Fish Farming and Conservation

A basic information booklet for rural communities on fish farming as a tool for sustainable fish management
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### List of acronyms and abbreviations

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADMADE</td>
<td>Administration Design for Management</td>
</tr>
<tr>
<td>ASP</td>
<td>Agriculture Support Programme</td>
</tr>
<tr>
<td>AWF</td>
<td>African Wildlife Foundation</td>
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<tr>
<td>CAC</td>
<td>Camp Agricultural Committee</td>
</tr>
<tr>
<td>CAG</td>
<td>Community Action Group</td>
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<tr>
<td>CASU</td>
<td>Conservation Agriculture Scaling Up</td>
</tr>
<tr>
<td>CBNRM</td>
<td>Community Based Natural Resources Management</td>
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<td>CBNRNF</td>
<td>Community Based Natural Resource Management Forum</td>
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<tr>
<td>CBOs</td>
<td>Community Based Organizations</td>
</tr>
<tr>
<td>CFU</td>
<td>Conservation Farming Unit</td>
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<tr>
<td>CSEF2</td>
<td>Support to Civil Society Organisations in Environment and Natural Resource Management in Zambia, Phase Two</td>
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<tr>
<td>ENRM</td>
<td>Environmental and Natural Resource Management</td>
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<tr>
<td>FBOs</td>
<td>Faith Based Organizations</td>
</tr>
<tr>
<td>FGD</td>
<td>Focus Group Discussion</td>
</tr>
<tr>
<td>FMC</td>
<td>Forestry Management Committees</td>
</tr>
<tr>
<td>FMCS</td>
<td>Fisheries Management Committees</td>
</tr>
<tr>
<td>GMAs</td>
<td>Game Management Areas</td>
</tr>
<tr>
<td>IGAs</td>
<td>Income Generating Activities</td>
</tr>
<tr>
<td>JFM</td>
<td>Joint Forest Management</td>
</tr>
<tr>
<td>MACO</td>
<td>Ministry of Agriculture and Cooperatives</td>
</tr>
<tr>
<td>NAPACC</td>
<td>National Adaptation Program of Action on Climate Change</td>
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<tr>
<td>NEAP</td>
<td>National Environmental Action Plan</td>
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<tr>
<td>NFP</td>
<td>National Forestry Policy</td>
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<td>NGO</td>
<td>Non-Governmental Organisation</td>
</tr>
<tr>
<td>PPCR</td>
<td>Pilot Program for Climate Change Resilience</td>
</tr>
<tr>
<td>PSAf</td>
<td>Panos Institute Southern Africa</td>
</tr>
<tr>
<td>REDD</td>
<td>Reducing Emissions from Deforestation and Forest Degradation</td>
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<tr>
<td>RLC</td>
<td>Radio Listening Club</td>
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<tr>
<td>SWOT</td>
<td>Strengths, Weaknesses, Opportunities and Threats</td>
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<tr>
<td>UNDP</td>
<td>United Nations Development Programme</td>
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<td>UNEP</td>
<td>United Nations Environment Programme</td>
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<td>VDC</td>
<td>Village Development Committees</td>
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<td>VFMC</td>
<td>Village Fisheries Management Committee</td>
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<tr>
<td>ZEMA</td>
<td>Zambia Environmental Management Agency</td>
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<tr>
<td>ZNFU</td>
<td>Zambia National Farmers Union</td>
</tr>
</tbody>
</table>
Acknowledgements

This booklet is meant to provide basic and easy to understand information for rural communities on the importance of conserving fish in natural water bodies to ensure that their fish-based livelihoods and food security remain sustainable. It highlights the fish depletion problem and suggests how this can be mitigated through fish farming as an alternative and sure source of livelihood and income.

The booklet is a product of the Deepening Community-based Natural Resource Management (CBNRM) in Zambia Project supported by the Civil Society Environmental Fund, Phase Two (CSEF2) and implemented by Panos Institute Southern Africa (PSAf).

PSAf conveys gratitude to the Government of Finland for supporting the Deepening CBNRM Project that funded the development of this booklet through the CSEF2.

We also thank the Department of Fisheries, Kazungula District, for the specialist services rendered in the process of developing this booklet.

We are hopeful that this booklet will contribute to uplifting the knowledge of citizens that heavily depend on fishing for livelihoods so that they adopt fish farming as an alternative source of fish-based livelihoods and in effect help to conserve the fish stocks in the natural water bodies.

