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Shrinking Lake Chad: Initialization of culture-based fisheries for improved livelihood in Nigeria

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Abstract

Climate change and high water demand from agriculture have resulted in the shrinkage of numerous water bodies including the Lake Chad. The fisheries resources of the Lake Chad are near collapse causing a huge loss of livelihood. Culture-based fisheries (CBF) which is a form of extensive aquaculture where fish seeds are stocked in existing water bodies enabling them to feed on the naturally occurring organisms is presented as a plausible strategy for augmenting fish production. Standard management strategies and steps for the initialization of CBF are highlighted in the form of consultations and decisions which include: community consultation; selection of water bodies; decision on stocking, harvesting strategy and sharing formula. Optimal utilization of the numerous water bodies around the Lake Chad for CBF would lead to increased fish supplies at an affordable price to rural communities as well as provide an additional source of income and thereby improve means of livelihood.

Keywords: lake chad; culture-based fisheries; livelihood; food security; climate change; community managed

1. Introduction

Water is a key driver of food production. Its scarcity can therefore, reduce food production and adversely impact food security [1]. In recent years, the world's waters are rapidly running dry, creating ecological crisis and impacting the livelihoods of millions of people [2, 3]. Water scarcity occasioned by the shrinkage of these water bodies is already of critical concern in most parts of the world. Furthermore, there are growing concerns that the negative impacts of water scarcity on the environment and food security are substantial [4]. In Africa, the great lakes in the continent such as Lake Victoria and Lake Chad are among important water bodies that have been undergoing steady shrinkage [5, 6].

Lake Chad is a large shallow lake lying at the centre of a semi-arid basin (Sudano Sahelian savannah region). This Lake has been a source of economic livelihood sustaining over 20 millions of people inhabiting the catchment areas in the four riparian nations: Cameroon, Chad, Niger and Nigeria [6]. The Lake which was once described as one of the richest fisheries in the world having production of 80 - 100kg/ha [7] is now plagued with both hydrological and ecological crises. This is because of the fact that the size of the lake, as well as its resources, have continued to diminish over the years. Hydrological status of the lake as shown in Figure 1, undoubtedly revealed a drastic reduction in the lake area over the years. The lake which covered an area of 23,000 km² in 1960 had been reduced to about 2,000 km² by 1990 [8]. Repeated droughts, evaporation as well as the intensification of irrigation, have been implicated as causes for the continuous emaciation of the water resources [9, 10]. This has resulted in poor access to water, the death of livestock, reduction in fish catch, malnutrition, increase in poverty and loss of livelihood [6, 10]. Many fishers and other actors along the fisheries value chain (i.e. input suppliers, processors and marketers) are finding it difficult to keep their activities profitable.

With a growing population of human around the Lake Chad basin but with corresponding water shrinkage, an urgent intervention is inevitable in order to abate the scourge of poverty and loss of livelihood. At the moment, fishers resort to the use of indiscriminate fishing practices as a coping strategy for survival. The natural fisheries resource is now unsustainable and near collapse. The alternate fish production through aquaculture (farming of aquatic animals) has not been able to bridge the gap between demand and supply as a result of the huge capital requirement when compared to fishing. The fisheries sub-sector must explore

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other potential and plausible means of increasing food fish production to ensure food security^[11]. Culture-based fisheries (CBF) are a credible strategy for augmenting fish production around the Lake Chad. It is a form of extensive aquaculture where suitable seed are stocked in existing water bodies enabling them to feed on the naturally occurring organisms in the water body and attain a marketable size^[12]. Culture-based fisheries are comparatively less resource intensive and environmentally less perturbing than most semi-intensive and intensive aquaculture practices, and almost always include community participation^[13]. While avoiding waste of scarce water resources, Culture-based fisheries would help in increasing fish production around the lake, and thereby creating jobs and reducing poverty and hunger.

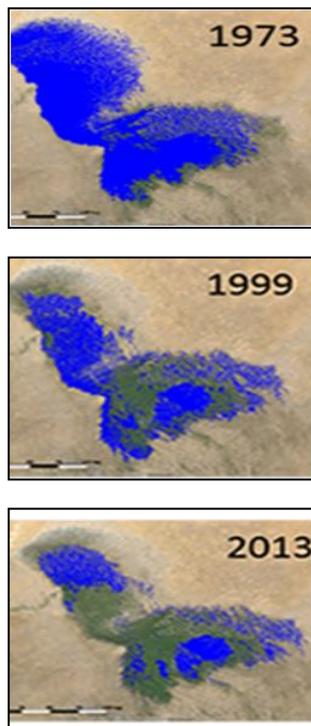


Fig 1: Time-lapse sequence of maps on the Lake Chad.
Source: Satellite images accessed at
<http://lcbconference2017.ng/English/index.php#>

2. Fishing dependent livelihood and Fish production from Lake Chad (Nigeria Sector)

Fishing is a vital livelihood for the poor as well as an important protein source at the household level^[14]. The fishery provides employment for over 2 million people, most of whom are engaged in fishing on a seasonal or part-time basis^[15]. Here, most communities are considered as fishing communities or villages, where the majority of households are involved in the harvesting, processing, distribution, marketing, and sale of fish resources^[16, 17, 18]. Although most of these households typically operate diversified livelihoods by including land-based agricultural activities, thousands of them are seasonally or occasionally dependent on fisheries-related activities. Apart from providing significant contributions to the household economy, fishing activities also play an important role in household nutrition and food security.

