

Farm-made Feeds: Preparation, Management, Problems, and Recommendations

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Abstract

Making feeds exclusively for certain farming activities is quite common in the tropics particularly in the farming of fishes that feed low in the food chain. Feed preparation will depend on several factors such as availability of feed ingredients, capital, labor, type of feed, size of farm, etc. Management procedures will also depend on factors such as frequency of feeding, capital, labor force, farming system, and availability of electricity in the area. Some problems in the use of farm-made feeds are the limited knowledge of pond dynamics, interaction between supplementary feeds and natural food organisms, quantification of the contribution of natural food to the nutrition of the fish, and quality of feed ingredients. Farm-made feed formulations, processing, and feeding management as well as future research and training approaches with reference to the needs of small-scale fish farmers as recommended by FAO are discussed.

Introduction

The Food and Agriculture Organization of the United Nations (FAO) /ASEAN - EEC Aquaculture Development and Coordination Programme (AADCP) Regional Expert Consultation on Farm-Made Aquafeeds held in Bangkok, Thailand in 1992 defined farm-made feeds as feeds in pellet or other forms, consisting of one or more artificial and/or natural feedstuffs, produced for the exclusive use of a particular farming activity and not for commercial sale or profit (New *et al.* 1993). In the tropics, farm-made feeds are usually prepared for semi-intensive rather than intensive farming systems (Tacon and De Silva 1993). Semi-intensive systems require fertilizers and/or supplementary diets as inputs in addition to the natural food in the ponds. Except probably for snakehead and catfish, most warmwater fishes are farmed by the extensive and semi-intensive methods while shrimps are farmed

intensively. However, there has been a shift towards semi-intensive methods in shrimp production because this culture system has been found to result in yields comparable to those obtained with high quality feeds (Akiyama 1993). Farmers also consider semi-intensive culture less risky, thus making life less stressful for them.

New and Csavas (1993) noted that only 10% of fish production in Asia use commercial feeds, the other 90% use farm-made feeds. Freshwater, non-carnivorous fishes account for 80% of total aquaculture production in Asia, all of which depend on farm-made feeds (New and Csavas 1993). Many of the species cultured using farm-made feeds are low-value crops like carp and tilapia for local markets rather than for export (Yakupitiyage 1993). This is also true for catfish (*Clarias* spp.) and snakehead (*Channa striatus*) which are intensively cultured in Thailand.

The economic viability of farm-made feeds is place- and time-specific. A fish farmer has to consider several factors in his choice of farm-made feeds (Tacon 1988, 1993). These are 1) market value of the cultured species; 2) financial resources; 3) farming traditions; 4) time available for the farming activity; 5) availability of labor services; 6) feed ingredient availability and cost; 7) feeding habit; 8) feeding behavior and nutrient requirements; 9) water quality requirements of fish; and 10) feeding cost per unit of production per unit time. Farm-made feeds are more economical for farms with access to inexpensive feed materials; however, the quality and quantity of their feed materials cannot be easily controlled. Feeds prepared from such materials, whether moist or dry feeds, will also vary in quality resulting in unpredictable and unmanageable fish production. Because of the uncertain availability of fish meal due to overfishing and competitive demand as livestock feed, alternative sources of non-fish meal protein sources should be explored. One of the alternatives is to use locally available ingredients (Chong 1993).

A farmer will have to decide whether to make his own feeds or buy commercial feeds. In many instances, he finds it more convenient to use commercial feeds because of lack of capital to invest on equipment or unavailability of feed ingredient. The small-scale farmer may opt to make his own feeds when feed ingredients and a large labor force are available. Only the basic equipment for grinding ingredients into a fine powder and forming the feed are needed.

Feed Preparation

Proper processing of feedstuff can result in a nutritionally adequate feed that will satisfy the feeding behavior of the fish and will not pollute the water. Farm-made feeds may contain one or more ingredients processed by cooking or grinding. There is no one formulation. The formulation will depend on the cost and availability of raw material. Preparation of farm-made feed, especially for carps and tilapias, is simple. Snails are crushed and leaves are chopped. If dry ingredients are used, they are ground well and dispersed throughout the pond. If a carbohydrate source is used, it is cooked and mixed with the other dry ingredients. A wet or moist dough may be extruded or pelleted using a meat grinder.

