SITE SELECTION AND POND CONSTRUCTION

Module II of 8

Site Selection and Pond Construction

Module II

FOREWORD

The growing demand for fish in Malawi and the Southern African Development Community (SADC) region requires additional efforts by the governments to increase fish production from aquaculture. All Malawi's development policies (Malawi Vision 2063, Malawi Growth and Development Strategy III 2017-2022, National Fisheries and Aquaculture Policy 2016, National Aquaculture Strategic Plan 2021) emphasise the need to promote aquaculture development in order to enhance production from aquaculture to supplement the dwindling capture fisheries production and cannot satisfy the ever increasing demand for fish. The development policies also emphasise the need to pursue sustainable practices and climate smart technologies.

Up until now, there were many reference materials which extensionists from both government and non-governmental organisations have been using to train farmers in aquaculture principles and practice. These manuals, however, were not coherent, often providing conflicting recommendations and were not vetted by the Department of Fisheries under the Ministry of Forestry and Natural Resources as proper training materials for aquaculture. Hence, it is timely that this new aquaculture manual has been developed for use in the aquaculture practice. This manual will become a nationally recognised tool for training in aquaculture practice.
The target users of this aquaculture manual are extensionists from government and non-governmental organisations, fish farmers and trainers of these groups. The manual contains technical information as well as training plans to help the trainers to conduct training in an orderly manner.

The Ministry of Forestry and Natural Resources remains committed to foster the development of aquaculture in the country for nutritional and food security, income generation and job creation.

Yanira Ntupanyama, PhD.
Secretary for Forestry and Natural Resources

PREFACE

This Technical Manual for Trainers on Good Pond Aquaculture Practices has been developed to address the gap that existed when the country did not have a universal, nationally recognised manual as basis for training our extension agents, fish farmers and for use by non-government organisations engaged in the aquaculture sub-sector. This manual will be a reference material for guiding aquaculture practices in Malawi. Accordingly, the manual has been developed to support the implementation of the National Fisheries and Aquaculture Policy 2016 which highlights sustainable aquaculture development as policy priority number 2 and the National Aquaculture Strategy (2021-2029).

There are several challenges that exist in the aquaculture sub-sector that need to be addressed for the benefit of fish farmers and extension workers. The major challenges include: lack of harmonised approaches and information to guide all players in the value chain, inadequate supply and access to inputs i.e. quality fingerlings and feed, unavailability of market structures to aggregate production and measures to increase the resistance of the sector against risks related to climate change.

It is expected that this aquaculture manual will become the necessary tool for all actors along the aquaculture value chain mainly for technical know-how regarding aquaculture production. Where possible, trainers or users may be guided by the aquaculture experts from the Department of Fisheries under the Ministry of Forestry and Natural Resources.

Friday Njaya, PhD.
Director of Fisheries

ACKNOWLEDGEMENTS

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The Department also acknowledges the efforts and technical contributions from all the government officers, academicians, technicians and practitioners who took part in the development of this manual. Thanks should also go to the team that finally edited the manual.

Special recognition and gratitude are extended to the GIZ Food and Nutrition Security Program (FNSP) for contributing the chapter on nutritional benefits of fish and all individuals who were involved and contributed in the development of this manual.

INTRODUCTION

Fish do not only live in water but they also get oxygen and food which is necessary for their survival. There should be a balance between the wellbeing of the fish and the environmental conditions. The fish is negatively affected if the environmental conditions are not optimal. The relationships between cultivated fish species and their environment are largely dependent on the biological characteristics of the fish and the degree of intensification of the culture. Therefore, consideration of culture systems should be made with regards to the type of fish species being raised.

For example, in extensive and semi-intensive systems, based on natural production, stocking fish species of different feeding habits together enables a more efficient utilization of pond resources. In polyculture systems only a proper combination of ecologically different species at adequate densities will utilize the available resources efficiently, maximize the synergies between fish and their environment and minimize the antagonistic ones. Synergistic interactions among fish species may be explained on the basis of two interrelated processes: increase of food resources and improvement of environmental conditions. The knowledge of fish and its environment enables choosing adequate combinations of fish species, stocking rates, input types and rates, and other management decisions according to the specific local conditions: climate, quality of water supply and pond fertility.

The of this module is to provide trainees with knowledge and understanding of the different species of fish cultured in Malawi, the different environmental parameters that affect the growth of these species and the different aquaculture systems in which these species can be raised. Skills on identification of the different fish species cultured in Malawi will be enhanced.

CONTENTS

Fish Farming Calendar

1

Introduction

In aquaculture, a farming calendar can make an important contribution to managing production as best as possible at different times of the year. When each and every farming operation has been clearly planned and indicated in the calendar, it is easy to carry out an activity or a necessary corrective measure for increased output. Knowing when to construct or maintain a pond makes the whole process not to be costly. For fingerling producers, knowing the period when the environmental conditions are most favorable for their good growth, the farmer will be able to know when to start recruiting broodstock and conditioning them for the exercise. As fish requires feed, the calendar will help the farmer to know when and how much to feed the fish depending on the time and season of the year as guided by the calendar.

Aim

The aim of this chapter is to help the farmer in understanding the idea of farming calendar, its importance as a production planning tool since farmers will have different demands over time to manage their business and how to prepare a calendar. The chapter further seeks to enhance skills in developing a fish farming calendar

Objectives

- Participants know
- Know what a farm calendar is
- The importance of a fish farming calendar
- Timing of fish farming activities linked to agriculture calendar, best times to market fish.
- How to address some of the challenges that arise during different times of the year
- The fish farming calendar in relation to Agro-ecological zones

- Acquired skills
- How to prepare a farm calendar
- Align their fish farming activities with annual farming activities

- Acquired attitudes
- A calendar is an important tool for planning farm operations

- Relevance to fish production
- A good fish farming calendar is a good tool for planning all fish farming activities leading to good returns

- Chapter Overview: This chapter is looking at the farm calendar in relation to agro ecological zones
- Materials: Flip- chart paper, markers, study notes, posters, note books
- Mode of delivery: Lectures and group discussions
- Duration: 40 minutes

1.1 The Farm calendar

A farm calendar is a tool that provides timely information about farming operations to promote crop or fish production. For agricultural crops, the calendar contains information on land preparation, planting, sowing, fertilizer or manure application, harvesting and marketing periods of locally adapted crops in specific agro-ecological zones. In aquaculture, a fish farm calendar provides, amongst other things best possible times to do site selection for pond construction, fish stocking, and fingerling breeding, harvesting and marketing in accordance with the agro-ecological zones.

1.1.1 Preparing your own fish farming calendar

Fish farming activities at each and every farm are the same only that the sequence of activities is what differs. This is as a result of seasons, level of operations and the different agro-ecological zones (AEZ) in which the different farms are falling under. For a successful aquaculture enterprise, each and very farm has to develop its own calendar which should be in line with the AEZ and following Good Aquaculture Practices (GAPs). Major fish farming activities will need to be indicated in the calendar and these may include:

1.1.2 Fish feeds availability and feeding

In Malawi harvesting of main agricultural crops starts towards the end of the Dry-Wet Season going into Cool-Dry Season. The calendar will help the farmer to know the lean months of certain farm inputs like maize bran and yet they are on high demand as feed for poultry, pigs, stall feeding cattle and fish. This will help in better planning on when to buy them as guided by the calendar. Buying the different raw materials for feed when they are cheaper is therefore advised to maximize profits.

1.1.3 Manure availability and application

Availability and demand for organic and inorganic fertilizers is well guided by the farm calendar. During crop harvesting and marketing, there is high supply and low demand for manure and yet there is high demand of manure during land preparation and crop planting as the manure is applied in gardens. As a corrective pond measure, although manures are in high supply during Cool-Dry Season, their application in ponds is reduced or stopped completely when water temperatures are low.

1.1.4 Labour demands and Availability

Looking at the agricultural calendar in Table 1.1, there is a high labour demand in the Hot-Dry and Warm-Wet season as people are busy in their gardens planting, weeding, applying fertilizer and later harvesting. There are some labour demands during the Cool-Dry season for winter cropping and harvesting of late maturing varieties. The high labour demand which is there during the Hot-Dry season coincides with best time of pond construction, fish pond harvesting, and pond maintenance and fingerling production. Fish sampling, fry – fingerling removal and nursing also require dedicated labour force to minimize mortalities and maintain good fish growth. At all times, labour should be used with due respect for customs, traditions and work ethics to ensure smooth operations of the farm and child labour should be avoided.

1.1.5 Pond Site Selection and Construction

A good site for pond construction should be selected towards the end of the Cool-Dry Season or early in the Hot-Dry Season. Slopes for the site, water availability, flooding issues must be considered beforehand. Constructing ponds in rainy season can prove to be costly as moving wet soils can pose a challenge.

1.1.6 Fingerling availability

Preparation of ponds and the breeding facility, selecting good quality brooders and conditioning the brooders can start towards the end of the Cool-Dry season as temperatures have now started increasing. Over wintering of fingerlings like in the Northern Region of Malawi can be well guided by the calendar as the farmer will know when to source fingerlings and stock them for better growth and yields.

1.1.7 Fish stocking for grow-out production

Availability and accessibility of quality fingerlings will lead to pond stocking for grow out production. Although Tilapia has a good resistance to poor water quality and disease, tolerance to a wide range of environmental conditions, seasonal cold temperatures affect both hatchery and food fish production thus water temperature between 15°C and 20°C. Temperature ranges from 25°C to 35°C are highly suited for raising Coptodon rendalli, Oreochromis shiranus, Oreochromis mossambicus and Oreochromis karongae. Minimum temperatures below 19oC are reported to delay reproduction and breeding ceases when temperatures fall below 17oC.

Catfish also tolerate a wide range of environmental conditions. The optimum water temperature for growth is 25oC -30oC, but the fish can survive at temperatures from just above freezing to about 30oC. Growth is reduced at temperatures lower than 18oC, while feeding activity stops at temperatures below about 10oC. A good fish farming calendar has to show when such activities can successfully be conducted.

1.1.8 Harvesting

Proper scheduling of fish harvesting helps farmers to reduce the risk of making losses. It has to be remembered that fish harvesting is one of the best fish farming practices. During the Wet – Dry Season, fish in other areas is in low supply because of the closed fishing season. Proper scheduling of harvesting is therefore required as not to make losses when there is stiff competition. Knowing when and where there is fish demand helps in maximizing profits. Fish value addition is another good option to minimize losses and increase profits.

