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Physical and Chemical Properties of Soil Quality Indicating Forests Productivity: A Review

[1]*Nelofer Jamil,* [2]*Naheed Sajjad,* [3]*Humaira Ashraf,* [4]*Zubia Masood,* [5]*Zahoor Ahmed Bazai,* [6]*Rukhsana Khan,* [6]*Nida Anjum,* [6]*Farah Akmal,* [6]*Nazia Arbab,* [6]*Palwasha Tareen and* [6]*Rabail Khan*

[1]Department of Chemistry, SardarBahadur Khan Women University, Quetta, Pakistan.
[2]Department of Biotechnology, SardarBahadur Khan Women University, Quetta, Pakistan.
[3]Department of Computer science, SardarBahadur Khan Women University, Quetta, Pakistan.
[4]Department of Zoology, University of Karachi, Karachi, Pakistan.
[5]Department of Botany, University of Balochistan, Quetta, Pakistan.
[6]Department of Environmental Sciences, SardarBahadur Khan Women University, Quetta, Pakistan.

Abstract: For supporting the productive forests, foresters mostly depend on the knowledge of physical and chemical properties of soils inorder to observe its productiveness. Sustainable management of forests includes soil quality of forest preferable criteria for its sustainability.The idea of soil quality incorporates appraisal of soil properties and proceduresas they identify with capacity of soil to work adequately as a part of a solid biological system. Segregation of soil chemical, biological and physical processes is very difficult because of their vibrant, inter-linked nature with each other. The physical and chemical properties of soil is directly affected by microbiological processes that encourage water holding capacity,nutrient cycling, accessibility of water, pH buffering, leaching and cation exchange capacity. Physical assets of woodland soil established beneath natural situations due to the influence of everlasting vegetation over an extensive time period. Physical assets of soil also effect the usual division of species of woodland trees progression and production of biomass of woodland. The amount of silt, sand and clay in soil can be refer as soil texture. The most expedient physical assets of soil is soil texture because the necessary components i.e. nutrient, water and aeration are provided by soil. Individual mineral particles of sand, silt, or clay, organic materials, water, air and individual mineral particles of silt, sand and clay made the soils. Intensive soils are base of sustainable forests all over the world. Excellent model would be theoretically simple and it would be inexpensive and easy to spread over.

Key words: Physiochemical Properties · Soil · Forest · Productivity

INTRODUCTION

Due to public interest in determining the impacts of management practices on the soil quality and its effects on the ecosystem functions and the productivity of plants the need to evaluate soil properties has increased. According to a forest plantation manager, soil quality can be defined asthe production of biomass due to soils capacity. Sustainable management of forests includes soil quality of forest as criteria for sustainability. Use of indicators for long-term sustainability of forest ecosystem depends on monitoring of soils functions. Indicators as a measure of soil quality determines the well-functioning of soil [1].The overall approach is that properties that indicate changes in ecosystem functions are monitored as sustainability indicators [2]. Therefore, present study was conduct to review about physical and chemical properties of soils inorder to observe its impact on forest productivity. In this study, the concept of soil quality, use of physical and chemical properties of soil to determine the quality of soil and opportunities for forest soil scientists to develop sustainable forest management practices as an indicator for sustainable productivity are included.

Review

An Enhanced Quality of Soil in Forestry and Agriculture: Several decades ago, early people used land and soil to compare the relative production of crops with the passage of time the knowledge of good soil

Corresponding Author: Zubia Masood, Department of Zoology, University of Karachi, Karachi 75270, Pakistan.

productivity enhanced and became indigenous as passed from generation to generation. After WW-II (World War II),agriculture development changed the productivity of soil type with the management practices. The application of drainage, tillage and fertilizers has a positive influence on soil productivity. The negative influence was due to run off organic matter, soil erosionand other degrading processes and physical structure of soil. Crop yield was measured by differences in soil affected by natural and anthropogenic changes. Cost of input was equally important for certain yield traditionally farmers evaluate soil quality by measuring crop yield [3].

