

# **1. Situational analysis of Nile tilapia and African catfish hatcheries management: a case study of Kisii and Kirinyaga counties in Kenya**

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## **Abstract**

The number of private and public hatcheries in Kenya has increased tremendously due to fingerlings shortage experienced at the launch of Fish Farming Enterprise Productivity Program (FFEPP) a move likely to compromise quality. This study aimed at assessing the management levels of hatcheries in Kirinyaga and Kisii Counties of Central and Western Kenya respectively.

Kisii and Kirinyaga Counties demonstrated high gender disparity with only 1 hatchery being owned and managed by a lady. Majority of Kisii hatcheries were owned and operated by individual investors while 29% were owned by institutions and 14% by farmer groups. In Kirinyaga, majority were owned by individuals and fewer by institutions. Kirinyaga hatcheries had a higher number of ponds and fingerling production compared to Kisii. Tilapia and catfish fingerling production was at 50:50 among Kisii hatcheries while majority of hatcheries in Kirinyaga produced tilapia. Most hatcheries in both Counties sold fingerlings at between US\$ 0.06 - 0.08. Most Kisii hatcheries reported no diseases while Kirinyaga had 40%. A strong positive correlation between method of tilapia fingerling production techniques and extension services in Kirinyaga and Kisii was observed. However, there was no correlation between

education of farm managers and technologies in Kirinyaga. Poor management practices resulted in overall low annual seed production thus the need for training on Best Aquaculture Management Practices for improved quality seed production and economic returns.

**Key words:** *aquaculture, development, ESP- FFEPP, fingerlings, market, quality*

## **Introduction**

Aquaculture in Kenya started in the early 1920s (Vernon and Someren 1960) and since then the growth has been low until 2009 when there was tremendous improvement with the Government embarking on an Economic Stimulus Program (ESP) aimed at jumpstarting the national economy (Musa et al 2012; ACPFish II 2013). In the financial year 2009/2010, the Ministry of Fisheries Development launched the Fish Farming Enterprise Productivity Program (FFEPP) as an ESP component geared towards expanding and intensifying fish farming in the country. Through this initiative, in a period of 4 years the government injected Kshs 6 billion (US\$ 75 million) to construct 48,000 fish ponds in the mapped aquaculture prime areas across the country; provision of high quality fish feeds, seed and pond liners where the soils were porous (Charo-Karisa and Maina Gichuri 2010). Through this program the area under fish farming grew from 722 hectares in 2009 to 20,000 hectares in 2011 with production from fish farming increasing from 4,220 tonnes to over 22,000 tonnes during the same period (FAO 2012).

However, like many other developing countries in the world, the Kenyan aquaculture fishery sub-sector perceived as having the greatest potential to produce more fish in the future was faced with several challenges, key among them was the increasing need for supply of quality fish seed for stocking fish ponds and natural water bodies (Charo-Karisa and Maina Gichuri 2010; FAO 2010; FAO 2012). Previous studies (Hussain and Mazid 1999; Bhujel 2000; Hans and Ingrid 2002) have indicated that hatcheries across the world specifically among the developing countries are constrained by poor broodstock quality an integral aspect in seed production, inbreeding and interbreeding, water quality and feeding management. At the start of FFEPP, most hatcheries were owned and managed by the government through the Department of Fisheries and lacked adequate production capacities (manpower, quality broodstock, holding tanks, incubation trays, and necessary production techniques) to meet the initial demand of 28 million fingerlings. Although wild caught juveniles are still utilised in the industry, there are concerns over sustainability of such practice, and the variable timing and magnitude of natural spawning events, make hatchery production an attractive alternative to support the growing demands of aquaculture ( Brain 1980; Kungvankij 1985; Helm 2004; Akankali 2011; FAO 2010). It is due to this high demand that small and large scale Nile tilapia and African catfish private hatcheries sprung to fill the gap with no proper systems put in place to enforce standards and ensure Best Aquaculture Management Practices (BAMPs). Consequently, this led to occasional losses by grow-out farms due to poor quality seed supply, handling stress and transport from hatcheries (Maina et al 2014). To mitigate the situation, the Ministry of Fisheries Development recommended a national government and private hatcheries authentication exercise to ensure that only authenticated hatcheries provided quality fish seed. Authenticated hatcheries were required to ensure availability of high quality broodstock, proper site selection, reliable source of water, a minimum of four breeding ponds and two nursery ponds, holding tanks, oxygen cylinder,

packaging bags, water quality meters, hapas, seine nets, fish handling buckets and farm management records.

