AN APPROACH TO A FIELD DRAINAGE PROBLEM BY LABORATORY EXAMINATION OF SELECTED PROPERTIES OF UNDISTURBED SOIL CORES.

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by

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The results on hydraulic studies reported herein represent the partial repetition of a more exhaustive study, all records of which were completely destroyed by a fire arising from an electrical defect in the laboratory. This loss has limited the drawing of conclusions and must be taken into account in evaluating the work.

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SECTION A

INTRODUCTION

For many years, soil drainage investigators, from a practical view point, have had to content themselves with expert appraisal of certain direct and indirect soil and environmental characteristics in order to ascertain the cause of a particular drainage problem. In a great many instances, observations of vegetative composition, topography and general soil type, aided by aerial photography and local experience, give completely adequate information. Normally, derivation of conclusions from such observations is based on well established principles, and the recognition of general broad classes of the cause of mal-drainage conditions. Such classes may be grouped as; (I) where infiltration capacity of a soil is inadequate to deal with the amount of water supplied to the surface, because of topography, abnormal rainfall, or through inherent inability of the soil to transmit water internally, (II) where the ground-water table rises to a height detrimental to vegetative survival and/or soil structure, or where its presence hinders the function of a free draining subsoil, and (III) where a similar situation exists, due to a perched or elevated ground-water table.

The allocation of a particular drainage problem to one or more of these broad classes is not usually difficult, but identification of causal processes within classes presents quite another problem. Often, drainage investigators have been content to evolve general treatments for each class, and, as a basic rule, such procedures have, more often than not, proved reasonably effective. However, with the increasing intensification of pastoral and agricultural farming, the fundamental causes of individual mal-drainage conditions must be positively identified and rectified within the broadly classified groups.

In many parts of the world, significant steps have been taken in this direction, especially within group (I) above. Here again, investigators pursue two different approaches; (a) indirect analysis of physical properties of soils, related, more or less, to the ability of the soil to transmit water, and (b) direct analysis of the hydraulic transmitting power of soils. The first approach includes critical examination of such factors as the following:

Type of structure
Grade (stability) of structural aggregates
Relative length of horizontal and vertical axes of structural aggregates
Texture
Comparative ease and direction of natural breakage

Size and number of visible pores, cracks and channels, visible under a hand lens

Character of clay minerals

Compaction

Size and shape of sand grains

Mottling

Organic Material

Soluble salts

While evaluation, on a basis of the above characteristics may be, in many instances, convenient and relatively non time-consuming, O'Neal (1949), the joint proposer of the above list (1951), stressed that few factors individually could be considered good guides to intrinsic permeability. Rather, all factors should be considered singularly and in relation to one another, and even then the correlation with intrinsic permeability is not always entirely satisfactory.

The second approach involves measuring, directly, certain fundamental physical properties of the soil as a means of establishing causes of low intrinsic permeability. Among the workers involved in direct measurements, two general approaches are again apparent. There are those who measure permeability rates in the field. Their methods include various single "auger hole" determinations, pumping between two auger holes, piezometer tube installation, infiltrometers, watershed balance sheets, and rainfall simulators. The other approach to direct measurements is to study the permeability of the profile in the laboratory, thus obviating the only real practical disadvantage of field determinations - that of the inconvenience of providing equipment in situ, in the field. These two approaches are, however, more closely related in their objectives than most, as the prime object of the laboratory techniques is to determine intrinsic permeability values that will be directly related and applicable to the field determinations. The latter, per se, must be applicable to the practical application of drainage techniques.

Under certain conditions, the traditional methods of drainage investigations may suffice, whereas under other conditions the more fundamental studies may be required. However, as increasing instances of the more difficult problems are encountered, such as in gley podsols, some Northern podsolised Yellow Brown Earths and many recent alluvial soils, the emphasis on investigation must swing more from the subjective and empirical assessments towards the attainment of direct experimental evidence based on scientific approach. It is therefore imperative that experimental techniques be evolved which enable investigators to objectively study the hydraulic characteristics of soils in order to ascertain precisely the causes of individual drainage problems.

SECTION B

REVIEW OF THE LITERATURE

The relevant literature is reviewed under the following headings:-

I Techniques for obtaining "undisturbed" soil samples.

II The transportation, storage, and preparation of soil samples prior to laboratory investigations of hydraulic characteristics.

III Supplementary laboratory equipment associated with hydraulic studies of "undisturbed" soil samples.

IV The laboratory study of water flow through "saturated" soil.

V Soil and fluid properties responsible for variations in intrinsic permeability.

VI Methods of indirect assessment of intrinsic permeability.