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Research Article

Assessment of Soil Fertility of Soils of Thanjavur and Thiruvarur Districts Using Heber Soil Quality Index

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2. Keywords

Heber soil quality index, Rice; Sugarcane; Potassium; Nitrogen; Soil texture

1. Abstract

Soil quality plays an important role in the assessment of sustainable land-use systems. Assessment of soil quality will always help farmers to apply correct fertilizers in correct proportions to their soil. This will definitely help them achieve maximum yield with minimum expenditure. Not only that, they can conserve their immediate environment. In the current investigation, an effort has been made to utilize Heber Soil Quality Index (HSQI) to examine the appropriateness of a soil of Thanjavur and Thiruvarur districts, Tamil nadu, India for the vegetation of rice and sugarcane as these are the major cash crops being cultivated. The overall HSQI values of all samples ranged from 71.76-79.9 divulging an information that the quality of soils inspected in this task are good for the effective farming of sugarcane and rice. Even though more than thirty five parameters are available, only twelve parameters were taken into consideration for designing the HSQI as those parameters are interrelated one way or other. Hence, it is a time saving method and gives lot information about the inherent nature of the soil with special reference to the plantation of sugarcane and rice. The main objective of this paper is to enlighten the researchers to frame one such index for other cash crops using minimal indicators.

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3. Introduction

In considering soil quality, attempts have been made to examine the factors that indicate good soil health or soil quality, to reach consensus on the definition, upon the key soil attributes that translate into variables to be examined, on their data value ranges, their value limits, threshold values, comparability; and to aggregate or integrate the variables/values in such a way as to develop meaningful indices that characterize the quality/health of varying soils in various world regions, across nations, or in local areas, and at the farm level. The creation of soil quality models is a difficult task even for specialists, due to high number of variables that are normally considered [1]. Furthermore, models are often difficult for farmers to understand [2]. Therefore, the development of simple models with a few variables can facilitate understanding and respond to local farmers needs. But, to generate these models, simple methods and indices of soil quality assessment are needed. Soil quality plays an important role in the assessment of sustainable land-use systems [3, 4]. Research supervisors and scholars of Bishop Heber College, India have devised a Soil Quality Index which is popularly

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known as Heber Soil Quality Index (HSQI). Commonly to assess the fertility of a soil with reference to the vegetation of sugarcane and rice, as many as thirty five parameters have to be considered. But the determination of the quantity of all these indicators is a time consuming one. As these thirty five parameters are interrelated in one way or other, twelve factors are considered more than sufficient to asses the fertility of a soil. Taking this as an advantage, HSQI was formulated. Herein, an effort has been attempted to use the HSQI to asses the suitability of a soil of a chosen area for better farming of rice and sugarcane. The twelve factors taken into consideration were pH, available phosphorus (kg/ha), available nitrogen (kg/ha), available potassium (kg/ha), Water Holding Capacity (WHC) (%), Soil Organic Matter (SOM) (%), Electrical Conductance (EC) (mmho/cm), texture, bacterial content (SPC/g), total hardness (mg/L), chloride (mg/L), and bulk density (g/cm3) [5,6].

4. Experimental

4.1. Study Area

Thanjavur district lies between 9° 50' and 11° 25' North latitude and 78° 45' and 79° 25' East longitude. The geological formation of the major area of Thanjavur district was found to contain Alluvial and Tertiary deposits. Soils in these areas are found to be with red, black and brown colors. Rice and sugarcane are the major crops being cultivated in these areas. Thanjavur is designated as the rice bowl of Tamilnadu.

Thiruvarur is located between 10 °20' and 11 °07' Latitude (N-S) and between 79 °15' and 79 ° 45' Longitude (E-W). Sample were taken from fifteen places of in and around Thanjavur and Thiruvarur district such as Oothukkadu, Paappakkudi, Perungudi, Poonthottam, Pulavarnatham, Puliyakkudi, Rajendiranallur, Saaranatham, Vaniyankarambai, Thenkuvalavelei, Arithuvaramangalam, Chandrasekarapuram, Uthamanathapuram, Veeranam and Velangudi.