Foresters evaluate soil productivity by measuring wood yield of tree. Usually foresters define soil productivity as production of biomass by soil ability per unit area per unit and per unit time [4].On the other side, soil quality also measured by production of plant biomass, maintain animal health and productivity, carbon restoration, recycling nutrients, human and animal waste remediation and regulate transform of energy.

Evaluation and measurement of soil serves to maintain quality of environment everywhere [5]. Soil and water quality: An agenda for agriculture' published by National academy of sciences raised public awareness by National Research Council in1993. Measurement and evaluation of soil resources was taken as awareness about the soil multiple function in maintaining a number of environment quality [5]. Public awareness was increased when National Academy of Science published "Soil and Water Quality: An agenda of agriculture". Degradation of soil quality is due to organic matter depletion, compaction and imbalance of nutrients but soil quality must be protected and enhanced applying sustainable agro ecosystems [6].Measurement of soil quality indicates the capacity of soil to produce nutritious and healthy food, favorable conditions for humans and animals and overcome exploiting processes [7].

Chemical Properties of Forest Soil Affecting Soil Quality: Discrimination of physical, chemical and biological properties of soil is very difficult because of their vivacious inter-linked with each other. The soil quality indicators like chemical and biological properties have prominent connection between them many researchers consider the similar attribute (e.g.N which is in mineralizable form) in any sort [5, 8, 9]. The physio-chemical properties of soil is directly affected on all those microbiological processes thatcan encourage the water holding capacity,nutrient cycling, accessibility of water, pH buffering, leaching and ion exchange capacity of soil. Chemical indicators of soil are same for farming and woodland soils [9]. Soil organic matter is also major key chemical indicator for assessing soil quality and in aggregate stability [10,11]. Soil chemistry determines the availability of nutrients, microbial growth, corrosively and stability of water. Chemistry of clays and humus determines soil chemical properties. Cation exchange capacity is the amount of exchangeable cations per unit weight of dry soil. The organic and inorganic colloidal

Table 1: Chemical properties of soil that anticipated as a pointer of agrarian, supplement supplying rangeland and woods soils

Indicator	Comments	References
Soil organic carbon status Organic C	Part of minimum agricultural soils; element of pedo allocation functions to determine CEC, substance densityand water holding capacity	Larson and Pierce [17]
Organic C	Soil chemical properties involved as basic gage of soil quality and biological gage of soil quality in different grass managing systems.	Doran and Parkin [5] and Reganold and Palmer [8]
Organic C	One of the chemical factors of nutrient obtainability with specific scoring functions to be Used for plant production and /or environmental constituents of soil quality.	Harris *et al*. [18]
	Crop yield was positively linked with soil organic carbon in tropical Oxisols, Ultisols, and Alfisols; above 1% soil carbon-based carbon crop yield was less subjective by SOC.	Aune and Lal [19]
Organic matter	Proposed as first-order chemical indicator.	Karlen and Stott [20]
Organic matter	art of a farmer-based qualitative calculation system (Score-card) of chemical `health' of agricultural soil	Romig *et al*. [21]
Nutrient availability Fertility	Proposed as chemical indicator	Karlen and Stott [20]
Soil N, P, K	Part of a farmer-based qualitative assessment system (Score-card) of chemical `health' Of agronomic soils.	Romig *et al*. [21]
Total N	Chemical soil assets used to evaluate changes in soil quality between different Grass administration systems in New Zealand.	Reganold and Palmer [8]

