FEED FORMULATION AND FEEDING PRACTICES IN FISH CULTURE

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ACKNOWLEDGEMENT

A key feature of scientific (technical) bulletins is that they usually contain information that are put together from different sources to address a subject matter. For this bulletin, the works of various authors was consulted in order to present fairly documented information that is simple to farmers in the art of fish feeding. These sources of information are referenced and duly acknowledged.

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Bolorunduro P.I.

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1.0 Introduction

Fish food consists of natural food and artificial (supplementary) feeds. When fish have balanced diet to eat, they grow fast and stay healthy. In natural waters and well-fertilized ponds, microscopic plants (phytoplankton), microscopic animals (zooplankton), insects, crustaceans, copepods and molluscs are examples of natural foods.

When natural foods are not available in sufficient quantities to provide adequate nutrition for fish growth, feeds that are manufactured or grown outside of the fishpond may be fed at regular intervals (daily, weekly, etc.). These feeds supplement natural foods. They are not nutritionally complete, and will not adequately support fish growth in the absence of natural foods. Natural food organisms in the water will provide essential nutrients. In the absence of natural foods, nutritionally complete manufactured feeds that contain all essential nutrients must be fed to fish. This is applicable to commercial oriented fishfarms or high technology based culture systems. Some examples of supplementary feeds that are acceptable to fish are commercially produced rations for chickens and pigs. Rice brans, cassava leaves, kitchen refuse, oil seed cakes or other agricultural products and by products. These are used in extensive or semi-intensive culture system.

Artificial feeds are well-compounded mixture of feedstuffs and can be in mash or pellets form that could be fed to fish. Mash feeds are good for fries and pellets (0.8m-1mm) for fingerlings, juveniles (2mm-3mm)and adults (4.5mm) depending on pellet sizes. Although the use of artificial feeds may be costly, especially the commercially compounded ration, they have the following advantages in fish culture:

1. Enable high stocking density (stocking maximization) especially in Polyculture system.
2. They promote faster growth of fish, since food will al ways be available.

3. High fish yield is guaranteed relative to the stocking density.
4. Uneaten artificial feeds in the pond water will be biologically degraded. This acts as fertilizer to promote plankton growth.
5. A fish farmer while feeding the fish can study the behavior of fish and monitor their health.

Generally in fish culture, the major factors affecting fish growth are stocking rate, stocking density, the water temperature, the quantity (adequacy) and quality of feeds, and the feeding method and frequency. It can therefore be seen that foods and feeds availability and the feeding practices used by farmers will determine to a large extent the success or otherwise of a fish culture enterprise. Recommended dietary crude protein (CP) requirements for fast and healthy growth of fish vary with fish species. Generally requirements are:- semi-intensive culture with natural foods (20-25%CP), intensive culture for fingerlings (40-48%CP) and juveniles/adult fish in intensive culture (30-35%). The dietary protein requirement of some locally cultured fish species are shown in Table 1.

2.0 Feedstuffs in Fish Culture.

Feedstuffs are classified into major groups in fish culture - energy feedstuffs and protein supplements.

1. Energy Feedstuffs.

These are feedstuffs containing less than 20% crude protein. They are essentially of plant origin. Examples are cassava, wheat offal, rice bran, maize, guinea corn, etc.

2. Protein Supplements.

These are feedstuffs containing 20% crude protein or more. They are made either of plant or animal materials. Protein of animal origin are of higher quality than those of plant origin. Examples of animal protein sources in fish culture are

fish meal, bone meal, blood meal, etc. Soybean meal, groundnut cake and cottonseed cake are some examples of plant protein materials.

A wide range of local feedstuffs such as agricultural by-products, animal meals, and on farm products are available in Nigeria for farmers to utilize in fish culture (**Table 2**). The conversion ratio in Table 2 presents the dry weight of feed needed to produce one unit wet weight of fish. A low conversion ratio means that fish will convert the feed into flesh more efficiently. High ratios indicate less efficient conversion. For example it takes about 4 to 6kg of ground maize, but 10 to 20kg of cassava peel to produce 1kg of fish flesh.

