

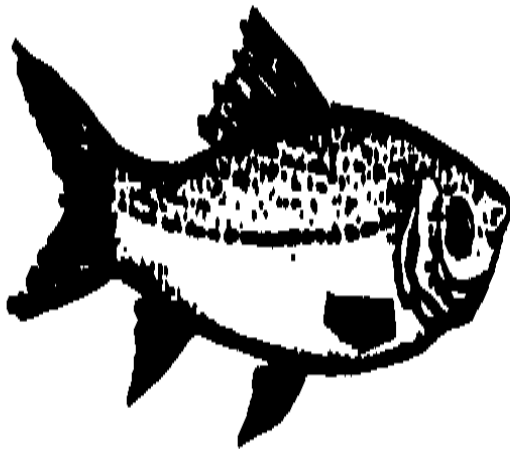
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FRESHWATER FISH POND
CULTURE AND MANAGEMENT

<FIGURE>

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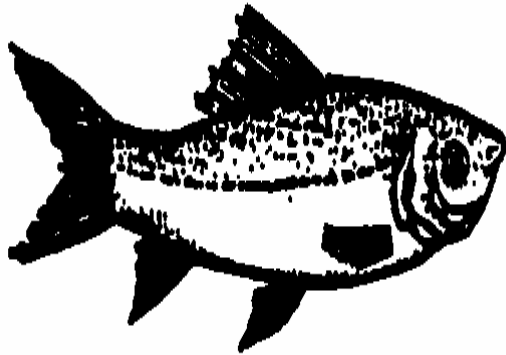
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APPROPRIATE TECHNOLOGIES FOR DEVELOPMENT

FRESHWATER FISH POND
CULTURE AND MANAGEMENT

<FIGURE>

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FRESHWATER FISH POND

CULTURE AND MANAGEMENT

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About this manual....

Freshwater Fish Pond Culture and Management is the second in a series of publications being prepared by the United States Peace Corps and VITA, Volunteers in Technical Assistance. These publications combine Peace Corps' practical field experiences with VITA's technical expertise in areas in which development workers have special difficulties finding useful resource materials.

PEACE CORPS

Since 1961 Peace Corps Volunteers have worked at the grass roots level in countries around the world in program areas such as agriculture, public health, and education. Before beginning their two-year assignments, Volunteers are given training in cross-cultural, technical, and language skills. This training helps them to live and work closely with the people of their host countries. It helps them, too, to approach development problems with new ideas that make use of locally available resources and are appropriate to the local cultures.

Recently Peace Corps established an Information Collection & Exchange so that these ideas developed during service in the field could be made available to the wide range of development workers who might find them useful. Materials from the field are now being collected, reviewed, and classified in the Information Collection & Exchange system. The

most useful materials will be shared. The Information Collection & Exchange provides an important source of field-based research materials for the production of how-to manuals such as Freshwater Fish Pond Culture and Management.

VITA

VITA people are also Volunteers Who respond to requests for technical assistance. In providing solutions, their aim is the most appropriate answers for specific situations. Therefore, VITA specialists often must produce new designs or adapt technologies so that they are of value in developing areas.

Many VITA Volunteers have lived and worked abroad. Most VITA people now work in the United States and other developed countries where they are engineers, doctors, scientists, farmers, architects, writers, artists, and so on. But they continue to work with people in other countries through VITA. Thanks to their contributions of time and expertise, VITA has been providing technical assistance to the Third World for more than 15 years.

Requests for technical assistance come to VITA from many nations. Each request is sent to a Volunteer with the right skills. For example, a question about fish pond operation might be sent to a VITA Volunteer who has had years of experience working to develop fish ponds in Asia, and who is now a university professor.

THE PURPOSE

Freshwater Fish Pond Culture and Management is a how-to manual. It is designed as a working and teaching tool for extension agents. It is for their use as they establish and/or maintain local fish pond operations. The information is presented here to 1) facilitate technology transfer and 2) provide a clear guide for warm water fish pond construction and management. A valuable listing of resources at the end of this manual will give further direction to those wishing more information on various aspects of fish pond operation.

THE PEOPLE WHO PREPARED IT

The strength of both Peace Corps and VITA lies in Volunteers. These manuals represent an excellent means of communicating important know-how gained through Volunteer experiences and inputs.

The author of Freshwater Fish Pond Culture and Management, Marilyn Chakroff, served with Peace Corps in the Philippines for three years in a number of fisheries programs. Ms. Chakroff, who holds a B.S. in Biology, now is an advanced degree candidate in the field of Environmental Communications at the State University of New York, in Syracuse. This manual is written out of her first-hand experience as a Peace Corps Volunteer.

Joan Koster, the illustrator, has been a VITA Volunteer for more than 3 years. She is a teacher, professional artist, and writer. Ms. Koster, who has travelled and studied in Greece for a number of years, currently is preparing a manuscript on looms and weaving.

OTHER CONTRIBUTORS

Many thanks are due here to a number of people who aided the preparation of this manual:

Dr. David Hanselman, Dr. Peter Black, and Dr. Robert Werner -- Faculty of the College of Environmental Science and Forestry, State University of New York, Syracuse, New York.

Dr. Shirley Crawford, Agricultural and Technical College, State University of New York, Morrisville, New York.

William McLarney, New Alchemy Institute, Woods Hole, Massachusetts.

A.F. D'Mello, Hawkesbury Agricultural College, New South Wales, Australia.

Richard T. Carruthers, Bioproducts, Inc., Warrenton, Oregon.

Dr. William Ribelin, Department of Veterinary Science, University of Wisconsin, Madison.

A special note of thanks is due John Goodell, VITA, for his layout work and staff assistance with this manual.

REPLY FORM

For your convenience, a reply form has been provided here. Please send it in and let us know how the manual has helped or can be made more helpful. If the reply form is missing from your copy of the

manual, just put your comments, suggestions, descriptions of problems, etc., on a piece of paper and send them to:

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If you have questions on the material presented in the manual, or if you run into problems implementing the suggestions offered here, please note them in the space provided. Use additional paper if you have to in order to be as specific as you can about the problem. Wherever possible, we will try to provide or direct you to an answer.

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1. How did you find out about the PC/VITA Freshwater Fish Pond Culture and Management manual? How did you get your copy?

2. Which parts of the manual have you found most useful? Least useful? Why?

3. Did you find the manual easy to read, too simple or too complex, complete or incomplete?

4. How has this manual helped your work? What have you done to apply the information?

5. Which plans have you used? Did you make changes in any of the plans? (For example, when you were building a drainage system, did you substitute any materials for the ones mentioned or change the design?) If you made changes, please describe what you did that was different. Include photos, sketches, etc., if possible or important.

