

Taking a critical look at some identified feed particles (e.g. corn and soy particles) with the aid of a feed microscope may also be helpful — provided the feed is simply pelletized and not thoroughly 'cooked' to gel. The eyes are trained to identify feed particles of specific ingredient and compare them with known quality feedstuff particles.

Odour

In a similar way, the freshness and scent of the feed may be used in quality assessment, based on experience. At times the scent of a particular feedstuff (e.g. fish meal) in a formulated diet may be picked on for the assessment.

Storage Time

Feed materials are expected to be stored under hygienic conditions. The period of storage of feed materials and concentrates has a role to play in feed quality control. The longer the length of time of storage of either the feedstuffs used or the produced

concentrate, the lower the quality. Generally, concentrates produced from quality feedstuffs are expected to be consumed within 1 to 3 months from the time of production. So, client should always endeavour to check for the batch number and date of manufacture of purchased finished feeds. Hygienically processed and preserved diets may however last much longer than the stipulated period, especially when expanded.

Microbes and Pests

The qualities of both feedstuffs and concentrates are greatly affected by some microbes and pests. The presence of a large number of weevils freely moving around, is a good indicator to the expected poor quality feed, more so when the materials are slowly consumed. Some feed contaminants such as salmonella, mycobacterium, aspergillus and mycotoxins are sometimes found in poorly managed ingredients / feeds.

In conclusion, the qualities of feed materials and concentrate produced should not be compromised, even when the feed formulation is right. Millers using low graded feedstuffs should be avoided, even when offering relatively low prices of materials / concentrates. Where possible, samples of produced feed(s) should be analyzed in any standard laboratory for better judgement.

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Feeding Your Fish

Quantity of Concentrate to Feed

The aim of most farmers has always been to maximize their gains and break even within the shortest possible period. However, no healthy animal can develop optimally without being adequately well fed. Fish are normally fed collectively without special monitoring of individual fish feeding behaviour or agility. Thus, it must be ensured that an adequate quantity of feed is served periodically without (much) wastage.

Feed may be served based on an estimated fish biomass (total body weight) or to satiation to ensure adequate growth. The biomass is estimated at intervals by random sampling of a number of fish through which the total weight and growth rate of cultured fish

are deduced. A selected percentage of the estimated biomass is then served as the daily feed intake, based on the age, size and management (Table 3).

Question 5

Suppose a farmer test cropped 50 fish out of his stock of 5,000 catfish. Assuming the total weight of the 50 randomly picked fish is 45kg. What quantity of feed needs be served at each feeding period, if they are to be fed thrice a day, at a feeding rate of 4% body weight?

