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Soil and Land Quality

for sustainable crop production

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THE concept of soil quality has evolved since the last decade of the 20th century to answer the growing concern about sustainable soil management.This is because in many developing countries the soils are used and abused by undermining its capacity to function within a given environmental boundary. Despite this fact, the assessment of soil quality has gained importance due to growing awareness and knowledge about soils. Moreover, high rates of soil erosion, loss of organic matter, reduction in fertility and productivity, chemical and heavy metal contamination, and degradation of air and water quality have sparked interest in the concept of soil quality and its assessment. The present day farmers are quite knowledgeable about their soils; however, the onus is on the scientists to make them more knowledgeable based on principles of soil science. Consequently, there is a need for indexing the quality of soil in a lucid manner for the benefit of farmers, planners and researchers because many times it is difficult to comprehend, understand or appreciate the complexities of soil resources. Soil quality assessment are intended to provide a better understanding and awareness that soil resources are truly living bodies with biological, chemical, and physical properties and processes performing essential ecosystem services.

Soil survey, classification and interpretation provide us the opportunity to assess the inherent soil properties to perform critical analysis, landscape characteristics, and their interpretations for use and management. Although it has long been recognized that land quality plays an important role in agricultural productivity, land quality has been difficult to quantify and to include in productivity models due to limitations of sufficient and quality data. Unlike soil quality index (SQI), the computation of land quality index (LQI), is more challenging due to the many other associated factors.

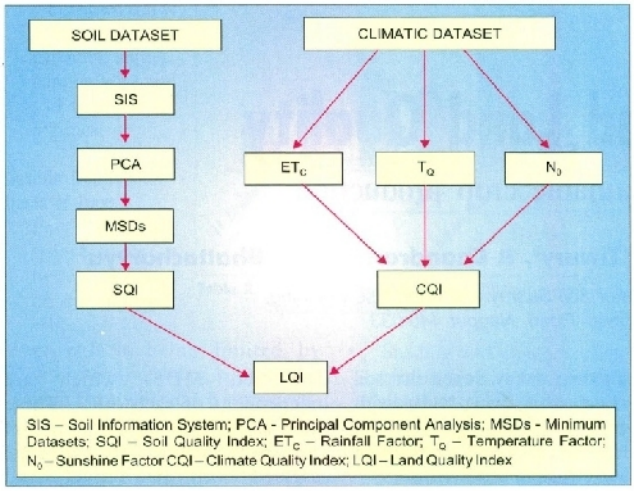
Minimum Data Set for Soil and Land Quality

Out of several physical, chemical, biological and other soil site parameters, it is difficult to consider all the parameters for soil and land quality assessment and therefore, it is necessary to consider minimum soil and parameters (or called minimum data set, MDS) which are independent of each other. These MDS are used as indicators of soil and land quality which can be assessed both qualitatively and quantitatively.

Qualitative Assessment of Soil and Land Quality

Some of these MDS for qualitative soil and land quality assessment can be obtained by visual soil and land quality assessment. These include soil and site characteristics such as land use, soil type, texture, moisture condition, climatic conditions and some soil morphological characteristics which are easily observable such as, soil structure, soil porosity, soil color, number and color of mottles, earthworm number, evidence of a tillage pan, surface cloddiness, and the apparent susceptibility to wind and water erosion. Other indicators namely plant indicators include, degree of emergence, crop height at maturity, size and development of root system, quality and quantity of yield, incidence of root diseases, degree of weed infestation, amount and duration of surface ponding, and cost of production.

Maintaining soil quality under intensive land use and economic development is a major challenge for sustainable resource use in the developing world. The basic assessment of soil health and soil quality is necessary to evaluate the degradation status and changing trends following different land use and management interventions for the small land holders. Since long it has been observed that there has been stagnation in the yields of major crops in the Indo-Gangetic Plains (IGP) of India. There are reports of deteriorating quality of land and soils. Novel methods have been found to determine soil and land quality for sustainable crop production in the IGP developed through the National Agricultural Innovative Project (NAIP).



Schematic diagram of development of LQI for the Indo-Gangetic Plains

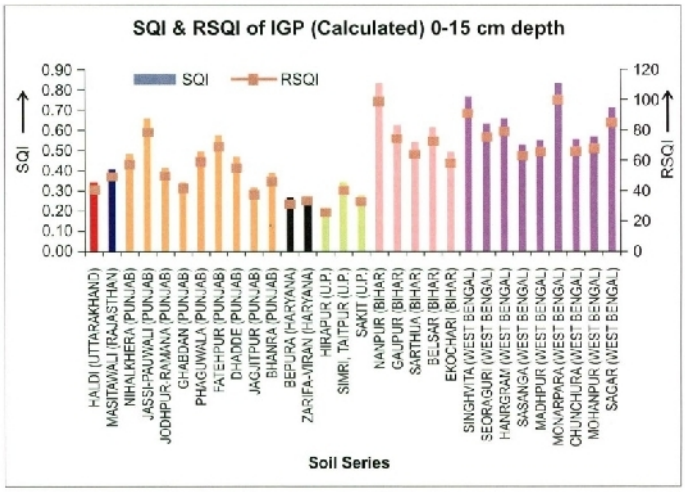
exchangeable magnesium percentage. Soil and land quality indices were correlated with the yield of some major crops such as, rice (R^2 = 0.56) and wheat (R^2 = 0.58). These have also been depicted spatially in the form of maps for the benefit of users. Land quality for the rice crop showed that the area under low category is only about 17%, whereas the areas under medium and high categories are 72 and 6%, respectively. The soils which have poor soil and land quality generally belong to the arid and semi-arid region where the major problems of soils are related to poor drainage due to calcareousness and sodicity.Proper management interventions *viz*, soil amendment, phyto-remediation, addition of regular doses of manures along with fertilizers are necessary to reduce the negative factors for soil quality.

Quantitative Assessment of Soil and Land Quality

In quantitative estimation of soil and land quality, measureable soil physical, chemical, biological and site characteristics are considered as indicators. Pedo-transfer functions were used to obtain data which were not available. The MDS of the indicators were obtained by using statistical software called principal component analysis (PCA) and other mathematical procedures (matrices) which minimizes the number of indicators as well as provides weightages for the calculation of soil quality index. The MDS can also be obtained by seeking opinion from experts in the field including farmers' opinion. These indicators are converted into score through standard methods. Land quality index (LQI) is assessed with the help of soil quality index (SQI) and climatic parameters.

Case Study

The SQI and the LQI were derived for the Indo-Gangetic Plains (IGP) as a case study.The IGP has been the major food producing region of the country for nearly five decades. The main crops of the region are rice and wheat apart from pulses, oilseeds, cash crops and horticultural crops.However, at present the yield of crops have stagnated due to high degree of land degradation, nutrient deficiencies and imbalances and depleting ground water level.



Variation of SQI and Relative SQI (calculated) in different soil series (hotspots) of the IGP

It has been shown that the soils of lower IGP (Bihar, West Bengal) have higher SQI than the upper IGP (Rajasthan, Punjab, Haryana, Uttarakhand, Uttar Pradesh) as shown in soils representing these two parts of the IGP. These are mainly due to lower values of rainfall, saturated hydraulic conductivity or internal drainage, organic carbon and clay content and higher values of temperature, exchangeable sodium percentage, calcium carbonate and

SUMMARY

Information on soil and land quality will be useful in assessing cropping systems and also to suggest alternate land use in a particular region. The soil and land quality is better in the lower IGP compared to the upper IGP. Soil and land quality assessment is a useful tool to monitor and maintain the quality of the land for sustainable crop production in the region.

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