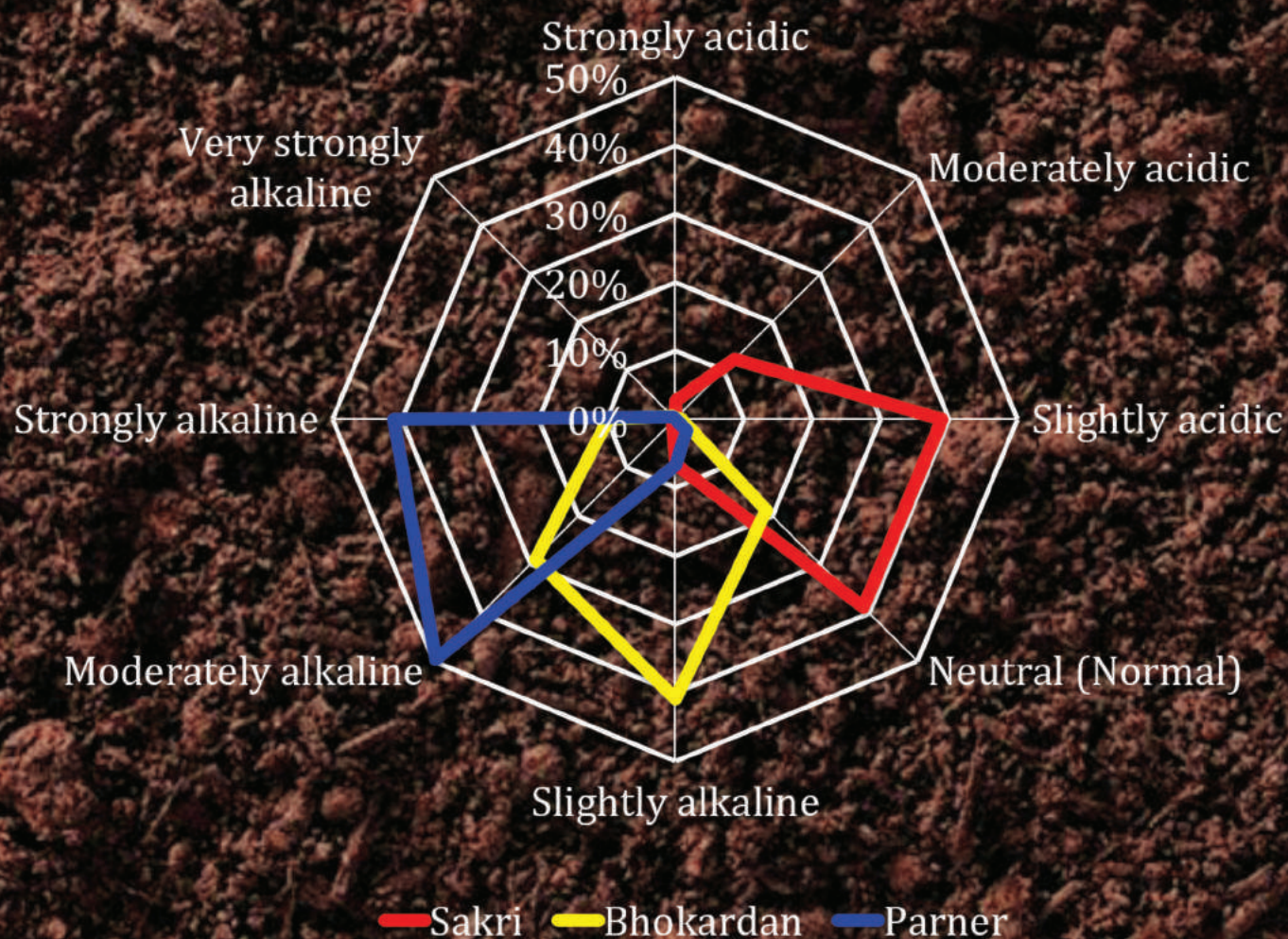


# A REPORT

## GIS BASED SOIL FERTILITY STATUS OF SELECTED VILLAGES IN SAKRI, BHOKARDAN AND PARNER BLOCKS OF DHULE, JALNA AND AHMEDNAGAR DISTRICTS OF MAHARASHTRA





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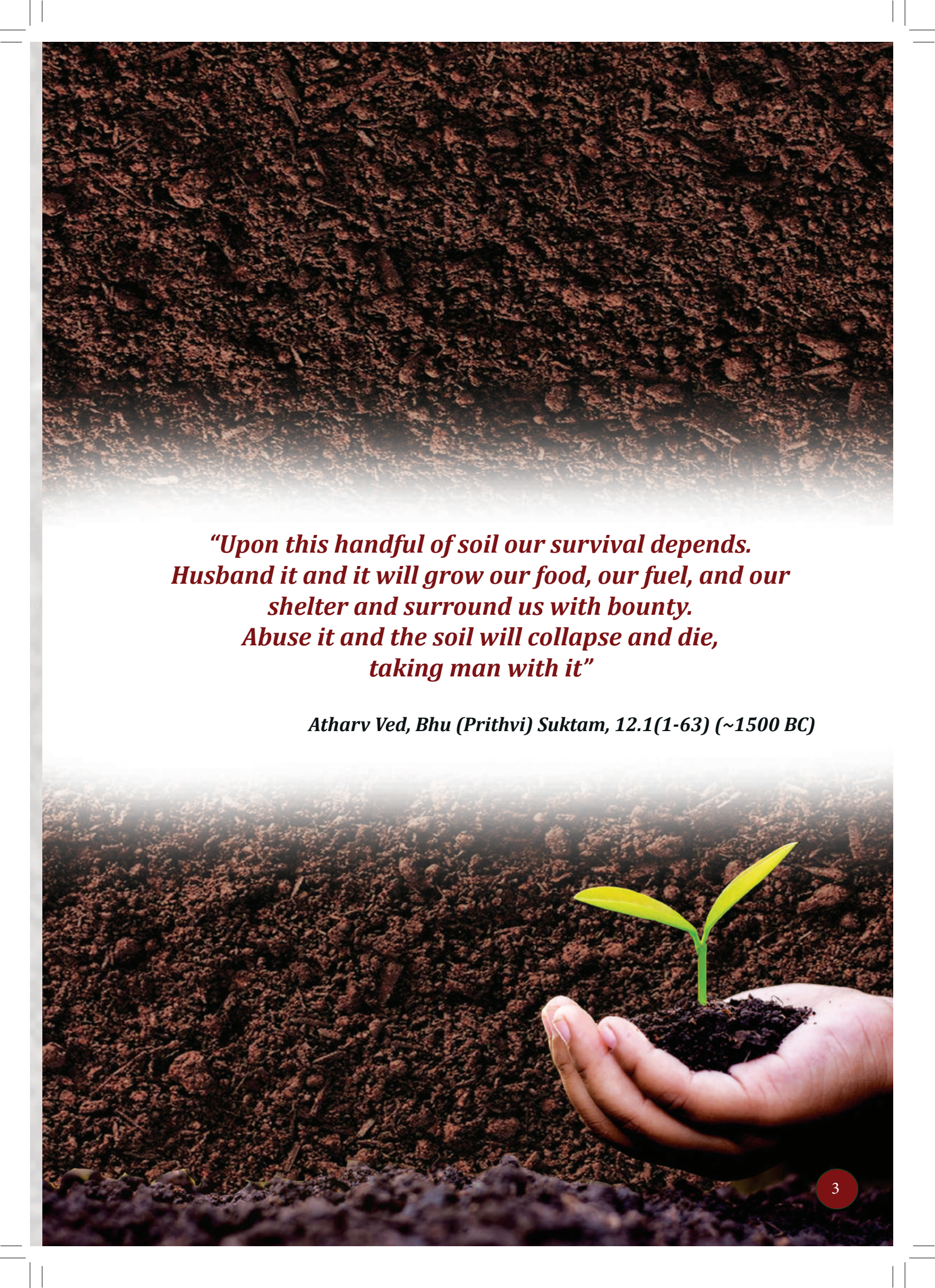
*This report has built on experiences from the project “Soil protection and rehabilitation of degraded soils for food security in India” funded by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH and implemented by WOTR.*

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***Disclaimer:***

The views, analysis, interpretation and conclusions expressed herein are those of the contributors/authors and do not necessarily reflect or can be attributed to the GIZ and WOTR





*“Upon this handful of soil our survival depends.  
Husband it and it will grow our food, our fuel, and our  
shelter and surround us with bounty.  
Abuse it and the soil will collapse and die,  
taking man with it”*

*Atharv Ved, Bhu (Prithvi) Suktam, 12.1(1-63) (~1500 BC)*





# Foreword

Soil is one of the most vital natural resources for sustenance of humankind on the planet Earth. Soils provide a natural habitat to a wide range of organisms including plants, which forms a rich and dynamic ecosystem. Soil not only supports the plant root systems but remains the basic source of nutrients and holds water for plants. Plant production and food security is solely dependent on soil health. Good management ensures that soils do not become deficient in nutrients or toxic to plants, and that the appropriate nutrient elements enter the food chain. Hence, proper soil management is important for crop productivity, environmental sustainability and human health. With the projected growth of world population and the consequent necessity for increasing food production, maintenance of soil fertility and productivity is important and urgent.

WOTR is implementing the project, “Soil protection and rehabilitation of degraded soils for food security in India” in 20 villages of 3 clusters in 3 districts in Maharashtra, India. The project addresses factors hindering sustainable and effective promotion of soil health, and the promotion of water and crop management practices. Measures for soil protection, rehabilitation and fertility management are implemented. Soil fertility evaluation is one of the major components considered in the implementation of the project.