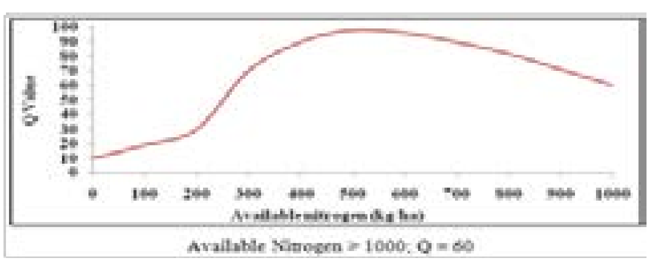

Figure 1: Standard 'Q' graph for Available Nitrogen

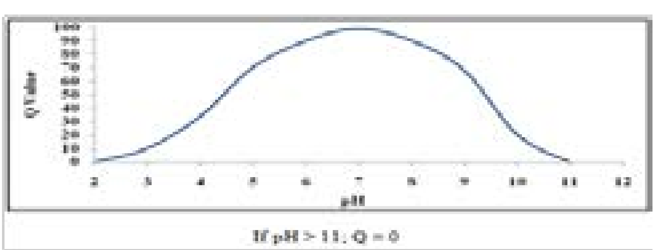

Figure 2: Standard 'Q' graph for pH

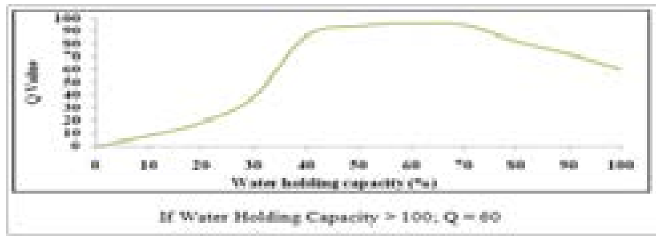

Figure 3: Standard 'Q' graph for Water Holding Capacity

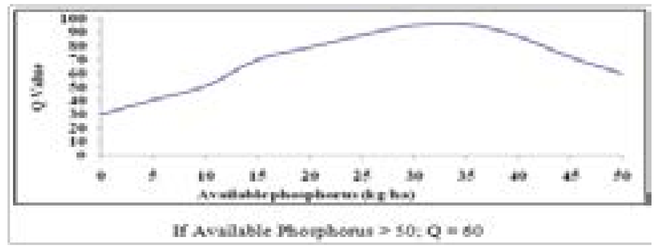

Figure 4: Standard 'Q' graph for Available Phosphorus

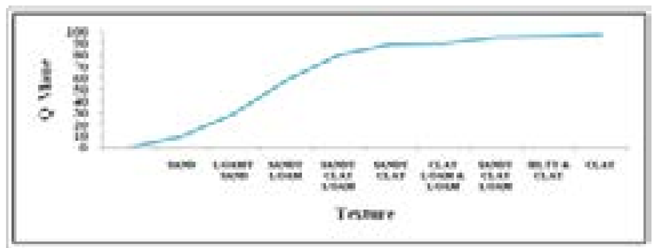

Figure 5: Standard 'Q' graph for Texture

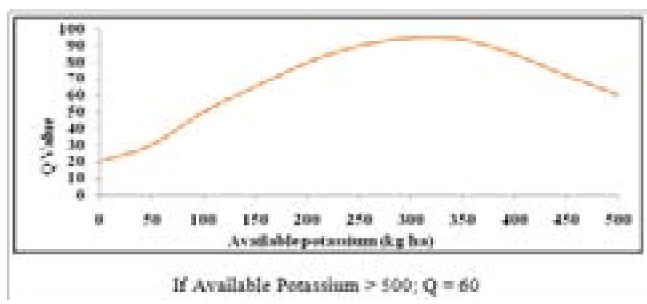

Figure 6: Standard 'Q' graph for Available Potassium

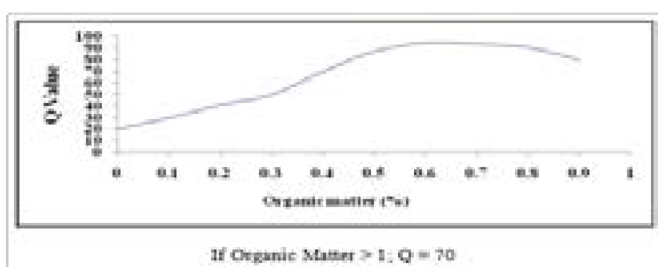

Figure 7: Standard 'Q' graph for Organic Matter

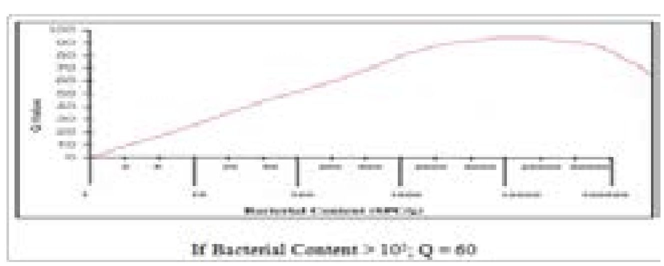

Figure 8: Standard 'Q' graph for Bacterial Content

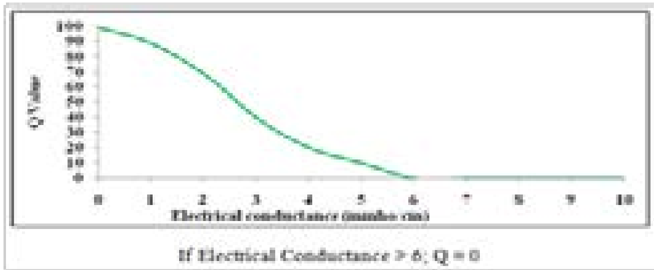

Figure 9: Standard ‘Q’ graph for Electrical Conductance

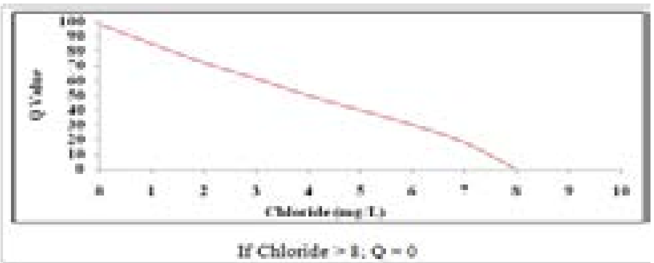

Figure 10: Standard ‘Q’ graph for Chloride

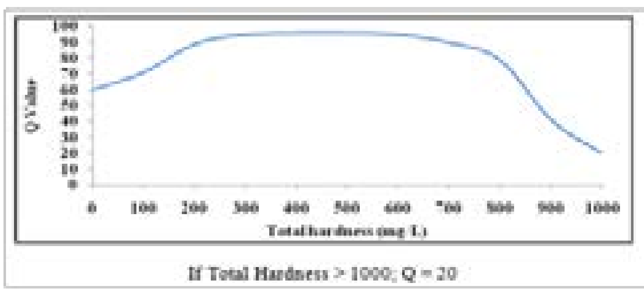

Figure 11: Standard ‘Q’ graph for Total Hardness

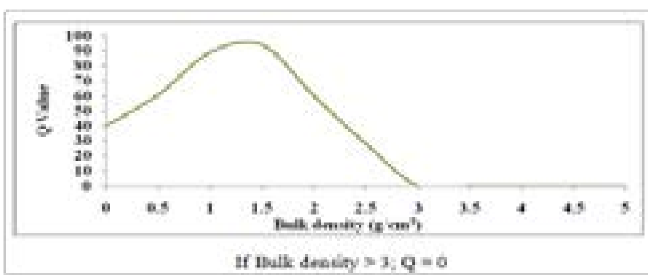

Figure 12: Standard Q graph for Bulk Density

4.2. Sampling Method

Soil samples were collected from the aforementioned area. Initially, the bulk or junk part of the soil was taken out and thrown off from each sampling site. Using a spade, Soil samples were collected from the four corners and middle place (at least 15cm) from five places of each sampling area. Five sub samples collected from each sampling area was thoroughly mixed and from the mixture, 1Kg of the composite sample was taken for lab analysis. These composite samples were thoroughly cleaned to ensure that they contain no strange materials such as pebbles, stones and roots. The unruffled soil of each sampling site was taken in a dirt free cloth bag and labeled with the required details. Before, the samples were subjected to lab analyses for the above said twelve parameters (Table 1), the composite soil samples of each area were crushed using timber hammer and separated to attain soil units of 2-mm dimension.

To frame the HSQI table, statistical results were gathered from agricultural scientists and other eminent of this research zone. They were advised to: (i) assemble the chosen twelve factors in their order of merit, (ii) award scoring on a 10 - point balance with ‘0’ showing the lowest rating and ‘10’ the highest, (iii) allot weighting curve value (Q -Value) (Table 1) and (iv) sketch the diagram for each factor as per their permissible and tolerance limits.