Table 1: Continue

Organic N	Soil chemical specific to be included as basic gage of soil quality. Change in carbon-based N pool to a given soil penetration used as indicator of soil quality change due To cropping.	Manley *et al*. [22] and Doran and Parkin [5]
Mineral N	Soil chemical properties to be comprised as basic indicator of soil quality.	Doran and Parkin [5]
Extractable NH4	One of the chemical factors of nutrient accessibility with specific scoring roles to be Used for plant productivity and /or environmental mechanisms of soil quality.	Harris *et al*. [18]
NO3 - N	One of the chemical limitations of nutrient availability with exact recording functions to be Used for plant yield and /or environmental modules of soil quality.	Harris *et al*. [18]
Mineralizable N	Soil biotic characteristic to be incorporated as basic sign of soil quality. Reposed as a good key for the nutrient delivering capacity of soils. Net N mineralization Used as indicator of nutrient adequacy term in a colorant SQI for southern pine.	Doran and Parkin [5] and Kelting *et al*. [23]
Total P	Chemical soil property used to calculate alterations in soil quality between different meadow management systems in New Zealand	Reganold and Palmer [8]
Mineral P	Soil chemical typical to be comprised as basic indicator of soil feature	Doran and Parkin [5]
Extractable P	Used in SQI of mine soil recovery with pine; P abundance curve to account for P Shortages due to high P fixation bulk of substrate.	Burger *et al*. [1]
Extractable P	Chemical soil property used to assess differences in soil value between different Grassland management systems in New Zealand.	Reganold and Palmer [8]
Bray P	One of the chemical constraints of nutrient obtainability with specific scoring tasks to be used for plant output and /or ecological components of soil quality.	Harris *et al*. [18]
P sorption	Considered through pedotransfer role using oxalate extractable Fe and Al.	Larson and Pierce [17]
Extractable S	Chemical soil property used to evaluate modifications in soil quality between different grass controlling systems in New Zealand.	Reganold and Palmer [8]
CEC	Proposed as first-order chemical sign.	Karlen and Stott [20]
CEC	Calculated over pedotransfer function consuming organic carbon and clay contented.	Larson and Pierce [17]
CEC	Proposed as chemical indicator	USDA NRCS (Cited in Karlen and Stott [20])
Exchangeable K	Soil chemical specific to be included as elementary indicator of soil quality.	Doran and Parkin [5]
Exchangeable K	One of the chemical restrictions of nutrient availability with specific scoring functions to be Used for plant efficiency and /or conservation components of soil quality.	Aune and Lal [19]
Extractable K, Ca, Mg	Chemical soil stuff used to evaluate variances in soil quality among different grass management systems in New Zealand.	Reganold and Palmer [8]
Soil acidity		
PH	First materialization of PI for agronomic soils; nothing in the acid range, i.e. below pH 4.4.	Kiniry*et al*. [24]
PH	PI for white dapper; with lower (pHˆ3) and upper limit (pHˆ8) and finest (pHˆ5±7) in The sufficiently curve for pH.	Gale *et al*. [25]
PH	Biological soil property used to estimate differences in soil superiority between different grassland structures in New Zealand.	Reganold and Palmer [8]
PH	Optimistic association between crop yield and this gage of soil acidity in humid Oxisols, Ultisols and Alfisols. Not measured a delicate indicator of soil acidity; acute limitsaround pH 5.	Aune and Lal [19]
Al saturation	Considered better gauge of soil acidity in hot Oxisols, Ultisols and Alfisols. Converse link between crop yield and Al capacity with critical limit massivelydifferent among acid-tolerance modules.	Aune and Lal [19]
Salinity	First incarnation of PI for agricultural soils; to account for salinity reducing productivecapacity of soils.	Karlen and Stott [20]
EC	Part of smallest dataset for agronomic soils; used in pedotransfer function for soil efficiency property	Larson and Pierce [17]
EC	Soil living characteristic to be involved as basic indicator of soil worth.	Doran and Perkin [5]
EC	Used in SQI of mine soil renovation with pine to reason for high soluble salt levels in Substrate; EC adequacy curves established based on practical growth data for white pine	Burger *et al.* [1]