1.2 The calendar and other farming activities

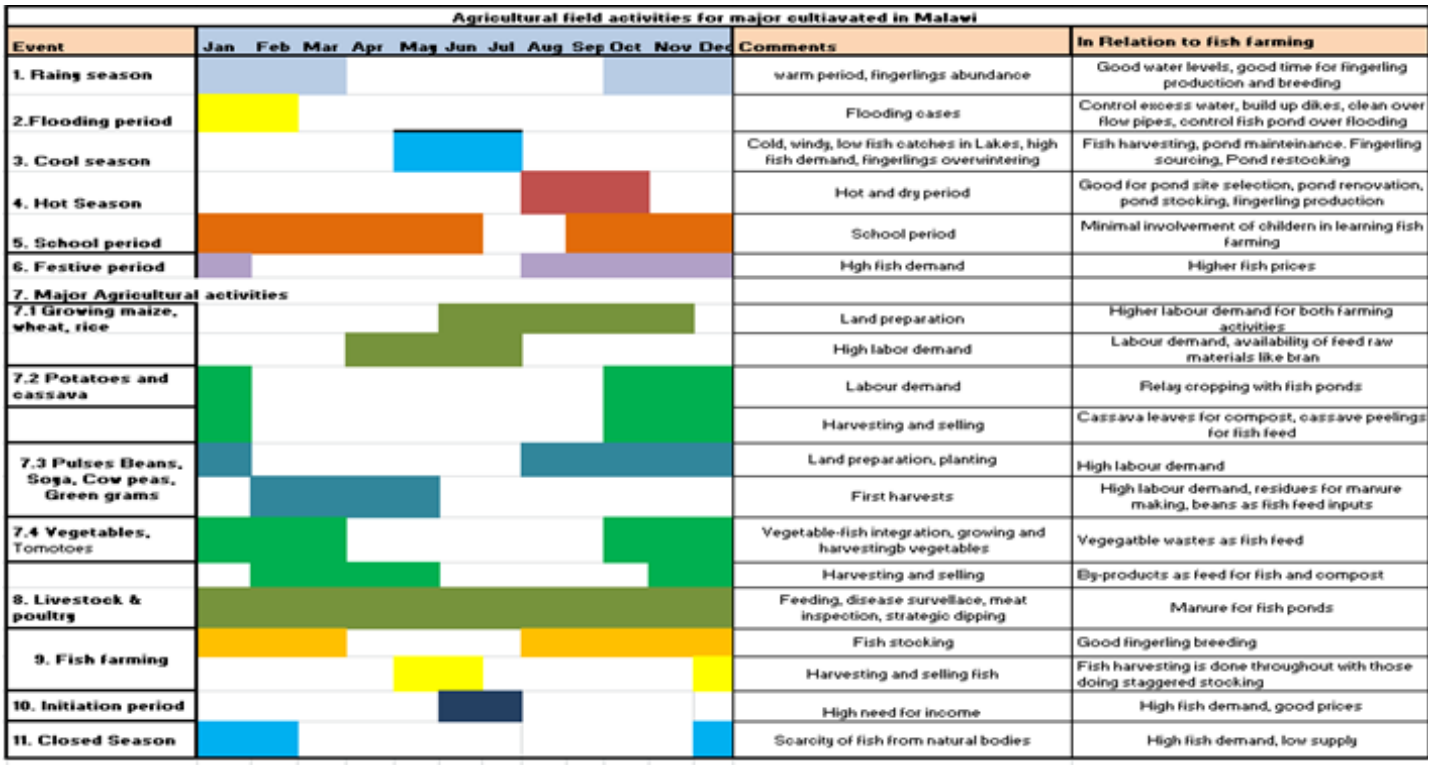
1.2.1 Other farming activities

A calendar should indicate other farm farming activities at the farm. This will help in aligning different resources like labor demands at different times of the year. In most cases, there is high labor demanding during times of land preparation, weeding and harvesting of major crops. This will therefore need to be needed to help in better planning for fish farming activities which will also require more labor. In farms where integrated agriculture aquaculture is being practiced, the calendar can also help in knowing where there are more agricultural by-products which can be used for making feed and availability of animal by-products which can be used for pond fertilization.

1.2.2 Water use and allocation and the farm Calendar

Water allocation for different farm operations is very important. And with the effects of climate change, water is becoming a scarce commodity. The fish farming calendar will help in knowing the water demand be it for broodstock conditioning, fingerling production and grow out. In times of water stress, the farmer is guided on where to allocate water depending on its availability and need of the operation. In areas where water is a challenge, few ponds are kept with water and the others are used for growing a crop which will provide some profits by the end of the day. In cases where integrated aquaculture agriculture is being practiced, use of herbicides is obvious. The calendar will therefore guide to know when herbicides will be heavily used and

therefore come up with a plan to prevent fish kills in ponds or tanks.



Agricultural field activities for major cultiavated in Malawi			
Event	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec	Comments	In Relation to fish farming
1. Rainy season		warm period, fingerlings abundance	Good water levels, good time for fingerling production and breeding
2.Flooding period		Flooding cases	Control excess water, build up dikes, clean over flow pipes, control fish pond over flooding
3. Cool season		Cold, windy, low fish catches in Lakes, high fish demand, fingerlings overwintering	Fish harvesting, pond mainteinance. Fingerling sourcing, Pond restocking
4. Hot Season		Hot and dry period	Good for pond site selection, pond renovation, pond stocking, fingerling production
5. School period		School period	Minimal involvement of children in learning fish farming
6. Festive period		Hgh fish demand	Higher fish prices
7. Major Agricultural activities			
7.1 Growing maize, wheat, rice		Land preparation	Higher labour demand for both farming activities
		High labor demand	Labour demand, availability of feed raw materials like bran
7.2 Potatoes and cassava		Labour demand	Relay cropping with fish ponds
		Harvesting and selling	Cassava leaves for compost, cassave peelings for fish feed
7.3 Pulses Beans, Soya, Cow peas, Green grams		Land preparation, planting	High labour demand
		First harvests	High labour demand, residues for manure making, beans as fish feed inputs
7.4 Vegetables, Tomotoes		Vegetable-fish integration, growing and harvestingb vegetables	Vegegatble wastes as fish feed
		Harvesting and selling	By-products as feed for fish and compost
8. Livestock & poultry		Feeding, disease surveillace, meat inspection, strategic dipping	Manure for fish ponds
9. Fish farming		Fish stocking	Good fingerling breeding
		Harvesting and selling fish	Fish harvesting is done throughout with those doing staggered stocking
10. Initiation period		High need for income	High fish demand, good prices
11. Closed Season		Scarcity of fish from natural bodies	High fish demand, low supply

Table 1 a sample agricultural calendar showing some major fish farming activities

Summary

A farm calendar is a tool that provides timely information about farming operations to promote crop or fish production. In aquaculture, a fish farm calendar provides, amongst other things best possible times to do site selection for pond construction, fish stocking, and fingerling breeding, harvesting and marketing in accordance with the agro-ecological zones. A calendar further helps in a number of things like;

- Knowing where and when to buy fish feeds and raw materials
- Availability and demand for organic and inorganic fertilizers is well guided by the farm calendar.
- Labor demands and Availability
- Good site for pond construction – slopes for the site, water availability, flooding issues must be considered beforehand. Constructing ponds in rainy season can prove to be costly as moving wet soils can pose a challenge.
- Preparation of ponds and the breeding facility, selecting good quality brooders and conditioning the brooders
- Proper scheduling of fish harvesting helps farmers to reduce the risk of making losses.
- A calendar should indicate other farm farming activities at the farm.
- Water use and allocation for different farm operations

Site Selection

2

Introduction

Proper site selection is recognized as the first step guaranteeing the eventual success of any aquaculture activity and therefore forms the basis for proper design, layout, construction and management of an aquaculture enterprise. In fish farming, profitability depends primarily on the selection of a suitable site and therefore site selection is critical and should be given utmost attention. If site selection is not properly done, it may be expensive to operate a fish farming business.

Aim

The aim of this chapter is to help the participants gain knowledge and understanding on how to choose a good site for opening up an aquaculture enterprise. The participants will gain skills in how to choose a good site for pond construction, how to determine the possibility of soils to hold water and other characteristics which will ensure the profitability and sustainability of the aquaculture venture on the selected site.

Objectives

- Participants know
- Characteristics of good site
- Importance of a good site for fish farming

- Acquired skills
- Use of different tools to test suitability of soils for pond construction

- Acquired attitudes
- Poor site selection has a negative cost on the profit and sustainability of a fish farming enterprise
- Good sites are cheaper to construct a fish pond

- Relevance to fish production
- Farmers needs to choose good sites for pond construction as they will not only be profitable but also sustainable
- Session Overview: This chapter has one session which is looking at the farm calendar and agro ecological zones
- Materials: Flip- chart paper, markers, study notes, posters, note books, hoes, panga knives, buckets, bottles
- Mode of delivery: Lectures, group discussions, practical
- Duration: 75 minutes

1.1 Site selection for pond construction

When selecting a site, one also needs to consider access to inputs (e.g. fingerlings, services) as well as the marketing channels for the product. Furthermore, you need to decide which kind of system (e.g. Extensive, Semi-Intensive) you want to operate. This will for instance determine the use of feed (e.g. agricultural by-products or commercial feed) and one must know where to access it. There might also be conflicts regarding

the land and water use which have to be solved before starting constructing the pond. Therefore, before the construction of the ponds starts, the following are the guidelines for the selection of a suitable site for fish ponds although may vary from one site to site:

- Water quality and quantity
- Soil suitability
- Topography of the land
- Proximity or accessibility
- Flooding incidence
- Climate
- Land and Water Rights
- Availability of fingerlings production objectives, environment and socio-economic factors
- Markets

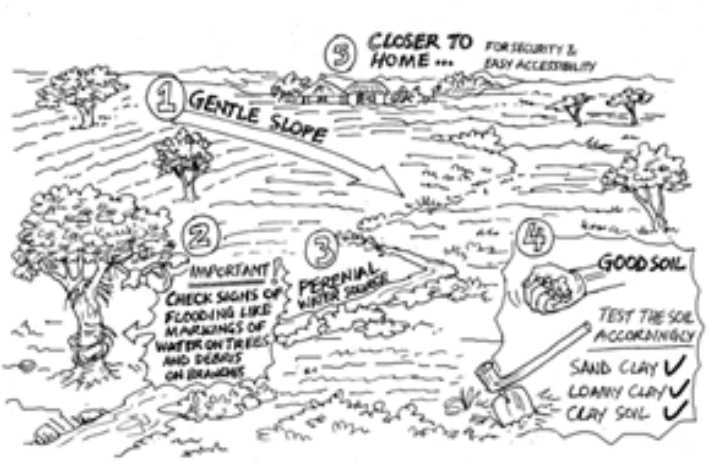


Fig 2.1 Planning before pond site selection Fig 2.2 Things to know before pond site selection

1.2 Guidelines for Site Selection

1.2.1 Water supply, quality and quantity

i. Water supply or source

Water quality and quantity is a critical factor when choosing a good site for pond construction. When selecting a site for fish farming ensure that

- The quality of the source water is carefully evaluated. Natural water quality may not be adequate, and treatment may be necessary to correct water quality problems. For example, if ponds are built on highly acidic soils, water in ponds may be so acidic that heavy liming is required.
- Water sources must to be highly polluted from anthropogenic sources, and this pollution can have serious effectson production.
- One should consider water quality limitations at a prospective site and estimate the cost of overcoming these limitations. If the cost is too great, the site should not be developed for aquaculture.
- A dependable source of water supply must be available within or around the site. The water source should be perennial and is required to fill the ponds and compensate water loss through seepage and surface evaporation.
- The water source or supply to the ponds should as far as possible be natural, preferably rain water or perennial sources like spring, stream,river, etc. However, alternative

arrangements of water supply can be made in areas where such a natural water source is unavailable. The alternatives can be like a deep tube well or an irrigation canal.

