International Scholars Journals

African Journal of Fisheries Science ISSN 2375-0715 Vol. 12 (2), pp. 001-007, February, 2024. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Review

Maximizing profitability and environmental sustainability through integrated fish farming in Nigeria

Gabriel, U. U.[1], Akinrotimi, O. A.[2], Bekibele D. O. [2], Anyanwu, P. E.[2] and Onunkwo D.N. [2]

[1]Department of Fisheries and Aquatic Environment, Rivers State University of Science and Technology, Nkpolu, Port Harcourt, Nigeria.

[2]African Regional Aquaculture Centre/Nigerian Institute for Ocenography and Marine Research, P.M.B. 5122, Port Harcourt, Nigeria.

Accepted 17 July, 2023

The population of people living in Nigeria has risen tremendously in recent years with its corresponding increase in demand for food. Thus, there is the need for a suitable agricultural system to meet this increasing demand and also maximize the utilization of the available limited resources without much wastage integrated fish farming offers hope in this direction. This system of farming was introduced into the country some years back, its uniqueness, lies in the fact, that it has capability of combining fish culture with live stock and crop production. Its economic benefits in the enhancement of food production and self sufficiency are thoroughly discussed. Its significance in making various types of food available all the year round as well as making farmers self reliant and occupied most time of the year sets it apart from all other systems of farming. Its ecological importance which are often overlooked by farmers i.e. manure loading, nutrient cycling and productive capacity of ponds, are critically analyzed. This ecological consideration is of paramount importance in integrated fish farming in that it allows recycling, and maximum utilization of resources without wastage. Suggestions, therefore, have been made on how integrated fish farming can be ecologically sustained.

Key words: Integrated, fish, economic, ecological, farming Nigeria.

INTRODUCTION

Hunger and malnutrition remain amongst the most devastating problems facing the world poor and needy (FAO, 2002). About 80 to 90 million people have to be fed yearly and most of them are in the developing countries. The most reliable source of protein for many is fish, yet millions of people who depend on fish are faced daily with the fear of food shortage (World fish center, 2003). With the population of Nigeria on the rise, there is a corresponding demand for fish consumption (Table 1). Thus, there is the need for a suitable agricultural system to meet the increasing demand for food, and also maxi-mize the utilization of the available limited resources with-out much wastage. In view of this, integrated fish farming fit exactly into this. Integrated fish farming is a diversified and coordinated way of farming with fish as the main tar-get (Ayinla, 2003) along with other farm products. The items produced are to be used either as a source of feed, fertilizer or source of additional income (Chen, 1989). Considering the relevance of integrated fish farming in the livelihood of every segment of the Nigerian population in the provision of food, employment opportunities and recirculation of waste for maximum utilization, this paper critically reviews the economic and ecological benefit of integrated fish farming.

Important socio-economic factors in integrated fish farming

In Nigeria Integrated fish farming has been reported in many states of the federation in which 50% of fish far-mers integrate, poultry, piggery or livestock with fish pro-duction, while integrated fish cum crop production is on the rise also in several states (AIFP, 2005). According to Asala (1994) the essence of integrated system is produc-tivity of fish as to meet the challenges of food shortage

*Corresponding author. E-mail: ugwemg@yahoo.com. Tel: +2348032720882.

Table 1. Nigerians projected population and estimated demand for fish (1991 - 2010).