Lake Chad has been contributing immensely to Nigeria's fish production for decades. However, a complete time-series data on the fisheries of the Nigeria part of Lake Chad basin is not readily available^[7, 19]. This is largely due to a lack of continuity in the operation of information gathering systems,

political instability and limited budgets for research^[20]. The contribution of fish production from the Lake Chad to Nigeria's total fish supply is presented in Table 1. Between 1985-1994, Lake Chad fishery contributed 10% of the 5,040,753 tons of the total National fish supply (Table 1). The observed increase in fish production beyond 1995 was as a result of the intensification in fishing effort as well as the use of sophisticated fishing gears. The percentage annual fish contribution from the Lake (range: 6 – 18%) clearly indicates that the lake plays a significant role in Nigeria especially in fisheries-dependent communities.

Table 1: Contribution of fish production from lake chad (Nigeria Section) to Nigeria's total fish supply (Mt) 1985 – 2000.

Year	National Total Fish Supply (mt)	Lake Chad Contribution (mt)	Annual % Contribution
1985	304,229	22,878	8
1986	372,301	31,352	8
1987	498,150	34,141	7
1988	463,540	53,070	11
1989	676,693	68,424	10
1990	434,548	71,639	16
1991	596,600	71,832	12
1992	721,454	46,398	6
1993	692,931	47,266	7
1994	280,307	34,657	10
1995	NA	76,211	15
1996	NA	96,413	18
1997	NA	96,411	18
1998	NA	94,345	18
1999	NA	82,398	16
2000	NA	79,307	15

NA (Not available). Adapted from FDF^[21] and Odogbo^[19].

3. Culture-based fisheries: concept

The FAO^[22] defined Culture-based fisheries as activities aimed at supplementing or sustaining the recruitment of one or more aquatic species and raising the total production or the production of selected elements of a fishery beyond a level, which is sustainable through natural processes. CBF are secondary user of existing water resources and is non-consumptive of this valuable resource. It is mostly practised in water bodies that are incapable of sustaining fisheries through natural recruitment^[23]. Water bodies selected for CBF are stocked with suitable species in pre-determined stocking rates. The stocked fish live and grow in the water body consuming the naturally produced food organisms in it. The fish are harvested at a suitable time or when the water level recedes. A selected community group, who will have ownership of the stock, prepare the water body for stocking, procure seed stock, and care for the stocked fish, in particular by keeping watch over the stock^[12].

Culture-based fisheries are a form of stock enhancement bordering on aquaculture. Fisheries enhancement in a broader sense includes, ranching and/or the introduction of a species that is capable of reproducing in the water body and, with time, forms sufficiently large populations that could be exploited commercially^[13]. On the other hand, ownership coupled with the need for some level of caring for the stocked fish, makes it a form of aquaculture in accordance with the Food and Agriculture Organization of the United Nations' (FAO) definition of aquaculture. Culture-based fisheries offers advantages over conventional aquaculture practices in that: it is a non-consumptive water use; it is a secondary user of existing water resources and rarely will compete with

primary water resource users; its activities require minimal skill levels and capital investment and it does not involve external feed inputs; a communal activity with the potential to generate synergies within and between communities; and attractive to governments and development agencies as a sustainable strategy that will contribute to enhancing fish food supplies at an affordable price to rural communities, thereby providing an additional source of income, and generally contributing to poverty alleviation [12, 13, 24].

In Asia, countries like China, India, Thailand, Vietnam, Cambodia, Sri Lanka, Indonesia and Bangladesh have developed culture-based fisheries in their natural water bodies. The yield from CBF varies between water bodies [25]. This variation is related directly to the size (the larger size the lower yield) and productivity of water bodies. An average of about 250 kg/ha ranging from 115 to 429 kg/ha is common. In this form of practice, stocked fish contributes about 80% of the catch and harvesting size varies between species and stocking times. Chinese water bodies have the most developed CBF in the world with an estimated total production of 1,165,075 tons in 1997 from a total area of 1,567,971 ha (yield of about 743 kg/ha annually) [24, 26]. CBF is, therefore, a very successful form of fish rearing providing cheap and easily available fish products to inland rural population as well as an important source of income for rural people. It also relies on existing inland open waters for fish production.

3.1 How to develop culture-based fisheries in the lake chad region

Non-perennial reservoirs, pools, numerous lentic water bodies such as free-flowing bore holes exist within the Lake Chad basin with the absence of established commercial fisheries. According to Ita *et al.* [27] the Lake Chad Basin Development Authority alone maintains borrow pits with a surface area of 101 ha; fish ponds with a surface area of 12.7 ha and irrigation canals of about 7.0 ha. Apart from this documentation, a vast number of water bodies that can be utilized for CBF exist around the Lake Chad Basin.

