PANYAM FISH FARM FOR COMMON CARP (*Cyprinus carpio)* FISH AQUACULTURE REVITALIZATION, MULTIPLICATION AND SUSTAINABILITY IN NIGERIA

ABSTRACT

Thirty three mature broodfish of Common Carp were harvested from Panyam Fish Farm, Plateau State (PFFPS), and from Federal University of Agriculture Makurdi Research Fish Farm (FUAMRFF). These farms are situated in two different agro-ecological zones of Nigeria (with a fading history of Carp fish culture). The broodfish were fed for 90 days, in preparation for on-farm breeding activities with the aim of determining hatching parameters (through un-induced natural spawning, induced natural spawning and induced breeding by stripping in indoor concrete ponds); percentage survival of the bred Carp fish progenies cultured for 56 days (in ponds sampled in PFFPS and FUAMRFF); to evaluate growth and potential economic returns from the two areas; and to further evaluate fish farmers perception of Carp fish culture in selected fish farms across other agro-ecological zones in Nigeria. After breeding activities, progenies were cultured and fed to satiation. The water physico-chemical parameters in the ponds and in water holding tanks was monitored daily. At the end of the research period, PFFPS showed better Carp fish hatching tendency, highest (94%) in Induced Natural spawning), and better environmental/water physico-chemical parameters for Carp fish culture (mean Dissolved Oxygen content (8.35 Mg/l), and pH (7.54). Furthermore, PFFPS has capacity to accommodate the mass production of Carp fish. Economically, PFFPS had a higher gross margin (402,250), and Profit index (5.0). Also, result from fish farmers perception on carp fish culture showed that 62% of farmers have no idea of Carp fish management, 66% have no idea of Carp fish selling price, 66% are aware of Panyam fish farm and 100% expressed that more awareness should be created on aquaculture diversification (with interest in Carp fish culture), as this will meet consumer demand and rescue this specie from its current track of going extinct in Nigeria's aquaculture, if given urgent attention).

Keywords: *Water, Physico-chemical parameters, Broodfish, Breeding, Revitalization, Mass production, Economic valuation, Farmers perception.*

INTRODUCTION
Background to Study

Worldwide, fish species used in fish farming are Common Carp, Salmon, Tilapia, and Catfish in that order of importance (FAO, 2012). Originally native to temperate region of Asia, especially China, Common Carp is now the most cultivated and refined among Carp species throughout the world. Common Carp, as the most common Cyprinid species, creates an important part of inland fish production (Cetinkaya, 2006). Also, according to Vilizzi and Tarkan (2015), Common Carp is the most common cyprinid species that generates a significant part of inland freshwater fish production, that is introduced to inland waters such as lakes, reservoirs and streams in different regions. Common Carp is currently classed as susceptible in most of its native areas of distribution owing to a significant loss of genetic variability in domesticated races, breeds and strains mixing with the pure wild form (Khalili and Amirkolaie, 2010).

Traditionally, the Common Carp is cultivated extensively and semi intensively, and spawning is natural. In 1964, this specie was imported from Thailand for the first time and released into ponds across European, lakes and reservoirs and then to various parts across the globe, including Panyam Fish farm in Nigeria, and this is because this specie has ability to breed in confined water bodies without any special efforts (Khan *et al.,* 2016).

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According to Billard (1995), *Cyprinus carpio* is tolerant to a variety of conditions but generally prefer large water systems with sufficient flow. They are omnivorous fish species which feeds on aquatic plants and animals. The optimal pH range for *Cyprinus carpio* culture is 6.5 to 9.0 and temperature between 3^{o}C and 35^{o}C (Billard, 1995). These basic water physico-chemical parameters for Common Carp aquaculture is a peculiar characteristic of pond water available for aquaculture practice in Nigeria. However, Carp fish aquaculture has been somewhat relegated as more attention is on Catfish (*Clarias gariepinus)* culture in Nigerian ponds and native waters. Importantly, the continuous exploitation of fish in native Nigerian rivers, coupled with low attention to Carp (the world's most important aquaculture fish species), this specie is progressively going extinct in Nigeria's inland waters. Thus, the need to draw timely attention to this important specie.

Water, on the other hand is one of the most essential requirements for aquaculture and fish farming. The quality and quantity of water is important for aquaculture (Summerfelt, 2000). Water quality for aquaculture refers to the suitability of a water system that facillitates the growth and production of any considered aquaculture organism or fish. The constant maintenance of a good quality (or physico-chemical parameter) of water is vital for the growth, survival and production or culture of any fish species. Physical, chemical and biological characteristics of water in the fish ponds offers the most suitable conditions for the existence of fish as well as other organisms which constitute essential components of the food chain. Water quality status is essential for both survival and optimum growth of organisms (Gupta and Gupta, 2006). However, no matter how good the quality of water is, and no matter how suitable it is for the culture of a certain fish species, upon pond stocking and fish cultivation, fish releases various waste products, such as Ammonia, Carbon dioxide, and organic material containing nutrients, while they remove Oxygen and particulate organic material (plankton and bacterioplankton) from the culture system in general. A continous uncontrolled practice increases toxicity of the water. Feed will pollute the water directly and indirectly: left-overs of feed, as well as excrements produced by fish, supply organic matter to the water, which on decomposition, consumes Oxygen and releases Ammonia (Val, *et al.,* 2006). The pollution of the pond water for fish culture reduces the quality of the water, and according to Bert, (2007) the most serious threat to fish production is poor water quality and lack of an acceptable quantity of water.

Carp can spawn naturally where favorable aquatic environment and physico-chemical parameters are within acceptable ranges. In a temperate climate, sexually matured Carp spawn once a year. While in a tropical climate, sexually matured Carp can spawn several times where favourable conditions for development of dormant eggs in the ovary and for spawning (which includes suitable spawning ground covered with vegetation or dense macrophyte cover and spawning substrate, adequate water temperature of 18-24^{o}C, adequate Dissolved Oxygen 5-10 mg/litre, light, enough natural food, flooding or gradually increased water volume, and presence of males) are met. Natural spawning is unlikely for the commonly cultured Catfish in Nigerian waters, since they cannot reproduce in captivity. However, artificial breeding (even for Carp fish) makes room for controlled practices and speeds up commercialization or saturation of a given fish species for optimum aquaculture ventures.

Problem Statement

The constantly increasing demand for fish and fish products for human consumption can only be met by fish farming (aquaculture). This necessitates some form of aquaculture processes and intervention in the growing of fish, to enhance production, eradicate species extinction, facilitate adequate supply of food and fish protein, boost aquaculture venture, and encourage diversification.

The economic value of Common Carp has increased with the increased growth rate in terms of length and weight, high meat yield, non-selective habitat use, tasty meat and production availability in fish farms (Demirkalp, 1992). Consequently, Common Carp has been introduced into many water bodies throughout the world, including Europe, Australia and North America. The broad distribution and successful introductions of Common Carp are frequent due to its tolerance to changeable environmental conditions (Mills *et al.,* 1993). However, aquaculture in West and Central Africa has not harnessed nor maximized this potential. Nigeria, one of the leading figure in Africa's aquaculture history has rather focused more on Catfish (*Clarias gariepinus*) production, rather than diversifying and sustaining the culture of other species.