Year	Projected Population (million)	Per Caput Consumption- (kg)	Projected Fish Demand (million Tons)
1991	88.5	11.0	973500
1992	90.36	11.0	993960
1993	92.36	11.0	1014420
1994	94.08	11.0	1034880
1995	95.94	11.0	1055340
1996	97.08	11.0	1075800
1997	99.66	11.0	1096260
1998	101.52	11.0	1116720
1999	103.38	11.0	1137180
2000	105.24	13.0	1368120
2001	107.10	13.0	1392300
2002	108.96	13.0	1416180
2003	110.82	13.0	1440660
2004	112.68	13.0	1464840
2005	112.54	13.0	1489020
2006	116.40	13.0	1513200
2007	118.26	13.0	1537380
2008	120.12	13.0	1561560
2009	121.98	13.0	1585740
2010	123.84	13.0	1609920

Source: (FDF) 1994.

and reducing the unemployment rate in Nigeria. Socio-economic conditions should be considered when developing integrated fish- farming systems. The development of a diversified economy depends on the harmonious interactions between socio-economic conditions, agricultural productions and regional environmental conditions (Huazhu and Boatang, 1989)

In any part of the country the type and level of integration depends on the prevalent environmental conditions, social norms, cultural values and religious factors. For example in the northern part of the country, fish cum pig integration is not advisable because of religions factors. The agricultural enterprise to be combined and their level of intensity determine the type of integration fish culture can be extensive, semi-intensive or intensive. The semi-intensive earthen pond fish culture is the most suitable integrated aquaculture system because of the natural ecosystem that can conveniently accommodate both crop and livestock production (Ayinla, 2003). Apart from market forces, demands for agricultural products should be put into consideration before establishing any integrated farming enterprise in any area.

Systems of integrated fish farming

In Nigeria integrated fish farming is carried out mainly at subsistence level (Nnaji et al., 2003). Ibiwoye et al.(1996) found out that out of 254 fish farmers sampled in the country only 46% did any form of integrated fish farming. Integrated fish farming can be practiced under different systems depending on the production function which largely depends on finance, and the level of integration to be engaged in The common types of integration that are being practiced in Nigeria are as follows:

Fish cum poultry farming

Poultry- fish farming is the integration of poultry animals like chicken, duck and geese with fish farming (Tokrisna, 1995.) The most common practice in Nigeria is fish cum chicken, which is widely practiced because of its profitability. Birds raised for egg (layers) or the one that are raised for meat (broilers) can be integrated with fish farming. This will reduce the cost of inputs, such as fertilizer and feed, so as to maximize profits (Asala, 1994). The poultry house can be constructed inside and raised over the pond or beside the pond as the case may be. The excreta from the birds serve as manure, which fertilizes the pond or the fish can feed on them directly. It will be more ideal and better if the poultry house is raised over the ponds that is, vertical integration, allows easy transportation of manure to ponds thereby maximizing the usage of the land. The poultry house will be cleaner, as the excreta falls directly to the ponds.

Fish cum pig farming

Pig farming is widely practiced across the southern and middle belt of Nigeria, offers the farmer a husbandry which is easier than chicken farming. It has good returns. (AIFP, 2005) The pig is a highly prolific animal and its combination with fish not only increase economic efficiency, but also increase its ecological efficacy as wastes, residues, and left over from kitchen, aquatic plants are often used as pig food. The excreta in turn are used as organic manure in fish ponds. Farmers practicing pig cum fish farming may benefit from up to 28% - 30% economic advantage over normal pig farming (AIFP, 2005), Ansa and Jiya (2002) recorded an impressive performance in the culture of *Oreochromis niloticus* using pig manure not only as source of fertilizer but as source of feed.

Fish cum crop production

This is the cultivation of agricultural crops (e.g. vegetables and arable like maize, rice etc) and aquatic plants (like water spinach, water chestnut, aquatic weeds like *Pistia*, duckweed, water hyacinth, *Azolla* etc) with fish farming (Nnaji et al., 2003) . The common practice in fish cum crop production in the country is in cultivation of fish with rice, and vegetables. This is widely practiced among the farmer in the rural areas, at subsistence level. The vegetables, like water leaf and spinach among others are

Table 2. Doses of manures required for maximum growth of cultured fish.

