



Implications of Inbreeding in *Clarias Gariepinus* Fish Farming: Farmers' Perspectives in Nigeria

Areola Foluke Omotayo^{1*}; Osanyinlusi Oladele Ige²; Alatisé Olasupo Michael³; Oladele Oludotun Olubusola⁴

¹Department of Fisheries, Lagos State University;
foareola@gmail.com; +2348033205882

²Department of Agricultural Economics, University of Ibadan;
osandele17@gmail.com; +2348067002496

³Layolat Fish Farm;
olasupoalatisé@gmail.com; +2348035701473

⁴Faculty of Veterinary Medicine, Department of Veterinary Medicine, Surgery & Radiology,
University of Jos;
oludotunoladele@gmail.com; +2348033823237

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***Corresponding author:** Areola Foluke Omotayo, Department of Fisheries, Lagos State University. Phone No.: +2348033205882, Email: foareola@gmail.com; **Orchid Number:** 0000-0003-0668-2607-2607

Abstract

There has been a nationwide unexplainable huge losses of fish at the fry/fingerling stage since 2013 by catfish breeders or farmers in Nigeria. This has prompted search for the probable causes for the huge losses during the fry/fingerling stage. The challenge has persisted with farmers looking for alternative ways to resolve the issue. The probable causes of the massive mortality of fish fry/fingerlings, by the practicing farmers and of the concerned supervising authorities, has been narrowed down to inbreeding of catfish. Hence, this study provides possible solutions to resolving problems associated with inbreeding in catfish farming in Nigeria. The data collected were analyzed using a mixture of narrative approach and content analysis.

Findings revealed that some of the causes for inbreeding are that, free movement of catfish from one farm to the other within the country was not monitored or documented as the filial generation of the catfish broodstock between farms and

geopolitical zones is unknown; and there is a lack of an established zonal broodstock bank. The general observation from empirical experience of hatching *Clarias gariepinus* through inbreeding was that, on hatching, there would be indiscernibly slow growth of fingerlings/juveniles. However, between 3rd and 4th week, the fry will suddenly die in large numbers and within three days the mortality is complete. Fish farmers practicing inbreeding also experienced different narrations of woes ranging from complete collapse of hatching catfish business to table size production. It has made hatching unpredictable/indeterminate and most broodstock have lost hybrid vigor.

It was therefore recommended that intervention on the establishment of zonal broodstock banks within Nigeria should be done in earnest to address the pains catfish breeders/farmers go through when engaging in inbreeding. Efforts should be intensified by relevant ministry/agency about sensitizing catfish breeders on record keeping to ascertain quality of fish seed/broodstock.

Keywords: *Clarias gariepinus*, Fish farming, Implications, Inbreeding, Perspectives

Introduction

Fisheries and aquaculture subsector contributes 3-4 percent of Nigeria's annual GDP [1]. It is also a key contributor to meeting the population's nutritional requirements; accounting for about 50 percent of the supply of animal-source food [1]. African catfish (*Heteobranchnus spp* and *Clarias gariepinus*) in particular, represents more than 80% of aquaculture production in Nigeria [2]. In spite of this, Nigeria is the fourth largest importer of fish globally following China, Japan, and United States. About 45% of total fish supply in Nigeria comes from imports [1]. This shows that the country has a deficit in fish supply. This has been associated with a growing population (which comes with a growing demand) and inadequate production [3]. The importation also spells growth limitation to local fish industries because funds are being siphoned from the economy. Aside importation bottleneck, inadequate availability of quality fish seed in the country is equally limiting the growth of this industry [3]. There has been a report of poor egg quality from farmers resulting in poor growth and low hatchability. In most hatcheries, before fingerlings reach the juvenile stage, 70-90% of them (2-5grams) are lost (5-52 grams) [4]. This has been associated with low or inadequate hatchery practices and genetic management of broodstock [3, 5].