One of the major challenges farmers have faced in the past is the early maturity (20-40g) and prolific breeding and eventual inbreeding of Nile tilapia (de Silva and Radampola 1990; FAO 1999; Leveque C 2002; Maina et al 2014). The Ministry encouraged the supply of sex reversed tilapia fingerlings feeding tilapia fry on 17-methyltestosterone laced feed to attain optimum returns for grow-out farms (Chakraborty et al 2007). Despite the Ministry’s effort to have measures on tilapia breeding in grow-out ponds, there have been complaints by fish grow-out farmers on poor growth, prolific breeding and low survival of the seed provided by hatcheries across the country. This study aimed at assessing the management levels of hatcheries in Kirinyaga and Kisii Counties of Central and Western Kenya respectively.

## Methodology

A survey was done targeting all government approved hatcheries in Kirinyaga and Kisii Counties of Central and Western Kenya regions respectively. Data was collected on gender representation, hatchery ownership, year of establishment, staff establishment, education level, aquaculture training, source of extension services, challenges and mitigations using a semi-structured questionnaire. The questionnaire was also used to collect data on availability of hatchery facilities and equipment’s, capacity for fingerling production, broodstock male to female ratio and exchange cycle, annual fingerling production and pricing. A sample (n=30) of brooders was seined from two production ponds at each hatchery and hand sexing performed to determine sex ratios. Data was analyzed using SPSS software package (Version 17.0). Socio-economic variables were recorded as proportions and correlations between variables determined.

## Results

Hatchery ownership in the two counties displayed high levels of gender disparity with only 1 hatchery out the 12 assessed being owned and managed by a woman in Kirinyaga County. Majority of the fish hatcheries in Kisii County were owned and operated by individual investors (57%; n=7) while 29% were owned by institutions and 14% by farmer groups. In Kirinyaga County, majority (80%; n= 5) were owned by individuals and 20% by institutions. In both Counties, institutional hatcheries were the oldest in establishment (1991-2000), while majority of private hatcheries started after the FFEPP (2009-2010) launch. Thus the study findings indicated that in both Kisii and Kirinyaga Counties, most of the hatcheries had been in operation for less than five years (Table 1).

**Table 1:** Proportion of establishments of hatcheries according to the years in Kisii and Kirinyaga Counties

County	Year of establishment				Total
	<1990	1991-2000	2009-2010	2011-2013	
Kisii	1	2	3	1	7
Kirinyaga	1	0	4	0	5
<b>Total</b>	2	2	7	1	12

