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Soil quality

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Soil quality is the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain biological productivity, maintain or enhance water and air quality and promote human health (Karlen *et al.*, 1997). Soil quality began to be interpreted as a sensitive and dynamic way to document soil conditions, as a response to management or as resistance to stress imposed by land use changes. An important feature of soil quality is the differentiation between inherent and dynamic soil properties.

Soil quality indicators (SQIs): Indicators are measurable properties of soil or plants that provide clues about how well the soil can function. Potential biological, chemical and physical indicators of soil quality, measurable at various scales of assessment (Karlen *et al.,* 2001).

Utilization of the soil quality concept requires that the following steps be followed:

– Identify critical functions

– Select appropriate indicators

– Develop appropriate scoring or interpretation guidelines

– Combine the information into index values to determine if the resource is being sustained, degraded, or aggraded.

Integrated approaches of soil quality evaluation:

– *Qualitative approach*: land use in combination with "sensitive soils", or other political boundaries using other combined criteria. e.g. Nitrate pollution, intensive cropping areas, urban areas.

– *Quantitative approach*: Physical or economic terms thresholds.

– *Model approach*: in the absence of monitoring data, the potential for soil degradation can be assessed.

Biochemical approaches of soil quality evaluation: There are three approaches regarding the use of both general and specific biochemical parameters to estimate soil quality:

– Use of individual properties;

Biological	Chemical	Physical
	Point-scale indicators	
Microbial biomass	pH	Aggregate stability
Potential N mineralization	Organic C and N	Aggregate size distribution
Particulate organic matter	Extractable macronutrients	Bulk density
Respiration	Electrical conductivity	Porosity
Earthworms	Micronutrient concentrations	Penetration resistance
Microbial communities	Heavy metals	Water-filled pore space
Soil enzymes	CEC and cation ratios	Profile depth
Fatty acid profiles	Cesium-137 distribution	Crust formation and strength
Mycorrhiza populations	Xenobiotic loadings	Infiltration
	Field-, farm-, or watershed- scale indicators	
Crop yield	Soil organic matter changes	Topsoil thickness and colour
Weed infestations	Nutrient loading of mining	Compaction or ease of tillage
Disease pressure	Heavy metal accumulation	Ponding (Infiltration)
Nutrient deficiencies	Changes in salinity	Rill and gully erosion
Growth characteristics	Leaching or runoff losses	Surface residue cover
	Regional- national- or international- scale indicators	
Productivity (yield stability)	Acidification	Desertification
Species richness, diversity	Salinization	Loss of vegetative cover
Keystone species and ecosystem engineers	Water quality changes	Wind and water erosion
Biomass' density and abundance	Air quality changes (dust and chemical transport)	Siltation of rivers and lakes

– Use of simple indexes;

– Use of complex indexes derived from combinations of different properties.

Various methods of assessment of soil quality:

– Simple assessment of soil properties using quick soil test kits and to observe the changes occurred as a result of management practices.

– Issuing of soil health cards to the farmers and to advise them to observe the changes in the visible soil and crop indicators and go on recording them periodically.