Animals	Animals/ha of fish pond	Fresh manure (Kg/adult/day)	Maximum manure loading (Kg/ha/day)
Pigs	30-3000	5 for 100kg pig	150
Chickens	1000-4000	0.15 for 1.5 kg bird	150-600
Ducks	750-3000	0.2 for 2 kg bird	150-600

Source: STOAS 1993.

planted on the dykes, while in the case of rice; it is planted right inside the pond. The crops derive water and nutrients from the fish ponds while the crops serves as food, especially for herbivorous fish. Besides, periphytons on the crop may enhance yield of cultured fish species (Miarana et al., 1995; Nnanji et al., 2003) Table 2.

Economic benefit of integrated fish farming

The economic benefit of integrated fish farming cannot be over-emphasized since the integration is varied and diversified in nature. It is one of the most viable, reliable and profitable of any farming enterprise. It contributes immensely to the economic empowerment of many families especially in the rural communities. It enables the farmer to be productive all the year round and fully maximize its production. Its contribution in the enhancement of food security and self sufficiency is highlighted below:

Food security

Nigeria is one of the developing countries affected by hunger, deprivation and abject poverty by its citizenry inspite of its enormous natural and human resources (Alamu et al., 2004). With the prevalent economic situation in the country, there is the need for farmers to engage in a result oriented farming system that will guarantee and sustain adequate food security. The supply of proteinous food in Nigeria is very expensive, a problem that needs to be tackled very seriously, considering the limited available resources. Integrated fish farming offers hope in this direction as it serves as food-production base that combines cultivation of crops, rearing of livestock and fish farming. The scope of integrated fish farming can be considerably wide. The fish farm supplies not only enough fertilizer to produce a large quantity of fish, but also produces meat, milk, eggs, vegetable, etc as it fully utilizes the water body, the water surface, the land and the pond silt to increase the food available for human consumption.

Self sufficiency

Integration is suitable for poor farmers with remarkably low expenditure pattern and continuous low spending for food and other dietary requirement (Ayinla, 2003). The varied nature of an integrated fish farm make more jobs available than in unitary system of fish farming (Huazhu and Baotony, 1989). The system is all encompassing as the time is well utilized in other farming activities depending on the type of integration involved. In fish cum crop production, crops like the vegetables are harvested continuously even in dry season as water from the pond is used to water the farms adequately. The farmers are engaged in one farming activity or the other throughout the year thus, making them self reliant and productive all year round.

Regular source of income

Integrated fish farming provides the farmer with a steady source of income all year round; this comes from various farm products. For example, in poultry-cum fish farming before the harvesting of the fish, which may take some months, the farmer can sell the eggs which will generate money for some time. Apart from this, money can also be generated from the vegetables or the crops that may be combined in the integrated fish farming. This corroborated the submission of Nnaji et al. (2003) that integrated fish farming is more profitable than unitary system of farming.

Ecological importance of integrated fish farming

Sustainable agriculture depends upon eco- friendly culture system for its survival (Dhawen and Kaur, 2002). One of the appealing features of integrated farming is that it leads us to view farms in terms of interdependent compo-nents (Dalsgaard, 1995). Integrated farms are comprised of different ecosystems (Conway, 1985) that can be described, modeled, analyzed and compared; they are gui-ded by principles, and the parts that make them up and the way these parts are related (Altieri, 1987). In any inte-grated system, the interrelationships are many; crop by-products are fed to animals, while fish and animal manu-res are returned to the crops and fish in the ponds. The fish may feed on insects and weed in the rice field plan-ted inside the pond and this in turn can increase the avai-lable nutrients to the crop (Dalsgaard, 1995).

The ecological efficiency of an integrated fish farm is very paramount to the success of the entire farming enterprise, this is discussed below.

