LABORATORY AND FIELD MANUAL ON

IRRIGATION ENGINEERING

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R.J. Patel

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FOREWORD

With the increasing population, the demand of water for domestic and other sectors is escalating and the efficient use of irrigation water would play a significant role in meeting the ever growing demand for food, fuel, fodder, etc. in the country. Any mismanagement of the precious irrigation water is leading to low irrigation efficiency and degradation of our highly productive lands due to salinization and water logging. Hence, it is the need of hour to take up scientific methodology of irrigation water management based on individual farm needs.

Therefore, a comprehensive knowledge of available soil moisture and its constants, scheduling of irrigation and evaluation of various irrigation methods with proper techniques is crucial. This manual on irrigation engineering is an attempt to fulfill this urgent need as it covers all major aspects of irrigation water management. This manual would be of immense help for the students of under-graduate and post-graduate students as well as scientific community and field functionaries.

I congratulate Dr. R. J. Patel for bringing out this important document. The efforts made by him for compilation of information of the crucial aspect of 'Irrigation Engineering' are commendable.

H. D. Rank

PREFACE

The irrigation water is considered as the essential input for crop production. In India, over exploitation of natural water resources has caused a menace for the future human generations. The depletion of underground water table in high productivity areas and under utilization of the water resources in rain fed areas of the country, poor irrigation efficiency and high seepage losses from conveyance system, poor land development and mismanagement of the irrigation water resources has acquired alarming proportions. As the share of water for agriculture in future is going to reduce, there will be tremendous pressure to produce more per drop of water in order to meet the food and other requirements of burgeoning population of the country. The existing irrigation water resources are not utilized judiciously and their mismanagement has lead to problems like low production efficiency, salinization, water logging and degradation of land. To manage these problems and increase the production efficiency of irrigation, it is pertinent to adopt judicious methods of irrigation water use, by efficient on-farm irrigation management based on scientific approach. Therefore, a comprehensive knowledge of available soil moisture and its constants, scheduling and quality of irrigation water and proper drainage techniques is crucial. This manual on irrigation engineering is an attempt to fulfil this urgent need as it covers all major aspects of irrigation water management. Although, manual is meant primarily for the students of agricultural universities, yet it will provide valuable basic information and guide to the scientific community and field functionaries.

I am very grateful to honourable Vice-Chancellor Dr. A. R. Pathak for motivating to bring out this publication. I am highly thankful to Dr. N. K. Gontia, Principal and Dean, College of Agricultural Engineering and Technology, Junagadh Agricultural University, Junagadh for his ever encouraging attitude. I am also obliged to Dr. H. D. Rank, Professor and Head, Soil and Water Engineering Department for his precious advice and all possible

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R. J. Patel

CONTENTS

CHAPTER 1

Measurement of Soil Moisture Content

Soil is a heterogeneous mass and consists of three phases, viz., solid, liquid and gaseous phase. Soil is a porous medium, and serves as a water reservoir or bank. Water is retained by a soil particle in the form of a thin film around it, and in the numerous small pores of the soil matrix with forces, such as surface tension capillarity, cohesion and adhesion.

Importance of Soil Water

- Soil water serves as a solvent and carrier of food nutrients for plant growth.
- Yield of crop is more often determined by the amount of water available rather than the deficiency of other food nutrients.
- Soil water regulates soil temperature.
- Soil forming processes and weathering depend on water.
- Microorganisms require water for their metabolic activities.
- Soil water helps in chemical and biological activities of soil.

Soil is the source of water for the plants, which is always present in a dynamic state. A soil profile holds water on its surface in a form of thin film with a certain force. Pore space, which is the space in between soil particles, contains both air and water in varying proportions. Soil moisture is expressed as percentage on oven dry basis either on weight basis, volume basis or depth basis. Moisture percentage is generally expressed on weight basis, unless stated otherwise. Determination of soil moisture content is needed to help in the estimation of i) available water in the root

zone, ii) scheduling of irrigation, iii) soil water potential and iv) changes in physical and chemical properties of soil due to changes in water content.

1.1 DETERMINATION OF SOIL MOISTURE CONTENT USING GRAVIMETRIC METHOD

Objective: To determine the moisture content of a soil sample in the laboratory using gravimetric method.

Definition: The water content, also called moisture content is defined as the ratio of weight of water to the weight of solids.

Apparatus: Soil auger, moisture boxes, weighing balance, drying oven with thermostat.

Procedure:

1. Weigh the moisture box along with lid (W_3).
2. Collect the soil sample from the desired soil depth with the help of auger and record the weight of moist soil and container along with lid (W_1).
3. Allow the soil sample to dry in the oven for 24 hours at a constant temperature of 105 °C to attain a constant dry weight.
4. Weigh the dried soil sample along with the container and lid after cooling (W_2).
5. Repeat the above procedure at least for five soil samples collected from various depth of soil profile.

Observations:

1. Sample No. = _____
2. Weight of moist soil and container along with lid W_1 g = _____
3. Weight of dry soil and container along with lid W_2 g = _____
4. Weight of container along with lid W_3 g = _____

Calculations:

1. Weight of moist soil sample = $(W_1 - W_3)$ g = _____
2. Weight of dried soil sample = $(W_2 - W_3)$ g = _____