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Over time, Carp fish existence in Nigeria has been successfully sustained in only a very few farms in Bauchi, Benue, Oyo, and Plateau States Nigeria, with Panyam Fish farm in Plateau state taking lead as compared with any other locations or farm in Nigeria, though its mass production has not been harnessed or given ample consideration to aid the availability of Carp fingerlings in commercial quantity for rural and urban farmers in Nigeria's contextual and contemporary fish culture systems. Carp broodstock which will definitely be instrumental for Carp fish breeding activities may only be sparsely scattered in very insignificant and in very few ponds nationally. This has made Carp fish a scarce species over time in the history of Nigeria's aquaculture, despite Nigeria's great agricultural potentials that could make aquaculture diversification in Nigeria stand out with an excellent wide margin in West Africa and Africa as a whole.

According to Isaac (2018), one of the biggest fish farms in Nigeria (Panyam Fish farm in Mangu Local Government Area of Plateau) has been in limbo for quite some time due to its being abandoned by the previous administrations in the state. Panyam Fish farm was established in 1950, and is reputed to be Nigeria's largest covering a land mass of 309 hectares, with the capacity to produce about 4.9 tonnes of fish and over 10 million fingerlings annually. The farm at a point was even adjudged as one of the largest in West Africa. Its deterioration, however, started during the military era, when its fortune nosedived; it became a shadow of itself as farming in the large pond scaled down to merely subsistence. The farm if properly resuscitated has the capacity of generating about N2.7 billion in revenue yearly. It spans 309 hectares, can produce 3,900 tonnes of fish annually and more than 10 million fingerlings, adding that it also has the potential to generate employment for thousands of youths.

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Nigeria has high potentials for aquaculture development and this potential can be realized substantially through extension services (Adetunji, 2011). It has been shown that Nigeria can substitute fish importation with domestic production to create jobs, reduce poverty in rural and peri-urban areas where 70% of the population live and ease the balance of payments deficits (Areola, 2007). Over the years a number of policies have been formulated by the Nigeria government with a view to developing small/medium scale industries. These policies include funding, setting-up industrial areas and estates, providing local finance through its agencies such as Central Bank of Nigeria (CBN, 2012). For Nigeria where the economy is largely Agrarian, fish farming can generate significant employment, enhance socio-economic status of the farmers as well as generate foreign exchange, reduce poverty, develop entrepreneurship, for which will optimize the use of the unexploited resources and self-sufficiency (Shimang, 2005).

Objectives of Study

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The broad objective of this study is to salvage the gradual extinction of Common Carp species in Nigeria's aquaculture practice, and encourage its development and sustainability in areas with comparative advantage through mass multiplication, and production, after identifying a suitable potential for its implementation. This encourages fish species diversification in Nigeria's aquaculture in addition to the catfish predominant venture. Hence, the specific objectives of the study are:

1. Assessment of water quality parameters of the experimental ponds
2. Evaluation of percentage hatchability of Carp through uninduced natural spawning, induced natural spawning, and induced breeding by stripping in indoor concrete ponds.
3. Growth response evaluation of carp fish progenies in study areas
4. Economic valuation of carp fish progenies in study areas
5. Evaluation of Nigerian fish farmers perceptions of Common Carp propagation and culture.

MATERIALS AND METHODS

Experimental Sites (Study Areas)

This study was carried out in two Farms namely Panyam Fish Farm, Panyam, Mangu Local Government Area of Plateau State (PFFPS), and Federal University of Agriculture Research Fish Farm, Makurdi, Benue State (FUAMRFF), Nigeria.

PFFPS has existed since 1950 (though fully established in 1954), it has about 34 earthen ponds of 309 hectares land mass and 106 hectares water surface area, and is well known specifically for Carp fish farming in West Africa. It is situated in Mangu, around 60 kilometers South-East of Jos, Plateau State, in the Southern Guinea Savannah Agro-Ecological zone in Nigeria.

Federal University of Agriculture Research Fish Farm, Makurdi (FUAMRFF) is one of the few, which has a pond section where some Carp fish are reared. It has over 6 earthen ponds of about 0.06 hactares. It is situated in east of the universities raw water booster station on the north bank of river Benue, in the Derived Savannah Agro-ecological zone of Nigeria.

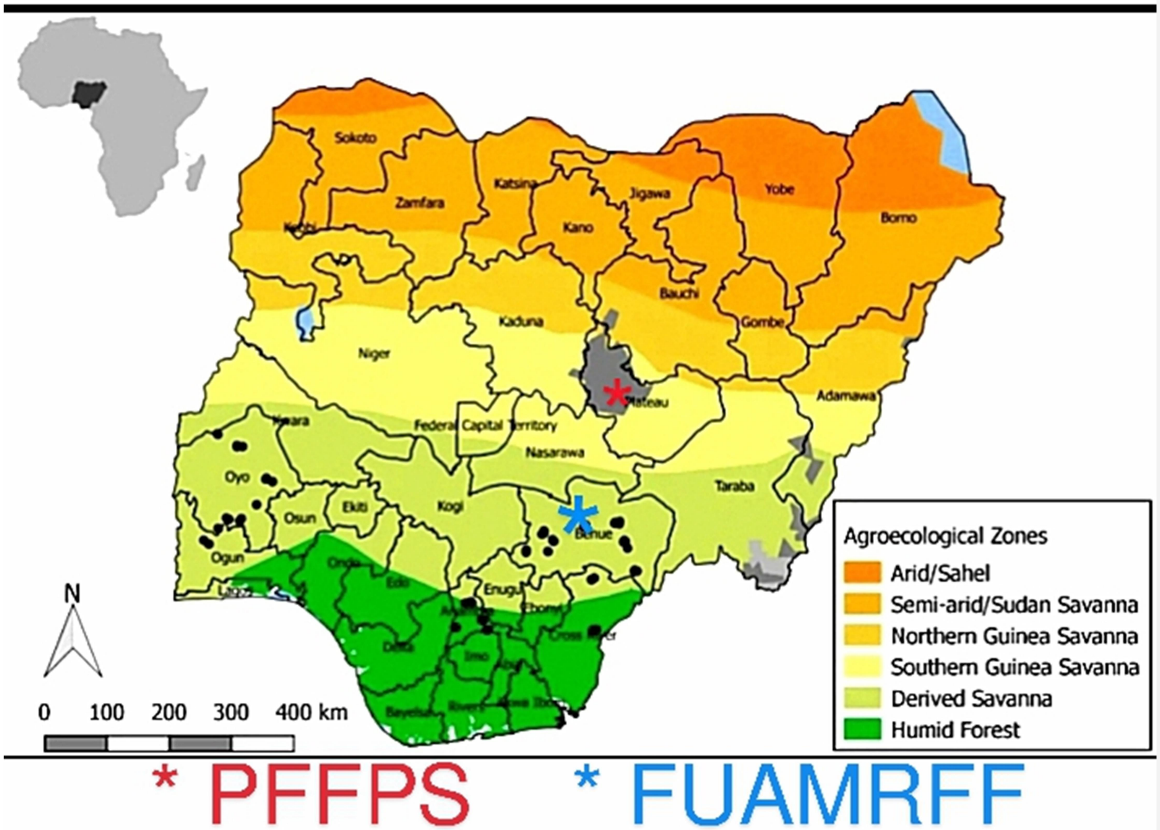

Plate 1: ***Map showing the Agro Ecological Zones of Nigeria (Charles C.N 2021), with locations of PFFPS and FUAMRFF situated.***

