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Eco-friendly Aquaculture for Sustainable Fish Production in Nigeria

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ABSTRACT

The ever-increasing population and hence higher demand for fish and other aquatic organisms for human consumption and exports have accorded greater priority to the aquaculture subsector. Therefore, there was need to conduct research to unveil facts relating to practices adopted by farmers in rearing fish and other aquatic organisms. This study emphasized concepts and importance of aquaculture, some common breeds of fish cultured, systems of aquaculture practices and methods of rearing fish and other aquatic organisms. The study also discussed eco-friendly aquaculture practices ensure sustainable fish production. The study further discussed the benefits of adopted eco-friendly aquaculture practices and constraints encountered by aqua-culturists. The study recommended among others that government should ensure proper training of extension workers who would in turn educate fish farmers on eco-friendly practices. The study also recommended that for expansion of aqua-cultural enterprises, government should provide more funds and liberalize land acquisition procedures to avail more land. Finally, the study recommended that requisite guidelines and regulations should be enforced to ensure that only practices that are sustainable and eco-friendly be adopted in the production of fish and allied products.

Keywords: aquaculture, eco-friendly, fish production, sustainable

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Introduction

Aquaculture has gained immense attention and has been in practice by many citizens of varying backgrounds. Farming of aquatic plants and animals known as aquaculture has been practiced for around 4000 years in some regions of the world (Iwana in Allsopp & Santillo, 2008). On the other hand, Are, Igbokwe, Asadu and Bawa (2010), defined aquaculture as the propagation and husbandry of fish and other aquatic organisms in man-made ponds, reservoirs, cages, lagoons, sea, ocean and other enclosures in lakes and crystal waters for commercial, recreational and scientific purposes. The production of fish is becoming a more enterprising venture and individuals, whether literate or illiterate strive tirelessly to engage in fish production because of the supply-demand gap for fish and fishery products (Brown, Agbulu & Amonjenu, 2017).

Aquaculture is done mostly in extensive, semi-intensive and intensive culture systems in ponds, pens, cages and coastal waters especially for food and other useful purposes (Are et al., 2010). In most cases, aqua-culturists adopt some practices with the goal of meeting up so many social, economic, and dietary demands without considering the negative impacts those practices have on the surrounding environment. Nevertheless, Lehoczky (2009) averred that sustainable fish production entails rearing fish, either in natural or artificial body of water using ecological and acceptable management practices that ensures continuity for future generation. Unfortunately, observation have showed that due to population increase and the need for more animal protein, high cost of other animal protein sources such as beef, high demand for fish has led to high pressure on the producers of aquatic organisms. Moreover, rapid development and expansion of intensive aquaculture for species such as salmon and shrimps has resulted in widespread degradation of the environment, as well as displacement of coastal fishing and farming communities (Lehoczky, 2009).

Research has indicated that advances in technologies for enhancing fish proliferation and multiplication, including synthetic fish feeds for large-scale production, manufacture and circulation of growth enhancers/artificial growth promoters, use of chemicals for protection against pest and diseases, weed control, excessive and indiscriminate use of fertilizers causing acidity have hindered sustainability of fish (Jones, 2017). In addition, the use of trash fish and smaller fries to feed larger fish, climate change effect and sea level rise due to warming of the aquatic habitats especially oceans and seas, scarcity of, or low water quality, poor managerial abilities in terms of water, feeds and other hygiene and sanitation are predisposing factors to non-environment friendly aquaculture practices. Adoption of such practices gives higher yields, which enable meeting of short-term needs but are harmful to the environment. Hence, they are regarded as unsustainable.

It is believed that if left unchecked, the dream of achieving sustainability in terms food security for both present and future generations may not be realized. This study therefore, discussed what aquaculture means, its social and economic importance, breeds and methods of rearing fish and other aquatic creatures. Finally, the study dwelt on some constraints of fish production and it made some recommendations that would ensure sustainable production of aquatic organisms if adopted.

Importance of aquaculture in Nigeria

Fish production in Nigeria comes from artisanal fisheries, industrial or commercial trawlers and fish farming in ponds. Thus, it is believed that the Nigerian fishery sub-sector plays an important role in the socio-economic development of the citizenry (Onemolease & Oriakhi, 2011). The increasing demand for fish and other aquatic organisms for human consumption and exports have made aquaculture a very important sector in both developed and developing economies. Fish is primarily a source of food in the forms of protein, iron, zinc, magnesium, phosphorus,

calcium, vitamins A & C, while the marine fish is good source of iodine (Asogwa, 2012). In the same vein, Daramola, Igbokwe, Mosuro and Abdullahi (2008), averred that fish farming is a rich source of food protein and essential amino acids, and vitamins; it is a source of foreign exchange and an efficient agent of land utilization. There is need to increase fish production because fish products are relatively cheaper compared to beef, pork and other animal protein sources (Amao, Oluwatayo & Osuntope, 2006). However, sustainability of the fish produced is the watchword in this study.

