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Soil Quality of Northeast India- A Review

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Abstract
Soil quality assessment needs to be comprised of baseline data or reference values this knowledge of the physical and chemical properties of soil helps in management of resources while working with a particular soil. North East India comprises of eight states which experiences different land use management has distinct soil characteristics. The majority soils of NE India are categorized under Inceptisols, Entisols, Ultisols, Alfisols. This paper aims to picture the soil quality of North east India under different land use pattern.
Keywords: *Soil quality, Land use Pattern, physical, chemical, nutrients.*

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I. Introduction

Soil quality is one of the three components of environmentalquality, besides water and air quality (Andrews *et al.,* 2001). The soil is the most important constituent for the purpose to achieve of all the basic demands of human beings.The word soil represents one of the most active andcomplex natural systems on the earth's surface. It isessential for the existence of many forms of life and provides medium for plant's growth and also suppliesthe organisms with most of their nutritional requirements (Gaur,1997). The term "soil quality" came into vogue in the 1990's following a 1993 National Research Council Committee (NRCC) report on long-range soil and water conservation entitled "Soil and water quality: An agenda for agriculture" (National Research Council, 1993)

All soils have different properties and working with them requires understanding of these properties. Soil quality assessment needs to be comprised of baseline data or reference values this knowledge of the physical and chemical properties of soil helps in management of resources while working with a particular soil (Griffith *et al.,* 2010). Soils often react slowly to changes in land use andmanagement, and for that reason it can be more difficult to detectchanges in soil quality before non-reversible damage has occurred thanfor the quality of water and air (Nortcliff, 2002). The physical and chemicalcharacteristics of soil play a big role in the plant'sability to extract water and nutrients. High qualitysoils not only produce better food and fiber, but alsohelp to establish natural ecosystems and enhance airand water quality.

1.1 North east India

The North-East India has eight states — Assam,Arunachal Pradesh, Meghalaya, Manipur, Mizoram,Nagaland, Sikkim and Tripura with a total geographicalarea of 262180 km2 which is about 8 per cent of thecountry's total area. The region lies between 21°57, and 29.5 °N latitude and 89.4° and 97.5° E longitude. The total geographical area of the region is 2.555 lakh km^2 which is about 8 per cent of the country's total area. The physiographic of the region is divided into three divisions, namely Meghalaya Plateau, the north–eastern hills and Basin and the Brahmaputra valley (Dabral,2002). The north eastern Hills and Basin alone account for 65 per cent of the total area while the Brahmaputra valley and the Meghalaya Plateau cover 22 per cent and 13 per cent of the area respectively. The region has a population ofabout 47.9 million (Sharma *et al.,* 2006). The net sown area is highestin Assam (34.1 %) where plains account for 84.4 percent of its total geographical area, followed by Tripura(23.5%), while Arunachal Pradesh has lowest net sownarea (2.1%). The cropping intensity is around 135 percent, highest in Tripura (185%), followed by Manipur (145 %). About 1.67 Mha areas is under shiftingcultivation (*jhum*cultivation). Out of 4 Mha net sownarea of the region, about 1.3 Mha areas suffers serioussoil degradation problems.The region receives an average annual rainfall of 2000 mm accounting for about 10 per cent (42.5 mhm)of the country's total precipitation of 420 mhm. (Roy *et al.,* 2015).

The people of Northeast India practice different land use systems like Food agriculture, Bamboo plantation, Horticulture, Agro-forestry, Natural forest, Shifting cultivation, etc. Practice of shifting cultivation is common in hilly slope areas. The burning process related to shifting cultivation practices has tremendous effect on soil ecosystem. The impact of fire on ecosystem is profound and its consequences are dependent on intensity and frequency of fire, proportion of biomass burned, the time of monsoon setting, and total annual precipitation. The extent to which organic matter is transformed into ash depends on a number of factors *viz*intensity and

duration of fire, fuel load, moisture content in the fuel, weather, and topography. Burning of above-ground vegetation showed an increase in pH and cations and a decrease in carbon and nitrogen contents in the surface soil (Ram and Ramakrishnan, 1988).

