The AGRODOK-SERIES is a series of low-priced, practical manuals on small-scale and sustainable agriculture in the tropics. AGRODOK booklets are available in English (E), French (F), Portuguese (P) and Spanish (S). Agrodok publications can be ordered from AGROMISA or CTA.

1. Pig keeping in the tropics
2. Soil fertility management
3. Preservation of fruit and vegetables
4. Small-scale chicken production
5. Fruit growing in the tropics
6. Simple construction surveying for rural applications
7. Goat keeping in the tropics
8. Preparation and use of compost
9. The home garden in the tropics
10. Cultivation of soya and other legumes
11. Erosion control in the tropics
12. Preservation of fish and meat
13. Water harvesting and soil moisture retention
14. Dairy cattle husbandry
15. Small-scale freshwater fish farming
16. Agroforestry
17. Cultivation of tomato
18. Protection of stored cereal grains and pulses
19. Propagating and planting trees
20. Back-yard rabbit keeping in the tropics
21. On-farm fish culture
22. Small-scale production of weaning foods
23. Protected cultivation
24. Urban agriculture
25. Granaries
26. Marketing for small-scale producers
27. Establishing and managing water points for village livestock
28. Identification of crop damage
29. Pesticides: compounds, use and hazards
30. Non-chemical crop protection
31. Storage of tropical agricultural products
32. Beekeeping in the tropics
33. Duck keeping in the tropics
34. Hatching eggs by hens or in an incubator
35. Donkeys for transport and tillage
36. Preparation of dairy products
37. Small-scale seed production
38. Starting a cooperative
39. Non-timber forest products
40. Small-scale mushroom cultivation
41. Small-scale mushroom cultivation – 2
42. Bee products
43. Rainwater harvesting for domestic use
44. Ethnoveterinary medicine
45. Mitigating the effects of HIV/AIDS in small-scale farming
46. Zoonoses
47. Snail farming
48. The Rural Finance Landscape

© 2004 Agromisa Foundation
Foreword

This Agrodok is about integrating fish culture on the farm, an important form of small-scale sustainable agriculture in tropical areas. The system can be built up in stages until an optimally integrated production system is achieved, based on the inputs available on the farm. The information in this book is designed to help with the first steps, and has been made as practical as possible. Please bear in mind, however, that production figures given are dependent on local conditions, and therefore can only give an indication of the possibilities.

The illustrations of water plants in this Agrodok were made available by the Information Office of the University of Florida, IFAS, Center for Aquatic Plants, Gainesville, USA. The other illustrations were adapted by the Agromisa Illustration Group. We would like to thank Dr A.A. van Dam and Dr M.C.J. Verdegem from the Department of Fish Culture and Fisheries at the Wageningen Agricultural University for their guidance.

We welcome additional information concerning the contents of this book.

Wageningen, January 1997

W.G. van de Poll
Co-ordinating editor
## Contents

1. **Introduction** 6

2. **Principles of integrated fish culture** 8
   - 2.1 The biology of a fish pond 8
   - 2.2 Water quality 9
   - 2.3 Management of fertilizer application 10
   - 2.4 Fertilizing the bottom of the pond 11
   - 2.5 Plant by-products and animal manure 13
   - 2.6 Choice of fish species 13
   - 2.7 Food supplements for fish 14

3. **Plant material for fish food and fertilizer** 15
   - 3.1 Introduction 15
   - 3.2 Composting 15
   - 3.3 Land plants 17
   - 3.4 Water plants 19
   - 3.5 Nutritional value of plants 23

4. **Integrated rice and fish culture** 25
   - 4.1 Introduction 25
   - 4.2 The biology of a rice field 26
   - 4.3 Suitability of a field for fish culture 29
   - 4.4 Choice of fish species 36
   - 4.5 Releasing the fish 39
   - 4.6 Fertilizing and feeding 40
   - 4.7 Fish yields 41
   - 4.8 Other integrated fish-rice culture systems 42

5. **Integrating animal production with fish culture** 44
   - 5.1 Animal manure 44
   - 5.2 Integrating fish culture with pig raising 45
   - 5.3 Integrating fish culture with chickens 48
   - 5.4 Integrating fish culture with ducks and geese 50
5.5 Integrating fish culture with other farm animals 54

Appendix 1: Fish species 56

Appendix 2: Water plants as fish food 57

Appendix 3: Grasses as fish food 58

Appendix 4: Plant crops as fish food 59

Appendix 5: Production figures 60

Appendix 6: Latin names 62
Fish species 62
Plant species 62
Others 63

Further reading 64

Useful addresses 67
1 Introduction

Advantages of integrating fish farming
This Agrodok describes how you can integrate fish culture with crop and animal production on a farm. This book follows on from Agrodok No.15 'Small-scale freshwater fish farming', which describes in detail the basic principles of raising fish and building a fish pond. Once agricultural activities on a farm have been diversified integration can be the next step. A farmer can diversify by raising different kinds of crops or animals. The different activities become integrated when the waste products from one activity are used for the production of another crop or animal. For example, animal dung can be used to improve the fertility of the soil, which will increase plant growth. Animal dung can also be used as a fertilizer in a fish pond to increase fish production. By using these methods production on an integrated farm will be higher than on a farm where activities are carried out separately. Production costs can be kept low by using the by-products (e.g. stalks and leaves) from the different activities on the farm for fish culture. These by-products form an inexpensive way of making fish feed, which is cheaper than having to buy feed.

The advantages of integrated farming include:
- Minimizing of waste products, which improves the local environment.
- Decreased need for artificial fertilizers, which can increase profits by decreased production costs.
- Increased fish and vegetable production, which can increase household consumption or income.
- Decreased dependence on production inputs from outside the farm, which increases the stability of the farm.
- Increased productivity and efficiency on the farm.

The most important of the above advantages is the decrease in waste products. Improved soil structure, through the use of pond bottom silt in agriculture as fertilizer, means that water is better retained and less
erosion takes place. These long-term advantages outweigh any others which lead only to an increase in fish production.

The advantages of integrated fish culture mentioned here give a general indication of what can be achieved. Production methods and yields depend on local conditions. For example, farmers in Malawi, Africa adjust their integrated plant-fish culture system each year according to the amount of rainfall. In dry years the farmers grow vegetables on the pond bottom as there is not enough water to raise fish. The vegetables grow well on the fertile soil at the bottom of the pond, and suffer less from the drought.

Both plant and animal by-products can be used as fertilizer for a pond on an integrated fish farm. Applying natural fertilizer increases the amount of food available in the pond, so that the fish need less direct feeding. The basic principles of integrated fish culture are outlined in Chapter 2.

Some fish can be fed directly with plant waste. For other sorts the waste must first be made into compost. The compost is then used as a fertilizer in the pond, which increases the amount of natural food available, in turn resulting in an increase in fish production. Chapter 3 describes how plant waste can be used in a fish pond.

Chapter 4 describes a special system of integrated plant-fish production: integrated rice-fish production. This production system is used commonly in Asia and can be practiced both extensively and intensively according to the local situation.

Animal dung can be used as fish food for some fish species, or alternatively as fertilizer for the fish pond. There are various systems in which fish production can be integrated with other forms of animal production e.g. ducks or pigs. Whether fish production can be integrated with other forms of production depends on the local production and marketing conditions. The soil must be suitable for making a fish pond, and suitable fish species must be available. Chapter 5 describes the use of animal dung in fish production.

In this book the common names are used of fish and plant species. In Appendix 6 is a list given of the Latin names.