In total 5590 soil samples from the 20 villages have been collected and tested in-house for various soil properties. Soil Health Cards describing the current soil status and measures to improve soil health, including suggestions on crop specific optimum nutrient doses have been distributed to the respective farmers. Soil testing helped to evaluate the nutrients available and thereby address the locale specific nutrient deficiency. Soil fertility assessment is the key that enables farmers and practitioners to apply optimum nutrient doses along with organic manure to enhance crop productivity and reduce the excessive cost of external inputs. The soil fertility maps presented in this report are useful for location specific nutrient recommendations and proper soil management practices. It also helps to identify areas where soil reclamation measures are needed. Limiting the doses of external chemical fertilizers and incorporating organic manure, prevents further degradation of agricultural soils.

I am sure that this document will be immensely useful to farmers, practitioners and policy makers to prepare plans and decide region specific sustainable agriculture and land management practices.

I would like to extend my sincere thanks to the BMZ and the GIZ who have generously funded this project. My special thanks to the National Bank for Agriculture and Rural Development (NABARD) and scientists from Mahatma Phule Krishi Vidyapeeth (MPKV) for their support and guidance during the implementation of the project.

I would like to thank all the farmers and our field staff, without their active participation, this project would not be successful. I appreciate the dedicated efforts of WOTR’s agriculture team.

I am delighted to also mention that the Watershed Organisation Trust has received the UNCCD’s “Land for Life Award 2017”, an award given for our efforts to combat land desertification. Having won this award, we recommit ourselves to regenerating degraded lands and provide better livelihoods and living conditions to rural communities.

Marcella D’Souza  
Executive Director  
WOTR





## Message

A comprehensive, vibrant and quality soil resource inventory, in congruence with a dynamic research and technology development setting, is fundamental to the national progress and prosperity. India is still home to one-fourth of the world's undernourished and poor, and while the food demand is likely to double by 2050, serious yield and total factor productivity gaps exist in our food and agriculture system. Studies reveal that with 'business-as-usual' approaches, in face of the declining land, water and biodiversity resources and the intensifying volatilities of climate change and markets, by the year 2030, only 59 percent of India's total demand for food and agricultural products will be met.

With an annual growth rate of about 10% and around 117 million people, Maharashtra state is one of the densest populated states in India. The solutions to alarming issues of agricultural land degradation can only be achieved through ecofriendly sustainable agricultural practices, with precise application of external inputs to the agriculture. With the above backdrop and to attain precision in the use of plant nutrients, the urgency for GIS based soil fertility evaluation for optimizing input use can hardly be over emphasized. This report on "GIS based Soil Fertility Status of selected villages in Sakri, Bhokardan and Parner Blocks of Dhule, Jalna and Ahmednagar Districts of Maharashtra", underpinning the congruence of excellence and relevance, has judiciously updated the status of soil resources of the region.

It gives me immense pleasure to congratulate Dr. Nitin Kumbhar, Mr. Madhav Gholkar, Ms. Pradnya Thombare, Dr. Ananda Wani and Mr. Prithviraj Gaikwad for accomplishing this mammoth task and bringing out this Report. I compliment the authorities of the GIZ and NABARD for their imperative efforts and overall coordination which is extremely crucial for the outcome. Special thanks are to the 'invisible' field staff and farmers for their very significant contribution during the course of the studies. I am sure the project partners and other agencies shall strive to effectively implement all the recommendations and reclamation measures contained in this Report.

Dr. Pradip Dey  
Project Coordinator (STCR)  
ICAR-Indian Institute of Soil Science (IISS)



# 1. Introduction

Soil is an almost non-renewable natural resource and is a critical part of agriculture production system. Soil is the original source of the nutrients to grow crops which supports the basic dietary need of other living beings including human. With the advent of 'Green Revolution' global per capita food supply is increased but at the same time the over-exploitation of natural resources like soils, riverine and groundwater caused serious threats to the sustainable agricultural production in the longer run. Unsustainable soil management leads to nutrient depletion, loss of organic matter, erosion, salinization, acidification and reduction of exchange capacity and many other forms of soil degradation. In the recent years, increasing use of chemical fertilizers and pesticides, adoption of farm mechanization, availability and accessibility to irrigation sources and use of high yielding crop varieties have led to increasing crop production but at the same time have resulted in soil degradation. On the other hand, further increase in the use of chemical fertilizers is unlikely to be as effective at increasing yields because of the diminishing returns of fertilizer application (Tilman et al., 2002).

India supports about 17% of the world population with 2.4% land area of the world and about 4% share of world's fresh water. In India, about 228.3 Mha i.e. 69.6% of the total geographic area of the country is dry land (arid, semi-arid and dry sub-humid) and degradation of these lands have severe implications on the livelihood and food security of a large number of population (Govt. of India, 2017). According to the National Bureau of Soil Survey and Land Use Planning (NBSS&LUP) about 146.82 Mha area is reported to be suffering from various kinds of land degradation in the country. Water and wind are the two major causes of land degradation in India, contributing 71% of the total land degradation while, about 15% of land degradation is caused by chemical deterioration like acidity and salinization (ICAR, 2010; MoEF, 2012).

In India, much of the soil erosion and degradation in the cultivable land is caused by faulty agricultural methods and inappropriate land management practices. Ploughing in wrong direction, lack of crop rotation, shifting cultivation, excess use of chemical fertilizers and injudicious use of irrigation are some of the main causes of agricultural soil degradation. In 2010-11, India's total consumption of chemical fertilizers has reached to highest level of 28.12 million tons out of it 12.36 million tons was imported (Govt. of India, 2016) which means about 142 kg of chemical fertilizer was applied per hectare of cultivated land. Many studies have reported that the extensive use of chemical fertilizers and irrigation not only leads to soil degradation but also contaminates the aquatic ecosystems largely by eutrophication and also changes the atmospheric composition by emission of gases (mainly greenhouse gases) detrimental to the environment.


With an annual growth rate of about 10% and around 117 million people, Maharashtra state is one of the densest populated states in India. In Maharashtra, approximately 30% of the arable land is severely degraded, contrasting the high relevance of agricultural sector in the region with 60% of the overall land under cultivation. In Maharashtra, 90.7% of the total degraded land is a result of water and wind erosion. Alkali/ sodic soil and acidic soil affect 4.3% and 2.8% of the total degraded area respectively. (MoEF, 2012)

The solutions to these alarming issues of agricultural land degradation can only be achieved through ecofriendly sustainable agricultural practices with precise use of external inputs in agricultural production system.

## 1.1 Pro-Soil project and its implementation in WOTR project areas

WOTR has implemented the Pro-Soil project funded by GIZ, in 20 villages of three districts namely, Dhule, Jalna and Ahmednagar of Maharashtra state covering about 5169 households over 18053 ha area. The primary aim of the project was to implement sustainable and inclusive approaches for soil conservation, rehabilitation of degraded lands and improve soil health to enhance the crop productivity. As the project underlines, the prime most importance was given to implement the ecofriendly Good Agricultural Practices for





better soil health and increasing crop productivity. Knowing the nutritional assets of soil is very crucial to decide the type and amount of external inputs to be added for the desirable agricultural production, thus, testing of soils for its available nutrients' content was given the first priority. In total 5590 soil samples were tested from 20 project villages to assess the soil nutrient levels and appropriate nutrient management practices were suggested to the farmers.

## 1.2 Importance of soil testing and Soil Health Card

The soils were tested for their primary nutrients like Nitrogen (N), Phosphorous (P) and Potassium (K) along with soil Organic Carbon (OC), Potential of Hydrogen (pH), Electrical Conductivity (EC) and some of the selected secondary and micronutrients such as Sulphur (S) and Iron (Fe), respectively. Based on the soil test results, plot specific nutrient recommendations for crops preferably through organic manures were reported in soil health card and given to the farmers. The soil health cards facilitate the implementation of System of Crop Intensification (SCI) while addressing it's one of the major components of soil health management through precise integrated nutrient management.

## 1.3 Importance and role of soil health indicators

Measurement of extractable nutrients shows the ability of soil to supply the essential plant nutrients for crop growth. It also helps to identify the overall availability of a particular nutrient and classify it in six tier (very low to very high) categories. Based on the categorization of available soil nutrients, location specific agricultural management practices can be framed with precision. The importance and the role of selected soil nutrients in crop physiology and soil-plant-water relationship is described here.

### a) *Nitrogen (N)*

Nitrogen is the most important nutrient element for all crops. The vegetative growth of plants is mainly governed by the availability of the Nitrogen. Nitrogen is a commonly limiting nutrient for plant growth in tropical soils and its availability is important to soil fertility. Nitrogen is a part of the chlorophyll molecule. Plants also require nitrogen in order to produce amino acids for building proteins. Nitrogen deficiency stunts the plant growth, restricts growth of lateral shoots and causes yellowing of older leaves. Nitrogen is easily lost from soils through various ways such as ammonia volatilization, leaching and de-nitrification processes etc. If external application of Nitrogen is not synchronized with crop demand, the losses of Nitrogen are large and this leads to reduced Nitrogen use efficiency and increased the environmental pollution (Crews and Peoples, 2005; Hirel et. al., 2011 and Rutting et. al., 2018).

### b) *Phosphorus (P)*

Phosphorus is essential for plant growth and grain development. It is an immobile nutrient and remains as abundantly in soils unlike nitrogen and potassium. Phosphorus is important in developing healthy root systems, normal seed development, uniform crop maturation, photosynthesis, respiration, cell division and many other processes. Phosphorus deficiency results in stunted plant growth and purple or reddish pigmentation in the older leaves.

### c) *Potassium (K)*

Potassium is responsible for the regulation of water usage in plants, disease resistance, stem strength, photosynthesis and protein synthesis. Deficiency in potassium results in scorching or necrosis of older leaf margins and poor root systems. Potassium deficient plants also develop slowly.

### d) *Organic Carbon (OC)*

Soil organic matter has a considerable role in physical-chemical constituents and biological processes in the soil. Soil organic carbon, which represents the availability of organic



matter in the soil, enhances soil structure, improves water holding capacity, cation exchange capacity and increases the ability to bind the nutrients and store it in soil pool (Binder and, 2001; Lal, 2004). Especially the soils managed with chemical fertilizer found to be deficient in soil organic matter (Khan et. al., 2007; Ratnayake et. al., 2017). Unlike forest lands, the biological produce of the agricultural lands is taken out of the production system leaving the soil deficient in organic matter in longer run. The deficiency of soil organic matter creates negative effects on crop productivity thus improving the soil organic matter is the prerequisite to achieve better soil health, increased production and sustainability of the agricultural production systems (Katyal et al., 2001).

