* bacteria from the selected sampling points on each site are very low and acceptable for cage culture.

3.5 Accessibility and Security

Accessible road facilitates distribution of farm products and transportation of feed, fingerlings, fuel, farm equipment, supplies and other necessities. Likewise, site visiting and management will be more often to ensure proper management. All the surveyed sites are accessible to project team and the targeted group. However, the main road from Bukoba town is accessible to Rubafu villages but the feeder road leading to Rubafu bay on the side where identified site is located needs some maintenance. With the exception of Rubafu bay, there were good accessible roads from Bukoba and Bunda towns heading to other identified sites.

Security is one of the very important criteria in fish farming site selection both for pond and cage culture. Generally, the information obtained from interview and group discussion showed that each identified site has enough security because of the strong leadership in the community around (village leaders, BMUs, and fishermen groups). Also, the information from fishermen, village leaders and fisheries officers revealed that no application of poison is being practiced in the fishing grounds.

3.6 Establishment of Land Based Hatchery

Aquaculture development in Tanzania faces a number of challenges such as availability of hatcheries and affordable quality fish seeds and feeds. The proposed project to implement a land based hatchery at project area will address one of the main challenges for sustainable aquaculture. Also, mass production of fingerlings from the established hatchery will reduce pressure of wild collection of seeds from capture fisheries in natural water bodies whose quality is usually not good. During the survey different sites including Kemondo bay (Kyetema and Ngogo), shores of Rubafu, Karukakere and Sikiro as well as Buramba JKT Detach were visited. Key issues for hatchery were considered, these includes; enough area for construction of breeding ponds and experimental room, space for drying fish feeds, reliability of quality water, power supply and security of an area. Furthermore, presence of skilled labour, manpower, suitable breed for cage culture and presence of operating fish ponds were also considered in site selection.

Study findings show that the surveyed area/identified sites had enough space for construction of hatchery facilities and reliability of quality water. Although, there is presence of electrical power and operating fish ponds at Kemondo areas but the land ownership is still in question, this is because land does not belong to public office or farmer's group. Also, the rest of proposed sites: Karukekere, Sikiro and Rubafu bays lack electrical power, operating fish ponds and skilled labour. However, besides the revealed information above, the findings of this survey realized that there is no pure breed of Nile Tilapia in all operating ponds that is suitable for cage culture. Many farmers complain about

prolificacy and frequent breeding of tilapia which resulted to large populations of small-sized fish of low value that seldom reach an average weight of <100g at harvest.

3.7 Market of Fish and Fish Products

Fish demand is still high in Tanzania in relation to the growing population, for which the available fisheries resource are not sufficient. The main consumer markets for fish and fisheries products from Tanzania are the domestic market and neighboring countries including the SADC region. Asian countries and the European Union (EU) provide the main market for Nile perch fillets and shrimps. The species of commercial importance in lake are Nile perch, tilapia and dagaa which form the bulk of exports from Lake Victoria. Results of baseline survey showed that market of fish and fish products from Lake Victoria proceeds through a series of stages and a wide variety of market sites. The observation and interview information indicated that primary stage of fresh fish market takes place at the landing sites, when fishermen return from the fishing grounds and discharge their catches to waiting traders, processors and consumers. Furthermore, the interviewed fishermen revealed that, in some cases, they sell fish directly on water to those operating collection boats owned by fish industries this is an indicator for high market demand of the fish.

In general, information revealed during the survey in all identified sites indicated that the total catch for both tilapia and Nile perch has decreased dramatically. Also, findings of the study showed that tilapia landed in all these areas is either locally marketed or sent to other market places (e.g Mwanza, Dodoma, Kahama, Shinyanga, Singida, Morogoro, Arusha and Dar es Salaam). Furthermore, price of tilapia seems to be uniformly higher than those of Nile perch. Tilapia fetch high price because they are scarce and delicious to consumers. At a local market tilapia price range from 4,000 – 8,000Tsh per Kg while the retail price of tilapia at town/cities is about 8,000 – 10,000 Tsh per Kg. Additionally, Nile perch price differ with length and size, a fish with less than 50cm fetch low price. At a local market a kilogram of Nile perch with less than 50cm is about 2,500 – 2,800Tsh while those with above 50cm fetch industrial price of 4,500 – 5,000Tsh per Kg.