II. Soil quality of Northeast India

The majority soils of NE India are categorized under *Inceptisols, Entisols, Ultisols, Alfisols*and other miscellaneous orders and their respective distribution is 49.6%, 22.2%, 15.1%, 3.6% and 9.5% of the TGA of NE India (Patiram and Ramesh, 2008).

2.1 Soil pH

The North Eastern region (NER) of India has the largest stretches of acid soils, followed by the neighboring states of West Bengal, Bihar and Orissa; because of the climatic conditions prevailing in the region, types of rocks and minerals along with other factors being involved. It is estimated that approximately 91% soils are acidic, and nearly 65% soils are suffering from strong acidity (pH < 5.5) in NE India (Sharma *et al.,* 2006). Other reports also shown that pH value is low in all the cases and it is lower in forest cover land. (Gogoi*et al.,* 2016, Jayanthi*et al.,* 2015, Sharma, 2015, Athokpam*et al.,* 2013, Baruah*et al.,* 2013 andJayanti*et al.,*2015. Low soil pH is basically due to leaching of thebases under the influence of high rainfall (Roy *et al.,* 2015). Most of the report shows that pH value was higher after burning of slash in shifting cultivation and became higher in fallow phase with respective to length of fallow period (Tawnenga*et al.,*1996). But in some cases, pH was lower in undisturbed area compared to disturbed area (Lalnunthari*et al.,* 2018, Kenye*et al.,*2020). From the table below, it is clear that landuse pattern and agriculture activity has great impact on soil pH.

Table 1. Soil pH from NE India

Parameters	Soil depth	Values	Authors	Sample Collection from
pH	0-10 10-20	5.9 5.7	Tawnenga*et al.,* 1997	Six years Jhum Fallow, Mizoram
	0-10 10-20	6.3 5.8	Tawnenga*et al.,* 1997	Twenty years Jhum Fallow, Mizoram
	NA	<4.9	Manpong*et al.,* 2019	From different land use systems of Mizoram
	NA	3.93	Manpong*et al.,* 2019	Natural forest of Mizoram
	NA	4.83	Kenye*et al,* 2020	Dense Forest of Mizoram
	NA	4.49	Kenye*et al.,* 2020	Open Forest of Mizoram
	NA	4.36	Kenye*et al.,* 2020	Grassland of Mizoram
	NA	4.11	Kenye*et al.,* 2020	Pine plantation of Mizoram
	NA	4.65	Saha*et al.,* 2012	Agrisilviculture
	NA	4.62	Saha*et al.,* 2012	Agrihorti culture (khasi mandarin + crops)
	NA	4.80	Saha*et al.,* 2012	Agrihorti culture (Assam lemon + crops)
	NA	4.25	Saha*et al.,* 2012	Silvihorti pastoral (Alder + pine apple + fodder grass)
	NA	4.61	Saha*et al.,* 2012	Multistoried AFS (Alder + tea + black pepper + crops)
	NA	4.62	Saha*et al.,* 2012	Natural forest
	0-10 10-20 20-30	5.64 5.68 5.68	Tangjang*et al.,* 2010	Harmutty, Agroforestry, Arunachal Pradesh
	0-10 10-20 20-30	5.54 5.49 5.45	Tangjang*et al.,* 2010	Nirijuli Agroforestry, Arunachal Pradesh
	0-10 10-20 20-30	5.66 5.51 5.85	Tangjang*et al.,* 2010	Doimukh, Agroforestry, Arunachal Pradesh

