Provisional edition

IRRIGATION WATER MANAGEMENT
Training manual no. 7

CANALS

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

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A manual based on the joint work of
B.E. van den Bosch, Consultant
J. Hoevenaars
C. Brouwer

International Institute for Land Reclamation and Improvement

and of
N. Hatcho
FAO Land and Water Development Division

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PREFACE

This is one in a series of training manuals on subjects related to irrigation, issued in the period from 1985 to 1993.

The papers are intended for use by field assistants in agricultural extension services and irrigation technicians at the village and district levels who want to increase their ability to deal with farm-level irrigation issues.

The papers contain material that is intended to provide support for irrigation training courses and to facilitate their conduct. Thus, taken together, they do not present a complete course in themselves, but instructors may find it helpful to use those papers or sections that are relevant to the specific irrigation conditions under discussion. The material may also be useful to individual students who want to review a particular subject without a teacher.

Following an introductory discussion of various aspects of irrigation in the first paper, subsequent subjects discussed are:

- topographic surveying
- crop water needs
- irrigation scheduling
- irrigation methods
- scheme irrigation water needs and supply
- canals.

A further three subjects to be covered are:

- structures
- drainage
- scheme irrigation management.

At this stage, all the papers are marked provisional because experience with the preparation of irrigation material for use at the village level is limited. After a trial period of a few years, once enough time has elapsed to evaluate the information and the methods outlined in the draft papers, a definitive version of the series can be issued.

In addition some complementary manuals are planned, the first of which, *Small-scale pumped irrigation - energy and cost*, is being published simultaneously with this volume.

For further information and any comments you may wish to make please write to:

Water Resources, Development and Management Service
Land and Water Development Division
FAO
Via delle Terme di Caracalla
I-00100 Rome
Italy

ABOUT THIS PAPER

CANALS is the seventh in a series of training manuals on irrigation. The manual explains the functioning of a canal network and describes the basic principles of water flow in small canals. It considers the elements that affect canal capacity.

Furthermore, this manual deals with maintenance aspects of a canal network and describes in detail some important technical problems that commonly arise in connection with small canals, and provides practical guidance in dealing with them.

Three annexes are included to provide the reader with additional information on how to increase a canal's capacity, on how to construct an irrigation canal, and on how to measure the slope of a proposed canal alignment.

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Chapter 1

Introduction

Manuals 1 to 3 in the Water Management Training Series introduce the reader to basic irrigation principles. Manual 1, *Introduction to irrigation,* describes soil, plant, climate and water relationships; Manual 2, *Elements of topographic surveying,* deals with simple topographic measuring techniques; and Manual 3, *Irrigation water needs*, makes the reader familiar with irrigation water needs at crop level.

Manual 4 provides an introduction to *Irrigation scheduling*, and Manual 5 describes various *Irrigation methods*.

Manual 6, *Scheme irrigation water needs and supply*, describes methods of calculating scheme water needs as a function of cropping pattern.

Manuals 7 and 8 deal with the system by which irrigation water is transported from the water source to the farmers fields. This manual, number 7, describes the canals, and Manual 8, *Structures*, deals with the structures, which are important elements in an irrigation canal system.

A problem that is frequently observed in irrigation schemes is the inefficient way in which farmers use and maintain their canal network. Irrigation extension officers can be of great assistance to farmers by helping them to make better and more durable use of the irrigation canal system. It is the aim of this volume to assist the extension officers in their efforts to improve the exploitation of the canal system.

To achieve this goal, the functioning of a canal system is explained, as well as some basic concepts involved, such as discharge, capacity, friction and slope. Attention is paid to the usefulness of canal maintenance, and how to achieve this. The manual looks at some problems that occur frequently in irrigation systems, and provides a guide to avoiding or overcoming these problems. The final part describes how a minor extension of an existing scheme can be carried out and how a small new scheme can be constructed.

The manual is limited to open canal systems, which worldwide are the most commonly used systems.