For more information and to request for copies, please contact:

Panos Institute Southern Africa (PSAf)
Plot 9028 Buluve Road, Woodlands
P. O Box 39163
Lusaka, Zambia
Tel: +260-978-778148/9
Fax: +260-211-261039
Email: general@panos.org.zm
Website: www.panos.org.zm

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# Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>List of acronyms and abbreviations</td>
<td>i</td>
</tr>
<tr>
<td>Acknowledgements</td>
<td>ii</td>
</tr>
<tr>
<td>1.0 Introduction</td>
<td>1</td>
</tr>
<tr>
<td>1.1. State of fish depletion</td>
<td>1</td>
</tr>
<tr>
<td>1.2. Causes of fish depletion</td>
<td>1</td>
</tr>
<tr>
<td>1.3 Consequences of fish depletion</td>
<td>1</td>
</tr>
<tr>
<td>2.0. Addressing fish depletion in Zambia</td>
<td>2</td>
</tr>
<tr>
<td>2.1 Policy and legal instruments</td>
<td>2</td>
</tr>
<tr>
<td>2.2 Regulations</td>
<td>2</td>
</tr>
<tr>
<td>2.3 Programmes</td>
<td>3</td>
</tr>
<tr>
<td>2.4 Community-based interventions</td>
<td>3</td>
</tr>
<tr>
<td>3.0 Fish farming</td>
<td>4</td>
</tr>
<tr>
<td>3.1 The Importance of Fish Farming</td>
<td>4</td>
</tr>
<tr>
<td>3.2 Types of fish farming practices</td>
<td>4</td>
</tr>
<tr>
<td>3.3 Establishment and Operation of a Fish farming project</td>
<td>5</td>
</tr>
<tr>
<td>3.3.1 Pond Construction</td>
<td>5</td>
</tr>
<tr>
<td>3.3.2 Fish pond management</td>
<td>10</td>
</tr>
<tr>
<td>4.0 Where to get assistance for a Fish farming project</td>
<td>13</td>
</tr>
<tr>
<td>5.0 References or Sources of information</td>
<td>14</td>
</tr>
</tbody>
</table>

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**Front Page Photo**

Fish ponds in Kasempa District, North-western Province of Zambia.
1.0 Introduction

In Zambia, fishing is one of the main sources of livelihood for rural households especially those that live near water bodies like rivers, dams and lakes. It is the third largest employer of the rural population after crop and livestock agriculture. It contributes significantly to income and food security. Available records on the fisheries industry indicate that there are more than 25,000 artisanal fishermen and women engaged in capture fishing in the country.

1.1. State of fish depletion

Over the years, Zambia has experienced dwindling fish stocks in the natural water bodies due to unsustainable fishing methods that do not give fish space to replenish itself. Annual capture fisheries output per person has declined from 11.4 kg in the 1970s to 8 kg in the 1990s, and to 6.4 kg in 2003. This translates into reduced revenue for the population that heavily depends on fishing and fish trading for their livelihood.

1.2. Causes

Unsustainable fishing practices such as wrong or illegal fishing gear, explosives such as dynamite and poison have caused fish stocks to dwindle to the point that catches have also drastically reduced. If not adequately addressed, this situation has potential to negatively impact on the economy and people who depend on fish as a source of livelihood and food security.

Other causes are the following:

a) Very high fishing effort – The number of fishermen and women in a given water body and at a given time is not proportionate to the amount of fish in that water body to sustain the expected catches.
b) Overfishing – more fish are caught than the population can replace through natural reproduction.
c) Water pollution – Hazardous domestic and industrial waste or chemicals released into the environment end up polluting the water bodies and killing fish.
d) Limited alternative employment opportunities – fishing is a source of livelihood for many unemployed people.
e) Lack of knowledge - Many fishermen and women lack knowledge on sustainable fishing methods, the importance of conserving fish and their role in this regard.
f) Limited community participation in fish conservation efforts.

1.3. Consequences of Fish depletion

Fish depletion, if not adequately addressed, has potential to negatively impact on the economy and people who depend on fish as a source of livelihood and food security, as follows:

a) Unemployment - About 25 000 people engaged in artisanal fishing and 30,000 others active in fish processing and trading will lose employment and livelihood that they derive from fishing.
b) National Economy - The contribution of the fisheries sector to the country’s Gross Domestic Product (GDP), which is estimated to average 3 percent out of the 18 percent share that agriculture, forestry and fishing contribute will be diminished and possibly lost.
c) Food Security - Fish is an important food item in the Zambian diet. Fish provides the cheapest source of animal protein. Therefore, reduced catches have a negative bearing on food security and nutrition of the people.
2.0. Addressing Fish Depletion in Zambia

Government and stakeholders recognise the importance of fishing to the people who earn a living from it and the economy. To this effect, they have put in place measures to address the fish depletion problem, conserve fish and make fishing sustainable and develop the fisheries sector to maximise benefits.

