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Soil Quality and Health-An Overview

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Abstract
Soil quality is the continued volume of soil to function as a vital activeecosystem that sustains plants, animals and humans. Soil quality is related tosoil function and soil health presents the soil as a fixed non-renewable anddynamic living resource. Soil flexibility is positively related with highquality soil will always be highly strong. Soil quality mainly influenced byinherent and dynamic qualities which is its natural ability to function and theproperties which changes with management practices respectively. Soilquality indicators such as physical, chemical and biological indicators areavailable for conservation and soil health assessment. Soil quality can beassessed both for agro ecosystems where the main, though not exclusiveecosystem service is productivity and for natural ecosystems where majoraims are maintenance of environmental quality and biodiversityconservation.

Keywords: soil quality, soil health, indicators and assessment

I. INTRODUCTION

Soil quality is one of the three components of environmental quality,besides water and air quality (Andrews et al., 2002). As per USDA (1994)Soil quality can be defined as "The capacity of a specific kind of soil tofunction, within its natural or achieved ecosystem limitations, to sustainanimal and plant production, maintain or enhance air and water quality andsupport human health and habitats. Improving soil quality is one of the bestmanagement practices to sustain crop yields and conserve soil health. Adifference in management practices results differences in biological,chemical and physical soils properties which in turn results changes infunctional quality of the soil (Islam & Weil, 2000). To develop sustainableagro ecosystem a knowledge about soil quality is essential which givespresent and future trends and early warning signs, provide information aboutthe problems of soils and gives a precious base which can be utilized tomeasureconsecutive and future capacity of soil (McGrath & Zhang, 2003; Azizet al., 2009).

Soil quality and soil health

Soil health and soil quality are defined as the capacity of soil to functionas a vital living system within land use limitations which sustains biologicalproductivity of soil and maintains the quality of nearby environmentand human health. Thus the two terms are used interchangeably although itis important to distinguish that soil quality is related to soil function, whereassoil health presents the soil as a finite non-renewable and dynamic livingresource. Soil health defined as the continued capacity of soil to function as avital living system, within ecosystem and land-use boundaries, to sustainbiological productivity, maintain or enhance the quality of air and water andpromote plant, animal and human health (Doran et al., 1996, Doran andZeiss, 2000). Soil quality is the capacity of a specific kind of soil to functionwithin ecosystem and land use boundaries to sustain biological productivity,maintain environmental quality and sustain plant, animal and human health(Doran and Parkin,1994).

Soil health is considered as the state of a soil at aparticular time, equivalent to the dynamic soil properties that changes inshort term while soil quality may be considered as soil usefulness for aparticular purpose over a long time scale equivalent to intrinsic or static soilquality (Goswami, 2006).Linking soil quality to soil functions and ecosystem servicesEcosystem services benefit human welfare through supporting orregulatory functions. Costanza et al. (1997) defined ecosystem services as"the benefits which humans derive from ecosystems". Soil quality not onlyaddresses ecosystem services but also trying to represent and balance themulti-functionality of soil (Doran and Safley, 1997). This further resulted inthe development of functional land management, which assesses both thebenefits and trade-offs of a multifunctional system for managing soil basedecosystem services in agriculture (Schulte et al., 2014) and a wider range ofland uses (Coyle et al., 2016).

The ecosystem services in this scheme can be seen as a soilrelated sub set of the ecosystem services mentioned in the CommonInternational Classification of Ecosystem, currently elaborated in theMapping and Assessment of Soil Ecosystems and their Services (MAES-Soil) Pilot project. It has been contended that soil quality can indeed only be measured in relation to one or several soil functions, ecosystem services orsoil threats (Baveye et al., 2016, Volchko et al., 2013). Therefore, cleardefinitions of these terms as well as firmly established associations with soilquality indicators are the basis of any functional soil quality concept.Linkages of soil quality to resilience and resistanceSoil quality is also been described as the balance between soildegradation and soil resilience (Kennedy &Papendick, 1995; Lal, 1998).Soil resilience is the ability of soil to return to a dynamic equilibrium afterbeing disturbed (Blum &Santelises, 1994). Soil resilience is controlled byinherent soil properties governed by the factors affecting soil formation(Blum, 1998). Soil degradation is the short to medium term deterioration ofsoil caused by land use, soil management and the soil's susceptibility to soilprocesses that promote loss of function (Blum, 1998; Lal, 1998). During adisturbance, soil quality is a function of resistance, while after a disturbance,soil quality is a function of resilience. Disturbances include pathogen andpest attacks, to which disease suppressive soils would be resistant andnatural or human induced soil threats such as erosion or acidification.Because disturbances are frequent, especially in agricultural soils, resistanceand resilience are integral components of soil quality. For both resistanceand resilience threshold values of soil properties can be established belowwhich the soil is not able to resist disturbance or recover from it that is soilquality is permanently deteriorated. Typically, soil quality and resilience arepositively related in that a high quality soil will also be highly resilient(Bouma, 2002). Resilience may indeed be applicable as a main criterion forhealth in agriculture in general, not only with respect to soils (Doring et al.,2015).