Broodstock Selection

Thirty three *Cyprinus carpio* broodfish (12 females and 21 males) were selected (based on physically observable characters after little pressure was applied on the abdominal regions towards the genital area of each broodstock, to check quality of milt and eggs). Same numbers were obtained from PFFPS and FUAMRFF respectively. The selected male and female fish were isolated in separate (male and female) hapa nets of 3m by 7m by 1.5m dimension for fish in Panyam, and in 4m by 8m by 1.5m concrete tanks for

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samples in Makurdi. Both fishes were fed intensively with 9mm size of vital feed extruded floating pellets, for 3 months, before they were certified ready (based on germplasm and gravidity worthiness) for spawning, and used for the experiment. Other data collection procedures are presented in experimental procedures.

Experimental Procedures

Objective 1: Assessment of Water Quality Parameters of Experimental Ponds

The physico-chemical parameters of experimental water from ponds in these two Farms were taken three times in a day at 7am, 12noon and 6pm respectively, using relevant instruments and was observed to be within tolerable range for Carp fish aquaculture as described by Bert (2007), Billard (1995), and (Sawyer *et. al.,* 2003). The water quality parameters of PFFPS and FUAMRFF were monitored daily and recorded weekly for twenty weeks (140 days) at 7:00am, 12:00pm and 6:00pm. Water quality parameters such as Temperature, pH, Dissolved Oxygen, Total Dissolved Solids, Electrical Conductivity, and Turbidity was taken into consideration, using the appropriate apparatus such as Thermometer, pH meter, DO meter, TDS meter, EC meter and Secchi disk, to determine readings.

Objective 2: To Evaluate the Percentage Hatchability of Carp through Uninduced Natural Spawning, Induced Natural Spawning, and Induced Breeding by Stripping in Indoor Concrete Ponds

Uninduced Natural Spawning:
Selected *Cyprinus carpio* fish were grouped 3 males to 1 female per hapa net, weighed, and enclosed with grasses, and other procedures for breeding Carp using Uninduced Natural Spawning as described by Ed-Idoko *et al.,* (2021) were followed. A total of 3 female and 9 male broodstock were used. No hormone was administered. Same processes was done in both PFFPS and FUAMRFF.

Induced Natural Spawning
Selected fish were grouped into male and female, and weighed. Spawning activities for Induced Natural Spawning were carried out as described by Ed-Idoko *et al.,* (2021).

Induced Breeding by Stripping in Indoor Concrete Ponds
As described by Ed-Idoko *et al.,* (2021), selected fish were grouped into male and female, and weighed. Upon weighing, Ovaprim hormone was administered, but the female broodstock was not allowed to shed her eggs naturally. Stripping in Indoor Concrete tanks was done manually by mild pressure application to let out milt and egg content from both spawners, after which a gram of eggs was scooped out for further evaluation process.

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Objective 3: Growth Response of Carp Fish Progenies in Study Areas
Two hundred (200) fry of the Carp fish hatched was counted and isolated in three replicates each, from the progenies gotten of the induced stripping in concrete tanks. The hatchlings were fed Artemia starter diets 3 times daily at 7:00am, 12:00pm and 6:00pm for a period of 8 weeks (56days). This was done at the two farms simultaneously.

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The weight of fish (fry-fingerling) were taken using a sensitive weighing balance and the length was measured by a measuring Rule. Hatchlings were monitored for eight weeks. In order to maintain good hygiene, reduce fish stress and water pollution, adequate management procedure (e.g debris, as well as crippled and dead larvae were removed by siphoning) was done daily.

Survival of fry and mortality rate were recorded from each sample. Offspring were fed to satiation, measured and administered at the feeding time, 3 times daily throughout the experiment. At the seventh day of every week, samples from the various treatments were collected and assessed morphometrically to obtain and subsequently record weight and length parameters the end of the 56 days of feeding, while Water physico-chemical parameters was taken at all levels primarily.

Objective 4: Economic Valuation of Carp Fish Progenies in Study Areas
Unit Price of Juvenile
At tthe juvenile stage size of the progenies of carp fish produced in PFFPS and FUAMRFF were sold in Naira. The average cost of sale varied per agro ecological zone.

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Labour Cost
The ponds in PFFPS and FUAMRFF were already dug earthen ponds and already constructed indoor concrete ponds, constructed by manual labour using professional fish pond construction techniques for aquaculture purpose. These farms existed since 1954 and 1992 respectively, prior to the experiment period. PFFPS ponds were significantly larger in size than that of FUAMRFF. The ponds used were not newly constructed for the purpose of this research.

However, farmers labour cost was valued in Naira, and allocated each, for farmers labour at PFFPS and FUAMRFF throughout the experimental period.

Variable Costs
The cost of buying feed used to raise the progenies, cost of fueling water pumping machine, cost of Hapa net construction, and other miscellaneous expenses was valuated in Naira, at each of the study areas.

Sourcing Water for the Fish Culture
The primary source of water for PFFPS is a natural spring with natural underground recharge mechanism. The ponds in FUAMRFF on the other hand are sited close to the famous Benue river. Though the FUAMRFF ponds have a natural underground water recharge mechanism too, during the dry seasons, water is artificially pumped into the ponds from the reservoirs with water sourced from the Benue river.

The tool for analysis was descriptive statistics as percentages and frequency distributions were used to analyse specific objectives.

Objective 5:
Evaluation of Nigerian Fish Farmers Perceptions on Common Carp Propagation and Culture

To assess the fish farmers perspectives on Common Carp culture in Nigeria, questionnaires were administered to one hundred and fifty fish farmers randomly across Nigeria by phone conversation and direct access. Elements of observation were: knowledge on Carp fish existence, preference of Carp fish in comparism with Cat fish and Tilapia culture, preference of Carp fish in comparism with Catfish and Tilapia meat quality, preference of Carp fish in comparism with Catfish and Tilapia meat quantity, preference of Carp fish in comparism with Catfish and Tilapia meat taste, cost of culturing Carp in relation to Cat fish and Tilapia, price of sale of Carp fish in relation to Catfish and Tilapia, possible challenge with Carp fish culture, and knowledge about Panyam fish farm in Plateau state. The responses obtained were analysed and result presented.

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RESULTS

Water Quality Parameters of Experimental Locations

The water quality parameters of PFFPS was monitored weekly for twenty weeks (140 days). Temperature readings ranged between 19°C -22°C, pH readings ranged between 7 – 8, Dissolved Oxygen readings ranged between 7.45 Mg/L– 9.05 Mg/L, Total Dissolved Solids readings ranged between 120 Mg/L– 150 Mg/L. Electrical Conductivity readings ranged between 223 µs/cm– 250 µs/cm. Turbidity readings ranged between 40cm– 60cm. Table 1 shows the mean water quality parameters for the test water, which captures a generalised detail of the physico chemical parameters of the water in ponds.