Answer

$$50 \text{ fish} = 45 \text{ kg}$$

$$1 \text{ fish} = 45/50 = 0.9 \text{ kg}$$

Therefore,

$$5,000 \text{ fish} = (0.9 \times 5,000) \text{ kg}$$

$$\text{Estimated fish biomass} = 4,500 \text{ kg}$$

$$\text{Quantity of daily feed} = 4\% \text{ of } 4500$$

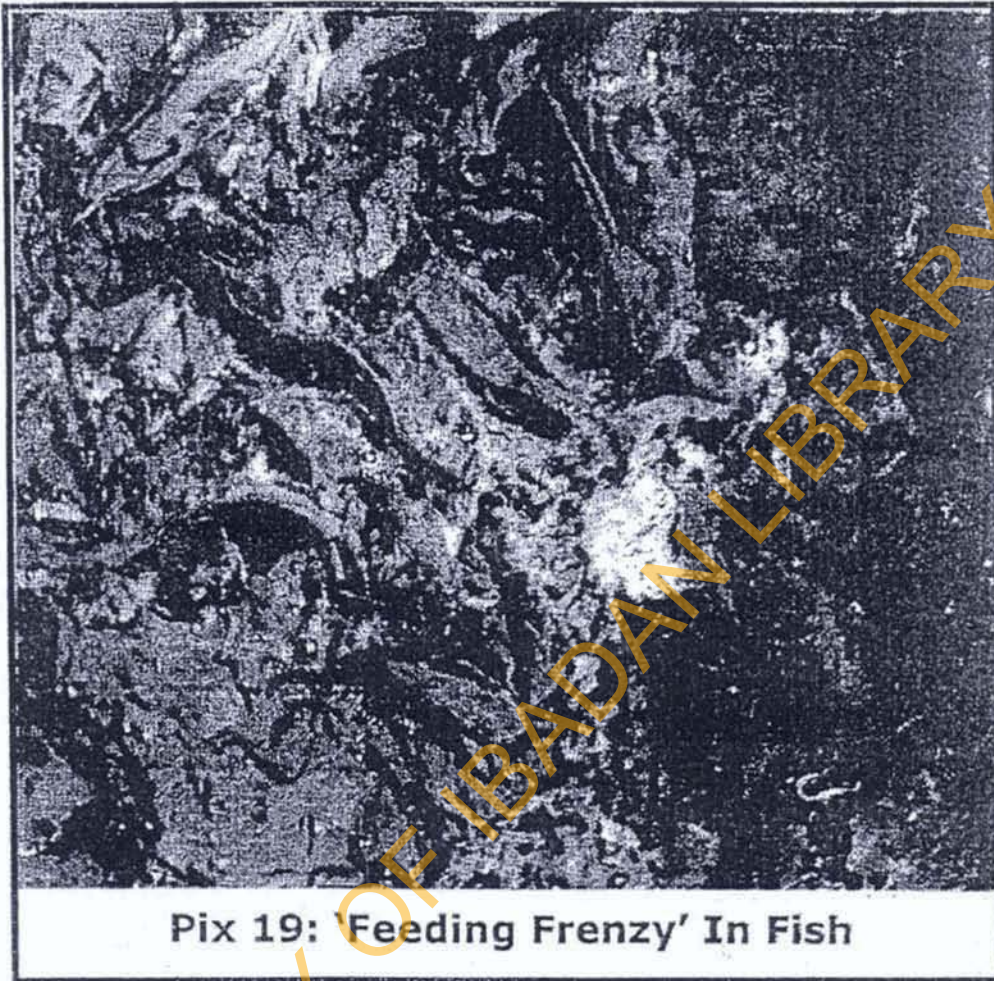
$$= 180 \text{ kg of feed}$$

$$\text{Quantity to feed at once} = \frac{1}{3} \times 180 = 60 \text{ kg}$$

So, 60kg of feed has to be fed to the fish in the morning, afternoon and evening i.e. 3 times a day.

The quantity of concentrate required to feed one's fish may also be determined by observing the feeding activities of the fish that are being fed, to know when they are satisfied. Normally, healthy fish are expected to rush at served feed, creating a splashing sight that is termed 'feeding frenzy'. As the feeding progresses, the splashing movement wanes gradually (figure 5) until they are all satisfied. As the struggle for feed diminishes, the quantity of feed dispersed should be reduced and the rate of feeding slowed down. Once some feed are sighted uneaten, the feeding should be stopped. It means they are satisfied. This method of feeding seems best for intensively raised fish that are manually fed, and are expected to be cropped within the shortest possible period.

Fish may likewise be fed based on previous feeding records. Preferably, a two to three standard production records should at least be carefully studied and adjusted to suit the desired goal. The fish are



expected to be produced under similar conditions, from the same strain of parent stock (preferably obtained from the same farm) and fed similar diets. However, the fish performance should be monitored regularly to verify if there is any significant deviation from the recorded norms for necessary adjustments.

Frequency of Feeding

Feeds are better utilized when served in bits over a period of time than bulk feeding. Thus, the calculated quantity of feed required for each day's feeding should be divided into parts that are then served, based on the frequency of feeding.