	NA	6.33	Borpatragohain*et al.*, 2019	Changlang, Arunachal Pradesh
	NA	4.40	Borpatragohain*et al.*, 2019	Sepahijala, Tripura
	NA	5.31	Borpatragohain*et al.*, 2019	Ri-Bhoi, Meghalaya
	NA	4.03 – 4.47	Haorongbam*et al.*, 2014	Silcoorie Tea Estate
	NA	5.2	Sharma, 2015	Rubber Plantation
	NA	5.9	Sharma, 2015	Orange orchard
	NA	5.47	Sharma, 2015	Teak plantation
	NA	6.26	Sharma, 2015	Rice Field
	NA	6.08	Sharma, 2015	Shifting Cultivation
	NA	5.4	Sharma, 2015	Bamboo
	NA	5.13	Sharma, 2015	Natural Forest
	0- 15 15- 30	7.0 6.3	Bhuyan and Sharma, 2017	KMC, Dimoria Tribal Development block, Assam
	0-15 15-30	7.3 5.8	Bhuyan and Sharma, 2017	Star Cement Factory, Dimoria Tribal Development block, Assam
	0-15 15-30	5.8 5.2	Bhuyan and Sharma, 2017	JD Brick FactoryDimoria Tribal Development block, Assam
	0-15 15-30	4.6 4.7	Bhuyan and Sharma, 2017	Control site, Dimoria Tribal Development block, Assam
	NA	5.76	Lalnunthari, 2018	Disturbed site, Mizoram
	NA	6.74	Lalnunthari, 2018	Undidturbed site, Mizoram

2.2 Bulk Density

Bulk density is an indicator of soil compaction and soil health. It affects infiltration, rooting depth/restrictions, available water capacity, soil porosity, plant nutrient availability, and soil microorganism activity, which influence key soil processes and productivity. From table no.2 bulk density increases with depth, fallow period also effects the bulk density of soil (Lungmuana*et al.*,). there is variation of bulk density with respect to states and agricultural practices Borpatragohain*et al.*, 2019, Tangjang*et al.*, 2010, Manpong*et al.*, 2019.)

Table 2. Bulk density of Soil from NE India

Parameters	Soil depth	Values	Authors	Sample Collection from
Bulk density g/m^3	NA	1.06 g/cm3 – 1.27 g/cm3	Manpong*et al.*, 2019	From different land use systems of Mizoram
	0-10 10-20 20-30	0.60 1.09 1.18	Tangjang*et al.*, 2010	Harmutty, Agroforestry, Arunachal Pradesh
	0-10 10-20 20-30	1.09 1.20 1.28	Tangjang*et al.*, 2010	Nirijuli Agroforestry, Arunachal Pradesh
	0-10 10-20 20-30	0.36 0.43 0.57	Tangjang*et al.*, 2010	Doimukh, Agroforestry, Arunachal Pradesh
	0-15 15-30	0.88 – 1.17 0.92 – 1.66	Baishya and Sharma, 2017	Agro Ecosystem in Dimoria Development Block of Assam
	NA	0.92	Borpatragohain*et al.*, 2019	Changlang, Arunachal Pradesh
	NA	0.91	Borpatragohain*et al.*, 2019	Sepahijala, Tripura
	NA	1.00	Borpatragohain*et al.*, 2019	Ri-Bhoi, Meghalaya
	NA	1.30- 1.38	Haorongbam*et al.*, 2014	Silcoorie Tea Estate
	NA	1.07	Lungmuana*et al.*, 2010	23 years fallow, Mizoram
	NA	1.03	Lungmuana*et al.*, 2010	21 years Fallow, Mizoram
	NA	1.06	Lungmuana*et al.*, 2010	14 years Fallow, Mizoram
	NA	1.08	Lungmuana*et al.*, 2010	10 years Fallow, Mizoram
	NA	1.13	Lungmuana*et al.*, 2010	6 years Fallow, Mizoram
	NA	1.20	Lungmuana*et al.*, 2010	3 years Fallow, Mizoram
	NA	1.24	Lungmuana*et al.*, 2010	1 year Fallow, Mizoram
	0-15 15-30	1.13 1.14	Bhuyan and Sharma, 2017	KMC, Dimoria Tribal Development block, Assam
	0-15 15-30	1.04 1.36	Bhuyan and Sharma, 2017	Star Cement Factory, Dimoria Tribal Development block, Assam
	0-15 15-30	1.15 1.17	Bhuyan and Sharma, 2017	JD Brick Factory Dimoria Tribal Development block, Assam
	0-15 15-30	0.89 0.69	Bhuyan and Sharma, 2017	Control site, Dimoria Tribal Development block, Assam