Catfish and snakehead are fed an 8:2 trash fish:rice bran mixture or an 8:1:1 trash fish:rice bran:broken rice mixture for fattening. The mixture is hand-mixed and minced. The resulting slurry is fed to fish in ponds until satiation (Jantrarotai and Jantrarotai 1993). Catfish can also be fed poultry viscera, fish gills, kitchen refuse and stale bread. Majority of farm-made feeds for catfish are moist, comprising a variety of unconventional raw materials like tofu waste, chicken bones, instant noodle waste and green mustard waste.

In Bangladesh, farmers improvise the equipment and make feeds by hand. Locally made sieves are used to sift the ingredients (Zaher and Mazid 1993).

In Cambodia, there is no commercial feed production. Most of the farm-made feeds are prepared daily and fed moist to catfish, tilapia, silver carp, and snakehead. Rice bran is cooked with water in large open vat until a dough is obtained. Cooked dough is cooled, rolled into small balls and fed to fish (Nuov and Nandeessa 1993).

The equipment needed to prepare feeds depends on the raw materials available and the method of processing feeds (Wood 1993). In many instances, farmers use their hands and feet as basic tools for size reduction and blending, or a ladle or spade and a basin or trough depending on the quantity of feed being prepared. A farmer has also several options on the equipment that he can use depending on his financial capability. But, he might find farm-made feeds impractical compared with commercial feeds.

Commercial feeds are drier and have longer shelf life than farm-made feeds containing local raw materials that are not well-processed. Agricultural by-products are sometimes insufficient for commercial purposes but can be used for farm-made feeds (Wood 1993). It is important that the feed is water stable to prevent pollution and is in a form that stimulates feed intake.

Management

Feeding practices using farm-made feeds are simple. Feed is broadcasted along the periphery of the dike and in the middle of the pond. Buckets, baskets, sacks and other containers may be used. In large farms, farmers use small paddle boats to broadcast the feed.

Feeding strategy is largely based on available feed ingredients. In Cambodia, fish are fed rice bran and broken rice during the first two months (Nuov and Nandeessa 1993). On the third month and onwards, second-class rice bran is fed. Feeding is done generally during the cool hours of the day from a boat. Fresh or dried fish, if available, is fed in addition to uncooked rice bran.

In the Philippines, fish is not fed during the first two to four weeks. In the case of milkfish, supplemental feed may be given when lab-lab growth is sparse and/or has collapsed due to heavy rains. Rice bran and other bakery products may be fed two to four weeks prior to harvest by broadcasting. Few farmers use mechanical devices or automatic feeders.

A mixed feeding schedule can result in yields similar to those fed nutritionally optimal diets. Sumagaysay (1991) noted that milkfish yield can be increased by using a low protein diet (23.8%) given at a lower rate (1.75% of body weight). The feeding rate, however, is gradually increased as biomass increases. Up to 50% substitution of fish feed with rice straw compost is possible without affecting fish growth and yield. Sumagaysay and Borlongan (1995) also showed that regardless of dietary protein level (24 or 31%), growth and yield are much higher when fish are fed at 4% than at 2% body weight. De Silva *et al.* (1989) suggest feeding low protein and high protein diets alternately to tilapia to reduce the cost of feeding. Because two diets have to be made, Yakupitiyage (1993) suggests that feeding fish at different rates - one low, the other high - may be more suitable than two different feeds.

In the polyculture of cyprinid in India, feeding bags are suspended at several locations and are perforated at the bottom (Nandeesh 1993). Feeding bags with holes may also be used.

In Thailand, feeds are shovelled into the ponds (Jantrarotai and Jantrarotai 1993). Feeding rate depends on visual observation and fish are fed once per day at 1500-1700 h. Calculated FCR is 3.6 and cost is US \$0.12 to 0.24/kg. The quality of feeds is more important for snakehead than for catfish. Snakeheads are fed fresh trash fish thrice a day; a minced fish is fed solely to fry *ad libitum*. Rice bran may be used as supplemental feed. Trash fish, chicken offal (heads, bones and legs), and rice bran may also be mixed at 7:2:1 proportion and shovelled into a mincer. Feed is formed into strands and placed in a 2 x 0.5 m platform. Feeding platforms are suspended along both sides of a wooden pier.

The catfish, *Pangasius larnaudii* and *P. sutchi* are reared in cages and are fed trash fish only once every two or three days. Small fish are spread on cage surface and allowed to rot because farmers believe catfish will voraciously eat spoiled fish. When there is no trash fish, rice bran is used.

More on-farm feeding trials will have to be conducted to compare various feeding strategies.