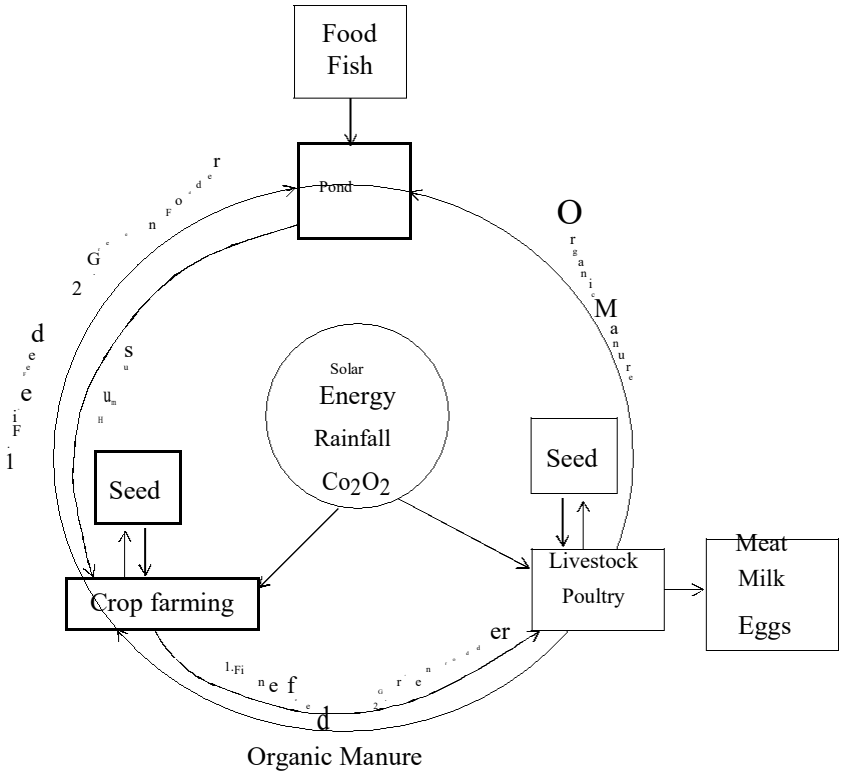

Figure 1. Recycling of material in a well managed integrated fish farm Source: NACA Technical Manual 7 (1989).

Manure loading

Manure loading in integrated fish farming basically comes from poultry and other farm animals, which contain considerable quantities of nutrients for fish production. Protein content from manure ranges between 10 – 30%, energy between 110 - 1400 kcal per kg manure with synthesized soluble vitamins in high concentration (Praff, 1975; Tuleun, 1992). It also contains non digested feed. Metabolic excretory products and residues resulting in microbial synthesis which can be utilized to replace reasonable parts of feed stuff used in conventional fish production cost (Falayi, 1998; Fashakin et al., 2000). According to Yingzue et al. (1986) the effect of manure produced in integrated fish farming depends on the species of the animal involved. It is observed that the manure added to fish ponds as feed give better result than fertilizing the pond and also vary in their efficiency to produce fish biomass (Ansa and Jiya, 2002). According to Otubusin (1983) the number of farm animals should be directly related to the manure loading that the fish would require. The quantity and composition of the resulting organic manure varies with feed, age and total live weight of the farm animal. Smitherman and William (1977) reported on the benefit of manure in the production of benthic organisms, and indicated also, that *tilapia* hybrid ingests manure directly. However the indiscriminate use of these manure in fish ponds instead of improving the pond productivity, may also lead to pollution (Asala, 1994; Otubusin, 1986; Arboleda, 1992) . Therefore, it is necessary to know the standard doses of these wastes which would keep the physicochemical parameters of pond water in a favorable range required for the survival and growth of fish.