5. Results and Discussion

Test results of samples are given in the tables 2–4. The total HSQI values of all samples are found in the range of 71.7 –79.9, which indicates that the fertile nature of samples examined in this work is good for the effective farming of sugarcane and rice.

Among the various samples investigated, sample 5 (Pulavarnatham) was found to have high total HSQI value, 79.9 (Table 2). For this sample, the test results of the parameter such as pH (7), water holding capacity (43.81 %), texture (clay loam), available ‘K’ (275 kg/ha) and organic matter (0.57 %) are found to be excellent in good agreement with the best possible values required for the best vegetation of sugarcane and rice(Table 1). The HSQI values of WHC, pH, available potassium texture, and organic matter were found to be extremely good with 8.56, 9.41, 8.00, 8.19, and 7.90 respectively. The parameters such as available phosphorus (187 kg/ha), electrical conductance (0.12 mmho/cm) and bulk density (1.35 g/cm3) contribute appreciably to the fertility of this soil sample with the HSQI values of 5.40, 7.52 and 6.49 respectively. Available nitrogen, bacterial content, chloride and total hardness do not significantly contribute to the quality of this sample.

The sample 1 (Oothukkadu) registered with the low HSQI, 71.76 (Table 2) which suggests that this sample is also rated good for the vegetation of rice and sugarcane. The pH (7), WHC (43.76 %), organic matter (0.87 %), electrical conductance (0.14 mmho/cm) and bulk density (1.27 g/cm3) were found to be good as per the most favorable value required for the best plantation of sugarcane and rice. The HSQI values of pH, WHC, organic matter, EC and bulk density were found to have 9.41, 8.56, 7.06, 7.30 and 6.49 respectively. The parameters such as available phosphorus (73.25 kg/ha), texture (sandy clay loam), available ‘K’ (150 kg/ha) and chloride (2.2 mg/L) contribute significantly to the fertility of this soil with HSQI values of 5.40, 5.16, 5.66 and 5.25 respectively. The test results of available ‘N’, total hardness and bacterial content and do not contribute much to the quality of the soil. This reveals that this soil sample has low contents of available ‘N’, available ‘P’ and available ‘K’.