6. Can you recommend additional methods or equipment which you feel should be included in a new edition of the manual? If you do know of such methods, etc., please include the information here.

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8. Do you have other recommendations?

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1 Introduction

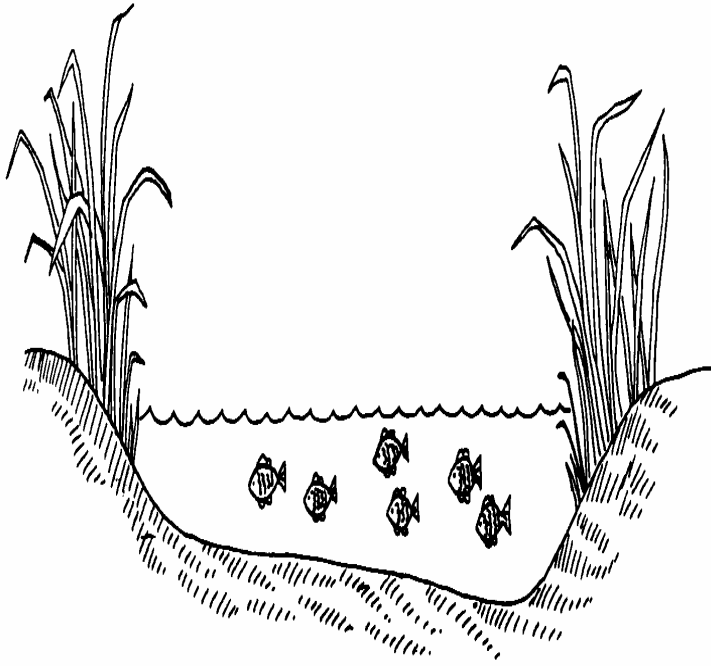
What is Fish Culture?

Fish culture is the growing of fish in ponds. Growing fish in ponds, from which they cannot escape, allows feeding, breeding, growing, and harvesting the fish in a well-planned way.

Fish culture is one form of aquaculture. Aquaculture is the science which deals with methods of growing (cultivating) animal and vegetable life in water. Some other kinds of aquaculture are concerned with growing frogs, oysters, seaweed, and even rice.

<FIGURE>

12p01.gif (353x353)



History of Fish Culture in Ponds

Growing fish in ponds is a very old practice. Carp were cultured as long ago as 2698 B.C. in China, where they were grown in ponds on silkworm farms. Fish culture seemed to occur whenever civilization was settled for a long period of time. For example, fish culture was done in ancient Egypt and in China, which has had a continuous civilization for over 4,000 years. The first written account of fish culture in ponds was by Fan Lai, a Chinese fish farmer, in 475 B.C.

The ancient Romans introduced carp from Asia into Greece and Italy. By the seventeenth century (1600's), carp culture was being done all over

Europe. A book written in England in 1600 by John Taverner gives the details of good pond management and talks about growing the common carp. Taverner also wrote about pond construction, fertilization and feeding. Another book, written in 1865, gave the details of the stripping methods of spawning fish. The methods of culturing common carp have not changed very much since that time.

The common carp is still a very important pond fish. In addition, today, other fish also are being cultured in ponds. Some of the most well-known are fish of the tilapia genus, like *Tilapia nilotica* and *Tilapia mossambica*. Some of the other Chinese carps -- the silver, grass, and bighead carps -- also are often used in pond culture. Most importantly, countries all over the world are using time and money to discover which of the fish commonly found in their own waters will grow well in fish ponds.

Why Fish are Grown in Ponds

The practice of culturing fish in ponds developed because growing fish in ponds is a more useful practice, for some purposes, than trying to catch fish from lakes, rivers, or streams. For example:

* Many interested people discover that building a fish pond close to home is possible and far more convenient than going to the nearest market or river. Ponds can be built wherever the soil, shape of the land, and water supply are right. This may sound as if a lot of factors are involved. But since a wide variety of soils, land shapes, and water supplies can be used for pond culture, a fish pond can even be made from a

rice paddy or an unused grain field.

* It is easier to get fish out of a pond than it is to catch a fish from a river or stream. Also, the number of fish taken out of a pond can be controlled. But it is very difficult to know how many fish can be caught in a river or stream or lake at any one time. When the farmer goes to his fish pond to get dinner, he knows he can take out the number of fish he needs -- quickly and easily.

* Fish growth can be controlled. The fish can be fed extra food to make them better for market; natural enemies can be kept from killing the fish. For a person who relies on fish for his food or his income, these are important factors.

* The only fish grown in a pond are the ones the farmer wants to grow. When he takes a fish out of his pond, the farmer knows what kind or kinds he will be getting. When he catches fish in a lake, stream, or river, many of the fish will not be the ones that are good to eat or to sell.

* Growing fish in ponds allows the farmer, or other fish grower, to produce fish cheaply, and to have a supply of fish available on his own land. Fish in ponds belong

to the pond owners; fish in the rivers and lakes do not.

<FIGURE>

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Why Growing Fish is Important

There are some very good reasons why a farmer or small land owner might be interested in fish farming:

- * Fish are an important food source.
- * Fish farming can help a farmer make the best use of his land.
- * Fish farming can provide extra income.

There may be additional reasons; you and the pond owners can determine these from the local situation. The three points listed above are very broad, however, and apply, at least in part, to most situations. Therefore, each point is discussed more fully below.

FISH AS FOOD Farmers know that all living things need food, and that without food, living things die. However, they are not as likely to know the characteristics of food which make it valuable (or not) to the body.

Food is important because it provides proteins, vitamins, minerals, fats, and carbohydrates. These things are called nutrients: they are materials that the body must have to live and grow. Every kind of food has different amounts of each of these nutrients. For example, some foods contain more protein; others have more fat than protein.

<FIGURE>

12p04a.gif (285x285)



Because foods contain different amounts of proteins, fats, and carbohydrates, for example, it is necessary to eat a number of different kinds of food to get the right amounts of each nutrient. All the foods together then give the body what it needs to grow.

The food that people eat is called their diet. Eating the right kinds of food -- foods that give the body the right amounts of proteins, fats, etc. -- is called eating a balanced diet. People who eat a balanced diet usually are healthy and strong; people who do

not eat the right kinds of food are more likely to be weak and get sick.

Proteins are the most important part of food. Protein is made of carbon, hydrogen, and nitrogen. These are called elements. The combinations of elements in protein make it the most useful nutrient. Foods that contain a lot of protein are especially good for people to eat. And fish contains a lot of protein.