Nutrient cycling

The re-cycling of organic wastes for fish culture serves the dual purpose of cleaning the environment (by avoiding the problem of waste disposal) and providing economic benefits (Nash et al., 1980; Oladosu et al., 1990). This is important to sustainable aquaculture, and also reduces expenses on feed and fertilizer to a large extent. The calculation of bioresource flows diversity is the first step in determining the approximation of cycled biomaterials within the agroecosystem (Dalsgaard, 1995). Bioresource flows here refers to the by products which are available to the farmer for re- use within the farm. The important thing in bioresources flows is their direction and closing of mineral regardless of the volume and their number. In the extreme case, all flows may be unidirectional into one particular field or pond (Schroeder, 1980). In such a case, the extent to which resources are efficiently recycled cannot be adequately expressed (Fin, 1980). For effective cycling of nutrients in an integrated fish farm, the farm must be well managed, (Figure 1) tak-

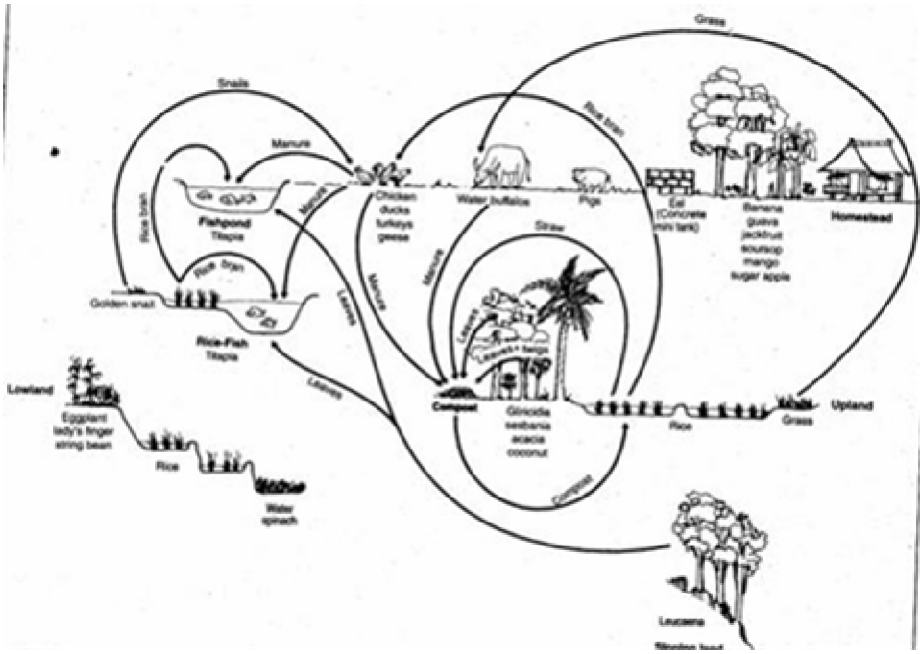

Figure 2. Bioresource flow model of an integrated aquaculture farm. Source: Dalsgaard et al. (1995).

ing into cognizance the type and level of integration involved.

In aquaculture animal waste has been recycled as fertilizer for centuries with the aim of promoting pond productivity of phyto-and zooplankton (Velasquez, 1980). Due to the short digestive tract of poultry, 80% of chicken manure represents undigested feed stuffs with as high as 20-30% been total protein ((Chen, 1989). In targeted poultry cum fish farming, the protein rich chicken dropping is made available to the fish either directly or indirectly via the primary producers in the aquatic food web (Oladosu et al., 1990), which in most cases reflects the productive capacity of the ponds (Figure 2).

Productive capacity of ponds

The biological productivity of any aquatic body is generally judged through the qualitative and quantitative estimation of planktons, which form the natural food of fish (Ahmed and Singh, 1989) . Animal wastes lead to increased biological productivity of ponds through various pathways, which result in increase in fish production (Orhibhabor and Ansa, 2006) . Productive capacity refers to the biomass produced in kg/ha, thereby measuring "net community production" of the system (Dalsgaard, 1995). This capacity reflects the quality of the underlying soil and the quality of the pond water; it also depends on the nature of the manure involved. According to Singh (1996), the nature of manure affects the community structure of plankton. In a given ecosystem the ratio of biomass supported per unit of energy flow (B/E ratio) determines how mature the system is (Odum, 1989) this reflects the ability of the system to convert available energy into something useful.