3.8 Willingness to opt Cage Culture

To avoid future obstruction and misunderstandings, the respondents' views on the proposed cage culture project were explored. In both districts, there was a strong willingness to accept this project whereby majority (88.4%) claimed that the project will bring positive impact to their livelihood as a source of food and income. However, 8.6% had the opinion that the proposed cage culture will bring both positive and negative impacts to their livelihood and the environment in general. In contrast, few respondents (2.8%) claimed that the proposed cage culture will bring negative impacts to their livelihood, particularly by interfering with their normal fishing activities by reducing fishing ground. However,

observation from the survey team revealed that, other people had doubt on the project because they are totally blind on the cage structure and alignment, size of the project and the area coverage. The data for views on willingness to opt cage culture are summarized in Table 4.

Also, an important observation made from the study is that, in Bukoba rural district the banana crop which is a major staple food crop has recently been threatened by a bacterial disease, the Banana Xanthomonas Wilt (BXW) which has lead to great losses of banana production in the district, leaving many families in short of food supply and therefore any alternative attempt aiming to increase household food supply is highly accepted by the majority regardless of their complexity and difficulties. Furthermore, the observation in this study with regard to food insecurity is in agreement with the findings of Tushemereirwe *et al.,* (2004) who reported that loss of Banana crops in Kagera region has contributed to decrease of household and national food security and income.

Table 4: Respondent's willingness to support proposed cage culture project

Table 4 ***Respondent's willingness to support proposed cage culture project***

Claims	Districts		Overall
	Bunda (n=24)	Bukoba Rural (n=45)	(n=69)
Positive	22	39	61
Positive & Negative	2	4	6
Negative	-	2	2
Total (%)	**100.0**	**100.0**	**100.0**

3.9 Pond and Cage Culture Awareness

The results obtained indicated that, there is quite a high level (100%) of awareness about pond culture in both districts. Most people have heard about fish farming practices from NGOs, friends, neighbors and government officials. Majority of respondents explained that tilapia pond culture was the most common fish farming system (97%) in their area followed by Catfish pond culture (3%). Other culture system mentioned by respondents (40.6%) in Bunda district was cage culture. However, the study revealed that, despite, the high level of awareness, only few respondents (3%) are involved in fish farming through pond culture. The reason behind this scenerio is that, there is no successful fish farmer already engaged in the business. They claimed small harvestable fish size and yield obtained from these ponds. Furthermore, this study investigated that the ongoing project failed due to pond

complications, culture system, lack of knowledge and skills on fish farming and poor seeds and feeds. The data for awareness on pond and cage culture are summarized in Table 5.

Table 5: Cage culture awareness in both districts

Table: 5 ***Cage culture awareness in both districts***

Awareness	Districts		Overall
	Bunda (n=24)	Bukoba Rural (n=45)	(n=69)
Pond Culture	24	45	69
Pond & Cage Culture	21	7	28
Unaware (Cage Culture)	2	38	40
Total (%)	**100.0**	**100.0**	**100.0**