The irrigated areas dealt with in this manual may be independent or they may be part of larger schemes. The areas are limited in size, 200 ha or less, and the extensions or the new construction schemes are for areas of less than 50 ha.

It is not the aim of this manual to teach the reader how to make complicated hydraulic calculations, nor to educate her or him in making complicated designs for new irrigation schemes. The manual's object is to provide support to irrigation extension officers in their efforts to improve the exploitation of minor irrigation schemes or small sub-units within large schemes.

Whenever a problem arises for which a solution is not given in the manual, the reader is requested to contact an irrigation engineer for help.

Chapter 2

Canal network and irrigation plan

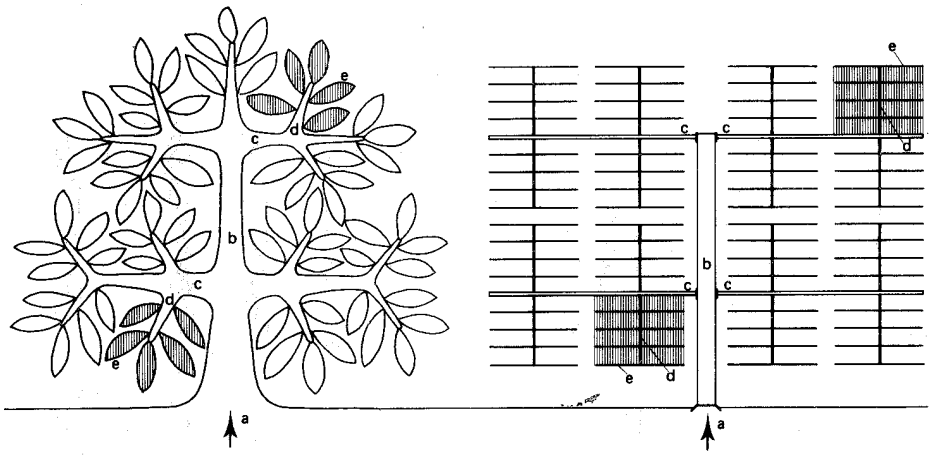
2.1 INTRODUCTION

This chapter introduces the functioning of an irrigation canal network and the use of an irrigation plan.

2.2 FUNCTION AND PERFORMANCE

A system of irrigation canals, also known as a 'canal network', transports water from its source to the fields, and is made up of many canals. To illustrate the functioning of an irrigation canal network, it can be compared to a tree, as in Figure 1.

FIGURE 1
An irrigation canal network compared to a tree



The main stem of a tree taps water from the soil and transports it to the branches. The branches supply the twigs with water and finally it enters into the leaves, where it will either be used for growth or will evaporate.

The same can be seen in an irrigation scheme: the main or primary canal (the stem) taps water from the water source. This may be a river, a lake, a reservoir or groundwater. Water is then distributed by the smaller secondary canals (the branches) to the tertiary canals (the twigs) which are even smaller. From these tertiary canals the water finally enters the fields (the leaves), where it will be used to irrigate a crop, and evaporate or soak away.

The canals are positioned in the field so that use is made of the natural slope, and water flows downhill through the canals and enters the fields by gravity. See also Figure 2, which shows part of a small irrigation canal system.