Components and concepts of soil quality

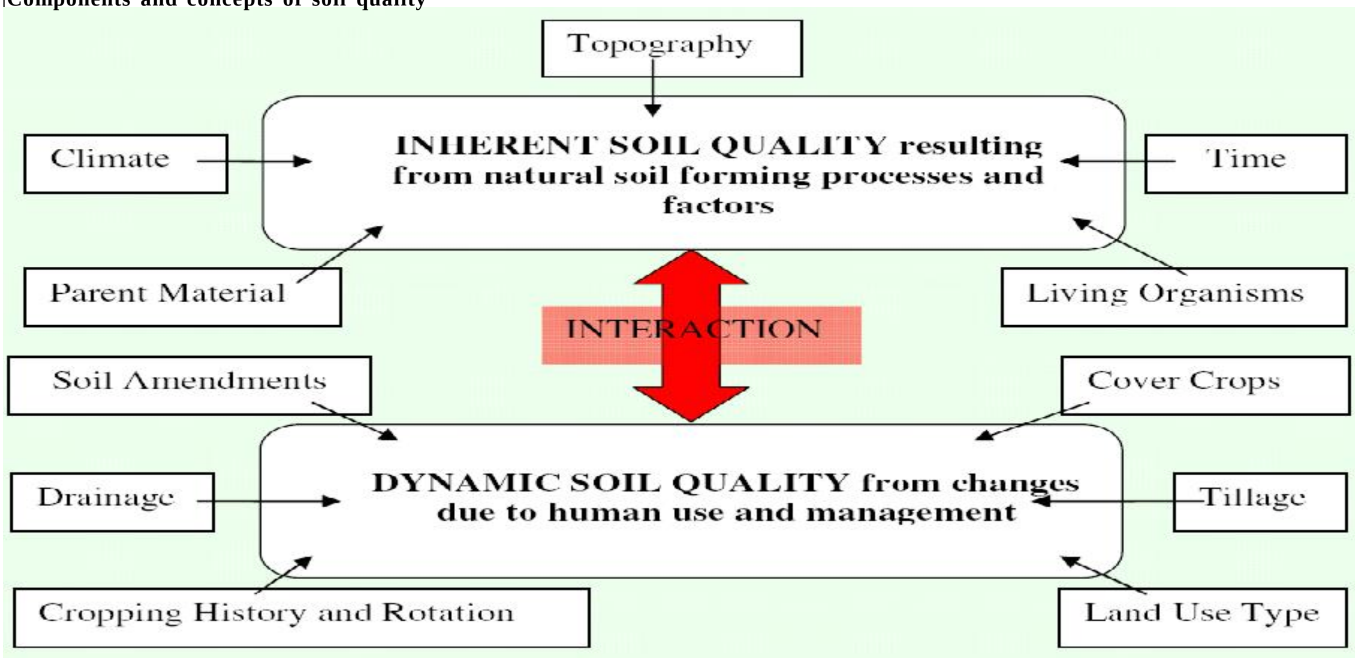

Fig. 1 : Components and concepts of soil quality

Major problems related to soil quality and productivity	
Physical degradation	Deterioration in soil structure, leading to compaction, crusting, accelerated erosion, reduced water-holding capacity, and decreased aeration, soil compaction, soil crusting
Chemical degradation	Nutrient depletion, nutrient leaching
Biological degradation	Loss of organic matter

Assessing dynamic soil quality involves three steps:

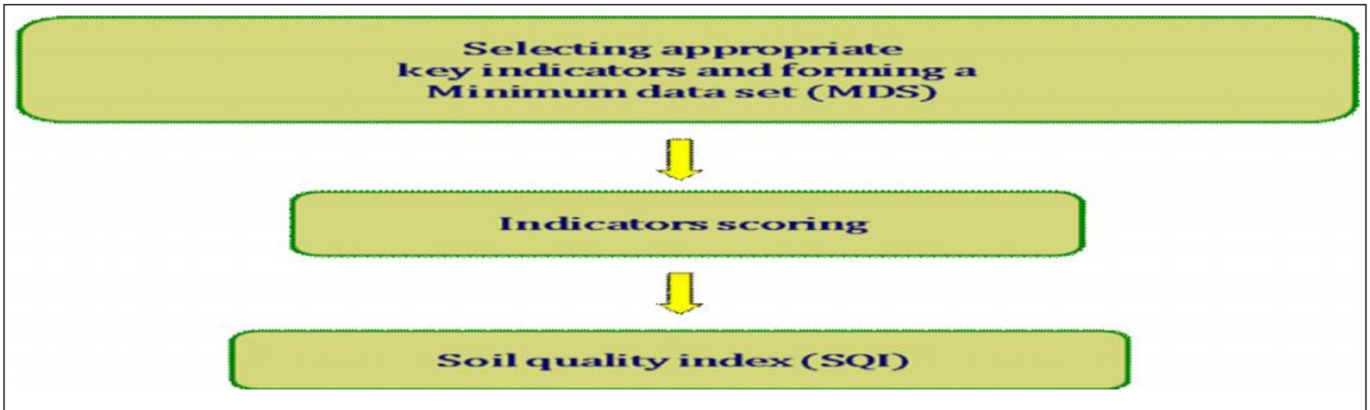

Fig. 2 : Assesing dynamic soil quality

– *Deviation from the normal*: Computation of per cent deviations in soil attributes with reference to control situation and to assign the score using score functions.

– *Key indicator approach*: Identification of key indicators using functional goals and computation of soil quality index.

– *Use of critical levels of indicators*: Identification of critical levels of indicators and assigning the rank and computation of cumulative rating index (CRI).

Solutions for soil and food quality improvements:

– Mulching and recycling organic residues

– Improve soil structure and quality

– Water conservation and water use efficiency

– Adoption of diversified cropping systems

– Agro-forestry and mixed farming

– No-till agriculture

– Use of micronutrient rich fertilizers

– Inoculating soils for improved biological nitrogen fixation

– Microbial processes to increase P-uptake

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