particles of clays are presents in most soils. Classification of plants nutrients are over 72 mineral elements present in soil. These plant nutrients are very expedient for plant growth and its enhancement. These nutrients are sulphur, magnesium, zinc, iron, copper, boron and phosphorous. Himalayan woodlands play an essential role in purifies reducing the atmospheric temperature. Also Buffer the enormous reserves of nutrients of soil. The information of chemical properties of soils, temperate area i.e., Garhwal Himalaya which contain different types of soil, is not scanty [12]. The agricultural soil can be defined as a fertile soil that can also be used as a forest soils. An another way to reduce this outcome could be the fractionation of the vital elements in compartments of discrete availability soil chemical properties due to eucalyptus cultivation are as follows; (a) lessening in the pH [13]; the pH dependent-CEC and base infiltration; (b) increase of transferable Al^{3+} [14];and (c) change in organic matter fractions [15,16].

Physical Properties of Forest Soil Affecting Soil Quality: Physical assets of woodland soil established beneath natural situations due to the influence of everlasting vegetation over an extensive time period. Physical assets of soil could be everlasting assets except altered due to harvesting processes, instable agronomy and fires of woodland. Forest soil's physical assets including texture porosity, structure, density, temperature, aeration, movement and water retention. The productivity and fertility of forest soil is affected by these properties that are determined for the comfort of root saturation, the water holdingcapacity and for the easily uptake of water by plants, the volume of oxygen and other gases in the soil and the point of which water transfers horizontally and vertically over the soil. Physical assets of soil also effect the usual division of species of woodland trees progression and production of biomass of woodland. Though physical possessions of forest soil are mainly controlled by arrangement size, dispersal and of soil particles [2].

One of the most significant qualitative assets of soil is soil texture which monitoring water retention, nutrient retention, oxygen exchange and uptake. It is a leading soil assets which effects most other assets and processes. Quantitative property like depth of soil influencing the quantity of resources existing to plants per unit area. The relative soil horizon thickness could also be a sensitive indicator of many functions of soil. Porosity of soil is an important parameter to assess the growth and development of tree roots because it affects the oxygen diffusion to roots of trees and the diffusion of unnecessary concentrations of carbon dioxide from areas nearby to tree roots [26]. In forests, organic matter helps to improve and maintain soil structure. In the formation soil aggregates organic colloids and materials synthesized by soil fungi and bacteria are important [27]. Soil characteristics can be greatly affected by nitrogen deposition, drainage, land use change, wildfire, timber harvest and site preparation, which alternatively will affect health and productivity of forests, as well as quality and quantity of water. The reversion of cropland to forest land increases the amount of carbon (C) sequestered in the forest floor and the soil [28]. The assessment on soil quality is important because it mention the ability of soil,which contribute within the ecosystem and land use limits, also uphold quality of environment, encourage plants and animals health and sustain biological productivity. Physical and chemical assets of soil are significant and the components that are a combination of characteristics, including soil carbon and soil quality index. The assessments and inventories of resources of forest soil provide critical basic information on production and health of forests particularly in the aspect of continuous natural and anthropogenic disturbance [5]. As the content of soil organic matter decreases the bulk density of soil also decreases. Bulk density and coarse fragments are integrated into a sol-quality [29].

As the soil texture of soil depends on the amount of its sand or clay or silt particles, therefore, the most advantageous physical assets of soil is soil texture, because all necessary components including soil nutrient, water and aeration are mostly depends on it. Individual mineral particles of sand, silt, or clay, organic materials, water, air and individual mineral particles of silt, sand and clay made the soils. These individual particles may be aggregated into larger particles known as soil peds. Arrangement and stability of the aggregates make the soil structure. Soil aggregation has a major soil physical function in maintaining and improving the soil. Plants and animal residues (Flora and fauna) are basically linked with soil aggregation. Animal tissues, roots and residues of plants are act as key carbon-based skeleton to tangle the soil elements unite for construct soil aggregates. Decay of soil carbon based substances proceeds, organic elements associate with soil medium and make macro aggregates (>250µm) and micro aggregates (<250µm) and sequester soil organic carbon (SOC) [30].