The water quality parameters of FUAMRFF was monitored weekly for twenty weeks (140 days). Temperature readings ranged between 26°C -31°C, pH readings ranged between 5 – 6, Dissolved Oxygen readings ranged between 4.65 Mg/L– 5.85 Mg/L, Total Dissolved Solids readings ranged between 115 Mg/L– 120 Mg/L. Electrical Conductivity readings ranged between 223 µs/cm– 250 µs/cm. Turbidity readings ranged between 55cm– 70cm. Table 1 shows the mean water quality parameters for the test water, which captures a generalised detail of the physic-chemical parameters of the water in ponds.

Table 1: Water Quality Parameters for PFFPS and FUAMRFF

Parameters	Readings per Time							
	PFFPS	FUAMRFF	PFFPS	FUAMRFF	PFFPS	FUAMRFF	PFFPS	FUAMRFF
	7 am	7am	12 noon	12noon	6 pm	6pm	Mean	Mean
Temperature (°C)	20.40±0.32	26.85 ± 0.05b	22.23±0.32	30.00 ± 0.10a	19.93±0.1	27.95 ± 0.10b	20.86±0.25	28.26±0.25 b
pH	7.48±0.05	5.51 ± 0.03	7.60±0.11	5.97 ± 0.04	7.55±0.08	5.83 ± 0.04	7.54±0.05	5.77 ± 0.04
Dissolved Oxygen (mg/L)	8.13±0.19	4.70 ± 0.20	8.73±0.13	5.04 ± 0.20	8.20±0.09	4.75 ± 0.50	8.35±0.09	4.83 ± 0.21
Total Dissolved Solids (mg/L)	133.67±2.84	118.05 ± 1.50	140.77±2.58	119.60 ± 0.50	135.88±2.22	116.62 ± 0.50	136.77±1.54	118.09 ± 0.50
Electrical Conductivity (µS/Cm)	237.21±2.90	235.50 ± 1.50	240.18±3.55	238.70 ± 0.50	230.28±1.65	232.60 ± 0.50	235.89±1.78	235.60 ± 0.50
Turbidity (Cm)	42.33±0.64^{b}	68.33±0.6^{a}	57.13±0.68^{a}	63.13±0.6^{b}	42.37±0.64^{b}	59.37±0.64^{c}	47.28±1.49^{b}	63.61±1.49^{b}

Means on the row with different superscript are statistically significant ($p<0.05$).

Hatching Parameters

The Percentage fertilization, Hatchability and number of fry in 1 litre of water after seven days at Panyam fish farm Mangu was recorded. Percentage Fertillisation was found to be highest in sample collected from the treatment of the induced natural spawning (94.44±0.40^{a}) as compared to Induced spawning by stripping (89.86±0.10^{b}) and uninduced natural spawning using outdoor hapa net (73.12±0.30^{c}). Percentage Hatchability was found to be highest in sample collected from the treatment of induced spawning by stripping in indoor concrete tank system (94.10±0.85^{a}) as compared to induced natural spawning (72.73±0.93^{b}) and natural (uninduced) propagation using outdoor Hapa net (37.54±0.20^{c}). Number of Post Fry in one litre of water at day seven was found to be highest in sample collected from the treatment of artificial propagation i.e induced spawning by stripping in indoor concrete tank system (1896.30±53.40^{a}) as compared to induced natural stripping (1572.30±52.00^{b}) and completely natural propagation using outdoor Hapa net (843.00±75.20^{c}).

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The Percentage fertilization, Hatchability and number of fry in 1 litre of water after seven days at the Federal University of Agriculture Research Fish Farm Makurdi. Percentage Fertillisation was found to be highest in sample collected from the treatment of the induced breeding by stripping (92.86±0.10^{a}) as compared to Induced natural spawning (54.44±0.40^{b}) and uninduced natural spawning using outdoor hapa net (07.12±0.30^{c}). Percentage Hatchability was found to be highest in sample collected from the treatment of induced spawning by stripping in indoor concrete tank system (59.10±0.85^{a}) as compared to induced natural spawning (32.73±0.93^{b}) and uninduced natural propagation using outdoor Hapa net (01.54±0.20^{c}). Number of Post Fry in one litre of water at day seven was found to be highest in sample collected from the treatment of artificial propagation i.e induced spawning by stripping in indoor concrete tank system (756.33±53.40^{a}) as compared to induced natural stripping (172.36 ±52.00^{b}) and completely natural propagation using outdoor Hapa net (00.00±75.20^{c}).

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Table 2: Basic Hatching Parameters of Carp using three different Breeding Systems in PFFPS and FUAMRFF Waters

Parameters	Rearing Systems in the Two Study Areas						P-Value
	Un-Induced Natural Spawning (T1)		Induced Natural Spawning (T2)		Induced Breeding by stripping (T3)		
	PFFPS	FUAMRFF	PFFPS	FUAMRFF	PFFPS	FUAMRF	
Percentage Fertilisation	73.12±0.30^{c}	07.12±0.30c	94.44±0.40^{a}	54.44±0.40b	89.86±0.10^{b}	92.86±0.10a	<0.01
Percentage Hatchability	37.54±0.20^{c}	01.54±0.20c	72.73±0.93^{b}	32.73±0.93b	94.10±0.85^{a}	59.10±0.85a	<0.01
No. of Post Fry per 1L of water	838.00±75.20^{c}	00.00±75.20^{c}	1572.36 ±52.00^{b}	172.36 ±52.00^{b}	1896.33±53.40^{a}	756.33±53.40^{a}	<0.01

Means on the row with different superscript are statistically significant ($p<0.05$).

Growth Performance

The result of Percentage Weight gained (%WG), Specific growth rate (SGR), Percentage mortality, and Percentage survival at the end of the eight weeks experiment of the fry to fingerlings stage of Carp Fish cultured in the indoor hatchery through purely artificial propagation, and fed with Artemia, showed slightly different indications from the experiment carried out in the two locations of Panyam Fish farm and University of Agriculture Research Farm Makurdi, with Panyam Fish farm taking the lead in most significantly different variables of Final Mean Weight (3.520±0.020^{a}), Mean Weight Gain (3.490±0.015^{a}), and Percentage Survival (98.900±0.115^{a}). Percentage Mortality was highest in the sample from Federal University of Agriculture Research Farm (4.133±0.467^{a}). Mean Initial weight, Percentage Weight Gain, Specific Growth Rate, and Percentage Jumper rate was insignificantly different. See Table 3 for details.