Table 1: Dietary Protein requirements of some locally cultured fish species

	Local Names			
Fish	Ibo	Yoruba	Hausa	%Crude Protein requirement.
Tilapia (*Oreochromis niloticus)* Fry Fingerlings Juveniles Adult	Ikpopo	Epere	Tarfasa	 50-55 35 - 40 30 - 35 25 - 30
Catfish (*Clarias gariepinus*) Fry Fingerlings Juveniles	Alala	Abori	Tarwada	 50 - 55 40-45 35-40
Catfish *(Heterobranchus bidorsalis*) Fry Fingerlings Adult	Echim	Aro	Ramboshi	 50 -55 42 - 45 35 - 40
Common Carp *(Cyprinus Caprio*) Fry Fingerlings Juveniles Adult				 50-52 38 30-35 25-30
Grass Carp (*Ctenopharynglo n idella*) Fry Fingerlings Juveniles Adult				 50 41 - 43 30 25

Source - NIFFR Extension Guide Series No. 4

Table 2: Nutrient Composition of some local feedstuffs and expected conversion ratio of feed to fish flesh

Feedstuffs	% Protein	%Fat	%Fibre	%Carbo-Hydrate	%Dry Matter	%Mineral	Conversion Ratio
Maize (white)	9.3	5.0	2.4	70.9	88.0	1.8	5
Maize (Yellow)	10.8	3.6	3.5	71.2	88	1.9	5
Guinea Corn	11.2	2.5	2.3	74.1	88	1.8	5
Palm kernel Cake	19.1	7.6	43.2	17.9	-	5.5	8
Cotton Seed Cake	40.1	8.3	31.9	12.4	91	5.1	5
Rice Bran/Husk	9.9	4.4	40.2	8.7	91	21.8	5
Groundnut Cake (Industrial)	48.0	13.2	8.1	18.9	93	6.3	5
Groundnut Cake (Kulikuli)	40.6	23.4	6.0	19.0	93	6.2	5
Raw Soyabean	40.7	22.0	6.3	16.6	90	6.4	4
Soyabean Meal (toasted slightly)	46.2	24.8	4.7	17.2	90	7.9	4
Soyabean Meal (toasted severaly)	48.1	23.9	4.1	20.7	90	7.9	4
Fish Meal (Tilapia)	57.7	1.8	5.2	-	92	33.6	2
Clupeid (large size)	71.3	8.0	1.1	-	92	20.2	2
Clupeid (Small size)	68.5	8.0	0.4	-	92	17.8	2
Cow Blood Meal	86.0	0.7	2.1	6.5	92	5.0	2
Millet	9.0	5.0	0.7	83.2	90	2.3	5
Flour Mill Sweepings	12.5	14.5	7.5	58.0	-	-	-
Brewers Waste	22.8	17.8	18.8	46.4	93	-	10
Cassava (Peeled)	2.6	0.5	0.4	94.1	88	2.4	18
Cassava (peels only)	5.3	1.2	21.0	66.6	88	6.0	18
Cassava (Unpeeled)	2.7	0.5	3.1	91.0	88	2.7	18
Cassava leaves	14.7	8.4	15.6	45.2	88	16.1	18
Mucuna	28.5	0.7	9.5	57.2	91	4.0	4
Water leaf	21.1	1.5	10.3	87.4	-	4.6	-

Source - Compiled from various sources.

3.0 Choosing the Feedstuffs.

Single feed ingredients may be fed to fish to supplement available natural food in a pond. However, combining ingredients may make better quality supplemental feed. Fish would grow well on a feed containing 20 to 30% crude protein, of which 7 to 10% of the protein is from animal sources. When natural food is abundant and fish are stocked at low densities, a 20 to 25% protein content is suitable. A 30% or more crude protein content is more suitable for commercial operations where fish are stocked at higher densities.

From **Table 2,** it is possible to choose a feed mixture of desired protein level when preparing supplemental feed. Two simple methods can be used to determine how much of a selected ingredient should be used for making a fish feed with a desired crude protein content. These are discussed below:

3.1 Trial and Error Method

To chose a combination of ingredients that will provide a feed containing between 25 to 30% crude protein (from **Table 2).**

Ingredient	*Amount of Ingredient (kg)*	*% Crude Protein*
Rice bran	40	9.9
Brewer Waste	20	22.8
Soyabean meal	28	46.2
Fish meal	12	57.7
Total	100	

Note: To calculate the required % CP in feed, E.g Rice bran $= \frac{40 \times 9.9}{100} = 3.96)4.0$

This feed would contain 28.4kg of crude protein if 100kg of the listed ingredients were combined as indicated. This would make a feed containing approximately 28% crude protein by weight since

$\frac{28.4kg}{100} \times 100kg = 28.4\%$ protein content.

