PED

Integrated Farming Manual











By
Dr. Leslie Chin, Walter Matadial,
Roopnaraine Itwaru and Sigmund McKenzie

© Copyright 2011, Institute of Private Enterprise Development

Parts of this book may be reproduced with acknowledgement of its source.

Original Title: Integrated Farming Manual
Authors: Dr Leslie Chin, Walter Matadial, Sigmund Mckenzie, Roopnarine ltwaru

Editor: John Clowes

Publisher: The Institute of Private Enterprise Development (IPED)
253 South Road, Bourda, Georgetown, Guyana
with Support form the Multilateral Investment Fund
Of the Inter-American Development Bank Project
ATN/M E - 10884-GY

Printer: F & H Printing Establishment
90 John Street, Campbellville
Georgetown, Guyana



INTEGRATED FARMING MANUAL

By

Dr Leslie Chin
Walter Matadial
Roopnarine Itwaru
Sigmund McKenzie

Edited by John Clowes

Funded by IDB-MIF project ATN/ME -10884-GY

Table of Contents

MESSAGE ii
FOREWORD iii
ACKNOWLEDGEMENTS iv
INTRODUCTION 1
Module # 1 INTEGRATED FARMING 2
Unit # 1 The Integrated Farm 3
Unit # 2 Summary Integrated Farming 13
MODULE # 2 MAKING FITTING UP AND OPERATING A BIODIGESTER 14
Unit 1 A Biodigester and the Biogas 15
Unit 2 The Size and Placement of Biodigester 18
Unit 3 Assembling a Biodigester 21
Unit 4 Air-filling and Loading the Biodigester 26
Unit 5 Connecting the Biodigester 28
Unit 6 Operating and Maintaining the Biodigester 30
MODULE #3 DUCKWEED GROWING AND USE 33
Unit #1 Knowing the Duckweed 33
Unit # 2 Farming Duckweed 35
Unit # 3 Feeding Duckweed To Tilapia 42
Unit # 4 Feeding Duckweed To Broilers, Layers, Ducks And Pigs 43
Unit # 5 Duckweed Facts Summary 49
MODULE # 4 FISH FARMING 50
Unit # 1 Classifying Aquaculture 51
Unit # 2 Methods of Fish Culture 58
Unit # 3 Selecting the site for a pond 60
Unit # 4 Designing and constructing a pond 62
Unit # 5 The aquatic environment 65
(The conditions inside a pond) 65
Unit # 6 Feeding Tilapia 71
Unit # 7 Feed Duckweed 73
Unit # 8 Feeding Rates 75
Unit # 9 Transporting and Stocking 77
Unit # 10 Marketing of Fish 80
Bibliography 82

MESSAGE by Ignatius Jean, IICA Representative in Guyana

Agricultural development in Guyana is fundamental to National economic development. Over the past 25 years, IPED has played an integral role in agricultural development and positioned itself as the premier micro-finance institution in the country. Indeed, it is widely acclaimed that IPED is "everywhere in Guyana for everyone in Guyana."

The Institute has responded to the myriad challenges faced by its clients in the agricultural and rural milieu by guiding them to solutions through an integrated farming systems approach – an approach to farming that combines the best of traditional methods with modern technology, to achieve high productivity with low environmental impact.

The Inter-American Institute for Cooperation on Agriculture (IICA) commenced its collaboration with IPED through its late Emeritus International Professional, Hector Muñoz, who promoted pasture development among small scale cattle farmers. Recognizing the immense potential for utilizing biomass generated on the farms and the energy needs of the farmers, he introduced low-cost plastic biogas digesters.

The use of biogas digesters in the production system could assist with reducing the negative effects of methane gas emissions on the environment. This may be achieved through the process of decomposition, including fermentation of organic material such as cattle dung, grass and other organic waste from the farm to produce methane gas. The stored methane gas could be used for energy needs on the farm, e.g. cooking or powering an electric generator. The use of biogas digesters, therefore, has a positive effect on climate change.

Other technologies introduced in the collaboration and promoted in the integrated farming system include: vermiculture (worm culture), i.e., the system of culturing worms (Elsenia foetida, Lumbricus rubellus and Red hybrid) to produce humus or organic fertilizer from plant and animal waste; trials with duckweed (Lemna family) as an alternative source of protein to supplement energy feeds such as cassava, corn, rice and bran in livestock feeds, as well as aquaculture systems.

IICA wishes to commend IPED on the timely production of this Integrated Farming Manual and above all, to congratulate the Board of Directors, management and staff on their milestone achievement of 25 years of promoting and direct support to agriculture and rural development in Guyana.

FOREWORD

The Institute of Private Enterprise Development's mission is to facilitate enterprise development for wealth creation and poverty reduction whilst being financially viable.

Access to credit is possibly the most important factor for Small and Microenterprises (SMEs). IPED is known for giving small and micro loans everywhere in Guyana. IPED provides supervised credit through 22 field officers functioning as business counselors. IPED also has an Entrepreneurial Development Centre that provides complementary business development services in the following programme areas:

1. Business skills training: We train approx. 1,000 persons annually
2. Market Facilitation: We are collaborating with the Inter-American Investment Corporation (IIC) to assist small and medium sized enterprises (SMEs) to improve their access to export markets.
3. Technology transfer: Collaboration with the Inter-American Development Bank Multilateral Investment Fund (IDB-MIF) for the Demonstration of an Integrated Farming Model for Poor Farmers project which increases farm productivity and contributes to reduction of poverty amongst small rural farmers in all ten (10) Administrative Regions of Guyana.

The Integrated Farming model has built-in sustainability features through the demonstration effect. The model depends on use of waste from livestock production as the key input. The output or waste from one production unit serves as the input for a subsequent unit. The model can be implemented in remote hinterland villages since there are very little inputs from outside the village.

All of these activities are geared towards ensuring SMEs are successful.

Ramesh Persaud
IPED'S CEO

ACKNOWLEDGEMENTS

The Institute of Private Enterprise Development (IPED) would like to acknowledge the matching funds grant of the Multilateral Investment Fund of the Inter-American Development Bank. We expect to get more than 300 farmers to adopt the integrated farming model and that would make a difference to their standard of living and quality of life.

The project team expresses its grateful thanks to the staff of the Guyana Country office of the IDB for their support and counseling. Our grateful thanks go out to the IICA Country Office and to our friend and consultant, the late Dr. Hector Munoz, who introduced us to low cost biodigesters and whose brochure we utilized in our early promotional months.

The project team thanks the Board of Directors of IPED, the key management personnel and the business counselors in supporting and promoting the project on Integrated Farming.

The project team would like to thank the three (3) Volunteer Specialists of the Farmer to Farmer Programme that was facilitated by Partners of the Americas. They were Dr Louis Landesman duckweed and aquaculture specialist, Mr Vance Haugen, biodigester specialist Ms Tamra Fakhoorian, algae specialist and duckweed promoter.

INTRODUCTION

Small and poor farmers are usually at a competitive disadvantage in the procurement of inputs. They buy in relatively small amounts and have to pay for transportation which can make up a significant part of the total input costs.

The adoption of integrated farming systems can address these two (2) issues. Integrated farming utilizes the waste from one operation as input into another operation on the farm.

In the Integrated farming model that is being proposed for poor farmers, Lemna Duckweed is a key component, since it grows very quickly and is rich in protein when grown in a well fertilized pond.

The opportunity cost of the waste is generally nil or there may even be costs involved in its disposal. The cost of moving the waste is low and can be reduced to near zero with properly designed structures.

Duckweed captures the carbon dioxide of the air and utilizes the sunlight to produce the living matter that includes proteins, carbohydrates and fats. Importantly, duckweed also utilizes the nitrogen in the water for the formation of protein.

The Lemna Duckweed that is being promoted is not the duckweed pest found in rice fields.

This project has a conscious objective to target farmers of the hinterland Regions, numbers 1, 7, 8 and 9, who are easily forgotten but for whom integrated farming is most appropriate.

This project also has a fish farming component which has the potential of creating considerable economic value added and at the same time provide high value animal protein to poor farmers.

Module # 1 INTEGRATED FARMING

Introduction

Welcome to this module on integrated farming. In this module, you will learn about this idea of an integrated farm and you will develop an appreciation for the application of such an enterprise on your farm.

This module is made up of two units:

- The integrated farm.
- The theory of financial values of an integrated farm.

Objectives

When we are complete with this module we shall together:

- Establish an integrated farm.
- Measure the dollar value of an integrated farm.
- List benefits and gains.

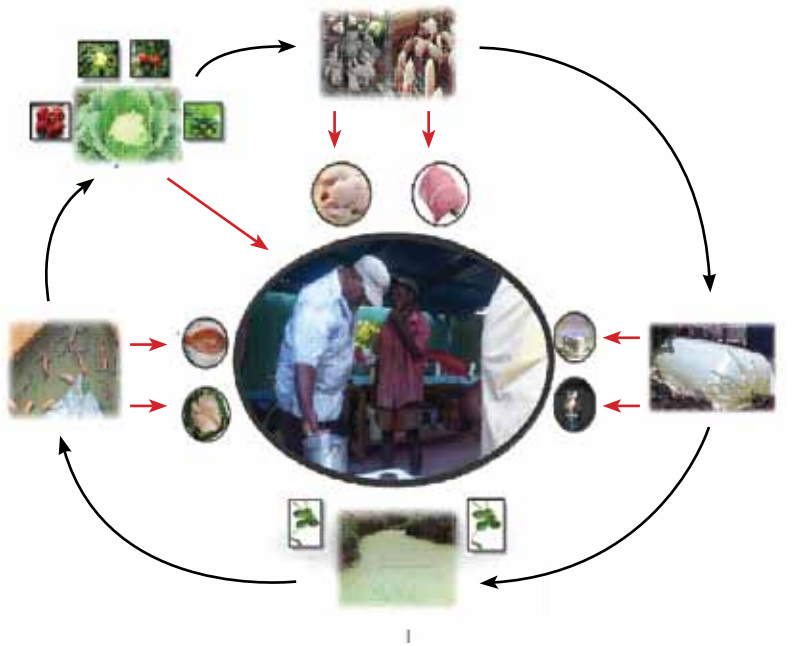


Figure 1: A fully integrated farming system

Unit # 1 The Integrated Farm

Introduction

Welcome to the integrated farm. In this unit you will learn about this idea of an integrated farm. We shall together build a picture and calculate the value of this idea.

Objectives

When we are complete with this unit we shall together:

- Identify the parts of an integrated farm.
- Trace the movement of products and by-products from one part of the farm to another.
- Measure the worth or value that is transferred and or created.
- Calculate the benefits and gains in dollar terms.
- Identify the benefits of preserving the environment for future generations.

What is an Integrated Farm

- An integrated farm utilizes the waste from one farming operation as the input into another operation.
- An integrated farm is more than a mixed farm. It is a combination of many small business units in one location.
    - Each unit is designed with efficiency, that is, it uses up inputs on the farm, passes them through a process and produces economic outputs.
    - Each unit produces commercial products and by-products, for sale. The main products are either used on the farm or sold on the open market.
    - The waste and by-products become the inputs for an important process on another part of the farm.

Different Levels of Integrated Farming Systems

There are many ways of achieving integrated farming where the waste from one farming operation is used as input into another operation as shown in the table below. The incorporation of duckweed production into an integrated farming system benefits from the fixing of carbon dioxide in the air through photosynthesis by the duckweed.