2.3 Soil Texture

Soil texture may affect productivity in a variety of way i.e. byaffecting moisture availability, soil temperature, nutrientsupply and the accessibility of soil organic matter to microbialdecomposition (Schimel*et al.,* 1996). Soil texture of this regionextend from siltyclay,silty loam, loamy clay, loamy sand (Gupta and Sharma, 2008, Padua *et al.,*2018, Haorongbam*et al.,* 2014 and Bhuyan and Sharma, 2015)Soil in different regions showsdifferent texture, the texture of the soil is mostly depending upon the size of particles. Soiltexture shows its effect on aeration and root penetration. It also effects on the nutritional statusof soil. Soil texture can be expressed significantly by its electrical conductivity.

Table 3. Soil Texture from NE India

Parameters	Soil depth	Values	Authors	Sample Collection from
Soil texture	NA	Sandy Loam	Tangjang*et al.*, 2010	Harmutty, Agroforestry, Arunachal Pradesh
	NA	Loamy sand	Tangjang*et al.*, 2010	Nirijuli and Doimukh, Agroforestry, Arunachal Pradesh
	NA	Snady Loam to Sandy clay Loam	Borpatragohain*et al.*, 2019	Changlang, Arunachal Pradesh Sepahijala, Tripura and Ri-Bhoi, Meghalaya
	0-15 15-30	Clayey Loam	Baishya and Sharma, 2017	Agro Ecosystem in Dimoria Development Block of Assam

2.4 Moisture Content

Moisture content of the soil was mostly higher inthis regiondue to high rainfall intensity and long monsoon season. And it is also due to high forest cover i.e. more than 70% of the geographical region. The moisture content for soil was highest in dense forest cover area followed by grassland and lower in cultivated land was reported from the study of Long-term effect of various multipurpose tree species onsoil physical behaviour.(Baishya and Sharma, 2017, *Kenyeet al.*,2019).Manpong*et al.,* 2019 also report that moisture content soil decreases in open forest and jhum land which in turn affect the nutrient content and microbial content of the soil.

Table 4. Soil MoistureContent from NE India

Parameters	Soil depth	Values	Authors	Sample Collection from
Soil moisture%	NA	17.4-22.3%	Manpong*et al.*, 2019	From different land use systems of Mizoram
	NA	23.4%	Manpong*et al.*, 2019	Natural forest of Mizoram
	NA	1.10	Manpong*et al.*, 2019	Natural forest of Mizoram
	NA	22.55 – 27.15	Haorongbam*et al.*, 2014	Silcoorie Tea Estate
	0-15 15-20	13.12-29.4 5.3 – 23.6	Baishya and Sharma, 2017	Agro Ecosystem in Dimoria Development Block of Assam
	NA	25.32	Lalnunthari	Disturbed site, Mizoram
	NA	27.11		Undidturbed site, Mizoram

2.5 Soil Organic Carbon

Soils of this region are rich in organic matter.Forest cover in the region is 14.2 Mha which is about54 per cent of total geographical area and is higherthan the national average (19.4 %) (Roy *et al.,*2015). This could be due to extended forest cover in most of the region where organic carbon value was high in forest cover land. Most of the report shows that organic carbon content was depleted due to slash burning because main source of organic carbon was from decompositionof leaves and litter (Ram and Ramakrishnan, 1988). Joshi and Negi (2015) also state that the %OC, had higher value in the forestland use system as compared to the agriculture andolericulure land use systems. There are some reportson the analysis of soil properties either fromcultivated areawhich states that organic carbon content of soil reduced on cultivated land compared to forest land(Saha*et al.,*2012, Sharma, 2015, Sahoo*et al.,*2019). The SOC content as percentage of total geographical area was highest in Sikkim followed by Nagaland, Manipur, Meghalaya, Assam and Tripura. Choudhuri*et al.,* 2013.