Table 3: Progenies Basic Growth Performance details from Feeding Trials

Growth Performance Indices	PFFPS	FUAMRFF
MIW (g)	0.026±0.003	0.030±0.005
MFW (g)	2.800±0.000[a]	2.600±0.000[b]
MWG (g)	3.490±0.015[a]	2.773±0.003[b]
%WG	99.149±0.159	99.048±0.119
SGR	0.085±0.003	0.083±0.002
% Mortality	1.900±0.115[b]	4.133±0.467[a]
% Survival	98.900±0.115[a]	95.867±0.467[b]
% Jumpers Per Treatment	15.50±0.00	15.17±0.01

Means on the row with different superscript are statistically significant ($p<0.05$).

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Economic Valuation of Carp Progenies in Study Areas

The result of Average Number of Fry per 1 litte of Water in PFFPS was higher (1435) than FUAMRFF (464). Revenue generated from PFFPS was higher (₦350,000) than FUAMRFF (₦160,000). Profit index was higher at PFFPS (3.5) than FUAMRFF (1.7). See tables 4 for details.

Table 4: Economic Valuation of Carp Progenies in Study Areas

SN	Valuation Indices	PFFPS	FUAMRFF
1	Average Number of Fry per 1 litte of Water	1,435	464
2	Unit Price of Fingerlings (₦)	150	250
3	Unit Price of Juvenile (₦)	250	400
4	Number of Juveniles sold at the end of experiment	1,400	400
5	Total Revenue Generated (₦)	350,000	160,000
6	Labour Cost (₦)	20,000	20,000
7	Other Variable Costs (₦) i.e feeding, Hapa netting, fueling, miscellaneous...	80,000	50,000
8	Total Variable Cost (₦)	100,000	70,000
9	Gross Margin (₦)	250,000	90,000
10	Profit index	3.5	1.8

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Nigerian Fish Farmers Perspectives on Common Carp Propagation and Culture

The result of the study on Nigerian Fish Farmers Perspectives on Common Carp Propagation and Culture Showed that 86% of Nigerian Fish Farmers do not culture Carp fish, though 94% of them think there are other culturable fish species in Nigeria. However, 84% of them are against the gross attention of Nigerian fish farmers on Catfish aquaculture, as 84% feel Carp aquaculture is a good venture and 80% of them will like to venture into Carp fish farming if given proper orientation and if exposed to Carp fish seedlings. 66% are aware of Panyam fish farm and its involvement with Carp fish farming, while 34% have no idea of this at all.

Tables 5: Nigerian Fish Farmers Perspectives on Common Carp Propagation and Culture

Section A: Knowledge of Carp existence

Question	Yes	No	Uncertain
Is carp cultured in Nigeria	96 (64)	21 (14)	33 (22)
Do you culture Carp?	9 (6)	129 (86)	12 (8)
Catfish is the only culturable fish in Nigeria		141 (94)	9 (6)
Do you culture Tilapia?	63 (42)	87 (58)	
Is carp aquaculture a good venture?	84 (56)		66 (44)
Will you be willing to try Carp culture venture?	120 (80)	18 (12)	12 (8)
Have you eaten carp meat before?	9 (6)	120 (80)	21 (14)

**Percentage response is in parentheses*

Section B: Response on Fish Meat Quality

Parameter	VH	H	M	L	VL	Void
Opinion about carp meat quality	30 (20)	21 (14)	9 (6)	6 (4)		84 (56)
Opinion about catfish meat quality	36 (24)	108 (72)	6 (4)			
Opinion about tilapia meat quality	39 (26)	30 (20)	81 (54)			

**Percentage response is in parentheses*

Comment [L58]: check table alignment

Section C: Response on Fish Meat Quantity

Parameter	VH	H	M	L	VL	Void
Opinion about carp meat quantity	15 (10)	24 (16)	51 (34)			60 (40)
Opinion about catfish meat quantity	21 (14)	108 (72)	21 (14)			
Opinion about tilapia meat quantity	18 (12)	84 (56)	30 (20)	18 (12)		

**Percentage response is in parentheses*

Section D: Response on Fish Meat Taste

Parameter	VH	H	M	L	VL	Void
Opinion about carp meat taste	30 (20)	21 (14)	33 (22)			66 (44)
Opinion about catfish meat taste	26 (24)	90 (60)	24 (16)			
Opinion about tilapia meat taste		9 (6)	36 (24)	87 (58)	18 (12)	

**Percentage response is in parentheses*

Section E: Relevance of Carp culture

Parameter	Positive	Negative	No Idea
Knowledge of carp farm management	57 (38)		93 (62)
Cost of Production	36 (24)	21 (14)	93 (62)
Selling price	30 (20)	21 (14)	99 (66)
General view of carp farming impact	75 (50)		75 (50)
Are you aware of carp farming at Panyam?	99 (66)		51 (34)

**Percentage response is in parentheses*

Section F: Challenges of Carp culture

Question	SA	A	D	SD	Void
Is carp aquaculture land intensive?	9 (6)	117 (78)			8 (16)
Is carp aquaculture labour intensive?		126 (84)			24 (16)
Is carp aquaculture capital intensive?	6 (4)	138 (92)			6 (4)
Is carp aquaculture water intensive?	81 (54)	63 (42)			6 (4)
Is carp aquaculture a risky venture?	21 (14)	72 (48)	45 (30)		12 (8)
Scaly fish should be cultured alongside non scaly fish	117 (78)		6 (4)		27 (18)
More awareness should be created about carp culture	150 (100)				
Aquaculture in Nigeria should continue to be catfish	21 (14)		54 (36)	75 (50)	

**Percentage response is in parentheses*

DISCUSSION

Water Quality Parameters of Both Experimental locations

Though the physiochemical properties (pH, Total dissolved solid, temperature, conductivity and dissolve oxygen) of water from FUAMRFF during this experimental process agrees with the findings of Onyia *et al*., (2015) and they are all within the tolerable ranges for fish culture, the physiochemical properties of the water available at Panyam Fish Farm showed better qualities and features that favours the culture of Common Carp fish (which is observed to be a more delicate fish species than the widely cultured and available *Clarias gariepinus* fish species that naturally has a higher tolerance rate to stress).

Water temperature is one of the most important factors affecting pond dynamics (Bert, 2007). Temperature readings which ranged between 19.93±0.1 to 22.23±0.32, with a mean range of 20.86±0.25 was observed to be highest at readings taken by 12noon. The temperature recorded was within the favourable range for Common Carp and general fish propagation as described by Bert (2007), and agrees with the work done by Siraj *et. al.,* (2016), which had temperature of his experimental site varying from 21.4 to 26.7 °C, with a total mean of 24.51±0.327°C. However, Desai and Singh (2009) too indicated from their study that Common Carp fry (Average weight 0.86 gm) showed better feeding and growth performance when they reared under temperature of 28ºC in comparison with 32ºC, considering it as an optimum for this life stage. The temperature observed from Ponds of FUAMRFF had higher degrees (between 26°C -31°C) than that of PFFPS and all permits Carp culture. Though that of Makurdi was higher than Panyam, it was not up to 32ºC, or higher than 32ºC. Too high temperature will not be ideal for Carp Fish Culture. By implication, too hot regions will not favour Carp life or existence, and Carp will have a slower growth rate at lower temperatures.