The table on the opposite page shows a list of foods that humans eat. The first number beside the food shows the number of grams of protein in the food when it is fresh. The second number tells how many grams of protein there are in food which has been dried. The table shows that fish -- whether fresh or dried -- is a very good source of protein. (100gm of dried fish contains more protein than 100gm of fresh fish only because dried foods have water taken out. Therefore, 100gm of fresh fish weighs less when it is dried.)

<FIGURE>

12p04b.gif (230x256)



If the farmers in your area already eat a lot of fish, or like fish, fish farming for food may not be hard to introduce and have accepted.

If they do not eat fish often, you will have to keep this in mind when you talk about fish as a healthy food. Food just may not be the most important reason, from their point of view, for wanting to grow fish.

PROTEIN CONTENT OF FOODS (*)

Fresh, gms protein	Dried, gms protein
Food per 100gm	per 100gm

FISH

Fatty (herring) 17 46

Non-fatty (haddock) 16 84

MEAT

Beef 20 67

Pork, loin 20 67

Liver 20 67

DAIRY PRODUCTS

Milk 3.4 26

Eggs 12 46

CEREALS

Wheat 12 14

Maize 10 11

Oats 10 11

Rice 8 9

OIL SEEDS

Soya 33 37

Cottonseed 20 21

Sesame 21 22

GREEN LEAFY VEGETABLES

Cabbage 1.4 - 3.3 24

Spinach 2.3 - 5.5 26

ROOTS

Cassava (manioc) 0.7 2

Potatoes 2.1 9

Yams 2.1 7

Plantains 1.0 3

(*) These values are estimates only; the amount of protein varies according to the age, size,

and quality of the food, and how it was cooked and stored.

Source: Aylward and Jul (1975)

But there are other reasons you can offer a farmer. For example, a farmer may consider cultivating fish if he realizes that fish are easy to grow, cheaper than some kinds of meat, available as food all year round, etc. You will have to see which combination of arguments works best for getting farmers interested.

BETTER LAND USE Some farmers may be more interested in fish farming when they realize they can accomplish two purposes: provide a reliable food supply and make the best possible use of their land.

"Fish farming" is a good thing to call "fish culture" because it can start the farmer thinking about raising fish with the same kind of planning and land-use management ideas that he puts into raising crops.

Whether the farmer raises fish, crops, or animals, he is using his land in certain ways. His aim in all cases is to increase the production of food and the yield from the land. What farmers, and other people, often do not realize is that fish culture can help get more out of the land. Here are a few ways in which fish culture can help support and extend a farmer's land use:

* Land gets tired when it is used for growing the same crop year after year. These crops use up nutrients in soil, and they begin to grow poorly. Fish ponds can be built on this

land and fertilized to provide food for the fish. After a few years of fertilizing and growing fish, the soil inside the pond regains some of the nutrients used up by the growing of crops year after year. The land can then be used for crops again.

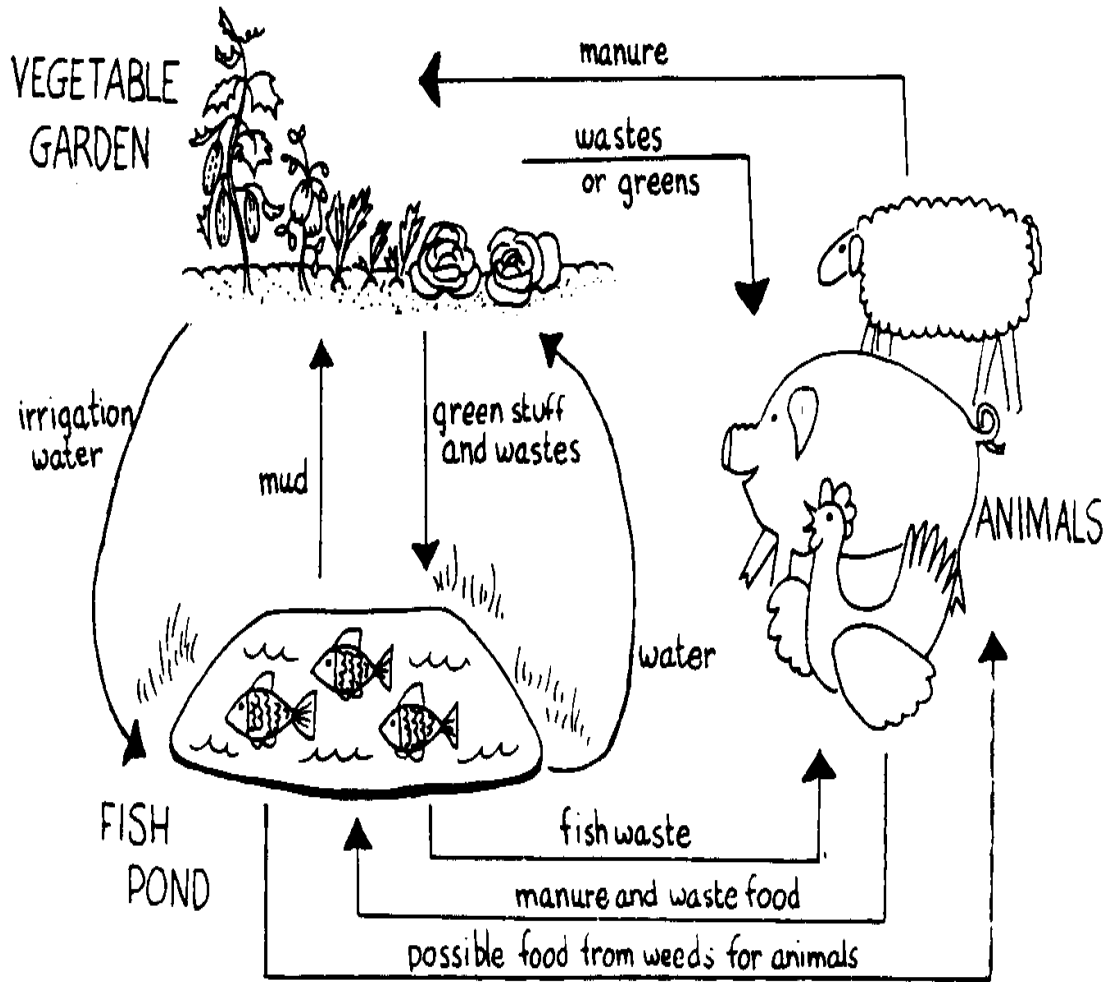
* Some farmers own land that may not be very good for growing crops: it is too sandy, for example. But there are ways of building fish ponds in sandy soil. So the farmer would be able to use land that was once not of much value to him.