- Seasonal rivers and streams are not recommended as direct source of water for fishponds. However, when abstracting water from a river or stream, make sure that nothing will downstream due to the lesser amount of water available.

Fig 2.3 Streams as water source

Fig 2.4 & Fig 2.5 Diverted water using local resources

Table 2.1 gives a summary of the main water sources for fish farming:

Water source	Main challenges
Natural waters Water can be diverted from streams, rivers or lakes	**Contamination, improper usage or abstraction** Animals, plants and rotting organisms can cause diseases. Danger of pesticides (or other pollutants) in the water. Water demand management should be adopted, and water allocations shall consider eco-systems integrity and bio-diversity. Efforts should be made to sustainably promote aquaculture in small- water bodies and reservoirs, and other water courses
Rainfall Ponds rely only on rainfall as a source of water	**Dependency** Its supply depends heavily on amount of rain and seasonal fluctuations. Ponds often dry up during dry season and need to be harvested before water levels drop. In years of erratic rains, ponds might not have adequate water to necessitate stocking. In times of heavy rains, flooding of ponds happens. In highlands, prolonged colder period leads to shorter rain season. Fish growth is reduced, drying of ponds common.
Run-off Ponds can be filled with running water from the surrounding area. Water is directed to the ponds	**High turbidity and dependency** Run-off water may be muddy and thus contributing to a high turbidity, low dissolved oxygen, silting of ponds. Run-off can be uncontrolled posing danger to flooding. Might dry up during dry season It can be contaminated with pesticides. Herbicides (or other pollutants) in the water. Diversion points must be put to divert muddy or infected water.
Springs Spring water is ground water. It is a good source for fish ponds because it is usually clean and usually not contaminated.	**Low oxygen level and low temperature** Aeration is required and can be expensive Low temperatures do affect fish breeding and growth
Wells Wells are places where ground water is pumped up	**Low oxygen level and low temperature** Aeration is required and can be expensive Low temperatures do affect fish breeding and growth

Fig 2.6 Rainfall as a water source

Fig 2.7 Run off as source of water

Fig 2.8 spring as a good source of water

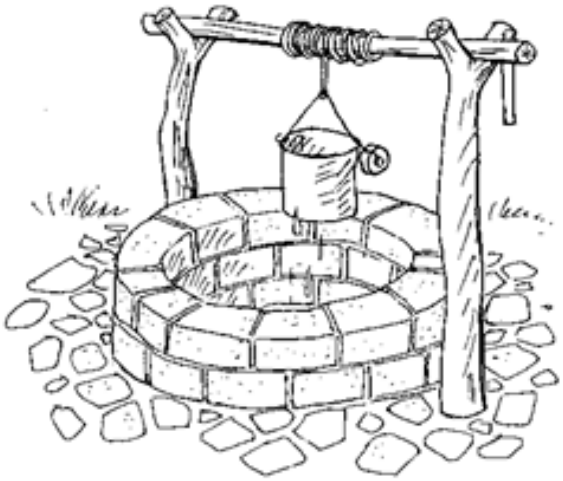


Fig 2.9 Well as a good source of pond water

ii. Water quantity

As earlier stated, the water supply is required to fill the ponds and compensate the water loss through seepage and surface evaporation. This means that the quantity must be able to sustain the water requirements for the pond operations. In an integrated enterprise, careful considerations must be made on how efficient the source will be able to supply the required quantities of water to the fishponds and the irrigated crops or livestock and poultry being raised. We should remember that;

- The volume of water supply depends on the amount of fish in the pond and the intensity of farming in relation to evaporation. In addition, the acceptable time for filling the pond with water is important.
- A good source of water should be sufficient to fill the total pond volume within 2–3 days. It is advisable to have ponds as close to the water source as possible to avoid long inlet pipes or channels.
- The amount of water needed is, of course, affected by evaporation. The total evaporation depends on temperature, cloud conditions, wind conditions and pond construction; normally it is in the range of 0.25–1 cm per day in temperate areas.

iii. Water Quality

The efficient and profitable production of fish and other aquatic organisms in aquaculture depends on a suitable environment in which they can reproduce

and grow. Because those organisms live in water, the major environmental concern within the culture system is water quality.

- Water supplies for aquaculture systems may naturally be of low quality or polluted by human activity, but in most instances, the primary reason for water quality impairment is the culture activity itself.
- Poor water quality stresses the cultured species, and stress leads to poor growth, greater incidence of disease, increased mortality, and low production.
- Therefore, water for ponds should be of good quality and free from free from contaminations as much as possible. Turbid water which carries suspended soils reduces light penetration, thus reducing primary productivity of the pond.

Fig 2.10 Catchment activities affect water quality

Fig 2.11 Runoff can have a lot of turbidity

Pond fish production is influenced by the physical and chemical properties of the water and poor water quality leads to poor fish growth. The chemical quality of water depends on its content of dissolved salts. Water for fish culture should be neither too acidic nor too alkaline. Neutral or slightly alkaline waters are most suitable hence acidic water can be limed to make them neutral. Water quality tests are therefore required to be done to know the physical properties.

1.2.2 Soil

The type of soil will determine if the pond is to hold water, maintain the water quality and is strong enough to maintain the dykes. Preferably, loamy clay must be considered because of its better water retention capacity and suitability for easy making of dikes. Although clay may be the best soil to hold water, some type of clay are not good for pond construction because once dry they crack. A rule of thumb is that the material must consist of at least 20% clay particles with diameter below 0.002 mm in a 1.5-m deep core taken where the pond is to be established. If the material contains too much sand, it will be porous and water will drain out much faster. The seepage loss in sand is reported to be 25–250 mm/day, in loam 8–20 mm/day and in clay 1.25–10 mm/day. Poor soils increase cost of operating as you may have to continue putting water in the fish pond. With the current climate change effects of drought or erratic rains, it is advisable to use good soils if pond liners are not to be used. Furthermore, the earth must be free of toxic substances, for instance copper.

Why is soil important to fish farming?

- Soil type affects the amount of work required to build a pond;
- Soil texture and structure affects the durability and size of dikes;
- Soil fertility and soil chemistry affect water

quality;

- Soil texture affects the permeability of a pond;
- Feed canals and dams are made of earth.

Soil structure is described as platy, blocky, angular, granular, columnar, etc. Water movement, heat transfer, aeration, and porosity are affected by soil structure. Soil texture refers to the relative proportion of particles of various sizes (% sand, silt and clay). Sand and gravel are large particles. Sandy soils are friable and soft (good for tuber crops), but have a low water holding capacity and low nutrient status (generally). Silt is a fine textured soil. Silt or loam soils are some of the most productive in the world. They tend to have a high nutrient status and good water holding capacity. Clay soils are very fine textured (less than 0.002 mm in size), and have a very high water holding capacity due to their high particulate surface area. Sandy soils are more easily eroded than clay or loam soils. Best soils for pond construction are clayey-loam soils as they hold water well and the nutrients help to make water green with natural food.

Good soils also have important biological characteristic: it should contribute to the fertility of a pond by providing nutrients through sufficient organic matter. A good indicator for this is whether the land can or has been used for crop production.

Soil can also be collected and sent to Lilongwe University of Agriculture and Natural Resources (LUANAR), Agriculture Research Stations (Bvumbe, Makoka, Chitedze, Lunyangwa, Mkondezi) Forestry Research Institute of Malawi (FRIM), Chancellor College and other notable Institutions for laboratory quality analysis.

1.2.3 Soil permeability testing practical

The most important ability is to hold water, especially for the bottom of the pond. Therefore a low porosity like in clay is required. There are three practical measures to predict whether the soil will be suitable for the pond construction: A) the "squeeze method" and B) Ring making method and C) The water permeability test.

Practical exercise
"Squeeze Method":
Wet a handful of soil with just enough water to make it moist. Squeeze the soil and if it hold its shape after opening the hand, the soil will be good for pond construction. Form a ball and throw it 1meter high. If the soil does not completely disintegrate then the soil is good

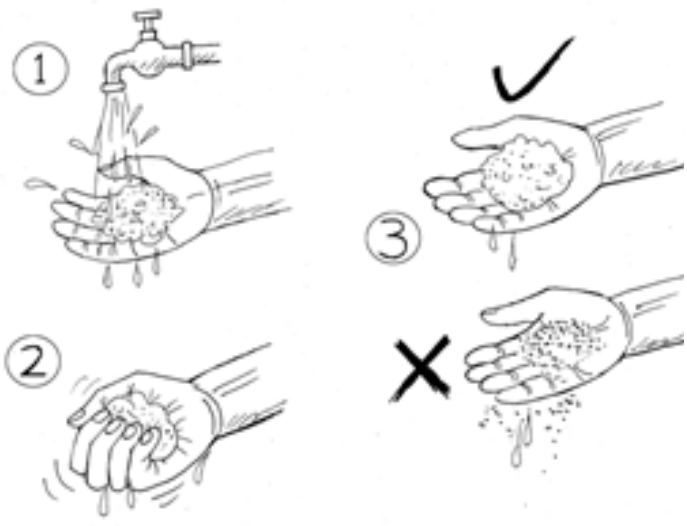


Fig 2.11 Soil squeezing method

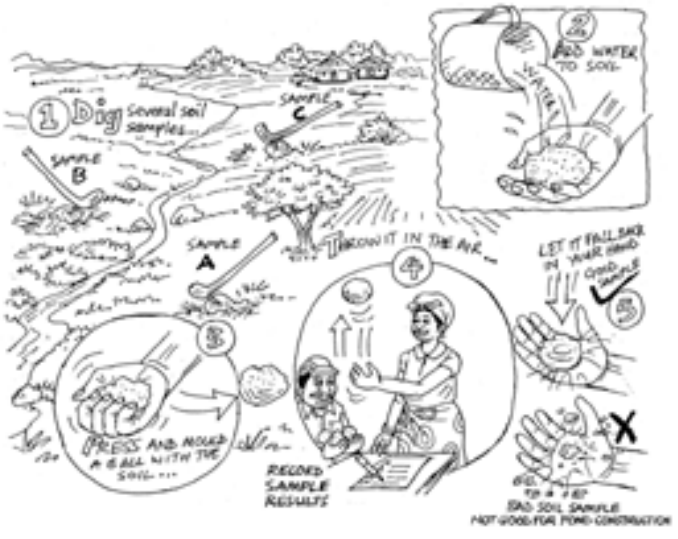


Fig 2.12 Ball soil testing

"Make a ribbon test"

Wet the soil and roll it on the floor to make a ring or ribbon. If the soil forms into a ribbon, then it is suitable soil for pond construction.