3.2 Pearson's Square Method.

This method may be used for two or more feed ingredients and is preferable to the trial and error method. Examples of feed formulations with two and more ingredients are shown.

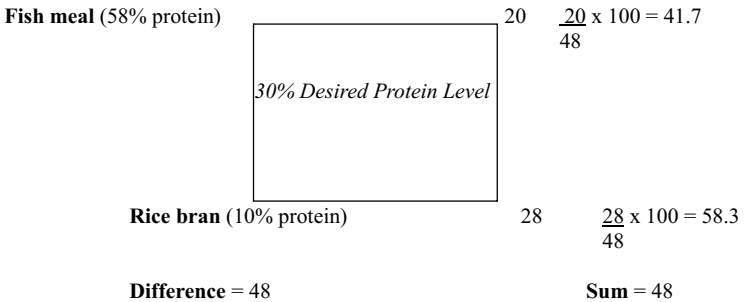
Example 1: - Two Ingredients.

Find the proportions of rice bran and fish meal (Tilapia) required to make a feed containing 30% crude protein. For ease of calculations the %CP figures are rounded up e.g. 57.7 = 58.

1. Draw a square (see Pearson's Square 1 Diagram)
2. Place the desired protein level at the center of the square. In this case, 30%.
3. Place the two ingredients on the two left corners of the square along with the protein content of each.
4. Calculate the difference in crude protein content of the two ingredients (58 and 10) and record this number (48) near the lower left corner of the square.
5. Subtract the desired protein level (30%) of the feed from the protein content of each ingredient. Ignore positive or negative signs. The difference between percentages of protein in rice bran and in the feed (20) represents the amount of fish meal needed. The difference between fish meal and the feed (28) represents the amount of rice bran needed.
6. Add the differences obtained at the right corners of the square (20 and 28) and record their sum (48) near the bottom right corner. The sum in the right corner should equal the difference in protein content recorded near the lower left corner of the square.

7. Divide the differences obtained in step 5, which were 20 and by 28 by the sum obtained in step 6, which was 48 and then multiply each by 100 to obtain the percentage of each ingredient needed for the feed.
Thus, 42kg of fish meal and 58kg of rice bran are combined to make 100kg of fish feed containing 30% crude protein. The feed can also be described as being composed of 42% fish meal and 58% rice bran.

Pearson's Square 1 Diagram



Example 2: - Three or more ingredients

In this example, find the proportions of soybean meal cake, fish meal, yellow maize and brewers waste needed to make a fish feed with a 30% crude protein content.

1) Draw a square and place the desired protein level (30%) at the center of the square. (Pearson's Square 2 Diagram).
2) Group the ingredients into energy sources (crude protein less than 20%) and protein supplements (crude protein greater than 20%).
3) Calculate an average for the crude protein (CP) contents of each group of ingredients (Table 1).

Protein Supplements:

Fish Meal	=	58%CP
Soybean Meal Cake	=	46%CP
Total	=	104%CP
Average: 104÷2	=	52%CP

Energy Sources:

Yellow Maize	=	11%CP
Brewers Waste	=	23%CP*
Total	=	34%CP
Average: 34÷2	=	17%CP

* Note that Brewers waste has a slightly higher crude protein content as an energy feedstuff.

4) Place the averages obtained above at the left corners of the square.

5) Calculate the difference in crude protein content between the protein supplements and energy sources and record this near the lower left corner of the square. The answer in this case is 35.

6) Subtract the desired protein level (30%) of the feed from the combined protein content of the protein supplements and energy sources and place the difference in the opposite diagonal corners. Ignore positive or negative signs. Results are 22 and 13, respectively for the protein supplements and energy sources.

7) Add these differences and record the sum near the lower right corner of the square. In this case, the answer is 35 on the left and 35 on the right side.

8) Divide the left side sum (35) into each difference obtained in step 6 (13 and 22) and multiply by 100 to calculate the percentage of protein supplement and energy source needed for the feed. The respective answers are 37% and 63%.

9) One half of the protein supplement (18.5%) is provided by fish

meal and one half is provided by soybean oil cake. One half of the energy sources (31.5%) is provided by yellow maize and one half is provided by brewer's waste meal.