In addition, government has been promoting the development of aquaculture. The following are the measures taken, among others:

2.1. Policy and Legal Instruments
The Fisheries Act No. 22 of 2011 is the principal law that governs the fisheries sector in the country. It is reinforced by the Fisheries Regulations No. 24 of 2012. The Act provides for the promotion of sustainable development of fisheries and a precautionary approach in fisheries management, conservation and utilization, and the regulation of commercial fishing and aquaculture.

The other key legal instruments that supplement the Fisheries Act are:

- The Environmental Management Act (EMA) No. 12 of 2011;
- The Water Resource Management Act, 2011;
- Local Government Act, Chapter 281;
- Biosafety Act No. 10 of 2007;
- Zambezi River Authority Act No. 17 of 1987;
- Lands act of 1995 (CAP 184);
- ZAWA Act No. 12 of 1998;
- Animal Health Act No. 27 of 2010;
- Cooperatives Act No. 20 of 1998; and

2.2. Regulations
These include:

- Annual Fishing Closure- Every year government announces and enforces a closed fishing period from 1 December to 28 February the following year. This coincides with the rainy season and was introduced to protect the breeding of fish.
- Mesh size restriction – This regulates the size of the fishing nets. The recommended size is not less than 50 mm for all stationary gillnets. This restriction allows for small fish to attain a minimum size before being captured.
- Introduction of permanently closed areas as sanctuaries and breeding grounds for commercially important species.
- A complete ban on use of some destructive fishing methods such as forcefully driving the fish into set nets, using explosives, use of weirs targeting migratory fish, and beach seine nets operated in shallow waters.
2.3. Programmes
In addition to the legal and regulatory framework, there are several programmes aimed at ensuring sustainable management of the fisheries sector, and some of these are:

- **National Aquaculture Strategy** – This, together with the National Aquaculture Development Plan of 2008, seek to attract private sector investment in aquaculture.
- **Development of Aquaculture Parks** – This programme is targeted at Aquaculture High Potential Zones in the country.
- **Extension Delivery** – The Department of Fisheries has placed extension workers in most parts of the country to provide extension services, especially in aquaculture.
- **The Aquaculture and Fisheries Fund** – This is provided for by the Fisheries Act No. 22 of 2011 with the aim of developing the fisheries and aquaculture sector and facilitating a community-based approach to fisheries management and development.
- **Citizen Economic Empowerment Commission (CEEC)** – This was established by the Zambian Government through an Act of Parliament No. 9 of 2006, to implement various economic empowerment programs, including fishing and aquaculture initiatives across the country. This initiative gives small-scale fish farmers an opportunity to access required support.

2.4. Community-based interventions
The people who depend on fish for livelihood and food security have a critical role to play in sustainable management of the fish resources, and, in this regard, they need to do the following:

- Abandon bad fishing practices and adopt sustainable methods.
- Adhere to existing laws and policies, with the knowledge that these statutes are for their own benefit.
- Work with government, particularly the Department of Fisheries and traditional leaders to enforce policies and laws.
- Own and sustain the community fisheries management structures.
- Above all adopt fish farming as a matter of priority in conserving fish resources by having an alternative source of livelihood.
3.0. Fish farming

Fish farming is the growing or rearing of fish in ponds, tanks and dams under good management systems with the aim of maximizing yields or harvest in the shortest possible time of about 5 to 6 months per cycle. Commercial fish farming is an ongoing income generating project. Besides commercial purposes, fish farming is used as alternative to capture fishing to conserve fish in natural water bodies like rivers, dams and lakes. People who depend on fishing for livelihood are encouraged to venture into fish farming to sustain fishing-based livelihoods.

In Zambia, fish farming is done at different levels, such as small scale using earth ponds and large scale in tanks, cages and dams. The most commonly reared species of fish include the three-spotted tilapia, the long fin tilapia, green-headed bream and the red breasted tilapia.

3.1. The Importance of Fish Farming

With most capture fisheries considered fully exploited, fish farming is central to conserving the remaining fish stocks and provision of an alternative source of livelihood and food security. Fish farming is a vital response to the fish depletion problem for the following reasons:

i. Fish farming does not put any pressure on the natural water bodies to the level of depletion.
ii. It assures sustained supply of fish and sustained livelihood and nutrition for the household during the annual closed fishing period between beginning of December and end of February.
iii. Preserves the endangered species for sustained livelihoods and food security.
iv. Fish farming also saves farmer money for buying fertilizer for vegetables in an integrated system because the same water that will come from the fish pond is already rich in nutrients and can be used to water the vegetables, hence cutting on water costs and the same fertilized water will provide nutrients to the vegetables.