"Water permeability test:" or "Pit Test"

Dig a hole with a depth of one meter. Fill the hole with water to the top and cover the hole with leaves. The next day the water level will be lower due to seepage. The dikes of the hole have probably become saturated with water and might hold the water better now. Refill the hole with water to the top again and cover it with leaves. Check the water level again the next day. If the water level is still high, the soil is impermeable enough and is suitable for pond construction. If the water has disappeared again, the site is not suitable, unless the bottom is first covered with heavy clays or a plastic liner is used.

The following steps can be followed to find out whether soil is suitable for pond construction or not:

Step 1: Dig a 1 m × 1 m pit in the middle of the land or potential location.
Step 2: Fill the pit with water.
Step 3: Let it stand for a few days.
Step 4: If the water remains for about a week with little leakage, the soil is suitable for pond construction. If half of the water is gone, the soil is unsuitable. However this could be rectified by bringing clay soil from another area to create a layer of about 25 cm at the bottom and around the sides of the pond. This can be costly and so a decision needs to be made about whether to buy clay soil to rectify the problem or whether to buy land in another area. If the water disappears from the pit within a day, the soil is very sandy or perforated, and is not suitable for pond construction, unless extra care is taken while constructing the pond. If there is no other option, a combination of a clay layer and a pond liner or a pond liner alone can be used.

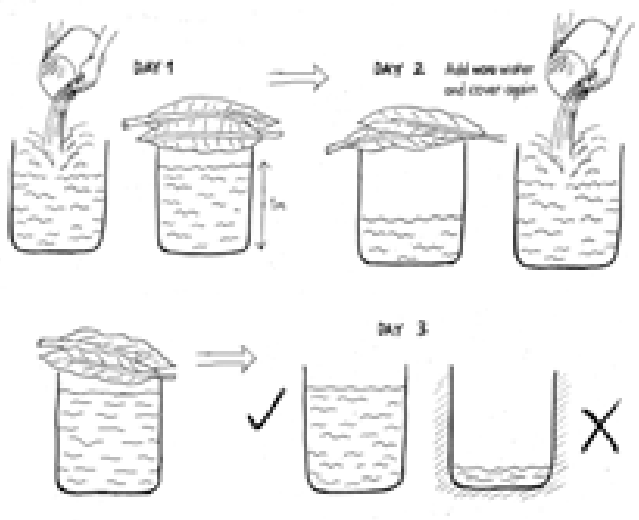


Fig 2.13 Water permeability method

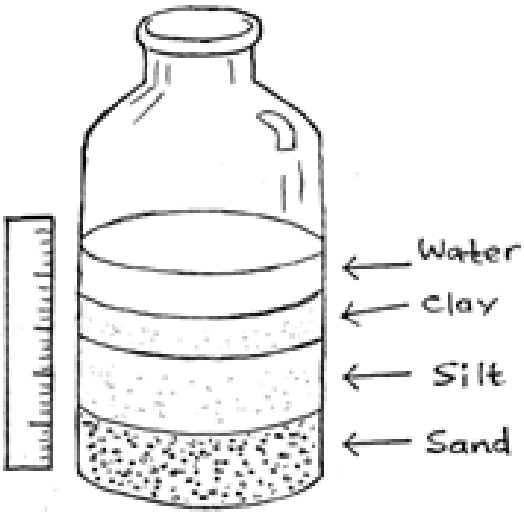


Fig 2.14 Soil sedimentation method

1.2.4 Topography

The land slope determines the way to build a pond and size as well as the amount of work required during construction. A gentle slope between 2% and 5% is generally regarded as ideal. The said slope facilitates good pond designing, construction, gravitation flow of water from the abstraction point through the furrow into the fish ponds. This gradual drop of land also makes it easy to put up derivative ponds that can easily drain. This becomes practically convenient during harvesting periods and therefore avoids partial which is not a good practice for entrepreneurs. A 2% slope means 2cm vertical decline for one meter of horizontal distance. Areas to avoid for fishponds are:

- Flat or swampy low areas, which cannot be drained
- Steep areas where building would be difficult
- Areas that flood such as valleys and gullies
- narrow deep sloping valleys

Fig 2.14 Avoid areas with steep slopes

Fig 2.15 Avoid areas prone to flooding

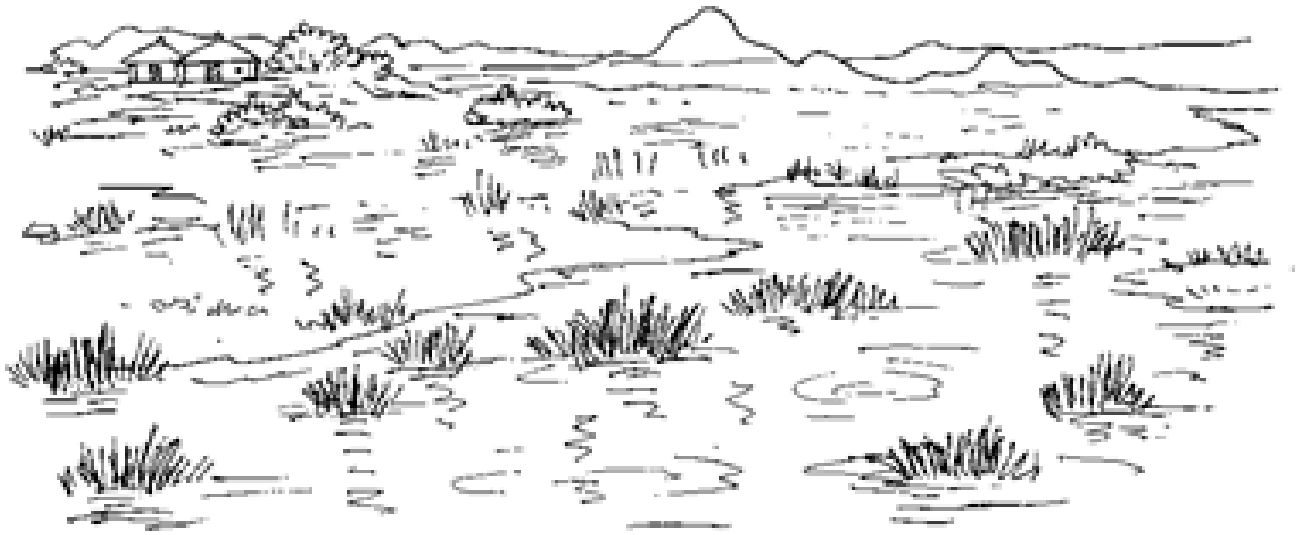


Fig 2.16 Avoid swampy areas – difficult to drain

1.2.5 Climate (Regional Differences)

Pond water temperature is very important when raising fish. Tilapia grow best in warm water (25oC-30°C), which is usually found at low elevations. Tilapia thrives in open, sunny locations where the water temperature remains warm. Areas having regular rainfall are more desirable.

In Malawi, there are regional differences in climate as highlighted in the Guide to Agro-ecological zones and Agriculture Common Practices. Annual rainfall in Malawi is in three categories i.e. less than 600 mm, between 600 and 1200 mm, and above 1200 mm. Southern region, despite having more fertile soils, is receiving less amount of rains <600 mm as compared to the Northern Region which is in the highlands above 1200 mm and consequently experiences lower temperatures thus less than 15oC to 20oC whilst southern region experiences 20oC to 25oC and above.

Tilapias and catfish have specific optimal temperatures for good growth therefore temperature differences can also dictate the type of species to be cultured in an area. Farmer experiences in some agro-ecological zones in the country and most notably in northern and central regions of Malawi indicate that Coptodon rendalli is tolerant over a wide range of temperatures (11-37oC) and as such it grows much better than Oss and Ok. Stocking rates also vary between different areas of farming and farmers in the same agro-ecological zone. For example, fish farmers in the cooler areas like Nchena chena in Rumphi, Kaphuka and Bembeke EPA's in Dedza and EPAs of Nachisaka, Nalunga and part of Chabvala in Dowa which hits as low as between 5oC – 10oC in the cold season, prefer to use Coptodon rendalli and or have deeper ponds. Sources of and accessibility of fish seed (fingerlings) in other areas, management strategies and water availability also affects fish stocking and stocking densities.

With these temperature differences, farmers in some parts of the south regions are in a different agro-ecological zone and have warmer temperatures than farmers in the north. Farmers in northern region of Malawi favor growing Coptodon rendalli than shiranus because of the issue of temperature differences. Seasons and other conditions are different with shorter pond cycles and an easier way of breeding fish for early stocking in the South than in the North.

1.2.6 Land and water rights

i. Land rights

Land is the most basic of all resources available for social and economic development in Malawi. When considered in combination with water, it produces other resources including arable soils, forest, pasture and marine ecosystems valuable to people (Ministry of Lands, Housing and Surveys, 2002). Ownership of land is crucial for the sustainability of the fish farming enterprise. Therefore before investing into the enterprise, one needs to assess the land access rights to avoid conflicts. In Malawi, ponds can be constructed on private land, customary land, leased land amongst others.

A good percentage of farmers in the country constructed their ponds on customary land managed by Traditional Authorities. For common access land such as dambos, mountains, community woodlots, streams and rivers, one need to seek approval from the local leadership as the land is classified as public land exclusive to members of the Traditional Authority. On customary land, the land is used for the benefit of the community as a whole and includes an allocated land within the boundaries of the Traditional Land Management Area (TLMA)

ii. Water rights

Most of the water sources like rivers, streams and Lakes are open access resources which can be used by anyone but in a sustainable and acceptable manner. Even though this is the case, water rights have to be sought and an environmental impact assessment should be conducted for larger scale investments. One of the Malawi Water Policy's mandates is to ensure proper management and development of fisheries services that do not adversely affect water resources (Ministry of Irrigation and Water Development, 2005). It further seeks to promote efficient and effective utilization, conservation and protection of water resources for sustainable agriculture and irrigation, fisheries, environmental protection etc. Therefore

when one wants to select a site for pond construction, should consider how and where water will be taken, impacts to the community, the environment and how wastewater or other fluid originating from the activity, whether treated or untreated and whether discharged directly or indirectly into the environment will be managed. The water policy requires that anyone using the water resource from rivers, streams and the lake should have a continuous or periodic assessment of the actual and potential impact of any activity on the environment.

