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Agricultural Land Use Planning

by Land Evaluation

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EFFICIENCY of agricultural development programmes as well as land-related environmental programmes can be enhanced considerably, if decisions are based on evaluation of land quality. Land evaluation is often carried out in response to recognition of a need for changes in the way in which land is currently being used. The information and recommendations from land evaluation represent only one of the major inputs into the agricultural land use planning process, which often follows land evaluation. While land evaluation primarily identifies and rates the land potential and recommends alternative use scenarios, land use planning focuses on effective choices using the options provided by land evaluation. Land evaluation is a part of the process of land use planning, the two processes are therefore interlinked. A fundamental challenge facing land evaluation is to prove its relevance to the many pressing land use problems. Predictions of land performance, no matter how soundly based, are only useful if they are used by decision makers, including individual land users, groups or governments to make better land use decisions.

No systematic land evaluation had ever been undertaken for major crops in the Indo-Gangetic Plain (IGP) and Black Soil Region (BSR), the two major crop producing regions which together address the issue of country's food security to a great extent. Quite understandably, no attempt was therefore made to identify the best method of land evaluation of major crops, viz. rice and wheat in the IGP and cotton and soybean in the BSR. These two shortcomings need to be addressed. Threshold values of soil/land quality parameters are used in monitoring change in soil/land quality. Besides assessing land quality, it also becomes important to monitor changes in land quality which has been seldom attempted. This is done by measuring appropriate indicators and comparing then with the desired values, i.e. threshold values.

INDO-GANGETIC PLAINS AND BLACK SOIL REGION

Soils were selected, one each from 15 Benchmark (BM) spots in major agro-ecological sub regions (AESRs) representing rice-wheat cropping system in the IGP and from 17 BM spots in major AESRs representing rainfed cotton-based cropping system in BSR representing large area of cultivated land and also its food bowl. Cotton-based cropping system is the dominant cropping system in BSR whereas rice-wheat cropping system is the major cropping system in the IGP. Cotton and soybean from BSR and rice and wheat from the IGPwere selected for land evaluation. Care was taken in the present study to ensure that all the selected pedons are from similar management for comparability of land evaluation results. The two regions are discussed below with reference to physio-graphic situations and other associated characteristics.

LAND EVALUATION METHODOLOGY

Step I: Identifying Minimum datasets (MDS)

Judging by the huge number of parameters influencing soil and land quality, Principal Component Analysis (PCA) was used to arrive at a few selected parameters that were mutually exclusive and locally most relevant and use them in determining soil/land quality.

Step II: Development of Land Quality Index

Modified Sys Method (M-I): In this approach, climate and other land characteristics having an influence on the performance of the crop (of interseet) are matched with its requirements, which are adapted to the conditions of the studied area. Land evaluation (LE) of the selected soils for rainfed cotton and soybean in BSR and rice and wheat was done

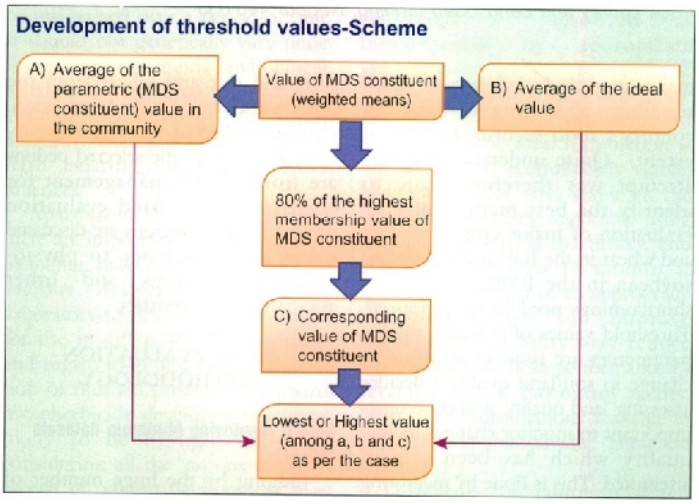
Land evaluation is one of the major approaches adopted to evaluating land quality. It is the assessment of performance (suitability or otherwise) of land for defined uses which also communicates information on possible alternative land uses. The land-evaluation process is developed on the basis of land characteristics, and uses land qualities as an intermediate between land characteristics and land suitability.