The SOC content as percentage of total geographical area was highest in Sikkim followed by Nagaland, Manipur, Meghalaya, Assam and Tripura. Choudhuri*et al.,* 2013.

The deterioration of soil quality/health is the combined result of soil fertility, biological degradation (decline of organic matter, biomass C, decrease in activity and diversity of soil fauna), increase in erodibility, acidity, and salinity, and exposure of compact subsoil of poor physicochemical properties. Northeast India is characterized by high soil acidity/Al+3 toxicity, heavy soil, and carbon loss, severe water scarcity during most parts of year though it is known as high rainfall area. The extent of soil and nutrient transfer, causing environmental degradation in North eastern India, has been estimated to be about 601 million tons of soil, and 685.8, 99.8, 511.1, 22.6, 14.0, 57.1, and 43.0 thousand tons of N, P, K, Mn, Zn, Ca, and Mg, respectively. Excessive deforestation coupled with shifting cultivation practices have resulted in tremendous soil loss (200 t/ha/yr), poor soil physical health in this region. Studies on soil erodibility characteristics under various land use

systems in Northeastern Hill (NEH) Region depicted that shifting cultivation had the highest erosion ratio (12.46) and soil loss (30.2–170.2 t/ha/yr), followed by conventional agriculture system (10.42 and 5.10–68.20 t/ha/yr, resp.). Saha*et al.*, 2012.

Table 5. Soil Organic Carbon from NE India

Parameters	Soil depth	Values	Authors	Sample Collection from
SOC %	NA	2.02% to 2.36%	Manpong*et al.*,2019	From different land use systems of Mizoram
	NA	2.81	Manpong*et al.*, 2019	Natural forest of Mizoram
	0-10 10-20 20-30	1.44 1.34 1.27	Tangjang*et al.*, 2010	Harmutty, Agroforestry, Arunachal Pradesh
	0-10 10-20 20-30	1.56 1.40 1.31	Tangjang*et al.*, 2010	Nirijuli Agroforestry, Arunachal Pradesh
	0-10 10-20 20-30	1.54 1.42 1.41	Tangjang*et al.*, 2010	Doimukh, Agroforestry, Arunachal Pradesh
		1.80	Borpatragohain*et al.*, 2019	Changlang, Arunachal Pradesh
	NA	1.70	Borpatragohain*et al.*, 2019	Sepahijala, Tripura
	NA	1.40	Borpatragohain*et al.*, 2019	Ri-Bhoi, Meghalaya
	NA	1.13 – 1.61	Haorongbam*et al.*, 2014	Silcoorie Tea Estate
	NA	2.1	Lalnunthari*et al.*, 2019	Disturbed site, Mizoram
	NA	2.8		Undidturbed site, Mizoram
	0-10 10-20	2.15 0.21	Tawnenga*et al.*, 1997	Six years Jhum Fallow, Mizoram
	0-10 10-20	2.65 2.22	Tawnenga*et al.*, 1997	Twenty years Jhum Fallow, Mizoram
	NA	0.11–4.5	Padua *et al.*, 2018	Quaternary surficial deposits with Sediments Lakhimpur dstrict Assam
	0-15 15- 30	0.24 0.24	Bhuyan and Sharma, 2017	KMC, Dimoria Tribal Development block, Assam
	0-15 15-30	0.72 0.34	Bhuyan and Sharma, 2017	Star Cement Factory, Dimoria Tribal Development block, Assam
	0-15 15-30	0.67 0.14	Bhuyan and Sharma, 2017	JD Brick Factory Dimoria Tribal Development block, Assam
	0-15 15-30	0.70 0.13	Bhuyan and Sharma, 2017	Control site, Dimoria Tribal Development block, Assam