*e) Soil pH*

Potential of Hydrogen (pH) is defined as the negative logarithm of the hydrogen ion concentration in the soil. Soil pH level indicates the acidity or alkalinity of the soil. The pH scale goes from 0 to 14 with the pH value 7 as the neutral point. Lower the pH more acidic the soil is, while higher the values above 7 is the indication of alkaline soils. It is an important property of the soil as it determines the solubility of the nutrients in the soil and how easily they are available for plant uptake. Moreover, some of the crops and crop varieties are sensitive to the acidic or alkaline soil environment which directly affects the crop growth and ultimate production of the crop.

*f) Electrical Conductivity (EC)*

Electrical conductivity (EC) of soil represents the soluble salts present in the soil. Higher the EC more is the soil salinity. Excess salts affect the soil-water balance and hinder the plant growth. Soil microorganism activities retard in higher EC levels and affect soil respiration, residue decomposition, nitrification and denitrification.

*g) Sulphur (S)*

Sulphur is a key macroelement essential for plant growth. It is a constituent of amino acids which are the building blocks of plant protein. It is responsible for many flavour and odour compounds in the plant. The efficiency of nitrogen fixation in the leguminous plants is also governed by Sulphur.

*h) Iron (Fe)*

Iron plays a major role in Chlorophyll synthesis activity and thus it is important for plant respiration and photosynthesis process. It also works as enzyme activator and involve in many physiological process in plants. Though required in small quantity it is essential constituent of many metabolic processes that regulates plant growth.

## 2 Methodology

### 2.1 Soil sample collection

Soil samples were collected from farmers' field along with the records of the GPS location and Plot ID Number. The soil sample collection procedure was followed cautiously so as to avoid manual errors in the soil test results.

### 2.2 Soil sample analysis

The analysis of soil samples was carried out at soil laboratories established at each cluster. Soil testing was carried out by using 'Mridaparikshak' mini soil lab kit – developed by Indian Institute of Soil Science (IISS), Bhopal and approved by Indian council of Agricultural Research (ICAR), New Delhi.

### 2.3 Categorization of available soil nutrients

Based on the availability of essential soil nutrients, the soils were classified in six categories from very low to very high. The Indian Council of Agricultural Research (ICAR), SAUs like Mahatma Phule Krishi Vidyapeeth (MPKV, Rahuri), Vasantrao Naik Marathwada Krishi Vidyapeeth (VNMKV, Parbhani) and some of the international institutions like Food



and Agriculture Organization (FAO), United States Department of Agriculture (USDA) have given guidelines for this classification (Table 1 to Table 4).

Table 1: Soil nutrient categories based on the soil nutrient availability (MPKV Krishidarshani, 2018)

Category	N (kg/ha)	P (kg/ha)	K (kg/ha)	OC (%)
Very Low	< 140	< 7	< 100	< 0.2
Low	140 – 280	7 – 14	100 – 150	0.20 – 0.40
Medium	280 – 420	14 – 21	150 – 200	0.40 – 0.60
Slightly High	420 – 560	21 – 28	200 – 250	0.60 – 0.80
High	560 – 700	28 – 35	250 – 300	0.80 – 1.0
Very High	> 700	> 35	> 300	> 1.0

Table 2: Categorization of soil samples as per the soil Electrical Conductivity (EC)

Category	Electrical Conductivity - EC (dSm <sup>-1</sup> )
Normal	< 1
Slightly above normal	1 – 3
Saline	> 3

Table 3: Categorization of soil samples as per the soil pH (USDA, 1998)

Category	pH
Ultra-acidic	< 3.5
Extremely acidic	3.5 – 4.4
Very strongly acidic	4.4 – 5.0
Strongly acidic	5.0 – 5.5
Moderately acidic	5.5 – 6.0
Slightly acidic	6.0 – 6.5
Neutral (Normal)	6.5 – 7.3
Slightly alkaline	7.3 – 7.8
Moderately alkaline	7.8 – 8.4
Strongly alkaline	8.4 – 9.0
Very strongly alkaline	> 9.0

Table 4: Soil nutrient rating categories based on the soil nutrient availability

Category	S (mg/kg)	Fe (mg/kg)
Low	< 10	< 4.5
Average	10 – 20	4.5 – 10
Sufficient	> 20	> 10

#### 2.4 GIS maps to represent the soil fertility status

Spatial maps of the soil chemical properties and available nutrient content were generated with the help of ArcGIS. The observed soil chemical properties and available nutrient content were plotted with the respective GPS locations. Using an Inverse Distance Weighting (IDW) method for interpolation the values were interpolated within the cluster boundaries to get the spatial distribution of the soil properties. Soil chemical properties and available nutrient content were generated for each cluster and presented in this report.



# Soil Fertility Status of Pimpalner Cluster of Sakri block, Dhule

Five villages from Sakri block in Dhule district, which cover an area of 5203 hectares, were selected under the project. Table 5 provides the area of each of the project village in the cluster. Figure 1 shows the location of cluster villages within Dhule district.

Table 5: Village wise area, households and the soil samples tested from the Pimpalner cluster

Sr. No.	Villages	Area (Ha)	Total No. of Households	No. of Soil Samples tested
1	Chorwad	476	189	209
2	Manjari	1,466	813	478
3	Mohagaon	748	281	412
4	Pimpalgaon kh.	840	220	260
5	Shenwad	1,673	349	442
	Total	5,203	1,852	1,801

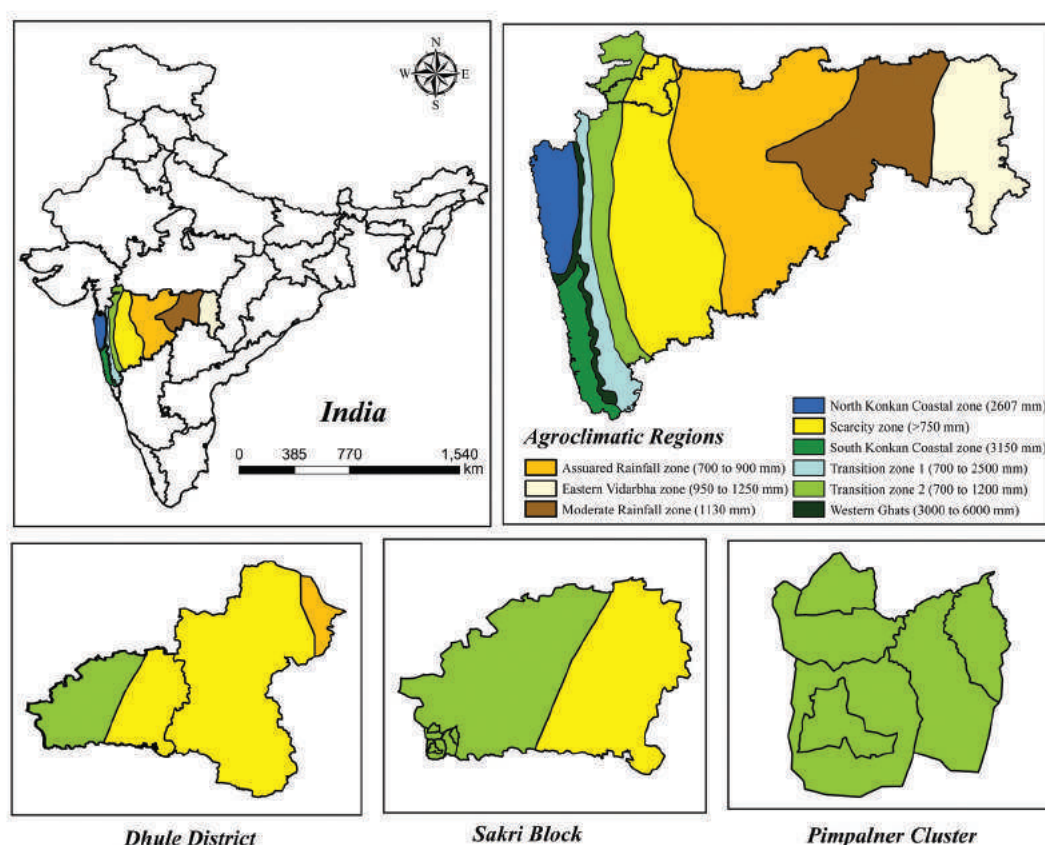


Figure 1: GIS based map showing geographical location of the Pimpalner cluster in Dhule, Maharashtra

The soil samples collected from Pimpalner cluster were categorized on the basis of soil nutrient availability and soil test results (Table 6 to Table 12).



## Soil pH

The soil pH values of Pimpalner cluster was ranged from 5.10 to 8.61 with an average soil pH of 6.59. About 77% soils samples were found slightly acidic to neutral category with an equal proportion. About 12.36% samples were found to be moderately acidic while, about 3% soil samples were found to be strongly acidic in nature. Less than 1% soil samples reported in moderately to strongly alkaline and about 6.5% soil samples showed slightly alkaline in reaction. More than 40% soil samples from Manjari and Shenwad villages showed neutral soil pH.