Feeding frequency is important in intensive fish management because of the bulk feed served, in relation to the biomass, as daily meal. Consequently, the higher the proportion of feed to body weight fed, the higher the frequency of feeding. This means that fry being fed on a 12% body weight daily feed intake are expected to be fed more frequently on a proportion of the daily feed, each time they are to be fed. Feeding fish frequently is expected to be of help in:

- increasing the assimilation of feed nutrients better than in bulk feeding, thus enhancing feed conversion to flesh.
- optimizing the rate of fish development.
- minimizing wastages as fish are served what they should be able to consume at each feeding

period.

- managing possible nutritional abnormalities that may likely arise from overfeeding.
- reducing water pollution.

Bearing this in mind, fish fry may be fed every 1 to 2 hours interval when placed on 12 to 15% body weight diet, while adult fish are fed 2 to 3 times per day (table 3). A proportion of about 1.0 to 1.5% of the biomass is thus recommended to be served at each feeding hour. However, the quantity of feed served early in the morning and late in the night is expected to be slightly higher than others, when not using auto-feeders. The frequency of feeding depends on:

- ❖ the age/size
- ❖ how intensive and fast the production is expected to be

Below is a table of suggested feeding rates, frequencies and likely feed size ranges that may be considered for each age group.

Table 3: A Guide to Manual Feeding of Catfish

Age group	Estimated Weight (g)	Feed Size (Mm)	Feeding Rate (%Bwt/dy)	Feeding frequency (X/dy)
Fry	< 0.05	0.1 – 0.3	12 – 15	≥ 12
	0.05 – 0.1	0.2 – 0.3		
Advanced Fry	0.1 – 0.5	0.3 – 0.5	10 – 12	8 – 12
	0.5 – 1.0	0.5 – 0.8		
Fingerling (Post fnglg)	1 – 5	0.8 – 1.2	8 – 10	6 – 8
	5 – 10	1.2 – 1.5		
Juvenile (Post jvnl)	10 – 20	1.5 – 2.0	6 – 8	4 – 6
	20 – 50	2.0 – 3.0		
Grower	50 – 250	3.0 – 4.5	5 – 6	4
Adult	250 – 1000	4.5 – 6.0	3 – 5	3
	≥ 1000	6.0 – 9.0	2 – 3	2

*Note: * Few days old larvae (swim-up fry) should be fed on hourly basis for better performance.*

** This data may only be considered for intensive fish farming that employs the right feed and management.*

How to Feed Your Fish

There are basically two ways by which they may be fed — using automated feeders or being hand-fed (manual). Automated feeders (auto-feeders) are often installed to stimulate continuous fish feeding to satiation, for optimal performance. Enough feeders are fed with the estimated quantity of feed or simply

filled and hung over the water body. The feeders are auto-regulated to release feed at specific periods or when stimulated by the fish. Thus, fish appetite is always satisfied as they are provided unlimited access to feed round the clock with minimal stress.

This feeding method encourages farmers to produce up to three sets of fish per year from viable juveniles that are fed on high protein and energy diets. A continuous, gradual feeding pattern is ensured, which minimizes feed wastage, energy wastage, water pollution and bullying to the barest minimum. It enhances good record keeping in that the quantity of feed consumed can easily be determined where such appliances are calibrated. Thus, the method ensures better feed management, cropping weight, probably better health status (because of reduced water pollution and bullying) and profitability than the other.

However, it is somewhat difficult trying to observe the physical fitness of satisfied fish since they won't rush for food or surface when someone is around. They also have to learn to adjust to the machine's mode of operation.

In the absence of auto-feeders, fish feed should be uniformly dispersed over the surface of the culturing medium to ensure that virtually all the fish have access to the feed (at the same time) and are adequately fed. Since more fish are being exposed per unit time to the dispersed feed, an even growth is encouraged, with less wide size / weight disparity and runts. When the usual rush for feed wanes considerably, gradually reduce the quantity of dispersed feed, as well as the area of feed dispersion, to spot feeding to avoid feed wastage.