4.0 CAGE CULTURE AND CROSS- SECTORAL ISSUES

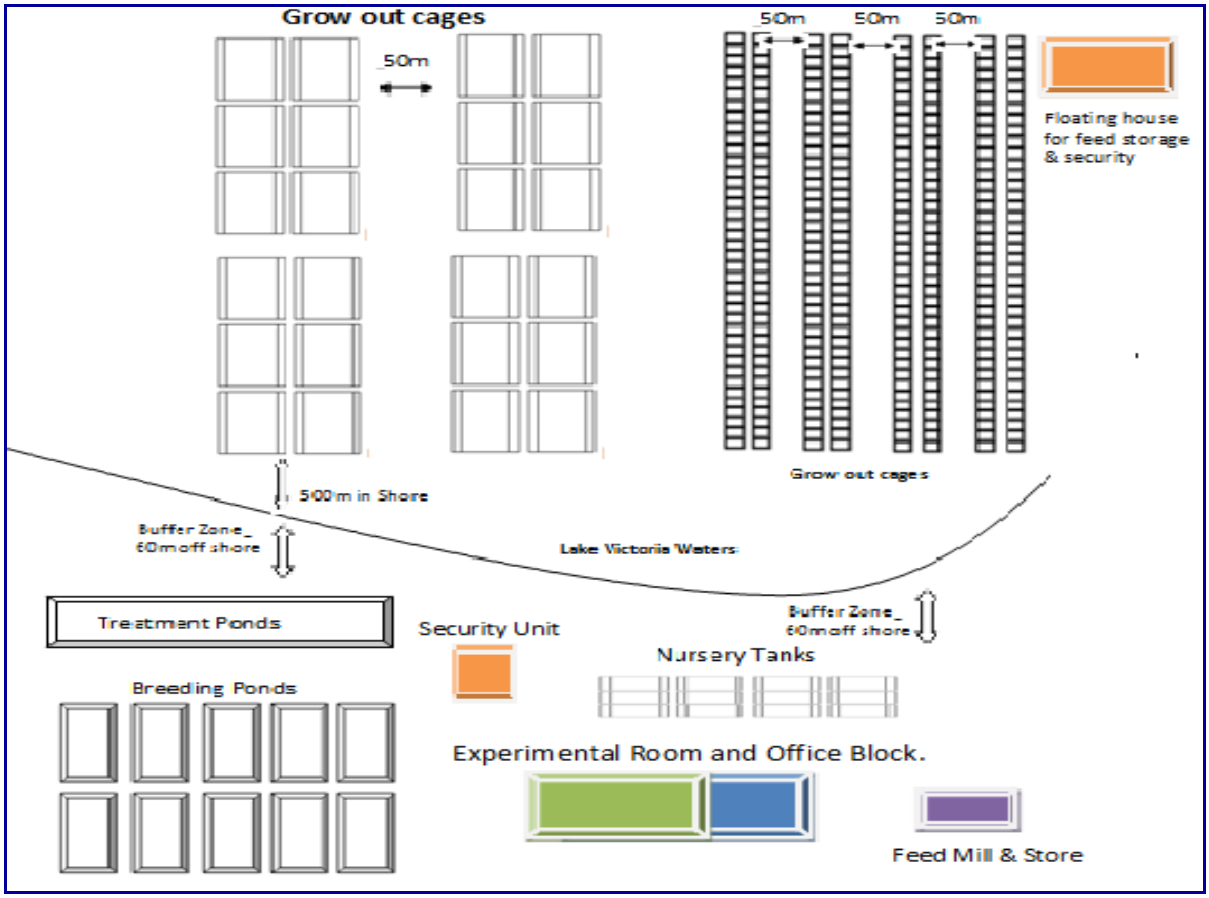
The National Fisheries Policy of 2010 provides for clear roles and responsibilities of stakeholders including private and public sectors to be engaged in fisheries and aquaculture sector. In case of cage culture, the Government emphasizes cage culture techniques should be applied in the ocean and on deep lakes (Lake Tanganyika) and not on shallow Lakes (Lake Victoria) although trials are being made on Lake Victoria to assess the sedimentation impacts. Also, the Tanzania Fisheries Research Institute (TAFIRI) has a concern that development of commercial cage culture in Lake Victoria may lead to further eutrophication in the lake. However this does not mean that the Authority is pessimistic in this type of farming since among its research priorities is to investigate the use of low cost technological aquaculture systems and their relation to socio-economic factors. The procedure and permit from National Environmental Council (NEMC) is very clear with no restriction whereby, developer of the project is required to carry out Environmental Impact Assessment and on completion the proposed project will be issued the operating license by the Minister of environment, Vice President Office (VPO).

In contrast to Tanzania, cage culture in Uganda is already in operating and some of the structures are constructed in front of the National Fisheries Resources and Research Institute (NaFIRRI) in Jinja town. In addition, the EAC countries has set a programme aiming at assessing the status and potential impacts for cage culture in Lake Victoria as well as developing Standard Operating Procedures (SOPs) for aquaculture research and development in the Lake Victoria basin.