Problems

Ingredients are often available seasonally, and the supply and quality are inconsistent. Thus, quality of farm-made feeds also vary with season. In addition, many of the nutrients may have been lost during handling and processing.

There is lack of knowledge on nutrient composition and digestibility especially of non-conventional feeds. The use of non-conventional feeds as real alternatives to conventional feedstuffs has been questioned (Cho 1993). However, some non-conventional feeds used thus far can support fish growth in ponds.

Many of the fishes fed farm-made feeds cannot efficiently utilize carbohydrates and preferentially use protein and fat for energy. The use of oil seed meals and cereals in farm-made feeds increases demand for the ingredients and causes competition

with human food and livestock feeds (Tacon and De Silva 1993). In contrast, seed meals and cereals can substitute fish meal and other animal protein sources in supplementary feeds for semi-intensive culture.

Tudor *et al.* (1994) noted that it is feasible to grow tilapia (*Oreochromis niloticus*) on farm-made feeds that contain fish meal substitutes. The diets have balanced amino acids, and contain corn gluten meal and distillers dried grains as protein sources. Protein content ranges from 32-36%, but the diets cost 35-40% lower than that of diets with fish meal.

Recommendations

The nutrition and feeding of fish and crustaceans in semi-intensive pond systems is very complex and still poorly understood (Tacon and De Silva 1993). The contribution of natural food in the "nutritional budget" of most pond-raised fish or crustaceans has not been quantified.

The FAO/AADCP Regional Consultation in 1992 (New *et al.* 1993) recognized that farm-made feeds have significant environmental advantages. In addition to agricultural by-products and agro-processing wastes, other alternative protein sources that are both inexpensive and sustainable have to be utilized. FAO/AADCP consultation recommended the following:

1. Recognizing that farm-made feeds can utilize locally available ingredients, simple and cheap methods of increasing their nutritional value for fishes and crustaceans should be developed, with particular reference to digestibility, removal of toxic substances, and palatability.
 - the development or improvement of simple and cheap machinery for farm-made feed production should be encouraged, bearing in mind the needs of small-scale farmers and;
 - improved techniques for on-farm processing and storage should be developed. Government institutions should be able to help the inventors of simple machinery and capital should be made available to them with less constraints.
2. Considering that farm-made feeds, whether for intensive aquaculture (e.g., marine fish in cages or snakehead in ponds) or for semi-intensive systems (such as pond culture of freshwater prawns), feed advisers should formulate feeds based on:
 - locally available ingredients and their quality;
 - the nutritional requirements of the specific farming system rather than mimicking commercial feed specifications and;
 - the minimal use of vitamin premixes, binders, and other expensive ingredients to maximize cost effectiveness.

3. Bearing in mind that profitability in small-scale aquaculture can be improved with feeding strategy rather than with perfect dietary composition, research should focus on:
 - feeding frequency;
 - methods of feed presentation, including high-protein feeds, two-component systems (e.g., alternation of feeds of different feeding rates);
 - biomass assessment of the cultured species;
 - reduction of feed wastage in the farming enclosure and during manufacture and storage and;
 - farmer-friendly sensory methods of assessing ingredient quality.

4. In view of the need to train farmers in simple formulation of feeds and ingredient choice, aquafeed processing, storage and on-farm feed management:
 - village-level trainings should be organized in local languages;
 - instructional videos developed and;
 - simple booklets prepared (e.g.. the FAO "Better Farming", a training manual for farmers and trainers that can easily be translated into local languages).

Tacon and De Silva (1993) recommended some basic research like pond dynamics for the semi-intensive and integrated farming systems. Knowledge in this area could enable farmers to regulate their feed inputs.

The farmers should be alert with regard to the type and quantity of feed used and to the natural food supply in the pond. Feeding must not be excessive. Farmers also need to keep good records.

Polyculture is appropriate for producing low-value fish or when feeds are not available (Milstein 1992). Financial risk can be minimized with enough knowledge on the qualitative relationships between fish themselves or between fish and the environment. To encourage small fish farmers to make their own feeds, the cost must be low and its quality comparable to commercial feeds (Chong 1993).

Farm-made feeds are becoming widely accepted in semi-intensive culture in the tropics and that optimal use of indigenous feed resources is the most appropriate economic and biological approach (Tacon and De Silva 1993). However, there are many farming practices that do not have sound scientific rationale, but these do not preclude their credibility. Gaillard (1991) as quoted by De Silva (1993) noted that there is reluctance in the scientific community to accept new concepts especially if they originate from third world countries. In truth, there are still many unknowns in our knowledge and understanding of feeds and feeding of fishes especially in the semi-intensive culture system.