3.2. Types of Fish farming practices

There are different types of fish farming practices. These can be summarized as follows:

i. Fish farming in reservoirs, impoundments and dams stocked with one or more fish species. There are no fertilizers or feeding involved and management levels are low.
ii. Fish farming in earthen ponds, and stocked with one or more species. Fertilizers consist mostly of poultry, animal manure and compost and the occasional use of supplementary feeds consisting of agricultural by-products, kitchen waste and green leaves. This is the common practice among small-scale farmers.
iii. Fish farming in large earthen ponds with two or more fish species, the regular use of inorganic and organic fertilizers, chicken or pig manure. This involves the regular use of supplementary feeds consisting of maize bran, rice bran mixed with fish waste, and combined with pigs or poultry production as sources of fertilisers. Medium and large-scale commercial farmers practice this method.
3.3. Establishment and Operation of a Fish farming project

Below are the key steps in pond construction and management, and fish farming project operation.

3.3.1. POND CONSTRUCTION

Fish pond construction involves the following:

**a). Locating the pond site**

The following are the recommended considerations when siting a fish pond:

i. The farmer should choose a good place to locate their pond while encouraging a well-integrated fish farming operation, where you integrate growing of fish side by side with livestock, vegetables and other horticultural products.

ii. It is best to choose a piece of land that has a gentle slope for easy filling and draining of the fish pond.

iii. Do not build your pond on a steep hill or where it can be flooded in the rainy season because then you will lose all your fish to the flood.

iv. Choose a sunny place for your pond, close to your home so people will not come and take your fish away and it’s easier to manage it.

v. The pond should be near water such as a stream or a spring, or in marshy ground where the water in the soil will fill up your pond.

**b). Water**

i. Your pond must be near a good supply of water such as a spring, stream, lake or reservoir with plenty of water all year round. Because we cannot grow fish and run out of water in the middle of the cycle, we need water throughout the cycle.

ii. You must be sure that you have enough water to fill your pond when it is time to fill it and to add more water when you need it.

iii. Do not depend on rain-water to fill your pond. When it does not rain, there may not be enough water to keep your pond full and the fish may die.

iv. Your water must come from a place that is higher than the pond so that the water will flow into the pond by itself thus reducing the amount of work demanded by this exercise (filling your pond).

v. The water should not have a bad smell, taste or colour. It should not be too muddy.

vi. The water should not have wild fish in it. You do not want wild fish in your pond because they may eat your fish or keep them from growing. Water from a natural spring close to the pond site is usually good and there will not be wild fish in it.

vii. Water from a stream or from a lake or reservoir is usually good but it may have wild fish in it. You will have to be careful that the wild fish do not swim into your pond.

**c). Soil Sampling**

When siting a fish pond, soil sampling is important to ensure good water retention. The following should be noted in soil sampling:

i. The soil in the place you choose must be good for a fish pond.

ii. To test if you have good soil, take a handful of soil from the surface and squeeze it into a ball.

iii. Throw the ball of soil into the air and catch it.

iv. If it sticks together it is good soil and will hold water well.

v. Bad soil with sand or gravel in it will not stick together and will not hold water. It will be losing a lot of water through seepage.

vi. In sandy soil the water will sink into the ground and there will not be enough water for your fish.

vii. If the ball sticks together well, the soil may be good but you cannot be sure. Now you should make a second test to be sure that the soil is good.
viii. Test the water retention capacity of the soil by doing the following:

- Dig a hole as deep as your waist.
- Early in the morning fill it with water. Fill it to the top.
- By evening some of the water will have sunk into the soil.
- Then fill the hole with water again. Fill it to the top. Cover the hole with boards or leafy branches.
- The next morning if most of the water is still in the hole, the soil will hold enough water to build a fish pond there.

As you carry out soil sampling, take note of the following:

- If the banks of your pond are built of sandy soil, they will not be strong enough to keep the water from flowing away.
- The soil where you build your pond should have enough clay in it. **Clay soil holds water very well.**
- In clay soil, very little water will sink into the ground, and banks of clay will be strong enough to hold the water in the pond.

**d). Size of the Pond**

The pond size depends on the kind or level of fish farming you want to go into; if it’s on a commercial basis, bigger ponds of 50 by 50 metres are better for a bigger harvest, but they also need intensive management. It is always good to start with a pond big enough to harvest good catches but at the same time easy to manage. For example, if you build a pond 20 by 25 metres, the pond will measure about 500 square metres (20m × 25m = 500m²).