In Nigeria, hatchers have depended so much on the use of catfish of same parentage, which results in inbreeding depression (decreased productivity) over many generations [3]. The speed at which inbreeding depression occurs is depended on the amount of inbreeding that has been produced and the trait [3]. To address this poor fish seed quality, the government of Nigeria at a time brought in subsidy of fish seed under the Growth Enhancement Support Scheme and later introduced a broodstock production and seed multiplication project [6]. This is because the poor seed quality may have been caused by inbreeding of broodstock and inadequate establishment of broodstock management in the country [3].

Inbreeding has been regarded as the mating between individuals with one or more common ancestors [7]. In respect to fish farming, it is the mating of close relative fishes [3, 7]. This phenomenon has the capacity to promote homozygosity in the offspring and decrease heterozygosity [3, 7]. In other words, this activity can lead to a decrease in diversity in genetic fish stock or undermine genetic gains. Literature has revealed to us that inbreeding could have dual effects; detrimental and desirable effects in fish farming. Reports of inbreeding in aquaculture that have detrimental effects include but not limited to fitness cost, reduced growth rate, body deformations, reduced fry survival, reduced fertilization success (not hatching rate), and reduced males' sexual activity [7-10]. Additionally, [7] reveals that inbreeding results into fitness cost called inbreeding depression. However, inbreeding

avoidance in animal kingdom also comes with consequences such as increased mortality, reduced fitness in offspring which comes as a result of overindulgence in outbreeding leading to outbreeding depression (breaking up adaptive gene clusters), and sustenance of reproductive success of relatives among others [7,11]. [3] Also states that the survival rate of inbred African catfish has been reported to be better than that of hybrids or wild fish. This is an evidence that inbreeding is not an absolute bad practice despite its huge limitations on fish production. In certain circumstances, it cannot be avoided. For instance, [7] asserts that inbreeding may occur relatively frequently due to constraints on choice of mate and dispersal. Also, most farmers cannot provide information on the pedigree of broodstock used; only few of them keep records of broodstock age and sources [3, 5].

There is still a paucity of empirical evidence of African catfish farmers' perspectives on the implications of inbreeding in *Clarias gariepinus* in Nigeria. It was concluded that there no evidence of inbreeding depression of aquaculture of African catfish in Nigeria [3]. [3] Focused her study on evaluating the potential effects of inbreeding on growth, feed intake, and the carcass quality of African catfish (*Clarias gariepinus*) in Nigeria. She concludes inbreeding of catfish does not lead to depression in Nigeria and that evidence of inbreeding in catfish in the country was still needed. The effect of inbreeding depression on the success of artificial reproduction of *Clarias gariepinus* in Senegal was examined [12]. Evidence of inbreeding in a traditional channel catfish hatchery in Mexico was investigated [13]. Also the effects of inbreeding on economic traits of channel catfish in US was investigated and it was found that inbreeding did not have effect on survival rates at various age intervals but had varying effects on between sexes and among families [14]. Most inbreeding studies [3, 5, 8-10, 14] on African catfish focused their studies more on the effect of inbreeding on various parameters of fish but less attention has been given to its implications on the farmers themselves. Thus, this study will examine implications of inbreeding in *Clarias gariepinus* from farmers' perspectives in Nigeria.

Material and Methods

This study was conducted in Nigeria among farmers producing African catfish (*Clarias gariepinus*). It is a case study among African catfish producers who have engaged in inbreeding practices. The respondents were purposively selected and are located at different places in the country. They have their own farms and are well experienced in African catfish production. A qualitative approach using an Interview Guide (IG) was employed. This guided our telephone-based interview with the respondents for this study. Before the interview, contacts were made with the respective respondents via phone and the purpose of the calls was discussed with them in order to know their availability and prepare them ahead of the interview. Those that gave us their consents were later interviewed. Individuals that agreed for the interview gave us the set dates to speak with them. Each interview took about 20-30 minutes. The data collected were

analysed using a mixture of narrative approach and content analysis. This involves storytelling through personal experiences with their engagements in inbreeding of *Clarias gariepinus* farming in Nigeria.

