

# GPS-GIS Based Soil Fertility Maps of Shahada Tahsil of Nandurbar District (M.S.) †

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**Abstract:** The GPS and GIS techniques i.e. (Global Position System and Geographical Information System) are widely utilized for delineating fertility maps of macro and micronutrients. Soil samples collected with GPS data can help in making critical decisions on nutrient management. Thematic soil fertility maps need the collection of soil samples using GPS technology. It is extremely important in agriculture for future soil nutrient monitoring in various locations/villages. Nandurbar district is located between 21.228° N to 74.1422° E North Latitude and East Longitude. Nandurbar district comprises six tahsils out of these the Shahada tahsil which is located between 21.5429691° N and 74.44691462° E is considered for the study. Micronutrient depletion has become a serious limitation for soil productivity and sustainability due to the acceptance of high-yielding cultivars and intensive cropping; as well as a move toward the use of high NPK fertilizers. The sampling of soil was done by random sampling method i.e. five random soil samples per village. The total soil samples collected from Shahada tahsil were 588 from total 118 villages. Latitude and Longitude were recorded by GPS instrument from soil sampling places of Shahada areas. The soils were collected at a depth of 0 to 22.5 cm from farmer's fields. The samples collected from Shahada tahsil were 588. All the precautions were followed while processing the soil samples in the laboratory. Standard procedures, such as pH (1:2.5), electrical conductivity (EC) (1:2.5), and organic carbon in percentage, were used to analyze soil samples. The GPS-GIS based fertility maps of Shahada tahsil of Nandurbar district (M.S.) was prepared by using Arc-4 software. The most soils of Shahada tahsil are medium black to deep black cotton soil which belongs to the soil order inceptisol and vertisol and the topographic condition is flat therefore the main crops grown in this study area are sugarcane, cotton, chilli, papaya, maize, wheat and gram. The cultivated soils of Shahada tahsil were saline to alkaline in reaction. The soils of Shahada tahsil were moderately saline according to their electrical conductivity. The EC of soils ranged between 0.06 to 2.90 dSm<sup>-1</sup> with an average value of 0.60 dSm<sup>-1</sup>. The average value of organic carbon in Shahada areas was 0.57 g kg<sup>-1</sup>. This data and fertility maps will be helpful in planning, maintaining the fertility, productivity, and quality of growing crops

**Keywords:** soil fertility; Shahada tahsil; GPS; GIS; fertility maps

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## 1. Introduction

The GPS and GIS techniques i.e. (Global Position System and Geographical Information System) are widely utilized for delineating fertility maps of macro and micronutrients. In agriculture, the Global Positioning System is utilized for land surveying, dams and canals construction, animal behavior research, and marine creature research. It is also used for obtaining digital road maps in vehicles when GPS and GIS are integrated. Soil

samples collected with GPS data can help in making critical decisions on nutrients management. The fertilizer required is to be established, for calculating exact amount of straight fertilizer rather than a ready mixed complex, compound fertilizer. Fertilizer used can be better optimized by utilizing knowledge of fertility maps prepared with the help of GPS-GIS techniques. Money spends on fertilizers can be modified to the amount actually needed to supply nutrients in soil for cropping systems. Fertilizer use can be customized to area and quantities needed on various parts of fields for better nutrients management. Collection of soil samples by using GPS is very important for preparing thematic soil fertility maps [1]. This device assists in determining the location's latitude and longitude. It is extremely important in agriculture for future soil nutrient monitoring in various locations/villages. It also helps to know elevation, road map, nearest city/town and speed of movement.

Nandurbar district is located between 21.228° N to 74.1422° E North Latitude and East Longitude. The geographical area of the district is 5035km<sup>2</sup>, It's annual rainfall is 769 mm. The maximum and minimum temperature of this district is 43.3 °C and 11.9 °C, respectively. Nandurbar district comprises six tahsil out of these Shahada is considered for the study. The global positioning system (GPS) is a space-based navigation and positioning system managed by the United States military that aids in determining an object's exact position on the earth's surface in terms of geographical coordinates [2]. Geographical information system (GIS) is a computer system for capturing, storing, querying and displaying geographical data [3]. It is feasible to alter data about the area's fertility status once the soil fertility maps have been developed. These maps give site-specific recommendations and assessment for future soil fertility [4]. Adoption of high yielding varieties and intensive cropping together with shift towards use of high NPK fertilizers has caused decline in the level of micronutrients in soil below normal at which productivity of crop cannot be sustained. The deficiency of micronutrients has become major constraint for productivity and sustainability of soil [5]. The main crops grown in Shahada tahsil are cotton, sugarcane, banana, wheat, papaya.