Nitrogen is the most important macro nutrient for plant growth. Nitrogen is available for plants in the form of nitrate and ammonium ions. Nitrogen is combined with C, H, O, and S to create amino acids, which are the building blocks of proteins. Amino acids are used in forming protoplasm, the site for cell division and thus for plant growth and development. All plant enzymes are made of proteins and all enzymatic reactions nitrogen is needed. It is also a major part of the chlorophyll molecule and is necessary for photosynthesis. It is a necessary component of several vitamins. It also improves the quality and quantity of dry matter in leafy vegetables and protein in grain crops. Deficiency of nitrogen in plants may cause stunted growth because of reduction in cell division. Depending on the severity of deficiency, the plant disease called chlorosis could result in the death or dropping of the older leaves. This is caused by the translocation of nitrogen from the older to the younger tissues. Reduced nitrogen lowers the protein content of seeds and vegetative parts. In severe cases, flowering is greatly reduced [7]. Excess of nitrogen in soil can cause excess vegetative growth, dark green leaves, lodging, maturity is delayed which increases susceptibility to pest and disease. It also causes lengthening of crop duration and narrow leaf, slender shoot, profuse vegetation, thick peel and skin will be rough and leathery. It interfere the K uptake causing imbalance between N and K. The availability of nitrogen in soil depends upon soil pH and soil texture. Nitrification occurs to be estimated between pH 6.5 to 8.8. The nitrates leaching are more rapidly in sandy soils because sandy soils have a lower WHC. The organic matter content of sandy soils is usually lower than those of finer-textured soils. Soil organic matter acts as a slowly available source of nitrogen. The best favorable quantity of the nitrogen for the better farming of rice and sugarcane is >328 kg/ha (Table 1). Available 'N' of the all soils ranged from 126 – 238 kg/ha indicating a fact that all the samples inspected in this study severely suffer from nitrogen shortfall. All the soil samples are reported as clay loam, rate of leaching is low all the nitrogen makes available for plant intake. pH range of all samples lie in the range of 6.4–8, the rate of nitrification is high. Soil organic matter of all soil samples is in the range of 0.44–0.87 %, indicates that low available nitrogen in samples.

pH is employed as an important pointer of the accessibility of other nutrients in the soil. Availability of potassium and phosphorus becomes problematic at pH less than 6 and also the availability of aluminium and manganese becomes decreased at pH less than 4. If pH is more than 7 most of micro nutrients are unavailable. If pH is between 6 and 7 then the soil is good for plant growth. Adjusting the pH will make these nutrients accessible by plants. SOM can typically buffer plants against the effect of acidity in order that a soil with a lower pH vary can still with success grow plants [7, 8]. Clay soils would like a way larger quantity of lime to move the pH than sandy soils. The supply of SOM is usually useful to the soil, no matter in what form it is supplied. pH of all the tested soil soils of this examination ranged from 6.4-8, which infers that these samples is moderately acidic to moderately alkaline. The range of pH suggested by experts for the better procurement of sugarcane and rice is 4.5–8.0 (Table 1). Soil samples 2 and 8 (Paappakkudi and Saaranatham) registered high pH (8), which indicates that this sample is basic (Table 2 and 3) and sample 4 (Poonthottam) presented low pH (6.4), which shows that this soil is acidic (Table 1). Other samples showed intermediate pH values.

The amount of water retained by the soil is called as water holding capacity. Water movement is principally in a very descending way by attractive force pull within the giant hole area with restricted sideward and rising movement by capillarity within the little pore area [9]. Thus, in drip cultivation the emitters should be placed nearer along than in clayey soils. Sandy soils have an occasional WHC as a result of the shortage of little pore area. Organic matter, that holds 10 times a lot of water than sand, considerably improves the WHC of sandy soils. As a degree of amplification, plants on sandy soils don't use additional water than plants on clayey soils. With the restricted WHC, sandy soils merely would like lighter and a lot of repeated irrigations than clayey soils [8]. Water without delay moves below the development zone once an excessive amount of is applied at a time. Clayey Soils have little pore area, presenting it high WHC. However, the shortage of enormous hole area deeply confines water movement. Water is sluggish to penetrate into clayey soil, typically resulting in surface run-off issues. Cycle and steep irrigation is suitable on clayey soils to slow appliance rates and cut back surface runoff. In clayey soils, soil structure (creating secondary massive pore space) additionally straight away affects water mobility and soil oxygen levels. Compactness more restricts water movement and minimizes soil oxygen levels, leading to a thin development depth. The overall facility offered to plants is lowered by the shallower growth. With WHC however restricted drain, clayey soils would like heavier, however less repeated irrigations than sandy soils. Watering too typically will irritate low soil oxygen levels. As a result of water moves slowly altogether a direction by capillarity, drip emitters could also be placed more apart than in sandy soils. Soil texture according in samples as clay dirt, that shows that each one samples have high water holding capability [10]. Soil organic matter of tested samples lied in the range of 0.44 – 0.87 % which is responsible for high water holding capacity. WHC of all the soils chosen in this task was found to be between 43.76 and 49.42 %. As per the suggestions of the eminents in this area of research, soils with WHC in the range of 40–55 % (Table 1) is fine for the plantation of rice and sugarcane form which better yield is expected. Sample 11 (Arithuvaramangalam) and sample 1 (Oothukkadu) recorded high (49.42 %) (Table 4) and low (43.76 %) (Table 2) water holding capacity values respectively.

