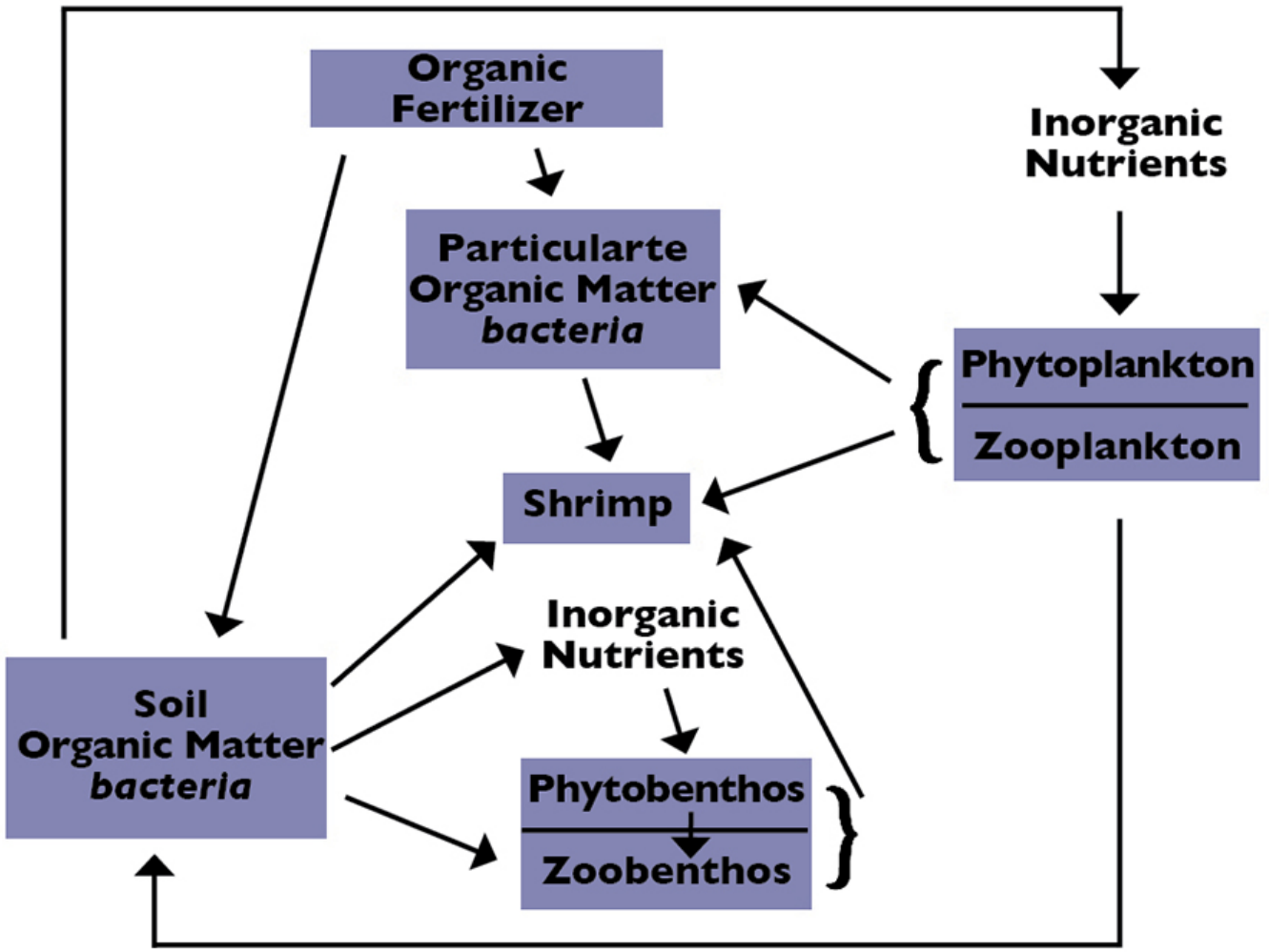
Organic matter for pond fertilizer

1 September 2011 Claude E. Boyd, Ph.D.

Agricultural byproducts important for small-scale farmers in developing countries



Organic fertilizers decompose and release carbon dioxide, ammonia nitrogen, phosphate and other nutrients to promote the growth of phytoplankton and enhance the food web in ponds.

