



## Study of Agriculture Soil through Statistical data analysis of soil Physico-Chemical Parameters of Mundra taluk in Kutch district

### Abstract

This paper presents the study of agricultural soil of Mundra tahsil of Kutch district in Gujarat state. Total 450 samples were collected from different fifteen sites of Mundra taluk. Under the soil health card programme of Government of Gujarat, all soil samples were collected by trained farmers and brought for analysis to Soil Test laboratory of Bhuj. Standard Methods were applied for the soil analysis. All soil samples were analyzed for pH, Electrical conductivity, Phosphorus, Potassium, Organic Carbon, Iron, Copper, Zinc, Manganese, Calcium, Magnesium and Sulphur. The purpose of this paper is to study soil fertility status and correlation of basic soil properties with micronutrients and also to evaluate agricultural soil quality based on electrical conductivity, pH, OC, P and K through reaction index, salt index and nutrient index. Discriminate and Correlation analysis is used for statistical data treatment. Present study shows that the EC of all samples is in salt free range and it shows that the study area fairly good for agriculture. This paper concludes that the application of statistical analysis can provide a scientific stand for agricultural soil fertility management. This work also concludes that the 'correlation analysis' and discriminate analysis can provide scientific basis for monitoring and controlling the tillage management.

**Keywords:** Correlation, Electrical conductivity, Kutch, Mundra, Micronutrients, Soil quality.

### Introduction

Healthy agriculture soil is basic need of the recent scientific tillage so that it is necessary to determine the fundamental needs of soil. Soil is normally viewed simply as a medium for growing plants. Soil is a basic component of tillage system so that it is necessary to obtain the basic needs of soil. Agriculture soil quality is that the ability of a soil to perform the functions necessary for its intended use. Soil health depends on the combined effects of three major interacting components. These are the chemical, physical and biological characteristics of the soil. The quality of soil are evaluated using soil properties. Soil properties include physical and chemical properties as well as macro- micro nutrients. Soil is natural resource that provides essential nutrients to crope growth, need proper care, conservation and management in order to maintain a high degree of soil fertility system. One of the ways to assess the soil fertility status is to get soil sample tested for different soil nutrients. Statistical analysis, as a powerful tools, can provide such information and assist the interpretation of soil tested data [1-2].

The objectives of present study are:

- To study and analysis of soil properties by the application of selected statistical tools.
- Soil quality analysis through different indices of electrical Conductivity, pH, OC, P, and K.
- To determine the correlation among soil parameters.

Pearson's correlation was applied to 450 soil samples( 0-20cm) from different 15 sitesof agricultural area (30 samples from each site) of Mundra taluk of Kutch district [3-10].

### Materials And Methods

#### The study area:

In this work the study area is agricultural soil of different site of Mundra tahsil of Kutch district. Mundra taluk is one among 10 taluks of Kutch district. Study location covers agricultural soil of 15 villages of Mundra taluk of Kutch district. Kutch is a district of Gujarat state in Western India,

covering an area of 45,652 km<sup>2</sup>. [11] Present study area covers 888.1 km<sup>2</sup>. Kutch district lies in the extreme west of India between 22° 44' to 24° 41' North latitude 68° 7' to 71° 46' East Longitude [12]. The temperature range is 45°C (max.) and 4°C (min.). Average rainfall is 587 mm. Mundra region was struck by major earthquake on 21 July 1956 as well on 26 January 2001, which caused a great deal of damage and loss of life and property.

Major soils are medium black, sandy and hydromorphic type [13]. Major field crops are groundnut, bajra, castor, green gram, wheat, cotton, moth bean and major horticultural crops [14] are mango, papaya, cucurbits, sapota, banana.