In the views of Eyo and Akeredolu in Onemolease and Oriakhi (2011), fish farming enhances development of cottage industries by providing ready source of raw materials, helps in preservation and propagation of various kinds of aquatic species and hence, puts our water and land into better use. Furthermore, Are et al. (2010) stated that fish farming is important because it provides high quality protein in human and livestock diets, provides employment opportunities, and income for people in the practice.

Aquaculture has contributed significantly to food security, income generation, trades, employment opportunities, improved living standards and aided foreign exchange earnings in many developing countries (Ayoola, 2010). To actualize the benefits highlighted above, adoption of various approaches and principles is required. Therefore, this study has identified and dwelt on common breeds of fish, systems and methods adopted in rearing aquatic organisms in Nigeria.

Breeds of fish cultured by farmers in Nigeria

Fish breeds are specific group of animals' species that are homogenous in appearance, behaviour and characteristics (Omotoyin, 2007). Fish breeding is synonymous with fish propagation, which means multiplication. Breeding entails all the various techniques used fish seed production and the choice of fish species to culture is very important for the success of fish farming business (Omotoyin in Brown et al., 2017). Some of the established breeds currently cultured in Nigeria include the catfish (Clarias gariepinus, Clarias lazea), Tilapia spp and their hybrids. The author further stated that certain features in catfish and tilapia made farmers to prefer rearing them. These include characteristics such as high rate of growth, ease of culture (suited to low technology farming systems), availability of fish seeds or fingerlings all year round, omnivorous food habits, resistance to diseases and handling, ease of reproduction in captivity, tolerance to wide range of environmental conditions and consumer acceptability or high market value.

Although consumers accept other fish types, lack of major breakthrough in their breeding technology hampers their culture in most cases. However, the animal species that tend to dominate world aquaculture are those at the lower end of the food chain-shellfish, herbivorous fish (plant eating) and omnivorous fish (eating both plants and animals). For example, carp and shellfish account for a significant share of species cultivated for human consumption in developing countries (Naylor & Burke, 2006). However, production of species higher in the food chain, such as shrimp, salmon, and marine finfish, is now growing, in response to a ready market for these species in developed countries (FAO, 2007; Naylor & Burke, 2006).

Aquaculture production systems and methods

In general term, there are three major production systems in aquaculture or fish farming. These include extensive, semi-intensive and intensive aquaculture systems. According to Are, et al., (2010) and Daramola, et al. (2008), under the extensive system, rearing of fish is done in natural water bodies such as ponds, lakes and rivers. In extensive system, there is little or no supplemental feeding. Breeds of fish reared are finfish, mussels, algae and some types of shrimps and prawns.

Semi-intensive aquaculture system: in this system, there is supplemental feeding even though fish is reared in natural water body. It means that the farmers source feedstuff from within the local environment to feed the fish. Typically, the specie commonly produced under this system is finfish. Finally, intensive aquaculture production system is the production system that entails very intensive management of fish in artificial water bodies such as the constructed ponds and cages; and tanks. The fish species reared here are mostly eels, tilapia and clarias. Consequently, different methods are adopted in pond aquaculture production.

For instance, fish production in earthen pond involves rearing of fish in dug out pond; fish production in concrete ponds constructed above the ground surface with blocks; and fish production in cages made with net, bamboo, wood or metal where fish are held captive or set in shallow portions of free flowing waters such as rivers, lakes and estuaries. Other methods include fish production in reinforced plastic ponds. These are ready-made fiberglass tank used for rearing fish and which, could be circular or rectangular and of different sizes; fish culture in ordinary plastic ponds exist (Are et al., 2010; Daramola et al. 2008). Establishing and managing the fishpond is not without constraints and these were discussed by the present study as follows.

Sustainable aquaculture

By sustainable aquaculture (fish farming), it refers to the ability to maintain an ecological balance in the process of exploiting aquatic resources and ensuring ecological balance of the area (Lehoczky, 2009; Ayinla, 2003). Sustainable aquaculture is a dynamic concept and the sustainability of an aquaculture system will vary with species, location, societal norms and the state of knowledge and technology (FAO, 2003). This implies that sustainable fish production entails providing an enabling environment that will ensure continuity in production of fish and allied products. Those practices that would guarantee sustainable fish production are known as eco-friendly practices. Therefore, sustainability in fish production is the ability to maintain an ecological balance in the process of producing aquatic organisms without depleting the resources in the area; in which case, future generations would benefit while the needs of current generation is being met (Lehoczky, 2009).