5.0 CAGE FISH FARM SKETCH PLAN

This ground sketch is developed as a master plan for cage farms; it consists of grow-out cage, feed mills and storage, feed store and security units and administrative block. The sketch also includes hatchery units with breeding ponds, nursery tanks, experimental room and nursing tanks.

Figure 6: Cage Fish Farm Sketch Plan



6.0 RECOMMENDATIONS AND CONCLUSION

6.1 Recommendations

This baseline survey did indentify key environmental and social issues pertaining to the proposed project of implementing cage farm and land based hatchery at Bukoba Rural and Bunda district. All key issues for introduction of cage farm have been assessed and described to gain an understanding of environmental conditions and social-economic status of the community around. This is necessary for identifying the challenges and obstacles that in one way or another could hold back the project achievements. Basing on the findings, the survey team recommends the following:-

(a) Based on study findings from the information revealed and data obtained from in-situ (direct measure) and ex-situ (laboratory) analysis, two sites namely; Rubafu bay and Karukekere bay at Bukoba Rural and Bunda districts respectively are qualify as a suitable sites for establishment of Aquaculture parks in Lake Victoria. Although, all identified sites had almost the same conditions, but the selected sites have a wide and large area that can be utilized for cage farm compared to Sikiro and Kemondo bays. Also, there is a challenge of oil spills from ship and fishing boat as well as water boundaries between the community around and Tanzania Port Authority (TPA) at Kemondo bay while at Sikiro bay there were lots of floating Island that could be threat to cage structures.

(b) Since some sampled points of Rubafu bay had soft muddy substrate, low stocking densities should be adopted, this is due to the fact that, the decomposition activities do reduce the amount of oxygen available for the fish hence impacting negatively on the farmed fish.

(c) For sustainable mass production of tilapia seeds, JKT Bulamba and Sengerema district are suitable sites for establishment of land based hatchery. Survey team selected Sengerema after knowing it is a project district. The selected areas have all key requirements necessary for hatchery operations. These includes; operating ponds with pure brood stock of Nile tilapia, enough manpower and qualified personnel, presence of electrical power and enough space for construction of breeding ponds and experimental room.

(d) In order to help participation of women in the proposed project, there is a need for women to be involved in all stages of the project. Women constitute the greater percentage of the fish mongers/processors and they represent the first segment of the fish market chain through buying fresh fish directly from the fishermen.

Despite the significant presence of women in the sector, most projects fail to capture the actual contributions of the women in small-scale fisheries and aquaculture. There is the need for the proposed project to engage women and assist them to rise up and overcome their challenges in order to benefit from fisheries and aquaculture resources.

(e) Since the ongoing cage farming project at Bulamba JKT acts as a model project in promoting aquaculture in Bunda district, the proposed project should launch the project of the same kind in Bukoba Rural that will act as demonstration site. This will encourage organizations, farmer groups, individual farmers and different stakeholders to engage in the same venture. Also, the demonstration site will cause a multiplier effect not only in Bukoba rural but also in the nearby towns such as Bukoba urban, Chato, Geita and Sengerema districts. The effect is slowly observed in Bunda whereby some of the people who have capital started to do the venture on their own.

(f) Education and public awareness campaigns should be carried out so that people will be aware on the vast aquaculture potentials in the country. Different firms and investors should be encouraged to participate in aquaculture business not only in fish farming but even in selling cage facilities and equipments; these will provide solid foundations for the growth of this industry from small scale to commercial business.

(g) So long as fisheries policy recognizes environmental conservation issues, all relevant government authorities/bodies must be consulted before the commencement of the proposed project, these include such as National Environmental Management Council (NEMC), Tanzania Fisheries Research Institute (TAFIRI), Lake Victoria Environmental Management Project etc.