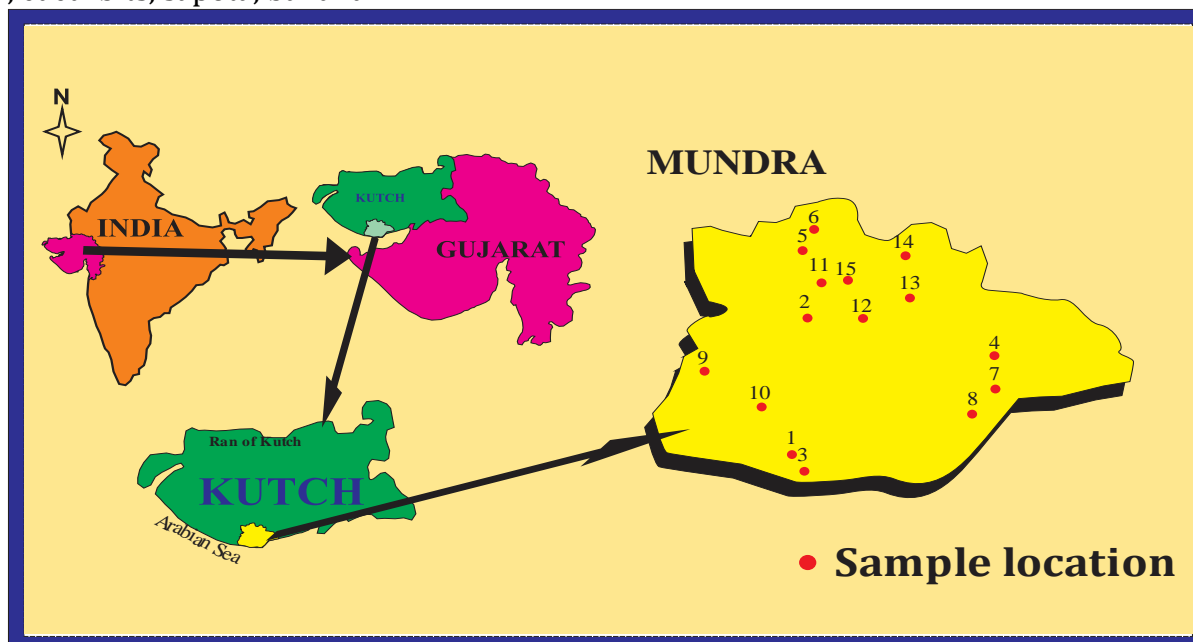


Figure 1: Study area, Location map of Mundra Taluk in Kutch district.

From the collected data at different science colleges and STL under the soil health card program by the government of Gujarat, India, we have selected 450 soil samples from different regions of Mundra taluk of Kutch district (Gujarat–India) for this study. All selected samples represent 15 villages (30 samples from each) of Mundra. (Table-2)

Numbers of soils samples, names of villages and village code shown in table 2. Location of study area and village code of 450 samples is shown in location map figure 1.

**Soil sampling and analysis:** Soil samples were managed by a systematic sampling strategy at 0 to 20 cm depth below the surface. Before testing all the samples were dried and passed through a 2 mm sieve to prepare them for laboratory analysis. All the samples were tested using standard method by following the “Methods Manual-Soil Testing in India”[15]. All the samples were tested and analyzed for soil properties like organic carbon (OC), phosphorus (P), potassium (K), electrical conductivity (EC), pH. Fe (Iron), Cu(Copper), Zn(Zinc), Mn(Manganese), Ca(Calcium), Mg(Magnesium), and S(Sulfur). Same study was reported for other location by M.Kumar [16] and Wajahat Nazif [17]

**Tools and techniques:** Statistical analysis namely minimum, maximum, mean, standard deviation (SD) and variance are calculated for measured soil properties. Descriptive statistical analysis and Pearson’s correlation analysis are used to analyze soil samples data. Variables used for analysis in this study include organic carbon (OC), phosphorus (P), potassium (K), electrical conductivity (EC), pH. Fe (Iron), Cu(Copper), Zn(Zinc), Mn(Manganese), Ca(Calcium), Mg(Magnesium), and S(Sulfur)[18]. MATLAB and EXCEL are used for all statistical analysis.