## 2. Materials and Methods

Shahada is located between 21.54296910° N and 74.44691462° E. It is one of the 6 tahsils in the Nandurbar district, is a town in the northwest corner (Khandesh situated 30 km away in the North-East direction of Nandurbar district place. It is spread between the banks of Tapi and Gomai River. The town has been famous for Grain market, co-operative dairy farming, sugar industry, Cotton spinning industry, etc. There are 172 villages and four Revenue Circles.

Shahada had a population of 61,376 people as per the 2011 India census, with 52 percent men and 48 percent women. Shahada has an average literacy rate of 86.62%, higher than the national average of 74.04%: male literacy is 90.67%, and female literacy is 82.40%. 12.95 percent of the inhabitants of Shahada is under the age of six. Languages/dialects spoken in Shahada town and Nandurbar districts are many local, tribal languages like Bhilu, Ladshi, Dogari, Bayadi, etc. and other languages are Marathi, Ahirani, and Gujarati.

The Shahada tahsil in Nandurbar district was chosen for the project to create thematic soil fertility maps using GPS and GIS. Latitude (Lat.) and Longitude (Long.) were recorded by GPS instrument from soil sampling places of Shahada areas. The soils were collected at a depth of 0–22.5 cm from farmer's fields. The samples collected from Shahada tahsil were 588.

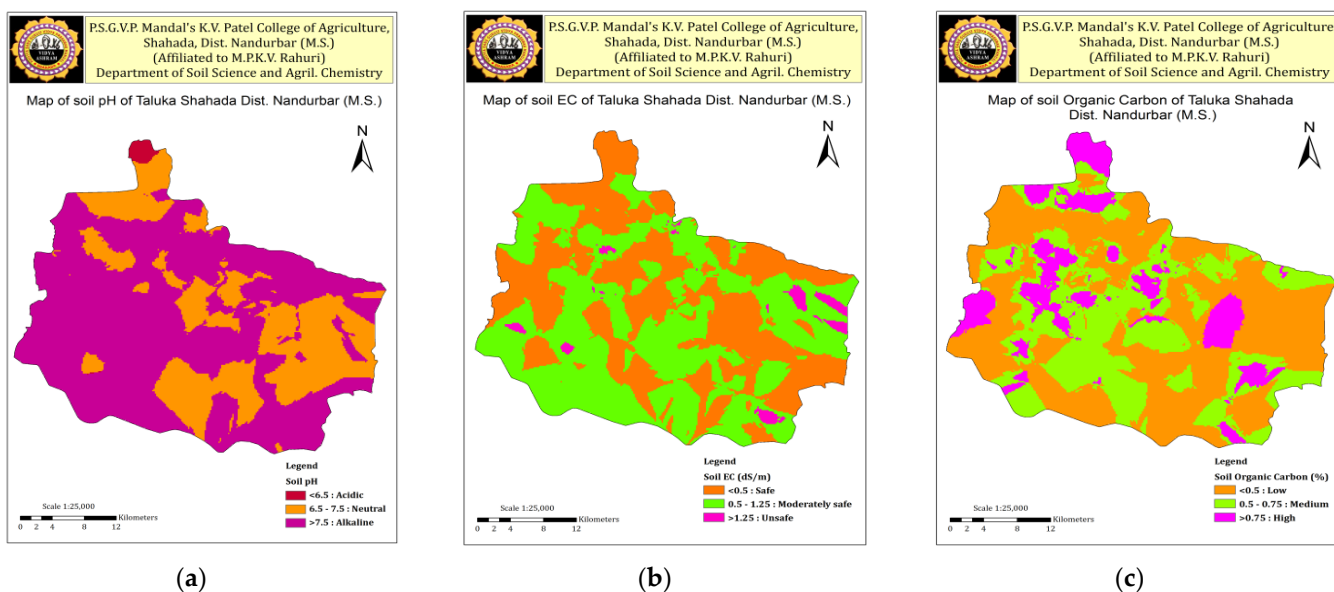
Soil samples were obtained from Shahada tahsil in Nandurbar district, completely mixed, air dried in the shade, pulverised with a wooden mortar and pestle, and put through a two-millimeter sieve for examination. For further analysis, the sieved soil samples were stored in cotton bags with suitable labelling. While processing the soil samples in the laboratory, all measures were taken. The analysis of soil samples have been done by using standard methods i.e. pH (1:2.5), EC (1:2.5), organic carbon, (Percentage).