2.6 Soil Nutrient Content

The nutrient content of soil in North east India is lower compared to neighbouringstate, this could be due to the acidic behavior of the soil (Borpatragohain*et al.*, 2019). The average crop productivity in acid soil regions (ASR), particularly in NE India, is very low, lagging far behind the national average. A multitude of acidity-related fertility constraints *viz.*, the toxicities of aluminum (Al), iron (Fe) and manganese (Mn), deficiency of phosphorus (P), calcium (Ca), magnesium (Mg), zinc (Zn), molybdenum (Mo), boron (B), low base saturation, reduced biological activity and related acidity-induced soil fertility and plant nutritional problems are associated with such soils (Sarkar, 2015; Thakuria*et al.*, 2016). Phosphorus fixation in soils depends upon many factors, *viz*. soil pH, organic matter content, type of clay minerals and sesquioxides, *etc*. The causes of low P-use efficiency (PUE) in highly weathered humid sub-tropical soils of NE India are Al and Fe induced P deficiency (Sharma *et al.*,2006).Tangjang*et al.*,2010 state that nutrient content of soil decreases with increases in depth. There is slight increase in total nutrient content with increases in fallow period Lungmuana*et al.*, 2017. Bhuyan and Sharma, 2017 observed that land use changes affect the nutrient content of soil.

Table 6. Soil Nutrient Content from NE India

Parameters	Soil depth	Values	Authors	Sample Collection from
Total Nitrogen mg/kg^3	NA	0.22 to 0.3 mg/kg^3	Manpong*et al.*, 2019	From different land use systems of Mizoram
	NA	38- 472 kg/ha	Padua *et al.*,2018	Quaternary surficial deposits with Sediments Lakhimpur dstrict Assam
	0-10 10-20 20-30	0.33 mg/kg^3 0.27 mg/kg^3 0.20 mg/kg^3	Tangjang*et al.*, 2010	Harmutty, Agroforestry, Arunachal Pradesh
	0-10 10-20 20-30	0.28 mg/kg^3 0.25 mg/kg^3 0.22 mg/kg^3	Tangjang*et al.*, 2010	Nirijuli Agroforestry, Arunachal Pradesh

