Livestock wastes: fish-wealth solution

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Abstract

A review of the use of livestock wastes for sustainable fish wealth creation was done, using information from literature and field survey. Livestock wastes including animal manure and poultry by-products, which are a menace to the environment, are sources of wealth creation in fish farming. In Nigeria, about 932.5 metric tonnes of manure is produced annually from the well established livestock industries which keep expanding at the rate of 8% year-1. Nigeria is the largest importer of frozen fish in the world with a fish demand of between 106,200–128,052 MT year-1. This situation calls for increased fish production which can be achieved through the effective utilization of livestock wastes. Livestock wastes are rich source of nutrients. Integration with fish farming makes livestock wastes assets in production. Properly treated animal manure can serve as organic fertilizer/feed component for enhancing fish farming profitability and reduction of Green House Gas (CHG) emission. Poultry by-products such as livestock offal, feather meal, housefly (Musca domestica) maggots from droppings can form part of fish feed ingredient. Research has shown that properly managed fish cultured under the integrated chicken-fish farming system are fit for human consumption. In Nigeria, integration of livestock with fish farming has lead to efficient resources utilization including labour, feed, land space, reduction on investment risk through diversification, income generation, family food source, employment opportunities and conservation of environment due to waste management.
Keywords: wastes, zooplankton, fertilizer, feed, fish, menace, assets, livestock, maggot, integration.

WIT Transactions on Ecology and the Environment, Vol 145, © 2011 WIT Press
www.witpress.com, ISSN 1743-3541 (on-line)
doi:10.2495/WRM110711

1 Introduction

Fish plays an important role in the diet of the people of Nigeria. Fish and fishing contribute immensely to the national economy by providing high animal food protein and generating employment. The need for fish protein has been emphasized with the projected population of 88.50-106.71 million and a population growth rate of 3% yr-1. Nigeria is the largest importer of frozen fish in the world with a fish demand of between 106,200-128,052 metric tonnes year-1 from 1991-2000 and a fish per caput consumption of 12kg [23]. Feeding of formulated feed to fish is extravagant for the resource-poor Nigerian farmer. This has therefore called for sustainable aquaculture feed development. Such package must, as of necessity, include integrating fish farming with other agricultural production as livestock. Such integration involves the recycling of livestock wastes and processing by-products as manure and/or direct food for fish. In Nigeria, the effectiveness of cow, chicken and pig manure as a direct fish feed has been tested in a variety of fish such as Oreochromis niloticus [5, 6] and Clarias gariepinus [9]. This study is a review of the use, profitability in fish production and a means of reducing greenhouse gas (GHG) emissions. The emerging challenges of climate change and its associated impacts, such as rise in temperatures, increased degradation of land and forest ecosystems, biodiversity loss, variable rainfall patterns and poor air quality, continue to undermine the provision of vital basic ecosystem services on which many African economies depend. Agriculture directly contributes 13.5% to the global GHG emissions. The use of chemical fertilizers alone contributes 8%. Poultry wastes in urban areas are often a major cause of litigation, apart from the associated public health problems. Using all or part of such wastes as fish feed and production of organic fertilizer will encourage increase in urban poultry farming.

2 The menace of livestock wastes

In Nigeria, about 932.5 metric tonnes (MT) of manure is produced annually from the well established poultry/livestock industries which keep expanding at 8% yr-1 [1]. As shown in Table 1, it has been reported that a layer produces an average of 161g of droppings/bird day-1 [2]. This large turnout of wastes from poultry, piggery, cattle rearing etc encourages the growth of microbes, attracts houseflies, constitutes health hazard to man, animals and thus become a menace to the environment. The droppings readily produce maggots when not cleaned or mixed with litter. Litter materials itself becomes wet and a nuisance when its moisture content exceeds 30% and temperature is below 100ºC. Such wet litter materials provide a suitable medium for the growth of Aspergillus and Coccidia which cause aspergillosis and coccidiosis respectively in chicks [14]. In this wet condition, ammonia in the litter increases. A continuous exposure of birds to a 20ppm ammonia concentration reduces feed intake, growth, egg production and predisposes chicks to Newcastle disease and air sacculitis [14].

Table 1: The average weight and unit weight of droppings of layers in a stair-case type battery cage.