* There are many ways that fish farming can fit into the farmer's plan for his land. The important thing is that all of these ways help the farmer make the best use and get more out of what he has -- readily, and often without much expense. For example, a farmer who grows paddy rice can grow fish in that paddy; fish ponds can be built as part of water supply and irrigation systems; vegetable scraps and animal manures can be collected and used for fertilizing ponds. The farmer should know that a farm with a fish pond or ponds can give a total food yield that is higher than a farm with no fish ponds.

The following diagram illustrates some of the ways in which the fish pond fits into the farm: The same water source is used by both the garden and the fish pond; the mud from the bottom of the pond makes good fertilizer for the garden; vegetable matter from the garden can be used to fertilize fish ponds; manure from the animals can be used for the pond and parts of fish can be used to feed animals; etc.

<FIGURE>

12p07.gif (540x540)



ADDED INCOME Fish ponds can be quite small, or they can be large. They can be made using expensive equipment and drainage systems, or they can be dug using hand tools and drained by a bamboo pipe. Fish can grow successfully in both of these types of pond, as long as the ponds are managed correctly.

If the major reason for building the fish pond is to get increased and better food for his family, a farmer certainly does not need fancy ponds or expensive equipment. Fish ponds can be very inexpensive to keep. Fish do not require fancy foods. Many ponds provide all the food the fish need. But besides the foods they find in water itself, some fish eat leafy garbage, mill sweepings, beer residues, spoiled grains, broken rice, and many other waste products that might not otherwise be used.

A farmer makes his income go further by growing more of the family's food and by selling leftover fish the family cannot eat.

<FIGURE>

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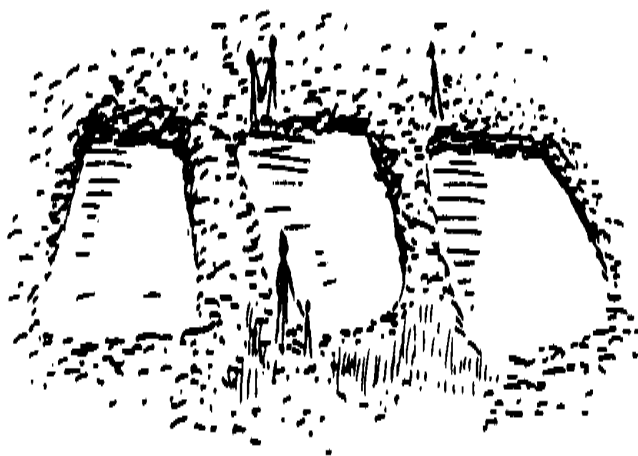
Growing fish to sell can also be very profitable. But the costs involved in getting started and in maintaining the effort are greater: if the farming is to be a solid commercial enterprise, then more ponds, more time, more money, and nearby marketplaces are needed. The business may or may not show a profit right away; in fact, the chances are that it will not. A farmer might be better advised to start small and work into a bigger enterprise slowly as he learns to manage the art of growing fish in ponds.

A Word about Cooperation

Often fish ponds are built by cooperatives. A cooperative is an organization of people in an area who come together to do something they could not or would not do alone. In this way, four or five people or families can pool their resources and build a fish pond operation together. Sometimes an entire village will form a cooperative and will build and operate a pond as a group. This kind of cooperation makes possible better pond construction and management. A fish pond cooperative may be a good way for a village to improve the diet of the community and to sell enough fish to maintain the enterprise. If the farmers in your area are not interested in, or are concerned about, building ponds individually, a cooperative may be a very acceptable idea.

<FIGURE>

12p08b.gif (256x317)



Getting Ready to Plan a Fish Farm

A farmer or other person interested in growing fish should read the following list carefully before going further. The following factors must be considered before the farmer builds his fish pond. Many pond owners have small fish ponds that are only used for their own families, but a farmer who sells fish must look for a market and a way to get his fish to that market. It does no good to harvest fish which cannot be sold or used by the farmer and his family.

- * Is the soil able to hold water for a fish pond?
- * Is there an adequate supply of water for a pond?
- * Is the land a good shape for a fish pond?
- * Is the pond area close to your home?
- * Who owns the land where the pond will be built?
- * Are there enough people to help build and harvest the pond?
- * Can the equipment for building a pond be built, borrowed, or bought.
- * Is there a marketplace nearby?
- * Are there roads from the pond area to a market place?
- * Are the roads passable even in the rainy season?

- * Is there a good way to get the fish to market?
- * Is there a vehicle available for transportation, if necessary?
- * If there is no market nearby, or if it is hard to get to the market, can the fish be kept by drying, smoking, or salting?
- * Is there enough food for the pond fish?
- * Are there fertilizers available?
- * Do the people in the area like fish? Do they eat freshwater fish?
- * Can the people in the area afford to buy the fish produced in the pond?

If the farmer can answer yes to the questions which most fit his situation, he has a good chance of having a successful fish pond. But he must consider these factors. Each is discussed in detail in the "Planning" sections.

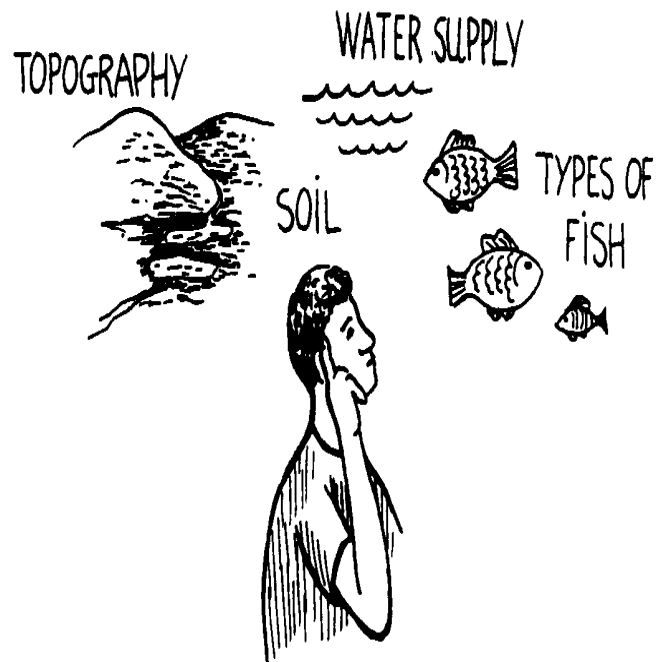
2 Planning: The Site and the Type of Fish Farm

Before construction can begin, the farmer must look over his land to choose the place or places where ponds can be built, and decide what kind and how many to build. He must also decide on the kind of fish culture he wants to do, and on the type of fish that he wants to raise.