Animal manures, grasses, agricultural by-products and other types of organic matter have been widely used in many countries as fish pond fertilizers and, to a lesser extent, to fertilize shrimp ponds. Plant and animal meals are sometimes applied to nursery ponds and production ponds for high-valued species during the first weeks of culture. Some shrimp farmers also apply molasses, an immediately available carbon source that can rapidly increase bacterial activity. This practice is especially common in heterotro-phic floc systems.

Major role

The primary role attributed to organic fertilizers is that of decomposing and releasing carbon dioxide, ammonia nitrogen, phosphate and other nutrients to promote the growth of phytoplankton and enhance the base of the food web – the same role of chemical fertilizers such as urea, triple superphosphate, ammonium phosphate, etc. However, particles of organic matter serve as surfaces for growth of microorganisms.

This phenomenon enhances the protein content of particles, and zooplankton and other aquatic animals, including some aquaculture species, consume the nutritionally enriched particulate matter directly. Plant and animal meals can serve directly as food for postlarval or juvenile stages of some culture species.

Composition

The typical range in composition of major types of organic fertilizers (Table 1) reveals that these materials have much lower concentrations of nitrogen, phosphorus and potassium than those found in chemical fertilizers. Moreover, manures are not constant in composition like commercial chemical

fertilizers.

Boyd, Nutrient composition of organic fertilizers, Table 1

	Nitrogen (%)	Phosphorus (%)	Potassium (%)
Animal manure	0.50-1.40	0.20-1.30	0.50-1.20
Agricultural by-products (rice hulls, grass)	0.25-2.50	0.03-0.70	0.40-2.60
Black-strap molasses	0.50	0.20	3.50
Plant meals (soybean, cottonseed, corn)	1.50-7.00	0.50-2.50	0.30-2.30
Animal meals (fish, bone, blood, meat scraps)	2.10-12.00	0.60-28.00	0.10-1.00
Chemical fertilizers	15-45	20-48	44-60

Table 1. Nutrient composition of organic fertilizers for aquaculture ponds.

They vary in composition with the composition of the diets provided to the land animals from which they came, as well as with the length of time and conditions under which they were stored. Grasses and agricultural by-products also vary greatly in composition depending upon their origins. Plant and animal meals and molasses have relatively constant compositions.

Application rates

A large amount of organic matter must be applied to achieve the same nutrient input possible with a much smaller amount of chemical fertilizer. For example, 1 kg of triple superphosphate is equal in phosphorus content to 230 kg of fresh dairy cattle manure. Just 1 kg of urea is equal in nitrogen to 90 kg of this manure.

This leads to two problems. High application rates of organic fertilizers are required to provide desired nutrient inputs, and an elevated demand for dissolved oxygen occurs when organic fertilizers decompose. The total oxygen demand of organic matter is roughly 2.7 times its organic carbon content, but the rate that organic matter decomposes – and removes dissolved oxygen from water – is related to the carbon:nitrogen (C:N) ratio of the material. The lower this ratio, the more intense the oxygen demand.

The C:N ratios of plant and animal meals, which decompose quickly, are typically 5-20:1. Application rates greater than 25 kg/ha/day could lead to dissolved-oxygen depletion in non-aerated ponds.

Manures, grasses and agricultural by-products usually have greater C:N ratios and decompose more slowly. Nevertheless, because high application rates are typically used, materials with a high C:N ratio can also cause a high oxygen demand. Because animal manures, grasses and agricultural by-products vary greatly in composition, it is not possible to recommend a safe, maximum daily application rate. However, daily application rates reported in the literature seldom exceed 50-60 kg/ha dry weight. Of course, for a manure with 80 percent moisture content, 250 kg/ha would be necessary to provide 50 kg/ha dry weight.

Results from the literature for four typical studies of fertilization with animal manures in non-aerated shrimp and tilapia ponds (Table 2) showed that manures can lead to comparable or greater shrimp and fish production than that achieved with chemical fertilizers. However, the use of feed can increase production far beyond that possible with manures.