LEVELS	EXAMPLES				
TWO components	Cattle + DUCKWEED	Pigs + DUCKWEED	Poultry +DUCKWEED	Compost + DUCKWEED	Fish + DUCKWEED
	Cattle + BIODIGESTER	Pigs + BIODIGESTER	Poultry + BIODIGESTER	Compost + BIODIGESTER	
	FISH POND + Cattle	FISH POND + Pigs	FISH POND + Poultry		
	DUCKWEED + BIODIGESTER	Livestock + CROPS			
THREE components	Cattle + BIODIGESTER + DUCKWEED	Pigs + BIODIGESTER + DUCKWEED	Poultry + BIODIGESTER +DUCKWEED	Compost + BIODIGESTER +DUCKWEED	
	Cattle + FISH POND + CROPS	Pigs + FISH POND + CROPS	Poultry + FISH POND + CROPS		
FOUR components	Cattle + BIODIGESTER + DUCKWEED + FISH POND	Pigs + BIODIGESTER + DUCKWEED + FISH POND	Poultry + BIODIGESTER + DUCKWEED + FISH POND	Compost + BIODIGESTER + DUCKWEED + FISH POND	
FIVE components	Cattle + BIODIGESTER + DUCKWEED + FISH POND + CROPS or AQUAPONICS	Pigs + BIODIGESTER + DUCKWEED + FISH POND + CROPS or AQUAPONICS	Poultry + BIODIGESTER + DUCKWEED + FISH POND + CROPS or AQUAPONICS	Compost + BIODIGESTER + DUCKWEED + FISH POND + CROPS or AQUAPONICS	

Table 1: Different levels of integrated farming system

Benefits of Integrated Farming

- Integrated farming saves money by utilizing waste.
- Integrated farming could be turned into organic production with better prices for produce.
- If a biodigester is adopted into the integrated farm, it would produce biogas and save the family the cost of buying cooking gas or labour of collecting firewood.
- It would be part of the Low Carbon Development Strategy and could also be eligible for payments on the carbon markets.
- The biodigester solves the problem of disposal of the waste from pig pens, which can be a nuisance to neighbours.

Integrated farming is especially worthwhile in isolated communities of the hinterland because it does not depend so much on inputs from the coast.

Evaluating the Costs and Benefits with Examples of Integrated Farms

1. Broilers and Duckweed

   100 broilers fed commercial broiler feed supplemented with fresh duckweed. Savings are 2 bags feed valued $9,000.

2. Pigs and Duckweed

   Six (6) weaner pigs fed a mix of rice bran, broken rice and wheat middlings supplemented with fresh duckweed. Savings are from improvement of total feed quality with reduction of feed conversion ratio from 4.5 to 3.5 or 900 lb feed valued $10,800.

3. Pigs and Biodigester

   Biogas produced replace a 20 lb cylinder of cooking gas per month valued $3,500 or $42,000 per year.

4. Pigs and Fish Pond

   Six (6) pigs could fertilize a 1,000 square metre fish pond with 2,000 Tilapia and 1,000 Hassar. Plankton is produced. The fish feed on plankton up to 150 g in body weight after which the fish are fed rice bran or other grain byproducts.

   Profits of the fish farm are about $500,000 per year.

5. Pigs, Biodigester and Fish Pond

   Six (6) pigs could supply enough manure for a biodigester to produce enough biogas to replace a 20 lb cylinder of cooking gas per month valued $3,500. The effluent from the biodigester is used to fertilize the fish pond and generate a profit of $500,000 per year.

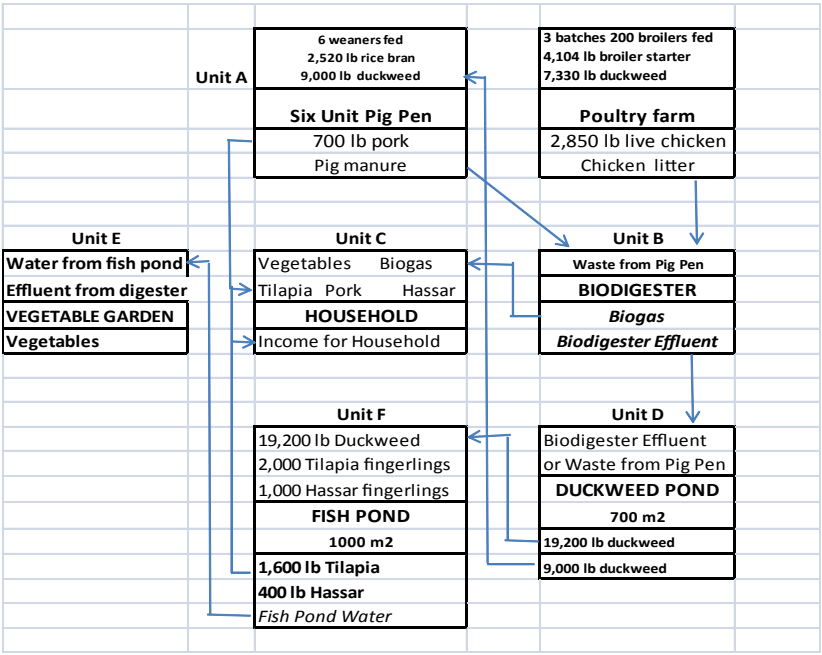
6. Pigs, Biodigester, Duckweed and Fish Pond

   Six (6) pigs could supply enough manure for a biodigester to produce enough biogas to replace a 20 lb cylinder of cooking gas per month valued $3,500. The effluent from the biodigester is used to fertilize a duckweed pond. The duckweed in turn is used as the only feed for Tilapia. The fish pond would generate a profit of $500,000 per year.

7. Pigs, Biodigester, Duckweed, Fish Pond and Vegetable Garden

   The additional benefits from the vegetable garden are estimated to be $75,000 per year.

Components of an integrated farm showing a six–month cycle



- A fully integrated farm is made up of a duckweed pond, a fish pond, a biodigester, one or more of the following livestock components: - Cows, Pigs, and Poultry. Ducks, Sheep or Goats, and crops such as Vegetables or Fruit trees.

How the Integrated Farm works in Theory

The farm is made up of six units with five farm enterprises. They are as follows:

Unit A: Represents a Pig unit

- This unit is run with batches of 6 weaner pigs for 6 months**.**

- The pig unit is made up of six weaners operation.
- They eat a total of 2,520 lb of rice bran.
- They are fed 9, 000 lb of fresh duckweed.
- The total product from this unit is 700 lbs of pork.



Figure 2: Swine production

Unit D: Represents a Duckweed Pond

- A pond of 1,800 square meters and can produce 400 lb of fresh duckweed daily.
- Duckweed has 35% protein on a dry matter basis and can double its volume every 48 hours.
- If the water level in the duckweed pond is maintained at a depth greater than twelve inches, hassar can be put to grow in it.



Figure 3: A well fertilized duckweed pond

Unit B: Represents a Biodigester

- Utilises waste from the pig pens, the entrails from chicken, fish and pigs. Peelings from cassava and other provisions can also be put into the biodigester.

- The biodigester produces biogas, which is a mixture of Methane, Oxygen, Hydrogen- sulphide and Carbon Dioxide. Because the gas is utilized for cooking, it is of little or no harm to the environment. The problem of pollution of the environment does not apply to this technology.



Figure 4: A Biodigester

- The effluent from the biodigester is used to fertilize the duckweed pond, or it may be applied to the vegetables garden.

- Biogas is clean and healthy, produces little smell or smoke.

- It is more convenient than fire wood.

- It is more affordable than commercial cooking gas.

Unit F: Represents a Fish Pond

- This pond is one thousand square metres or quarter acre.

- It is stocked with 2000 Tilapia and 1000 Hassar fingerlings.

- It utilizes waste from the biodigester and duckweed from the duckweed weed pond.

- The slush from the bottom of this pond can be thrown into the duckweed pond.

- The fish production is given as 2000 lb in 6 months. It can be utilized in the household or sold on the local market.

- Fish can be fed with duckweed and commercial ration mixed in equal proportions. It has been proven that they grow better than those fed with full commercial ration throughout their lives.

- The pond can be stocked at a rate of 8,000 to 10,000 fish per acre. The feed cost of commercial ration, which is approximately $1, 000, 000 can be drastically reduced by feeding duckweed exclusively.

- One acre of duckweed can feed a two acre fish pond. The Tilapia fish harvested can give you an average weight of one pound in six months and an average of half pound Hassar over one year. The Hassar feeds on the waste from the Tilapia.

- Fertilize the pond daily with effluent from the biodigester so that plankton can grow. Fingerling fish can live and grow on the plankton for as long as seventy five days without supplementary feeding.



Figure 5: A Fishpond

Unit E: Represents a Vegetable Garden

- The garden is 1,000 square meters. It would subsidize the home.

- The water from the fish pond is used on a daily basis to water the garden beds.

- Vegetable waste from the farm is fed into the digester.

- The garden can produce as much as thirty pounds of fresh vegetables a week.

Unit C: Represents the Farm Household

- It provides management, supervision and labour for the system**.**
- It makes all the important decisions for the system.



Figure 6: A vegetable garden for home

- It benefits from the cooking gas, fish, vegetables, meat etc.
- It earns good-will and savings from the entire system.

Calculating the <u>ANNUAL</u> Profit and Loss Status of the integrated farm

Inputs and Cost	Sales
1. Biodigester investment $60, 000 Wear and Tear over 3 years $20,000	Cooking gas 12 of 20 lb cylinder @ $3, 500 $ 42, 000
2. Weaners 2 x 6 x $8000 $ 96, 000	Pig. 2 x 6 x 180 x $150 $ 324, 000
3. Rice Bran. 2 x 6 x 150 lbs x 3.5 x 0.8 x $10 $ 50,400	Fish. 2 x 1,600 x $160 + 1 x 400 x $300 $632, 000

4. Tilapia & Hassar fry. 2 x 2000 x $15 Hassar fry. 1 x 1000 x $15 $75,000	Vegetables. 50 x 30 x $50 $ 75, 000
Total Cost $241, 400	Total Sales $ 1, 073, 000

Approximate Gross earnings from integrated farming.

Total sales $1, 073, 000: Total Expenditure $241,400: Returns to Labour and Profit $831, 600

Duckweed Pond Area Calculations.

Specifications	Weight
Wet duckweed **per year** For pigs 20% dry duckweed of feed at Feed Conversion Ratio 3.5 For tilapia using fresh duckweed only for Feed Conversion Ratio of 12 lbs fresh duckweed to 1 lb live weight gain	18,000 lb 38,400 lb
Pond area needed based on 0.100 kg per sq metre fresh duckweed harvested daily	700 square metres

Unit # 2 Summary Integrated Farming

Introduction

Welcome to the summary on integrated farm.

Objectives

When we are completed with this unit we shall together:

- Answer important questions on integrated farming.
- Defend the value of integrated farming.
- State a value in dollars for the savings to be obtained from integrated farming.

SUMMARY
The integrated farm utilizes the waste from one farming operation as the input into another operation.
Integrated farming could possibly create a savings of more than $800,000 per year using one acre of land
A biodigester could supply a family enough biogas for cooking each day.
Duckweed is a key component of integrated farming because of its high protein content and it is very productive. One acre of duckweed pond could yield as much as 150, 000 lb a year.