FIGURE 2
Part of a small irrigation canal system

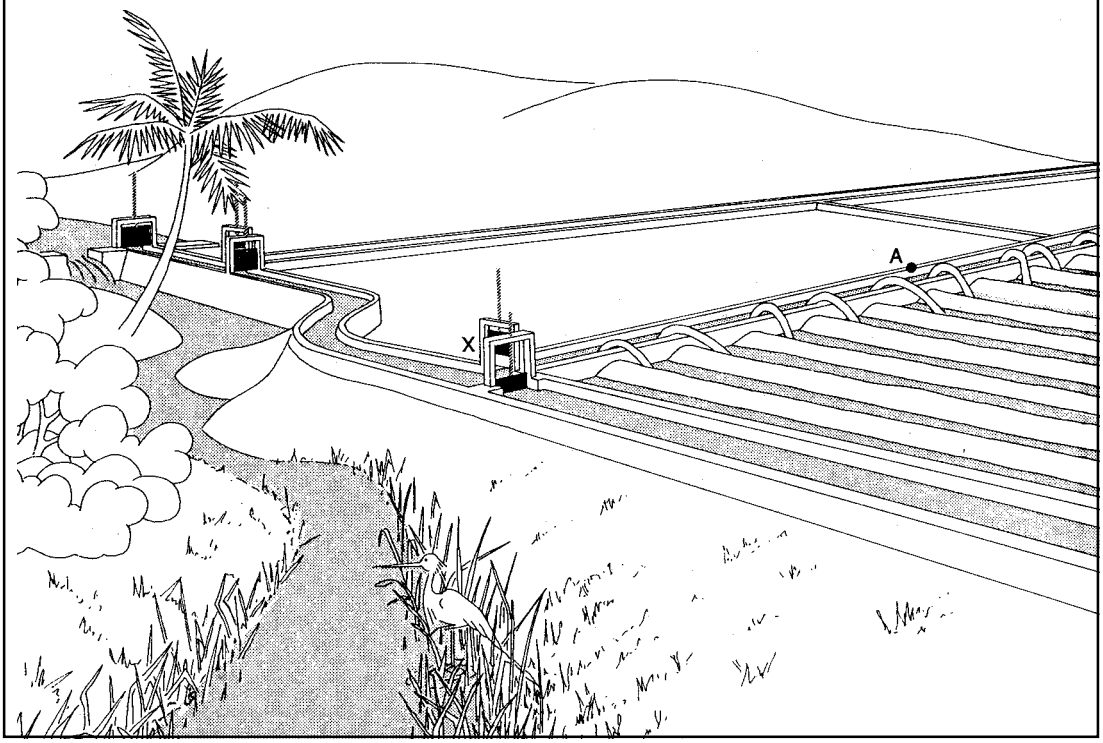
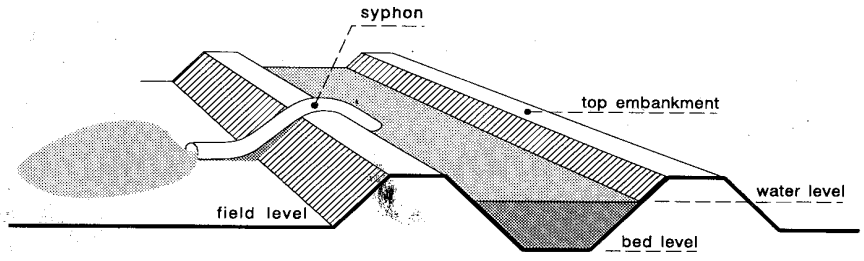


Figure 2 shows a dam on a river, from which water is tapped and passes into the main canal. The water then passes into two smaller canals, and finally enters the fields through siphons.

The smallest canals in a system serve the fields. Water in these canals should therefore be at a higher level than the fields. This can be seen in the following figures. Figure 3 shows a tertiary canal from which a field is irrigated by syphons. Figure 4 shows a longitudinal section of this canal and Figure 5 shows its cross-section.

FIGURE 3
Tertiary canal serving a field



It is best if the canal bed is lower than the field, as shown in the figures, but if a canal crosses a depression in the field, the canal bed may have to be partly raised above the field.

