Status of Fish Health Management and Biosecurity Measures in Fish Farms, Cages and Hatcheries in Western Kenya

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ABSTRACT

Aquaculture is one of the critical sectors contributing to food and nutrition security, income and employment opportunities to millions of people and is currently the fastest growing food-producing sector globally. With the global increase in aquaculture production, focus on biosecurity and fish health management is becoming increasingly important to address the risks and impacts of aquatic diseases. Within the framework of adaptive research, this study

aimed at assessing the levels of awareness and preparedness of fish farmers in Western Kenya to meet fish health management and biosecurity requirements as important parameters determining the success of their farming activities. A total of 243 fish farmers were interviewed using a pre-tested questionnaire generated by a computer-aided personal interview (CAPI). The key findings were that 76.1% of the fish farmers reported mortalities in their farms, with 2.3% reporting mortalities above 50% of the stocked fish, but with a majority 85.5% reporting loss of up to 10%. In extrapolation, the total loss from the farms correlates with stagnation in aquaculture production in Kenya. This study recommends the development of a coordinated awareness campaigns on fish health management and biosecurity measures to fish farmers in Kenya.

Keywords: Fish; Health; Management: Biosecurity; Aquaculture; Kenya

Declarations

If any of the sections are not relevant to your manuscript, please include the heading and write 'Not applicable'

Funding

This research was funded by KARLO-KCSAP grant agreement number GA02-4/1

Conflicts of interest/Competing interests

The authors declare that there are neither conflict of interests nor competing interests

Availability of data and material

Not applicable

Code availability

Not applicable

Authors' contributions

Not applicable

Ethics approval

Not applicable

Consent to participate

Not applicable

Consent for publication

Not applicable

Acknowledgments

We wish to thank the Kenya Agricultural and Livestock Research Institute for funding this project through the Kenya Climate Smart Agriculture Project grant agreement number GA02-4/1

INTRODUCTION

Aquaculture has been identified as one of the critical sectors contributing to food and nutrition security, income and employment opportunities to millions of people and is now the fastest growing food-producing sector globally (FAO 2020). In Kenya, aquaculture is mainly divided into mariculture which is still at an infancy stage and a more progressive freshwater aquaculture (Opiyo et al. 2018). The Government of Kenya has recognized this critical sector and has continued to invest towards intensification of aquaculture through different initiatives. For instance the economic stimulus programme (ESP) which resulted to a significant expansion from 4,218 metric tonnes (MT) in 2006 to a peak of 24,096 in 2014 (Munguti et al., 2017; Obiero et al., 2019). As a result, freshwater aquaculture has been prioritized in some counties such as Kakamega, Siaya and Busia, with many fish farmers venturing into cage fish farming in the Winam Gulf of Lake Victoria (Munguti et al. 2014; Aura et al. 2018; Njiru et al. 2018). However, aquaculture has been associated with some challenges such as fish diseases and parasites (Shitote et al. 2013; Munguti et al. 2014; Ojwala et al. 2018; Opiyo et al. 2018). As a result, there should be adequate biosecurity measures to reduce economic losses through fish mortalities and unnecessary treatment costs (Bhujel 2014). Fish health management is a term used in aquaculture to describe management practices which are designed to prevent fish diseases. A sustained and consistent practice of biosecurity is becoming an increasingly critical requirement for successful aquaculture (Noble and Summerfelt 1996; Browdy and Bratvold 1998; Timmons et al. 2002; Lee and O'Bryen 2003; Delabbio et al. 2005). According to World Organization for Animal Health (OIE 2019), the term biosecurity can be defined as a set of management and physical measures designed to reduce the risk of introduction, establishment and spread of pathogenic agents to, and from and within an aquatic animal population. Therefore, unless governments are informed about the implications of fish diseases for the development of the fisheries and aquaculture sectors coupled with limited support for fish health management, is bound to create a potentially dangerous situation which can result in massive fish mortalities and economic losses (Akoll and Mwanja 2012). According to the recently held Aquatic Biosecurity Governance Workshop in Durban, South Africa in the year 2014, African states were urged to be proactive rather than reactive to a healthy aquaculture production that protects producers and the emerging sector from the risks and threats of aquatic pathogens and diseases (FAO 2018). Globally, the risks of pathogen introductions into aquaculture systems are on the increase (Kent 2000). In addition, some previous studies have strongly recommended the need for baseline studies on fish emphasizing the health of farmed fish and health management practices to provide basic information for planning necessary interventions for fish health management in Kenya (Opiyo et al. 2018).