Standard management and stocking strategies must be adopted for the initialization of CBF in settlements around the Lake Chad. Development of CBF must include technical considerations on ecological, socio-economic, and institutional aspects [28]. The brief is as presented below [12, 29, 30, 31, 32, 33].

▪ Community consultation

- a. Briefing on community leadership, *sarki ruwa*, fishers, processors, marketers, faith-based organization, community-based organizations and youths on the benefits of CBF
- b. Formation of community group to manage CBF
- c. Establishment of guidelines

▪ Selection of water body for culture-based fisheries

The suitability of water bodies for culture-based fisheries is usually based on various criteria such as physical, biological and social aspects. Generally, all reservoirs and lakes are appropriate for the development of CBF. Although, water bodies with an area of less than 200 ha are suitable because small water bodies have the highest potential fish yield compared to large water bodies and are easier to control and manage properly [28]. An ideal water body for CBF must be able to retain sufficient water to sustain fish production, have

high biological productivity, situated in the vicinity of the community and close proximity to markets, lack of conflicts among water users, absence or low abundance of rooted or floating macrophytes and readiness of community, farmers' organizations, cooperative societies and fishers to accept culture-based fisheries as a form of fish production.

▪ Determination of fish species to be stocked, species combination and stocking densities.

The choice of stocked species is based on their feeding niches and local preferences, ensuring that all naturally produced food organisms are utilized. Also, the stocked fish must have high food conversion rate, rapid growth rate, high economic value, easy availability of fish seeds and easy to capture.

▪ Decision on time for stocking, source of fish seed and stocking density

The size of fish at the time of stocking is a major factor determining the final fish yield in CBF. If small fish are stocked, the risk of natural mortality is higher. Therefore, stocking of juveniles is preferable in order to enhance survival rates. Such juveniles can be produced from brooders obtained from natural water. Reliance on hatchery bred fingerlings/juveniles may result in genetic contamination or inbreeding depression in a long run.

Various studies have shown that the final fish yield increases with increasing stocking density up to an optimum level and then begins to decrease. This is due to the limitations in space and food availability for the growing fish. The optimum stocking density lies between 2000 and 3000 fingerlings per hectare for most species. Although, a reasonable proportion (approximately 10%) should be included as an allowance for loss of seed stock due to escape and natural mortality.

▪ Decision on time for harvest and adoption of harvesting strategy

Fish should be harvested based on the size preference of the final consumers. The amount of fish to be harvested per day should be determined in accordance with demand. All fishes from a water body are harvested using efficient methods. It is recommended to carry out the cropping of fish in the early hours of the day to enable fish vendors to purchase the harvest and reduce chances of spoilage.

▪ Sharing formula for proceeds of CBF

The net CBF income is the proceed from the sale of fish after the deduction for the costs for procurement of fingerling other labour costs such as for keeping watch of the stocks, purchase of harvesting gear etc. Since CBF are essentially developed in water bodies that are often communal property, there is the need to share the proceeds of CBF using a predetermined mutually acceptable sharing formula. If a small group of the community is engaged in this activity, there should be an arrangement to pay the rest of the community some compensation for the loss of their user rights. The group may agree to retain a proportion of the harvest for household consumption or outright sale to fish vendors. Funds should also be set aside for procurement of fish stock for the following year.

3.2 Potential constraints to the development of culture-based fisheries in the lake chad region

Like every CBF practice globally, the most anticipated constraint to the development of CBF in the Lake Chad is the

availability of suitably sized, good-quality seed stock, and the increasing demand on seed from increasing conventional aquaculture activities which tend to exacerbate the situation further ^[13]. Other potential challenges include: scarcity of information on the results of previous CBF efforts on which to design new, more appropriate activities both for stocking and for evaluation of the outcome; poor means of transporting fingerlings from hatcheries to reservoirs; inadequate culture technology for some species, but not lack of appropriate, indigenous species and poaching. However, the increasing involvement of the Nigerian government and private sector in the seed stock supply in the aquaculture industry of Nigeria would ultimately result in ensuring a sustainable supply of seed stock.

Most of the reservoirs that are suitable for CBF in Nigeria usually dry out at the peak of the dry season. This condition tends to influence fish harvest within a narrow time span. This could result in glut and summarily reduces the market prices of the fish from its regular value. A management strategy is to spread out the cropping period. Such spreading would stabilize market prices as well as ensure regular supply of fish. In situation where the above approach is not practicable, value addition can be done by adopting available processing and preservation technology such as smoking and freezing.

4. Conclusion

Culture-based fisheries which are a secondary user of existing water resources have the potential of increasing fish production within the Lake Chad basin and beyond. Since CBF are often community-based practices with the goal of generating an adequate standard of living, its implementation would ultimately lead to increase in fish production while improving livelihood, especially in fisheries-dependent communities. Policy makers should therefore establish synergy between the research institutions and communities in order to effectively develop and manage CBF. Such synergy would lead to the formation of co-operative societies; presentation of hydrological characteristics of the lake indicating water holding capacity, water draw down and contours; identification of suitable water bodies for fish and identification of indigenous fish species for culture.

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