Table 6: Village wise categorization of soil samples (%) based on soil pH in Pimpalner cluster

Villages	Soil pH						
	Strongly acidic	Moderately acidic	Slightly acidic	Neutral	Slightly alkaline	Moderately alkaline	Strongly alkaline
Chorwad	7.18	18.18	37.80	33.49	3.35	0.00	0.00
Manjari	1.35	10.81	40.35	42.66	3.67	1.16	0.00
Mohagaon	3.88	13.59	40.05	33.25	9.22	0.00	0.00
Pimpalgaon kh.	3.08	14.62	39.62	36.92	4.62	1.15	0.00
Shenwad	1.00	9.36	36.45	42.63	9.56	0.80	0.20
Pimpalner Cluster	2.68	12.36	38.87	38.82	6.52	0.68	0.05

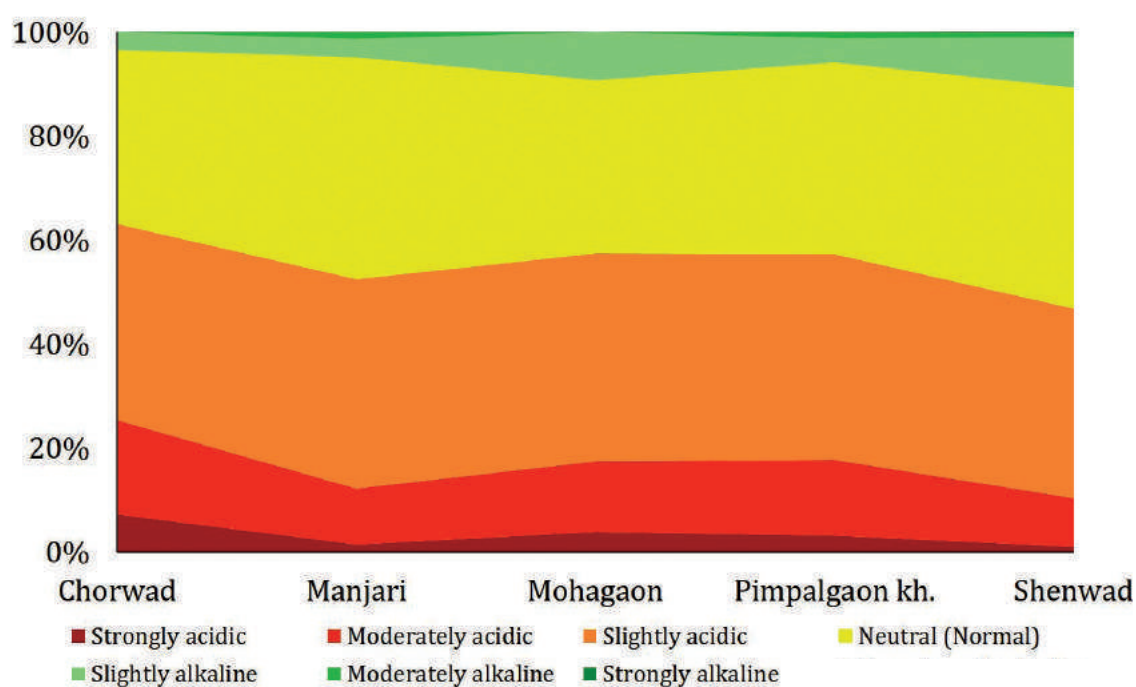


Figure 2: Village wise representation of soil samples (%) based on soil pH in Pimpalner cluster

## Soil Electrical Conductivity (EC)

The electrical conductivity of soil samples collected from Pimpalner cluster was ranged from 0.02 to 1.0. The average soil electrical conductivity of the cluster was 0.29. All the soil samples from the Pimpalner cluster were in normal range of their soluble salt content.



## Soil Organic Carbon (OC)

The organic carbon in the soil samples collected from Pimpalner cluster was ranged from 0.11 to 1.25% with an average value of 0.63%. About 55% of collected soil samples from all the villages in the Pimpalner cluster were reported slightly high to high availability of organic carbon in the soil while, 12.15% soil samples were reported low to very low levels of organic carbon. Only 3.7% soil samples were reported in very high carbon content.

Table 7: Village wise categorization of soil samples (%) based on available soil organic carbon in Pimpalner cluster

Villages	Soil Organic Carbon (%)					
	Very Low	Low	Medium	Slightly High	High	Very High
Chorwad	2.39	11.96	27.75	32.06	21.05	4.78
Manjari	0.58	6.18	31.47	36.87	21.04	3.86
Mohagaon	0.73	15.78	25.49	33.98	20.63	3.40
Pimpalgaon kh.	1.92	11.54	33.08	38.46	13.08	1.92
Shenwad	1.99	10.56	28.49	35.66	18.92	4.38
Pimpalner Cluster	1.37	10.78	29.20	35.61	19.31	3.73

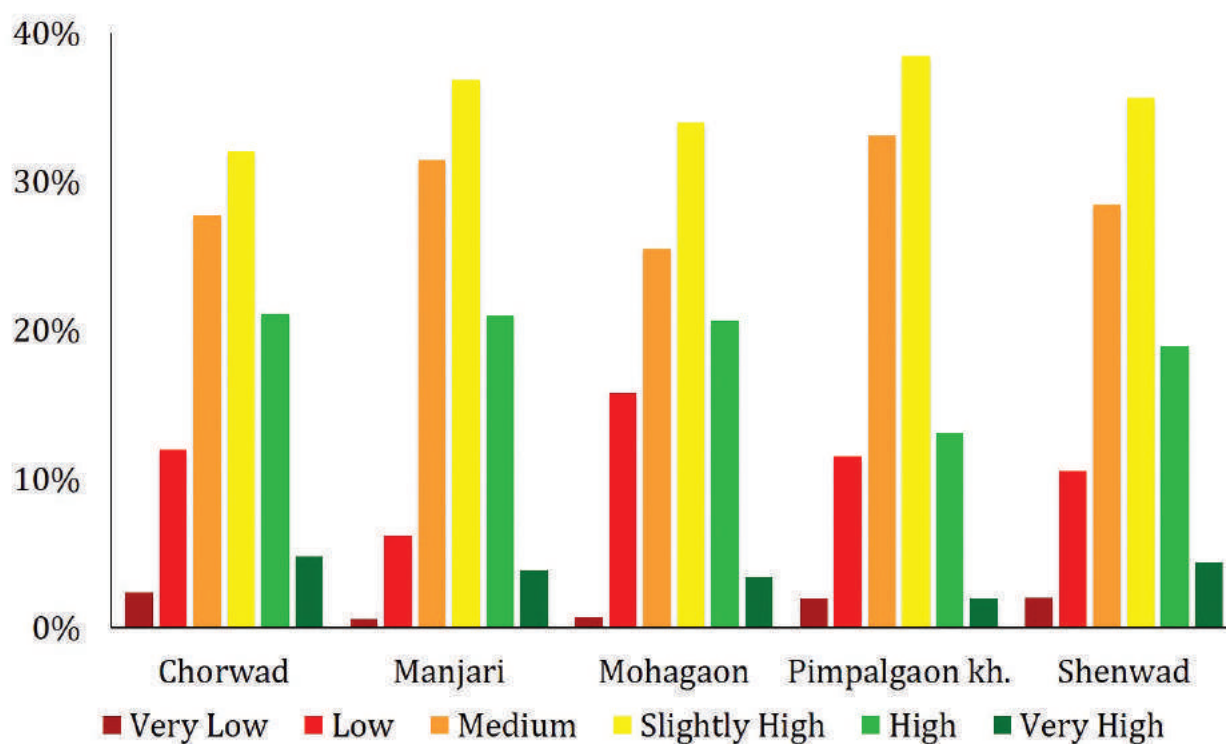


Figure 3: Village wise representation of soil samples (%) based on soil organic carbon availability in Pimpalner cluster



## Soil Nitrogen (N)

The available nitrogen in the soil samples collected from Pimpalner cluster was ranged from 91.7 to 490.4 kg/ha with an average value of 227.51 kg/ha. Most of the soil samples from all the villages in the Pimpalner cluster reported low nitrogen availability in the soil. About 87.69% samples reported low nitrogen availability while about 11.15% soil samples showed medium soil nitrogen. No soil sample from the cluster reported in high and very high nitrogen level. Soil samples from Pimpalgaon kh. and Manjari villages showed higher nitrogen deficiency (more than 90%).

Table 8: Village wise categorization of soil samples (%) based on available soil Nitrogen in Pimpalner cluster

Villages	Soil Available Nitrogen (%)					
	Very Low	Low	Medium	Slightly High	High	Very High
Chorwad	1.91	79.43	18.66	0.00	0.00	0.00
Manjari	0.00	91.51	8.30	0.19	0.00	0.00
Mohagaon	1.21	85.44	13.11	0.24	0.00	0.00
Pimpalgaon kh.	0.38	92.69	6.92	0.00	0.00	0.00
Shenwad	1.39	86.45	11.55	0.60	0.00	0.00
Pimpalner Cluster	0.89	87.69	11.15	0.26	0.00	0.00