A square or rectangular pond is easier to build. But your pond can have a different shape to fit the size and shape of your land. Like shown below.

**e). Pond Pegging and Marking**

Follow the following steps in constructing a fish pond:

i. First mark out a big rectangle on the site you have chosen, about 26 by 31 metres. Mark the corners with pegs and run a string between the pegs to show you where the outside of the banks will be.

ii. Clear the big rectangle of all trees, bushes and grass and take away all the big roots you can.

iii. Take away about 20 centimetres of topsoil from all over the square. Put the topsoil aside. Later you will put it back on the top and outer sides of the banks.

iv. Then mark out a small rectangle inside the big rectangle about 20 by 25 metres. Mark the corners with pegs and run a string between the pegs to show you where the inside of the banks will be.

v. The bottom of the bank in the shallow part of your pond and along the sides should be about 1 metre from the upper end and sides of the small rectangle.

vi. The bottom of the bank in the deepest part of your pond should be about 2 metres from the lower end of the small rectangle.

vii. Now mark out a third smaller area in the centre of your pond, about 18 by 22 metres. We will call this the central area. Mark the corners with pegs and run a string between the pegs to show where the bottom of the banks will be.

viii. Be sure that all the pegs and strings 26×31 metre rectangle 20×25 metre rectangle and the central area are set up correctly.
f). Pond Digging

Now you are ready to begin digging out soil from inside the central area to build the banks of your pond.

i. If possible, ask your neighbours to help you to dig your big pond. Then you can help them in turn to dig their ponds.

ii. Begin digging at the 1-metre string marking the central area at the upper end of your pond.

iii. Dig about 20 centimetres deep.

iv. As you dig toward the lower end, dig a little deeper.

v. When you get to the deepest part, at the 2-metre string marking the central area, you should be digging about 30 centimetres deep.

vi. As you dig out the soil, put it between the 20 by 25 metre rectangle and the 26 by 31 metre rectangle where the banks will be. Put it nearest to where you are digging. This way, the banks will be higher and wider as you move toward the lower end.

vii. When you come to roots, take away as much of them as you can.

viii. Whenever the loose soil you put on the banks reaches half as high as your knees, pack it down tightly. You can do this by beating the soil with a heavy plank, a length of tree trunk or an earth tamper.

ix. When you are digging, keep the slope of the pond bottom as regular as you can. It should slope gently down from the upper end to the deepest part. The bottom of the pond should have slopes like those in the drawings.

x. Begin again to dig soil out of the central area. Dig 20 more centimetres from the upper end and 30 more centimetres from the deepest part. Put the soil on the banks and pack it down tightly as before.

xi. Now begin again, for the third and last time, to dig soil out of the central area. Dig 20 more centimetres from the upper end and 30 more centimetres from the deepest part. Put the soil on the banks and pack it down tightly.

xii. When you have finished digging out the central area and you have put on the banks all the soil that you have taken out, you will have a hole 18 by 22 metres with straight sides. Now it is time to shape the banks.

xiii. Dig the soil away from the edges of the central area to form the slope of the banks. Put this soil on top of the banks and pack it down tightly.

xiv. The inside of the banks should slope less steeply than the outside. The drawing shows you what the banks should look like when they are finished.

xv. The top of the banks should be about 1.5 metres wide and should be straight and flat all the way around the pond.

xvi. Put the 20 centimetres of topsoil you took away when you began digging on the top and outer sides of the banks. Plant grass on the banks. Banks covered with grass last longer.

xvii. The bottom of your pond should be about 1.10 metres from the top of the banks at the shallow upper end and about 1.40 metres from the top of the banks at the deepest part.

xviii. Be sure that the bottom of the pond is fairly smooth and regular.

xix. Now dig a ditch in the bottom of the pond from the centre to the lower end. The ditch should be about 50 centimetres wide and about 20 centimetres deep. This ditch will help to drain out all the water when you empty your pond.

xx. When the ditch is finished, remove all loose soil and other trash from the bottom of the pond.

xxi. Now you are ready to install your inlet, outlet and overflow.

g). Inlet Setting

Keep the following in mind when setting the inlet:

i. You will need an inlet to let water into your pond when you want to fill it.

ii. You should place the inlet at the point nearest to the water supply. This will be at or near the upper end of your pond.

iii. Your inlet can be made from a piece of a pipe of plastic or metal. The inlet pipe should be about 10 to 20
centimetres in diameter.

iv. The inlet pipe should be long enough to reach through the top of the bank from one side to the other. You will need a pipe about 3 metres long to reach through the bank at the upper end of your pond.

v. Now dig a gap in the bank where you want the inlet to be. It should be a little above the water-level on the inside of your pond and a little below the level of the water which flows from the source on the outside of your pond.