The pH of PFFPS water during the experimental period ranged between 7.48±0.05 and 7.60±0.11 with mean at 7.54±0.05. The pH readings for the experimental water used for this experiment was within optimum range as described by Billard (1995), and therefore is suitable for fish pond culture. The pH of Ponds of FUAMRFF that ranged between 5 and 6 was slightly acidic and not too good for the survival of Carp fry or fingerlings. Though pH level was at its peak during the afternoons, the adult fish available could thrive manageably, it was not the case with the Carp offspring. This should be one of the reasons why breeding success at Panyam was far higher than that of Makurdi.

The Dissolved Oxygen content of Panyam Fish Farm water was measured three times daily at 7am, 12noon and 6pm, during the experimental period, the experimental water used for this work was measured using a Digital Dissolve Oxygen Meter, with readings in milligram per liter. Dissolved Oxygen readings had a mean value of 8.35±0.09. As required for Common Carp fish propagation, Dissolved Oxygen values during the experiment was conducive for Common Carp fish propagation due to the presence of aeration system and photosynthesis. pH and Dissolved Oxygen concentrations are dependent upon water temperatures (Sawyer *et. al.,* 2003). The Dissolved Oxygen content of Makurdi ponds were between 4.65 Mg/L– 5.85 Mg/L, with an average of 4.83 ± 0.21. That of Panyam was higher. This certainly will be attributed to the structure and size of the ponds available in Panyam. The Ponds at Panyam are Mining Ponds with large Acres, large volume and sufficient freshness. The Dissolved Oxygen levels were at their peak during the measurements at noon, certainly because Carp Fish thrives better with increased volume of water. They spawn naturally at points where water level increases too. They do not thrive well in very shallow waters. The attempt for natural propagation of this specie in Makurdi was not a success as it was in Panyam. The lower volume of water in the confinement is definitely a pointer to their inabillity to spawn naturally. Even breeding success was not as high *($p<0.05$)* in Makurdi, when compared with the result from Panyam. This suggests that Dam structures or bigger constructed ponds would be a plus for intending Carp farmers. However, this is not to say Carp cannot be cultured in areas without Dams or very large ponds. Panyam Fish farm is only advantaged, and this advantage can be harnessed in Carp fish multiplication.

The Total Dissolved Solid (TDS) content of the experimental water in Panyam and Makurdi had readings ranging between 133.67±2.84 mg/l and 140.77±2.58 mg/l with mean at 136.77±1.54, while Total Dissolved Solids readings from Makurdi ranged between 115 Mg/L– 120 Mg/L. In fish culture, the maximum TDS value of 400mg/l is permissible for diverse fish production (James, 2000). The physicochemical parameters of both experimental water was suitable for the experiment (not up to 400mg/l), though that of Panyam waters had slightly lower range value.

The Electrical Conductivity (EC) of PFFPS ranged between 230.28±1.65 µS/cm to 240.18±3.55µS/cm, and that of Makurdi waters ranged between 238.70 ± 0.50 and 232.60 ± 0.50.According to (James, 2000), a fresh water body supporting good mixed fisheries has a range of EC between 150 µS/cm and 500 µS/cm.

The transparency level in PFFPS pond waters, readings ranged between 42.33±0.64cm to 57.13±0.68cm, with readings at 12noon having the highest transparency at 57.13±0.68cm. However, the mean recording for Transparency was at 47.28±1.49cm, indicating that the water was neither too turbid, nor too clear. The fertility of the experimental water is hence termed as ideal for the propagation of Common Carp, as well as any other Fresh water fish specie. On the other hand, the ponds in Makurdi had Turbidity readings ranging between 55cm– 70cm, with an average of 63.61±1.49. The ponds in Makurdi appeared brownish at physical observation, indicating that the mineral turbidity was higher than that of Panyam waters. However, Plankton turbidity was relatively higher in PFFPS than FUAMRFF pond waters.

Hatching Parameters from Experimental Focus

According to (Bromage 1992), a high quality seed production demands a particular nutrition of brood stock which significantly affects fecundity and survival. However, Ovaprim hormone is used commonly for inducing breeding on finfish artificially, because it has a Salmon gonadotropin-releasing hormone equivalent and a dopamine antagonist, this hormone is very effective for finfish species (Malik *et al.,* 2014; Shoaib *et al.,* 2014).

In this study, all the broodstock used were mature and healthy. They were isolated and given intensive care and intensive feeding for a period of three months prior to breeding/spawning activities. Obviously, the same high quality and ration of feed was fed the broodfish to satiation. Consequently, if fecundity were based on feeding alone, the three different treatments would have had no significant difference *(p<0.05)* with number of eggs per gram. Also, another discussable reason for the statistical difference could be based on age of fish, genetic and inherent factors peculiar to the broodfish used by the respective treatments. However, during selection process, broodfish used were seemingly of equivalent size, age, and weight. As reported by Parameswaran *et. al.,*(1972), Common Carp is found to attain table size maturity when six to eight months old, the males about two months earlier than the females, with a generally smaller size than the female, suggesting that the gene, size or age of the broodfish may not have been the sole cause of the significant differences observed in hatching. Hence, this could be due to hormone administration, and the complete stripping of eggs from the egg sac of the induced gravid female broodfish in the artificial breeding.

Percentage Fertillisation in hatching activity at PFFPS was found to be highest in sample collected from the treatment of the induced natural spawning (94.44 ± 0.40^{a}) as compared to Induced spawning by stripping (89.86 ± 0.10^{b}) and uninduced natural spawning using outdoor hapa net (73.12 ± 0.30^{c}) with a significant difference at ($P<0.05$). Possibly, the percentage of fertilization which was higher in treatment two (induced natural spawning of 94%), could also be as a result of the less stress on the brood stock which was already to shed eggs after hypophysation (inducement from action of Ovaprim on sex gamates). For fertilization to have occurred, milt from the male mixed with the eggs from the female. The union between the sex cells from both parents must have been without stress from handling on both broodstock as compared to the manual stripping of fish eggs and milt. However, as stated by Ed-Idoko *et al.,*(2018), variation in sperm quality may be due to sex ratio, stocking density, age, size, nutrition and feeding regime; (Tahoun *et al.,* 2008). Studies have shown that qualitative parameters of the milt (sperm motility, sperm lobe length, milt volume and count) can be influenced by several factors such as feeding regime, the quality of the feed (Cerovsky *et al.,* 2009), environmental factors, variations between individual, age, weight, length of the fish. Ochokwu *et al.,* (2015).

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Stress on broodfish affects reproduction potentials. Though the completely natural (uninduced natural spawning) too was without handlers stress on the broodfish used, it is imperative that its lowest output could have been from the fact that the completely natural process of spawning may not have had a 100% conducive breeding environment, which could draw attention to the fish being in a confined area or in captivity in the hapa net, thereby depriving the sex cells of broodfish from optimum development.73% fertilization yielded 37% hatchability in treatment one. 94% fertilization yielded 72% hatching success in treatment two, and 89% fertilization yielded 94% hatching success in treatment three. Keen observation shows however that the treatment of the Induced spawning by stripping did better than all other. Ordinarily, percentage fertilization should be commensurate to, or be a direct pointer to percentage hatchability. But in this experiment, the treatment with the highest percentage fertilization did not yield the highest percentage hatchability.