Soil quality aspects (NRCS, 2019)

1. Innate/Inherent soil qualities

(Soil Formation & Characteristics) Inherent soil quality is a soil'snatural ability to function, For example, sandy soil drains faster than clayeysoil. Deep soil has more room for roots than soils with bedrock near thesurface. These characteristics do not change easily. Inherent soilquality depends on the five soil-forming factors as classified by Hans Jenny(1941) and others:

I. Climate (precipitation and temperature)
II. Topography (shape of the land)
III. Biota (native vegetation, animals, and microbes)
IV. Parent material (geologic and organic precursors to the soil)
V. Time (time that parent material is subject to soil formationprocesses)

2. Dynamic soil qualities (Soil erosion & management)

Changes in dynamic properties dependboth on land management practices and the inherent properties of the.Management choices affect the amount of soil organic matter, soil structure,soil depth, and water and nutrient holding capacity. Bulk density can beconsidered inherent properties below 20-50cm but at near the soil surface areconsidered as dynamic soil quality.

Soil quality assessment

Soil quality is evaluated to learn about the effects of management practices on soil function. Reasons for evaluating soil quality fall into these categories:

1. Awareness and education
2. Evaluation of practice effects and trouble-shooting
3. Evaluation of alternative practices
4. Assessment as an adaptive management tool

Soil quality assessment tools (NRCS, 2011)

Field test kits: These are in field soil tests provide semi-quantitativedata. Kits have been developed in India, U.S., New Zealand and Australia.

Lab based assessments: Based on the indicators requiring morespecialized equipment or more precise measurement than possible with fieldtest kits, such as microbial biomass carbon, soil test phosphorus or potentially mineralisable nitrogen.

Practice predictors: Use research outcomes to predict the effects ofmanagement practices on soil quality. The NRCS Soil and Water EligibilityTool (SWET) and Conservation Measurement Tool (CMT) are examples ofthis type of assessment tool.

Landscape level assessments: Use satellite and remote sensingtechnology to assess resource quality at large spatial scales.

Multi factor sustainability tools: Which combine environmental,economic and social indicators, are a logical outgrowth from soil qualityassessment of agroecosystems due to the important relationship between soilquality and sustainability.

Soil quality cannot be determined by measuring only crop yield, waterquality, or any other single outcome it is an assessment of how it performsall of its functions now and how those functions are being preserved forfuture use. Soil quality cannot be measured directly, so we evaluateindicators.

1. Soil quality indicators

Soil quality indicators are used to evaluate how well soil functions.These indicators may be qualitative (drainage is fast) or quantitative(infiltration rate). Gomez et al. (1999) define six indicators and thresholdvalues for measuring sustainability of agricultural production systems atfarm level. Other examples of soil-quality studies are reported by Doran andJones (1996) who list soil characteristics as indicators of soil quality.

Ideal indicators should (Doran and Parkin, 1996)

1. Correlate well with ecosystem processes
2. Integrate soil physical, chemical, and biological properties &processes
3. Be accessible to many users
4. Be sensitive to management & climate
5. Be components of existing databases
6. Be interpretable

There are mainly three categories of soil indicators

2. Chemical indicators: indicates the equilibrium between soil solutionand exchange sites, plant health, the nutritional requirements of plant andsoil and levels of soil contaminants and their availability for uptake byanimals and plants

1. Electrical Conductivity
2. Soil Nitrate
3. Soil Reaction (pH) and more

Physical indicators: provide information about soil hydrologiccharacteristics, such as water entry and retention that influences availabilityto plants.

1. Soil depth and water holding capacity
2. Physical environment-Structure, aeration, drainage, texture, density
3. Soil erosion-Water and wind erosion

3. Biological indicators: indicates microorganisms present and theirinteraction among themselves

1. Earth worms activities
2. Soil enzyme activity
3. Organic matter content etc.

II. CONCLUSION

Although many indicators and indices of soil quality and soil health have been proposed, a globally satisfactory and applicable definition and methodology of calculation of soil quality or soil health are still not in place. Further, the existing knowledge provides a better understanding of the current capacity of a soil to function than of making predictions about capacity of the soil to continue to function under a range of stresses and disturbances. Another limitation of most of the available studies is that efforts have been made to measure soil characteristics in surface soil and not in the whole profile (Sparling et al. 2004). While simultaneous analysis of physical, chemical and biological characteristics of soil is required to evaluate sustainability/unsustainability of different management practices, most studies in developing countries have looked at physical and chemical characteristics only.

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