Therefore, the aim of this study was to assess the fish health management and biosecurity practices in the Counties of Kakamega, Siaya and Busia, Kenya, where aquaculture has been prioritized for food security in the respective County Integrated Development Plans.

MATERIALS AND METHODS

Description of the study area

This study covered selected fish farms, cage farms and hatcheries in three counties in Western Kenya namely Kakamega, Siaya and Busia as shown in Figure 1.

Sampling technique

A modified systematic random sampling technique was used for sample selection. The rationale for choosing this technique is its simplicity and it also gives assurance that the population is evenly sampled. Field plan was prepared and finalized after consultation with the stakeholders. There were nine (9) Focus Group Discussions (FGDs), (3 FGDs in Siaya, 3 in Busia and 3 FGDs in Kakamega counties) and five (5) Key Informant Interviews with the major stakeholders. Mixed-sex groups were used for the FGDs since the survey was not considered to include 'gender sensitive' topics. The FGDs were chosen in such a way to ensure they included a minimum of 30% female respondents. A total 243 fish farms, cages and hatcheries were sampled. The sampled units and sample sizes are indicated in Table 1.

Data collection

A semi-structured questionnaire was used for data collection using computer aided personal interview (CAPI). The questionnaire was used to collect information on fish health management, biosecurity measures, common fish diseases and parasites, fish mortality and mitigation measures. Prior to the main survey, the questionnaire was pretested through ten (10) in-depth interviews with the smallholder fish farmers in the project areas with the aim of testing and validation of the various aspects of the survey including data collection instruments, methodology and field logistics.

Data analysis

The data collected was summarized using descriptive statistics using SPSS version 25. The homogeneity of frequency data of all the parameters between the three counties was tested using a non-parametric Pearson Chi-Square test at $\alpha=0.05$.

RESULTS

RESULTS

Fish health management systems

From this study, 76.1%, (n=243) of the fish farmers reported mortalities in their farms (Figure 2a), with 2.3% reporting mortalities above 50% of the stocked fish (Figure 2b), but with a majority 85.5 % reporting loss of up to 10% (Figure 2b). There was homogeneity between the three counties in terms fish mortality levels (Pearson Chi-Square test, $p<0.005$). Although these numbers seem to be low, if one extrapolates the total loss from the farms, then one can know why aquaculture production is stagnating. For the average farmer with a fish pond of $300m^2$, 10% loss in all the farms amounts to approximately 25MT for Western fish ponds, and if it is the cages, the loss is even higher. For about 4500 fish farms in Kenya, then the total loss is 450MT, accounting for 2.25Million USD in losses. Interestingly, 66.7%, (n=243) of the fish farmers have never seen a sick fish (Figure 2c). However, some of the fish farmers (32.5%) seemed well aware that water quality management was critical to avoid stressing the fish, hence controlling fish diseases (Figure 2d).

Biosecurity measures

Some management practices reported included the choosing springs/streams as the source of water to the farms (49%), use of inlet screens (2%) to keep off unwanted organisms, use of liming (5%) to ensure the farms are well buffered hence moderate the pH fluctuations and regular water exchanges in fish ponds were reported. There was homogeneity between the three counties in terms of biosecurity measures (Pearson Chi Square, $p<0.005$). Only (<1%) of the farms in the study use disinfection (Footbath) to prevent any possible introduction of pathogens into the system. This was a very serious problem and challenge whose impacts can be detrimental to the aquaculture sector, not only in the studied areas but also to the wider region given the transboundary trade in live fish.

Common fish diseases and parasites in the three counties

The most recognizable disease by most farmers was the fungal infections, and other minor diseases such as cysts on the skin. Most farmers reported loss of scales, swollen scale, abnormal swimming activities, fin rots, and gulping for oxygen as common symptoms. Most of the diseases reported occurred during the rainy/cold season. The most commonly sighted parasite by the farmers is the leech (Hirudinea /leeches). Mortalities reported. In the present study, 60% of farmers would report incidences of sickness in the farm to the fisheries officers. There was homogeneity between the three counties in terms of common fish diseases and parasites (Pearson Chi Square, $p<0.005$).