MODULE # 2 MAKING, FITTING UP AND OPERATING A BIODIGESTER

Introduction

Welcome to module # 2. This module, will simplify all of the needs and the requirements for making and operating a biodigester in your backyard.

The module is set out in six Units as follows:

- The biodigester and biogas.
- The size and placement of a biodigester.
- Assembling the parts of a biodigester
- Air filling and loading a biodigester.
- Connecting the biodigester.
- Operation and maintenance of the biodigester.

Objectives

When you are finished reading this module, you would be able to :

- Understand the savings and appreciate the benefits of biodigesters.
- Calculate the size and requirements for a biodigester.
- Select the site for a biodigester.
- Construct your own biodigester in your back yard.
- Operate and maintain a biodigester.



Figure 7: A biodigester being installed (Lethem)

Unit 1 A Biodigester and the Biogas

Introduction

Welcome to *Unit* 1. In this unit you will understand the simple idea of a biodigester and the biogas that it produces. Before we begin this process, let us set our objectives.

Objectives

By the end of this unit you will be able to:

- Identify the list of requirements for a biodigester.
- Fit up, connect and use a biodigester.
- Understand how the gas is produced in a biodigester.

What will you need?

- Sixty feet of polyethylene plastic tubing that is eight feet wide when laid flat 8 mils or 200 microns thickness.
- Two pieces of six inch diameter PVC pipe. Each must be four feet long.
- PVC ½" pipe to connect the digester to the stove. The number of lengths required, depends on the distance from the digester to the stove.
- One ½" PVC T-piece.
- Four ½"knees.
- Two ½" coupling to join pipes.
- One ½" PVC cap.
- One ½" female adapter.
- One ½" male adapter.
- One small tin PVC paste.
- Two car or truck inner tubes.
- One packet steel wool.
- One used soft drink bottle about *2 litre* capacity.
- Two ½" PVC valves.
- Two 4-inch hose clips.
- Two 6-inch hose clips.
- The land site for the installation and operation should be approximately 30 feet long by 10 feet wide.
- You will be required to dig a trench 24 feet long, five feet wide and *2.5* feet deep.

- You should also have 5 gallons of manure daily from either 3 cows or 6 pigs for the biodigester.

What is a Biodigester?

- It is a device that allows us to use farm waste such as pen manure or crop waste to produce methane gas. This is similar to the gas used for cooking in our kitchens. This entire process takes place in a large sealed polyethylene plastic bag. A typical digester for the home would measure twenty feet by five feet. The whole unit can fit in your backyard.

- Biodigesters can be custom made for small farmers, urban dwellers and also industrial producers.

- The primary feedstock is a mixture of a 4 to 1 water / manure mix, that is, four buckets of water to one bucket of pen manure. This diluted mixture is then poured into the biodigester. Plant waste, such as peelings or spoilt fruits and vegetables can also be added. The entrails from the slaughtering of chicken or pigs also produce much biogas when used as feedstock.

- The Biogas produced from this unit is a mixture of many gasses and the main gas is cooking gas. It is trapped and stored in the plastic tube above the liquid level and it has the following advantages:

- It is clean and healthy, produces no smell or smoke.

- It is more convenient than fire wood and kero oil.

- It is more affordable than commercial cooking gas.

How is a Biogas Produced?

The gas is produced when the organic materials are broken down by bacteria. These organisms feed on the organic materials and *they* do their work, in the absence of air, in the biodigester. Biogas is a composite of methane (cooking gas)

and other gasses.

30 to 35 days after the organic mixture is poured into the digester, the gas should be ready for use.

The organic materials we used are reduced to a liquid effluent which has some of the same properties like a mixed NPK commercial fertilizer plus trace minerals.

The effluent can be used to fertilize your duckweed pond or your vegetable garden.




Figure 8 & 9: A biodigester being installed (Berbice)

Unit 2 The Size and Placement of Biodigester

Introduction

Welcome to unit # 2. In this unit you will understand how to place and estimate the size of your biodigester:
Before the beginning of this process, let us set our objectives.

Objectives

By the end of this unit you will be able to:

- Calculate the size of the biodigester that you will need.
- Decide where to place the biodigester

The Size of a Biodigester

The size of the digester we construct is dependent on our average monthly consumption of cooking gas. A digester twenty five feet in length and five feet in diameter could be loaded on a daily basis, with a 5 gallon bucket of animal dung. This amount can come from 3 cows or 6 pigs or 20 sheep. If the animals are only penned during the night, use twice the number of animals.

The quantity of gas supplied by this unit could provide an equivalent of a twenty pound cylinder of cooking gas per month. This is regarded as the standard requirement for an average household.

The amount of pen manure and other forms of farm waste materials which can be acquired either from your own back yard or from the neighbourhood.

Placing the Biodigester

- **Location**
  - Close to the place where the dung, pen manure and plant waste are located.
  - Away from any low spots that flood easily.
  - The site should be easy to fence off from animals.
- **The Pit**
  - The Pit should be a semi-circular trench the width of your plastic tube and the depth being one half the

tube diameter. For a five foot tube the trench should be at least five feet wide at the top and 2.5 feet deep.

- Line the pit with old plastic sheets to protect the new plastic tube.
- A layer of concrete blocks, one or two rows high can be placed around the pit to prevent the pit from being flooded in the rainy season.
- The soil taken out can be placed around the blocks as a form of reinforcement.

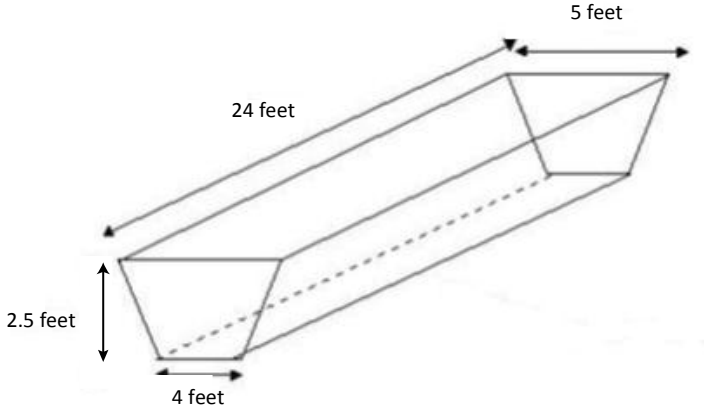


Figure 10: The dimensions of a pit to be dug for installation of a biodigester

- **Fencing**
  - Fence the biodigester with sturdy staves to prevent animals from accessing and damaging the biodigester plastic.



Figure 12: Fencing used to protect a biodigester

Unit 3 Assembling a Biodigester

Introduction

Welcome to unit # 3. In this unit you will understand how to fit-up your Biodigester.

Objectives

By the end of this unit you will be able to:

- Outline the steps involved in assembling a biodigester.
- Prepare the polyethylene plastic tube.
- Prepare the Inlet and Outlet pipes by securing two pieces of six-inch PVC pipe each four feet long.
- Prepare the gas outlet with its gaskets and washers.
- Assemble and fit a pressure release valve.

• How to assemble the Biodigester

• First, prepare the polyethylene plastic tube

- The plastic is usually obtained in rolls of 300 feet in length. Roll it out in a large open space such as a play field. Check all around and remove any pebbles and sharp edged materials.

- After unrolling and cutting it to the correct length, you now slide one plastic tube inside the other for a double layer without pleats, folds or space between the two layers of plastic. Make sure that the seam of the inner layer is aligned with the seam of the outer layer.

- **Secondly prepare the inlet and outlet pipes**
  - The six-inch PVC pipes are to be used as funnels to fill the digester and for emptying it.
  - Smooth the ends of the PVC pipe with sand paper or flame to ensure that they do not damage the polythene plastic.
- **Thirdly, prepare the washers**
  - A washer is a spacer or a sealer used to fit the gas outlet pieces through the plastic tube.
  - Use either hard plastic or sheet plastic from an old plastic bucket bottom or drum cover.
  - Two round washers should be about 3" in diameter, mark it with a pencil and cut it neatly with a hacksaw. Smooth the edges with sand paper. Cut or drill a hole to fit the male adapter closely.
- **Fourthly, prepare the gaskets**
  - A gasket protects the surface and seals the gas valve opening.
  - Use a rubber inner tube for this purpose.
  - Use pencil to draw a circle 3½" in diameter, and cut on the line.
  - Cut a hole to fit the male adapter closely.
  - Two gaskets are used, one inside and one on the outside of the plastic tube.
- **Fit the gas outlet**
  - The gas outlet can be located at any point along the center line of the gas bag. It is recommended that the gas outlet be at least 4 ft from the outlet pipe connection.

- Mark a circle smaller than the ½" PVC pipe and cut the hole very neatly. A close fit will ensure that there is no space for gas leakage.

- Place one washer and one gasket on the threads of the PVC male adapter. Place this assembly from the inside of the double plastic. Only the threads of the adapter must be seen upwards from the small hole on the plastic.

- Place a gasket and then the outer washer on the threads at the top end. Attach the female adapter, it must be tightly secured to the gasket and washers placed above and below.

- Using the PVC paste, fit a 3" length of PVC pipe to the female adapter. To this 3" length, fit a PVC knee. From this assembly, run a pipe to the stove.

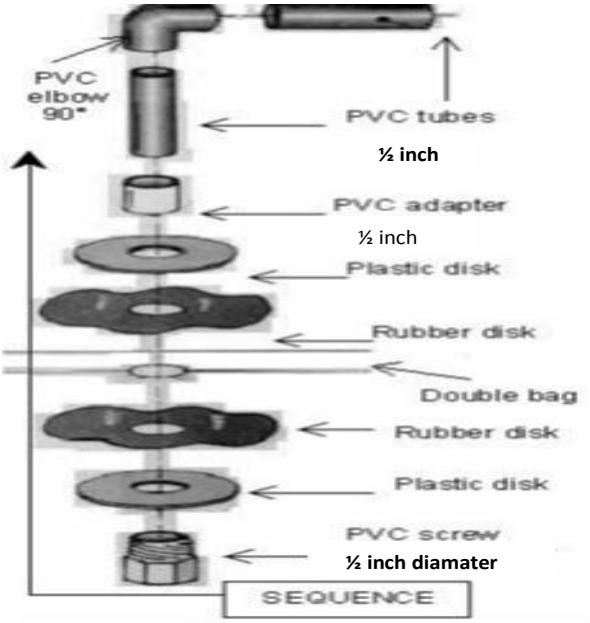


Figure 13: Position of components for a gas outlet

- **Fit the Pressure release Valve**

  The valve is assembled to look like the picture on the right. To make this valve, you need the following;

  One ½" PVC T-piece.

  One ½" ball valve.

  One used plastic 2 litre bottle.

  Two eight-inch and one ten-inch lengths of ½" PVC pipe.

  - Assemble all the parts to look just like picture on the right. Paste all of the parts tightly, except the ten-inch piece of PVC.
  - At this stage, the "T" is open at two ends. One open end pointing downwards, while the other open-end points horizontally and forward.
  - Do not paste this assembly, just push-fit it.
  - Take two whole steel or steel wool pot scrubbers and push them into the "T" section. Next, push-fit the ten-inch piece of PVC tightly into the "T". The pot scrubber will act like a sponge. It will remove any smell which can arise from the biogas (Hydrogen sulphide).
  - To make the valve, we need a soft-drink bottle with the head portion cut off.
  - Suspend it from the main gas line. Let it hang on the "T", in such a way that the pipe dips 8 inches into the hanging half bottle.
  - Two inches from the top end of the suspended open-mouthed bottle, cut a small hole.
  - Fill the bottle with water, until the open end of pipe dips at least six inches into it. Any excess gas escapes from this valve.