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The Percentage Hatchability in experiment carried out at Panyam Fish Farm was found to be highest with a significant difference at ($P<0.05$) in sample collected from the treatment of artificial propagation through stripping in indoor concrete tank system (94.10 ± 0.85^{a}) as compared to induced natural spawning through stripping in outdoor hapa net system (72.73 ± 0.93^{b}) and natural propagation using outdoor hapa net (37.54 ± 0.20^{c}).According to (Montchowui *et. al.,* 2011), the knowledge of artificial breeding is a key aspect as it permits intensive production of a given species in controlled conditions. This allows continued production of juveniles for restocking natural or artificial water bodies. This justifies the result obtained here, as the two treatments that were administered the ovaprim hormone had more hatching success, with other factors like water physico-chemical parameters same for every treatment. Also, reproduction of Carp is most often performed in hatcheries. After hatching, the larvae are transferred to small shallow pools or ponds with water rich in plankton, a sufficient food for the young Carp (Zaykov, 2008).

The number of Post Fry in one liter of water at day seven in PFFPS was found to be highest in the sample collected from the treatment of artificial propagation through stripping in indoor concrete tank system

(1896.30±53.40^{a}) as compared to semi-artificial propagation through stripping in outdoor Hapa net system (1572.30±52.00^{b}) and natural propagation using outdoor Hapa net (843.00±75.20^{c}). Considering the fact that there was no significant difference at ($P<0.05$) in the fecundity of all treatments, and the fact that the Hapa net used for the experiment was double netted (to avoid escape of fry into the water body, with the external layer of the netting of a smaller mesh size than the internal netting that housed the broodfish in the natural and semi-artificial treatments), the significant difference in the number of post fry in one litre of water at day seven after hatching could be obviously due to the complete stripping of the gravid and injected broodfish. It means that despite the conducive environmental conditions for the hatching of fry in all the treatments, the treatments without stripping may have obviously had some eggs left in the belly of the gravid female, ready for reabsorbtion. It also indicates that the use of hapa nets may have conditioned the broodfish to a limited space for movement, which could be a source of stress to the fish. Furthermore, the application of synthetic hormone is relevant to the total ripening of the eggs embedded in the broodfish, ready for fertilization, hence the significant difference.

Generally, Common Carp can breed in natural water bodies. However, artificial breeding at commercial farm level is much more important for the successful expansion of aquaculture and farmers economic condition (Md. Monirul Islam *et. al.,* 2016).

The Percentage fertillisation, Percentage Hatchability, and Number of Fry in 1 litre of water after 7 days of hatching of all treatments in FUAMRFF was generally lower than the treatments of Panyam Fish farm. Obviously, the records from Treatment 3 (breeding through stripping in hatchery concrete ponds) was clearly significantly different from the other treatments of the same experiment, and these records (from variables in treatment 3 of Makurdi waters) was lower than that of Mangu waters, except in the case of Percentage Fertillisation which had treatment 3 from Makurdi even comparatively higher than that of treatment 3 from Mangu experiment. It is worthy of note that the fertillisation process was highly controlled from inducement to hand stripping, all in the hatchery. Thus, there was no need for influencing the natural environment to facilitate natural spawning.

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This is a pointer to the fact that every other regular fish pond may not permit the natural spawning of Carp fish species except through controlled manipulation, or in instances where a dam is made, or where mining ponds are available in acres, with large volume of water which has increased volume during the raining seasons. This increases the water physic-chemical properties of Dissolved Oxygen and Temperature primarily.

It was discovered from observation in the course of these studies carried out in the various farm settings (with different atmospheric and water physico-chemical parameters of water), that Common Carp (*Cyprinus carpio)* is a highly sensitive non tolerant fish species, and not as hardy or tolerant as other common culturable species of fish like *Clarias gariepinus* as we have commonly available in Nigeria, unlike it was described by Sultana *et. al.,* (2001) to have a hardy nature and also described by Mills *et., al* (1993) to have a high tolerance to changeable environmental conditions. The experiences gathered from these processes suggests the need for a highly professional and skilled handling of Common Carp (*Cyprinus carpio)* fish species, in addition to ensuring the right culture medium in order to achieve spawning and culturing success.

Growth Performance of Hatched Progenies

Percentage Weight Gained (%WG) had no significant difference ($P<0.05$) between the treatments fed Artemia in Panyam (99.149±0.159), and Makurdi (99.048±0.119)The three replicates each had fry gaining weight at seemingly even rate as they grew. The insignificant difference in Percentage Weight Gained could be in association with the insignificant difference from their Specific Growth Rate throughout the 56 days of observation.

Specific Growth Rate (SGR) too had no significant difference ($P<0.05$) between the treatments fed Artemia in Panyam (0.085 ± 0.003) and Makurdi (0.083 ± 0.002). This is not different from the result gotten and reported by Solomon *et. al.,* (2015), which had Artemia (5.95 ± 0.02^{a}) significantly different ($P<0.05$) from Dried Quail Egg (5.69 ± 0.02^{b}), Coppens Starter Feed (5.69 ± 0.02^{b}), and On-farm Compounded Feed (5.69 ± 0.02^{b}). Though only Artemia differed significantly from the rest, compared with the result gotten from my experiment, there is no difference since the Aremia feed fed had no statistical difference between the treatments in the two farms (Panyam and Makurdi). This implies that all the starter diets of both Artemia, Commercially Compounded Starter Feed, On-Farm Compounded Feed, Coppens Starter Feed, Dried Quail Eggs, and Smashed Chicken Egg Yolk are justifiably utillised as feed by Carp Fry and Fingerlings. However, Artemia has a credit of re-occurring lead result.

Mean Final Weight Gained (MFW) had a little significant difference ($P<0.05$) between the treatments fed Artemia in Panyam (2.800 ± 0.000^{a}), and Makurdi (2.600 ± 0.000^{b}). Since Artemia had the highest Mean weight Gain and fastest growth rate at the initial feeding stage, the Mean Final Weight may have consistently been higher most probably because the feed size had changed with the change in the mouth size of fish as they grew bigger. The change in feed size is generally accompanied with a difference in the percentage composition and mixture rate of feed ingredients and additives. The result obtained from my experiment is supported by the documentation from the work done and reported by Solomon *et. al.,* (2015) which states that the growth pattern of fish changes according to the developmental stage of the fish. Decapsulated Artemia Cyst is the best for carp fry as a starter feed.

Percentage Mortality was highest in treatment from Makurdi (4.133 ± 0.467^{a}), as compared to Panyam (1.900 ± 0.115^{b}), at significant difference ($P<0.05$). According to Takeuchi *et al.,* (2002), with the poorly developed digestive system of Carp fry, fry feeds must be formulated carefully to gain the maximum advantage of supplementary feeding. Therefore, the goal of feeding of fry is not limited with growth enhancement but also includes another crucial aspect which is fry survival rate and its implication on the final productivity and profitability of the culture process. My result on Mortality should have justified the documentation by Takeuchi *et al.,* (2002) if other feed types were used in the experiment. However, it is worthy of note that the higher mortality rate could have been due to water pollution which was observed to be faster in treatment in Makurdi than in Panyam, even though the whole ponds where fed with water in a flow through system at even flow rates. Hence, Artemia fry feed has a higher tendency of water pollution.