He must look at his resources and his needs very carefully before he actually begins building and operating a fish pond. This section will give information to guide the farmer in the planning of ponds and kind of fish culture.

<FIGURE>

12p11.gif (317x317)



The Site

One of the most important parts of planning is finding the right place (selecting the site) for the pond. Fish ponds use the land in a different way from agricultural crops such as rice or wheat, but fish also are a

crop. And when a farmer builds a fish pond, he is choosing one use of his land instead of some other use. If the site for the pond is well-chosen, the pond can be more productive than the land by itself. But if it is not chosen well, the farmer may lose, or, at best, gain nothing from his fish pond. When considering a site for the fish pond, the farmer should remember and consider several points that were made in the introduction:

* Often poor agricultural land can be turned into very good fish ponds. In general, the better the soil of an area, the better the fish pond. But this does not mean that a pond cannot be built on poor land. It does mean that the farmer will have to work harder to maintain the pond and the fish.

* If the pond is built on agricultural land which is not producing good crops, but the pond is cared for well, eventually the pond bottom soil will become more fertile than it was before. If this pond is a large one, after harvesting the fish, the pond can be planted again with a land crop, like corn, and allowed to grow. Then when the corn is harvested, the land can be turned back into a fish pond. This means that a farmer can get two good uses out of his land instead of one poor crop.

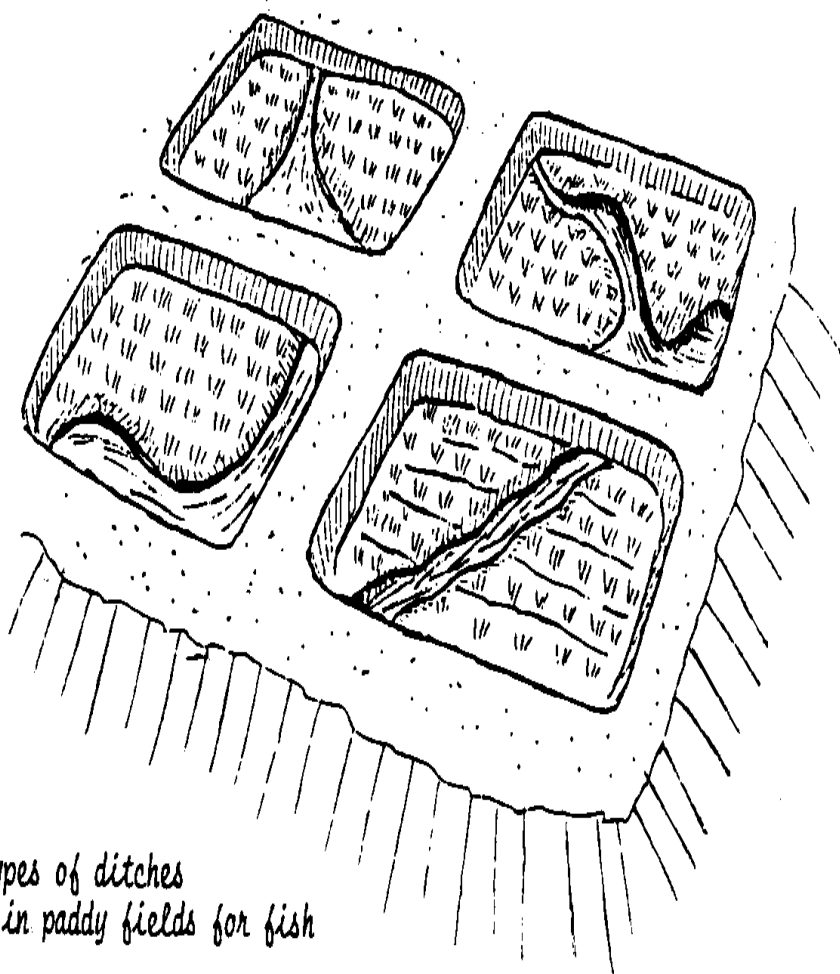
* Other farmers may want to grow fish in rice paddies by digging trenches around the edges of the paddy for fish to swim in. This is another way of culturing fish which will be discussed in somewhat more detail later in the manual.

The point of the discussion above, is that a fish pond is just one use

that a farmer's fields can have, and the choice of how the land can be used is important.

<FIGURE>

12p12.gif (486x486)



*4 types of ditches
dug in paddy fields for fish*

There are three factors that work together to make a good site for a fish pond:

* Water supply

* Soil

* Topography

WATER SUPPLY Water supply, soil, and topography all are important, but water supply is the most important factor in selecting a site. Fish depend upon water for all their needs: fish need water in which to breathe, to eat, and to grow and reproduce. If a site has water available year-round, that site meets its first test easily. If water is not available all the time but there is some way to store water -- in large tanks, barrels or drums, in depressions, ponds, or wells -- for use when the natural water supply is low, then that site may still be all right. The key, of course, is that water must be available at all times and in good supply.

Where Can Water for Fish Ponds Come From? Water used in ponds comes from many sources:

* **Rainfall.** Some ponds, called "sky" ponds, rely only on rainfall to fill their need for water.