Discussion

Source of water for Fish farming in Western Kenya

Springs are the most preferred source of water in Western counties of Kenya because farmers consider the need to site farms in areas with permanent sources of water (Nguka et al. 2017). Besides being considered as a permanent water source, springs also have the best water quality with little or no known pathogens infecting fish. High water quality and its maintenance is considered a major mitigation against stress with predispose fish to diseases. Shitote et al. (2013) also reported the same results in the study about challenges Facing Fish Farming Development in Western Kenya. Other farmers (20%) rely on water from rivers for the fish farming operations. On the contrary farmers from the Central Kenya have been reported to use permanent rivers at 61% (n=56) followed by public piped untreated water at 27% (25/92) (Wanja et al. 2020).

Common fish diseases and parasites in the three counties

It was noted generally that most fish farmers (76%) reported mortality in their hatcheries and farms with an overall loss of about 10%, but did not attribute the mortalities to fish diseases, hence seem to have accepted mortalities as being a normal occurrence. The most recognizable disease by most farmers was the fungal infections, and other minor diseases such as cysts on the skin. Most farmers reported loss of scales, swollen scale, abnormal swimming activities, fin rots, and gulping for oxygen as common symptoms. Most of the diseases reported occurred during the rainy/cold season. The most commonly sighted parasite by the farmers is the leech (Hirudinea /leeches). This finding is strikingly similar to that of Omasaki et al. (2013) in which leeches were also reported to be the common parasites infecting fish from the Counties of Kakamega, Kisii and Siaya.

Biosecurity measures

A neglible percentage (<1%) of the studied farms, for instance only in Wakhungu Hatcheries did the study find the use of disinfection to prevent any possible introduction of pathogens into the system. This could be possibly due to a lack of awareness of the importance of the same. This was a very serious problem and challenge whose impacts can be detrimental to the aquaculture sector, not only in the studied areas but also to the wider region given the transboundary trade in live fish. As indicated by Assefa and Abunna (2018), biosecurity measures are very critical in preventing entry of pathogens to farms.

With the global increase in aquaculture production, focus on biosecurity and fish health management is becoming increasingly important to meet the risks and impacts of aquatic diseases (Bondad-Reantaso et al. 2005). This is the first study focusing on fish health management and biosecurity measures in Kenya. The topic of fish health management, a significant input factor in modern fish farming seems to have undergone little scrutiny in the context of successful industry development in Sub-Saharan Africa (Børge 2018). The findings of this study on biosecurity are strikingly similar to the study in Uganda, which found a low level diseases knowledge and awareness, some basic biosecurity measures being carried out in hatchers, but very few or no basic basic biosecurity measures are implemented routinely in grow-out farms (Børge 2018). Aquaculture has been touted as a promising solution for food insecurity, poverty and malnutrition in Kenya (Ogello and Munguti 2016), and indeed the Government of Kenya continues to invest heavily towards the intensification of aquaculture. Unfortunately, in the recent times, some of the most infectious diseases which can cause serious losses in farmed fish, some up to 90% such as Tilapia Lake Virus (TiLV) (Matolla 2020), Infectious Pancreatic Necrosis (Mulei et al. 2018) and the Infectious Haematopoietic Necrosis Virus (IHNV) the causative agent of infectious haematopoietic necrosis, a disease of salmonid responsible for great economic losses (Mulei et al 2019) have all been reported infecting fish in Kenya and Uganda. It is important to note that the country's aquaculture production has been reported to be in a short fall of the required demand, hence imports such as those from China, and for us to have a true expansion in production, adequate fish health management is critical (Børge 2018). There are existing technologies in aquaculture including those of fish health management and biosecurity, however, there are gaps in technical skills which hinder the uptake of those technologies and best management practices (Obiero et al. 2019). The most successful countries in terms of aquaculture production mainly in Asia and led by China have adequate fish health management systems and biosecurity measures (Mohammed and

Subasinghe 2017). For example, with the onset of Tilapia Lake Virus (TiLV) outbreaks in several Asian countries, WorldFish, in collaboration with Bangladesh's Department of Fisheries, has developed a program to improve biosecurity in the tilapia industry throughout the country (Mohammed and Subasinghe 2017).