Ecological sustainability of integrated fish farminig

The sustainability of ecological parameters in any agro ecosystem is very important in determining the success of the farming venture. The Broundtland Commission (WCED, 1987) defined sustainable development as the ability to meet the needs of the present without compromising the ability of the future generation to meet their own needs. Some forms of integrated aquaculture development have caused severe social and environmental impacts (Pullin et al., 1995; Black, 2000). The degraded state of most aquatic ecosystems combined with public concerns about adding "new" sources of aquatic pollution to the already overburdened ecosystems will require aquaculture to develop new ecosystem approach and sustainable operating procedures (Akpan and Okafor, 1997). Poorly managed integrated systems usually have high nutrient loading leading to deleterious effect of cyanobacterial bloom (Pearl and Turker, 1995). Cyanobacterial bloom is undesirable in aquatic ponds because they are relatively poor aquatic food base. They are poor oxygennators of pond waters with undesirable growth habits, some species produce odorous metabolites and impact undesirable flavour to the cultured fish species while others produce compounds that are toxic to aquatic animals (Osuji et al., 2003). These and other reasons call for serious attention to the ecological sustainability of integrated fish farming.

However, ecologically sustainable aquaculture is the

development of aquatic farming systems that preserve and enhance the forms and functions of the natural and social environments in which they are situated (Pierce, 2002). It involves realistic ecological approaches that will develop aquaculture production techniques for various integration systems, by using local resources effective recycling of wastes and materials that can degrade natural ecosystems and proper planning for job creation and marketing strategies that will be widely accepted as meeting both economic and ecological considerations (Costa Pierce, 1992).

Conclusion

Integrated fish farming varies from one area to another in terms of production combination, rates and sizes. It is more profitable than unitary system of farming as it ensures a spread of financial risk for its varied and diversified nature in rearing of fish, animals and crops; it has a capacity of making more food available thus enhancing food security and creating more jobs for the teeming unemployed masses in the country. Before this potential can be fully realized, its ecological importance must be taken into consideration, as this will dictate the pace for effective management that will lead to its maximum yield. Clear and explicit linkages between aquaculture and the environment must be defined and the complementary role of aquaculture in contributing to environmental suitability must be developed and made known to all stakeholders in aquaculture industry for effective and efficient ecological management which will in no time facilitate optimum yield.

REFERENCES

Ahmed SH, Signh AK (1989). Correlation between antibiotic factors of water and zooplanktonic communities of a tank in Patra, Bihar. In proceedings of National Seminar on forty years of Fresh water Aquaculture in India, Central Institute of Fresh water Aquaculture, Bhubneshwar. pp. 119-121.

AIFP (2005). Farming Nigeria waters Newsletter of the Aquaculture and Inland Fisheries project of the National special Programme for food security in Nigeria. FAO Office Abuja, Nigeria. 3(4): 2-4.

Akpan ER, Okafor N (1997). On organic fertilization and plankton development in two experimental fresh water ponds. Nigeria. J. Aqua. Trop. 12: 147-154.

Alamu SO, Abiodun JA, Miller JW (2004). Food Security and Poverty Alleviation Under the National special Programme for food security: A. preliminary socio-economic assessment of Yamama Lake, Kebbi State: In P.A Araoye (ed). Proceedings of the 19th fisheries Society of Nigeria Conference. pp. 149-162.

Altieri MA (1987). Agro ecology the scientific basis of alternative agriculture. Intermediate Publications London. pp. 45-48.

Ansa EJ, Jiya J (2002). Effect of pig Manure on the growth of Oreochromis niloticus under integrated Fish cum-pig faming system. J. Aqua. sci. 17 (2): 85-87.