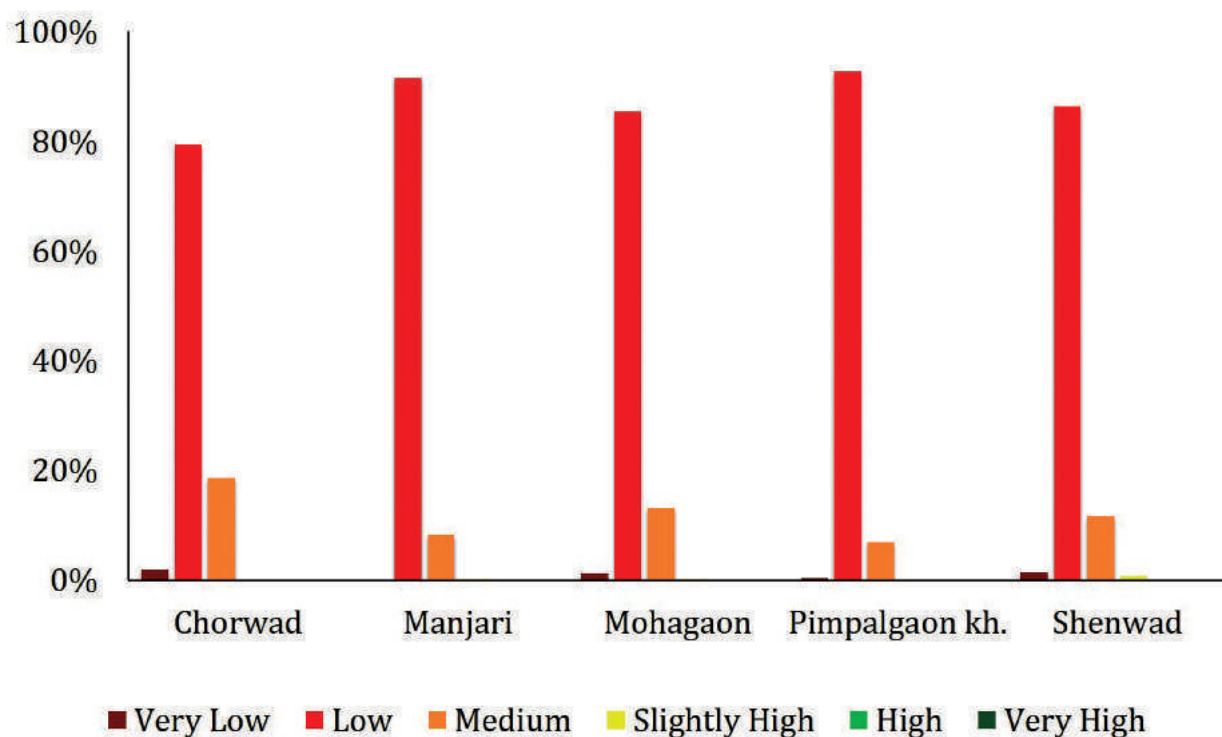


Figure 4: Village wise representation of soil samples (%) based on soil Nitrogen availability in Pimpalner cluster

## Soil Phosphorous (P)

The available phosphorous in the soil samples collected from Pimpalner cluster ranges between 2.68 to 83.11 kg/ha with an average value of 27.71 kg/ha. Most of the soil samples from all the villages in the Pimpalner cluster reported slightly high to very high availability of phosphorous in the soil. About 63.97% samples reported slightly high to very high phosphorous availability while about 16% soil samples showed low to very low soil phosphorous category. More than 70% soil samples from Mohagaon village showed higher content of available soil phosphorous.

Table 9: Village wise categorization of soil samples (%) based on available soil Phosphorous in Pimpalner cluster

Villages	Soil Available Phosphorus (%)					
	Very Low	Low	Medium	Slightly High	High	Very High
Chorwad	1.44	12.44	17.22	16.75	18.66	33.49
Manjari	1.16	15.83	22.97	18.92	19.11	22.01
Mohagaon	0.49	12.86	15.05	15.78	17.48	38.35
Pimpalgaon kh.	1.15	12.31	20.38	20.00	19.62	26.54
Shenwad	3.19	16.14	22.11	16.93	18.73	22.91
Pimpalner Cluster	1.58	14.41	20.04	17.62	18.67	27.67

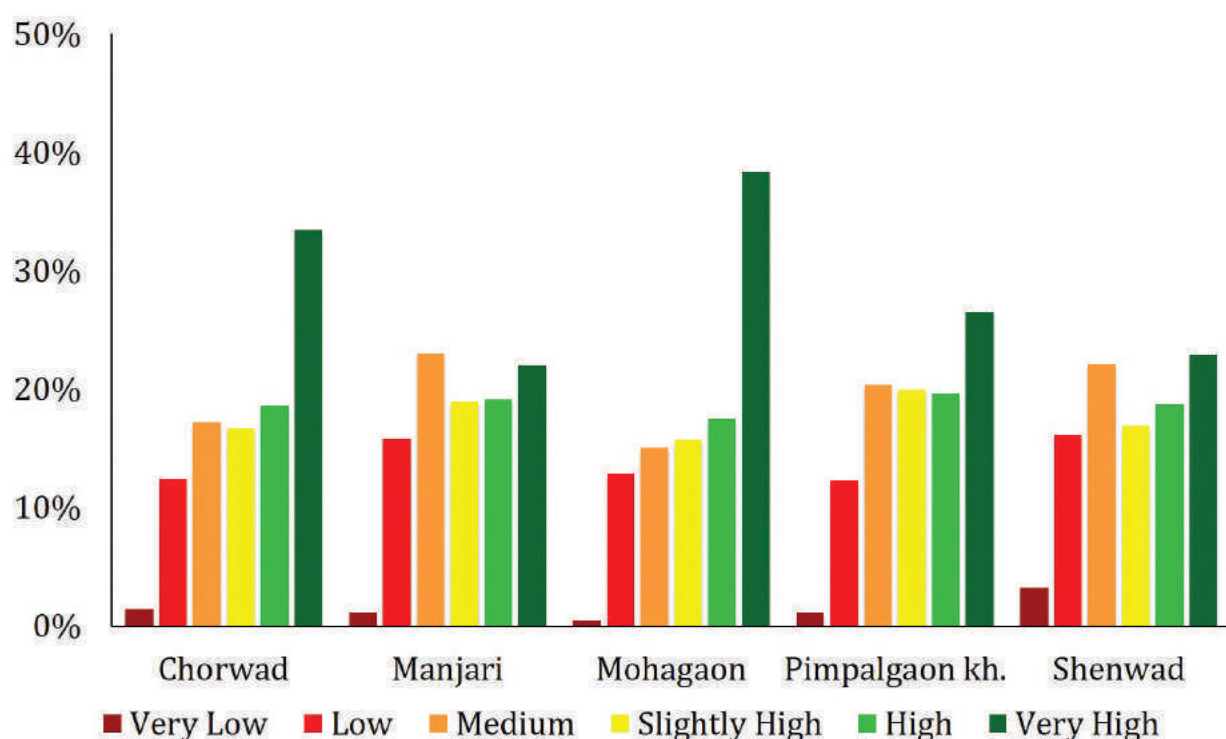


Figure 5: Village wise representation of soil samples (%) based on soil Phosphorous availability in Pimpalner cluster



## Soil Potassium (K)

The available potassium in the soil samples collected from Pimpalner cluster ranges between 15.32 to 678.30 kg/ha with an average value of 279.69 kg/ha. Most of the soil samples from all the villages in the Pimpalner cluster reported slightly high to very high availability of potassium in the soil. About 75.22% samples reported slightly high to very high potassium availability while about 7.36% soil samples showed low to very low soil potassium. No soil sample from Manjari and Shenwad villages reported in very low category of soil potassium.

Table 10: Village wise categorization of soil samples (%) based on available soil Potassium in Pimpalner cluster

Villages	Soil Available Potassium (%)					
	Very Low	Low	Medium	Slightly High	High	Very High
Chorwad	0.48	6.70	13.40	22.49	17.22	39.71
Manjari	0.00	3.47	19.88	18.92	18.34	39.38
Mohagaon	0.97	10.44	17.48	16.50	18.20	36.41
Pimpalgaon kh.	0.00	8.85	13.08	22.69	15.00	40.38
Shenwad	0.00	7.37	18.73	20.52	17.13	36.25
Pimpalner Cluster	0.26	7.10	17.41	19.73	17.41	38.09

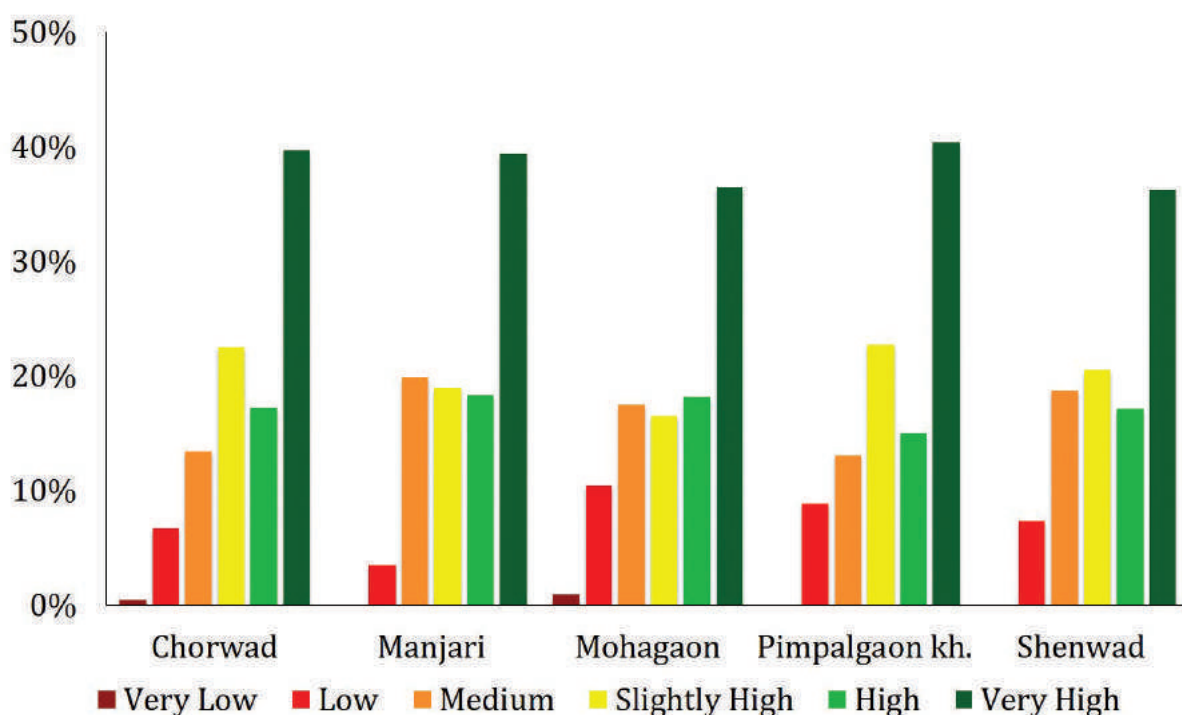


Figure 6: Village wise representation of soil samples (%) based on soil Potassium availability in Pimpalner cluster

## Sulphur (S)

The available Sulphur in the soil samples collected from Pimpalner cluster ranges between 3.08 to 98.50 mg/kg with an average value of 31.65 mg/kg. About 74% samples reported sufficient Sulphur availability while about 21% soil samples showed average soil Sulphur.