(h) The Government through its institutions and authorities should create attractive and friendly environment for cage culture investors. The environmental issues and advice should be promptly provided as a service to cage farmers by the relevant authorities. In addition, after the introduction of cage farms in these selected sites, continuous monitoring should be done to ensure that any changes in the bio-physical and chemical parameters are recorded; this will help to know the change trend of natural environmental parameters and those caused by cage farms before exposing the farmed fish to disastrous effects.

(i) Finally, strong Government support should be engaged in promoting aquaculture projects, these includes tax exception for aquaculture equipments and facilities and provision of experts from successful countries. A well equipped aquaculture

training centre(s) should be established in the region to offer practical training at both supervisory and management levels. Furthermore, financial institutions should be educated about aquaculture investment.

6.2 Conclusion

The current study revealed that, cage culture is an ideal cultural system for commercial tilapia production compared to pond culture in terms of investment costs and production. Relative to the cost of pond construction and its associated infrastructure cage culture is inexpensive, it is also, offers multi-use of water resources because cage structures do not hinder other uses of the water resource, such as fishing, boating, swimming, irrigation or livestock watering (Masser, 2008). However, the findings of the study indicated that, all the considered parameters under the topographical, physical, chemical and biological criteria were within the acceptable range for cage culture. Furthermore, the proposed project was strongly accepted by the targeted communities as an income generating activity for their livelihood.

Given the nature and size of this proposed project, it can be concluded that by implementing this project successfully, it will promote expansion of tilapia farming on a commercial scale as envisaged in the national aquaculture development strategy (URT, 2009). Thereafter, tilapia production from cage farms will contribute significantly to increased economic growth, reduced poverty and improved social well-being of many coastal communities. Additionally, high production from tilapia farming will reduce pressure of capture fisheries in the lake, thus preserve the lake's biodiversity.

7.0 REFERENCES

Dennis PD, Thomas ML and James ER. 2009. Tank Culture of Tilapia. Southern Regional Aquaculture Center (SRAC), Publication No. 282.

FAO (1989). Site Selection Criteria for Marine Finfish Netcage Culture in Asia. Rome: FAO. p. 16.

FAO 2012. United Republic of Tanzania. Aquaculture Sector Overview. http://www.fao.org/fishery/countrysector/naso_tanzania/en retrieved on October 16, retrieved on October 2012.

Lightfoot C, Perin M, and Ofori JK. (1996). Analytical framework for rethinking aquaculture development for smallholder farmers. Pages 4–10 in M. Perin, J. Ofori,

Lake Victoria Fisheries Research Project (LVFRP). 2001. Lake Victoria Fisheries Research Project Phase II, 1997–2001: Final Report of UNECIA Ltd. Compiled by Cowx IG, Crean K, Geheb K, MacLennan D. Sheffield (United Kingdom):Universities of the North of England Consortium for International Activities.McGinty AS and Rakocy JE. anonymous. Cage culture of Tilapia. Publication No. 281 (L-2408) *Southern Regional Aquaculture Center*.

Masser MP. 1997a. Cage culture. Species Suitable for Cage Culture. Publication No. 163. *Southern Regional Aquaculture Center*.

Masser M.P . 1997b. Cage culture. Site Selection and Water Quality. Publication No. 161. *Southern Regional Aquaculture Center*.

Masser MP. 2008. What is Cage culture?. Publication No. 160. *Southern Regional Aquaculture Center*.

Molnar JJ, Rubagumya A, and Adjavon V. 1991. Sustainability of aquaculture as a farm enterprise in Rwanda. *Journal of Applied Aquaculture* 1(2):37–62.

Muhoozi l. 2003. Aspects of the commercial exploitation of fish stocks in Lake Victoria. PhD dissertation.University of Hull,United Kingdom.

Tushemereirwe WK, Kangire A, and Ssekiwoko F. 2004. First report of *Xanthomonas campestris pv.musacearum* on banana in Uganda. *Plant Pathology*, 53: 802.

URT, 2009 Fisheries sector development programme. Ministry of Livestock and fisheries development. Dar es salaam, Tanzania.

Water Resources Control Board. 2004. The Clean Water Team Guidance Compendium for Watershed Monitoring and Assessment State. FS-3.1.4.0(pH)V2e http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/cwt/guidance/3140en.pdf retrieved on August 6, 2015.