	0-10 10-20 20-30	0.28 mg/kg^3 0.25 mg/kg^3 0.23 mg/kg^3	Tangjang*et al.*, 2010	Doimukh, Agroforestry, Arunachal Pradesh
	NA	0.50 - 78 mg/kg^3	Haorongbam*et al.*, 2014	Silcoorie Tea Estate
	0-10 10-20	3900kg/ha 3000kg/ha	Tawnenga*et al.*, 1997	Six years Jhum Fallow, Mizoram
	0-10 10-20	4500 kg/ha 3900 kg/ha	Tawnenga*et al.*, 1997	Twenty years Jhum Fallow, Mizoram
	NA	0.237 mg/kg^3	Lungmuana*et al.*, 2017	23 years fallow, Mizoram
	NA	0.230 mg/kg^3	Lungmuana*et al.*,	21 years Fallow, Mizoram
	NA	0.226 mg/kg^3	Lungmuana*et al.*,	14 years Fallow, Mizoram
	NA	0.163 mg/kg^3	Lungmuana*et al.*,	10 years Fallow, Mizoram
	NA	0.176 mg/kg^3	Lungmuana*et al.*,	6 years Fallow, Mizoram
	NA	0.144 mg/kg^3	Lungmuana*et al.*,	3 years Fallow, Mizoram
	NA	0.147 mg/kg^3	Lungmuana*et al.*,	1 year Fallow, Mizoram
	0-15 0-15	285.5 kg/ha 170.2 kg/ha	Bhuyan and Sharma, 2017	KMC, Dimoria Tribal Development block, Assam
	0-15 15-30	229.9 kg/ha 153.02 kg/ha	Bhuyan and Sharma, 2017	Star Cement Factory, Dimoria Tribal Development block, Assam
	0-15 15-30	335.5 kg/ha 170.2 kg/ha	Bhuyan and Sharma, 2017	JD Brick Factory Dimoria Tribal Development block, Assam
	0-15 15-30	385.6 kg/ha 109 kg/ha	Bhuyan and Sharma, 2017	Control site, Dimoria Tribal Development block, Assam
Available Phosphorus mg/kg	0-10 10-20 20-30	3.09 1.97 1.28	Tangjang*et al.*, 2010	Harmutty, Agroforestry, Arunachal Pradesh
	0-10 10-20 20-30	6.16 5.06 4.45	Tangjang*et al.*, 2010	Nirijuli Agroforestry, Arunachal Pradesh
	0-10 10-20 20-30	5.10 4.44 3.26	Tangjang*et al.*, 2010	Doimukh, Agroforestry, Arunachal Pradesh
	NA	0.37 – 1.22	Haorongbam*et al.*, 2014	Silcoorie Tea Estate
	0-10 10-29	25.8 kg/ha 20.6 kg/ha	Tawnenga*et al.*, 1997	Six years Jhum Fallow, Mizoram
	0-10 10-20	35.7 kg/ha 24.6 kg/ha	Tawnenga*et al.*, 1997	Twenty years Jhum Fallow, Mizoram
	NA	7.92 kg/ha	Singh *et al*., 2015	Rubber Plantation, Assam
	NA	12.8 kg/ha	Singh *et al*.,2015	Orange Orchard, Assam
	NA	11.84 kg/ha	Singh *et al*., 2015	Teak Plantation, Assam
	NA	14.5 kg/ha	Singh *et al*., 2015	Rice Field, Assam
	NA	13.4 kg/ha	Singh *et al*., 2015	Shifting Cultivation, Assam
	NA	10.6 kg/ha	Singh *et al*., 2015	Bamboo, Assam
	NA	15.82 kg/ha	Singh *et al*., 2015	Natural Forest, Assam
	NA	2.70	Lungmuana*et al.*, 2017	23 years fallow, Mizoram
	NA	3.0	Lungmuana*et al.*, 2017	21 years Fallow, Mizoram
	NA	2.1	Lungmuana*et al.*, 2017	14 years Fallow, Mizoram
	NA	3.2	Lungmuana*et al.*, 2017	10 years Fallow, Mizoram
	NA	2.3	Lungmuana*et al.*, 2017	6 years Fallow, Mizoram
	NA	4.3	Lungmuana*et al.*, 2017	3 years Fallow, Mizoram
	NA	2.8	Lungmuana*et al.*, 2017	1 year Fallow, Mizoram
	NA	5 – 129 kg/ha	Padua *et al.*, 2018	Quaternary surficial deposits with Sediments Lakhimpur dstrict Assam
	0- 15 15- 30	0.04 0.03	Bhuyan and Sharma, 2017	KMC, Dimoria Tribal Development block, Assam
	0-15 15-30	0.09 0.03	Bhuyan and Sharma, 2017	Star Cement Factory, Dimoria Tribal Development block, Assam
	0-15 15-30	0.05 0.02	Bhuyan and Sharma, 2017	JD Brick Factory Dimoria Tribal Development block, Assam
	0-15 15-30	0.02 0.05	Bhuyan and Sharma, 2017	Control site, Dimoria Tribal Development block, Assam
Potassium mg/kg		11 – 15.30	Haorongbam*et al.*, 2014	Silcoorie Tea Estate
	0-10 10-29	508.3 kg/ha 469.2 kg/ha	Tawnenga*et al.*, 1997	Six years Jhum Fallow, Mizoram
	0-10 10-20	641.2 kg/ha 492.6 kg/ha	Tawnenga*et al.*, 1997	Twenty years Jhum Fallow, Mizoram
	NA	26.73 kg/ha	Singh *et al*., 2015	Rubber Plantation
	NA	71 kg/ha	Singh *et al*., 2015	Orange Orchard
	NA	26.01 kg/ha	Singh *et al*., 2015	Teak Plantation