FIGURE 4
Longitudinal section

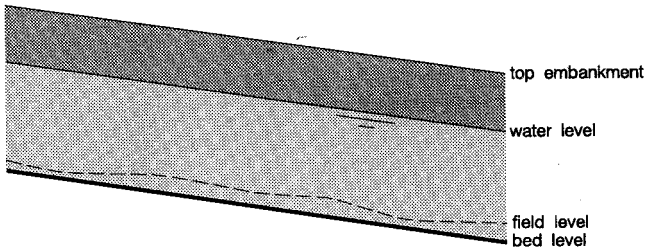
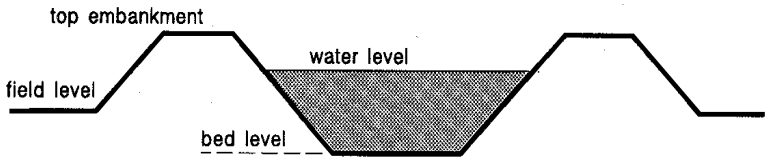


FIGURE 5
Cross-section



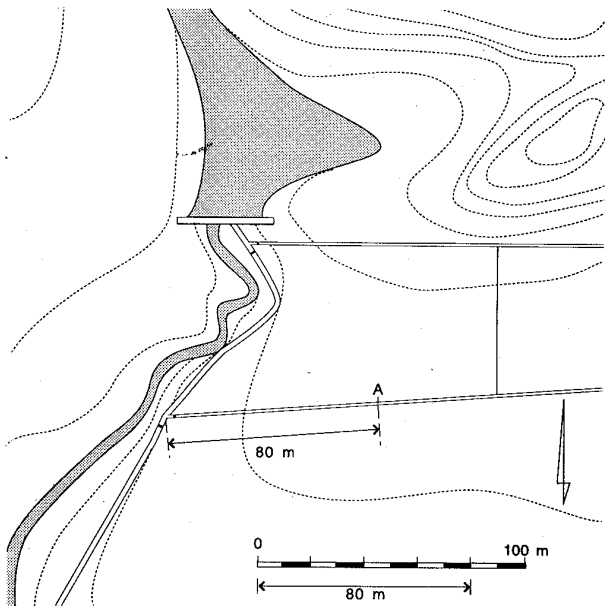
2.3 IRRIGATION PLAN

Before designing a canal network, a topographical survey of the area should be done and a topographical map of the area drawn. On this map the layout of the canal system is planned so that water delivery will be as efficient as possible. This map is called the irrigation plan. Figure 6 shows an example of such an irrigation plan, which corresponds to the canal system in Figure 2.

Figure 6 shows how the irrigation network is positioned in the field. The main canal and the field canals can clearly be seen in the plan. The correspondence between the plan and the canal system is made clear in Exercise 1.

An irrigation canal network can be drawn as a schematic lay out

FIGURE 6
Irrigation plan



EXERCISE 1

Question: Which point in the field corresponds to point A on the irrigation plan?
Point A is situated along a field canal.

Solution:

Step 1 Look for a point on the map that is close to point A and which is easy to find in the field; in this case it is the offtake of the field canal concerned.

Step 2 Measure the distance on the map from this reference point to A.

Step 3 If the map has a line scale, then measure the distance found in Step 1 along it and read off the true distance.
If the scale is given in figures, then multiply the measured distance (in centimetres) by the scale figure, and convert to metres. E.g., if the scale of the map is 1:2 000, then 1 cm on the map is equivalent to 2 000 cm [= 20 m] on the ground.

Step 4 Go into the field and find the reference point used , the field canal offtake marked 'X' in Figure 2. Measure downstream along the bank of the field canal for the distance determined in Step 3.
That is point A on the map and in Figure 2.

as well as as a topographically correct map. Such a schematic irrigation plan shows the main and secondary canals, and the off-takes and the areas served by each. Figure 7 shows the schematic irrigation plan of the scheme which is given in Figures 2 and 6. The irrigation units are symbolized by small squares in which, in this case, the area served by each offtake is written.

EXERCISE 2

Question: Which offtake in the schematic lay-out in Figure 7 corresponds to the tertiary offtake which is marked X in the field in Figure 2?

Solution:

Step 1 Offtake X is offtake number 2 along the main canal.

Step 2 Find offtake number 2 along the main canal in Figure 7.

FIGURE 7
Schematic irrigation plan