Conclusions

Western Kenya is one of the leading regions for aquaculture production in Kenya. This study concludes that there is a paucity of knowledge on fish health management systems and biosecurity measures which presents a serious threat to aquaculture production in the studied counties and poses a great risk to trans-boundary live fish trade between Kenya and her neighbouring countries. Although fish farming is a promising area, it has had so many challenges among them high mortality rates. In China and other Asian countries, which are the world leaders in aquaculture production, they are making headway in fish health management and biosecurity. Lessons can be learnt from these countries and under the concept of blue economy development, the Kenyan government can develop aquaculture. Therefore, it will require collaborative efforts between the relevant ministry, departments and research institutions to formulate a strategy for the effective development, awareness creation and implementation of the best fish health management practices and aquaculture biosecurity plans of the country.

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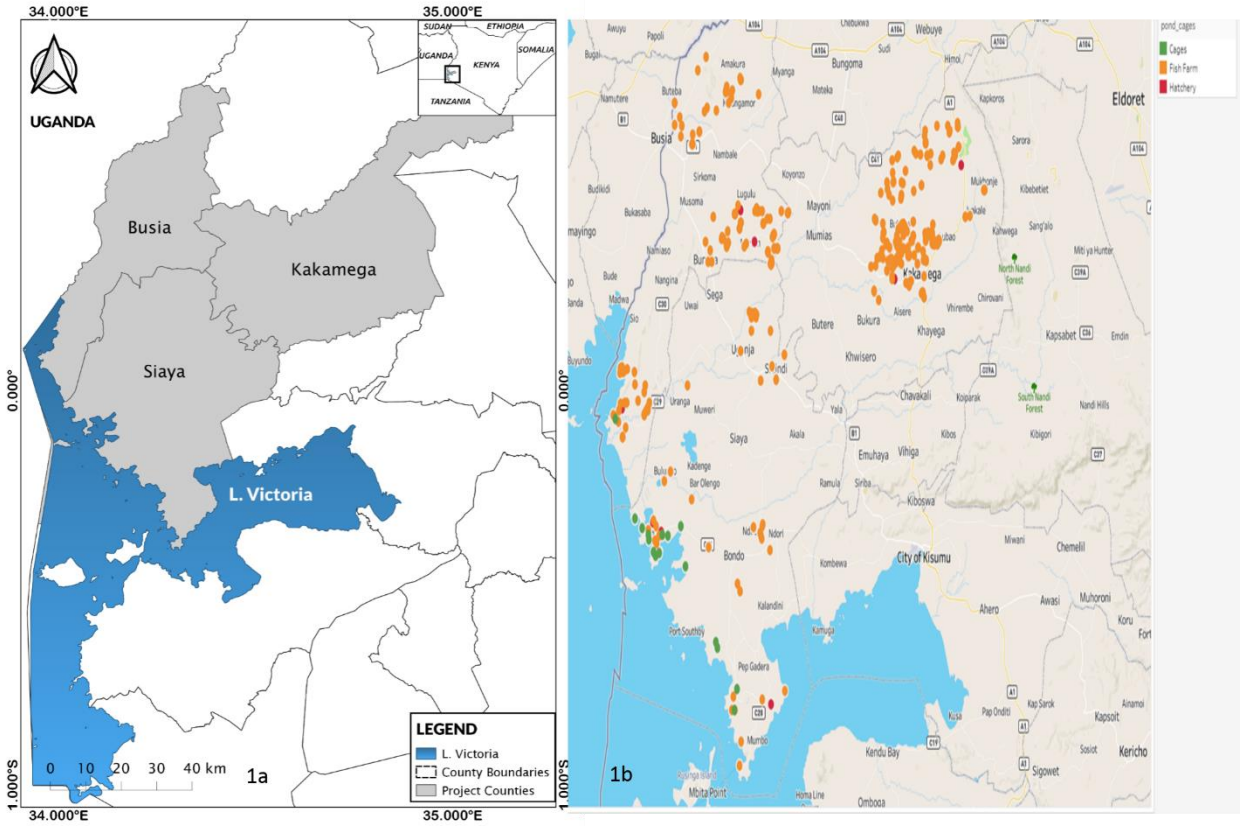
List of figures

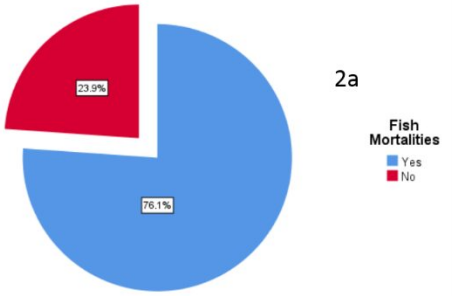
Figure 1: Showing (a) The map of the study area within Kenya, and (b) showing the sampled farms