### Results And Discussion:

Soil properties (pH, EC, C, P, K, Fe, Cu, Mn, Zn Ca, Mg, and S) and descriptive statistics of soil analysis is shown in table 1.

**Table 1. Descriptive statistics of the distribution of soil parameters of mundra taluk**

Sr. No	Soil parameters	N	Minimum	Maximum	Mean	Std. Deviation	Variance
1	pH	450	7.10	7.90	7.57	.23	.05
2	EC	450	.10	.96	.47	.19	.04
3	OC	450	.19	69.00	.85	3.22	10.39
4	P	450	13.00	387.00	33.76	18.33	335.92
5	K	450	141.00	532.00	277.05	55.36	3064.70
6	Fe	450	1.00	5.20	2.79	1.10	1.21
7	Cu	450	.20	.80	.42	.15	.02
8	Mn	450	2.00	8.00	4.65	1.43	2.05
9	Zn	450	.25	25.00	4.65	2.37	5.61
10	Ca	450	7.00	15.40	11.46	2.65	7.02
11	Mg	450	2.00	8.00	5.11	1.51	2.28
12	S	450	22.32	49.60	35.85	6.59	43.45

(N= Total samples)

#### Electrical Conductivity, pH and OC of soil samples:

Statistical data analysis of collected soil samples shows pH range maximum (7.9) and Minimum (7.1). Soils are neutral in reaction, pH varied from 7.1 to 7.9 with the mean value of 7.57. Electrical conductivity (EC) is varied from 0.1 to 0.96 dSm<sup>-1</sup> with a mean value of 0.47 dSm<sup>-1</sup>. All samples (100%) are salt free i.e. values are between 0 - 2 (ref: table 3 and 1).

Organic carbon (OC) of the soil is varied from 0.19 – 69.00 % with a mean value of 0.85 %.

#### Available Macronutrients in soil samples:

Phosphorus content of studied samples is minimum 13 kg/ha and maximum 387 kg/ha with mean value 33.76kg/ha. With the consideration of critical limit (table 3) the available Phosphorus of almost samples was found to be normal. Potassium (K) range 141-532 kg/ha with mean 277.05 kg/ha shows high value in study area.

**Table 2. Soil properties and rating of Mundra taluk**

S C	Sample Site	TS	Rating	pH	EC	OC	P	K	RI	SI	NI		
											OC	P	K
1	Navinal	30	Low	0	30	2	15	0	2.0	1.0	2.2	1.5	2.3
			Medium	30	0	19	15	21					
			High	0	0	9	0	9					
2	Gelda	30	Low	0	30	3	9	0	2.0	1.0	1.9	1.7	2.4
			Medium	30	0	25	21	17					
			High	0	0	2	0	13					
3	Borana	30	Low	0	30	3	11	0	2.0	1.0	2.1	1.6	2.6
			Medium	30	0	21	19	12					
			High	0	0	6	0	18					
4	Chhasara	30	Low	0	30	13	12	0	2.0	1.0	1.6	1.6	2.4
			Medium	30	0	16	18	18					
			High	0	0	1	0	12					
5	Tappar	30	Low	0	30	0	8	0	2.0	1.0	2.5	1.7	2.7
			Medium	30	0	14	22	9					
			High	0	0	16	0	21					