1.2.7 Theft and Proximity

Theft of fish by predators and people can negatively affect production. One can lose an entire production through theft and predation. Efforts should therefore be made to prevent theft and predation of fish. This is therefore one of the importance of the nearness of fish ponds to the farmer's house.

Fig 2.17 and Fig 2.18 proximity of your ponds will help in controlling theft and predators

To minimize theft and predation, construct ponds near your premises. This enables the farmer to easily manage the ponds on daily basis. The farmer is able to daily feed the fish and make any other routine checks with much ease. Therefore, ponds that are close to the farmer's house can be easily protected from thieves and predators.

1.2.8 Environment and socio-economic factors

For the establishment of the fish farm the environment has to be taken into consideration, for instance water sources and water use by other persons, factors that might affect water supply and drainage, gazette areas such as wetlands or national parks, likely negative environment impacts such as pollution. Other socio-economic factors such as public health concerns and access and ownership of land have to be taken into account.

1.2.9 Other considerations

Based on the production objectives it needs to be assessed which species will be farmed, the targeted production volume, the scale of the production, capital investment required, and number of personnel required, channels for input supply and markets for the end product. When most of these factors for selecting of a site for a particular purpose are not met one may need to modify objectives in order to meet the characteristics of the sites available.

It should be borne in mind that each and every site is unique and therefore one's financial ability may dictate the suitability and use of the chosen site. But efforts must be made to minimize costs when choosing a site.

It is important to remember the following points:
- If the water supply is well controlled, ponds will be easier to manage when you are, for example, fertilizing the water or feeding the fish.
- Better drainage also makes the pond easier to manage during tasks such as harvesting farmed fish and preparing and drying the pond bottom.
- Ponds with a regular shape and correct size are easier to manage and adapt to specific purposes.
- The choice of a particular type of pond will largely depend on the available water supply and the topography of the site selected.

Summary

A good site for a fish farming enterprise has to critically consider the following;
- Water quality and quantity, has to be enough for all operations for the whole year
- Soil suitability: they must hold water and should not crack when dry
- Topography of the land: should be cheaper to construct and supply water by gravity
- Proximity or accessibility: it has to be easily reachable
- Flooding incidence: it should be free from floods and it shouldn't have a history of floods
- Climate: conducive for good fish growth
- Land and Water Rights
- Availability of fingerlings production objectives, environment and socio-economic factors
- Markets

Pond Construction

3

Introduction

Before starting fish farming operations, farmers spend a good percentage of their fish farming expenses in construction of fishponds. They have to critically decide how many and what type of ponds they have to dig before making their first fish harvest. Before the construction works start, think of the design of the pond, the layout according to the land size, topography and source of water. Type of soils can also guide on how to design, layout and construct the ponds. Before constructing ponds, a farmer needs to check the type of soil, and whether or not the soil can hold water. Clay soil can hold water for a long time whereas land with sandy soil may not retain water for very long. Clay soils and similar types such as sandy clay and sandy loam soils are found in most areas, but most of the land available for aquaculture is unused or unfertile soils. It is likely that soil will not completely hold water and so a quick investigation is necessary. After considering the soil type, it is very important to fully understand the design and functions of facilities for running this particular pond farming system. This chapter provides information on types of ponds to construction, how to construct ponds to the point of filling water. This module encourages construction and use of use deeper ponds in colder areas and where water is a challenge as shallow ponds do give a number of challenges when it comes to profitable production

Aim

The aim of this chapter is to help participants gained knowledge and understanding on the different types of ponds, benefits of properly designing and constructing ponds and also impart them with skills on how to design, lay and construct ponds

Objectives

- Participants know
  - How to design ponds
  - The benefits of laying out ponds properly
  - How to construct good ponds

- Acquired skills
  - Pond design and lay our
  - Pond construction

- Acquired attitudes
  - Well designed and constructed ponds are sustainable
  - Good ponds promote good growth for fish hence good profits

- Relevance to fish production
  - Fish farmers and investors should be aware of the necessary steps required for pond construction. This will lead to good fish growth, good profits and sustainability of the enterprise
- Chapter Overview: This chapter is looking at pond lay out, designing and construction.
- Materials: Flip- chart paper, markers, study notes, posters, note books, hoes, panga knives, buckets, shovels, wheelbarrow, empty tins, pick, axe, measuring tape, ruler, rope, rubber
- Mode of delivery: Lectures, group discussions, practical
- Duration: 75 minutes

3.1 Types of ponds and pond layout

3.3.1 Types of ponds

There are several types of fish ponds and these are based mainly on the topography of the land, how the ponds are constructed and also the purpose of the ponds. The main types of ponds available in Malawi are
.

a) Contour ponds are constructed on a fairly level land or valley with walls on three walls.
b) Paddy ponds are usually constructed on a flat land (Dambo) with walls on all sides.
c) Barrage ponds consist of a dam built across a deep gorge or steep slopping valley
d) Diversion Ponds – three to four walls

Fig 3.1 a Paddy ponds showing inlets

Fig 3.2 Contour ponds showing an inlet

Embankment/level and Excavated ponds

Pond types are usually determined by the topography and some features of the terrain. And based on their construction, a pond can be identified as: watershed, excavated and embankment or levee ponds. Watershed ponds utilize features of the terrain, for instance a ravine can be dammed so the construction is quite.

- An excavated pond is simply a pond dug in the ground. The whole pond depth is in the ground.
- Embankment or level ponds are pond made through digging and building. What you dig is what you use to build to achieve the kind of depth a farmer wants.
- On contour and paddy ponds, there may be different types of ponds on a fish farm, each used for a specific purpose and these can include:

i. Spawning ponds for the production of eggs and fry
ii. Nursery ponds for nursing young ones to fingerling stage
iii. Broodstock ponds for rearing brooders
iv. Holding ponds for temporary holding fish often prior to marketing or transportation

3.3.2 Pond layout

Each and every farm normally comprises several ponds. Proper arrangement of the ponds is important for pond construction, optimal utilization of the area and to ensure efficient water movement, fish handling, fish feeding, fertilizing, harvesting and general day to day management.

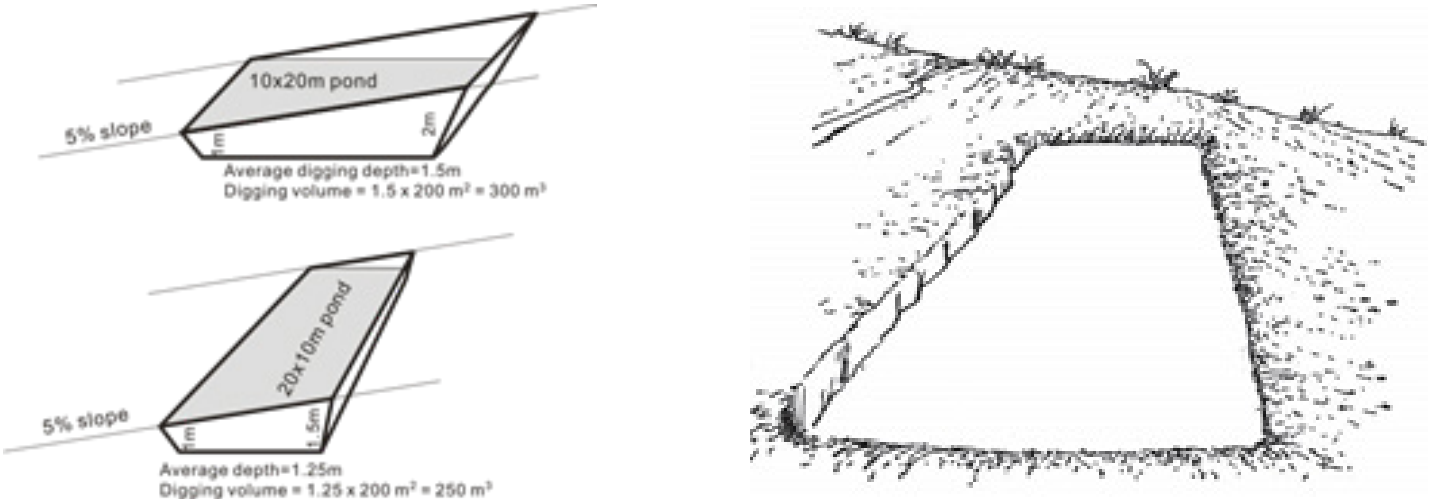


Fig 3.3 & Fig 3.4 pond layout according to topography

If watershed ponds are used, they must be adapted to the ground conditions and the layout is normally predetermined. If using levee or embankment ponds the layout is more important. Rectangular ponds are usually best regarding utilization of the area. And the two main pond layouts common in Malawi;

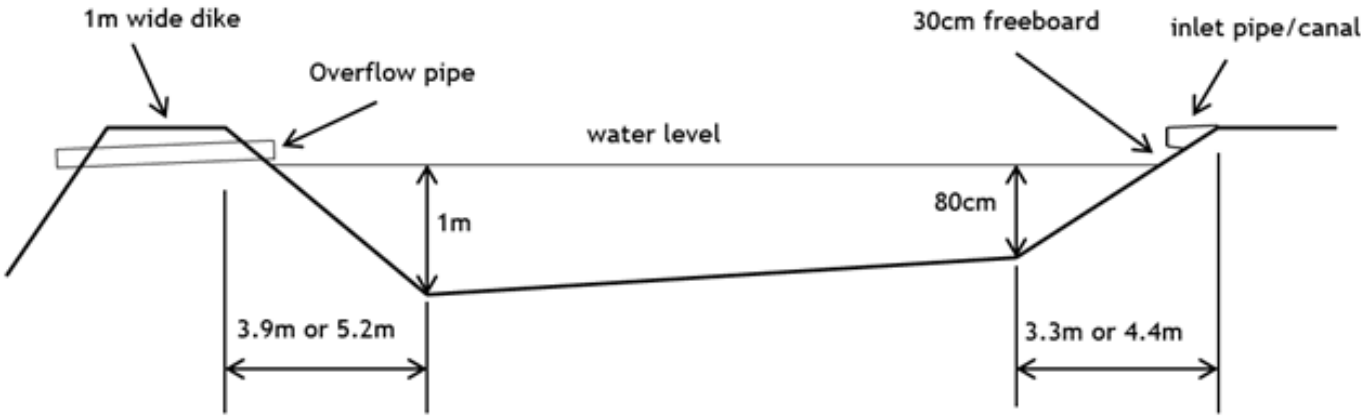


Fig 3.5 showing a cross section of a nursery fish pond

i. Series/Rosary ponds:

Ponds are constructed in such a way that water flows from one pond into the next pond. The advantage is that gravity can be used to ensure the water flows through the entire farm. The water may be aerated when flowing from one pond to the other. The main disadvantage is that the effluent water from one pond is the inlet water to the next pond and water quality decreases from pond to pond. Eventually disease pathogens will also follow the water and spread disease from pond to pond as isolation of a single pond is impossible.

ii. Parallel ponds

Ponds are set out beside each other, with a common water supply canal and a common effluent water canal. This is the most usual layout for a pond farm. The advantages are that the water quality is the same in each pond and it is also possible to increase and reduce the water flow to the separate ponds. Parasites and disease control per pond is possible. Running each pond as a separate business helps to maximize profits.