In large ponds however, feeding zones (not spots) may be randomly sited over each pond surface, where feeding should take place simultaneously. The feed is then divided equally and dispersed over the surface of each feeding zone until the rush wanes, and their feeding is gradually localised to feeding points.

It is a good practice to maintain specific, regular periods of feeding. With constant feeding at such periods, the fish population becomes accustomed to the timing, thus they are expectant and well positioned to receive the feed when served. At the slightest sound

or movement, they often would rush, creating splashing sounds and sights similar to what obtains when being fed. Thus, less feed wastage and better feed conversion is ensured.

Fishes perform optimally within certain water temperature range, being cold-blooded animals. As water temperature increases and decreases, so does the feeding activity of fish. To ensure optimal feeding / performance, cultured fish may be raised in a controlled system. In the absence of such facility and a cold weather results, slow-sinking feeds should be provided and the quantity of served feed reduced because they will prefer to stay away from the (cold) water surface.

Observations to note while feeding your fish

While the feeding is on, the fish should be observed and their performance assessed. The questions that need be answered are:

- How active / vibrant are they?
- Are they brilliant looking?
- Do they respond well to feeding?

- Do they look well fed? Is the growth rate (visual assessment) appreciable?
- Is there a little / wide size disparity?
- What quantity of the feed was consumed before the rush for feed subsided? Is the observation similar to previous ones?
- Is there any sign of sickness / body lesion?
- Do you notice the presence of any pest or predator within or close to the water body?
- Is there any need to adjust the water quality?
- Is the weather warmer or cooler than what it use to be?

The answer to some of these questions may suggest the next step to take in ensuring proper management and good fish health. A prompt response may make a difference between success and loss. For instance, assuming the fish were looking healthy and ready to feed, but the expected rush for feed wanes faster than expected. The first thing to suspect should be the quality of feed, if the fish population is intact. Has the formula been changed? Was one of flavoured

ingredients (e.g. fish meal) reduced / changed / replaced with another of lower grade or scent? Once observed and a prompt solution found, probable negative sequel would have been prevented, and a steady fish growth recorded.

In conclusion, fish diets may be economically computed and produced from a careful selection of fairly cheap, adequately processed unconventional and conventional feedstuffs, without compromising the quality. Fish that are intensively farmed should be fed on well-processed, complete diet to satiation. The right quantity of feed required per day may be calculated based on selected fish biomass, divided based on the frequency of feeding and served as at when due. They may also be fed to satiation without feed wastage by monitoring their response to served feed. The smaller the fish size, the more frequent the feeding should be. The quantity of feed to be served per meal should be dispersed over the tank surface or feeding zones in sizeable ponds rather than having a feeding point or spots.



Nutritional Problems

Nutritional diseases (or abnormalities) are often problems resulting from excessive consumption, poor availability or lack of some essential nutrients required for normal body functions. It is quite different from diseases caused by pathogens or environmental factors, although they are inter-related.

This type of problems may result from a sudden change in diet (as often experienced in fish fry nutrition, when there is a sudden change of diet to concentrate from zooplankton feeding), inadequate feeding, poor feed storage, prolonged period of feed storage, poor ingredient/feed quality, poor feed quality resulting from the processing method, anti-nutritional factors, use of unpalatable feeds and a host of other

associated factors.

A list of some important nutrient based problems is presented below.