Feed type	Av. wt of feed (g/bird day-1)	Vol. of water (ml/bird day-1)	Av. wt of droppings (g/bird day-1)	Unit wt. of droppings (kg /m^3)
Growers' marsh	125	500	160. 5	1.20
Layer's march	135	540	161. 5	1.20

3 Livestock wastes as assets

Integration with fish farming makes livestock wastes assets in production. Livestock wastes are rich source of nutrients. The digestive tract of a chicken is very short, only six times its body length. Therefore, some of the eaten foodstuffs are excreted by the chicken before being fully digested. Research has shown that about 80% (dry weight) of feedstuff is utilized and digested by the poultry thus making 20% available to the fish in an integrated fish cum poultry culture system. Nitrogenous manure inputs in ponds clearly influence the pond water productivity as it supplies the plankton with essential nutrients needed for the multiplication and growth life food organisms which are the natural food for the newly hatched baby fishes [17].

Table 2: Percentage proximate constitution (dry matter) of chicken excrement.

Constituents	**Cage on fish pond**	**Ground Raising**	**Dry grass/sawdust bedding**
Moisture	11.4	12.3	15.5
Crude protein	26.7	21.9	22.3
Crude fat	1.7	1.7	2.3
Nitrogen-free extract	30.6	30.0	27.1
Crude cellulose	13.0	17.2	18.7
Minerals	16.5	16.9	14.1

Source: [12].

Experiments conducted in open ponds, (the fish having access to the feed pellet decay products) gave results such that feeds containing as high as 30% manure produced fish growth equal to the growth obtained with conventional fish feed pellets. High pond water productivity and comparatively high yield has been reported for tilapia fish cultured in manured ponds [3, 4] (Table 3). It was observed that the growth of the fish cultured in manured ponds compared favourably with those fed with commercial pellet. Though the yields from manured ponds are significantly lower than pellet-fed ponds, yet the profitability of the former was higher since manure is available at a nominal cost. In all cases, the use of such organic wastes resulted in large increases in the yield of fish per unit area of the pond and sharp decrease in the use of supplementary feeds, an indication that Tilapia can achieve reasonable growth under fish-cum-pig integration without addition of supplementary feeds. The mechanism of manure-fish recycling is illustrated in Fig. 1 [8]. The origin of this cycle lies in the mineral nutrients of water which come from soluble substances, carried to the water by exogenous detritus (animal waste) and also by rain-fall.

Table 3: Growth rates and yield of Oreochromis niloticus in pig-manured and formulated diet-fed ponds.

Growth parameters	**A**	**B**	**C**	**D**
Daily grass rate (g/day)	0.25	0.22	0.27	0.30
Average weight in stocking (g)	6.26	7.53	8.00	8.35
Specific growth rate (%/day)	0.81	0.67	0.76	0.79
Average weight in 70days	3.46	22.61	26.9	29.68
Yield in 70 days (Kg/ha)	246	237	287	318

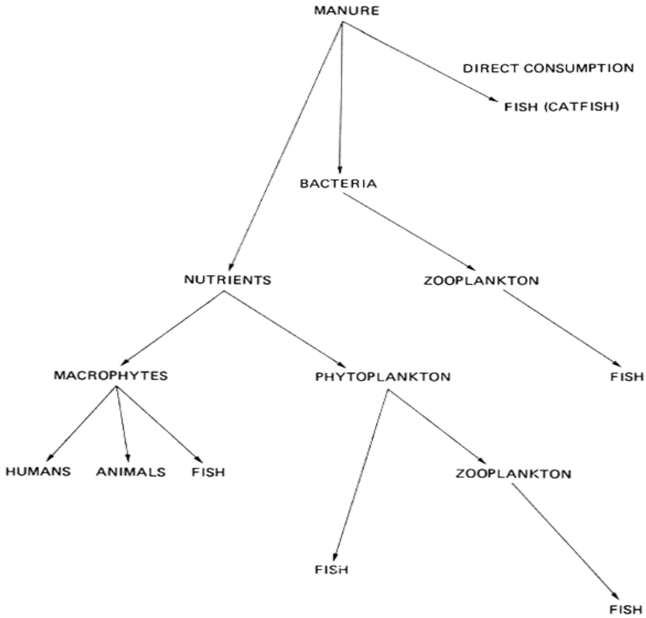

Figure 1: Manure-fish recycling.

