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Soil Water Assessment

for Crop Planning in Black Soils

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Black soils extend to the central, western and southern part of the country and cover about 76.4 m ha. These soils represent dominantly arid to semi-arid climate with dry and hot pre-monsoon months (April-June) and a dry mild winter. The mean annual rainfall (500 to 5000 mm) covers 42 to 77% of the mean annual potential evapotranspiration.

More than 60% area under the black soils is rainfed and for rainfed agriculture, assessment of soil water is highly useful in preparing crop planning/crop production strategies including the selection of technologies and allocation of resources. It also provides guidance for the effective implementation of crop plans and to avoid or minimize risks. Soil water content is critical not only to supply the water needs of the crop but also to dissolve nutrients and make them available to the crops. However, the quantum of available soil water for plant depends on the amount of rain water entered and stored in a soil profile, and the extent of this soil water released during the crop growth. The soil water retention and release is greatly influenced by the saturated hydraulic conductivity (sHC), the nature and content of clay minerals, and also by the nature of the exchangeable cations.

Importance of Soil Water

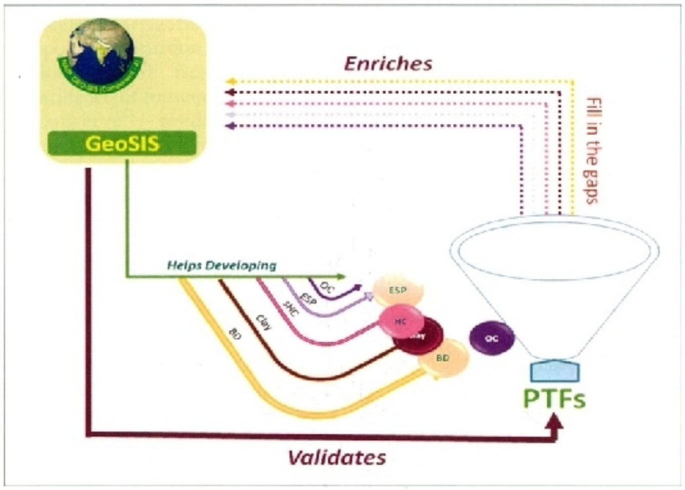
- Soil water is the medium from which all plant nutrients are assimilated by plants. Soil water, sometimes referred to as the soil solution, contains dissolved organic and inorganic substances and transports dissolved nutrients, such as nitrogen, phosphorus, potassium, and calcium, to the plant roots for absorption.
- It is essential for photosynthesis
- It regulates soil temperature and soil air
- Soil forming processes and weathering depend on soil water
- Microorganisms require soil water for their metabolic activities
- It helps in chemical and biological activities of soil.

Readily available soil water (AWC) to the plant is the difference between the soil water content at field capacity and wilting point. The AWC can be used for assessment of crop suitability and irrigation method. An irrigation system can be better designed and operated with the use of soil water information for better water delivery planning resulting in higher water use efficiency. Soil water information is also required for the various other applications such as drainage water management and recharge estimation. This will also assist in analyzing various scenarios of land use change and management in a catchment, which will help in better decision making and management of a catchment.

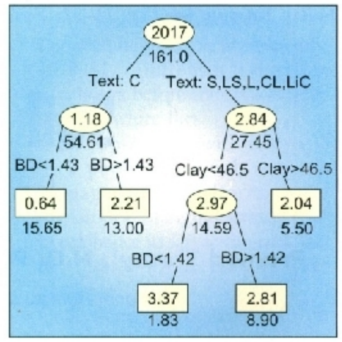
Therefore, information of soil water at both temporal and spatial scales plays an important role not only in natural resource management, but also in land use planning, crop and environment modeling and also for monitoring soil properties influenced by dynamic land use changes. This fact assumes added importance to agricultural land use planning in view of the declining trends in factor productivity. However, direct measurement of soil water both at field and laboratory conditions are time-consuming and labour-intensive. Therefore, the soil water at field capacity and wilting point is estimated using some indirect methods or some mathematical equations, known as pedotransfer functions, from easily measurable and readily available soil properties such as particle size distribution (sand, silt and clay content), soil organic carbon.

These functions fill the gap between the available soil data and the properties which are more useful for crop planning. A schematic

Estimation of soil water parameters is vital for any crop planning especially in the semi-arid regions of India. Saturated hydraulic conductivity is one such parameter which governs the growth and yields of major crops in the semi-arid black soil region. As saturated hydraulic conductivity is not an easily analyzable soil parameter, there are options to derive it from statistical methods using pedotransfer functions for better crop planning.



Schematic diagram showing data source and validation of pedotransfer functions (PTFs).



A regression tree to predict saturated hydraulic conductivity from field texture grade (Text: S=sand, LS=loamy sand, L=loam, CL=clay loam, LiC=Light clay, C=clay), bulk density (BD), and clay content. Values in nodes are the predicted $\log_{10}(K_s)$ (in mm/day), values underneath the nodes are the standard deviation of prediction.

diagram for enrichment of soil database through pedotransfer functions is presented in the figure.

Pedotransfer Functions (PTFs)

The term pedotransfer function (PTF) was first coined in 1989 by Bouma as translating data we have into what we need. The most readily available data come from soil survey, such as field morphology, texture, structure and pH. Pedotransfer functions add value to this basic information by translating them into other estimates.

Pedotransfer Functions Classification

- Class PTFs predict certain soil properties based on the class (textural, horizon, etc.) to which the soil sample belongs
- Continuous PTFs predict certain soil properties as a continuous function of one or more measured variables

Methods for Development of Pedotransfer Functions

There are mainly two approaches, generally used to arrive at PTFs of different kinds.

Mechanistic-empirical approach: This approach attempts to describe a physical/chemical model relating basic properties to the predicted properties.

Empirical approach: This is the most common method, i.e. correlating the basic soil properties to the more difficult-to-measure soil properties by using different numerical fitting methods. The most frequently used technique for fitting or deriving PTFs is multiple linear regression analysis. Regression tree is also a simple empirical method which is used as multi-level look up table. It is a special type of decision tree that can predict continuous variables. The figure below presents a regression tree to predict $\log_{10}(K_s)$ from field texture, clay content and bulk density.

Using the multiple regression technique, PTFs were developed for the black soils to estimate the soil water at field capacity and wilting point, and saturated hydraulic conductivity.

SUMMARY

The availability of soil water is related to the drainage process and its retention-release behaviour which ultimately leads to crop and land use planning. The sHC greatly influences the drainage process and soil water retention-release behaviour. However, the sHC and water retention are not available as routine dataset and therefore, PTFs developed for different soil parameters will be useful for crop planning in black soil region.

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