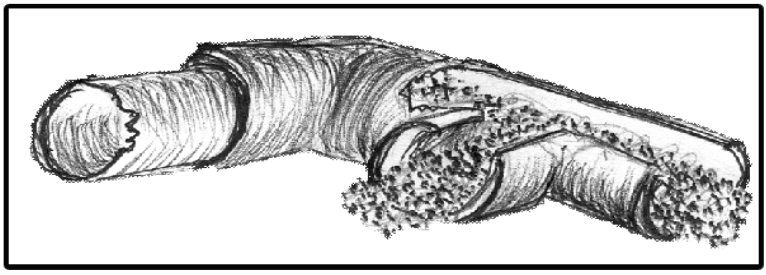


Figure 14: Cross section view of a pressure release valve

- **Fifthly, place the double rolled plastic in the pit**
  - Keep the inlet pipe at the desired angle which will be between 30-45 degrees. This will allow for easy loading and discharging and not harm the biodigester.
  - The two open ends should be left lying at both ends of the pit.
  - Align the center seam of the plastic to be straight, running the length of the trench.

- **Fit the Inlet and Outlet Pipes**
  - The four foot long PVC pipe funnels which we made earlier must now be attached.
  - With the plastic tube lying flat on the ground, place the inlet pipe into the inner polythene tube to a distance of 2½', with the free end 1½'showing.
  - Start pleating from both edges of the plastic and move towards the pipe. The pleats are 6" to 8" inches wide. These pleats are held together temporarily by a rubber strap. The pleats are then evenly distributed around the pipe and permanent strapping commences with 2" strips of rubber from a car or truck tyre.
  - Start strapping from the end of the plastic for a distance of 1 ½'. Place a 10" clamp made by combining a 4" with

a 6” size hose clamps, about 4” from the lower end of the rubber strapping. Place a rubber guard around the pipe before tightening the hose clamp. Complete the strapping with a layer of duct tape.

- Repeat the above operation to fit the outlet pipe.

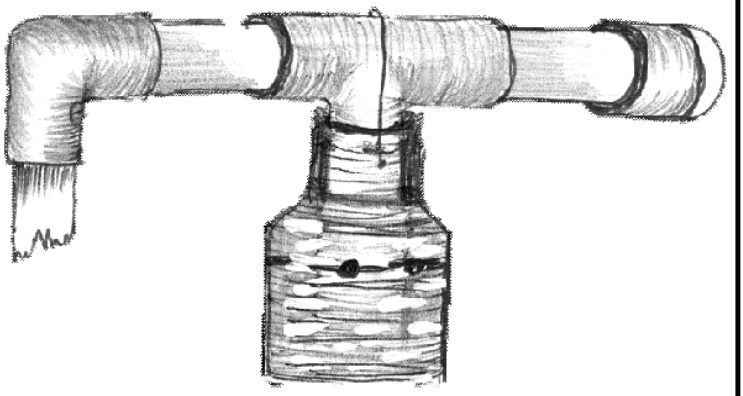


Figure 15: Fully assembled pressure release valve

A pressure release valve showing an overflow hole on the plastic bottle.

Unit 4 Air-filling and Loading the Biodigester

Introduction

Welcome to unit # 4. In this unit you will understand how to load-up your biodigester.

Objectives

By the end of this unit you will be able to:

- Air-fill and water load the biodigester
- Load the manure into the biodigester.

Fill the plastic tube with air

Place the digester tube carefully in the pit. We must check and be sure that it is lying neatly in the pit and there are no folds and wrinkles.

- **Air-fill the Digester**
- Seal one end of the biodigester with a plastic bag and seal the outlet gas tube temporarily with a PVC cap. Get ready to attach the other end to a Motor Blower.
- Place the Blower hose into the plastic pipe at the other end.
- Do not stop blowing until the bag is completely filled with all wrinkles and folds removed.
- When you are finished, the digester sits like a big balloon in and out of the pit with the gas outlet valve standing erect on top. Centre the balloon as necessary.
- Both inlet and outlet funnels are facing upwards and outwards.

Water-fill the Digester

- Adjust the motor blower to idling speed and introduce a water hose.
- Add water until the digester is half full. The bottom of the inlet and outlet pipes should be covered with water. When this happens remove the motor blower.
- Any additional water should overflow from the outlet.
- At the same time add the 4 to 1 manure mix that has been partially fermented (a mix that has been allowed to set in a barrel for 2 weeks). This mixture makes the digester start to work faster.
- The final water level should be six inches or more above

the upper lip of the inlet pipe inside the digester.

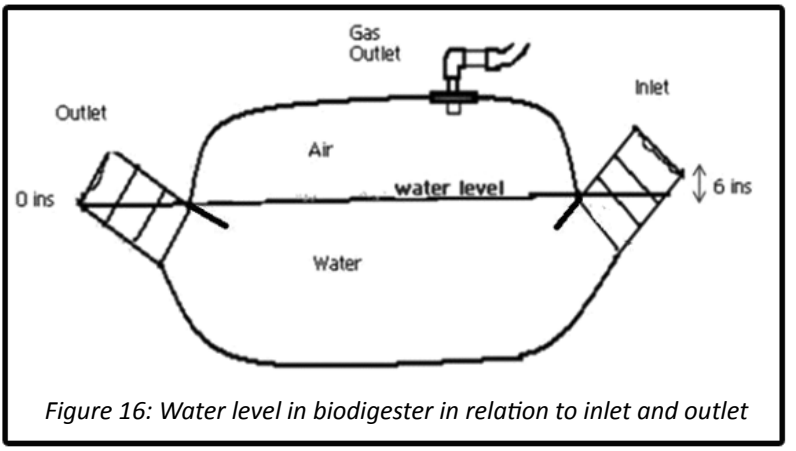


Figure 16: Water level in biodigester in relation to inlet and outlet

- The outlet pipe should start to overflow. This is the stopping point.
- The inlet pipe must stand at an approximately 45 degree angle position as shown in the picture. The open end of the inlet pipe should be at least six inches above the ground level.
- The outlet pipe should be placed with the bottom end just at ground level. The lower lip of the outlet pipe should be 6" to 8" above the upper lip of the same pipe. The outlet pipe is usually sloped at 30^{o}
- Deflate the digester of all air and then allow the biogas to accumulate over a period of time.

Unit 5 Connecting the Biodigester

Introduction

Welcome to unit # 5. In this unit you will understand how to connect the biodigester to the kitchen.

Objectives

By the end of this unit you will be able to:

- Assemble the PVC fittings for connection.
- Connect the PVC pipe lines from the digester to the stove.
- Connect the PVC pipe lines through the kitchen wall.

Connecting the Biogas Unit

- After 14 to 35 days, the digester will start producing gas. All of this depends on the manure mixture you feed the digester, as well as the temperature during the day.
- When you observe the tube inflated like a balloon, you must test to see that the gas lights. First open the gas valve to the stove for one minute to blow out the air from the lines. If it does not light, you must open the gas release valve and let all of the air out of the digester. This is because the first batch of gas produced may be mixed with air and be of poor quality.
- After the tube inflates for the second time with good biogas, it is ready for use.
- Begin connecting the gas to the kitchen.

Connecting to the stove

- You will need the following items.
  - A ½" PVC ball valve.
  - A few ½" knees and a T-piece
  - A few lengths of PVC pipe and paste.
- Begin connecting the pipe lengths from the gas release

valve towards the kitchen. From the top of the release valve, the pipe should slope to a condensation drain point. Install a PVC ball valve to drain the water as needed.

- From this connection, the remaining connections depend on the site and the distance from the kitchen.
- A PVC ball valve is inserted just before the main gas line to the stove.
- The kitchen stove is then attached to the main gas line.
- The pressure adapter of the cooking gas bottle is removed and the rubber hose is securely attached to the main gas line using the hose clip.
- Remove or drill the propane gas jet on your stove to allow the gas to flow freely. The orifice of the jet should be 1.5 mm to 2.0 mm diameter. If there is an adjustment for air, reduce the air intake.
- The flame is clear blue to transparent and should be protected from strong wind which could extinguish the flame.

Unit 6 Operating and Maintaining the Biodigester

Introduction

Welcome to unit # 6. In this unit you will understand how to operate and maintain a Digester.

Objectives

By the end of this unit you will be able to:

- Feed the Biodigester Unit.
- Protect the Biodigester Unit.
- Perform daily maintenance.
- Perform periodic maintenance.



Figure 17: Biogas used for lighting and cooking

Operating and Maintaining the Biodigester

- **Feeding the Unit**
  - Microbes in the digester need food so feed the biodigester on a daily basis.
  - A mixture of one part of manure to four parts of water can be poured into the digester. After 25-40 days it will begin to produce the equivalent of a twenty pound cylinder of gas per month.
  - Animal entrails and meat scraps can also be put through the digester.
  - If there are not enough animals to supply manure, you may add cassava peelings, waste banana, molasses and other carbohydrate sources such as rice bran or molasses but be sure to add some manure. Do not use rice hulls.
  - Biodigesters will need cleaning in two to four years.

Protecting the Unit

- Build an arbor to grow carilla, squash or passion fruit over the biodigester.

OR

- Build a roof over the unit, using either plastic, troolie or manicole leaves to reduce the biodigester plastic rotting and prevent wide temperature swings inside the biodigester.

- Erect a fence or wall around the unit to prevent damage by animals.

Daily Maintenance

- Feed the system daily or on a regular basis.

- Check the water level in the trap bottle and top it up to maintain a level of 6” to 8” above the tip of the gas tube. The water level must never fall below the tip of the gas tube since gas will escape.

Periodic maintenance

- Every three months, replace the two steel wool in the PVC “T”.

- Check valves and joints frequently for leakages

- Contact any knowledgeable IPED Extension agent often for updated advice.

MODULE #3 DUCKWEED GROWING AND USE

Introduction

Duckweed has been found to be a useful source of vital nutrients for the pigs, poultry and fish which are reared on a farm. Duckweed has also found to be simple to cultivate and use on the farm. In this module will together set out to explore the simplicity of duckweed and its use.

Objectives

By the end of this module, you will understand important aspects of Duckweed as set out in five Units.

- Unit # 1. Knowing Duckweed.
- Unit # 2. Farming Duckweed.
- Unit # 3. Feeding Duckweed to Tilapia.
- Unit # 4. Feeding duckweed to broilers, layers, ducks and pigs.
- Unit # 5. Summary

Unit #1 Knowing the Duckweed

Objectives

By the end of this unit, you will understand two things about the duckweed itself.

- Facts about the duckweed.
- Properties of duckweed.





Duckweed (Lemna minor)



Water Lettuce
(Pistia stratiotes)



Water Fern
(*Azolla filiculoides)*



Hassar weed
(*Salvinia)*

Facts about Duckweed

The two key facts about Duckweed are as follows. It doubles its weight every 48hrs and it is rich in protein when grown in well fertilised waters.

Duckweed is the smallest of all flowering plants. It consists of a flat round-like green leaf-like structure called a frond. The fronds are about 2 mm to 4 mm in diameter, about quarter the size of a rice grain. Each frond usually has about two daughter fronds, budding from its side. Most species have hair-like roots.

The entire plant is used as a feed for livestock compared to such crops as corn, soybeans, or rice where only the grain is used.