Nutrient Deficiencies in Cultured Fish

Table 4: Nutrient Deficiencies in Fish
(Modified from Cho, 1983)

S/N	Deficient Nutrient	Diseases / Disorders	Clinical Signs/ Comments
1	Vitamin A	Keratomalacia	Poor vision + poor growth
2	Vitamin B		
a	Folic acid	Nutritional anaemia	Anaemia + poor growth
b	Pantothenic acid	Nutritional gill disease	Fusion of primary lamellae of affected gills results in respiratory & excretory problems
c	Thiamine	Neurologic disorders	Acute disease convulsion & death. Chronic form oedema, loss of balance & poor growth.
d	Riboflavin	Ocular defects	Defects of the eyes e.g. cloudy lens & blindness.
e	Niacin, biotin & pyridoxine	Neurologic disorders	Spasms & convulsions. (Niacin helps to prevent sunburn)

Nutritional Problems

3	Vitamin C (Ascorbic acid)	Broken back disease	Cartilage abnormalities, impaired wound healing & immune function. Vertebral column may collapse. (Use phosphorylated Vit C + proper feed storage).
4	Vitamin E/ Selenium	Myopathy	Muscular deformities.
5	Choline, Inositol, Vit E & Biotin	Fatty liver disease	Poor growth due to poor fat/oil metabolism
6	Calcium & Phosphorus	Broken head disease	Weakened, cracked or broken skull
7	Iodine	Goitre	Also caused by goitrogenic substances
8	Fat /oil (excess) & Rancid fats	Fatty liver Anaemia Obesity	High dietary fat/oil Yellow to pale orange coloured, swollen, greasy liver
9	Aflatoxins (in feed)	Aflatoxicosis (Hepatomas)	Liver tumor & emaciation. Avoid mouldy feeds

Other Nutritional Abnormalities/Causes

- ❖ **Starvation** — may result from poor feed palatability or husbandry/environmental problems/blindness
- ❖ **Poor feed efficiency** — Biotin, energy, fat, protein, folic acid, niacin, riboflavin, choline, inositol & Ca.
- ❖ **Poor growth** — Energy, fat, protein, folic acid, niacin, pantothenic acid, pyridoxine, riboflavin, thiamine, biotin, vitamins A, B₁₂, C, D & E, inositol, choline and calcium
- ❖ **Anaemia** — deficiency of folic acid, niacin, pyridoxine, riboflavin, vitamin B₁₂, ascorbic acid, vitamins E & K, inositol, rancid fat and Fe
- ❖ **Ascitis** — deficiency of vitamins A, C & E
- ❖ **Fatty liver** — deficiency of biotin, inositol, choline, vitamin E and excess fatty acids

Table 2: Some Anti-Nutrients Found in Feedstuffs that May Cause Physiological Abnormalities Or Impair the Growth of Fish

Anti-Nutrients	Feed items
Trypsin inhibitors	Soybean and rapeseed meal
Gossypol	Cottonseed meal
Nitrosamines	Fish meal
Phytates	All plant feedstuffs
Mycotoxins	Cereal-based meals. Not naturally occurring but produced by microorganisms
Cyclopropenoid fatty acids	Cottonseed oil and meal
Haemoglutinins	Soyabean meal
Glucosinolates	Rapeseed meal
Histamine and putrescine	Fish meal, primarily tuna
Tannins	Rapeseed meal
Oxidized and polymerized lipids	Fish meal; poultry by-products, krill meal
Mimosine	<i>Leucaena</i> leaf meal
Glycosides	Grass and leaves

Prevention of Nutritional Problems

- Ensure that the right feed formulation (with essential additives) is fed to your fish.
- The adopted feeding pattern should ensure that each cultured fish is adequately fed.
- Examine the quality of the miller's feed ingredients to ensure that the materials are in good conditions.
- Feed processing should be hygienically handled.
- Feeds in which easily contaminated materials are incorporated as ingredients should be adequately processed and stored to check microbial feed degradation.
- Proper monitoring should be ensured to prevent the transmission of possible pathogens through the use of live foods (plankton).
- Protect feed from pests & rodents to avoid feed contamination, degradation and wastage.
- Feeds should be properly processed to manage anti-nutrients (e.g. thiaminase). Anti-nutrients may cause vitamin deficiencies.