6	Kanajara	30	Low	0	30	1	10	0	2.0	1.0	2.4 7	1.6 7	2.3 3
			Medium	30	0	14	20	20					
			High	0	0	15	0	10					
7	Vadala	30	Low	0	30	10	11	0	2.0	1.0	1.5 0	1.6 3	2.6 0
			Medium	30	0	16	19	12					
			High	0	0	1	0	18					
8	Luni	30	Low	0	30	1	11	0	2.0	1.0	2.5 0	1.6 3	2.8 0
			Medium	30	0	13	19	6					
			High	0	0	16	0	24					
9	Khakhar moti	30	Low	0	30	3	6	0	2.0	1.0	2.3 7	1.8 0	2.2 7
			Medium	30	0	13	24	22					
			High	0	0	14	0	8					
10	Shiracha	30	Low	0	30	1	10	0	2.0	1.0	2.6 0	1.6 7	2.6 3
			Medium	30	0	10	20	11					
			High	0	0	19	0	19					
11	Vanki	30	Low	0	30	1	9	0	2.0	1.0	2.4 7	1.7 0	2.6 0
			Medium	30	0	14	21	12					
			High	0	0	15	0	18					
12	Patri	30	Low	0	30	3	10	0	2.0	1.0	1.9 7	1.6 7	2.4 3
			Medium	30	0	25	20	17					
			High	0	0	2	0	13					
13	Bagada	30	Low	0	30	9	9	0	2.0	1.0	2.0 7	1.6 3	2.4 0
			Medium	30	0	10	20	18					
			High	0	0	11	0	12					
14	vaghura	30	Low	0	30	2	6	0	2.0	1.0	2.5 0	1.8 0	2.4 7
			Medium	30	0	11	24	16					
			High	0	0	17	0	14					
15	Lakhapa r	30	Low	0	30	1	9	0	2.0	1.0	2.5 0	1.7 0	2.5 3
			Medium	30	0	13	21	14					
			High	0	0	16	0	16					

(Where SC= Site code, RI= Reaction Index, SI = Salt Index, NI= Nutrient Index, TS= Total Samples )

Sulfur content range 22.32 – 49.60 ppm with mean 35.85 ppm. All the 450 samples contain high value of Sulfur. Looking to critical limit table 3, 100 % samples are in high (>10) range for Sulfur. All the samples were containing adequate amount of Calcium (Ca) (Minimum 7 and maximum 8 meq/100gm) and also Magnesium (Mg) (22.32 -49.60 meq/100gm).

#### Available Micronutrients in soil samples:

The available Micronutrients Iron (Fe) contents of the soils are minimum 1.0 ppm and maximum 5.2 ppm with mean value 2.79ppm. As per critical limit ref. table 3, the soils of the study area appeared to be low amount in available Fe. The available (Cu) content of the soils is minimum 0.20ppm and maximum 0.80ppm with mean 0.42ppm. According to Critical limit all samples are quite sufficient in available Cu. The available Zinc (Zn) varied from 0.25 ppm to 25 ppm. Looking to mean value 4.65, it shows that most of the soils contain high amount of available Zn. The available Mn(Manganese) content of soils is minimum 2.0 ppm and maximum 8.0 ppm with mean 4.65 ppm. Considering the critical limit suggested by MMSOIL [15], the soils of study area appears to sufficient in Mn.

**Table 3. Critical limit of Soil properties (followed by MMSOIL-Gov. of India-2011 and Soil Test laboratories of Gujarat)**

Sr. No	Soil Parameters	Unit	Low	Medium	High
1	pH		< 6.5 (Acidic)	6.5 - 8.2 (Neutral)	> 8.2 (Alkaline)
2	EC	dS/m	< 1.0	1.0 - 3.0	> 3.0
3	C	%	0.5	0.50 - 0.75	> 0.75
4	P	Kg/ha	< 28	28 - 56	> 56
5	K	Kg/ha	< 140	140 - 280	> 280
6	Fe	ppm	< 5	5--10	> 10
7	Cu	ppm	< 0.2	0.2 - 0.4	> 0.4
8	Mn	ppm	< 5	5--10	> 10
9	Zn	ppm	< 0.5	0.5 - 1.0	> 1.0
10	Ca	Meq/100gm	6.0 - 18		
11	Mg	Meq/100gm	2.0 - 10		
12	S	ppm	8.0 - 10		

The nutrient index in soil was evaluated for the soil samples analyzed using the following formula:

$$NI = (1 \times NL) + (2 \times ML) + (3 \times HL) / \text{Total number of samples}$$

Where **NI**= Nutrient index, **NL**= no. of samples in low category, **ML**= no. of samples in Medium category, **HL**= no. of samples in high category.