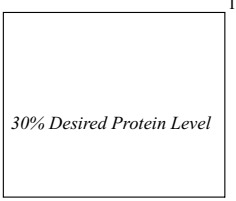
Thus, to make 100kg of fish feed containing 30% crude protein from a combination of ingredients including fish meal, soybean meal cake, yellow maize and brewer's waste the following proportions would be mixed

Fish	18.5kg
Soybean meal cake	18.5kg
Yellow Maize	31.5kg
Brewer's Waste	31.5kg

Pearson's Square 2 Diagram

Protein supplements:

(*Fish meal + Soybean cake*) = 52%



13% $\frac{13}{35} \times 100 = 37\%$

Energy Sources:

(*Yellow maize + Brewers waste*) 17%

22% $\frac{22}{35} \times 100 = 63\%$

Difference: 35 **Sum**: 35

4.0 Supplementary feed Formulation

For a successful fish feed formulation, a fish farmer must be acquainted with the following information:

4.1 Nutrient requirement of the fish.

Essential nutrients required by fish include

1. Protein and amino acid - for body building, growth main tenance and reproduction.
2. Carbohydrates - for needed energy in body activities.

3. Fats and fatty acids - for energy and normal body functioning. Lipid also function as sparing nutrient for protein synthesis.
4. Vitamins and minerals - for growth maintenance and reproduction.

4.2 Nutrient Composition of Feedstuffs

These are either energy feedstuffs or protein supplements. Refer to **Table 2** for some locally available feedstuffs used in fish culture.

4.3 Processing of the Feedstuffs

Most feedstuffs have anti-nutritional factors, which will be harmful to fish. The anti-nutritional factors are substances, which alter the nutritional value of the feedstuffs and at the same time affect the health of fish. They may be inherent in the foodstuffs or contaminants on the feedstuffs. They prevent easy digestion of protein in the feed. The best way to destroy anti-nutritional factors is to heat treat the feedstuffs. Heat destroys such factors e.g. tripsin inhibitors in raw soybean or groundnut and gossypol in cottonseed.

4.4 Feed Formulation

This is the method of combining selected ground feed ingredients in varying proportions to comply with predetermined nutrient requirements. When feedstuffs for desired % crude protein content have been chosen (as in section 3.0 of this bulletin), they can be prepared/compounded through a process of milling, mixing and pelleting.Milling can be carried out with the hammer milling (**Figure 1**).

Figure 1. Hammer Mill

Mixing of ingredients including the premixes can be performed by hand before adding warm/hot water with stirring to form dough. If cereals in the formular are not adequate to bind the particles of the feed mixture, cassava starch may be added as a binder. A mechanical mixer can be used for large scale feed production (**Figure 2**).

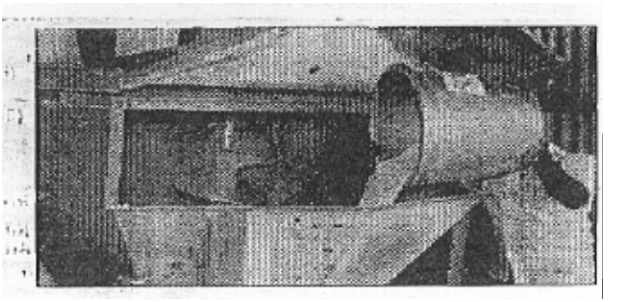


Figure 2.Mechanical Mixer

Some companies are fabricating pelleting machines locally. The Product Research and Development Agency (PRODA), Enugu fabricated some attached with hammer mill for ease of feed production. The common kitchen hand cranker can also be used for pelleting by small-scale farmers. (**Figure 3**).

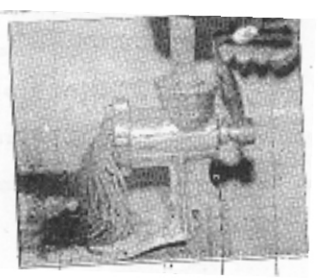


Figure 3: Kitchen hand Crack3er

After pelleting, the pellets should be dried in the sun or oven and packed in water impermeable bags e.g. nylon bags. This is to prevent attack by mould and other pests.