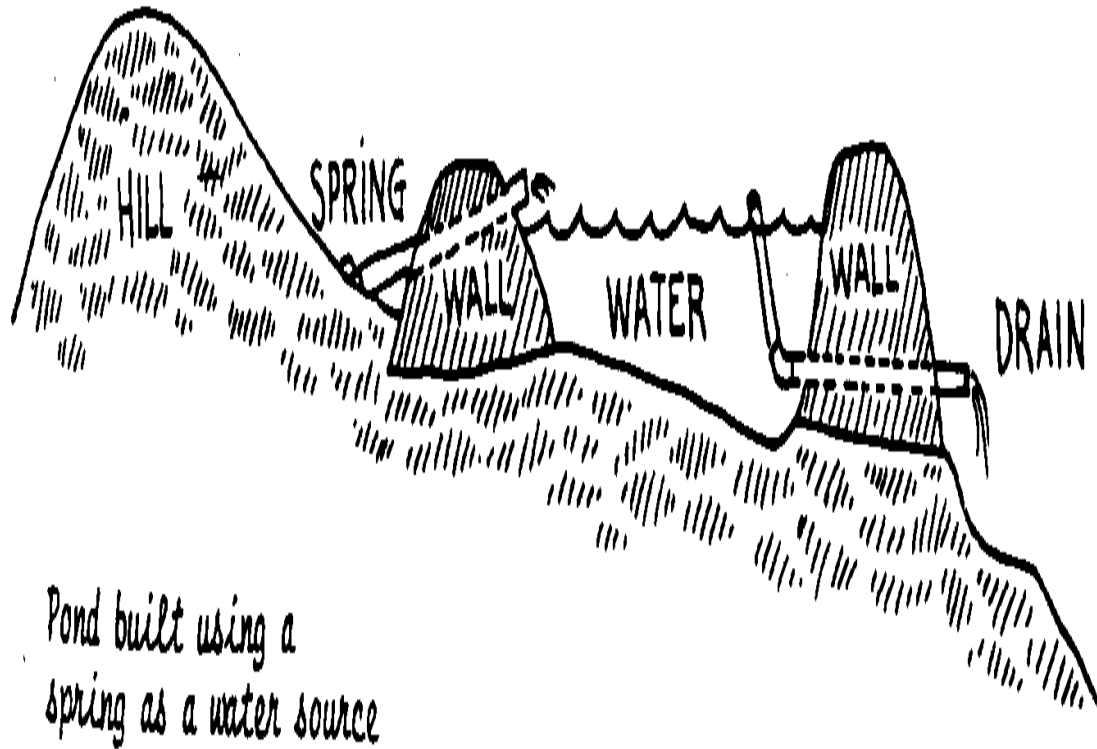
* **Run-off.** Some ponds are gravel and sand pits which fill when water from the surrounding land area runs into them.

* Natural waters. Most ponds are filled with water that comes from natural springs or wells, or with water that has been channelled (diverted) and brought in from streams, rivers, or lakes.

* Springs. Some ponds are built where there is a spring to supply water. Spring water is water under the ground that has found a way to get out. It leaves the ground and becomes a stream as it flows away. Spring water is good for fish ponds because it is usually clean (uncontaminated) and has no unwanted fish or fish eggs in it. If the water from a spring has travelled very far, it may need to be filtered before it is used for a fish pond. But filtering is easy to do (see the "Construction" section) and the important fact is that the water supply is available.

<FIGURE>

12p13.gif (426x528)



*Pond built using a
spring as a water source*

* Wells. The best source of water for a fish pond is well water. Well water has few contaminants and, if the well is a good one, the water is continuously available. Well water and spring water, however, are both often low in oxygen content. Fish need to have oxygen in their water to live. Since this problem is overcome easily (see water quality information in the section on "Preparing the Pond") the major factor to be considered here is an adequate water supply.

Most fish ponds use water that comes from a stream, river, or lake. A diversion ditch or channel is dug between the water source and the pond to take water from source to pond. This is a good way to fill a pond because the water can be controlled easily. When the pond is full, the channel can be blocked with a gate or a plug (see "Construction" section), and the water will stop moving into the pond.

There can be problems with this kind of water supply; for example, often in tropical areas streams flood in the rainy season. This extra water can be dangerous to the pond and must be diverted away from the pond by a channel built for that purpose. IT IS BEST NOT TO CHOOSE A PLACE THAT IS KNOWN TO FLOOD WHEN CHOOSING A WATER SUPPLY AND SITE FOR A POND. When a pond floods, all the fish escape, and the pond is empty at harvest time.

If the water for the pond is being taken from a stream, lake, or river, then the farmer should plan to filter the water carefully when filling the pond. Water from these sources sometimes contains unwanted fish or fish eggs. Filtering prevents these fish or eggs, and other harmful animals, from entering the pond.

Quality of the Water Supply. Finding an adequate water supply is the first step. Then the farmer has to check that supply to make sure it can be used for a pond. This check of the water should include:

- * looking at the water, smelling it and tasting it.
- * looking to see if there is a family upstream who take baths in the water before it gets to the pond.

* making sure that there is no family or village downstream that depends upon the source for their drinking water.

If the water supply seems all right, the farmer must also find the answers to some other questions. Where the water comes from, how far it travels to get to the site for the pond, and what kind of soil it travels over will all affect the quality of the water. These questions and their answers tell what must be done to make the water right for a pond:

* Is the water very clear? Then the farmer may have to fertilize the pond because there are not enough nutrients in the water.

* Is the water very muddy? Then it will have to settle before it is used in the pond: a special place will have to be made where the mud can settle out of the water before the water goes into the pond.

* Is the water a bright green? It probably has a lot of fish food in it.

* Is the water a dark, smelly brown? It may have acid in it, and the farmer will have to add lime to the water.

There are many things which can be done to make water good for a pond. If the farmer knows his supply and the kind of water he has, he can take the steps necessary to use his supply well.

SOIL The second important part of site selection is the soil of the area. The soil of the pond must be able to hold water. It also contributes

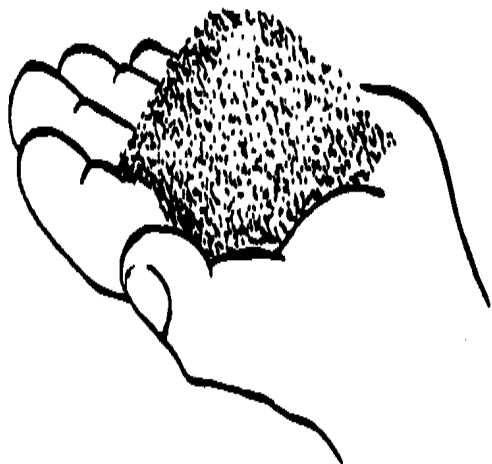
to the fertility of the water because of the nutrients it contains.

Ability of Soil to Hold Water. The best soil for a pond contains a lot of clay. Clay soil holds water well. When a place with a good water supply is found, the farmer must test the soil. He can tell a lot about the soil simply by feeling it. If the soil feels gritty or rough to the touch, it probably contains a lot of sand. If it feels smooth and slippery, it probably means there is a lot of clay in it. This smooth soil is good for a fish pond.

A very good way to tell if the soil is right for a fish pond is to wet a handful of soil with just enough water to make it damp.

<FIGURE>

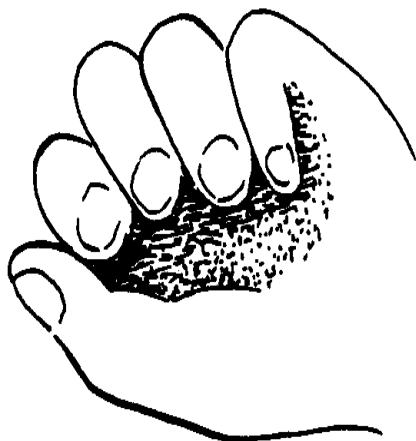
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Then squeeze the soil.