Accordingly, several certification programmes have defined key characteristics of sustainable aquaculture and these characteristics must be practicable and visible in every system for it to be known as sustainable (Jones, 2018). Jones enumerated these characteristics, linked with the adopted management practices as ensuring effective bio-security and disease control system; minimal use of synthetic antibiotics and other pharmaceutical products; maintaining microbial sanitation; and strict adherence to global standards for hygiene. Others include efficient and humane harvest and transport; accountable record keeping, traceability, and profitability. Therefore, any aquaculture system that possesses those features may be considered as adopting eco-friendly practices.

Secondly, every community has regulations and practices to follow. This means establishing well defined rights, aquaculture zones and individuals' responsibilities for aqua culturists, compliance and effective enforcement, community involvement, workers' safety, fair labor practices and equitable compensation. Finally, the ultimate among those features of sustainability in terms of aquaculture practices is the environmental practices. That practices ensure sustainability. The characteristics include aqua-conservation, effective effluent management and water control, and sludge management, soil and water conservation, efficient fishmeal and fish oil use, responsible sourcing of breeding stock and juvenile fish, control of escapes and minimizing biodiversity and wildlife impact.

In the light of above, Greenpeace (2018) identified the following as sustainable aquaculture. They include

1. Continuous use of plant based feeds originating from sustainable agriculture.
2. Use of fishmeal and fish oil-based feds form sustainable fisheries, which promote net gain in protein yield
3. No use of wild-caught juveniles as breeding stocks for ponds
4. Restrict cultivation of native species in open water systems. Thus, it uses restricted water system such as tanks and constructed ponds for exotic species to avoid escape into the wild.
5. Releases no effluents or toxins in the surrounding areas (ensures effective bio-security measures)
6. Constitute no nuisance to local wildlife (plants and animals) population. Thus, sustainable aquaculture practices provide protection for coastal ecosystems and local habitats.
7. Does not use genetically modified species or feeds
8. Avoids overstocking and therefore, minimizes risk of disease outbreaks
9. Does not cause depletion of local resources of water and forests
10. Constitute no threat to human life and
11. It supports long term economic and social wellbeing of local communities

Effect of unsustainable aquaculture practices

Under unsustainable practices, modern technological practices are common and they emphasize production of species for high-value export markets (Greenpeace, 2018). Under this kind of practice, there is high level of pollution, run-off water from fish farms can contaminate nearby natural bodies of water, which leads to diseases and disturbances on the wild fish population. This will extend to affect the natural ecosystem. In addition, feeding of carnivorous fish with wild caught smaller fish such as anchovies or herrings cause controversy around the world aquatic environment. Technologies have also evolved some technologies that have hitherto been in use. These include herbicides, pesticides, synthetic foods and feeds among others. The focus was however, to raise productivity and profit maximization.

However, the negative impacts of above practices on the surrounding ecosystem and community have left much to be desired. Since there is need to ensure continuous supply of fish protein for human consumption, there need to advocate for sustainability in the fish production industry becomes inevitable. Thus, this study is very necessary because recommendations would be made with the expectation that if implemented, they would be enhance continuous supply of fish and other aquatic products for both present and future generations.

Eco-friendly aquaculture practices

Eco-friendly is an adjective that literally mean not environmentally harmful or not harmful to the environment to the environment (Merriam, 2018). On the other hand, the term most commonly refers to products and practices that contribute to green living and helps to conserve natural resource of air, water and energy (Lehoczky, 2009). In the view of Jones (2018), eco-friendly products help in preventing pollution or contamination of the air, water and land. This implies that eco-friendly connotes a scenario that does not entail any bad or negative effect on the natural environment status. Therefore, understanding of eco-friendly concept and principles make it possible to implement the practices that will lead to healthier living for inhabitants.

Eco-friendly fish farm management is applied in ponds for culture of fish. Thus, eco-friendly otherwise regarded as responsible practices could successfully address negative impacts of intensive fish farming. This is because intensive fish farming is good avenue that predisposes diseases due to self-pollution. Adoption of eco-friendly practices help to eliminates wanton

losses in freshwater and marine cages and pens attributed to heavy organic loading of open waters that result in massive fish kills (Guerrero, 2000). According to Guerrero, through eco-friendly methods such as the use of reservoirs with “green water,” pro-biotic, sedimentation ponds with bio-filters, and re-circulating water systems, the prevention of virulent bacterial outbreaks has been possible.