4.5 **Producing of Pellets and Ground Ingredients**

i Get good quality feed ingredients

ii Particle size of ground ingredients should be uniform. Fine grinding is preferable. Leaf meals should be sun or oven dried before grinding.

iii Measured ingredients should be mixed thoroughly in desired proportions.

iv Determine what pellet type to produce i.e. whether floating or sinking types for surface feeders or bottom feeding fish respectively. Sand may serve as sinker when added to pellet. For floating pellet, add or spray oil.

v Particle size of pellets for most fish range from 2mm-9mm in diameter.

vi Dry rations, such as rice bran, ground maize and leaf meals, may be stored in a cool, dry place for several weeks. Portions may be taken as needed to feed fish.

vii Moist rations can be prepared daily by adding about 350ml of water per kg of ingredients to form a dough-like mixture. This ration may be stored in plastic bags or containers and divided for morning and afternoon feeding.

Examples in Feed Compoundment

The examples illustrated below are based on the use of standardized weight measures (kilogram and litre) and equivalents, using local measures (Tiya and milk-tin). **Table 3** shows the standardization of home gadgets.

Table 3. Standardization of Home Gadgets.

Volume	Weight of Water Equivalent
1 litre of water	1 kg of water
1 mudu of water (8 milk tin)	1 kg of water
1 tiya of water (16 milk tin)	2 kg of water
2 tiyas (1 gallon)	4 kg of water
1 bucket (4 gallons)	16 kg of water
1 kerosine tin (5 gallons)	20 kg of water
1 head pan (3 gallons)	12kg of water

Source:- Aduku (1992)

Example 1. To prepare Vitamin Premix

		KG.	Milk Tins
Blood meal	-	2.6	18
Fish meal	-	1.0	8
Wood Ash	-	0.5	10
Red Pepper	-	0.5	6
Total	-	4.6kg	42 Milk tins

Example .2. 44% CP for Fish Fingerlings

		KG	Tiya/M.Tin
Soyabean meal	-	100.00	40.00 tiya
Salt	-	0.5	2.00 m.tin
Vit. Premix	-	0.25	1.90 (2m.tin)

Example 3. 35% CP for Juvenile/Adult Fish

		KG	Tiya/M.tin
Soyabean	-	80.00	32.00 tiya
Maize	-	17.00	6.8
Bonemeal	-	2.25	0.5 tiya (1 mudu)
Salt	-	0.50	2.00 m.tin
Vit. Premix	-	0.25	1.90 (2m.tin)

Source . Aduku (1992).

5.0 Feeding the Fish

Feeds are provided to increase fish yields, and are especially beneficial;

i. When fertilization is not practiced
ii When a pond does not respond well to fertilization
iii. When fish are stocked at high density in a pond
iv. When fish are confined in a cage, pen or other culture media.
v When fish are held in tanks.

Fish usually feed to satisfy their energy requirements. The quantity of feed fish would consume depends on various factors such as the fish appetite initiated by hunger for food, the feed quantity as well as its palatability. All things being equal, a well-fed fish will grow well and a poorly fed fish will have retarded growth and prone to diseases.

Farmers must supply fish under culture with nutritious diet on regular (daily or weekly) basis at the required level (recommended rates).

5.1 Fish Feeding Habits.

Generally, fish species have different feeding habits.

Some fish are carnivores i.e. they feed mainly on flesh foods like fingerlings crustaceans and worms in the water environment e.g. the Tiger fish, Hydrocynus forksali. Some are omnivores i.e. they feed on both plant and animal materials e.g. Tilapia. While some are herbivores i.e. feed mostly on plant materials e.g. Grass carp. Most fish under culture are able to feed on plant and animal food materials and accept supplementary feeds.

In a polyculture system, fish species can exploit different levels of the pond for food. Surface feeders include the Tilapias, mid water feeders include Clarias while Heterotis is a typical bottom feeder. A fish culturist should take these feeding habits into consideration in planning pond stocking.

5.2 Quantity of Feed

Feeding rates may be adjusted on a monthly basis by estimating the fish biomass (total weight of fish in a pond). There are several ways of determining this. The two most common ways are:

i. Catch small number of fish and weigh them. Use the average weight of the sample to multiply the number of fish stocked to calculate the fish biomass in the pond. Then feed them at 3-5% of the biomass daily.