vi. Put the inlet pipe in the gap in the bank and rebuild the bank over it.

vii. You can also make an inlet by cutting a shallow trench through the bank to let the water into the pond. If you use a shallow trench to get water into your pond, you can improve it and keep it from washing away by using a trough of roofing metal to line the bottom of the trench.

h. Outlet Setting
Below are the specifications:

i. You will need an outlet to let water out of your pond when you want to empty it.

ii. You should place the outlet at the bottom of the bank at the lower end of your pond at the deepest part for easy draining.

iii. The outlet can be made from a piece of a heavy pipe of plastic or metal. The outlet pipe should be about 20 to 30 centimetres in diameter. The bank of your pond is much wider at the lower end than at the upper end, so the outlet pipe will have to be longer than the inlet pipe.

iv. The outlet pipe should be long enough to reach through the bottom of the bank from one side to the other. You will need a pipe about 6.5 metres long to reach through the bank at the lower end of your pond.

v. If you cannot get a pipe that is long enough to go through the bank, you can join shorter pieces of pipe together using straight pieces of pipe like the ones in the drawing.

vi. If you are using bamboo, you can join short pieces of bamboo together with pieces of smaller bamboo in the centre, but the smaller pieces should be at least 8 to 9 centimetres in diameter. Wrap the bamboo joints with rope and close them with tar to keep water from seeping out.

vii. Now dig a gap in the bank where you want the outlet to be. It should reach from the deepest part on the inside of the pond through the bank to the outside of the pond.

viii. If the outlet pipe is below ground level on the outside of the pond, you will have to dig a ditch to take the water away from the outlet.

ix. Put the outlet pipe in the gap in the bank and rebuild the bank over it.

x. If you use an outlet of about 20 centimetres in diameter, it will take about half a day to empty your pond.

xi. It is easier to place the outlet where you want it to be before you dig out the centre of the pond and build the banks. When you build another pond, you will understand this and you will be able to do it when you are building the banks. But now, when you are building your first pond, you should place the outlet in the way you have just learned in this booklet because it is easier to understand.

xii. If you use a plastic or metal pipe for the outlet of your pond, you can make it better by putting an upright length of pipe on the end of the outlet using an L or a T piece like the ones in the drawing. Close the T piece with a plug as shown.

xiii. Put the L or T piece and the upright pipe on the end of the outlet outside the pond, but protect it so that it cannot be reached by animals or other people.

xiv. The top of the upright pipe should reach about 3 to 5 centimetres above the water-level of your pond. If the water rises above this level, it will overflow from the upright pipe.

xv. Tie the upright pipe to a pole which has been pounded into the ground so that it will not slip down and let the water out of the pond before you want it to.

xvi. When you want to let out the water, untie the upright pipe and push it down. The water will then flow out of the pond.

xvii. There is still another way to let water out of your pond, using a siphon. You will learn how to use a siphon in Items 118–128
i). The overflow
The pond overflow is managed through the following means:
i. If there is too much water in your pond, some of the water may flow over the banks. This may wash the banks away and some of your fish may get out.
ii. You can use an overflow to keep the water in your pond from rising over the banks.
iii. If you use a straight pipe outlet or a siphon to let water out of your pond, you will need another kind of overflow.
iv. This kind of overflow can be made from a pipe of plastic or metal. The overflow pipe should be about 10 centimetres in diameter.
v. The overflow pipe should be long enough to reach through the top of the bank from the inside of the pond to a place far enough on the outside to keep overflow water from washing away the bank. You will need a pipe about 4.5 metres long to do this.
vi. If you cannot get a pipe that is long enough, join short pieces of pipe.
vi. It is best to place your overflow in the bank at the lower end of your pond right above the outlet so that the water that overflows can run off in the outlet ditch.
ix. If you are going to put the overflow over the outlet, you can put it in the same gap that you dug for the outlet above. The water-line should be about 50 centimetres below the top of the bank, so put your overflow there as you rebuild the bank.
x. When the pond is full, the overflow will keep the water about 60 centimetres deep at the shallow upper end and about 90 centimetres deep at the deepest part.