Phosphorus is available in plants in the form of orthophosphate ions. It plays a major role in photosynthesis and respiration. It is also important for energy storage and transfer as ADP and ATP (adenosine di- and triphosphate) and DPN and TPN (di- and triphosphopyridine nucleotide). It is a part of the RNA and DNA structures, which are the major components of genetic information. Seeds have the highest concentration of phosphorus in a mature plant, and P is required in large quantities in young cells, such as shoots and root tips, where metabolism is high and cell division is rapid. It aids in root development, flower initiation, and seed and fruit development. P has been shown to reduce disease incidence in some plants and has been found to improve the quality of crops. Phosphorus is needed in large quantities during the early stages of cell division; the initial overall symptom is slow, weak, and stunted growth. It is mobile in plants and can be transferred to sites of new growth, causing symptoms of dark to blue-green coloration to appear on older leaves of some plants [11]. Under severe deficiency, purpling of leaves and stems might seem. Lack of phosphorus will cause delayed maturity and poor seed and fruit development. Phosphorus (P), is directly suffering from soil pH. At pH larger than 7.5, phosphate ions tend to react quickly with Ca (Ca) and magnesium (Mg) to make less soluble compounds. At acidic pH, phosphate ions react with aluminum (Al) and iron (Fe) to again form less soluble compounds. The Organic Matter (OM) in soil may account for anywhere from 3% to 75% of the total P in a soil. Usually, increased SOM results in higher fixation of iron and Aluminium. This in turn results in less 'P' fixation by these elements, and more movable (available) P. Generally, low ion Exchange Capability (CEC) of soils needs higher soil phosphorus tests to provide equivalent quanta of phosphorus to a crop [13]. The best possible amount of available 'P' for better yield of sugarcane and rice is >30 kg/ha (Table 1). Available 'P' of the soils investigated in this work ranged from 32.5–406.25 kg/ha which reveals that all soils have surplus phosphorus. All samples have the pH in the range of 6.4–8 at this pH availability of phosphorus is high.

Soil texture refers to the size and percentage of the mineral substances in the soil. Explicitly, it refers to the relative proportions of silt, clay and sand (Lipiec and Hatano, 2003). Based on the percentage of each type of mineral, soils can be classified into four groups namely, silty soils, sandy soils, loamy soils and clay soils It allows faster penetrability of water than clays as their grain size is larger [11, 12]. The imperfection in clay, sandy and silty soils can be rectified by improving the soil structure and adjusting the pH, as essential. Organic matter breaks down quicker in sandy soils than in fine-textured soils, given similar environmental conditions, tillage and fertility management, attributable to a better amount of oxygen available for decomposition within the light-textured sandy soils. The ion exchange capability of the soil will increase with % clay and organic matter and therefore the pH buffering capability of a soil (its ability to resist hydrogen ion concentration amendment upon lime addition), is additionally largely supported clay and organic matter content [12]. Soil texture of soils reported as clay loam which supports high WHC and bulk density values.

Potassium is available in soil in the form of potassium ion for uptake. It is vital for plant growth because it is known to be an enzyme activator that promotes metabolism. It assists in regulating the plants use of water by controlling the opening and closing of leaf stomata. In photosynthesis, it has the role of maintaining the balance of electrical charges at the site of ATP production. It also promotes the translocation of photosythates (sugars) for plant growth or storage in fruits or roots. It also involved ATP production and protein synthesis. It has been shown to improve disease resistance in plants, improve the size of grains and seeds, and improve the quality of fruits and vegetables. The most common symptom of potassium deficiency is chlorosis along the edges of leaves (leaf margin scorching) [13]. This occurs first in older leaves, because potassium is very mobile in the plant. Deficiency affects plant growth makes slow. Due to deficiency the stem are weak and lodging. The size of seeds and fruits and the quantity of their production also reduced. Plants imbibe 'K' in the form of K+ from the soil. They may take K+ that is adsorbed onto exchange sites (exchangeable K) or 'K' that is dissolved in the soil water. As a result of this, in dry farms, transferable 'K' tends to be more significant than dissolved K. Because 'K' dissolves instantly, it's extremely portable within the soil. However, it will get at bay between covers of increasing clays. 'K' tends to stay in ionic form among cells and tissues [14]. The optimum value of available 'K', for the better vegetation of sugarcane and rice is > 280 kg/ha (Table 1). The samples registered potassium in the range of 106.25–912.5 kg/ha. The sample 6 (Puliyakkudi) recorded high (912.5 kg/ha) (Table 3) and sample 14 (Veeranam) showed low (106.25 kg/ha) (Table 4) values of available potassium.

SOM is the lifeblood of fertile, fruitful soil. Lack of SOM, agricultural procurement is not sustainable. Beneficial micro organisms like bacteria and earthworms decompose organic matters present in the soil system and convert them into humus (SOM). The process of degradation discharges nutrients which can be absorbed by plant roots [15]. The ultimate artifact of decomposition is humus, a black flaky substance reluctant to undergo further degradation. A multipart chemical material, humus stores plant nutrients, retains humidity and progresses soil structure. The strength of soil structure is associated to the concentration of SOM at the surface, not the whole quantity present in the soil [16]. The most favorable range of SOM for the better yield of rice and sugarcane is 0.6–0.8 % (Table 1). All the samples of this task were found to have SOM in the range of 0.44–0.87 %. The sample 1 (Oothukkadu) showed high (0.87%) (Table 2) and sample 10 (Thenkuvalavelei) presented low (0.44%) (Table 3) SOM. pH of samples lied in the range of 6.4–8 and the activity of microorganisms make high value of organic matter. Soil texture is reported as clay loam, which is also the reason for high value of organic matter. The bacterial count of the soils of this task ranged from 150000–4000000 SPC/g, which causes decomposition to occur rapidly thereby giving high value of organic matter.