It is recommended that at least 100 fish samples per hectare of fish farm should be randomly taken. Then use the following equation to estimate the quantity of feed required for daily ration.

$$F = \frac{W \times S \times P}{1000 \times 100} \text{ kg/ha/day}$$

Where,

F = Weight of feed
W = Weight of fish
S = Stocking rate

P = Percentage body weight

Example

A farmer has 3000 fingerlings in an hectare of fish farm with average weight of 15g. The quantity of daily ration at 5% body weight can be calculated as follows.

$$F = \frac{15 \times 3000 \times 5}{1000 \times 100} = 2.25\text{kg/ha/day}$$

The feed should be divided into two equal portion i.e. 1.13kg and fed twice daily - morning before sunrise and evening before sunset. Daily ration for fry can be divided to 4 to 8 and fed at intervals.

ii. Another way to adjust feeding rates is to assume a growth rate for the fish based on previous experience that a farmer has.

Growth rate will differ depending on the amount of natural food in the pond, the type and amount of supplementary feed given, fish species and size, the stocking rate, and the water temperature. Table 4 shows what percentage of body weight should be fed to Tilapia of a certain size. This information may be used as a rough guide to determine feeding rates. The following formula can be used in calculating the daily ration (based on Table 4).

$$F = \frac{S \times W \times P}{100} \text{ kg/ha/day}$$

Where,

F = Weight of feed

S = Stocking rate

W = Average Weight of Fish (determined from average length reading)

P = Percentage Body Weight

Example.

A farmer has 3000 fingerlings of Tilapia in a hectare of fish farm with average length of 16cm. The quantity of daily ration at 5% body weight can be determined thus:

$$F = \frac{3000 \times 90 \times 5}{100} = 13.5\text{kg/ha/day}$$

Note:- The value for w (average weight) is read from value for average length in Table 4.

Table 4:

Approximate length/weight relationships for tilapia and appropriate feeding rates.

Fish Size (cm)	Average Individual Fish Weight (g)	Percentage of Body weight Fed Daily
2.0	1	----------
3.0	5	
7.5	10	
9.5	20	5%
11.0	30	
12.0	40	
13.0	50	----------
14.0	60	
14.5	70	
15.0	80	4%
16.0	90	
16.5	100	----------
17.0	110	
17.5	120	
18.0	130	
18.5	140	
19.0	150	3%
19.5	160	
20.0	175	
20.5	185	
21.0	200	----------

Source - ICA (1991)

5.3 Methods of Feeding Fish

Fish can be fed supplementary feeds in two ways - Manually or Mechanically.

1. Manual Feeding

   This is carried out by a process called broadcasting i.e. throwing feeds into the pond by hand either on one spot in the pond or over a wide area (Figure 4). Broadcasting is a good method of feeding fish because the farmer can observe the behavior of the fish. This practice is however labor intensive, especially in large fish farms. It is however very suitable for small-holder aquaculturists. When a farmer feeds the fish from one spot in the pond, feeding frames can be placed at one or 2 spots in the pond to minimize feed wastage (Figure 5).

Figure 4. Feeding Fish in the pond by broadcasting.

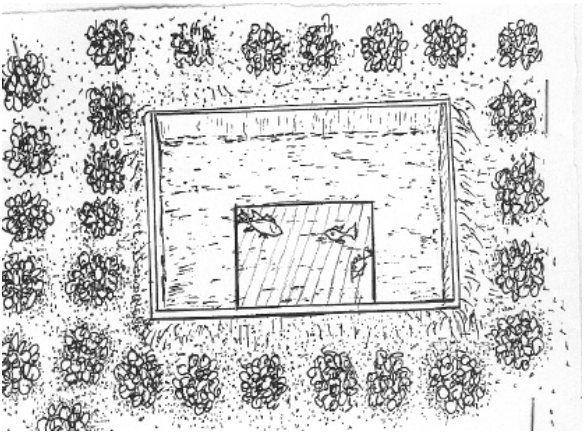


Figure 5. Feeding Frames in a Fish Pond.

2. Mechanical Feeding

This is suitable for large-scale commercial fish farms. The method is capital intensive and is performed by mechanical feeders, which could either be demand type or automatic.

i Demand Feeder.

This makes feeds available to fish on "demand". It operates through a simple funnel shaped device with a metal trigger hanging into the water. A measured amount of feed is placed in the funnel and the feed is released when the fish shakes the metal trigger (Figure 6).