#### **Reaction, Salt and Nutrient Index value:**

Based on concept of Reaction index, Salt index and Nutrient index (Ref. table 2) values, the soils of study location were found in fair and salt free with respect to Electrical conductivity and Neutral in reaction with respect to pH. Study shows considerable nutrient indices for OC (Organic carbon), P (Phosphorus) and K (Potassium).

#### **Correlation of EC and PH with soil parameters:**

Correlation matrix and coefficient (r) is given in table-4.

Correlation studies of EC with Micronutrient Fe, Cu, and Zn shows Less positive relationship with r value 0.023, 0.050 and 0.054 respectively, where as negative correlation with Mn (r =-0.085), Relationship of EC with available P shows (r=0.032) positive but not significant correlation. Available OC(r=-0.004), K(r=-0.047), Zn(r=-0.023), and S(r=-0.075) shows negative relation with EC. Low degree positive correlation was found between pH and micronutrients Cu(r=0.044), Mn(r=0.003) and Zn(r=0.038), macronutrients P(r=0.009), K(r=0.017), Ca(r=0.003), Mg(r=0.027). There was positive significant correlation with S(r=0.5)

Similar study about relationship among pH, EC and soil parameters were also reported [3-5, 16].

**Table 4. Tabular form of Matrix correlations among soil parameters.**

PR	pH	EC	OC	P	K	Fe	Cu	Mn	Zn	Ca	Mg	S
pH	1											
EC	.012	1										
OC	-	-	1									
	.055	.002										
P	.009	.032	.017	1								
K	.017	-	.039	-	1							
		.047		.004								
Fe	-	.023	-	.021	-	1						
	.040		.036		.013							
Cu	.044	.050	-	-	.059	-	1					
			.048	.062		.072						
Mn	.003	-	.012	-	-	-	-	1				
		.085		.093	.010	.020	.087					
Zn	.038	-	.000	.047	-	-	.053	.044	1			
		.023			.038	.045						
Ca	.003	.044	.018	-	.080	.048	.064	-	.039	1		
				.047				.024				
Mg	.027	.055	-	.030	.024	.074	.034	.092	.055	.209	1	
			.035									
S	.051	-	-	.043	-	-	.028	-	.018	.111	.035	1
		.075	.043		.031	.035		.080				

(PR = Properties of Soil)

## Conclusion

- Based on reaction index and salt index through electrical conductivity and pH, the study area posses fairly good agricultural land.
- Nutrient index with respect of OC, P and K shows sufficient amounts of nutrients in the soil samples.
- This study shows that the study area is free from salt with respect to EC.
- High value of Sulfur in soil samples shows excess fertilizer practice. 100% samples shows over value (>10) of sulfur.
- In present tillage system the value of EC and pH are fairly good for agriculture practice.
- Present study concludes that statistical methods e.g. correlation analysis can provide a scientific basis for controlling and monitoring agriculture soil fertility management.

- Observation shows low positive correlation of EC with Phosphorus, Iron, Copper, Calcium and Magnesium.
- Sulfur has high degree of positive correlation with pH.
- Electrical conductivity inversely correlates with Organic Carbon, Potassium, Manganese, Zinc and Sulfur.

### Suggestions

Most of the farmers, practices the agriculture methods, which are traditional. It does not meet the modern expectations of farming methodology. Most may not be aware about strengths and weaknesses of their own land, especially soil's nutrients values in relation to their excessiveness or deficits. Most of them are not capable of understanding the requirement of essential components, needed for the crop they are going to farm or farming. All these lack of awareness or absence knowledge culminates in to, either low yield or crop failure, ultimately resulting in to financial loss. What needed is, the sustained educational campaigns for farmers, imparting correct techniques of farming, and establishing a local information resource centers in their areas, to meet their need of information and guidance. Repeated educational campaigns will generate the awareness and knowledge among farmers leading them to inform farm practices.

### Future Scope

In present work and most study of this kind was performed for horizontal soil properties distribution but there is also necessary to know the vertical distribution of soil parameters.

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