MAJOR FINDINGS

Minimum Data Sets (MDS) for Land Evaluation in IGP and BSR

IGP		BSR	
Rice	**Wheat**	**Cotton**	**Soybean**
➢ COLE	➢ EC(dSm^{-1})	➢ sHC	➢ Clay
➢ Rainfall(mm)	➢ BD (Mgm^{-3})	➢ ESP	➢ sHC
➢ Clay (%)	➢ T.Min (°C)		➢ ESP
➢ Slope (%)	➢ ESP		

*COLE: Co-efficient of Linear Extensibility, *EC-electrical conductivity, BD: Bulk Density, *T.min: Minimum Temperature, ESP: *Exchangeable Sodium Percentage, *sHC: Saturated hydraulic conductivity.



The threshold values for land quality parameters

Crop	LQ Parameters	Threshold values
Indo-Gangetic Plains		
Cotton	sHC (mmhr^{-1})	<25
	ESP	>4
Soybean	Clay (%)	>27
	sHC (mmhr^{-1})	<25
	ESP	>4
Rice	Rainfall (mm)	<600
	ESP	>5
	COLE	<1
	Clay (%)	<21
	Slope (%)	>2
Wheat	ECe (dSm^{-1})	>6
	BD (Mg m^{-3})	>1
	ESP	>32
	Minimum Temperature	>20

*COLE: Co-efficient of Linear Extensibility, *EC-electrical conductivity, BD: Bulk Density, *T.min: Minimum Temperature, ESP: *Exchangeable Sodium Percentage, *sHC: Saturated hydraulic conductivity.

in IGP using the developed systems on the basis of available literatures and knowledge of experts. The method was modified recently where LE was performed using only the MDS constituents. The land index was calculated as the product of the individual rating of all the characteristics of the MDS constituents.

Fuzzy Approach (M-II): Fuzzy-set methodology is a refinement of conventional methodologies (based on Boolean logic), in that it overcomes limitation of abrupt boundary by adopting continuous land classes. Moreover, it also rationally assigns weightage to land parameters on the basis of relative importance it holds for a particular crop and thus minimizes human bias.

Soil Properties Crop Performance (SPCP) method (M-III): It is an assessment of the similarity in geometrical shape between the observed yield distribution at different soil units and the distribution of each soil property separately in the same land units.The higher the similarity between the yield and a soil property distribution, higher will be the relationship between both. This relationship is quantified mathematically and expressed by a value between 1 and 0. Higher the value, stronger the impact of the soil property on crop production.

Crop Modeling (M-IV): Crop modeling was used for land evaluation in the present study. Infocrop model was used to simulate the potential and water limited yields of rice and wheat crops for the IGP, and cotton and soybean for the BSR. A ratio of simulated potential yield and water limited yields was calculated as a land quality index which reflects the yield reduction due to the soil moisture deficits/stress. The yield gap analysis was carried out for determining the difference in simulated potential and water limited yields to identify the soil quality parameters limiting the crop yields and to also quantify the carrying capacity of an agro eco system.

Land Evaluations – at a Glance

Indo-Gangetic Plains (Rice and Wheat)
Modified Sys method: 11 BM sites belong to land class I for rice and wheat.
SPCP method: 3 and 7 as land class I for rice and wheat, respectively.
Fuzzy method: 7 and 2 spots as land class I for rice and wheat crops, respectively.

Black Soil Region (Cotton and Soybean)
Modified Sys method: 8 and 2 BM spots as land class I for cotton and soybean, respectively.
SPCP method: 3 spots as land class I for cotton crop. Soybean crop was not evaluated.
Crop modelling method: only 1 spot for cotton crop and 5 BM spots for soybean as land class I.
Fuzzy method: 9 and 5 spots as land class I for cotton and soybean, respectively.
Crop modelling method was not used in the IGP.

SUMMARY

Land evaluation methods are effective in evaluating the specific spots in the IGP and BSR for the selected crops.

The modified Sys' approach doesn't seem to deliver realistic results of pragmatic values as it does not assign weightages to the land quality parameters based on their

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relative importance to the crop of interest.

The SPCP method is yield dependent but at the same time, it does not incorporate any yield influencing management decisions.

In the LE method using crop simulation model that takes into consideration yield influencing management decisions besides considering the biophysical parameters, ratio of water-limited yield to potential yield is taken as a land quality index to compare the land units.

The fuzzy modelling-based LE, is a robust approach that does not necessitate consideration of crop yield directly as indicator of land quality, and which can stand on its own.

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