**Figure 1:** Proportions of hatcheries according to number of operating years in Kisii and Kirinyaga Counties, Kenya

Fingerling production and rearing units varied from one hatchery to another in both study sites with government hatcheries having the highest number of production and nursery rearing units. In Kirinyaga County, (60%; n=5) hatcheries had more than 20 production ponds whose measurements ranged between 300 to 800m<sup>2</sup>, while the rest had between 4 and 6 ponds with a size range of 200 to 300m<sup>2</sup>. Only (29%; n=7) of hatcheries both run by the government in Kisii County had more than 9 production ponds while the rest had between 3 to 5 ponds. All hatcheries in both counties with less than 6 production ponds lacked resting and nursery ponds. Thus, they harvested fingerlings for sale from breeding ponds, conditioned in the same ponds before sale against recommended practice. Apart from catfish seed producing hatcheries, none of the hatcheries in the two counties used incubation facilities for tilapia eggs despite some having the facilities in place. Species based seed production varied between and within the two Counties. Kirinyaga County had 2 hatcheries producing catfish, tilapia and ornamentals, 1 hatchery producing tilapia and ornamental and another producing catfish and tilapia, while only 1 hatchery concentrated on catfish fingerling production. Kisii County had 4 hatcheries purely producing tilapia fingerling, 2 hatcheries producing catfish and tilapia and 1 hatchery producing tilapia and ornamentals. Most of the hatcheries (80%; n=5) in Kirinyaga County had an annual fingerling production exceeding 100,000 fingerlings as compared to few hatcheries (29%; n=7) in Kisii County (Table 2). The average price of tilapia and catfish fingerlings was between US\$ 0.06 - 0.08 in both counties but 2 hatcheries in Kirinyaga and 1 in Kisii posted a price of between US\$ 0.09 - 0.12 for catfish and tilapia.

**Table 2:** Annual Number of fingerlings produced in Kisii and Kirinyaga Counties

County	Year of establishment			Total
	<50000	50,000-100,000	>100,000	
Kisii	4	1	2	7
Kirinyaga	0	1	4	5

Most hatcheries (60%; n=5) in Kirinyaga County produced both monosex and mixed sex tilapia fingerlings with a few hatcheries producing either monosex (20%) or mixed sex fingerlings (20%)(Figure 2). Kisii County, hatcheries produced both monosex and mixed sex tilapia fingerlings in equal proportions (43%) as shown in figure 3. Monosex fingerlings production using 17-Methyltestosterone (MTH) was practiced by most hatcheries in Kirinyaga (60%; n=5) and a few in Kisii County (14%; n=7). The rest of the hatcheries either performed hand sexing of post fingerlings or supplied mixed sex fingerlings to grow-out farms.

**Figure 2:** Proportions of monosex and mixed sex tilapia fingerlings produced in Kirinaga country

**Figure 3:** Proportions of monosex and mixed sex tilapia fingerlings produced in Kirsii country

During the study period, it was established that the main fish health challenges experienced by hatcheries were diseases, parasites and deformities. In Kirinyaga, only 2 hatcheries reported leeches, gastropods, nematodes, trematodes, finrot and fungal infection as the main health challenges. Similarly, 2 hatcheries in Kisii reported nematodes on catfish and deformities on tilapia as their main challenge. However, no growth (length-weight) differences were reported between diseased, deformed or parasitized fish.

There was a strong significant positive correlation between the number of operating years and the technology employed in aquaculture in Kirinyaga ( $r^2 = 0.87$ ;  $p = 0.036$ ) and Kisii Counties ( $r^2 = 0.62$ ;  $p = 0.01$ ) Counties. Notably, there was a strong significant positive correlation between method of attaining all male fingerling and extension services in Kirinyaga ( $r^2 = 0.72$ ;  $p = 0.02$ ) and Kisii ( $r^2 = 0.92$ ;  $p = 0.00$ ) Counties. Unlike Kisii County, Pearson correlation indicated a weak correlation ( $r^2 = 0.22$ ;  $p = 0.82$ ) between education of farm manager and technology employed in aquaculture in Kirinyaga County.

There was no direct relationship between fingerling production and female to male broodstock ratios as well as exchange cycle (Figure 4 and 5). Hatcheries in both counties with right broodstock ratios had fewer production facilities thus lowering their annual fingerlings production.

**Figure 4:** Female to male ratios and exchange cycle against annual production in Kirsii country

**Figure 5:** Female to male ratios and exchange cycle against annual production in Kirinyaga country

Few privately owned hatcheries (33%;  $n=12$ ), two in each County lacked all the basic hatchery requirements despite being authenticated and in operation.