Modeling of Soil Quality: Intensive soils are base of sustainable forests all over the world. Soils are complex supporting system of life on Earth. Forests remain coped at various Forces. A number of determinations consume to model soil value. Forest practices can damage or soil quality associated recover to a pre-disturbance. Now the forests are able to intensive care of soil fertility will be able to the usage of a soil quality models. The model is essential to be Mortified to manage the traditional input differs significantly among systems [24]. Soil quality images would must be fundamental sort unequivocal soil because of trademark adjustments between soils [31].

Degrading methods consist of soil movement, compaction soak, soil organic matter damage, Nutrient reduction and acidification of soil, among others. The dirt's worth checking model for a youthful, "Insufficiency Entisol got from marine sandbanks would not be the same as one Developed for concentrated consideration on more established soil quality. Ailing weak-Alfisols resulting since aquatic fen soil credits" [1].

Abundance, or scaling, per capita of soil influence is built on a Perfect root sharing in size of soil, It was a significant application for the reason that it was practice to regulate management Effects on soil output. Burger *et al.* [1] practiced a model soil quality in this studyobserved fluctuations in Production because of the terrestrial Recovery. In their study, least acknowledged the set of indicators which consist of bulk density, pH, Phosphorous fixation and additional salts. Positioned by same locations. By the regular Output of white pine attitudes grow in the identical zones as the production Standards, they establishes a standard of soil values use as a model projections. In alternative use in forest, Kelting*et al*. [23] "Study was information in which they were functional soil quality ideas that recognize properties of rigorous supervision to Carry out forest soil on Efficiency".

There were different stages by Which they begin to launch the forest location form; Utilities categorize soil, characteristics and signs, in soil quality model; create model to compare circumstances soil variation; Among authenticate dealings indicators and Productivityand for Measuring system for selecting indicators, examine tendencies and to understand the Variations adopt the forest values, that they originate "The soil quality index" via penetration of water table remaining Nitrogen mineralization and depth aeration as an indicator adjustable clarified "60%" change in first year loblolly pine measurements.

Excellent model would be theoretically simpleand it would be inexpensive and easy to spread over. This Practice would not to disorganize with the objectives of forest, the Practice was to improve the information and understandings of nature [2].

Indication of Long Run Sustainability by Adopting Nutrient Cycle Patterns: When comparing with the background of agronomy, which expressing the production and benefits of ancient chemical and physical properties of plants may not be appropriate for the forestry in an area, because it neglect contact between soil and plants and responsibilities of movement of nutrients. Usually the expansions of plants thoroughly rely on the manure addition and the movement of nutrient from soil in the direction of plants. The length of plants in forest system arise when forest generate as a result of change in nutrients stream gently and lager amount of nutrient accumulate in alive biomass, nutrients direction change from plants to soil and also slow down the reliance of plants on soil and forest decaying material. Form of Vegetation, different sorts of tress and nutrient influence patterns of cycle and classification [32].

Requirement for nutrient by tress differs on different stages, it sometime increases and sometime decreases, nutrients use of plants also continuously changes with passage of time relay on matter derived from living organisms to provide nutrient to inner parts of plants and this can be shown by movement of plants to high altitude with growth [45].Sometimes degradation of different parts of tree takes place after long period of time because of plants greater nutrient use effectiveness and nutrient deficient raw material is producing which cause nutrient shortage in conifer forest [46, 47]. Patterns are anciently erroneous and not completed because they are showing ordinary and conceptual reality. Simple and complicated patterns can be developing relay on the aims of their development; if the patterns are applied outside from their structural plane result should be with error [47, 48].