APPENDICES

Appendix 1: Laboratory Analysis Results

Matrix of Criteria for Site Selection

Parameter	Chemical criteria						Physical criteria		Biological criteria
	Dissolved oxygen	Biological Oxygen Demand (BOD)	Salinity	Hydrogen ion index (pH)	Phosphate	Nitrate (NO_3-N)	Suspended solid	Water temperature	Bacteria count (E. coli)
Acceptable Standard / Sites	> 4 ppm	< 5 mg/l	<5 ppt	6.0-9.0	< 70 mg/l	4 mg/l	<.10 mg/l	27-31 °C	< 3000 cell/ml
Kemondo 4.7m	9.09	6.6		8.5	-	-	< 0.1 ml/L	24.5	3
Rubafu bay 3.8m	9.80	10.2		7.8	-	-	< 0.1 ml/L	24.5	6
Karukekere 4.0m	8.69	13.2		7.9	-	-	< 0.1 ml/L	24.3	6
Sikiro 4.5m	8.99	11.0		8.3	-	-	< 0.1 ml/L	24.4	4

Note: Suspended solid are in ml/L, E. coli are in colonies/100ml

Date 06/07/2015 Signature and Stump

MINISTRY OF WATER
REGIONAL WATER QUALITY LABORATORY
P. O. BOX 81
BUKOBA

Appendix 2: Depth and GPS coordinates of surveyed stations

Sampling and Survey stations

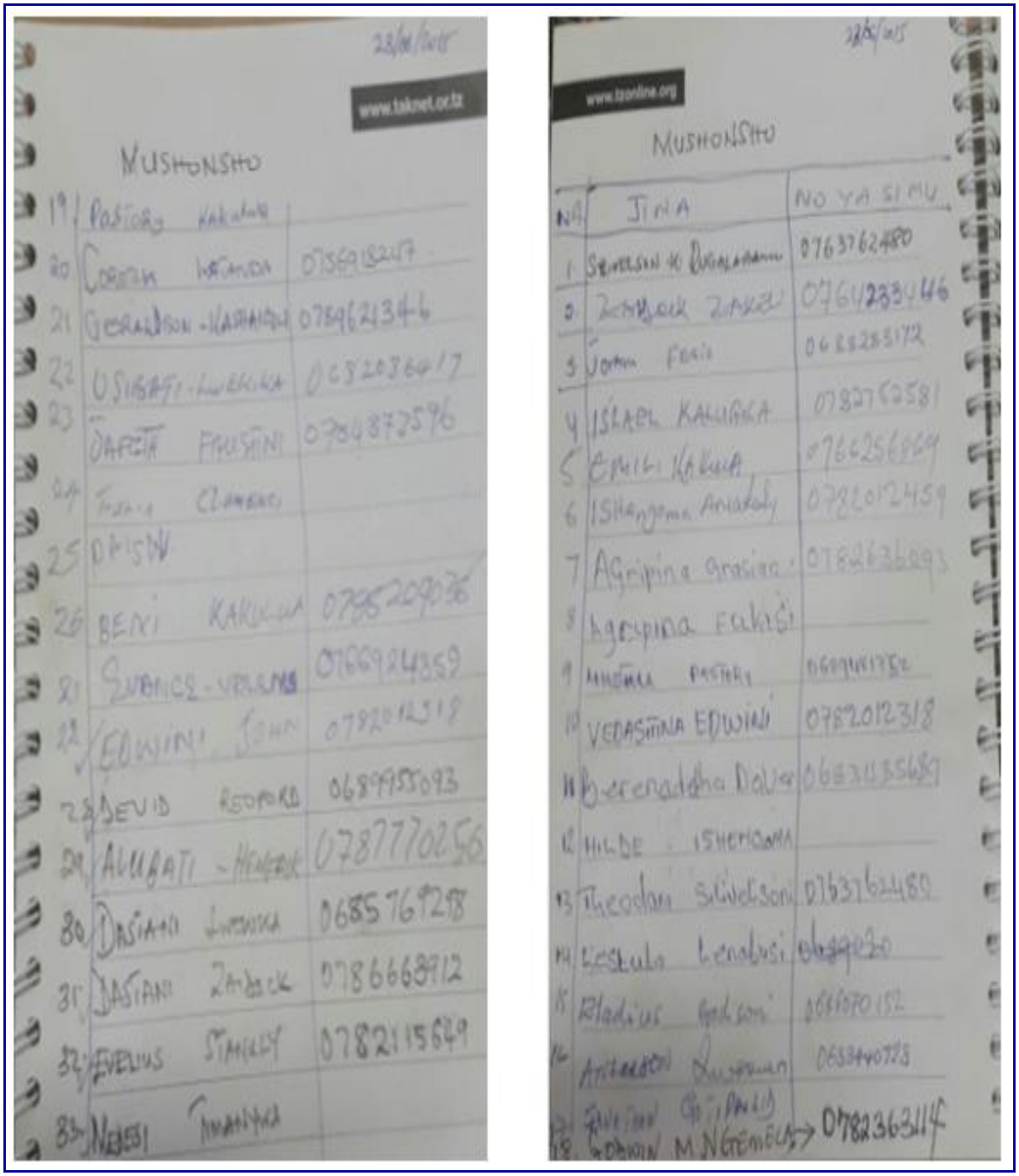
District	site	station	depth	GPS Coordinates.	
Bunda	Karukakere bay	A	2.5m	S02.0210°	E033.5261°
		B	3.5m	S02.01916°	E033.52986°
		C	4.0m	S02.1393°	E033.53330°
		D	3.7m	S02.00427°	E033.53767°
		E	4.2m	S01.99950°	E033.51892°
		F	4.3m	S01.99874°	E033.48096°
	Sikiro	A	5.0m	S02.03392°	E033.39014°
		B	4.4m	S02.03955°	E033.39075°
		C	7.2m	S02.02786°	E033.38476°