Arboleda CR (1992). Integrated livestock – fish production system in the Phillippines;,In: Mukherjec, T.K et al. (eds). Proceedings FACT/IPT workshop on integrated liivestock-fish production systems (Kuala, Lumpur, Institute of Advances studies University of Malaysia, Kuala Lumpur. pp. 95-100.

Asala G (1994). Principles of Integrated Aquaculture. In: AA Olatunde;

Ayinla OA (2003). Integrated fish farming: Averitable tool for poverty alleviation/Hunger eradication in the Niger Delta Region. In A.A Eyo and J.O Atanda (eds). Conference Proceedings of Fisheries Society of Nigeria, Owerri, Nigeria. pp. 40-41

Black KD (2000). Environmental Impacts of Aquaculture C.R.C Press Boca Raton Florida. p.36.

Chen FY (1989). Chicken Farming in integrated fish farming Regional Aquaculture, Center Wuxi China. NACA Technical Manual. 11: 4-30.

Conway GR (1986). Agro ecosystem analysis for research and development, Winrock International, Bangkok, Thailand. pp. 14-16.

Costa Pierce B.A. (2002). Farming Research and Extension Methods for the development of sustainable aquaculture Eco-system. Ecological Aquaculture CRC Press Boco Raton Fl. pp. 103-123.

Costa Pierce BA (2002). Farming Research and Extension Methods for the development of sustainable aquaculture Eco system. Ecological Aquaculture CRC Press Boco Raton Fl. pp. 103-123.

Dalsgaard JPT, Light foot C, Christensen V (1995). Towards quantification of ecological sustainability in farming systems analysis. Ecol. Eng. 4: 181-189.

Dhawen A, Kaur S (2002), Pig dung as pond manure effect on water quality, pond productivity and growth of crops in polyculture systems. ICLARM (25:11): 11-14.

Falayi BA (1998). Inclusion to poultry manure in a complete ratio for *Tilapia O. niloticus* fingerlings. Project submitted to the dept. of fishers and wild life fed unit tech Akure. In partial fulfillment OF P.GD Awards in Wild Life and Fisheries. pp. 14-17.

FAO (2002). Food and Agriculture publication, Year Report 2002. FAO Rome. pp. 1-6.

Fashakin EA, Falayi BA, Eyo AA (2002). Inclusion of poultry manure in a complete feed for *Tilapia O. niloticus* fingerlings. J. Fisheries Technol. 2: 51-56.

FDF (1994). Federal department of fishery 1994 statement based on 1991 population census. FDF Report 1 (6): 14-16.

Fin JT (1980). Flow analysis of models of the Hubbard brook ecosystem. Ecology 61: 62-571.

Huazhu Y, Baotony (1989). Integrated fish farming in China, Naca Technical Manual Bangkock, Thailand. pp. 153-209.

Ibiwoye TII, FC Okoye, PUA Okojie G, Opeloye PA Iyoinyoon, PS Omachonu (1996). Integrated laying chicken-cum-fish culture system NIFFRI Annual Report 1996. pp. 32-36.

JSO Ayeni, IM Ogun Suyi (eds). Proceedings of the National Fisheries workshop on aquaculture development, fish seed production and post harvest tech. NIFFRI-FACU, 1994. pp. 206-220.

NACA (1989). Integrated Fish Farming in China. A World Food Day publication of the Network of Aqcentres in Asia and the Pacific. Bangkok, Thailand. p. 278.

Nash E, Collins FH, Brown J, Carol M (1980). A Theoretical comparison of waste treatment processing ponds and fish products ponds receiving animal wastes. In: R.S.V Pullin and Z.H. Shehadeh (eds). Integrated Agriculture- Aquaculture farming system ICLARM-SEARCH Manila, Phillipinnes. pp. 87-97.
Nigeria . NIFFRI, New Bussa. pp.16-76.