Table 11: Village wise categorization of soil samples (%) based on available soil Sulphur in Pimpalner cluster

Villages	Soil Available Sulphur (%)		
	Low	Average	Sufficient
Chorwad	4.31	16.27	79.43
Manjari	6.37	21.04	72.59
Mohagaon	5.58	18.69	75.73
Pimpalgaon kh.	2.31	26.54	71.15
Shenwad	4.78	21.71	73.51
Pimpalner Cluster	5.00	20.94	74.07

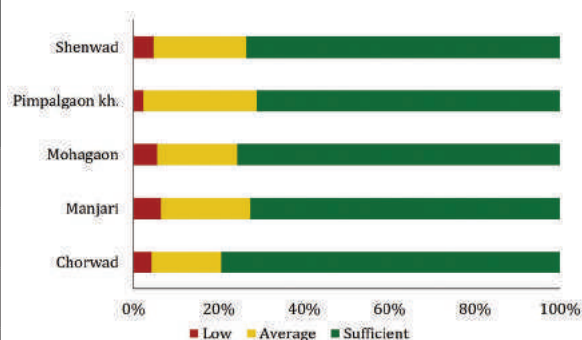


Figure 7: Village wise representation of soil samples (%) based on soil Sulphur availability in Pimpalner cluster

## Iron (Fe)

The available Iron in the soil samples collected from Pimpalner cluster ranges between 1.56 to 60.28 mg/kg with an average value of 19.83 mg/kg. About 89.37% samples reported sufficient Iron availability while 9.89% soil samples showed average soil Iron.

Table 12: Village wise categorization of soil samples (%) based on available soil Iron in Pimpalner cluster

Villages	Soil Available Iron (%)		
	Low	Average	Sufficient
Chorwad	0.96	11.00	88.04
Manjari	0.19	8.69	91.12
Mohagaon	0.73	6.55	92.72
Pimpalgaon kh.	0.77	13.08	86.15
Shenwad	1.20	11.75	87.05
Pimpalner Cluster	0.74	9.89	89.37

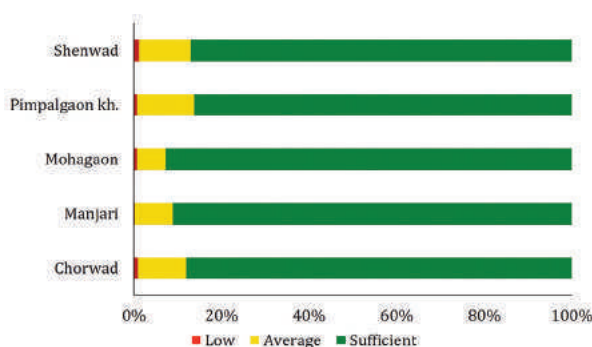
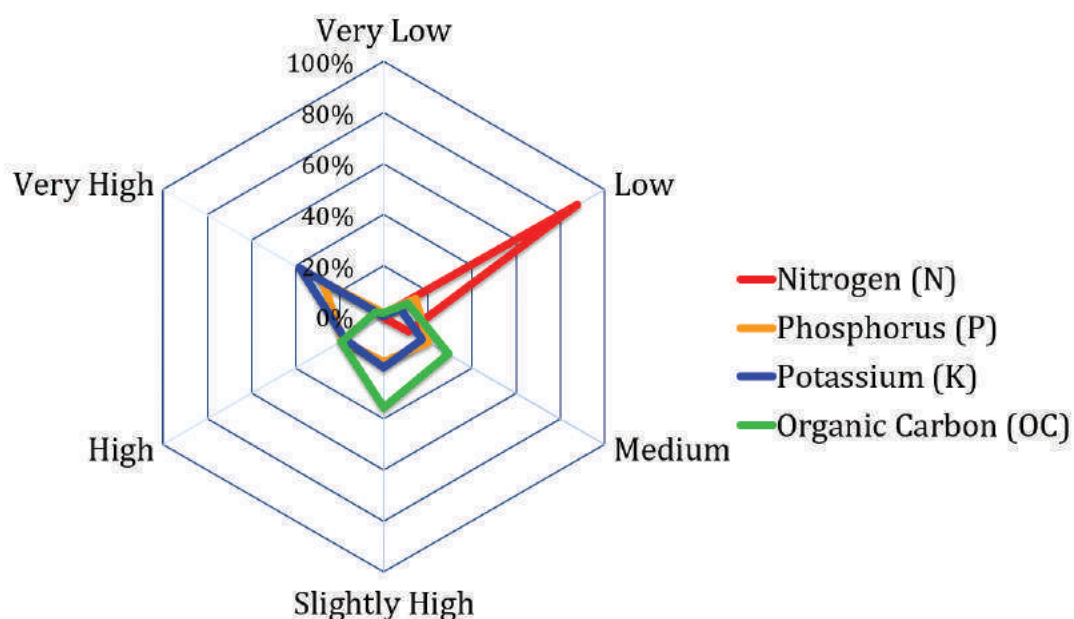


Figure 8: Village wise representation of soil samples (%) based on soil Iron availability in Pimpalner cluster



## Overall Soil Health status of Pimpalner Cluster

Most of the soil samples in the selected villages of Sakri Block ranging between moderately acidic to neutral with normal range of soluble salt content (EC), medium to high in organic carbon. Soils were predominantly low in available Nitrogen, medium to very high in Phosphorus and Potassium. Secondary nutrient like Sulphur and micronutrients like Iron are available in sufficient quantity.



**RADAR CHART REPRESENTING THE OVERALL SOIL HEALTH STATUS OF PIMPALNER CLUSTER**

### Reclamation measures for soils in Pimpalner Cluster

In Pimpalner cluster the soils observed are slightly acidic to moderately acidic in nature. Therefore, the reclamation measures for such type of soils are given below:

- 1) Addition of lime materials such as Lime stone ( $\text{CaCO}_3$ ), Quick lime ( $\text{CaO}$ ), Hydrated lime ( $\text{Ca(OH)}_2$ ), Dolomite limestone ( $\text{CaMg}(\text{CO}_3)_2$ ), Blast furnace slag etc. to the soil is necessary to balance the soil acidity and reclaim the acidic soils.
- 2) Basic fertilizers (sodium nitrate, basic slag etc.) are recommended to reduce the acidity in soil.
- 3) Proper soil water management is necessary to check leaching of bases and enhancing the composition of organic matter helpful to maintain appropriate soil water balance.
- 4) In acidic soils, crop can be selected based on their ability to tolerate the soil acidity.