<FIGURE>

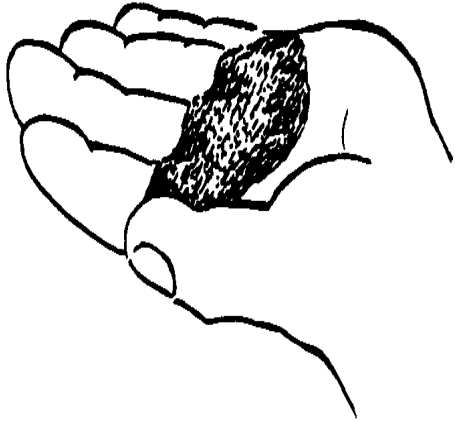
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If it holds its shape when the farmer opens his hand, it will be good for a pond. Remember, the more clay in the soil, the better it is for building a pond.

<FIGURE>

12p16b.gif (230x230)



If the soil is sandy, or does not contain much clay, the farmer can still build a pond. There are ways of building ponds in these soils. But he should be aware that building a fish pond in such soils requires more effort and may not be as successful. Digging test holes will tell the farmer what his soil is.

Larger ponds can be built in soils with clay. If the soil is rocky or has shifting sand, etc., only small ponds are possible. If there are other locations available, the farmer would be wise to see if there is another place with soil better suited to the fish pond. More information on soil

is included in the "Construction" section.

Ability of Soil to Provide Nutrients. Soil also contributes to the pond's fertility. Fertility is a measure of the nutrients in the pond, and it simply refers to how much food there is available in the pond for the fish to eat. A very fertile pond is one which contains a lot of fish food. The soil of the pond contains some of these necessary nutrients -- like iron, calcium, and magnesium. In addition, however, soil also can contain acids; these substances often are harmful to fish. Whatever a soil has in it is drawn into the pond by the water and thus comes in contact with the fish. Sometimes after a heavy rainstorm, there are big fish kills in new ponds. This happens because the heavy rain carries larger amounts of acids from the soil into the pond. So the farmer who is aware of the kind of soil he has for his fish pond can prevent this problem before it happens.

REMEMBER: One good indicator of the quality of soil is whether it has been used for growing crops. If crops grow well in that location, the soil will probably be good for the fish pond. If crops did grow well there before the nutrients were used up, then it will probably still be free of harmful substances.

TOPOGRAPHY The third factor in site selection is topography. Topography is a word used to describe the shape of the land -- whether it is flat or hilly, upland or lowland, etc. The topography of the land determines the kinds of ponds which can be built. Ponds can be built in valleys or on flat ground. They can be square or rectangular, or uneven in shape. They can be large or small. All of this is determined by topography of the land, as well as by the farmer's requirements.

The most useful topography for fish ponds is that which allows the farmer to fill and drain ponds using gravity. Ponds built on a slope, for example, can be drained easily. If ponds are located on flat land, the pond must be built with a slope inside it so it can be drained by gravity, or it will have to be drained using a pump.

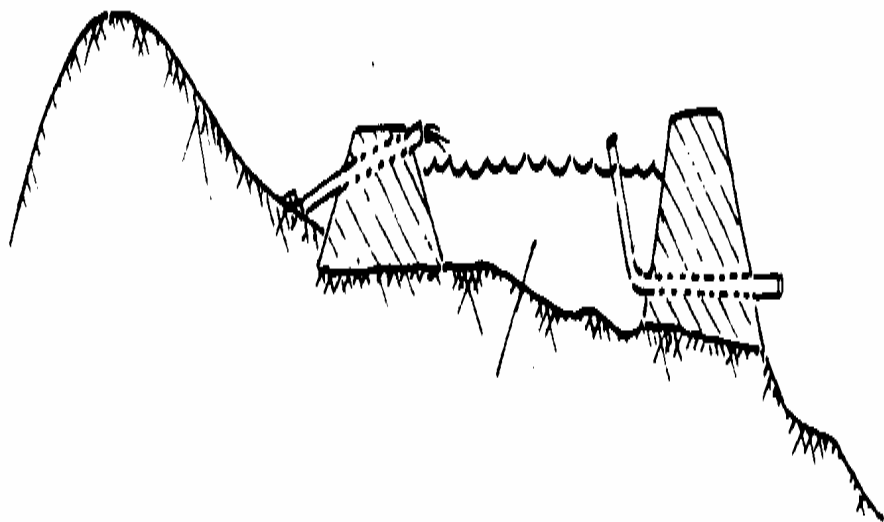
Slope. If the farmer looks at a hillside, he can see that it rises. It is higher at one point than at another. This difference in height, from high to low point, is the slope of the land. In more scientific terms, slope is the relationship between the horizontal distance (length) and the vertical distance (elevation) over a piece of land.

Slope is usually written as a ratio (1:2) or as a percentage (5%). A slope of 1:2 means that for every change in length of 2 meters, there is a change of 1 meter in height. A slope of 5% means that for every change in length of, say, 100cm, there is a change in height of 5cm. Pond bottoms usually have a slope of 2-5%, whether they are on level ground or in a hilly area. As long as the pond bottom has a slope, it can be drained completely.

A farmer does not require a scientific understanding of slope to build a pond. He does need to know how the shape of his land determines the best place for building ponds. Ponds built in hilly places often are made part of the hill. The picture on top of the next page, of a pond with a spring as a water source, shows how the slope of the land has been used to set up the pond's drainage system.

<FIGURE>

12p18.gif (437x437)



In flatter areas, ponds are usually square or rectangular because it is easier to use a harvesting net in ponds of these shapes.

The farmer will learn quickly to recognize by sight the slope that is best for a pond. Because a slope is so important, the first thing a farmer should look for is a site with a slope and a water supply. If

he can use a natural slope for his pond, the pond will be cheaper and easier to construct.

The best places to look for such combinations of slope and water supply are where water collects from streams and flows through the valley at the bottom of a slope. If the pond is built on the slope above the water flow, water drained from the pond can flow directly into the stream. Water might be brought to the pond in a number of ways depending upon the situation -- by streams running down the slope upon which the pond is situated, for example. Another good place to look for a good combination of slope and water supply is on plains or flattish ground between hills. These plains often receive water from brooks or streams.

There are many possibilities. The important thing is that the farmer look for a topography that makes fish farming as easy and as successful as possible.