3.2 Size and shape of ponds

Square and rectangular ponds are easiest to build and rectangular ponds are easiest to harvest. The width of the pond determines the length of the seine. Ponds can have different shapes to fit the shape and size of the land. The sizes of the ponds vary depending on function of the pond and market requirements. For family ponds sizes of 200 - 300m2 with a typical length to width ratio of 2 - 3:1 is recommended. These can be easily built without the use of machinery. Having several smaller ponds is recommended in order to harvest fish more often. The optimal size for a fishpond that can provide a viable income for the fish farmers is a total of 1,000 m2. One can reach that level in a variety of ways; one can build two ponds of 500 m2 each, or build five ponds of 200 m2 each.

Table 3.1 below provides an overview of the advantages of small and big ponds

Description	Advantages
Large ponds	- Cost less to build per hectare of water - Better production possible per hectare - More stable – less prone to temperature fluctuations - Have more oxygen available for fish - Fish have more room to escape from thieves and predators
Small ponds	- Easier to net and harvest fish - Easier to manage, maintain and treat for disease - Not easily eroded by wind - Easy for thieves and predators to take pout fish

3.3 Key features of a pond

The key features of a pond include;

- Inside slopes (shallow end and Deeper end slopes); a ratio of 3:1
- Slopes helps the pond to be strong and stable,
- Reduces water seepage,
- Create space for fish to breed
- It makes it safe to work around the pond
- Provides a range of temperature variation depending on depth along the slopes
- Outside slopes; a ratio of 2:1
- Helps with stability of the pond
- It is easier to go in and out of the pond.

- Pond depth
- Shallow depth can range from 1.1 -1.3m (preferred fish breeding area)
- Deeper end depth can range from 1.3-1.5m even 2m for deeper ponds (shelter place for fish especially in the cold season).

- Free board, can range from 30 -50cm depending on the size and depth of the pond.
- Prevents the pond from flooding

- Dyke which is normally 1m – 1.5m wide depending on pond size
- Facilitates easier work on and around the pond.

- Pipes (inlet pipe, drainage pipe & overflow pipe)
- Inlets for filling pond water
- Outlets for draining pond water
- Overflows for maintaining a good pond water level

3.3.1 Slope of pond bottom and depth

A slope of around 2% is recommended. The optimal depth at the inlet is 0.80 m to 1.2m (above knee high) and 1.2 m to 2m (above waist high) at the outlet. Higher water levels help maintaining the water temperature of the ponds. If the ponds are too shallow the water might get too hot during the day and too cold during night (optimal range 25oC - 30˚C). This is why bigger and deeper ponds are recommended.

3.3.2 The inlet

Inlet is where water is allowed to get into the pond. The water can either be supplied by a pump or under gravity; the latter is the best solution. In addition to supplying water, it may be necessary to supply extra air or oxygen. Control of CO2 and ammonia concentrations in critical situations may also be necessary; additional inlet water may be required in such circumstances.

Place the inlet pipe 30 cm above the intended water level to avoid fish swimming out. For ponds larger than 1000m2, 6 inches PVC pipes are recommended and for smaller ponds 4 inches PVC pipes. Fit and anchor the pipe at a slope within pond wall from inlet channel or pipe.
Water flow at inlet should be adequate to fill pond in at least 10 days for bigger ponds. For ponds smaller than 1000m2 or ponds with limited water supply 2'' pipes are recommended. Where there is an abundant water use 4'' pipe.

3.3.3 The outlet: drainage

Each and every pond must be drainable and this can be possible if the pond has an outlet. How the outlet is constructed depends on the size of the pond and whether there is a collection basin for the fish, and if this is inside or outside the pond. A drainage point can be;

- A concrete monk
- A stand on pipe which stands inside the pond and also functions as a water level control
- Dyke breaking where pipes are lacking

3.3.4 Overflow pipes

Overflow pipes are used to allow excess pond water to go out. This is done to prevent water from overfilling the pond thereby going out of the pond over the dykes. This prevents fish from escaping and or dykes to eroding. Place the overflow pipes 30 cm to 50cm above the intended water level to avoid fish swimming out. For bigger ponds, overflows can be on the monk. For smaller ponds, overflows can either be on the stand on pipe or on one of the dykes where more water rests. A 30cm to 50cm freeboard should always be observed.

3.3.5 Top – width

The minimum top-width of the dykes should be 1 meter and should be greater at the deep end of the pond. It is recommended to have a height difference of 20-30 cm between water level and the top of the dyke because it allows free movement of air currents above the pond water surface which improves mixing and oxygenation of the water. Furthermore it is cheaper to construct and maintain and there is less surface erosion into the pond.

The key features of pond include:

- Inside slopes (shallow end and Deeper end slopes); 3:1
  - Slopes helps the pond to be strong and stable,
  - Reduces water seepage,
  - Create space for fish to breed
  - It makes it safe to work around the pond
  - Provides a range of temperature variation depending on depth along the slopes

- Outside slopes; 2:1
  - Helps with stability of the pond
  - It is easier to go in and out of the pond.

- Pond depth
  - Deeper depth can range from 1.1 – 2m (Preferred fish breading area)
  - Shallow end depth can range from 0.9 -1.5m (shelter place for fish especially in the cold season).

- Free board, can range from 30 - 50cm depending on the depth of the pond.
  - Prevents the pond from flooding

- Dyke, is normally 1m to 1.5m wide makes it easy to work around the pond.

- Pipes (inlet pipe, drainage pipe & overflow pipe)

3.4 Pond staking

Pond construction must be guided by the objective of creating an optimal environmental condition ideal for fish survival and proper growth. Good site selection and pond demarcation will make pond construction much easier, faster and cheaper. Ultimately good pond construction will make pond management easier and prolong the life of the pond.

There are different fish pond construction procedures. However the following order of activities may be followed:

- Determine the exact location for pond.
- Prepare site, by removing all organic materials from the surface of the site.
- Marking pond and dikes with stakes
- Removing tree stumps, rocks
- Digging out bottom Building
- Installing inlet outlet
- Protect planting grass

3.4.1 Steps in pond staking

To stake a pond assuming the site is already cleared, you need these tools;

- Stakes/pegs,
- Measuring tape,
- Line level or dump level
- Hammer
- String
- Tool for digging hoe to place stakes
- Panga knife for cutting stakes
- Slasher for clearing the site

Fig 3.7 to 3.9 some required fish construction equipment

Fig 3.10 Consult before pond layout and construction Fig 3.11 Pond staking

Ensure that

- Pond staking is done on a site that has been cleared of grass, trees and rocks. Never stake a pond on site that is not cleared.
- Determine the slope of the land. It is recommended to put the pond on a slope of between 2%- 6%. However, in cases where the only available space is outside the recommended range you have no option but to construct the pond right there.
- Remember that slopes outside the recommended range attract extra cost of construction and also drainage might prove difficult.

The next step is to determine the orientation of the pond.

- Orienting the pond across the slope is the best approach or put the long side of the pond across the slope.
- It reduces on the amount of work whilst moving soils during digging and also reduces the pressure of water applied on the low dike.

3.5 Pond pegging

3.5.1 Determining the external wall of your pond

Put the first peg on one corner of the cleared land. Ensure that all pegs are put perpendicular to the ground and firm.

- The next step is to do a right angle triangle (or 3-4-5 rule) to ensure that all sides of your pond have right angle. The triangle created will help you know where to run the lines to measure two sides of your pond. Note that to make a triangle you need three pegs.
- Once you have done a 3-4-5 rule then you can measure two sides (1 length & 1 width) of the pond. At this stage you have put three pegs of the external wall.
- The last peg (4th) can be determined by measuring one width side and one length side. Where the two lines intersect place the 4th Peg.

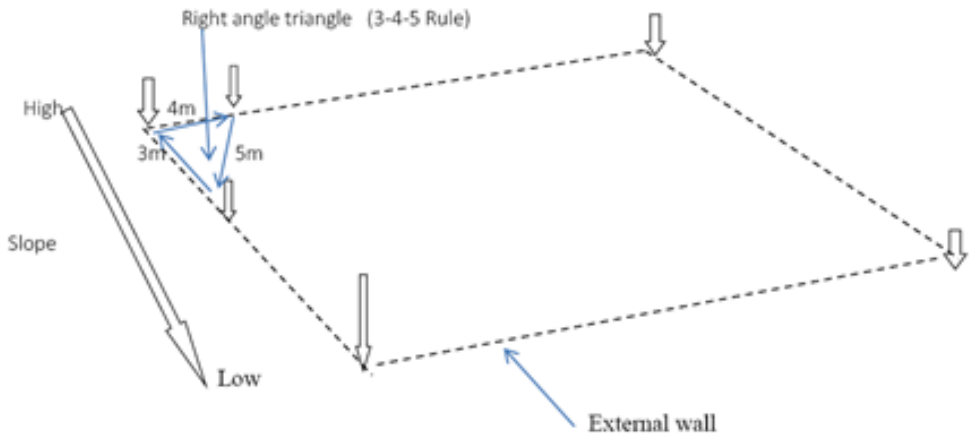


Fig 3.12 showing a stake external wall of a pond, sides aligned using a right angled triangle

3.5.2 Determining the internal wall of your pond

We use the external wall to find the internal wall. The internal wall is a 1 meter off the external wall. To stake the internal wall creating a 1 square meter box off the 1st peg on the external wall inward of the pond. Repeat the procedure of creating a square meter on the pegs of the external.