# OVERALL SOIL HEALTH STATUS OF PIMPALNER CLUSTER

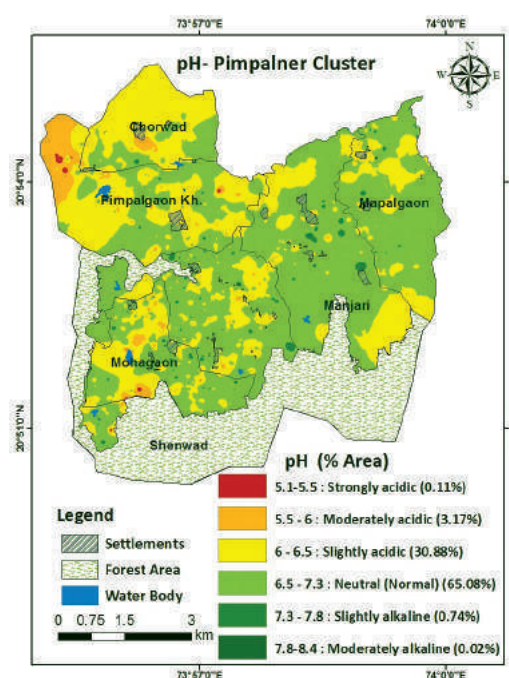


Figure 9: Status of pH in the soils of Pimpalner Cluster

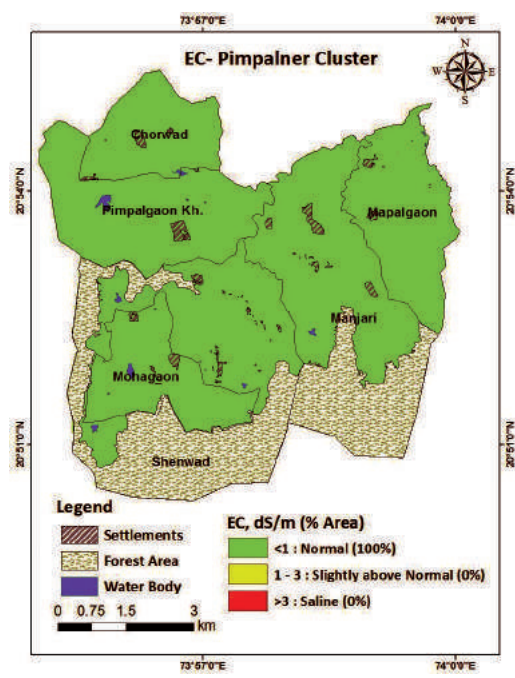


Figure 10: Status of electrical conductivity in the soils of Pimpalner Cluster

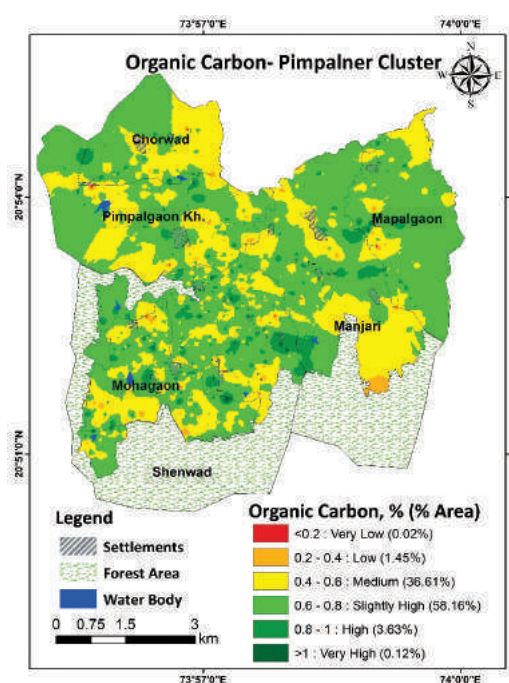


Figure 11: Status of Organic Carbon in the soils of Pimpalner Cluster

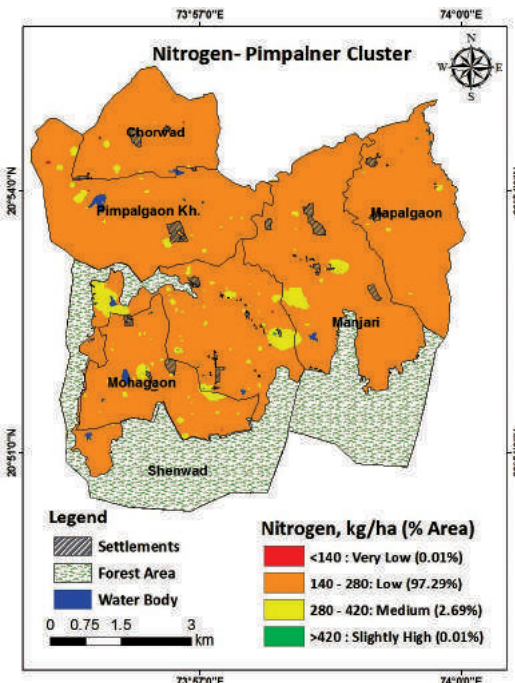


Figure 12: Status of available Nitrogen in the soils of Pimpalner Cluster



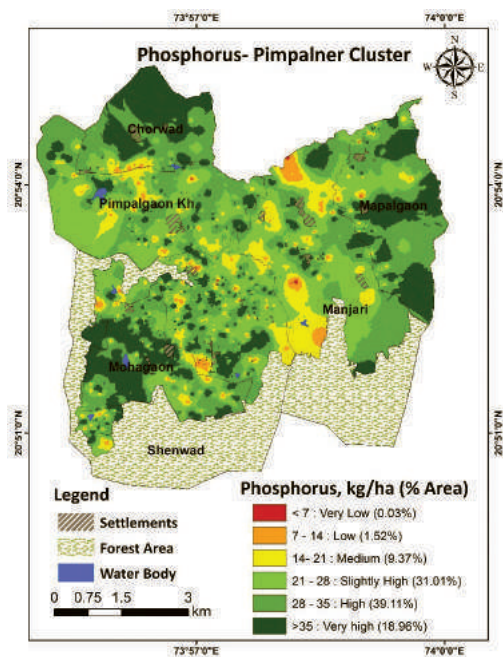


Figure 13: Status of available Phosphorus in the soils of Pimpalner Cluster

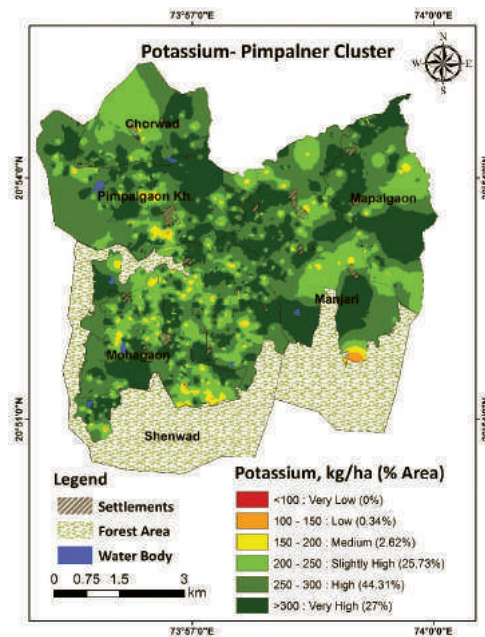


Figure 14: Status of available Potassium in the soils of Pimpalner Cluster

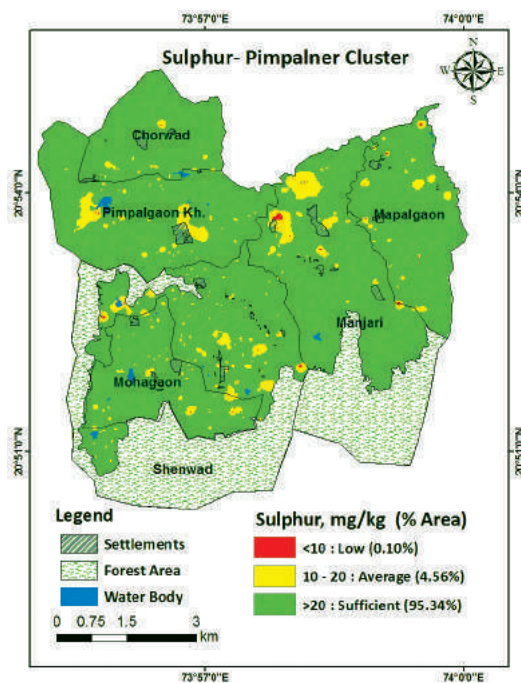


Figure 15: Status of available Sulphur in the soils of Pimpalner Cluster

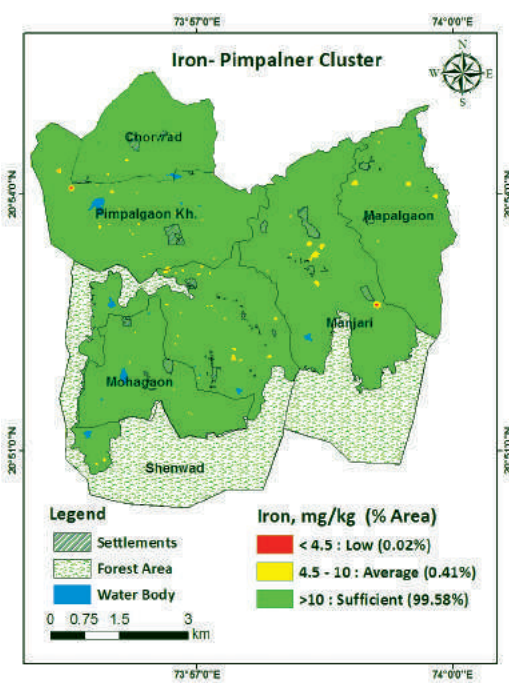


Figure 16: Status of available Iron in the soils of Pimpalner Cluster

# Soil Fertility Status of Bhokardan Cluster of Bhokardan block, Jalna

Eight villages from Bhokardan block in Jalna district, which cover an area of 6989 hectares, were selected for the project. Table 13 provides the area, total no. of households and no. of soil samples tested from each of the project village in the cluster. Figure 17 shows the location of cluster villages within Jalna district.

Table 13: Village wise area, households and the soil samples test from the Bhokardan cluster

Sr. No.	Villages	Area (Ha)	Total No. of Households	No. of Soil Samples tested
1	Banegaon	916	333	83
2	Chandai Tepli	788	295	296
3	Chandai Thombri	1,024	351	268
4	Chincholi	1,239	259	216
5	Deulgaon Tad	760	186	233
6	Palaskheda Thombari	575	200	161
7	Pimpalgaon Barav	619	146	211
8	Thigalkheda	1,068	357	356
	Total	6,989	2,127	1,824

The soil samples collected from Bhokardan cluster are categorized in various categories on the basis of soil nutrient availability and soil test results (Table 14 to Table 20).

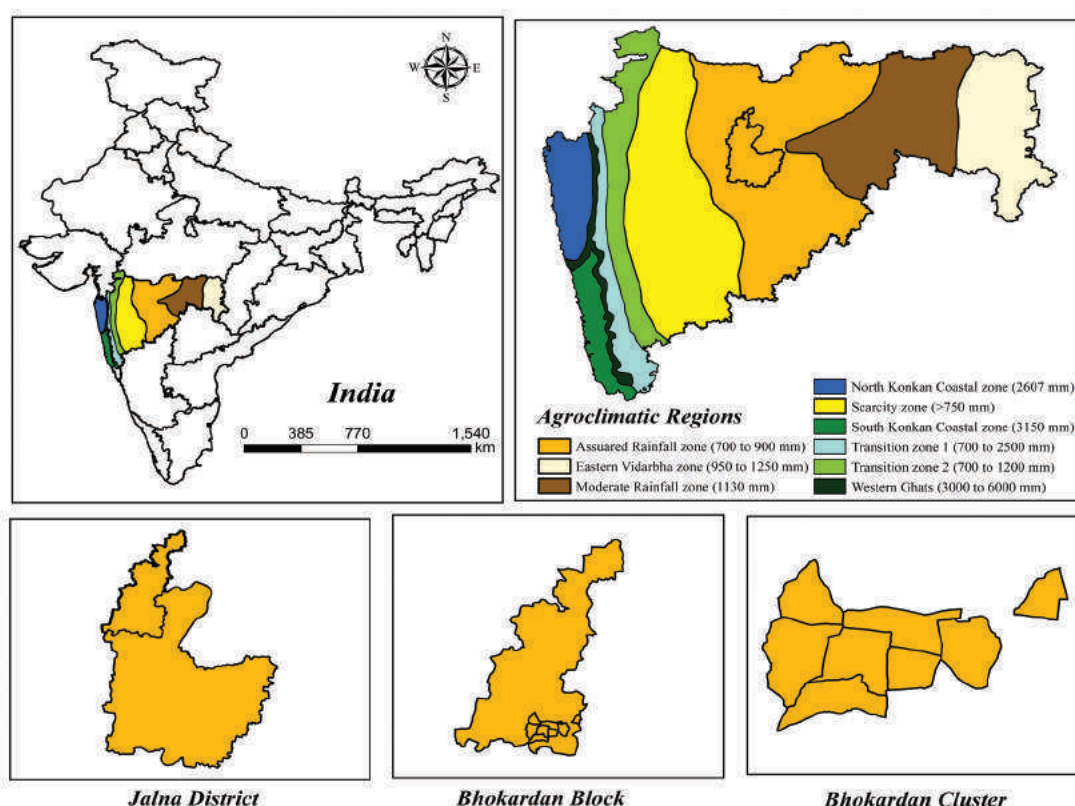


Figure 17: GIS based map showing geographical location of the Bhokardan cluster in Jalna, Maharashtra



## Soil pH

The soil pH of Bhokardan cluster ranges between 5.80 to 9.22 with an average soil pH of 7.78. About 69.74% soil samples were reported in slightly to moderately alkaline while, 18.86% soil samples reported neutral soil pH. About 9.76% soils samples were found in strongly alkaline category with only 1% samples were reported in slightly to moderately acidic category. Few soil samples (less than 2%) from Banegaon, Pimpalgaon barav and Thigalkheda were found to be very strongly alkaline in nature. More than 50% soil samples from Banegaon and Thigalkheda reported in moderately to very strongly alkaline category.