- Heat-sensitive nutrients (some amino-acids, lipids & vitamins additives) should be added in the right proportion, after extrusion.
- The feed should be well bound (and dried) to keep the particles / additives intact i.e. water stable.
- Fish feed / ingredients should preferably be stored for not more than 1 month (before use) to prevent degradation of sensitive nutrients. Maximum storage time should not exceed 90 days.
- Feeds should be stored dry in dry, cool place to prevent rancidity, mouldy feed and or feed degradation.
- Avoid using stale or mouldy feed.
- Ensure that served feed has no odd smell.

Control Measures to Nutritional Problems

- Avoid handling stressed / unhealthy fish, unless necessary.
- Take history / clinical signs of ailment.
- Assess and rule-out environmental abnormalities/ pathogenic diseases.

- Check the feed formulation / quality.
- With the help of a veterinarian or fish nutritionist, administer the required nutrient/therapy based on clinical signs.
- Feed fed to stressed/unhealthy fish should be reduced, the quality improved and essential vitamins, minerals & fatty acids included to satisfy their daily needs.

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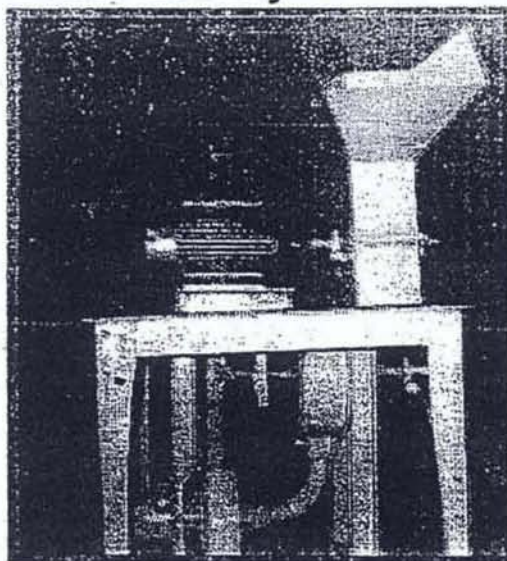
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Appendices

Job Opportunities Linked with Fish Feed Production

1. Aquafeed production / toll milling.
2. Conventional feed-items (e.g. maize, soyabean & groundnut) production and sales.
3. Unconventional feedstuffs (e.g. insect meal, maggot meal & poultry by-product meal) production and sales.
4. Feed machines production & sales.
5. Buying & selling of fish feeds.
6. Fish feed analysis laboratory.
7. Fish feed additives production.
8. Feed additives marketing / sales.

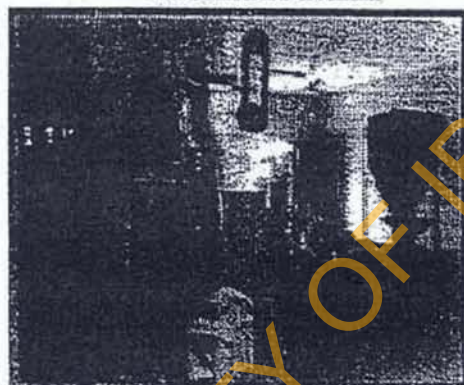
Some Locally Fabricated Aquacultural Tools