j). Screens
The following should be noted with regard to screens for the pond:
♦ Your inlet should have a screen to keep out wild fish, dirt and trash when you fill the pond.
♦ If you fill your pond with an inlet trench, it should have a screen, too.
♦ Your outlet should have a screen to keep your fish from getting away when you empty your pond.
♦ Your overflow should have a screen to keep your fish from getting away when the pond is too full and the water begins to overflow.
♦ You can easily make screens for your inlet, outlet and overflow from fine-mesh plastic or metal or from a tin with holes in the end.
♦ Screens should be placed outside the pond on the inlet pipe and inside the pond on the outlet and overflow pipes.
♦ This will keep the pipes from filling with trash which could stop the flow of water.
♦ Lash the screens tightly in place on the pipes, using heavy cord or light wire.
♦ If you fill your pond by cutting a trench through the bank, you can screen the opening using a fish trap, split and woven bamboo, a clay pot with holes in the bottom or a piece of metal roofing with holes.
♦ Clean the screens often to ensure easy filling or emptying of your pond. If you do not do this, dirt and leaves will cover them up and the water will not flow in or out easily.
3.3.2. FISH POND MANAGEMENT
Effective fish pond management is cardinal to optimise production and returns from the investment. The following are the features to consider in fish pond management.

a). Filling the pond
Before you let the water into your new pond, there are a few things that you must do.

i. Make sure that the screens on the inlet, outlet and overflow are in place and tight.

ii. Make sure that the outlet is tightly closed. To do this, wrap a wood plug with old cloth, put it in the outlet pipe on the outside of the pond and tap it lightly with a hammer so that it will stay in the pipe when the pond fills with water.

iii. If you have built a better outlet with a T or an L piece turn it to the upright position.

iv. Put rocks on the bottom of your pond under the inlet where the water will fall when it begins to come into the pond.

v. This will keep the bottom from washing away. It will keep the water from getting too muddy. It will make the water splash when it first comes into the pond and bring air for the fish to breathe.

vi. Let the water run into the pond until it reaches the level of the overflow pipe on the inside of the pond.

vii. If your inlet pipe is about 10 centimetres in diameter, you will need about half a day to fill your pond.

viii. When the water reaches the level of the overflow pipe it will be about 60 centimetres deep at the shallow upper part of the pond and about 90 centimetres deep at the deepest part.

b). Water Fertilisation
To achieve high yields, the water of the fish pond should be fertilised to support growth of the fish population. Fertiliser is added to water to ensure that there are required amounts of nitrogen, phosphorous and potassium to support algae growth. Fertiliser application should be done at intervals of about ten days apart to maintain a good bloom – desired algae population. The bloom must be controlled to avoid too much algae that can reduce oxygen levels and therefore kill the fish. The richer the food in the water is, the greater will be the fish yield at cropping. To achieve the above, the following steps will assist in coming up with a good green bloom:

i. Aquatic weeds should be removed from the pond.

ii. A compost crib should be built in the corner of the fish pond and this compost crib should be regularly fed with animal manure, kitchen waste, maize sweepings, vegetables, etc.

iii. The water should turn green as quickly as possible.

iv. The water level should be kept constantly at a maximum level during the whole growing period.

Pond fertilisation can be done in several ways, including the following:

- Spreading the fertiliser over the water surface.
- Placing perforated fertiliser bags at even distances around the edge of the pond to enable dissolving of fertiliser by the water’s wave action.
- Placing fertiliser on submerged floating or stationery platforms off the bottom of the pond. This provides the best results with the less amounts of fertiliser.
- Placement of animal manure in bags sub-merged in the water at the edge of the pond. This method is also effective in producing algae and it is the cheapest source of fertiliser. However, there is likelihood of oxygen being used up and an increase in ammonium levels, but these risks can be minimised by moderate use or pre-treatment in an aeration pond.
c). Stocking the fish pond
The first time you stock your pond, you will need to find some baby fish called fingerlings. Good quality fingerlings bring good yields of fish during harvest and they grow fast and healthy. Care must always be taken when selecting a source for the fingerlings. When one is stocking the Three-spotted bream (*Oreochromisandersonii*) one will need to stock 4 fish per metre squared for mixed sex.

The ponds must not be over stocked because the fish will become too many and start competing for food, space, oxygen etc. As a result, they will be smaller in size at the time of harvest and one can even experience high mortality during the cycle.

Before you put the baby fish in the pond, be sure that the water where they are is not hotter or colder than the water in the pond.

You can find this out by putting one of your hands in the water with the fish and the other in the pond. If one is hotter or colder, slowly put water from the pond in the water with the fish until they are both the same temperature, to avoid fish shock and death.

Do not pour the fish into the pond. Gently put the container into the water, tip it a little, and let the fish swim out by themselves.

d). Daily Pond Management
Once the fingerlings are stocked, the production period has started and all efforts should be made to attain as quickly as possible, therefore feeding the fish will be priority number one.

1. Feeding
There are mainly two types of feed:
   i. The feed on small/tiny plants and animals called planktons. These are found in the green bloom.
   ii. Artificial food such as stock feed.