By means of photosynthesis, the green vegetation transforms these inorganic substances into organic matter which forms vegetable tissue (higher and lower plants). Living or dead, the plants are consumed by numerous small animal organisms. These then serve as food for larger water animals (and also certain type of vegetation) which are in turn; both living or dead; eaten by fish.

Reduction is brought about by bacteria. Bacteria, by a mineralization mechanism, permits the return in solution of all dead components of organic matter – vegetable and animals, and their re-integration into the biological cycle. Fish is ultimately a beneficiary of the complex biological cycle. The productivity of a fish pond depends, in the final analysis, on the production of vegetation which in turn is dependent on the nutrients found in the pond. The vegetable growth of the fish pond can thus be increased by introducing animal manures.

Furthermore, while picking the feedstuffs, the chicken scatters 10% of their food, and these, drop directly for fish consumption. Usually, good chicken feedstuff have a protein content of over 18% and the total protein content of dry chicken excrement is between 10–30% (Table 2), energy between 1100–1400 Kcal kg^{-1} manure and soluble vitamins are synthesized in high concentration [20]. Metabolizable energy in cow and chicken manure is reported to range from 600–800 and from 900–1200 Kcal/kg for conventional feed pellets [21] and 3,000-4,000 Kcal/kg for zooplankton. Use of livestock wastes in fish culture thus has a synergistic effect and is profitable [5, 6]. Battery system of raising poultry on fish pond makes maintenance and management easy and economical while it also helps in the production of ‘clean’ eggs [24].

3.1 Poultry by-products

Poultry by-products such as livestock offal, feather meal, housefly (Musca domestica) maggots from droppings can form part of fish feed ingredient. Maggots are readily available and are accredited for its high nutrient value with an amino acid profile with biological value exceeding that of soybean and groundnut. This organism can be harvested, processed into a meal that can be used to substitute or replace fishmeal like some other non-conventional feedstuffs such as periwinkles, frog etc. It was reported that 25% replacement of fishmeal in feed of hybrid catfish culture with maggot gave growth and profitability comparative to that of fishmeal-based diet [22]. Maggots are readily available in Nigeria poultry houses. It is thus a no waste, low cost and low energy production system in which the by-products of one enterprise is recycled into another as input.

Ponds A, B = pig manure as feed source; Ponds C, D = formulated fish diet (combination of ox -blood and wheat bran). Source: [3]

3.2 Other benefits of integration

Other benefits of integration of livestock with fish farming are efficient resources utilization including labour, feed, land space, reduction on investment risk through diversification, income generation, family food source, employment opportunities and conservation of environment due to waste management [10, 16]. Livestock integrated culture system is quite compatible with the earthen pond culture, which in Nigeria, is the most economic fish farming system particularly in the rural areas. The fish farm supplies not only 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.

It has thus been established that well treated animal manure can serve as organic fertilizer and feedstuffs in fish ponds while maggots, livestock offal, bones and feather meal can form part of fish feed ingredient in earthen ponds without affecting the taste, meat quality of the fish. Integration also increases the profitability of fish farming. Other benefits of integration of livestock with fish farming are efficient resource utilization and conservation of environment due to waste management.

4 Fish pathology and quality

Research has shown that fish cultured under the integrated chicken-fish farming system are fit for human consumption. Pathological examination of such fish prior to harvest showed that they are not infected by any micro-organism that could render them unfit for human consumption [19]. Also, it was observed that the nutrient content of the fish fed on pelleted fish diet is not better than for fish fed on chicken manure. Analysis of the fat content of approximately 100 carps grown on manure, grains and on fish meal-enriched pellets showed fat concentrations of 6%, 20% and 15% respectively [9]. There is no significant difference in the taste and texture of flesh of fish grown in manured ponds and those fed commercial diets. Allen and Hepher (1979) reported that fish from ponds receiving well-treated domestic wastes taste as good, or, even better than fish grown in waste-free ponds with good flesh colour and intramuscular fat-levels [11].

Poorly managed integrated systems however, usually have high nutrient loading, leading to deleterious effect of cyanobacterial bloom [18]. Cyanobacterial bloom is undesirable in aquatic ponds because they are relatively poor aquatic food base and poor oxygenators 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 [15].

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