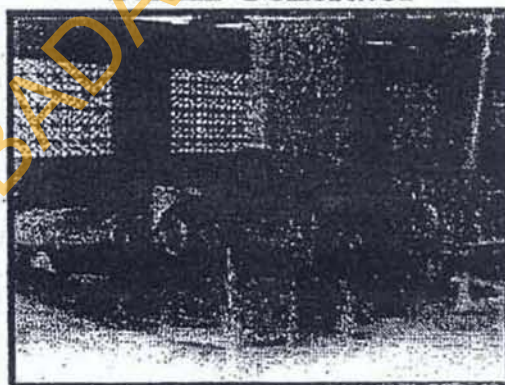
Bhurrh Mill



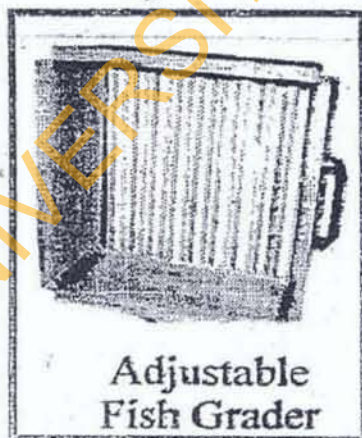
Steam Generator



Aquafeed Mill



Rotary Dryer (under construction)



Adjustable Fish Grader



Aerators Water



Auto-Feeder
(For sizeable fish)

OAK!

Some Feed Formulations for Farm Use			
Feed Items	Quantity (%)		
	A	B	C
Corn meal	17	14	13
Rice meal	10	8	12
Soybean meal	30	35	32
GNC	10	15	11
Fish meal (72%)	20	10	10
Blood meal	10	—	10
Insect meal	—	10	—
Hatchery BP	—	6	10
Vit/Min Premix	0.3	0.3	0.3
Vit C	0.2	0.2	0.2
DCP	1	0.5	—
Oil	1.5	2.0	1.5
CP	43	43	43
ME (KCal/kg ⁻¹)	>2900	>2900	>2900

Note:

- $\pm 0.1 - 0.2\%$ Salt
- It is better to process the feed under high temperature – using an extruder or steam pelletizer.

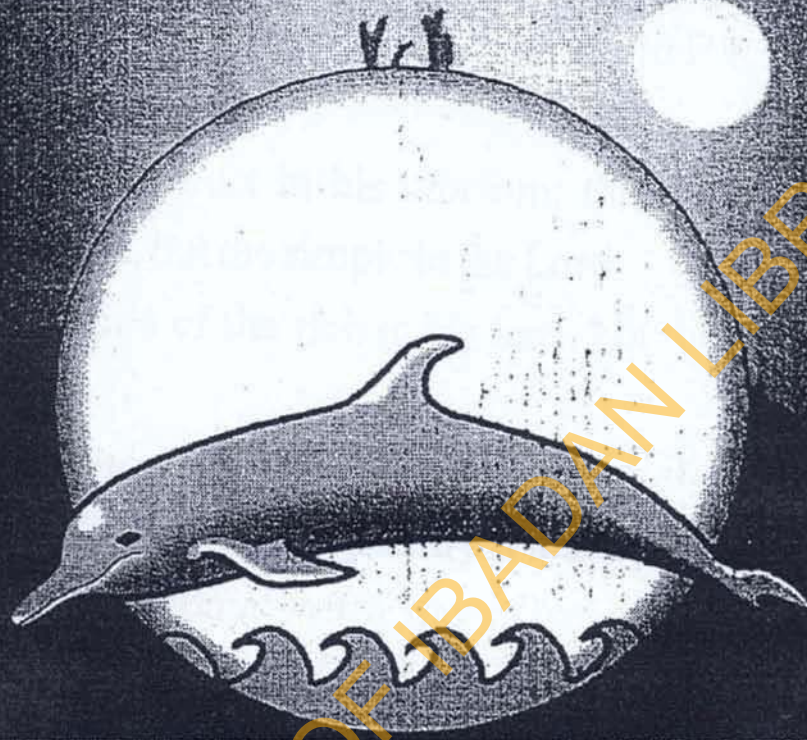
Other Fish Related Businesses

1. Fish seedlings production.
2. Fish production materials sales.
3. Fish processing factory.
4. Fish & fish products marketing.
5. Fish fast food joints
6. Fish production consultation.
7. Fish health & disease consultation.
8. Fish disease diagnostic laboratory.

Advice To Farmers

- ❖ Own and regularly visit your farm animals to learn from them.
- ❖ Always have an up-to-date record.
- ❖ Be kind on your animals to get the best from them.
- ❖ Do not hesitate to seek the assistance of a veterinarian, animal nutritionist or other professionals when need be.