- It looks like the green cover of a pools table top.
- It grows well in stagnant water that is rich in plant foods.

- Two small floating plants, Pistia (water lettuce) and Salvinia (water fern) also grow in canals and can be confused with duckweed. Both plants are much larger than duckweed.

Properties of Duck-weed

- Fresh duckweed contains about 95% water.
- Duckweed grown in water rich in nutrients could have as much as 35% to 45% protein on a dry weight basis.
- Duckweed protein is rich in the key essential amino acids, methionine and lysine.
- For feeding poultry and other farm animals, duckweed has a lot of trace minerals and vitamins.
- Duckweed is a complete feed for fish. It is as nutritious as soybean meal.
- A pond 15 feet by 20 feet (300 square feet) will produce enough duckweed to provide the supplementary protein for 100 chickens being fed factory feed.

Unit # 2 Farming Duckweed

Introduction

This unit is about farming duckweed like a crop. Because we are now farming this crop, our discussion will be focused on cultivation practices.

Objectives

By the end of this unit, you will understand four things about the duckweed itself.

- Pond design and construction.
- Conditions for growing duckweed.
- Fertilizer requirements of the duckweed plant.
- Harvesting the pond.

Duckweed never stops growing, therefore the daily work of harvesting on a duckweed farm never ceases. This type of farming requires daily harvesting and careful attention.

Pond Design and Construction

- The soil must be able to hold the pond water.
- Where there is a high clay content in the soil the floor and wall of the pond soon become impervious to the seeping out of water.



Mixing the soil and cement



Putting the mixture on the walls of the pond



Putting the mixture on the bottom of the pond



The pond ready and full of water (next day)



Adding duckweed

- In sandy soil it is necessary to line the ponds with a mixture of soil and cement. For a pond 40 cm deep and with an area of 20 m², the required overall quantities are 25 kg of cement and 300 kg of soil. For smaller ponds mixes of 30 kg soil, 2.5 kg cement and 1.5 kg water are prepared and a thin layer of the mixture is applied to the floor of the ponds and to the walls. Plastic sheeting can also be used to seal the pond bottom.

- Alternatively, if the soil cannot hold water, it could be lined with construction plastic, leatherette or made of concrete.

- A concrete pond can be filled with water and seeded with duckweed two days after it has been plastered.

- The banks of the pond must be at least one foot above the highest flood level.

- The pond should be long and narrow to make it easy to harvest.

- The long direction of the pond should be at right angles to the normal wind direction.

- The soil must not be too sweet (alkaline) or too sour (acid).

- The pond should be sheltered from strong winds by planting bananas on the embankment

- Eddoes should be planted along the edges of the pond to prevent the duckweed from being blown onto the parapet.

- Duckweed growth is inhibited by too much sunlight that could overheat the pond water.

- For a pond that is in the open and fully exposed to sunshine, provide cover using a squash arbor or a carilla vine or netting or palm leaves to allow about 75% sunshine. A duckweed pond can also be shaded by nearby trees.

- Duckweed does not tolerate saline water and salt or sea water should not be allowed into the pond.



Figure 18: Duckweed in concrete pond and duckweed in earthen pond



Small biodigester (3 m long) linked to a pig pen (2 pigs) and connected to a duckweed pond

Conditions for growing Duckweed

To grow duckweed in your pond, follow these points:

- Duckweed grows best in ponds and pools of still or stagnant water in depths of 6 to 12 inches.
- The water should not be too acid or alkaline, the pH should be 6.5 to 7.5.
- Water that has a lot of rotting leaves, roots and stems is ideal for its growth.
- To stock your new pond, collect duckweed from a nearby farmer or drains and ditches.
- As a guide you can use 1.5 to 2 pounds for every 10 square feet. The greater the surface-cover, the better it will be for starting the new pond.
- Duckweed provides complete cover of the pond water. Loss of water by evaporation is therefore minimized.
- A duckweed layer should continuously cover the surface of the pond. This covering will keep out unwanted algae and moss.

Fertiliser requirements for the Duckweed plant

- Duckweed feeds directly from the water in which it grows.
- Duckweed is a plant and like rice and corn requires fertilisers.
- In integrated farming, we get our fertiliser from the dung of livestock like cattle, pigs, broilers, layers and ducks or from the effluent of a biodigester which has been fed such animal manure.

- The duckweed pond is fertilised at the start to provide the optimum 20 mg to 60 mg N per litre. Practical farmers use one feed bag containing manure placed into the windward end of the pond for every 300 square feet pond surface. Another bag is introduced when the first bag is half utilized.

- Duckweed grown in well-fertilised water should have roots less than half inch long. Longer roots indicate that the water is short of nutrients. For every bucket of duckweed harvested you must add one bucket of manure-water mixture (half and half).

- If the duckweed roots grow longer than ½ inch, add another bucket of manure-water mixture to the pond for every 300 square feet of pond surface.

- The effluent from the biodigester is ideal fertilizer for duckweed but should not be used in excessive quantities.

Harvesting Duckweed

- The amount and time to harvest will depend on the amount of cover there is in the pond. The best time to harvest is when the pond is completely covered. Harvesting is best done in the morning.

- Push the duckweed to one corner of the pond with a bamboo stick attached to a handle in order to concentrate it for harvesting.

- To harvest you can use a dip net.

- You should not harvest more than ¼ of the surface area per day. .

- Duckweed can be transported conveniently in baskets or buckets with holes

- Fresh duckweed without water will begin to rot at high temperatures after two days.



A bamboo stick : the tool to harvest



Preparing to harvest



Usually every day 25 % of the area of the pond is harvested



Pushing the duckweed with the bamboo stick



Pushing the duckweed to one corner of the pond



Collecting the duckweed with a porous plastic container



The density of duckweed in the pond after harvesting

Unit # 3 Feeding Duckweed To Tilapia

Introduction

This unit is about feeding duckweed to tilapia. Because we are now using this crop like any feed ration, our discussion will be focused on practices which ensure that feed is utilised well.

Objectives

By the end of this unit , you will understand :

- The feeding of Tilapia with duckweed.

About Feeding Tilapia with Duckweed

- Tilapia is well adapted to feed on duckweed. They have grinding teeth-like structures in their mouth, an acid stomach and a long intestinal tract. This means that they can digest their food well and absorb the nutrition in their bodies.
- Duckweed can be considered as a total feed.
- When used correctly, the duckweed is supplying nutrition

to the fish as a single input.

- Bring the duckweed in baskets to the pond and spread it in small floating enclosures in areas near the edges.
- It is easy to see the feed being consumed, because it is spread in floating enclosures in the pond. The Tilapia is a top feeder.
- Feed the Tilapia once per day.
- At time of feeding the next day, a small amount of duckweed still present within each floating enclosure ensures that the Tilapia are getting enough to eat.

Unit # 4 Feeding Duckweed To Broilers, Layers, Ducks And Pigs

Introduction

This unit is about feeding duckweed to livestock such as broilers, layers, ducks and pigs. The feeding strategy is to use the high protein content of duckweed grown in well-fertilised ponds to supplement factory feeds. This improves the protein value of the feed. It can also serve as a protein concentrate to be mixed with locally available feed materials such as rice bran, wheat middlings, corn and molasses to produce high quality farm-made feeds.

These feeds are the equivalent of factory feeds. The costs of these feeds are less than half of factory feeds.

Objectives

By the end of this unit, you will understand :

- How to feed duckweed to broilers.
- How to feed duckweed to layers.
- How to feed duckweed to ducks.
- How to feed duckweed to pigs.

1. Feeding Duckweed to Broilers



Figure 19: Broiler chickens feeding on duckweed

Feeding Week 1

- Feed broiler starter freely to the chicks.

Feeding Weeks 2 to 5

- Offer broiler feed freely.
- In addition feed fresh duckweed two times a day. Place the duckweed in separate containers, use approximately four containers for every one hundred birds in the feeding area.
- Offer them as much as they can eat, so that there is very little duckweed remaining after 1/2 hour.
- Remove the trough after 1/2 hour. Wash and dry containers for next feeding.

Feeding After Week 5

- Mix the duckweed with rice bran, three parts of drained duckweed to one part of rice bran and use it as an exclusive feed.

2. Feeding Duckweed to Layers

- Feed commercial egg ration freely.
- In addition feed fresh duckweed two times a day. Place the duckweed in separate containers, use approximately four containers for every one hundred birds in the feeding area.
- Offer them as much as they can eat, so that there is very little duckweed remaining after 1/2 hour.
- Remove the trough after 1/2 hour. Wash and dry containers for next feeding.

Feeding Duckweed to Ducks



Figure 20: Ducks feeding on duckweed

- During the first week feed commercial broiler starter only.
- From week 2 to week 7, feed according to the following alternative mixtures :

  2 parts rice bran to which molasses has been added to 1% level plus 3 parts fresh duckweed.

  OR

  58 parts rice bran, plus 41 parts of wheat middlings, plus 1 part of molasses.

OR

You may use 85 parts of rice bran, plus 12 parts of copra meal, plus 1 part of molasses and 2 parts of poultry or fish meal.

- After 7 weeks feed 1 part rice bran to which molasses has been added to 1% level plus 1.2 parts of fresh duckweed.

OR

64 parts of rice bran + 35 parts of wheat middlings, added to 1 part of molasses

OR

85 parts of rice bran added to 12 parts of copra meal, 1 part of molasses, added to 2 parts of poultry or fish meal

Feeding Pigs

- The most common problem of feeding pigs is the feed being short of protein. This leads to slower growth, more feed to get the same weight and the pork being too fatty.
- In commercial factory feeds, the supplementary protein comes from soybean meal, which is imported.
- Farmers who mix their own feeds get their protein concentrate from fish waste collected from the markets or fish processing plants or the offals of chicken from people who pluck chicken for sale.
- Commercial protein concentrates are available from Protein Recovery Inc. at Timehri, East Bank Demerara. These are fish meal 62% protein and poultry meal 59% protein. Shrimp meal 40% protein is available during the shrimp season from people who make dry shrimp.




Figure 21: Pigs feeding on duckweed

Feeding Duckweed to Pigs

- IPED is promoting the use of Lemna duckweed in an Integrated Farming Model. The duckweed pond is fertilized by the dung of the farm livestock and contains 35% to 45% protein on a dry weight basis if it is harvested from a well fertilized pond. It is fed to livestock as a protein concentrate to supplement rice bran, which is the cheapest energy feed on the Coast. It could also supplement cassava and other ground provisions that are part of the unmarketable waste of a typical crop farm.

- The following are simple guidelines for feeding rice bran and duckweed to pigs:

  - **Pig Starter** for pigs weighing 22 lb to 44 lb. Daily feed per pig is 1.6 lb rice bran mixed with 5 times by weight of fresh duckweed.

  - **Pig Grower** for pigs weighing 44 lb to 110 lb. Daily feed per pig is 2.5 lb rice bran mixed with 3 times by weight of fresh duckweed.

  - **Pig Finisher** for pigs weighing 110 lb to 220 lb. Daily feed per pig is 5 to 6 lb rice bran mixed with an equal weight of fresh duckweed.

Feeding Pigs with Farm made Rations when Duckweed is not available

These rations are formulated based on available local ingredients such as grain byproducts and locally produced fish meal or optionally poultry meal. These local ingredients are good value for money and results in cost savings of the order of 70% on feeding commercial factory feeds.