Figure 2: Showing (a) Proportion of fish farmers who experienced losses in their farms in western Kenya, (b) Mortality rates, (c) Proportion of fish farmers who have seen sick fish and (d), the methods used in controlling fish diseases

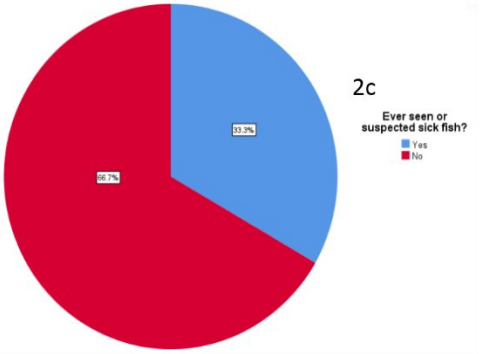
Table 1: Showing the number of fish farmers who were interviewed during the study and their distribution within the Counties

County	Sub county	Baseline	Mapping
Siaya	Bondo	9	41
	Rarieda	5	9
	Ugunja	20	26
Kakamega	Lurambi	55	69
	Malava	23	48
	Navakholo	63	91
Busia	Bunyala	14	82
	Butula	18	98
	Malava	1	1
	Samia	2	2
	Teso South	33	37
Total		**243**	**504**

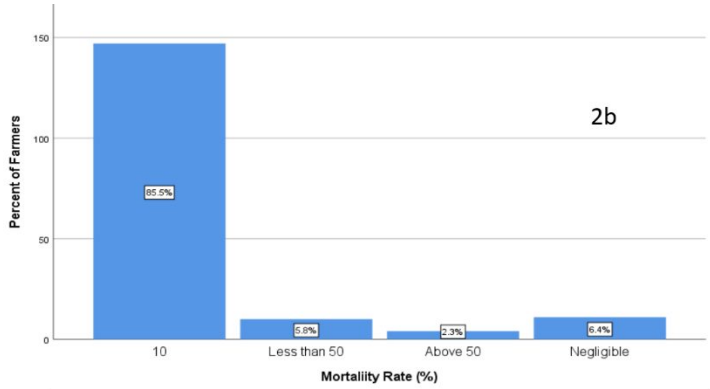

34.000°E
35.000°E
SUDAN
ETHIOPIA
UGANDA
KENYA
SOMALIA
TANZANIA
UGANDA
Busia
Kakamega
Siaya
L. Victoria
0.000°
1.000°S
0 10 20 30 40 km
1a
LEGEND
L. Victoria
County Boundaries
Project Counties
1b
pond_cages
Cages
Fish Farm
Hatchery
Eldoret
City of Kisumu


23.9%
76.1%
Fish Mortalities
Yes
No

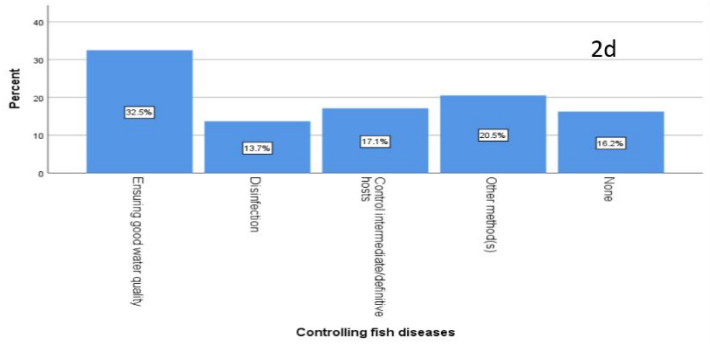
2a


33.3%
66.7%
Ever seen or suspected sick fish?
Yes
No

2c


Percent of Farmers
150
100
50
0
85.5%
5.8%
2.3%
6.4%
10
Less than 50
Above 50
Negligible
Mortality Rate (%)

2b


Percent
40
30
20
10
0
32.5%
13.7%
17.1%
20.5%
16.2%
Ensuring good water quality
Disinfection
Control intermediate/definitive hosts
Other method(s)
None
Controlling fish diseases

2d