The Type of Fish Farm

After the farmer has found a site or sites for his fish pond, he must consider what kinds of fish culture are possible in the space he has available. He also must decide what his resources will allow him to get started. This planning is necessary because the answers will determine the number of fish ponds the farmer builds and the kind of fish he will want to culture. The following pages present a range of ideas concerning the kinds of fish farm operations (raising fish or breeding fish); the types of pond used in fish culture; fish culture in one or several ponds; advantages of small and large ponds; and mixing or separating fish types and sexes. A discussion of these subjects will

provide the farmer with the background he needs to decide what kind of fish farm is possible for him, given his resources and the kind of fish he wants to raise.

A NOTE OF CAUTION Before a farmer even begins, however, it is important for him to include in his planning the fact that some fish will die. This is an extremely important fact for the first-time fish grower to understand. It is very natural for some fish, the weaker fish, to die in ponds. As long as fish are protected in ponds and are well taken care of, fewer fish will die in ponds than would die in natural waters. But a farmer who does not expect some death may get discouraged and give up before he has given his pond a chance to work. It is never too early to introduce this idea.

KINDS OF FISH FARM OPERATION In nature, many fish never reach adult size because they are eaten by other animals (predators), or they die from disease or lack of oxygen. In fish culture, the farmer tries to control the pond situation in order to produce more fish. In ponds, predators and so on can be controlled so that the pond yields more fish per hectare than do natural waters.

There are two major kinds of fish farms -- those which breed fish and raise the fry, and those which rear fry and fingerlings (the young fish) to market size. So the farmer, after finding possible sites, etc., must decide if he is going to breed his fish and raise the fry. Or if he is going to buy fry and fingerlings and rear them to market size, not getting involved in breeding.

Breeding fish requires more time and more ponds than simply rearing

fingerlings. And building more ponds can be more expensive and require more ongoing management. So the farmer must finally determine his reason for raising fish: to eat; to sell; to use his land better; or all of these. He will have to have all these things firmly in mind so that he can:

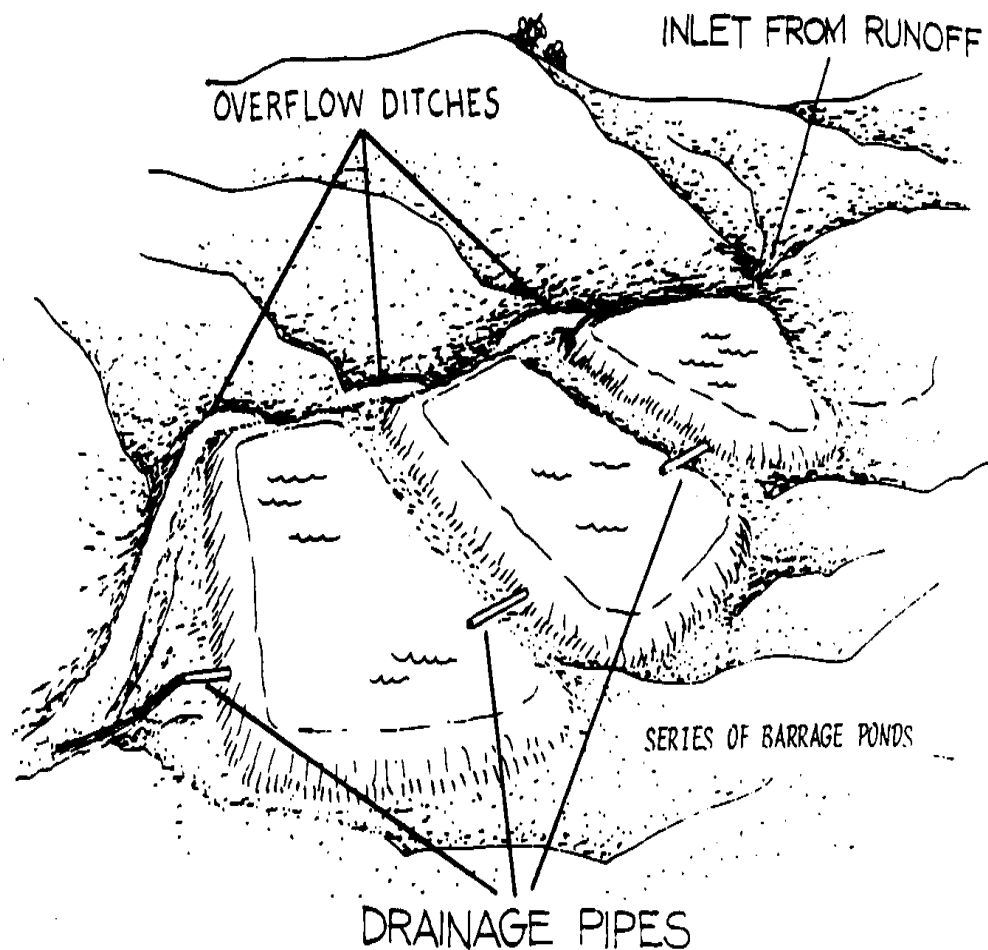
- * build the right kinds of pond.
- * build the right number of ponds.
- * stock the right kinds of fish.

TYPES OF PONDS The types of pond a farmer can build depend on water supply, soil, and topography, the factors which were just discussed. The two types of pond most often built are barrage ponds and diversion ponds. Many aspects of the construction of these ponds are the same. The main difference between these two types of pond is the water source.

Barrage Ponds. These ponds are usually filled by rainfall or by spring water. A spring, for example, sends water flowing through a small valley or down a slope into a low place. Or a spring bubbles from the ground into a natural depression. The pond is formed by collecting water at the base of the valley and in the low places. The farmer does this by building a wall (dam) which holds the water inside what now is the pond area. The wall keeps the water from entering and leaving except as needed.

<FIGURE>

12p20.gif (486x486)



The number of pond walls the farmer must construct depends upon the land and on how he fixes his drainage system. A barrage pond usually needs only one wall -- the main wall between the water source and the pond area. One kind of drainage system called a sluice (see "Construction" section) can be used to let water both in and out of the pond. There are also a number of simple drainage systems which can be used that do not require

any complicated construction.

Barrage ponds should not be built where the flow of water is too great: it is difficult to keep the water from breaking down the wall if the pressure of the water is too great. Brooks and streams which flow well, but not too strongly, make good sources for barrage ponds.

Even when the flow of water is not great, however, barrage ponds require overflow channels. Because, barrage ponds are usually built in low areas, they are likely to fill up in heavy rains. Overflow channels are any kind of system which can be set up to stop the pond from collecting too much water. The overflow takes extra water away from the pond. If this extra water is not taken out, the pond wall may break. Therefore, the overflow system is needed to help the drainage system handle the flow of water when there is too much water in the pond.

The overflow system can be wide grooves cut into the top of the wall toward the ends away from the middle; it can be large hollow