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With God, we serve you better!

Quotable Quotes

- ❖ To seek the lord is wisdom; to live in His counsel is great gain.
- ❖ The wise trust in his wisdom; the strong in his strength, but the simple in the Lord.
- ❖ The fame of the rich is his hurt, but the wise lies low.
- ❖ A man is a 'king' where he is wanted; the presence of his 'subjects' brings him joy and courage.
- ❖ A loving home worth more than rubies, the joy therein is healing to the soul.
- ❖ A wise man makes his hands a subject to his brain, and his brain an instrument of God.
- ❖ Success comes with patience; the hasty often outruns it.
- ❖ The heart that trusts in the Lord, and applies itself to sound teachings, lives forever in peace.
- ❖ He that has understanding shall strife for nothing, but the soul of the greedy shall be troubled.

- ❖ For fear of want, a man stores up treasure, but the wise disseminate it wisely for prosperity.
- ❖ He that is insensitive to mockery, but is focused on his goals shall be called an achiever.
- ❖ The zeal of a determined man paves ways for his success, but he that faints in the days of trial shall prolong his woos.
- ❖ A man of valour is he that sees hardship as a challenge and calls innovation his friend, for in challenges come victory.
- ❖ He that is kind to his neighbour fortifies his soul, and he that shut not his heart to the needy shall have his name written in gold.
- ❖ The love shown to a dog makes it wag its tail and not bite.
- ❖ The profit of life is eternity; he that invests in it shall rejoice.
- ❖ I love wisdom but for its price; I seek power but it's too demanding; I prefer wealth but for the troubles it brings; yet I want to live but for life's worries.

OAKman

Food for Thought

Consider to learn from the goose and hen, and sheep and goat. The one brags and fights for itself, yet it ends up being a victim of circumstance, while the other (gentle and humble) is always fought for By GOD.

OAKman

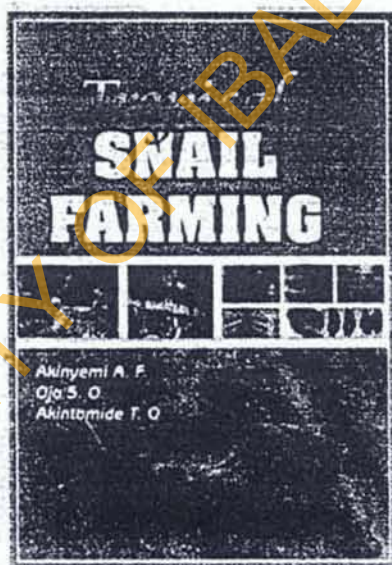
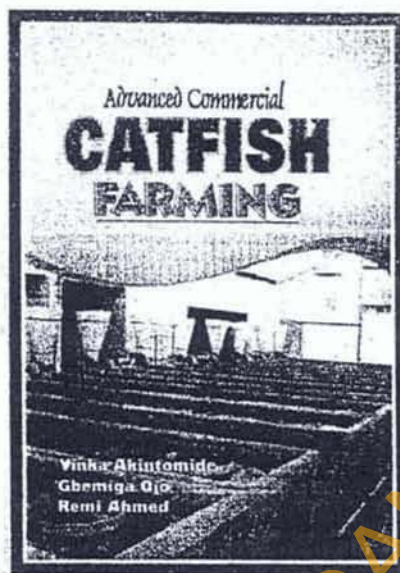
My True Love (JESUS)

My true love; my faithful neighbor; my cherished memory. You care to scold me when need be, and pet me when depressed. A true friend that sells not out, but candles the dark side of me. Yes! I will enjoy every moment I have with you, that the memory may always be sweet.

OAKman

Be a **Determined, Diligent, Disciplined Discipler** of what is good and **Pleasing to God.**

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