Percentage Survival was highest in treatment in Panyam (98.900 ± 0.115^{a}), as compared to Makurdi (95.867 ± 0.467^{b}), at significant difference ($P<0.05$). Definitely, this should be obvious, comparing with result from Percentage mortality. This is a little bit different from the report from the work done by Basavaraja and Anthony (1997) that documented a survival rate of 98% for fry fed with conventional commercial feed instead of Artemia. But in the words of Solomon *et. al.,* (2015), fry inspite of high quality starter feed must be married with appropriate management skill and handling. However, water quality is still primary to fish survival, just as said by (Gupta and Gupta, 2006), water quality status is essential for both survival and optimum growth of organisms. This is irrespective of how good the quality of feed fed is.

Economic Valuation of Carp Progenies in Study Areas

Factors that affects fish farming and culture are majorly categorised into land, labour and capital resources. 78% of respondents feel that Carp fish farming is land intensive. 84% feel it is water intensive, and 84% feel that it is labour intensive. These are not strange as it is common with fish farming generally. The question then, is if the venture is worth it. According to Akinrotimi Abu, Ibemere, & Opara, (2009), aquaculture practices as a business venture is capable of bringing significant development in the rural and urban areas by improving family income, providing employment opportunities and reducing problems of food supply and security, and FAO (2010) reports that aquaculture is the fastest growing sector of animal production worldwide, growing more rapidly than all other animal food production sectors. During the last 25 years, aquaculture production grew by up to 8.5 % annually (FAO, 2012) and currently covers roughly half the global demand for fish products for human consumption (FAO, 2012). Worldwide, the most important fish species used in fish farming are, in order Common Carp, Salmon Tilapia, and Catfish (FAO, 2012). No matter how intensive that land labour, capital and water for aquaculture is, it is worth it, since it is relatively profit generating.

From this study, a fixed standard selling price of Carp fish doesn't seem to exist nationally, reason being that the market value of this species is contextual, based on the agro-ecological zone and the cost of production. The selling Price at PFFPS was (₦250), which was relatively lower than that of FUAMRFF (₦ 400). The Profit index was higher from PFFPS (3.5) than FUAMRFF (1.8). However, the total revenue generated at PFFPS was higher (₦350,000) than FUAMRFF (₦160,000) due to the higher percentage hatchability and higher Average Number of Fry per 1 litte of Water of PFFPS (1,435) to FUAMRFF (464). 66% of respondents had no idea of the selling price, further studies could be carried out subsequently. However, Rondon and Nzeka (2010) reported that Nigeria's fish demand amounted to nearly 2.0 million metric tons (valued at more than $1.8 billion) in 2009, leaving approximately 600,000 metric tons of untapped market potential and about 800,000 metric tons valued at approximately $900 million. The opportunity of bridging the widening demand-supply gap of fish in Nigeria through domestic production offers a great investment potential to the Nigerian populace and also the inflow of foreign direct investment into the country.

The profitability Index was calculated as ratios of Total Revenue Generated (₦) to Total Variable Cost (₦). The values indicated the return on every naira invested in the Fishing business in the study area. Therefore, the value of 3.50 means that for every one Naira invested in Carp fishing Business at PFFPS, there is a return of three Naira and fifty Kobo in the study area, and the value of 1.80 means that for every one Naira invested in Carp fishing Business at FUAMRFF, there is a return of One Naira and Eighty Kobo in the study area. This is a very important parameter For investment decision as Aquaculturists and Fish farmers like any other Investor may wish to know the profit that can possibly be generated from their limited financial resource invested.

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Evaluation of Nigerian Fish Farmers Perceptions on Common Carp Propagation and Culture

50% of the respondents in this study had a positive view on its impact, 0% had negative perspective to Carp aquaculture, and 50% had no idea whatsoever. 66% of the respondents were aware of Panyam Fish farm and Carp fish production, however, 34% of them had no idea. 56% know that Carp fish farming is a good venture, while 44% were uncertain. However, 0% of the respondents are willing to diversify into carp fish farming. Thus the need to increase the multiplication of carp fish seedlings along side creating awareness and training on Carp fish farming and sustainability. According to George, Olaoye, Akande & Oghobase (2010), the major problem hindering the promotion and development of the aquaculture industry in Nigeria has been the scarcity of fish fingerlings. Also, 100% of the responding farmers during this study opined that more awareness should be created on Carp culture since 62% of them had no idea about Carpfish farm production and management. This indicates that there is need for Carp fish orientation for a sustainable farming in Nigeria. Nigeria has high potentials for aquaculture development and thus potentials can be realized substantially through extension services (Adetunji, 2011). It has been shown that Nigeria can substitute fish importation with domestic production to create jobs, reduce poverty in rural and peri-urban areas where 70% of the population live and ease the balance of payments deficits (Areola, 2007).

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CONCLUSION

The analysis of Profitability Index and Total Revenue Generated (₦) of the fisheries venture in the study areas, like any business enterprise reveals the strength and/or weakness of a business. This suggested that Carp Fish farming, if promoted and supported Could be a vital source of Aquaculture livelihood for farmers, and that PFFPS should be a pivotal structure for Carp fish aquaculture multiplication and sustenance in Nigeria.

To revive the culture and propagation of Common Carp fish from extinction, and to diversify aquaculture in Nigeria, more attention should be given to the culture of Common Carp through artificial propagation by induced stripping using indoor hatchery systems for its sustainability.

To boost Common Carp fish aquaculture in West Africa, especially in Nigeria, more attention should be given to Panyam Fish farm, Plateau state, to supply fingerlings and broodfish of Common Carp fish. Panyam Fish farm has mega sized fish ponds, a working practice of the indoor hatchery technique, satisfactory atmospheric, environmental and good water quality conditions maintained all year round, availiable for the mass production, control and conditioning of Common Carp fish fry, fingerlings and broodfish.

Common Carp (*Cyprinus carpio),* the world's most important fish species used in fish farming (FAO, 2012), which can be naturally distributed with translocations and introductions of domesticated and wild forms since Roman times (Balon, 1995), should be established in significantly more than the 91 out of 120 countries worldwide, beyond what was documented by (Casal, 2006) because so far, despite its adaptability to a very wide range of environmental conditions (Balon, 2006)**,** this specie has not been exploited in West Africa and particularly Nigeria's aquaculture practice.

Fish farmers in Nigeria are of the opinion that diversifying aquaculture in Nigeria from Cat fish dependence, is a welcome development. It will increase opportunities for entrepreneurs to generate income and employment, which in turn is a plus to the Nigerian economy.

Panyam fish farm has the capacity to provide carp fish seedlings for nationwide utilization amongst fish farmers, hence facilitating Carp fish aquaculture sustainability in Nigeria, in West Africa

COMPETING INTERESTS DISCLAIMER

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge.

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

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