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# LAND DRAINAGE

## PRINCIPLES, METHODS AND APPLICATIONS

A K Bhattacharya  
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*Principles, Methods and Applications*

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## ***Principles, Methods and Applications***

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# Preface

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Providing drainage facility to irrigated agricultural land is as important an activity as irrigation itself. Drainage provides for an escape of the unwanted excess water that occurs over the flow-irrigated lands. Without adequate drainage, water congestion on the surface and in the crop root zone occurs that harms the crop environment and the crops. Runoff due to heavy rains in the monsoon season also needs to be removed from the crop land to save the growing crops, avoid fast water table rise into the crop root zone and also to make the soil workable faster. A properly designed, executed and maintained agricultural drainage system ensures all these, which enhance the sustainability of irrigation benefits. The benefits of irrigation are quick to accrue, while the ill effects of improper water management are visible later. Meanwhile, gradual degradation occurs to the irrigated lands due to water table rise, soil salinization and alkali condition, all adversely affecting crop production. At an advanced stage of land degradation, the remedy through drainage becomes expensive or difficult. Land drainage is well-practised in most of the developed nations even though agriculture may not be the main stay of their national economy. The general principles of surface and sub-surface drainage are universally true. However, the applications of specific procedures vary with the soil, climate, topography and socio-economic situations. Drainage needs in Monsoon Asia, for example, are distinctly different from those in other geographical regions. In many of the Central and West Asian countries and in North Africa salt management assumes major importance along with water table control. Absence of a comprehensive and authoritative text/reference book, oriented to the problems of agricultural drainage in India and the developing world has been a major limitation in the application of appropriate technology in this area of vital importance in agricultural production.

*Land Drainage—Principles, Methods and Applications* presents the latest information, concepts and technology for ensuring sustainable agricultural production and environmental management by adopting land drainage measures. The book has been prepared as a text for a university level Land Drainage course (the degree or the post-graduate programme) in Agricultural Engineering (Irrigation and Drainage Engineering & Soil and Water Conservation Engineering), Civil Engineering (Water Resources Engineering) and Agricultural Science (Soil and Water Management and Watershed Management). It is intended to serve as a valuable reference book for professionals (scientists/engineers/technicians) engaged in the area of land development and water management, including land development in general and irrigation project command areas and watershed development in particular. In addition to its use as university level text and reference, students of Polytechnics (engineering/agricultural) and professionals undergoing training in Water and Land Management Institutes (WALMIs) and allied institutes will find the book a valuable reference.

The book provides a clear understanding of the physical and chemical processes leading to land degradation and how drainage helps in preventing or controlling such processes. The relationships between main design variables, soil, climate and other relevant environmental factors as well as the reliability and limitations of the current theories and formulas are thoroughly described. Economics and institutional aspects of drainage are presented wherever applicable. The case studies presented give relevance to the applicability of the theory and practice to solve real world problems and are of great value to practising professionals. The subject matter is

divided into eleven chapters, each dealing with a distinct area of study. The introductory chapter highlights the relevance of drainage as an integral component of irrigation system development. A global review of large-scale irrigation development and resulting drainage and salt problems arising out of their mismanagement has been presented. Many indigenous technologies, which are relatively inexpensive and are being successfully practised in some of the developing countries, have been cited.

The treatise covers the subject matter of the various chapters, including problem identification, theoretical analysis, drainage system design, layout, construction and maintenance. A large number of solved examples have been included to facilitate the understanding of the subject matter. Adequate number of unsolved problems at the end of each chapter have been provided for self-assessment in order to gain confidence in the subject. Different types of questions have also been added at the end of each chapter, keeping in view the students' need to prepare for competitive examinations. A list of references including those cited in the text and referred to by us in developing the information presented and those intended for supplemental reading has been included at the end of each chapter. Suitable illustrations are provided wherever applicable. While a universal approach is adopted in developing the text, a special emphasis has been given to the situations in India in particular and the developing countries in general.

Much of the current information on land drainage, including reclamation and management of saline and alkali lands has been developed over the past many decades and we have depended heavily on the available information, besides adding substantially from our expertise and experience in the area. Every effort has been made to give credit to the source of information. Omissions, if any, are inadvertent and will be corrected when pointed out.

We are indebted to many individuals, institutions and organizations for supplying us with useful information for developing the manuscript. Doctoral and Masters level theses of the post graduate students whom we have had the opportunity to guide were of great value in developing the material for the case studies reported in the text. We are grateful to our colleagues at the Water Technology Centre, IARI and at the regional Centres of the All India Coordinated Research Project on Agricultural Drainage of ICAR for their help in the development of the manuscript. We thankfully acknowledge Dr R K Panda, Principal Scientist, Directorate of Water Management (ICAR), Bhubaneshwar for sharing the cover page photograph from his personal collection.

New Delhi

A K Bhattacharya

A M Michael

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# 1 CHAPTER

# Drainage and Salt Management for Sustainable Agricultural Production

## LEARNING OBJECTIVES

By the end of the chapter you will understand the:

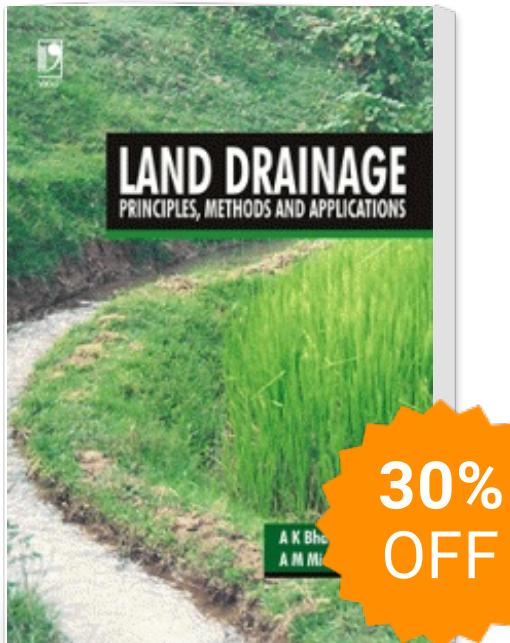
- Concept of sustainable development and use of the natural resources for agriculture
- Causes of unsustainability like waterlogging, water table rise and salt effect
- Overview of agricultural land drainage situations and interventions in different countries and in different states of India
- Monsoon features and its influence on drainage need
- Broad classification of drainage methods for runoff disposal and for controlling waterlogging and salinity
- Effect of drainage on soil physical and chemical environment and crop yield
- Methods alternative to conventional drainage

*'No grain is ever produced without water, but too much water tends to spoil the grain. An inundation is as injurious to growth as dearth of water'.*

**NARADA SMRITI, XI 19**

Sustainable development is a process through which the needs of the present generation are met without compromising on the ability of the future generations to meet their needs. Food, fibre and fodder are the three most important agricultural products necessary for sustenance. The future generations will grow in number thereby, resulting in greater consumption of the agricultural produce. The two important production bases, land and water are, however, limited and degradable. From past experiences, it can be concluded that when water availability for agriculture is ensured, there is a vast improvement in the production. However, in many countries, little attention is paid to proper agronomic practices, soil management and the need for a good drainage system. In large parts of the world, including India, the production from irrigated agriculture is much less than its potential. This can be enhanced by adopting a proper mix of activities complimentary to irrigation, such as drainage, soil management and crop selection. In India, the near stagnation of the cropped area for food grains and decline in the productivity of crops in the recent past should

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