Nnaji CJ, Okoye FC, Ogunseye JO (2003). Integrated Fish Farming practices with special reference to combination rates production figures and economic evaluation In: AA Eyo, JO Ayanda (eds). Conference proceedings of fisheries society of Nigerian (FISON) Owerri 8th-12th December, 2003. pp. 173-178.

Odum HT (1989). Self organization transformation and information:
Ecol. Sci. (242): 171-181.

Oladosu GA, Ayinla OA, Onuoha GC, Mecdom JG *(1990).* Performance of Clarias gariepinus in a polyculture with Orechromis niloticus under the integrated broiler chicken fish farming. NIOMR Technical/paper p. 65.

Oribhabor BJ, Ansa EJ (2006). Organic waste reclamation, recycling and re-use in integrated fish farming in the Niger Delta. J. Appl. Sci. Environ. Mgt. 10 (3): 47-53.

Osuji CN, Alfred Ockiya J, Chinda AC (2003). Dominance shift of phytoplankton in relation to different organic fertilizer treatment in *Clarias Gariepinus* Culture. In: AA Eyo, JO Ayanda (eds). Conference proceedings of fisheries society of Nigeria (FISON). Owerri 8th-12th December, 2003. pp. 62-66.

Otubusin SO (1986). Pronosed integrated guinea fowl cum fish culture

in lake Kaiinji. In: JSO Ayeni (ed). Helmited guinea fowl (NMGP) in
Pearl HW, Tucker OS (1995). Ecology of blue green algae in aquaculture ponds. J. World Aquacult. Soc. 26 (2): 109-131.
Pratt PF (1975). Utilization of Animal manure and sewage Sludges in food and fiber production. Never form the council on Agric. Sci. Technol. 3 (3): 23- 25.
Pullin R, Rosuthal H, Mclean JC (1995). Environmental and aquaculture in developing countries *ICLARM* conference processing 31 KLARM, Manilla Philippines.
Schroeder GL (1980). Fish farming in manure loaded ponds. In: R.S.V Pullins H, Ziad; and T Schehadeh (eds). Integrated Agriculture-Aquaculture farming systems. ICLARM–SEARCH, Manila, Philippines. pp. 73-86
Singh AK (1996). Investigation on the effect of pig manure on growth and survivability of Indian major crop and exotic carps spawn in nursery a pond pp.6-8. In the fourth Indian fisheries forum. pp. 24-28.
Smitherman RO, William JC (1977). Production of Tilapia Hybrids with cattle manure as diet in fish culture. Oxford University Press Oxford pp. 43-54.
STOAS (1993). Integrated fish farming in the tropics Book 1 Aquaculture volunteered in Thailand foundation for the development of Agricultural Education and training Wageniga Netherland. pp. 40-42.
Tokrisna R (1995). Integration of Agriculture, livestock and fish farming in Thailand. *In* JJ Symoens and JC Micha (eds). *RAOS*/CTA/FAO Seminar Proceedings 1995. pp. 245-263.
Tuleum CD (1992). The utilization of heat treated poultry manure in chicks diets. Paper presented at the 17th annual conference of the N.S.A.P Abuja 23RD – 27TH March, 1992. p. 8.
Velasquez CC (1980). Health constraints to integrated animal fish farming in the Philippines. In: Rogers S.U, Pulins and Zrad H (eds). Integrated Aquaculture farming systems ICLARM- 58A RCA Manilla Philippines. pp.103- 111.
WCED World Commission on Environmental and Development (1987). Environment our common future. Oxford University Press Oxford. pp. 1-4.
World Fish Centre (2003). Fish an issue for every one: A concept paper for fish for all Summit. p.10.
Yingzue F, Xianzten G, Jikun W, Xiuzherg F, Zhinyna L (1986). Effect of different animal manure in fish farming.. In: Maclean, JL, Dixon LB, and Hosillos LV (eds). First Asia Fisheries Forum. The Asian Fisheries society, Manila, Philippines. pp .117-120