Nutrient cycling patterns that have various processes emphasize critical processes that predict to examine ecosystem reaction and broadly reflect the current knowledge [49]. Sometimes, forest nutrient cycling is in complex condition and its elements of controlling cause some problem to build accurate patterns. Particularly when the aim is to show the effects of long run management practices or future of forest productivity.Nutrient cycling patterns will have use at small scale for the examining the qualities of soil expect management effect the nature of soil is merged [40].

Table 2: Indicating assessing soil quality used by Pedologist

Soil quality indicators	Impact on quality of soil	Measurement unit	References
Stationary indicator			
Soil texture	Movement and Preservation of nutrients andwater	%silt, clay and sand	Doran and Parkin [5]
Soil tilt	Impact on root growth	Index (Singh *et al*., [33])	Burger and Kelting [34]
Porosity of soil	Improve root growth, nutrient and air balance and water retention	%soil volume	Powers *et al*. [35]
Existing water holding ability	Plant accessible water, reduce soil erosion	Water (cm), 33>1500 kPa	Doran and Parkin [5], Larson and Pierce [17], Arshad and Coen [36] and Kay and Grant [37]
Damage of soil	Requirement of water, nutrients for plant	Water (cm), 33>1500 kPa	Harris *et al*. [18] and USDA [38]
Saturated hydraulic conductivity	Role in air and water stability, regulation of hydrology	Water flow in soil column (cm3 s ÿ1)	Larson and Pierce [17] and Arshad and Coen [36]
Roughness of soil	Soil tilth, Erosion	Tilled/flat ratio	Larson and Pierce [17]
Bulk density of soil	Degree of movement of water, impact on root growth and expressed volume of soil	Core sampling (g cm ÿ3)	Doran and Parkin [5], Larson and Pierce [17], Arshad and Coen [36] and Kay and Grant [37]
Strength of soil	Role in root growth	Resistance to penetration (Mpa)	Burger and Kelting [34] and Powers *et al.* [35]
Size, Stability of aggregate stability and dispersal	Growth of roots, enhance water and air equilibrium	Wet-sieving method	Arshad and Coen [36] and Kay and Grant [37]
Soil depth, topsoil depth	accessibility of Entire oxygen, nutrients and water	Thickness (cm)	Doran and Parkin [5],Larson and Pierce [17], Arshad and Coen [36] and Gomez *et al*. [39]
Vibrant indicators Minimum water limiting range	Root growth and equilibrium of air/water balance	Water retention curves, penetration resistance	Burger and Kelting [34], Arshad and Coen [36], Kay and Grant [37] and Da Silva *et al*. [40]
	Environmental concern Existing soil nutrient, root growth, water environmental concern	WEPP (Timlin*et al*. [41])	Wagenet and Hutson [42]
Potential of Leaching	Carrying, alter, reduce useful chemicals	Model (Petach*et al*. [43])	Wagenet and Hutson [42]
Trafficability of soil	Capacity to work	Model (Wosten and Bouma [44])	Wagenet and Hutson [42]

CONCLUSION

Forest is not only providing us timber but also provide habitat for biodiversity. Soil is an important component of ecosystem. Soil quality determine by physical and chemical properties of soil. Conservation of soil quality remains common criteria when considering long term sustainability of forest system. To assess the condition of forest soil, soil indicator is developing. Since current soil conditions are now well quantified. The soil indicator delivers the malicious of pathway variation in forest soil conditions going forward. The undertaking of creating a specific standard for soil quality is challenges because purpose and consequent values provided through forest systems of soil physical chemical and biological properties. Although these experiments, improvement of soil quality of forest is a key of systematic and smallest fact sets has projected [34, 36]. Chemical and physical soil properties will be most willingly approved if they are delicate management brought changes, easy to measure, low cost, thoroughly linked to quantity of anticipated values such as, biodiversity and adjustable for specific ecologies. Our experiment to increase our awareness of forest soil properties thus we can expect active behavior of soil practices [2].

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