In the submission of Jones (2018), the benefits of eco-friendly aquaculture practices are as follows: maintenance local water quality, freedom to operate or manage, waste is effectively managed, less emissions since fuel combustion may be totally avoided and customer demand for quality products are met. Others were more protein per unit area, reduced negative impact on wild fish thus population would increase, lower disease incidence and effective environmental resource management. In order to ensure sustainability, aquaculture or fish farming should be technically appropriate, economically viable, and socially acceptable; and environmentally sound (Metzer & Garcia, 2005; Jones, 2018; Lehoczky, 2009).

Sustainable fish production which connotes adoption of economically viable and socially acceptable aqua-cultural practices that conserves land, water, environment and (FAO, 2012; Lehoczky, 2009). Lehoczky, (2009) maintained that sustainable fish production means rearing fish either in natural or artificial body of water using ecological and acceptable management practices that ensures continuity for future generation. This involves management and conservation of the natural resources and the adoption of technologies that leads to attainment of satisfaction and continuous supply of human needs for present and future generations (Ayinla, 2003).

Technological advancement has led to evolvement of novel approaches in sustainable aquaculture. Worldwide Aquaculture (2018), referred to it as “innovative aquaculture system” called “Aqua pod Marine Containment System” also called “Aqua pod System”. This is a new method of fish culture that uses of large cages made with wire and submerged under the water and allows rearing of the fish. The system projects that the future of marine fish farming could be assured because it is an eco-friendly innovation and thus, sustainable. The strong structure and nature of the Aqua pod system makes it more advantageous over the net or simple cage system. This is because it can withstand harsh weather conditions. It will hold up to a hurricane and protect fish from common predators.

Constraints of aquaculture or fish farming in Nigeria

Constraints of fish farming were identified by various other studies including: inadequate financing, scarcity of fingerlings, flooding, water pollution, ignorance, inadequate technologies, lack of loans and grants, fish diseases and insufficient processing and preservation mediums (Are et al. 2010). Other constraints include absence of standard norms of marketing practices and lack of enforcement by legal authorities (Olukosi et al. 2009). In addition, inadequate agricultural education and poor fish farming extension services were advanced (Egbule, 2004; Are et al. 2010). Most importantly is the constraint of fish farming is non-implementation of land use act of 1978. According to Are et al. (2010), apart from the challenge posed by tenure through inheritance, rich individuals purchase expanse of land without any immediate objectives thus, hindering access by genuine intended fish farmers. Lack of access to loans or credit facilities also poses challenge and poor managerial skills contribute to the constraints of aquaculture. Investing in fish farming involves a systematic approach with good record keeping. Record keeping would help the fish farmers to measure progress in the fish farming business (Ayinla, 2003).

Conclusion

The need to enhance fish farming is very vital food security, improved livelihood and

infrastructural development. To achieve this, there should be a good balance between resource utilization and development in order to meet the needs of the present, while enhancing good opportunities for the future through planned, focused and coordinated effective management approaches by individual farmers, cooperative societies, relevant institutions and government agencies. Hence, all stakeholders must put in effort in the transformation of fish farming venture from its present state to sustainable level of production.

The fact remains that numerous constraints and challenges ravage the aquaculture industry. These include scarcity of fingerlings, flood, water pollution, insecurity, inadequate technical expertise, inadequate preservation and processing facilities, poor marketing of inputs and outputs, poor extension services among others. Notwithstanding, the success of fish farming business depends largely on how well it is planned, designed, constructed and maintained. Effective maintenance of the fish farm ensures that the resident fish and the whole pond ecosystem remain healthy and productive.

Recommendations

This study has made the following recommendations for ensuring sustainable fish production through eco-friendly aquaculture practices:

1. Government and other stakeholders should prepare and package programmes for training farmers on sustainable aquaculture practices. This should be done through workshops and seminars.
2. Government, NGOs, community leaders, and educational institutions should be involved in enlightenment of fish farmers on sustainable approaches that will enhance fish farming.
3. Government and relevant financial institutions such as World Banks, Bank of Industries, Bank of Agriculture and Cooperative societies and agencies should make funds available for both existing and intending fish farmers.
4. Government should also liberalize land acquisition procedures to make it easier for willing entrepreneurs.
5. Higher institutions involved in training extension agents should enhance training mechanisms. This is to ensure properly trained graduates for effective delivery of aquaculture skills to fish farmers and prospective ones on sustainable aquaculture practices.
6. Well-established entrepreneurs and farmers should encourage fish farmers to organize and form cooperative associations, which would enable them, obtain credit and soft loans.
7. Aqua-cultural regulations should be written in simple and comprehensive languages for the practitioners to follow easily to ensure sustainable productivity.
8. On a global perspective, the UN-FAO (department of fisheries) should ensure strict compliance to set aquaculture and fishery regulatory standards for nations to follow. This should focus on ways to support sustainable and environmentally safe aquaculture practices to guarantee the best possible populations of harvestable fish for future generations.

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