Findings

Participants are seasoned breeders in African catfish farming. They have their own farms and engage in inbreeding due to certain factors such as lack of records from sources, quality broodstocks, and establishment of zonal broodstock banks in Nigeria. One of the participants is the managing consultant of Fishhouse Consult Limited, Kaduna. Another is the owner of the Layolat Farm, Kaduna.

Introduction and Discovery of Inbreeding of *Clarias gariepinus* in Nigeria

In the 50s, history has it that the Dutch in East Africa, observed the African catfish growing to different sizes. All these species of *Clarias* were collected and taken to Netherlands where genetic engineering took place to get us the present day Dutch *Clarias*, *Clarias gariepinus*. The first person to import the Dutch *Clarias* into Nigeria was the Director of Kainji Lake Research Institute, Dr. Ayeni in the early 80s. On the box, as he said, was written: "Do not cross". This is a research of 30 years. Conversation were with Dr. Ayeni, Mr. Obakin, Director, Federal Department of Fisheries Abuja, Mr. Alatise Fisheries officer, Department of Fisheries Abuja, in Ndjamena, Chad, 1990.

Fisheries began to grow with the Federal Department of Fisheries under the then Director, Mr. Dada in the 80s. Big time players came to fisheries aquaculture importing *Clarias gariepinus* from source. There were others too, but no records to show. Breeders were always getting new broodstock from the table size being sold by big-time players in the industry then. So hatching wasn't a headache. The turbulence in the Nigerian economy makes all the big-time players to stop importation of new broodstock. Breeders now started to buy from each other nationwide. It is common to hear breeders say, "I chose the shooters which I raised and are used as my broodstock". Well, no one will not blame them as many are not experienced to know that the shooters still have the same genetic makeup as their parents. So there is no new gene introduced. Ask them the filial generation of their broodstock, none can tell. So our present broodstock filial generation is undetermined and it remains indeterminate. The discovery of inbreeding as a major problem in the hatching of *Clarias gariepinus* in Nigeria was by serendipity, which is behind the most monumental discoveries of science worldwide. It was a problem never knew that was present or could come at the beginning.

Location of Broodstock Purchases in Nigeria

The broodstock (male and female *Clarias*) used then, were left over of the males and females sourced from Ilorin Kwara State, Nigeria. They were in different sets. They were crossed

with some broodstock bought then in Kaduna State. Broodstock were bought several times in Kaduna and Southern parts of the country like Ibadan, Idi-Iroko, Oshogbo, Lagos, Abeokuta, Warri, Abakaliki, nationwide in short.

African Catfish Farming Experience

Participant, Mr Alatise, started hatching around 2012 to 2013 using fiberglass with the flow through system. That is about 11 years of experience in catfish breeding. Participant 2, Mr. Dosumnu, has involved in catfish fish breeding on his farm in the last 14 years. Dr. Ladan Aliyu has over two decades of experience catfish breeding. On the average, all have had over a decade experience in African catfish breeding.

Experience of Other Farmers Nationwide

There were complaints from other breeders nationwide who are equally experiencing the same problems in inbreeding of *Clarias gariepinus*. Funnily enough, breeders attribute this phenomenon to bad weather and bad water. My question to them all is, can our water and weather go bad at the same time nationwide? The answer is always, "No". Then, what is the cause? Alatise asked.

Inbreeding Hatching Experience

According to one of the participants, at the beginning, hatching was without impediment. This is done by just taking a gravid female with a matured male. Doing the needful, hatchlings will come out successfully by the second day. Matured eggs were selected based on our egg quality curve parameters. It is a parabolic graph. Immature or over mature eggs when hatched result in mortality. Spasmodic hatching still occurred despite our perfection. Instead of continuous success in hatching, hatchlings survival became spasmodic. Out of 10 hatchings, probably one or two will result in juvenile sales. This is about 10 or 20% hatching success rate, which is quite low. Another participant reported that he had so many trials. At times, 10-12 trials can be done but eventually succeed in 1. That is about 10% success rate in inbreeding.