Bacteria are unicellular and ultra-microscopic organisms. Some of them are useful to man in one way or the other, while others are very dangerous as they are the basis of various plant and animal illness. Good bacteria help in decomposition of dead SOM of plants and animals and convert tem into a highly useful humus by the secretion of enzymes [17]. Therefore, these bacteria not exclusively degrade the SOM however also flush out the harmful wastes from the globe and hence serve as nature's scavengers [18]. A biologically active soil is a healthy soil should expect a faster decomposition of organic matter [19]. Anything that affects the microbes and different living organisms within the soil, as a result, can have an effect on the rate of organic matter break down. A low pH scale indicates an acidic soil, and this may have a significant impact on the decomposition of organic matter. bacteria is most accountable for breaking down organic matter and experience a sharp drop-off in activity once the pH scale drops below 6 [20]. The bacterial content of the soil samples of this study ranged from 150000–4000000 SPC/g. The recommended optimal range of bacterial content for a good soil is. 107–108 numbers per gram soil (Table 1). The sample3 (Perungudi) had high (4000000) (Table 2) and sample1 (Oothukkadu) showed low (150000) (Table 2) bacterial content values. All other tested soil samples had moderate soil bacteria content. Soil organic matter lied in the range of 0.44–0.87 % shows that micro organisms have enough food so that the rate of decomposition is high.

Soil Electrical Conductivity (EC) is that the ability of soil to conduct electrical current. EC is expressed in (mS/m). Traditionally, soil scientists used EC to measure soil salinity. However, EC measurements even have the potential for estimating variation in a number of the soil physical properties in a field wherever soil salinity is not a problem. Greater the soil porosity, the more easily electricity is conducted [21]. Soil with high clay content has higher porosity than sandier soil. Compaction normally increases soil EC. Dry soil is much lower in conductivity than moist soil. Increasing concentration of electrolytes (salts) in soil water will dramatically increase soil EC [22]. Mineral soil containing high levels of organic matter (humus) and/or 2:1 clay minerals such as montmorillonite or vermiculite have a much higher ability to retain positively charged ions than soil lacking these constituents [23]. The presence of those ions within the wet stuffed soil pores can enhance soil EC within the same way that salinity wills [24]. As temperature decreases toward the freezing point of water, soil EC decreases slightly [25]. Below the freezing point soil pores become progressively insulated from one another and overall soil EC declines quickly. EC of the soils examined in this area is determined to be in the range of 0.10–0.92 mmho/cm. The most required value of EC recommended by agricultural scientists is < 1 mmho/cm (Table 1). Sample9 (Vaniyankarambai) recorded high EC value (0.92 mmho/cm) (Table 3) and the samples 3 and 4 (Perungudi and Poonthottam) had low value of electrical conductance (0.10 mmho/cm) (Table 2). All other tested samples were found to have good electrical conductivity. Soil texture is reported as clay loam, which also supports the high value of electrical conductivity.

Chlorine in the form of Cl– is essential in photosynthesis, where it is involved in the evolution of oxygen. It also increases cell osmotic pressure and the water content of plant tissues. It reduces the severity of certain fungal diseases [26]. Deficiency of chlorine occurs in drooping, followed by chlorosis, undue divisions of lateral roots, bronzing of leaves, chlorosis and necrosis in tomatoes and barley [27]. Chloride content of the samples was estimated to be in the range of 1.2–18.8 mg/L. The most required level of chloride content for the better cultivation of sugarcane and rice is < 4 mg/L (Table 1). Sample9 (Vaniyankarambai) tested high value of chloride (18.8 mg/L) (Table 3) and the sample4 (Poonthottam) showed low (1.2 mg/L) (Table 2) Cl- content.

Soil alkalinity or salinity could be a condition that results from the accumulation of soluble salts in soil. Alkali conditions are caused primarily by a high concentration of sodium carbonate. The injuries caused by alkaline conditions are additional extravagance than those caused by salinity and include the following: (i) acute impact of the Na+ in flouting down the soil construction, (ii) poisonous nature of the CO32-, (iii) condensed uptake of Ca. The total hardness of the inspected soils ranged from 29 - 253 mg/L. The suggested optimum quantity of total hardness is <1.5 mg/L (Table 1). The sample9 (Vaniyankarambai) had high total hardness (253 mg/L) (Table 3) and sample4 (Poonthottam) presented low value (28 mg/L) (Table 2). Almost all samples were found with extreme hardness which is an indicator for poor yield.

The oven dry weight of a unit volume of soil comprehensive of pore areas is named bulk density. The bulk density of the soil may be a manifestation of the quantity of hole gap within the soil. The bulk density of a soil is usually smaller than its particle density. Other factors impacting the bulk density are they types of natural resources present, the texture and the quantum of SOM. The bulk density of sandy soil is about 1.6 g/cm3, whereas that of organic matter is about 0.5. Bulk density normally decreases, as mineral soils become finer in texture [28]. The bulk density varies indirectly with the total pore space present in the soil and gives a good estimate of the porosity of the soil. Bulk densities of sandy soil have 1.6 g/cm3, loam soils 1.4 g/cm3, silt loam soils 1.3 g/cm3, Clay 1.1 g/cm3. Fine textured soils such as silt loams, clays and clay loams generally have lower bulk densities than sandy soils is due the fine textured soils are likely to adequate organic matter content, high pore space and low bulk density. However, in sandy soils, organic matter content is generally low. More the organic matter content in soil results in high pore space thereby showing lower bulk density of soil and vice –versa [29]. Bulk density of the soils examined in this work was found to have the ranged from 1.16–1.41 g/cm3. The best possible range of bulk density values for the effective vegetation of sugarcane and rice is 1.23–1.50 g/cm3 (Table 1). Samples 8 and 14 (Saaranatham and Veeranam) showed very high bulk density value (1.41 g/cm3) (Table 3 and 4) and sample3 (Perungudi) registered low value (1.16 mg/cm3) (Table 2). Soil texture is reported as clay loam, this makes high value of bulk density values. Moderate value of organic matter 0.44–0.87% shows moderate value of bulk density values [30].