Bukoba	Kemondo bay	A	4.7m	S01.46368°	E031.76817°
		B	3.1m	S01.446354°	E031.77028°
		C	4.7m	S01.46513°	E031.77040°
		D	7.7m	S01.46753°	E031.77085°
		E	8.0m	S01.46775°	E031.77085°
	Rubafu bay	A	3.8m	S01.06247°	E031.79204°
		B	5m	S01.05892°	E031.78419°
		C	6m	S01.04930°	E031.77472°
		D	4.3m	S01.04695°	E031.76794°
		E	7.8m	S01.04058°	E031.77646°
		F	9.2m	S01.03460°	E031.78729°
		G	8m	S01.03701°	E031.81169°
		H	5m	S01.03662°	E031.82040°

Appendix 3: Different photos during baseline survey






Appendix 4: Stakeholders' Attendance



Appendix 5: Stakeholders' Attendance

22/06/2015

www.taknet.or.tz

KEREMWOO

NAME	MOBILE
HAMAD [illegible]	0755547872
A.SUMAIYA MOHAMED	0765051852
HAMZA S. MZINGA	0754665178
BUSHIRA MZINGA	0754505051
SHAKIRU [illegible]	0784989013
KHATIMBU MUSSA D.	0759973222
BEATHA - [illegible]	0753231578
FATUMA - TAHYA	0768456882
IBRAHIM SABURI	0755765991
JOSEPH HENERICO	0762 811288
HABIBU HAMDANI	0759 183431
NASSOR MPEMBENKALAKI	0754506302

KATA: IRAMBA

www.taknet.or.tz

MUGARA

No	JINA	No YA SIMU
1	SILAS MLAGALA	0783 351880
2	NUYAB MAKWAMBA	0786021287
3	SEBASTIAN M. ANTHONY	0785-421179
4	MUGANGA K MUGANGA	0764-42195
5	ZEPHANIA MUHERO	0688211002
6	BRUNO UWERO	0752682094
7	JUSTIN MUGETA	0683641610
8	SENGURA KAMUGA	0684119463
9	MANDE M. MZUNA	0688404810

Appendix 6: Stakeholders' attendance