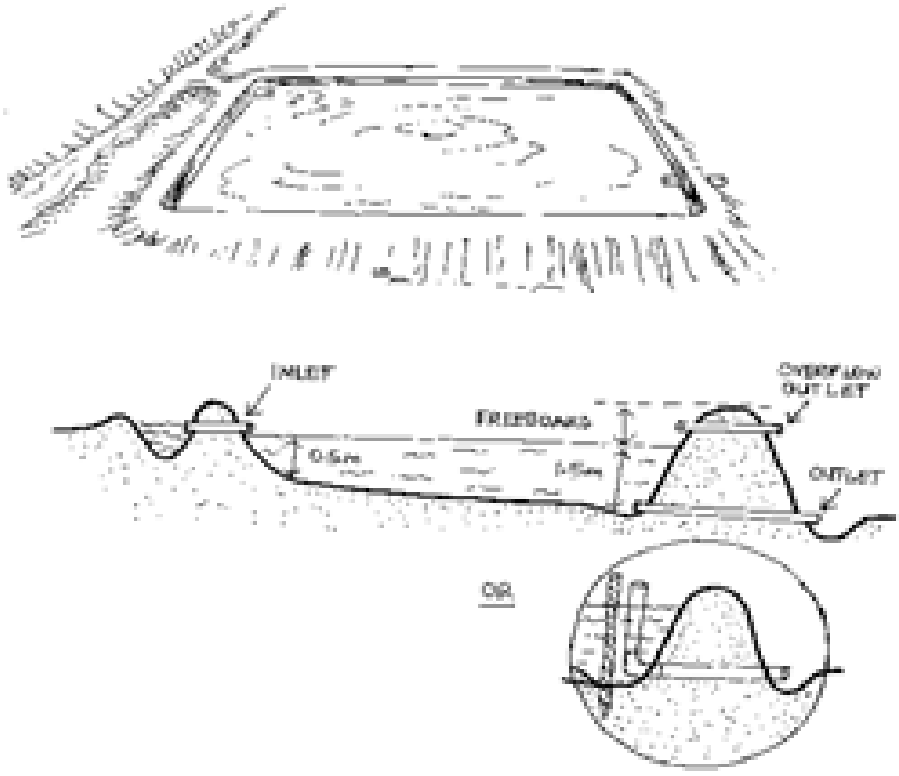


Fig 3.13 general pond orientation

3.5.3 Determining the pond bottom box

We use the internal wall to determine the pond bottom box. The inside slopes of the pond is 3:1 or the slopes are 3 times the pond depth. Note the depth of the pond different on the shallow end and deeper end.

Now to mark the pond bottom box, we start with the shallow end of the pond. On the shallow end of the pond the depth can range from 1.1m to 1.3m. In this case our shallow end depth of the pond is 1.1m. The slopes being 3 times this depth will be 3.3m. To mark the pond bottom slopes on the shallow end we make 3.3m2 box off the two internal wall pegs that are positioned on the shallow end.

This procedure is repeated on the deeper end using different measurements. The depth of the pond on the deeper can be a range from 1.3m to 1.5m. In this case our deeper end depth of the pond is 1.3m. The slopes being 3 times this depth will be 3.9m. To mark the pond bottom slopes on the shallow end we make 3.9m2 box off the two internal wall pegs that are positioned on the deeper end.

3.5.4 Pond leveling

The next step after staking is leveling. This will help to determine the height of the wall above the normal ground and also how much to dig and build. Leveling involves tying a string (6 – 18 ply) from one stake to another using a line level to determine where to tie exactly. Start leveling from on one of the pegs on external all. Start leveling on the peg that is on the highest elevation. Tie the string 10cm off the ground on the stake on the highest elevation. The next tying on the following stacks is determined by the line level. Leveling is done on all the stacks on the external wall, internal wall and pond bottom box.

3.5.5 Construction of earthen ponds

After a pond has been leveled the next step is construction. Construction of ponds is best after the rain season when the soil is still moist. The rain is a difficult time to construct ponds due the fact that the soil is very wet. Construction of ponds can be done any time of the year but the construction cost will vary.

Tools required for pond construction;

- Wheelbarrows
- Shovels
- Spades
- Hoes
- Picks
- Compactors

Step for pond construction

- Determine cut and fill: cut and fill line falls usually between inner side of the dike crown and toe of the pond bottom. It separates the potion requiring fill to that requiring digging.
- Determine dig depth on all the bottom box
- Making a T-cut: At each stake in the corner of the deeper pond bottom box, dig the required depth. Join the holes to each other and form a trench. Dig another trench running from the shallow side of the pond running from inlet stake crossing the deep end trench to the evacuation point. When digging, maintain correct depth at every level as it will help in maintaining the bottom slope required.
- Note that the drainage point is lower than any other point in the pond so as to facilitate complete pond drain.
- Build dikes and slopes; Start at the low side of the pond. Make sure the soil piled along the dike walls is well spread and must be compacted at every 30cm pile.
- keep on verifying all levels during construction
- Demonstrate local techniques for removing soil e.g. use of basins buckets & sacks

3.6 Pond construction process

3.6.1 Prepare the site

- First remove trees, tree stumps, bush and rocks and cut the grass in the area planned for the pond. Then measure and stake out the pond. Remember the pond banks will extend several meters beyond the water area.

- In sloping areas, build a Contour pond with

the long side of the pond running along the low end of the slope of the land.

- Then remove the top layer of soil containing roots, leaves, etc. Put it well outside of the pond area. Save this topsoil because you will use it later when you plant grass on the finished pond walls.

Figs 3.14 and Fig 3.15 remove and keep the top layer of soil containing roots, leaves

3.6.2 Build a Clay Core (In Contour Ponds)

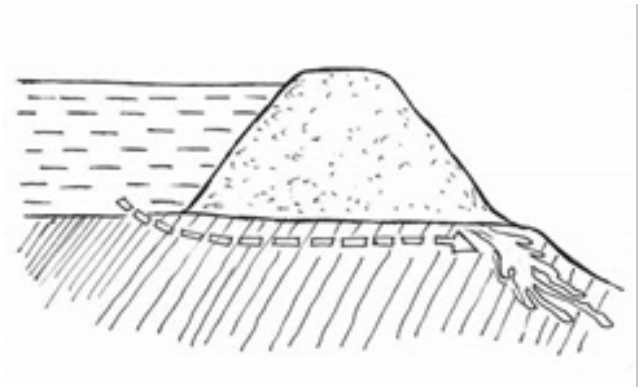


Fig 3.16 Contour Pond WITHOUT clay core leaks

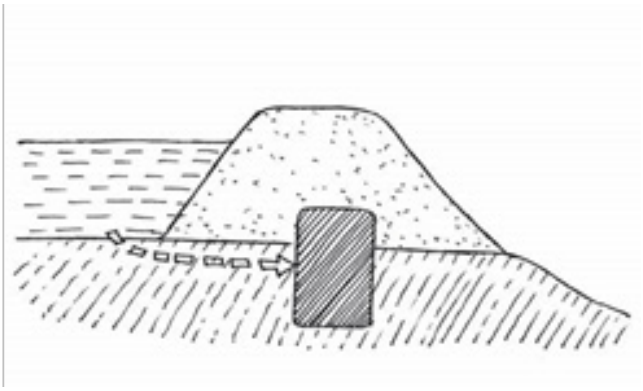


Fig 3.17 Contour Pond WITH clay core cannot leak

A clay core is the foundation for the pond wall when the pond is built on a slope. The clay core makes the wall strong and prevents leaks. A clay core is needed in Contour ponds, and is built under the wall where the water is higher than the surrounding ground level.

First remove all the topsoil from the area for the pond walls. Then dig a "core trench" like a foundation for a house. This trench should be about 50 cm wide and 30 to 60 cm deep or until you hit a strong clay subsoil layer. The trench should be dug along the lower side of the pond, and half way along each side of the pond. Fill in the trench with good clay soil. Compact this soil each time you add several inches of new clay.
It takes effort to build a strong clay core but it provides a foundation for the walls and prevents water from seeping out of the pond. Where there is no clay core, water seeps under the pond wall and can eventually break down the entire wall; the clay core stops the water from seeping under the newly built wall.

3.6.3 Digging the Pond and Building the Walls

As you dig out the pond, use the clay soil to begin building up the wall known as a "dyke" on the top of the clay core. If you hit poor sandy soil, throw this outside of the pond area.
Sandy or rocky soil, or soil that contains roots, grass, sticks, leaves, etc. should not go into the wall. These will decay later and leave weak spots where the water can leak out.

Fig 3.18 and Fig 3.19 compact your soils every 20 to 30cm for strong dykes as you build walls
Compact the soil often as you build the wall. After adding 30 cm of loose soil, trample on it by foot or use a rammer. You can pound it with your hoe, a heavy log, or a piece of wood attached to the end of a pole. This will make the dam strong. If you don't do this, the soil will remain loose and the wall will not hold water.

The pond walls should be about 30 cm above the water level in the pond. Once you have reached this height, add a little more soil to allow for more settling. Then do not add any more soil on top of the walls.

If the walls reach this height and you are still digging the pond, throw the soil outside the pond area. If the pond walls become too high, they become unstable and high walls make it hard to work around the pond.

The pond walls should have a gentle slope similar to the slant of a house roof. This makes them strong and prevents them from undercutting and collapsing into the pond. Additionally it is easier and safer to enter the pond like this during seining. It is easier to slope the walls after digging out the main part of the pond.

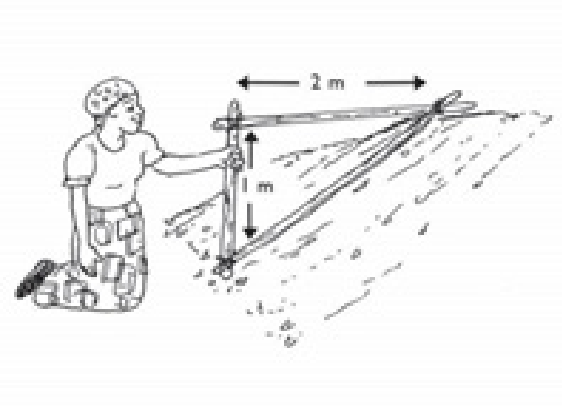


Fig 3.21 shaping inside pond slopes Fig 3.22 levelling and slopping the pond dykes

The best slope for the pond walls is to rise only 1 m in height for every 2 m in length. You can easily make a triangle to help build the slope at this angle. The pond bottom should also slope gently or be stepped, so that the water will vary in depth from 50 cm to 1 m. It is important to smooth out the pond bottom after reaching the proper depth. This will make it easier to use nets for harvesting fish; they will slide easily over the pond bottom.

3.6.4 Build the Inlet and Outlet

The inlet consists of a canal to bring in the water, a silt catchment basin, and a pipe to carry water into the pond. The water coming into the pond often contains a lot of soil and silt. This will make the pond very muddy. A silt catchment basin will stop this soil from entering the pond. Widen and deepen the inlet canal just outside of the pond bank. The soil will settle into this hole, instead of entering the pond.