Besides keeping the water with a good green bloom, it is advisable to provide supplementary feed, mostly commercially produced stock feed, to increase the production and speed up the growth rate of the fish. Follow the following feeding norms:
   ♦ The feed should be distributed daily at the same feeding place/feeding ring. Fish should be fed 6 days a week at the time rate of 2 to 3 hours after sunrise or before sunset. This way the fish becomes accustomed to the feeding trend and will gather at the feeding place at the usual feeding time.
   ♦ Feed only amounts that will be eaten daily and within 10 to 15 minutes.
   ♦ Maize bran, rice bran, mill sweepings, oil cake, molasses, brewery wastes and other wastes such as decomposed fruits and vegetables can be used as plant-based food for the fish.

2. Observe Fish Behaviour
The two key behavioural traits to look out for are:
   ♦ Active fish that are easily swimming around the pond are in good health.
   ♦ The fish waiting at the surface water at the feeding point are likely hungry.
   ♦ The best time to carry out the observation is during the early morning hours.

3. Check the water fertility
There are three ways to test the fertility of the water and these are:
   ♦ If the fingertips become out of sight before your arm reaches the depth of the elbow, it means the water is over-fertilised. You should stop applying fertiliser to the water.
   ♦ If your fingertips disappear out of sight at elbow depth, then the water is well-fertilised.
   If your fingertips are still visible at elbow depth, the water is under-fertilised and must be re-fertilised.
4. Fish Harvesting
Fish breed in captivity at an earlier stage than in natural water. It is, therefore, not advisable to raise certain fish species particularly the three-spotted tilapia (*Oreochromis andersonii*) for more than six months if a size of fish has reached table size. A fish pond should, therefore, be completely drained and the fish cropped, with a view to achieving the highest yield possible with a high quality final product.

5. Fish Marketing
In Zambia, fish is a regular part of people’s diet and it is estimated that each Zambian consumes on average 10 kg of fish per year. This consumption trend is however unevenly distributed between rural areas and urban areas. There is more demand, and, therefore, available market for fish in urban areas, particularly bigger cities where it fetches more and provides good returns.

Fish can be distributed through a variety of outlets, which include retail stores selling meat and other food products, and city markets.
4.0. Where to get assistance for a Fish farming project

For expert advice and any assistance required, a fish farmer should consult the following:

♦ The Department of Fisheries District Office field staff.
♦ The Fish farmers who have been practising farming for more than 2 years.
♦ Written documents on Fish farming, which can be obtained from the Department of Fisheries.
♦ Any recommended publication with information applicable to the Zambian context.
5.0. References or Sources of information

i. Mr. Evans Mutanuka – Chief Fisheries Officer (Department of Fisheries)
ii. Mr. M. Maboshe – Provincial Fisheries Officer (Southern Province)
iii. Mr. Joseph Mbozi - District Marketing Development Officer (Kazungula)
iv. Aquaculture production- National Agricultural Information Services (Ministry of Agriculture)
v. FAO publications related to aquaculture for Zambia(2005)
vi. Fisheries in Zambia: An undervalued contributor to poverty reduction (Musumali et.al. 2013)
Contact us
Panos Institute Southern Africa
Regional Office
Plot 9028 Bulwe Road
Off Leopards Hill, Woodlands
P.O. Box 39163, Lusaka Zambia
Tel: +260 211 263258   Fax: +260 211 261039
Email: general@panos.org.zm   Website: http://www.panos.org.zm

South Africa Office
P.O. Box 3286, Parklands, 2121
168 Jan Smuts Avenue, 3rd Floor
Rosebank, 2196
Johannesburg
Email: admin@panos.org.za

Mozambique Office
Rua Castelo Branco,47 -1st Floor
Mulangallele
Tel/Fax: (+258) 21415549/ 849414984
Mobile: (+258) 823050604/ 848585135
Email: mozambique@panos.org.zm

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Panos Caribbean
www.panoscaribean.org

Panos Eastern Africa
www.panoseasternafrica.org.ug

Kampala, Uganda
(regional centre)
tel: +256 414 344231
fax: +256 412 54729
pesa@panoseasternafrica.org.ug

Panos Paris
www.panosparis.org

tel: +33 1 40 41 05 50
fax: +33 1 40 41 03 30
panos@panosparis.org

Panos South Asia
www.panossouthasia.org

Kathmandu, Nepal
(regional centre)
tel: +977 1 5521889
fax: +977 1 5844641
psa@panossouthasia.org

Panos West Africa
www.panos-wa.org

Dakar, Senegal
(regional centre)
tel: +221 84918666
fax: +221 8221781
info@panos-wa.org

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