The rations were scientifically formulated to meet minimum recommended protein-energy ratios. They are generally low in energy and so at a practical level the pigs will consume more feed to make up.

	Pig Starter	**Pig Grower**	**Pig Finisher**	**Pig Finisher II**
Weight Range	**22-44 lb**	**44-110 lb**	**110-176 lb**	**176-264 lb**
Average Weight lb	**33**	**77**	**143**	**220**
Avg. Daily Feed consumption on standard 3400 kcals/kg diet in lb	**2.20**	**4.08**	**5.67**	**6.77**
Ingredient				
Rice broken	20.0	20.0	20.0	20.0
Rice bran	48.5	50.0	35.0	38.0
Wheat middlings	20.0	20.0	40.0	40.0
Molasses	1.0	1.0	1.0	1.0
Fish meal by-product	10.0	8.0	3.0	0.0
Limestone	0.0	0.5	0.5	0.5
Salt	0.5	0.5	0.5	0.5
Total	100.0	100.0	100.0	100.0
Protein	16.3%	15.5%	14.2%	13.1%
Calories kcals/kg	2333	2313	2302	2289
Avg. Daily Feed consumption practical lb	3.2 lb	6.0 lb	8.4 lb	10.0 lb

Table 2: Feed formulation when duckweed is not available

Unit # 5 Duckweed Facts Summary

DUCKWEED FACTS
1. The Protein content of Duckweed grown in a well fertilized pond is 35 to 45% of dry weight.
2. Duckweed can substitute for soya bean meal as a protein source.
3. Duckweed can double its weight every 48 hours
4. One acre duckweed pond can produce up to 800 to 900 pounds per day.
5. One acre of duckweed can feed a two acre pond with 12,000 fish for a year.
6. As much as one quarter of the amount of factory feed that we feed to meat birds, layers, pigs or ducks can be replaced by duckweed.

MODULE # 4 FISH FARMING

Introduction

Welcome to module # 4, in this module, we shall learn how to farm fish.

Objectives

- Classifying Aquaculture.
- Methods of fish culture.
- Selecting the site for a pond.
- Pond design and construction
- Fertilizing the pond
- Stocking the pond
- Feeds and feeding
- Water quality.
- Harvesting fish marketing fish



Figure 22: Fish pond with happas

Unit # 1 Classifying Aquaculture

Introduction

The rearing of fish is correctly called Aquaculture and in this unit, we shall explore the following objectives.

Objectives

- Classifying Aquaculture.
- Types of Aquaculture
- The importance of Aquaculture species.

Classifying Aquaculture

When we take into consideration the salty areas of our coast, it will be possible to divide the practice of aquaculture into three categories. To confirm these categories, we must conduct a test of the saltiness of the water, even though the Tilapia can be grown in both fresh and brackish water. The amount of salt in the water is measured in Parts per Thousand (ppt). It is on this basis that we know the following:

Fresh-water Culture

This type of practice is restricted to inland waters where the salt can be measured at less than 1.0 (ppt) parts per thousand.

Brackish water Culture

- This type of practice is restricted to inland waters where the salt can be measured at least as 1 ppt and full strength sea water.
- Brackish water culture can take place in water with a salinity of 1 part per thousand to up to 20 parts per thousand.

- This type of practice is restricted to coastal lagoons or the open sea.

    - Marine Aquaculture: Marine aquaculture takes place in full strength sea water (35 parts per thousand).

We can also classify aquaculture according to production systems:

- **Fingerling production.**

  When we undertake this type of practice, we are producing small seed stock of fish or fingerlings in a nursery.



Figure 23: Fingerling production using happas

Types of Aquaculture

- **Grow-Out Production**

  When we undertake this type of practice, we are taking fingerlings and growing them out to sizes or weights that the market wants.

- **Brood Production**

  When we undertake this type of practice, we are using small fish seed stock or fingerlings. These would be grown as genetic or breeding stock. They can help to improve the future production and productivity of aquaculture.



Figure 24: Brooding ponds

Generally, there are three **systems** of practicing aquaculture:

- **Extensive Culture**

  If we use this system, we should select a large flooded area. It is characterized by a low stocking rate, no use of fertilizer, little or no use of supplemental feed and consequently a relatively low level of input. As a result the level of investment is low, and consequently, yields are low. Extensive culture is normally carried out over very large areas of water.

- **Semi-Intensive Culture**

In this system, we are trying to use a smaller area, investing larger sums of cash.

We need to utilize more up-to-date methods and higher stocking rates. Both feed and fertilizer are used.



Figure 25: Semi-intensive aquaculture farm

- **Intensive Culture**

This method involves aquaculture as a science because of the amount of inputs required. Stocking rate is very high, complete feeds are used instead of a combination of fertilizer and feed. Aeration and purification of water is practiced. Yields are much higher than the semi-intensive culture but there are higher risks.

The importance of Aquaculture species

Fish Species recommended

The Tilapia (*Oreochromis nilotica*)

- It has a deep lateral compressed body.
- It has large scales and a double lateral line.
- The body colour is generally dark with even darker bands.
- Some varieties are red in colour.
- The throat and belly are white.
- The female broods the fry in her mouth.



Figure 26: Red and Grey Tilapia

Overcrowding. The Tilapia spawns very easily and produces many offspring. This makes them a good fish to culture. However, this trait also creates its own problem of overcrowding. Whenever this happens there is depleted food supply and stunted growth. As much as seventy five percent or more of the stock will be less than three ounces in weight.

To avoid this problem the following options are available;

- Periodically harvest fry and fingerlings with nets.
- Separate the sexes after initial growth periods.

- Stock hybrid all male fingerlings as much as 14,500per acre. This will be the equivalent of one fingerling per 3 square feet.

- Culture in cages which are suspended above the bottom of the pond.

- Stock a few predator fish such as Houri in the pond.

Reproduction

- The Nile Tilapia is a mouth brooder. This means that the female will incubate eggs in her mouth.

- The optimum temperature should be 23^0 to 28^0 Celsius.

- They spawn three or more times per year, with fifteen hundred to four thousand three hundred eggs being produced over that period.

- This process will take place in fresh and brackish water of up to one fifteen ppt of salt.

- Eggs hatch in three to five days and the female will guard the fry for an additional eight to ten days after hatching.

- No serious pest or disease of major economic significance has yet been identified in tilapia culture in Guyana.

Polyculture

- Polyculture is rearing different fishes that occupy and feed at different levels of the pond, for example Tilapia or Tambaqui in the top part of the pond and Hassar at the bottom of the same pond.

- When we are rearing Tilapia and Hassar in the same pond, the number of Hassar should be half the number of Tilapia. The Hassar feeds on decaying vegetation and the waste of the Tilapia.

- The Tilapia should be fed with duckweed freely. Remember that the Hassar does not eat duckweed.

Tilapia up to a weight of 100 g will need no added feed provided there is enough plankton in the water. Plankton growth can be accelerated by adding some manure to the water. Water colour of a faded- green tinge indicates the presence of plankton. If fish are seen coming up to the surface to gulp air stop adding feed and manure.

- Tilapia fed plankton and duckweed can attain a weight of one pound in six months.

Tambaqui (*Colossoma macropomum)*

- This fish is known locally as fresh water Pacu.
- Tambaqui can be grown in ponds or in cages and may be fed with duckweed and rice bran.
- After six months of growth feeding with duckweed and rice bran, the Tambaqui will attain a weight of about 2 pounds and after 10 months about 4 pounds.
- Tambaqui will start to reproduce only after three years.
- Cages may be used to rear the Tambaqui. A cage is usually eight feet square and six feet deep. A stocking rate of two fish per cubic foot is recommended.
- Plastic drinks bottles will keep the cage buoyant in ponds as well as in streams.



Figure 27: Tambaqui (Fresh water Pacu)

Unit # 2 Methods of Fish Culture

Introduction

Welcome to Unit # 2. In This unit, we shall discover that there are many methods of managing a Tilapia fish farm.

Objectives

Upon completion of this unit, we will understand advantages and disadvantages of :

- Pond Culture.
- Cage culture.



Figure 28: Open pond fish culture

Pond Culture

- A pond can take many forms, such as, earthen enclosures, concrete enclosures, and plastic lined embankments.
- Make ponds at least four feet deep and close to a reliable

source of water.

- Grade the bottom of the pond in such a way that whenever the water is drained off, there is a convenient catchment area for harvesting fish.

- An earthen pond is usually the cheapest and most widely used of the many types of ponds.

- Earthen ponds are easy to stock and harvest, and are of low risk. Ensure however that the perimeters are fenced to safe guard against alligators and poachers.

- Closeness to natural feed sources makes pond management simple and easy. This is described as low technology farming. It is safe to fertilise the pond with pen manure until the water attains a slight green tinge.

  Always be on the watch for poor water quality in your pond. The fish farmer should test his pond water with a Dissolved Oxygen meter daily.

Cage Culture

- A cage is a bag, either mesh, or nylon, submerged in the water.

- It is fitted on to a strong frame to which are attached a number of floatation devices.

- Together this entire assembly floats in the water and we rear the fish in it.

- We can use a cage to rear fish intensively, or semi-intensively.

- Everything which the fish needs is given to them in the cage. The cage prevents them from getting out and prevents unwanted fish or animals from getting in.

- We can place fish cages in ponds, lakes, reservoirs, rivers, canals and estuaries. The flow of the water should be one

meter per second to ensure adequate dissolved oxygen and removal of waste products.

- As you may well imagine, this method makes harvesting easy and is low cost relative to pond construction. However ensure that you feed duckweed or you have nutritionally complete diets and be careful about storms, thieves, poor water quality and diseases.

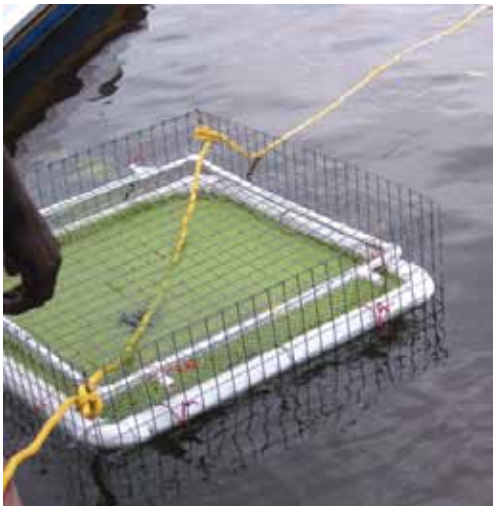


Figure 29: Cage culture using duckweed

Unit # 3 Selecting the site for a pond

Introduction

Welcome to Unit # 2. In this unit, we shall discover that the selection of the site for a fish pond is important in Tilapia fish farming.

Objectives

Upon completion of this unit, the criteria for selecting the best site would be outlined. We shall discuss the importance of :

- Land and climate.
- Water.
- Access to market.
- Financial aspects.

Land and Climate

The ideal site is flat or gently sloping land. This type of terrain is good for drainage and irrigation.

Water should be available for filling and topping up the pond at all times. The supplies can either be fresh or brackish water.

The fish farm like any other business entity will benefit from access to good roads, power supplies and technical services.

The daily temperature should be between 22^{o} to 34^{o} Celsius for satisfactory growth.

Market analysis

The site should have easy access to the targeted markets, which would include such infrastructure as roads or waterways.

Seed stock supply. When the decision is made to rear fish then seed stocks should be acquired at the most convenient place and price.