The challenges experienced at the hatcheries were many and wide spread. Each of the Kisii County hatcheries had different challenge combinations while majority (80%;  $n= 5$ ) of the Kirinyaga County hatcheries singled out 2, 3, 6 and 7 as their major challenges as indicated by crosstabulation (Table 3)

**Table 3:** Proportions of challenges according to the County

County	Challenges						all
	2,3,6,7	3,4,7,8,9	3,7,10	3,8,9,10	1,3,6	5,7,10	
<b>Kisii</b>	1	1	1	1	1	1	1
<b>Kirinyaga</b>	4	1	0	0	0	0	0

[1] Poor quality broodstock, [2] Lack of technical knowledge, [3] Inadequate finances, [4] Insecurity due to theft, [5] Inadequate extension services  
 [6] Lack of quality feed, [7] Lack of market for fingerlings, [8] Predators  
 [9] Lack of infrastructure (electricity), [10] Unfavourable weather and climatic conditions

## Discussion

The study findings indicated that most hatcheries in Kisii and Kirinyaga Counties were established less than 5 years ago a trend that confirms the impact of the FFEPP government supported program under ESP which started in 2009. FFEPP supported farmers in constructing and stocking of the ponds with ESP funds provided by the government of Kenya, creating a drastic high demand for fingerlings nationally. One of the principal activities of the FFEPP was the revamping of fish hatcheries across the country to ensure sufficient production of fingerlings to stock the FFEPP constructed ponds. By so doing, the FFEPP played a key role in jump starting aquaculture economy, especially in tilapia culture by creating motivation in private investment in fish hatcheries.

Both counties displayed major similarity in hatchery ownership with study findings showing higher individual than institutional and group ownership. Kirinyaga County had more (60%; n=5) fingerling production ponds as compared to Kisii County (29%; n= 7) a trend that can be closely associated with size and number of ponds. Other production limiting factors in Kisii County were land scarcity resulting from dense human population and hatchery management challenges associated with group ownership. The increased number of fingerlings produced in Kirinyaga County could have resulted from increased number of grow-out farms and intensified media publicity in the region. The Counties' proximity to the capital city Nairobi a ready market may have also contributed to quick adoption of fish farming. Due to recent establishment of most hatcheries, there was no direct relationship between fingerling production, female to male broodstock ratios as well as exchange cycle. However, there is need for the hatcheries of both Counties to ensure right broodstock male to female ratios and exchange cycle. Fingerlings price disparities were attributed to increased hatchery competition, lack of ready market outside the government supported program, lack of nursery ponds and increased cost of keeping excess fish. Tilapia culture preference in Kirinyaga County a traditionally non fish eating region was as a result of the government's FFEPP publicity which was more inclined to Nile tilapia culture as compared to African catfish. On the other hand, in Kisii County, Nile tilapia and African catfish farming had equal strength (43%) a factor attributed to the County's fish eating tradition and close proximity to Lake Victoria. The study findings revealed that religious barrier mainly by Seventh day Adventist (SDA) a predominant church in Kisii County had no effect on African catfish culture.

Despite the most preferred monosex supply of Nile tilapia fingerlings by most hatcheries across the world, supply of both monosex and mixed sex fingerlings indicated limitation of technology knowhow and farmers' knowledge limitation on monosex fingerlings benefits.

Diseases, parasites and deformities reported in both Counties could be attributed to poor management levels (feed and feeding frequencies, water quality and handling of eggs, fry and brooders), inbreeding and the cold season (June-August). Lack of growth variation between infected and non-infected fish maybe associated with the intensity of infection. However, in Kirinyaga County, the managers education level did not influence the technologies employed at the hatcheries a factor associated with numerous tailored made trainings offered at the National Aquaculture Research Development and Training Center (NARDTC) under the FFEPP.

The study revealed the importance of frequent tailor made courses to improve on the knowledge and skills of hatchery owners, managers and staff to ensure supply of high quality fingerlings, increased income and ultimately a fast growth of the aquaculture sub-sector in Kenya. Regular monitoring by the authentication team from the Ministry will ensure authenticated hatcheries maintain set standards at all times.

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