Table 1: Methods of determination, optimum range and weighting factor various Parameters

Parameter	Methods	References	Optimum Range	References	Weighting Factor
Physical-WHC (%)	Weight loss method	Soil testing procedure manual 2008	40 – 55	Majumdar, 2000	0.093
Texture	International pipette method	Singh et al., 1999	Clay and Clay loam	Thiyagarajan and Kalaiyarasi, 2011	0.089
Chemical-Available 'N' (Kg ha^{-1})	Alkaline permanganate method	Subbiah and Asija, 1956	>328	Yadav et al., 1998	0.095
pH	Electrometric method	Davis and Freitas, 1970; Singh et al., 1999	4.5 – 8.0	Thiyagarajan and Kalaiyarasi, 2011	0.095
Available 'P' (Kg ha^{-1})	Olsen's method	Olsen and Sommers, 1982; Davis and Freitas, 1970	> 30	Yadav et al., 1998	0.09
Available 'K' (Kg ha^{-1})	Flame photometer method	Ghose and Bajaj, 1993; Knudsen and Peterson, 1982; Somawanshi et al., 1994	>305	Yadav et al., 1998	0.087
OM (%)	Walkley and Black method	Page et al., 1982	0.34 - 0.95	Mandal et al., 2013	0.084
EC (mmho/cm)	Digital conductometric method	Davis and Freitas, 1970; Singh et al., 1999	< 1	Dahnke and Whitney, 1988; Smith and Doran, 1996	0.076
Cl^- (mg L^{-1})	Titrimetric method	Davis and Freitas, 1970; Jackson, 1967	< 4	Horneck et al., 2011	0.075
TH (mg L^{-1})	Titrimetric method	Nelson, 1982	< 1.5	Tucker, 1984; Wurts and Durborow, 1992	0.07
BD (g cm^{-3})	Clod Method	Kadam and Shinde, 2005	1.23 – 1.5	Mandal et al., 2013	0.069
Bilogical- BC (SPC g-1)	Standard plate count method	-	$10^8 – 10^9$	Hoorman and Islam, 2010	0.082

Table 2: Soil properties of various locations of Oothukkadu, Paappakkudi, Perungudi, Poonthottam and Pulavarnatham

Parameter	Weighting Factor	Oothukkadu			Paappakkudi			Perungudi			Poonthottam			Pulavarnatham		
		Test Result	HSQI		Test Result	HSQI		Test Result	HSQI		Test Result	HSQI		Test Result	HSQI	
			'Q' Value	Total		'Q' Value	Total		'Q' Value	Total		'Q' Value	Total		'Q' Value	Total
Physical-WHC (%)	0.093	43.76	92	8.56	46.24	93	8.65	45.38	92	8.56	47.65	94	8.74	43.81	92	8.56
Texture	0.089	SC	58	5.16	CL	92	8.19	SCL	94	8.37	CL	92	8.19	CL	92	8.19
Chemical-Available 'N' (Kg ha^{-1})	0.095	126	22	2.09	150.5	24	2.28	196	30	2.85	196	30	2.85	238	44	4.18
pH	0.095	7	99	9.41	8	90	8.55	7.5	96	9.12	6.4	96	9.12	7	99	9.41
Available 'P' (Kg ha^{-1})	0.09	73.25	60	5.4	235.75	60	5.4	32.5	96	8.64	32.5	96	8.64	187	60	5.4
Available 'K' (Kg ha^{-1})	0.087	150	65	5.66	262.5	92	8	112.5	56	4.87	112.5	56	4.87	275	92	8
OM (%)	0.084	0.87	84	7.06	0.83	88	7.39	0.71	94	7.9	0.74	94	7.9	0.57	94	7.9
EC (mmho/cm)	0.076	0.14	96	7.3	0.44	94	7.14	0.1	99	7.52	0.1	99	7.52	0.12	99	7.52
Cl^- (mg L^{-1})	0.075	2.2	70	5.25	2.6	66	4.95	3.4	56	4.2	1.2	82	6.15	2.8	63	4.73
TH (mg L^{-1})	0.07	41	64	4.48	49	66	4.62	37	63	4.41	29	63	4.41	57	66	4.62
BD (g cm^{-3})	0.069	1.27	94	6.49	1.24	94	6.49	1.16	94	6.49	1.34	94	6.49	1.35	94	6.49
Biological-BC (SPC g^{-1})	0.082	$15x10^4$	60	4.92	$17 x10^4$	60	4.92	$4 x10^6$	60	4.92	$1x10^6$	60	4.92	$16x10^5$	60	4.92
Total HSQI				71.76			76.58			77.84			79.8			79.9

Table 3: Soil properties of various locations of Puliyakkudi, Rajendiranallur, Saaranatham, Vaniyankarambai and Thenkuvalavelei