	NA	82.5 kg/ha	Singh *et al.,2015*	Rice Field
	NA	75.1 kg/ha	Singh *et al*., 2015	Shifting Cultivation
	NA	34.80 kg/ha	Singh *et al*., 2015	Bamboo
	NA	43.29 kg/ha	Singh *et al*., 2015	Natural Forest
	NA	157 mg/kg	Lungmuana*et al.*, 2017	23 years fallow, Mizoram
	NA	150 mg.kg	Lungmuana*et al.*, 2017	21 years Fallow, Mizoram
	NA	209 mg/kg	Lungmuana*et al.*, 2017	14 years Fallow, Mizoram
	NA	198 mg/kg	Lungmuana*et al.*, 2017	10 years Fallow, Mizoram
	NA	164 mg/kg	Lungmuana*et al.*, 2017	6 years Fallow, Mizoram
	NA	158 mg/kg	Lungmuana*et al.*, 2017	3 years Fallow, Mizoram
	NA	131 mg/kg	Lungmuana*et al.*, 2017	1 year Fallow, Mizoram
	NA	28-645 kg/ha	Padua *et al.*,2018	Quaternary surficial deposits with Sediments Lakhimpur dstrict Assam
	1- 15 15- 30	39 kg/ha 17 kg/ha	Bhuyan and Sharma, 2017	KMC, Dimoria Tribal Development block, Assam
	0-15 15-30	80 kg/ha 23 kg/ha	Bhuyan and Sharma, 2017	Star Cement Factory, Dimoria Tribal Development block, Assam
	0-15 15-30	32 kg/ha 12 kg/ha	Bhuyan and Sharma, 2017	JD Brick Factory Dimoria Tribal Development block, Assam
	0-15 15-30	21 kg.ha 19 kg/ha	Bhuyan and Sharma, 2017	Control site, Dimoria Tribal Development block, Assam

Tawnenga*et al.,* (1997) report that there in decreased of nutrient after slash burning and cropping phase which is gradually increased with respect to the length of fallow years. Ramakrishnan and Toky, 1981 also report the length of the fallow periodoften played a crucial role in conserving soil organic carbon (SOC) andsoil available nutrients. The total phosphorus contents of the soil decrease with increasing depth while the total potassium content of the soil increase with increasing depth (Haorongbam*et al.,* 2014). Total phosphorus content was highest in natural forest compared to others crop plantation (Singh *et al.,* 2015).

High level microbial activity is widely accepted for maintenance of better soil quality. Soil microbial carbon, nitrogen and phosphate content was lower compared to others tropical region (Tangjang*et al.,* 2010, Bordoloi*et al.,* 2013). Soil microbial biomass was reported higher during monsoon season and dense forest cover area which could be due to high accumulationof organic matter from decomposition of leaves (Singh *et al.,* 1989, Arunachalan and Pandey, 2003, The soil MBC and enzyme activities was drastically after slash burning upto 2 years of fallow period and gradually increased after 6 years (Lungmuana*et al.,* 2010).

III. Conclusion

The soil of Northeast India is mainly acidic in nature. From the report given by various states shows the soil pH were lower, organic carbon content was higher compared to neighboring state viz. Orissa, West Bengal and other eastern Himalayan region. Moisture content was higher in this area due to high rainfall and large forest cover. The nutrient and microbial biomass content was reported lower compared to other part of tropical region. Many reports showed that land use activity and cropping system as well as farming practices has great effect on soil quality. Especially shifting cultivation drastically reduced soil quality which wasrecovered only after 10 years of fallow length (Tawnenga*et al.,* 1996). Due to this crop productivity was lower from this region (Roy *et al.,* 2015).

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