Our observations remained the same in mortalities of hatchlings after yolk absorption. Instead of the hatchlings to look robust after yolk absorption, they will appear needle-like, very thin, not feeding or feeding little. Few will come up to swim while majority will be at the tank bottom even when they pass this stage. Their growth was slow. They were weak at times another set will show some activities but no growth. This made us to coin *asymptomatic third week syndrome ATWS of Clarias fry*. Even at juvenile stage, they could be weak and show stunted growth. Some might even reduce in size, dry up so to say. When sold to fish farmers, percentage runt is always high at the end of the culture period, no matter the quality of culture given thereby impacting on our income.

Culture Environment of African Catfish Breeding

There was no hiccup in water source, which is from a borehole of 30 meters deep. The pH directly from the borehole is 6.2 and when passed through the showers, it rises to 6.5 to 6.7. Temperature directly from the borehole is about 24 to 25 degrees centigrade, borehole water is transparent as you can imagine, and dissolved particles etc. were minimal. So water challenge was not a headache. A test was done on the borehole water; it was very good. Temperature posts no headache, as the weather was favorable, particularly during the heat and rainy seasons. When it is cold, the hatching tank is covered with cellophane.

Challenges in *Clarias gariepinus* Inbreeding

Of course, there were hiccups. Starter feed was a major challenge as there were contaminated feeds from all the imported starter feeds in the country. It was so bad that batch difference contamination occurred.

"We have hatched 30 times in between 2022 and 2023 with no success, same as for some others, but few others are lucky with time to determine their luck." -----Mr. Alatise

"We have been into catfish breeding since 2002 and we have a lot of stories to tell. We experienced a lot in our hatcheries using parent stock of the same siblings because there are no quality broodstock to be precise. It ended up with either stunted growth fish or total mortality of the whole hatchlings." Dr Ladan Aliyu

"We have not been getting encouraging results. So, in fact, that has made me to be so discouraged not to continue hatching." Mr. Dosunmi

Implications of Inbreeding in *Clarias gariepinus*

The complaints received nationwide are very similar with dropping (mortalities) of their fries after yolk absorption or complete mortality from 3-4 weeks of slow growth or high mortality at sixth week. It ended up with either stunted growth fish or total mortality of the whole hatchlings. All these are symptoms of inbreeding but there are many more. The degree of inbreeding depends on the filial generation of the male and female broodstock crossed which is not known by most breeders. The filial generation of our broodstock is undetermined and it remains indeterminate. The consequences of inbreeding in *Clarias gariepinus* can be summarised as follows: 1) slow growth of the fish; taking longer days to reach market size of an average of 700g-1kg; 2) slow conversion ratio of feed; 3) percentage runt is high; 4) low immunity to infections; 5) low returns on investment if not total capital loss; 6) high efflux of fish farmers; and 7) Mental trauma due to several trials of little or no results in breeding

Efforts Made to Address Inbreeding Problems

A lot of effort has been made towards addressing inbreeding problems in *Clarias gariepinus* by these farmers. "At a time, one of them made some contacts in Egypt through a consultant of FAO FISH4ACP project to bring in quality parent stock of catfish to us. "Till today, no response has been received from them, said Ladan Aliyu."

"To address bad starter feeds, whenever it was suspected, feeding was stopped for a day or two. Thus, mortality was reduced. So, there was success in eliminating this. Inexperienced fish farm handlings resulting in pollution, inadequate flow through, system cleaning, disease prevention and cure were all perfected." Mr Alatise

Conclusion

The implications of inbreeding of *Clarias gariepinus* are not only limited to decline in fish growth parameters after hatching, high mortality (low survival rate), and poor immunity to infections but also psychologically affect catfish breeders due to frequent trials or attempts with poor success rate and loss of investments or returns on investments (economic loss) through high mortality or unsuccessful hatching and poor market value. Intervention on the establishment of zonal broodstock banks within Nigeria should be done in earnest to address the pains catfish breeders or farmers go through when engaging in inbreeding. Efforts should be intensified by relevant ministry or agency such as Federal or State Ministry of Fisheries about sensitizing catfish breeders on record keeping to ascertain quality of fish seed or broodstock through track records.