Expansion and financial aspects

Any successful business would see the need for expansion

of the operations. It is very essential to retain some land space for future expansion.

Making a decision to expand, must be based on:

- A carefully developed budget.
- A favourable cash-flow projection.

Unit # 4 Designing and constructing a pond

Introduction

Welcome to Unit # 4. In this unit, we shall discuss the methods of designing and constructing a fish pond

Objectives

Upon completion of this unit you shall recognise the importance of :

- Principles of pond construction.
- Inlet structures.
- Outlet structures.
- Water conductors.

Principles of pond construction

- All ponds should be individual units, i.e. each pond should have independent inlet and outlet for individual irrigation and drainage.
- Ponds should be dug to an average depth of 5 feet for an average water depth of 4 feet.
- All ponds should be constructed with a 1% to 3% gradient

towards the outlet. In the case of a 100 foot pond the outlet end should be at least one foot lower than the inlet end.

- The sides of the pond should be sloped 30^0 to prevent slippage. In case of clay embankments the slope could be steeper. . Grass should be planted on the pond banks to minimize erosion.

- The irrigation and the drainage ends should be carefully designed to allow for easy intake and outlet of water respectively.

- At the entrance of the inlet structure, a filter, preferably saran netting must be fitted. It will prevent unwanted species or their larvae from entering.

- At the mouth of the outlet structure, a filter must also be fitted. It will prevent the cultured species from leaving.

- Always try to locate the water table of your soil. Excavate the pond to a level that is 3 feet below the lowest water table in the dry season.

- Whenever a pond is to be constructed on sandy types of soil, be careful to line the bottom and sides of the pond with either plastic pond liner or leatherette, or a composite mixture of soil and cement or concrete.

Pond Inlet Structures

- Inlets are positioned at the shallow end of the pond.

- Inlet pipes are usually of PVC and they are fitted with filters.

- A filter is an entrance protector and several of them may be placed along the inlet channel. The filter prevents unwanted fish from entering the pond

- The feeder reservoir for irrigation water should always be at a higher elevation than the pond. The

inlet pipe could then be imbedded near the bottom of the reservoir. The water will flow by gravity.

- Arrange the structures such that water splashes and mixes into the pond as much as possible upon entry in order to get oxygen into the water.

Pond Outlet Structures-

When we are designing outlets for the pond, we should make provision for the following:

- A collection area inside the pond from which the water drains and into which the fish collect for easy harvesting.
- Fitting accessories such as drain plugs, valves, boards, screens, gates.
- Over-flow structures that will allow the excess water to be drained away easily.

Good pond outlet structures will ensure that:

- Structures are designed to keep the water level constant.
- Ponds can be completely drained in a reasonable time.
- There is no loss of fish during drainage.
- Excess water is carried away.
- The outlet can be serviced with ease.

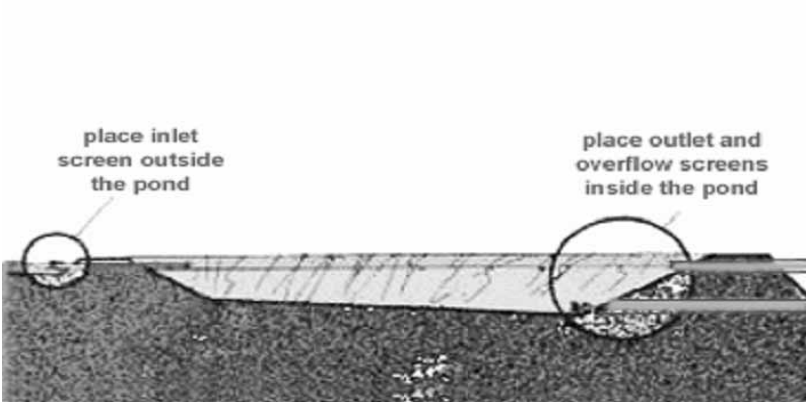


Figure 30: Placement of inlet and outlet structure of fish pond

Water conductors

- The pond should be linked to sources of fresh water supply, such as irrigation canals which allow for filling or topping up of pond, diversion of excess water and protection from unwanted aquatic life.
- Siphons and pipelines may also be added.

Unit # 5 The aquatic environment (The conditions inside a pond)

Introduction

Welcome to Unit # 5. In this unit, we shall discuss the environment inside the fish pond.

Objectives

Upon completion of this unit, the criteria for selecting the best site would be outlined. We shall discuss:

- The importance of Dissolved Oxygen.
- Oxygen depletion.
- Overcoming oxygen depletion.
- The pH of the water.
- Dissolved nutrients and gasses.
- Temperature.
- Fertilizing and liming.

The Aquatic Environment

- The aquatic environment consists of the pH, light, temperature, the salt in the water and dissolved gasses such as Oxygen, Carbon Dioxide and the food nutrients.

- It also takes into account those organisms which live in the water such as phytoplanktons, zooplanktons, the larvae of insects and snails.

○ Dissolved Oxygen

- Oxygen is vital for all life in the pond.

- The atmosphere contains 20% of oxygen, but the amount which is dissolved in water is much lower. When the wind blows, this stirring effect increases the dissolved oxygen level even more.

- In fish culture, the major source of oxygen is photosynthesis by the phytoplanktons. They use light and carbon dioxide to produce carbohydrates and oxygen. This is a day-time operation. At nights, the phytoplanktons use up the oxygen and produce carbon dioxide.

- This means that at nights, dissolved oxygen is low and carbon dioxide is high in the water.
- Water quality must be monitored daily. One way to maintain water quality will be to exchange some of the water in the pond with fresh water each day.

What causes Oxygen to be low in the pond

Cloudy or rainy days

- Oxygen from the air has to be dissolved in the pond water before fish can use it. At times however it is at such a low level that the fish cannot obtain an adequate supply.
- This condition is noticed on cloudy or rainy days. It is on these days that the phytoplanktons die, and the oxygen they supply to the pond water ceases.
- The oxygen is further reduced because the dead bodies of the phytoplankton will require oxygen also for its decomposition.

Shortage of nutrients

- When the nutrients such as nitrates and phosphates are absent, they will eventually cause the phytoplankton to die. Their role in producing oxygen is again curtailed. And use of oxygen.

Overstocking

- When the pond is overstocked, the crowded situation produces a large amount of waste from the fish population. The combination of large numbers of fish, together with the waste matter they produce, both deplete the oxygen in the water.

Hot Weather

- When hot days and no wind occur together, the pond

water will warm up to above 32^{0}C and hold less oxygen. This is usually the worst time for active healthy fish.

Indicators of Oxygen depletion

Check the Pond Daily.

- If you have access to a **Dissolved Oxygen meter** take readings at intervals. With at least 4 ppm of dissolved oxygen, fish will grow well

Use a Secchi Disc

This is a round flat disc, on which two alternate surfaces are painted black and white. A rope or a pole marked at 10 cm intervals is attached to this instrument and it is lowered in the water until it disappears. The following table gives us a guide to the various readings and what they are telling us.

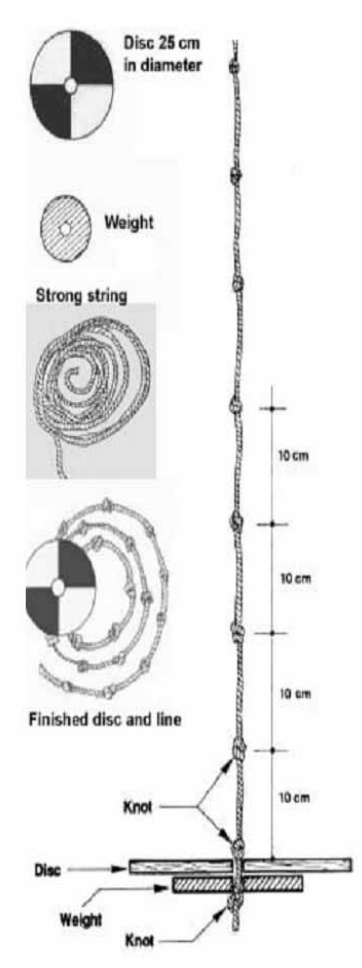


Figure 31: Secchi disc used to measure suitable quality of pond water

Secchi Disc Visibility	Comments
Less that 20 cm.	Pond has too much plankton, there will be problems with low oxygen. Water should be exchanged immediately to reduce the amount of plankton.
20 – 30 cm.	Plankton becoming too much, the pond is still in good condition.
30 – 45 cm.	**Pond in good condition.**
45 – 60 cm.	Phytoplankton becoming scarce, pond should be fertilized.
More than 60 cm.	Water is too clear. Pond should be fertilized.

Table 3: Table used to determine water quality when using a secchi disc

Observe the fishes early in the morning just after sunrise. If the fishes are near the surface gulping for air, the dissolved oxygen is too low. Add water by allowing it to splash on the surface of the water or by spraying in the air. Exchange part of the pond water if the water is very green.

The pH of the Pond Water

The pH is a term used to refer to how acid (sour) or how alkaline (sweet) the pond water is. Fish grow well when the pH is between 6.5 to 9. To measure the pH, we can use a pH meter.

- Dark coloured water (black water) which we see in pegasse or savanna lands, is often sour (acid).
- When the pH is lower than 6.5 (sour) or higher than 9,

low pond-production will be experienced.

- Wherever the need exists to correct the pH of the pond, advice on the use of limestone should be sought.
- At a pH of 4, fish will die and between 4 and 5 there may be no reproduction.
- At a pH of 5 to 6.5, there is slow growth because of low fish food production.
- At a pH of 6.5 to 9, fish grow well and thrive best.
- At pH of 11 fish die of alkalinity.

Fertilizing or Liming the Pond

Fertilizers are natural (organic) or man-made inorganic substances which are used to increase the production of plankton as a source of feed for the fish. There are many things we must consider when the need arises to apply fertilizers to our pond.

- **Liming the pond**

  A liming agent is either man-made or natural. It is used whenever we wish to add sweet, (alkaline) to the soil. By applying it, the acid (sour) is reduced.

- **Waste from Fish**

  Three quarters of the mineral nutrients from feed are returned to the water as excreta or waste feed. The pond is naturally fertilized as a result and it may not be necessary to fertilize after the start-up dosages.

- **Inorganic fertilizers**

  These are man-made fertilizer and they are used when large amounts of nutrients are needed for the fish.

Two fertilizers often recommended are Urea (to supply Nitrogen) and TSP, (to supply Phosphorus).

- **Organic Fertilizers**

  These are natural materials such as pen manure and crop residues. They supply nutrients in varying amounts.

- **Compost**

  Compost is well-rotted pen manure or the waste from crops. It is rich in organic matter and is considered a fertilizer. In a drained pond, the compost is applied to the bottom before the pond is refilled. Compost may be applied to the pond at regular intervals to fertilize the water.

Unit # 6 Feeding Tilapia

Introduction

Welcome to Unit # 6. In This unit, we shall discover the feeding habits and feed requirements of Tilapia.

Objectives

Upon completion of this unit, feeding habits and feeding requirements will be made simple. We shall learn about :

- Fish feed, and fish feeding with duckweed and rice bran.
- Feeding habits.
- The essential feed ingredient requirements.

Fish Feed

Before we offer the tilapia a meal, we should try to understand a few facts about the feed itself.

- The feed we offer them must be something which they will accept.
- The feed we offer them must have the correct amounts of nourishments for their growth and development.