Parameter	Weighting Factor	Puliyakkudi			Rajendiranallur			Saaranatham			Vaniyankarambai			Thenkuvalavelei		
		Test Result	HSQI		Test Result	HSQI		Test Result	HSQI		Test Result	HSQI		Test Result	HSQI	
			'Q' Value	Total		'Q' Value	Total		'Q' Value	Total		'Q' Value	Total		'Q' Value	Total
Physical- WHC (%)	0.093	48.25	94	8.74	46.3	92	8.56	44.38	92	8.56	45.2	92	8.56	46.81	92	8.56
Texture	0.089	CL	92	8.19	CL	92	8.19	CL	92	8.19	CL	92	8.19	CL	92	8.19
Chemical-Available 'N' (Kg ha^{-1})	0.095	203	38	3.61	154	24	2.28	146.25	24	2.28	210	36	3.42	178.5	26	2.47
pH	0.095	7.8	94	8.93	7.3	98	9.31	8	90	8.55	7.3	98	9.31	7.5	98	9.31
Available 'P' (Kg ha^{-1})	0.09	113.75	60	5.4	243.75	60	5.4	92	60	5.4	75	60	5.4	162.5	60	5.4
Available 'K' (Kg ha^{-1})	0.087	912.5	60	5.22	225	84	7.31	237.5	88	7.66	612.5	60	5.22	387.5	87	7.57
OM (%)	0.084	0.47	84	7.06	0.53	92	7.73	0.52	90	7.56	0.55	92	7.73	0.44	78	6.55
EC (mmho/cm)	0.076	0.91	90	6.84	0.65	92	6.99	0.27	96	7.3	0.92	92	6.99	0.58	94	7.14
Cl^- (mg L^{-1})	0.075	2.8	63	4.73	3.6	54	4.05	1.4	80	6	18.8	0	0	2.4	68	5.1
TH (mg L^{-1})	0.07	73	68	4.76	65	68	4.76	37	64	4.48	253	93	6.51	53	64	4.48
BD (g cm^{-3})	0.069	1.37	94	6.49	1.34	94	6.49	1.41	94	6.49	1.29	94	6.49	1.31	94	6.49
Biological-BC (SPC g^{-1})	0.082	$18x10^5$	60	4.92	$28x10^5$	60	4.92	$27x10^5$	60	4.92	$35x10^4$	60	4.92	$53x10^4$	60	4.92
Total HSQI				74.88			75.98			77.37			72.73			76.18

Table4. Soil properties of various locations of Arithuvaramangalam, Chandrasekarapuram, Uthamanathapuram, Veeranam and Velangudi

Parameter	Weighting Factor	Arithuvaramangalam			Chandrasekarapuram			Uthamanathapuram			Veeranam			Velangudi		
		Test Result	HSQI		Test Result	HSQI		Test Result	HSQI		Test Result	HSQI		Test Result	HSQI	
			'Q' Value	Total		'Q' Value	Total		'Q' Value	Total		'Q' Value	Total		'Q' Value	Total
Physical- WHC (%)	0.093	49.42	94	8.74	47.32	93	8.65	47.41	93	8.65	45.83	92	8.56	47.18	93	8.65
Texture	0.089	CL	92	8.19	CL	92	8.19	CL	92	8.19	CL	92	8.19	SCL	95	8.46
Chemical- Available 'N' (Kg ha^{-1})	0.095	192.5	30	2.85	221	36	3.42	154	24	2.28	203	32	3.04	181.5	28	2.66
pH	0.095	7.5	98	9.31	7.7	94	8.93	7	99	9.41	7.9	92	8.74	7.4	98	9.31

Available 'P' (Kg ha^{-1})	0.09	203.25	60	5.4	260	60	5.4	406.25	60	5.4	325	60	5.4	250.8	60	5.4
Available 'K' (Kg ha^{-1})	0.087	400	85	7.4	562.5	60	5.22	212.5	84	7.31	106.25	54	4.7	252.45	90	7.83
OM (%)	0.084	0.66	95	7.98	0.68	94	7.9	0.83	88	7.39	0.75	93	7.81	0.76	93	7.81
EC (mmho/cm)	0.076	0.56	96	7.3	0.17	97	7.37	0.43	96	7.3	0.19	97	7.37	0.24	95	7.22
Cl^- (mg L^{-1})	0.075	2.6	65	4.88	2.6	65	4.88	2	72	5.4	2.6	66	4.95	1.4	80	6
TH (mg L^{-1})	0.07	49	65	4.55	73	68	4.76	53	66	4.62	41	64	4.48	72	68	4.76
BD (g cm^{-3})	0.069	1.31	94	6.49	1.34	94	6.49	1.26	94	6.49	1.41	94	6.49	1.29	94	6.49
Biological- BC (SPC g^{-1})	0.082	$53x10^4$	60	4.92	$36x10^4$	60	4.92	$17x10^5$	60	4.92	$32x10^4$	60	4.92	$3x10^6$	60	4.92
Total HSQI				77.99			76.12			77.34			74.64			79.5

6. Conclusion

The chief basis of revenue for the farmers residing at Thiruvarur and Thanjavur districts, India, depends on the procurement of cash crops such as sugarcane and rice. Highly useful and newly formulated HSQI was exploited in this study to rate the samples derived from fifteen places of Thanjavur and Thiruvarur district as excellent, good or bad with particular reference to rice and sugarcane farming. The total HSQI values of all the samples studied in this current task were found to be in the range of 71.76–79.9 suggesting that these soil samples are of good. Soil quality index refers to the vibrant fertility of soil those characteristics that are disturbed by soil management. HSQI was found to be high useful, time saving and economically useful one. After this study was conducted, farmers of these study area were informed about the inherent quality of their soils and advised them to apply correct fertilizer in correct proportion in correct time. Not only was that, the state agricultural officers also advised to make use of such soil quality indices for their investigations.

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