References

1. Subasinghe R, Siriwardena SN, Byrd K, Chan CY, Dizyee K, Shikuku K, Tran N, Adegoke A, Adeleke M, Anastasiou K, Beveridge M, Bogard J, Chu L, Fregene BT, Ene-Obong H, Cheong KC, Nukpezah J, Olagunju O, Powell A, Steensma J, Williams G, Shelley C and Phillips M. (2021) Nigeria fish futures. Aquaculture in Nigeria: Increasing Income, Diversifying Diets and Empowering Women. Report of the scoping study. Penang, Malaysia: WorldFish. Program Report: 2021-16. <https://digitalarchive.worldfishcenter.org/bitstream/handle/20.500.12348/4951/62fb904f473578437cc01022f3595031.pdf?sequence=2&isAllowed=y>
2. Adewumi AA, and Olaleye VF (2011) Catfish culture in Nigeria: Progress, Prospects and Problems. *African Journal of Agricultural Research* 6(6); 1281-1285.
3. Olalere OA (2020) Is there evidence of inbreeding in African catfish (*Clarias gariepinus*) culture in Nigeria? UNESCO GRÓ Fisheries Training Programme, Iceland. Final project. <http://www.grocentre.is/ftp/static/fellows/document/Abimbola19prf.pdf>

4. FAO (2007) Assessment of freshwater fish seed resources for sustainable aquaculture. FAO Fisheries Technical Paper No. 501, Rome.
<http://library.enaca.org/inland/assessment-freshwater-seed.pdf>
5. Ibiwoye Y (2017) Assessment of broodstock management practices in Nigeria. United Nations University Fisheries Training programme, Iceland final project.
<https://www.grocentre.is/static/gro/publication/368/document/yetunde17prf.pdf>
6. WAAPP (2017) West Africa Agricultural Productivity Programme-Nigeria. Abuja, Nigeria. Retrieved from <http://www.waapp.gov.ng>
7. Nichols HJ (2017) The causes and consequences of inbreeding avoidance and tolerance in cooperatively breeding vertebrates. *Journal of Zoology*, 303 (2017) 1–14. doi:10.1111/jzo.12466
8. Akinoshun KM (2015) Quantifying the effect of inbreeding on the growth performance and yield of Mozambique tilapia, *Oreochromis mossambicus* (Peters, 1852) over three generations of repeated full-sib mating Stellenbosch University.
<https://scholar.sun.ac.za/server/api/core/bitstreams/9db0b309-fa50-42e1-86e6-d147ab7cb29b/content>
9. Mariette M, Kelley JL, Brooks R, and Evans JP (2006) The effects of inbreeding on male courtship behaviour and coloration in guppies. *Ethology* (112); 807-814.
10. Gallardo JA, and Neira R (2005) Environmental dependence of inbreeding depression in cultured coho salmon (*Oncorhynchus kisutch*): aggressiveness, dominance and intraspecific competition. *Heredity* 95; 449–456.
11. Kokko H, and Ots I (2006) When not to avoid inbreeding. *Evolution* 60, 467–475.
12. Mbaye T, Ndiaye F, Bale K, Magblenou LD, and Sene MA (2022) Effects of inbreeding depression on the success of artificial reproduction in the African catfish *Clarias Gariepinus* (BURCHELL, 1822). *International Journal of Aquaculture and Fishery Sciences*. DOI <https://doi.org/10.17352/ijafs>
13. Parra-Bracamonte GM, Sifuentes-Rincón AM, De la Rosa-Reyna XF, Arellano-Vera W, and Sosa-Reyes B (2011) Inbreeding evidence in a traditional channel catfish (*Ictalurus punctatus*) hatchery in Mexico. *Electronic Journal of Biotechnology* ISSN: 0717-3458 <http://www.ejbiotechnology.info> DOI: 10.2225/vol14-issue6-fulltext-7
14. Bondari K, and Dunham RA (1987) Effects of inbreeding on economic traits of channel catfish. *Theor Appl Genet* (TAG) (1987) 74:1-9.

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