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Review of SEAFDEC/AQD Fish Nutrition and Feed Development Research

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Abstract

Research on fish nutrition and feed development at SEAFDEC Aquaculture Department has focused on three major areas: nutrient requirements and their interrelationships, digestive enzymes and digestibility, and practical feed development for important species such as milkfish (*Chanos chanos* Forsskal), sea bass (*Lates calcarifer*), Nile tilapia (*Oreochromis niloticus*), bighead carp (*Aristichthys nobilis*), and tiger shrimp (*Penaeus monodon*). Early studies on the nutrient requirements were mainly on protein, lipid and carbohydrate. Studies on essential amino acids and fatty acids, and optimum protein:energy ratio in the diets for cultured species were conducted later. Likewise, requirements for other essential nutrients in shrimps, like phospholipid and cholesterol, were studied. Dietary calcium and phosphorus required to prevent soft-shelled shrimps were determined. Requirements for water-soluble vitamins and bioavailability of stable forms of vitamin C were evaluated. Little is known of the vitamin and mineral requirements.

The major digestive enzymes in milkfish have been studied. The apparent digestibility of common feedstuffs were determined *in vivo* and *in vitro* for milkfish and tiger shrimp, and presently, for sea bass. Development of cost-effective practical feed continues to be a major research undertaking at SEAFDEC/AQD. Diet refinement emphasizes on use of inexpensive and indigenous materials in diet formulations. The feasibility of using legumes, leaf meals, and agricultural by-products and wastes as feed components has been demonstrated. Feed and feedstuff quality control and proper processing techniques were found to improve the nutritional value of low-grade raw materials. Improved feeding techniques and practices have been pursued to minimize feeding costs. Studies on the effect of feeds on the environment are being initiated. Economically feasible grow-out diets for semi-intensive culture of milkfish, Nile tilapia, and tiger shrimp, and diets for broodstock and larvae of these species have been developed.

Introduction

The thrust of the SEAFDEC Aquaculture Department's Feed Development Section is to develop cost-effective fish and shrimp diets for the industry. To achieve this goal, research studies on nutrient requirements and nutrient interrelationships are conducted to provide baseline data for practical diet development and refinement. Considerable effort has been made to determine the nutrient requirements of important aquaculture species: milkfish (*Chanos chanos*), tilapia (*Oreochromis niloticus*), sea bass (*Lates calcarifer*), and shrimp (*Penaeus monodon*). In practical diet development, the primary concern is nutritionally-balanced and low-cost feed that makes use of inexpensive, indigenous feed ingredients. Research efforts are also geared towards a simple and appropriate feeding technology affordable to the small-scale fish farmers.

Highlights of research on nutrition and feed development conducted at SEAFDEC/AQD are reviewed. A similar review was presented earlier (Millamena 1993) during the Aquaculture Workshop for SEAFDEC/AQD Training Alumni held on September 8-11, 1992 and updated to include more recent work for purposes of this seminar-workshop.

Milkfish

Nutrient requirements

Milkfish juveniles require 30-40% protein, 7-10% lipid, 25% carbohydrate, and digestible energy of 2,500-3,500 kcal/kg diet. A protein to energy ratio of 44% is optimal for milkfish. The ten essential amino acid requirements of milkfish have been established (Table 1). The requirements correlate well with milkfish tissue levels except lysine, leucine, tryptophan, and valine wherein the levels required are lower than those present in milkfish tissues. In the formulation of a diet for milkfish, the use of tissue amino acid profile as reference may result in disproportionate amounts of dietary lysine, leucine, tryptophan, and valine, and sub-optimal growth rates (Borlongan and Coloso 1993).

Milkfish cultured in seawater require n-3 polyunsaturated fatty acids. Good growth and survival were obtained using either linolenic acid (18:3n-3) or n-3 HUFA as lipid sources (Borlongan 1992). Preliminary studies on mineral requirement of milkfish juveniles are being conducted.

Digestive enzymes and digestibility

The major digestive enzymes in milkfish are: carbohydrases, proteases, and lipases while cellulase is absent (Chiu and Benitez 1981; Benitez and Tiro 1982; Borlongan 1990). Milkfish reared in ponds rely mostly on filamentous algae and cellulosic plant materials for food. Cellulase activity in milkfish is probably derived from the gut microflora. Milkfish proteases have two well-defined pH optima, one