### 3. Results

The GPS-GIS based soil fertility maps of Shahada tahsil of Nandurbar district (M.S.) was prepared by using Arc-4 software. The cultivated soils of Shahada tahsil were saline to alkaline in reaction. Soils of Shahada tahsil were moderately saline according to their electrical conductivity. The EC of soils of Shahada tahsil was found to be in the range between 0.06 to 2.90 dSm<sup>-1</sup> with an average value 0.60 dSm<sup>-1</sup>. The organic carbon content in soil of Shahada is in the range of 0.01 to 2.40 g kg<sup>-1</sup>. The average value of organic carbon in Shahada areas was 0.57 g kg<sup>-1</sup>.

**Table 1.** Range and average values of soil chemical properties of Shahada tahsil

Sr. No.	Chemical Properties	Shahada	
1	pH(1:2.5)	Range	5.09 to 8.98
		Average	7.66
		SD ±	0.55
2	EC (dSm <sup>-1</sup> )	Range	0.06 to 2.90
		Average	0.60
		SD ±	0.39
3	Organic carbon (g kg <sup>-1</sup> )	Range	0.01 to 2.40
		Average	0.57
		SD ±	0.32



**Figure 2.** Thematic maps of Soil fertility of Shahada tahsil Nandurbar district (a) pH; (b) EC; (c) Organic carbon.

**Table 2.** Number of samples and Percent distribution of soil chemical properties in different category in Shahada tahsil of Nandurbar district.

Sr. No.	Chemical Properties	Category	Value	Shahada	
				No. of Samples	Percent Distribution
1	pH(1:2.5)	Acid	<math>< 6.5</math>	22	03.74
		Neutral	6.5 to 7.5	188	31.91
		Alkaline	>7.5	378	64.29
2	EC (dSm <sup>-1</sup> )	Safe	<math>< 0.5</math>	296	50.34
		Moderately Safe	0.5 to 1.25	245	41.66
		Unsafe	>1.25	47	07.94

3	Organic Carbon (g kg <sup>-1</sup> )	Low	<0.5	279	47.44
		Medium	0.5 to 0.75	155	26.36
		High	>0.75	154	26.20

#### 4. Discussion

Alkaline condition of maximum soil samples might be due to intensive sugarcane cultivation, where excessively cultivated soils were irrigated with flood irrigation and least use of organic material to improve the physical condition of soil. The soil alkalinity of Shahada tahsil was observed because of accumulation of salts due to high temperature and use of high analysis fertilizers. The cultivated soils of Shahada tahsil are medium deep to deep black soil so the drainage is restricted which also leads to higher pH.

#### 5. Conclusions

It was observed from the maps that the major portion of the study area in Shahada area registered alkaline in nature, moderately safe in respect of EC, low in organic carbon. This approach is proposed as a method for the evaluation of sustainable soil management. The fertility maps could be used to predict potentials and constraints of land for specific crop production. The soil test values have further been utilized for prescribing fertilizer recommendations for optimum crop production in order to maintain the soil fertility, productivity, sustainability and better crop quality in the studied area. This data and fertility maps will be helped in planning, maintaining the fertility, productivity and quality of growing crops viz., banana, papaya, sugarcane, onion, cotton, chilli, etc. in the soils of Shahada tahsil.

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