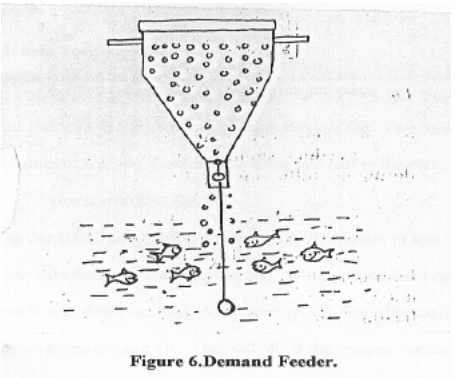
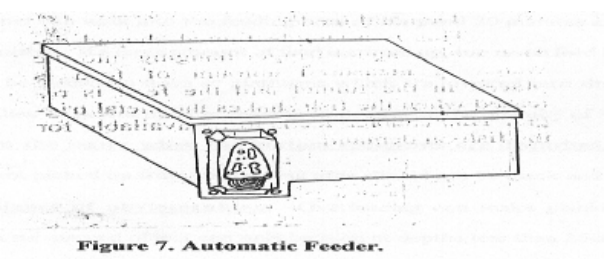


Figure 6. Demand Feeder.

- **Automatic Feeder**

  This is a clock work programmed device that discharges a measured amount of feed at specified intervals in a day. It is highly capital-intensive and not suitable to small-scale fish farmers **(Figure 7).**



5.4 Golden Rules in Feeding Fish

RULE 1: Always feed fish at the same time and place.

Fish become trained and learn when and where they are fed. Two feedings per day are normal. Half of the daily amount is given about mid-morning and half in the early afternoon.

RULE 2: Never overfeed the fish

Give only as much feed as the fish will consume in 20 minutes or less. Uneaten feed will pollute the water and increase the cost of raising your fish. When accumulated uneaten feed decomposes water may become low in dissolved oxygen. In such ponds, fish will usually be seen at the pond surface in the predawn hours gulping air. They will die if the oxygen concentration in the water becomes too low. Steps must be taken to exchange or aerate the pond water. Feeding should be temporarily suspended when dissolved oxygen is low to improve water quality.

Signs of overfeeding are listed below.

1. An obvious inability of the fish to consume all of the feed offered within a 20-minute period. A farmer can walk into the feeding area of his pond 20 minutes after feeding and feel the pond bottom. If a large amount of feed is stirred up, too much feed is being offered. Feed may also be placed on trays or plat forms, which are lowered into the water. These platforms can then be pulled up after feeding to determine the quantity of feed consumed.
2. A foul smell in the water when the bottom sediments are disturbed. A handful of bottom sediment picked up from the feeding area should not be black and foul smelling.
3. An overabundance of phytoplankton. Overfeeding can make plankton become so abundant that a submerged object can only be seen at depths less than 25cm. This should be a warning sign to farmers that indicates possible overfeeding.

RULE 3: ***Do not feed on harvest day***

Stop feeding fish 24 to 48 hours before they are harvested. This allows them to clean their intestines and makes them better able to survive the stress of handling and transportation. It will also save feed.

RULE 4 ***Regulate feed quantities at cold season***

The daily ration for fish should be halved during cold season (<20◦c temperature) Most fish will not feed on floating pellets at such season, continuous feed addition to the pond, since there will be low feed utilization. At such periods sinking pelletes are preferable. Most tropical fish are off-feed when temperature is below 20◦c

Bibliography

1. Aduku,.A.O (1992). Practical Livestock Feeds Production in the tropics. Asekome and Co.Publishers, Zaria.

2. Bolorunduro P.I (1994) Feeding and Management of Fish in Ponds. Technical Paper for training of ADP Subject Matter Specialists in Monthly Technology Review Meetings.

3. Bolorunduro P.I. (1995) Practical Method of Formulating Com pounded Feeds using Locally Available Ingredients for Small Scale Producers of Poultry and Fish. Technical paper for training of ADP Subject Matter Specialists in Monthly Technology Review Meetings.

4. Eyo. A.A. (1996). Fish Feed Formulation NIFFR Extension Guide Series NO. 4. In collaboration with GTZ and NAERLS.

5 Eyo. A.A. (1996). Feeding Practices in Fish Farming. NIFFR Extension Guide Series NO. 7. In collaboration with GTZ and NAERLS.

6 ICA (1991) International Centre for Aquaculture and Aquatic Environments. Feeding your Fish. Water Harvesting Manuals. GTZ. Auburn University.