Boyd, Results reported in studies of pond fertilization, Table 1

Fertilizer (Amount)	Production (kg/ha)
Shrimp – Study 1	
Chicken manure (4,500 kg/ha/crop)	262
Cow manure (4,500 kg/ha/crop)	218
Control (no manure)	160
Shrimp – Study 2	
Fresh cow manure (1,800 kg/ha/week)	
5 postlarvae/m^2	950
10 postlarvae/m^2	1,700
15 postlarvae/m^2	1,860
20 postlarvae/m^2	1,750
Tilapia – Study 3	
Dairy cow manure (1,020 kg dry matter/ha/week)	1,626
Chicken litter (500 kg dry matter/ha/week)	2,075
Inorganic fertilizer (10-20-0 – 140 kg/ha/week)	1,513
Tilapia – Study 4	
Inorganic fertilizer (108 kg nitrogen and phosphorus/ha/crop)	1,109
Fresh cow manure (19% dry matter at 28,380 kg/ha/crop)	1,646
Fish feed (3,520 kg/ha/crop)	2,660

Table 2. Results reported in studies of pond fertilization with organic matter or chemical fertilizers.

Advantages

There are several advantages of organic fertilizers. They can serve directly as food for both zooplankton and zoo-benthos, eliminating the lag period between primary and secondary production that occurs in chemically fertilized ponds. Bacteria growing on organic particles not only increase the nutritional value of the particles, but also remove potentially toxic ammonia from water for use in synthesizing bacterial protein.

Organic fertilizers often are available from other agricultural activities on family farms in developing countries, but if they must be purchased, they usually are cheap in comparison to chemical fertilizers. Moreover, utilization of organic fertilizers in aquaculture is ecologically desirable, because it results in waste recycling.

Disadvantages

The disadvantages of organic matter as pond fertilizer sometimes outweigh the advantages. The problems of low nutrient content, high application rate and elevated oxygen demand have already been mentioned, but there are several other issues.

Organic fertilizers may not be available nearby, and transport of the large amounts of organic material needed to fertilize ponds is expensive. Soil quality may be impaired by organic matter that settles to pond bottoms. Fibrous, organic particles can be sites for growth of macrophytic algae that compete with phytoplankton for nutrients. Humic compounds in manures, especially grasses and other plant residues, can inhibit phytoplankton growth through direct toxicity, and discoloration of the water by these compounds can interfere with light penetration and photosynthesis.

Off-flavor in fish and shrimp may result from odorous compounds in manure or produced by actinomycetes, a filamentous bacteria, growing on it. Manures often have a high trace metal content that possibly could lead to increased trace metal concentrations in the culture species.

Antibiotics used in land animal production have occasionally been passed from manure to fish or shrimp. It also is likely that many consumers would not like to know that their aquaculture products were produced in ponds treated with animal waste. This fear is compounded by the idea that human wastes may be used to fertilize fish ponds in a few countries.

Safety precaution

As a food safety precaution and to avoid possible consumer dissatisfaction, the use of animal manures as organic fertilizers should be discouraged when resulting aquaculture products are intended for export. Of course, animal manures that have been composted for several months before application to ponds would be more acceptable than fresh manures for production of export products. Nevertheless, manures, grasses and agricultural byproducts are extremely important for use in ponds to produce fish for family use and domestic markets by small-scale farmers in developing countries – especially in Asia and Africa.

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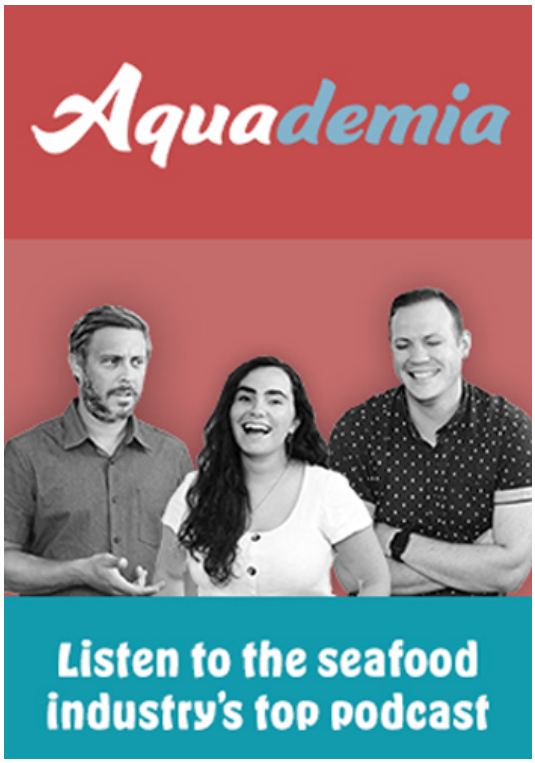

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