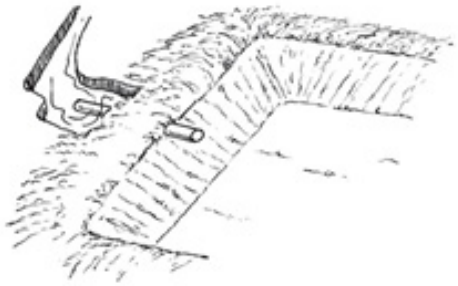


Fig 3.25 an inlet pipe

Once cut and fill is competed and the pond is levelled, arrange fill and drainage systems. Determine the placement of pipes; inlet, outlet and over-flow

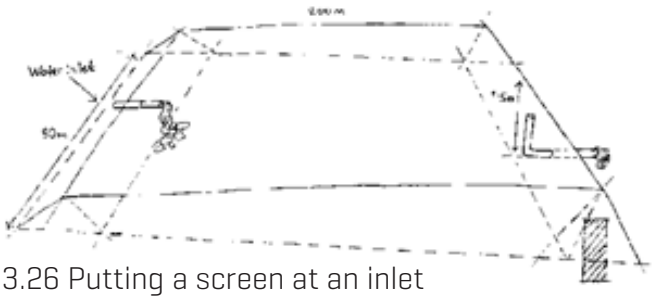


Fig 3.26 Putting a screen at an inlet

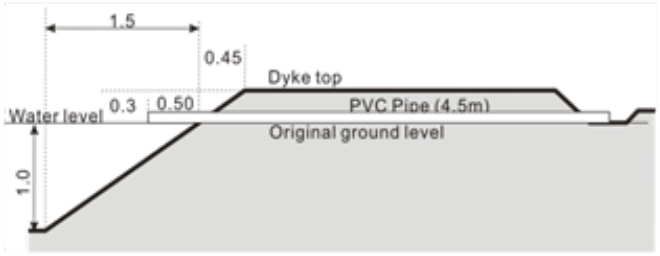


Fig 3.23 Positioning inlet and outlet pipes Fig 3.34 Standard Inlet Structure for fishpond with 100 mm PVC pipe

Standard Inlet

The inlet pipe runs from the catchment basin through the pond wall into the pond. It should be about 15 to 30cm above the water level so that the incoming water splashes down into the pond. This will prevent fish from escaping by swimming into the inlet pipe. It will also help mix air into the water.

The overflow pipe is used only in emergencies. Water should not flow out of the ponds on a daily basis. During heavy rains, the overflow pipe helps remove excess rainwater and runoff from the pond.

The overflow pipe can be installed at an angle. It is best to install the overflow pipe with the intake below the water level; this prevents the screen from clogging with debris that may be floating on the pond surface.

The inlet and outlet pipes can be made of metal, plastic, bamboo, wood or other materials. All pipes used in fish farms should have screens to stop fish from entering or leaving the pond. Screens can be made from many types of materials. Anything will do that allows water but not small fish to pass through:

- Screen or wire mesh
- A clay pot with holes punched in it
- A piece of metal with holes punched in it
- A loosely woven grass mat
- A basket

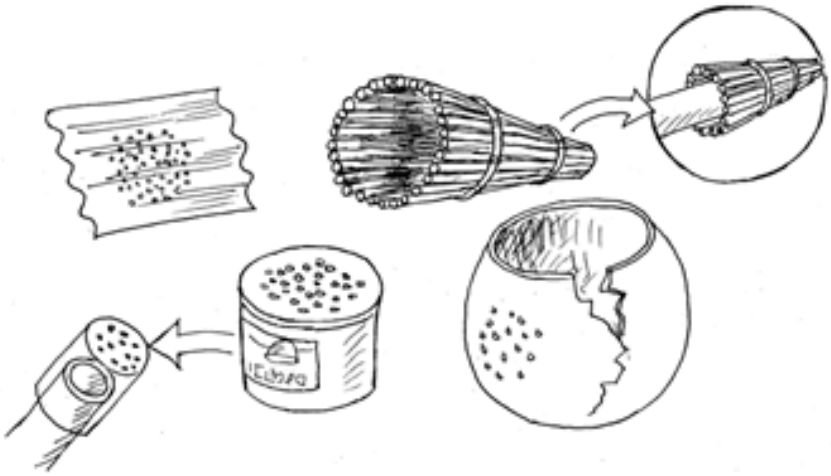


Fig 3.27 locally available materials used as pond screens

The screens must be checked and cleaned almost daily.

Fig 3.28 a monk used as an outlet and overflow

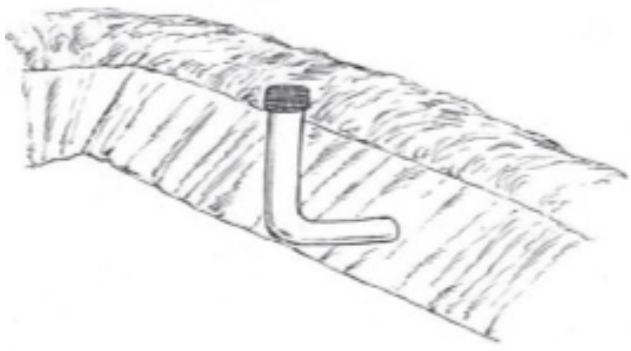


Fig 3.29 a stand on pipe used as an outlet and overflow

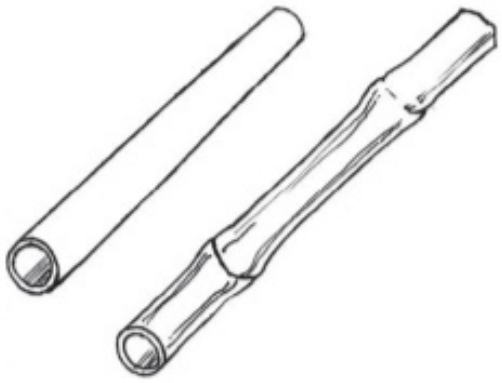


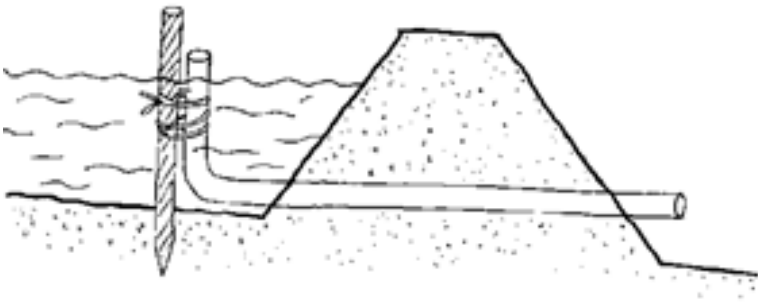
Fig 3.30an overflow pipe with a 30cm freeboard Fig 3.31 a PVC pipe or bamboo used as inlet or outlet pipes

3.6.5 Level the pond floor

The pond bottom should be smooth and firm. Therefore level and clear all pot holes since they provide shelter for fish when the pond is being drained and it poses a danger to persons working in the pond. Compact the pond bottom to avoid a muddy pond bottom which provides refuge for fish to hide and thus more difficult to seine and fish might get trapped in the mud when the pond is being drained. A muddy pond has a lot of turbidity which negatively affects fish growth.

i. Protect/solidify dikes

When you finish building the pond banks, cover them with the topsoil that you saved when you started digging the pond. Then plant grass on the banks. The fertile topsoil will help the new grass get started quickly. Once the grass begins to grow, it will help to protect the walls from



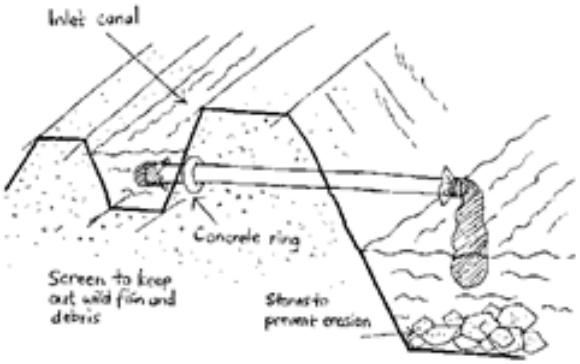


Fig 3.32 stand on pipe lay on pond bottom Fig 3.33 screens rightly fixed on inlet pipe

Heavy rains, flooding and too much runoff going directly into the pond can destroy the pond banks. This problem is most common in Contour ponds built on hillsides. To prevent this, divert the runoff water around the sides of the pond. Dig a ditch along the upper side of the pond. Using the soil from this ditch, build a small ridge below it. The ditch will carry runoff water away from the pond. This will prevent flooding and protect the pond walls. Add lime or wood ash on the pond bottom in addition to manure before filling the pond.

Fig 3.34 and Fig 3.35 pond dykes planted with grass

ii. Preventing/reducing water seepage in the earthen pond

There are several methods to prevent leakage from ponds. If the leakage is only slight, a solution is to break down the earth structure, reduce the aggregate size and puddle the bottom. Breaking up the lumps in the surface layer achieves this and is quite commonly done on rice fields. Addition of chemicals may also reduce the aggregate size. Compression of the surface may also be used to reduce the water loss, for example by using a road roller. Several thin layers of compressed earth are better than one thick layer. If the natural soil is unsuitable, a membrane of clay or plastic may be used. A clay layer transported to the site must be about 30 cm thick for a 3-m deep pond. However, this represents increased costs for establishing the pond. To avoid the layer of clay crumbling as a result of drying or freezing, a covering layer of sand or gravel may be used; this can be 30–45 cm thick on clay and 15–20 cm thick on plastic.

3.6.6 Considering measures against predators/theft

Putting a fence around the pond will help in several ways. It will protect young children from falling into the pond, and it can help keep out thieves and predatory animals. To make a low cost and sturdy fence, plant a thick hedge around the edge of the pond. Using a thorny bush like Mtete, Lunguzi can make this kind of fence even more effective. Or you can build a fence using poles and thorn branches. Avoid the presence of weeds and tall bushes around the pond. These would act as hiding places for thieves and predators.

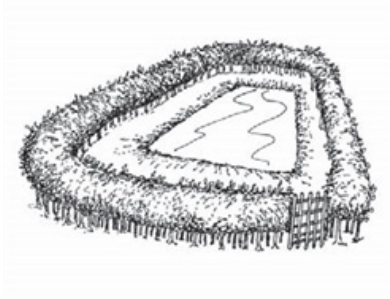


Fig 3.36 an example of fenced pond

Fig 3.38 screen rightly fixed on overflow

Fig 3.37 Pond fenced with Lunguzi

SITE SELECTION AND POND CONSTRUCTION

Module II of 8