Feeding Habits

The Tilapia is a daytime and surface feeder. This is what we mean:

- They eat at the feed floating on the surface of the water.
- They eat most of their food in the daytime when the oxygen level in the water is high.
- At night, there is little or no feeding activity.

Feeding Habits at various stages

- The fry and the larvae eat planktons which can be found in the pond water.
- The juveniles up to a weight of about 100 grams also eat mainly the plankton.
- The adult fish will eat almost all types of feed offered to them including plankton in the water.

Protein requirements

The Tilapia requires many essential food ingredients for good growth and to develop to an adequate size and weight for the market. However, the protein needs are very important and the amounts required vary from stage to stage as the fish develops. Here are some examples:

- The first feeding should continue until a weight of 0.5 grams is attained. Throughout this period, the feed should have 50% protein.
- From 0.5 gram, and up to 10 grams, the feed should have

35% - 40% protein.

- From 10 grams to 35 grams, the feed should have 30% – 35% protein.
- From 50 grams up to when the fish is at market weight, the feed should have 25% - 30% protein.
- The brood-stock generally needs 30% protein.

Tilapia may however feed on less than their required diet and still develop to a marketable size.

Unit # 7 Feed Duckweed

Introduction

Welcome to Unit # 7. In this unit, we shall discuss the benefits of feeding duckweed as the key input of an Integrated Farming System that is being promoted by IPED.

Objectives

Upon completion of this very short unit, we shall discover:

- The economic benefits of feeding tilapia with Duckweed.
- How to feed duckweed to Tilapia

Benefits of Duckweed

- The high cost of commercial feeds contributes around 60% of production cost of tilapia. Duckweed is an affordable alternative to commercial fish feed.
- Duckweed has 18-45% crude protein content on dry

weight depending on the fertilizer level of the water in which it grows.

- Duckweed is easy to produce; it can be produced at almost no cost at all.
- Duckweed is very palatable to Tilapia and many animals.
- It is used or digested very efficiently by Tilapia. It can also be fed to poultry with good results.
- It reproduces easily and can double its weight within 16 hours to 2 days thereby a large amount of production from minimal area is possible.
- It has balanced essential amino acids and has a highly digestible dry matter which results in minimal waste by the fish, optimum metabolism on the use of nutrients and better feed conversion ratios, good content of carotenes and xanthophylls.
- Fish could be fed exclusively on duckweed. However, a combination of 50% Duckweed and 50% rice bran can be fed daily to get good growth, if enough duckweed is not available.
- Fish produced is palatable, safe and nutritious for human consumption.

Feeding Duckweed



Figure 32: Feeding of Tilapia using duckweed in a floating enclosure

- Place duckweed within a floating frame made out of bamboo or PVC pipe.
- Feed duckweed daily. Ensure that enough is fed so that a small amount of duckweed still remains at the time of the next feeding.
- As part of your standard farm practice, avoid the habit of throwing fresh kitchen waste into your pond

Unit # 8 Feeding Rates

Introduction

Welcome to Unit # 5. In this unit, we shall discover that fish are fed daily and the amount given each day depends on their body weight.

Objectives

Upon completion of this unit, we shall learn that:

- Tilapia requires various amounts of feed, to match their growing body weight at different stages of their growth.
- At the various stages of their development, the frequency of feeding will vary.

Feeding Rates

Size of Fish	Feeding Rates
1. Fry	Should eat 5% - 10% of their body weight in food each day.
2. Fingerlings	Should eat 3% - 5% of their body weight in food each day.

3. Juveniles	Should eat 2% - 3% of their body weight in food each day.
4. Market sizes	Should eat 2% - 3% of their body weight in food each day.

Water Temperature

- The pond water should ideally be maintained at about 28^0 Celsius.
- If this temperature cannot be maintained we should always ensure that it stays within a range of 25^0 – 30^0 Celsius.
- Whenever the water temperature goes beyond 28^0 Celsius, the fish will either stop eating or will tend to eat less.
- This situation is not good for fish farming.

Feeding Schedule

Tilapia can be trained to eat constantly, or to eat small amounts at regular intervals.

Tilapia fish can feed on plankton only up to body weight 100 g to 150 g without any supplementary feed and grow just as well as when fed commercial feed. Make sure that the pond is adequately fertilized to maintain a Secchi disk reading of 30 to 45 cm.

From 100 g body weight duckweed is made available in small floating enclosures. Replenish the duckweed once daily so that at the next feeding time there is still some duckweed left.

If the pond does not have enough plankton (algae) i.e. the Secchi disk reading is more than 45 cm, then you should make available duckweed.

If the supply of duckweed is inadequate, it can be supplemented with up to 50% rice bran.

Unit # 9 Transporting and Stocking

Introduction

Welcome to Unit # 9. In this unit, we shall discuss transporting fish and stocking the pond.

Objectives

Upon completion of this unit we shall learn about :

- Harvesting fish.
- Transporting fish.
- Preparing fish before transport.
- Water quality for transport.
- Methods of transport.
- Stocking fishes.

Harvesting fish



Figure 33: Harvesting Tilapia

- Harvesting methods may include the partial harvesting of the pond by seining or by cast net.

- When seining the Tilapia, remove the amount of fry that is more than 20% of the total weight of fish caught. These excess fry can be fed to ducks or pigs.

- Harvesting an entire pond is a simple operation and it is accomplished by reducing the water levels, until all the fish are in a small catchment section at one end of the pond.

- Separate and prepare to sell all fish of marketable size.

- Fingerlings could be set aside for re-introduction to the pond.

Transporting Fish

- Transporting live fish from one location to another is crucial to fish farming. At times it may be necessary to move them from farm to farm, or from point to point on the same farm.

- When transporting, we must ensure the fish have large amounts of space, and water with dissolved oxygen. Remember to travel with a portable air pump or oxygen.

- If the fish have to be taken over long distances, the quality of the water will deteriorate after a period. We must ensure that provision is made for a change of the water during the course of the journey lasting more than 24 hours.

Preparing the fish for transport

- Confine them to a separate area twenty four hours before the time of departure.

- Do not feed them for forty eight hours before transport. This will ensure they do not foul the water during transport.

Water quality for transport

- Use clean rain water if possible and keep it at room temperature.
- A small amount of ice added to the water will help to avoid temperature increases.
- A cup of salt for every 100 gallons of water will help keep the fish healthy.

Stocking Rate for Transport

- This is a technical point and advice should always be sought.
- There are many considerations for stocking and transport, which are dependent on the size, species and oxygen requirements. See your extension officer for specific advice.

Methods for transport

- The simplest way to transport small fish, fry or larvae, is to use forty liter double plastic bags partially filled with water and oxygen gas.
- These bags are quarter filled with water and three quarters filled with oxygen.
- The top of the bag is tied with rubber bands to secure the oxygen and water.
- Portable solid or plastic containers fitted with an air pump are also used. They are efficient and reliable.

Stocking Fishes

- Upon arrival at the pond, the plastic containers in which the fish are transported, should be placed in the pond and allowed to float for a while.

- After fifteen minutes, the temperature of the water on either side should be about the same. At this point the container is submerged and the fish allowed to swim out into the pond.

- If you use a solid container, then add some pond water to the container and leave it for about fifteen minutes. After this time the container is submerged and the fish allowed to swim out into the pond.

Unit # 10 Marketing of Fish

Introduction

Welcome to Unit # 10. In this unit, we shall discuss the importance of marketing.

Objectives

Upon completion of this unit we shall learn about :

- Market in the community
- Markets in other villages, in town and at supermarkets.



Figure 34: Marketing of fish in village market

Market in the community

This market is the neighbours and other families in the community. Fish can be sold fresh and with some effort even live if they are stocked in drums or a small concrete pond.

Markets in Other Villages, in towns and at Supermarkets

Fish can be sold fresh to vendors, who would take the fish to other villages or towns. It is advisable to ice the fish in these instances. Fish that is sold to supermarkets would generally be degutted and descaled, placed in styrofoam trays and sold fresh on ice or frozen.

Branding

Fresh fish or salted fish can be branded “Green” produce, in keeping with the method of production using duckweed as feed. A premium price is then possible.

Bibliography

1. Geer Tejnarine and Singh Kamila, *Basic course in Aquaculture*. Mon Repos Fresh water Aquaculture demonstration farm and training centre. Guyana, 2001.

2. Leng, R.A. *Duckweed: A tiny aquatic plant with enormous potential for agriculture and environment*. FAO, Rome(ltaly) 1999.

3. Maximiliamo Ortega, *Installation of Low cost polyethylene biodigester*. IICA Print shop Headquarters, Belize. Audubon Society, Ministry of Agriculture and Fisheries, 2009.

4. Skillicorn Paul, et al, *Duckweed Aquaculture*. A world bank Publication 1993.

GUYANA YOUTH BUSINESS TRUST

Promoting the Development of Youth Entrepreneurship.

Applicants Should:

- Be between the ages of 18 and 35 years.
- Have a good or viable business idea or business plan.
- Be unemployed or underemployed.
- Be classified as being disadvantaged or underprivileged.
- Have no access to capital or funding from commercial financial institution.

Services Provided

- Business or Entrepreneurial Training.
- The provision of credit or loans.
- The assignment of experienced and Trained Business Mentors.
- Ongoing business supervision by Business Counsellors.

OFFICES

Region 1
Mabaruma

Region 2
54 Cotton Field
Essequibo Coast
Tel: 771-4298

Region 3
312 Parika
East Bank Essequibo
Tel: 592-260-4399

Region 4
IPED Building
253 South Road
Bourda, Georgetown.
Tel: 592-226-4675

Region 5
11 D' Edward Village
West Bank Berbice
Tel: 592-327-5367

Region 6
1 Port Mourant
Corentyne.
Tel: 592-336-6171

Region 9
Lethem Rupununi
Tel: 592-772-2229

Region 10
Hand-in-Hand Building
Republic Avenue
Linden.
Tel: 592-444-3001

MISSION

We exist to facilitate enterprise development for wealth creation and poverty reduction whilst being financially viable

GOALS

To develop a culture of entrepreneurship amongst our clients and to inspire and empower them to achieve excellence.

To provide timely financing to Micro, Small and Medium Enterprises to enhance their production potential and capacity to supply both local and foreign markets.

To provide technical and managerial support services through training and counselling to all loan beneficiaries.

To promote sustainable environmental practices and technologies and mitigation of any pollution of the environment by our clients.

To network with organization providing complementary support services to communities in order to effectively develop entrepreneurs.

To provide a work environment where all employees are treated fairly, are adequately compensated, trained and highly motivated.

SERVICES

LOANS-Our loans are considered to be non traditional and are for clients who might not have access to formal banking systems. We currently offer loans under the following three windows.

Micro Loans up to 600,000
Small Loans up to $5,000,000
Medium Loans up to $20,000,000

Region 1
Mabaruma

Region 2
54 Cotton Field
Essequibo Coast
Tel: 592-771-4298

Region 3
312 Parika
East Bank Essequibo
Tel: 592-260-4399

Region 4
IPED Building
253 South Road
Bourda, Georgetown.
Tel: 592-226-4675

Region 5
11 D' Edward Village
West Bank Berbice
Tel: 592-327-5367

Region 6
1 Port Mourant
Corentyne.
Tel: 592-336-6171

Region 9
Lethem Rupununi
Tel: 592-772-2229

Region 10
Hand-in-Hand Building
Republic Avenue
Linden.
Tel: 592-444-3001