Table 14: Village wise categorization of soil samples (%) based on soil pH in Bhokardan cluster

Villages	Soil pH (%)						
	Moderately acidic	Slightly acidic	Neutral	Slightly alkaline	Moderately alkaline	Strongly alkaline	Very strongly alkaline
Banegaon	0.00	1.20	14.46	25.30	46.99	10.84	1.20
Chandai Tepli	0.34	0.68	16.22	45.95	31.76	5.07	0.00
Chandai Thombari	0.00	2.61	22.76	48.88	17.54	8.21	0.00
Chincholi	0.00	1.39	21.30	40.28	29.63	7.41	0.00
Deulgaon Tad	0.43	1.29	19.74	47.64	21.03	9.87	0.00
Palaskheda Thombari	0.00	0.00	31.68	45.96	20.50	1.86	0.00
Pimpalgaon Barav	0.00	0.47	16.59	34.12	33.65	13.74	1.42
Thigalkheda	0.28	0.00	12.64	31.74	36.52	17.13	1.68
Bhokardan Cluster	0.16	0.93	18.86	40.84	28.89	9.76	0.55

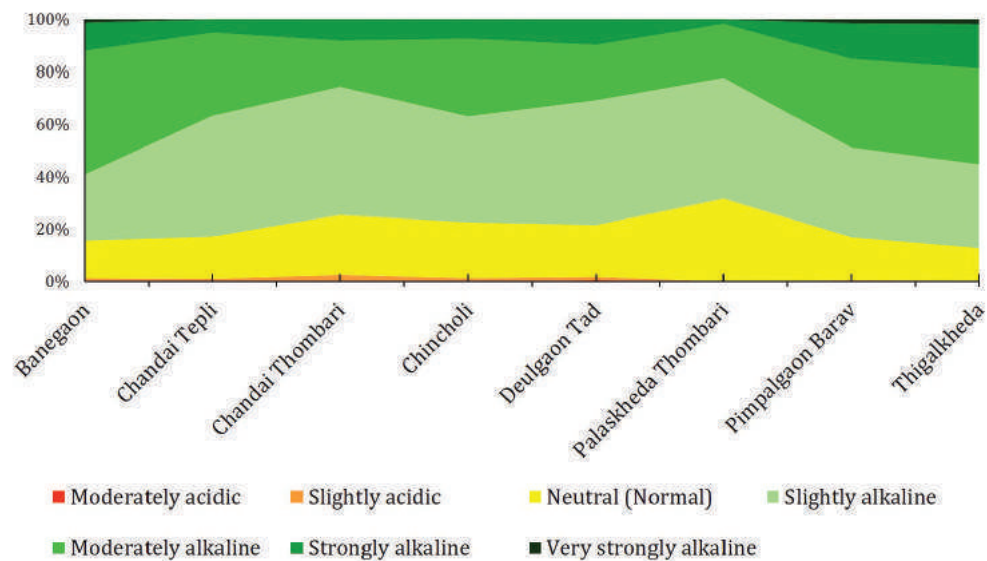


Figure 18: Village wise representation of soil samples (%) based on soil pH in Bhokardan cluster

## Soil Electrical Conductivity (EC)

The electrical conductivity of soil samples collected from Bhokardan cluster ranges between 0.01 to 1.84 with an average value of 0.42. Almost all the soil samples (99.23%) from the Bhokardan cluster are in normal range of their soluble salt content (EC below 1).

## Soil Organic Carbon (OC)

The organic carbon in the soil samples collected from Bhokardan cluster ranges between 0.03 to 1.78% with an average value of 0.47%. About 74.67% of collected soil samples from all the villages in the Bhokardan cluster reported very low to medium availability of organic carbon in the soil while, about 24.34% soil samples reported slightly high to high levels of organic carbon. Less than 1% soil samples were found in the very high category of organic carbon.

Table 15: Village wise categorization of soil samples (%) based on available soil organic carbon in Bhokardan cluster

Villages	Soil Organic Carbon(%)					
	Very Low	Low	Medium	Slightly High	High	Very High
Banegaon	3.61	15.66	40.96	30.12	8.43	1.20
Chandai Tepli	10.47	39.19	33.45	12.84	3.72	0.34
Chandai Thombari	11.94	32.84	41.04	8.21	5.22	0.75
Chincholi	5.09	25.93	43.06	20.37	5.09	0.46
Deulgaon Tad	3.43	35.62	39.06	17.60	3.86	0.43
Palaskheda Thombari	5.59	38.51	38.51	14.29	2.48	0.62
Pimpalgaon Barav	3.32	29.38	33.18	27.96	5.69	0.47
Thigalkheda	5.06	25.00	32.30	24.44	10.39	2.81
Bhokardan Cluster	6.52	31.20	36.95	18.59	5.76	0.99

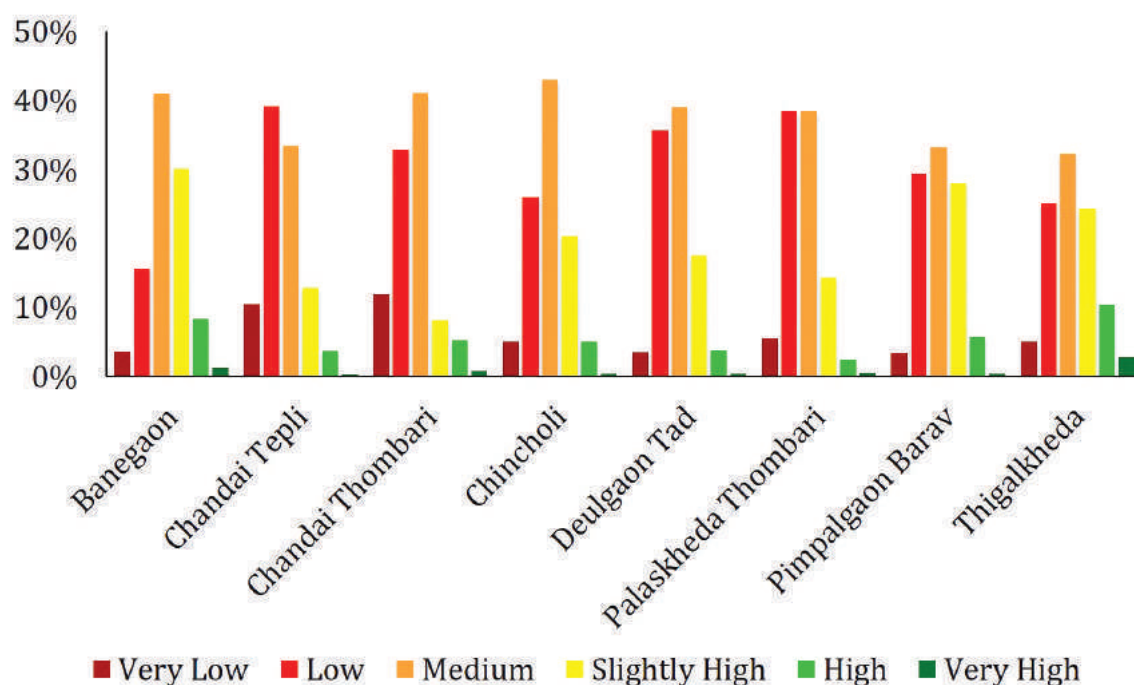


Figure 19: Village wise representation of soil samples (%) based on organic carbon availability in soil of Bhokardan cluster



## Soil Nitrogen (N)

The available nitrogen in the soil samples collected from Bhokardan cluster ranges between 12.5 to 608.3 kg/ha with an average value of 186.3 kg/ha. Almost all soil samples from all the villages in the Bhokardan cluster reported low to very low available nitrogen in the soil. About 74.45% samples reported low nitrogen availability while about 19.63% soil samples showed very low soil nitrogen levels. Few soil samples (5.7%) from the cluster reported average nitrogen level while no soil sample from the cluster showed in very high nitrogen category. Almost all soil samples from the Bhokardan cluster showed higher nitrogen deficiency (above 90%).

Table 16: Village wise categorization of soil samples (%) based on available soil Nitrogen in Bhokardan cluster

Villages	Soil Available Nitrogen (%)					
	Very Low	Low	Medium	Slightly High	High	Very High
Banegaon	9.64	78.31	12.05	0.00	0.00	0.00
Chandai Tepli	29.73	65.54	4.73	0.00	0.00	0.00
Chandai Thombari	26.12	69.03	4.85	0.00	0.00	0.00
Chincholi	17.59	76.39	6.02	0.00	0.00	0.00
Deulgaon Tad	20.60	71.67	7.30	0.43	0.00	0.00
Palaskheda Thombari	24.84	73.29	1.24	0.00	0.62	0.00
Pimpalgaon Barav	9.00	84.83	6.16	0.00	0.00	0.00
Thigalkheda	13.20	80.06	6.18	0.56	0.00	0.00
Bhokardan Cluster	19.63	74.45	5.70	0.16	0.05	0.00

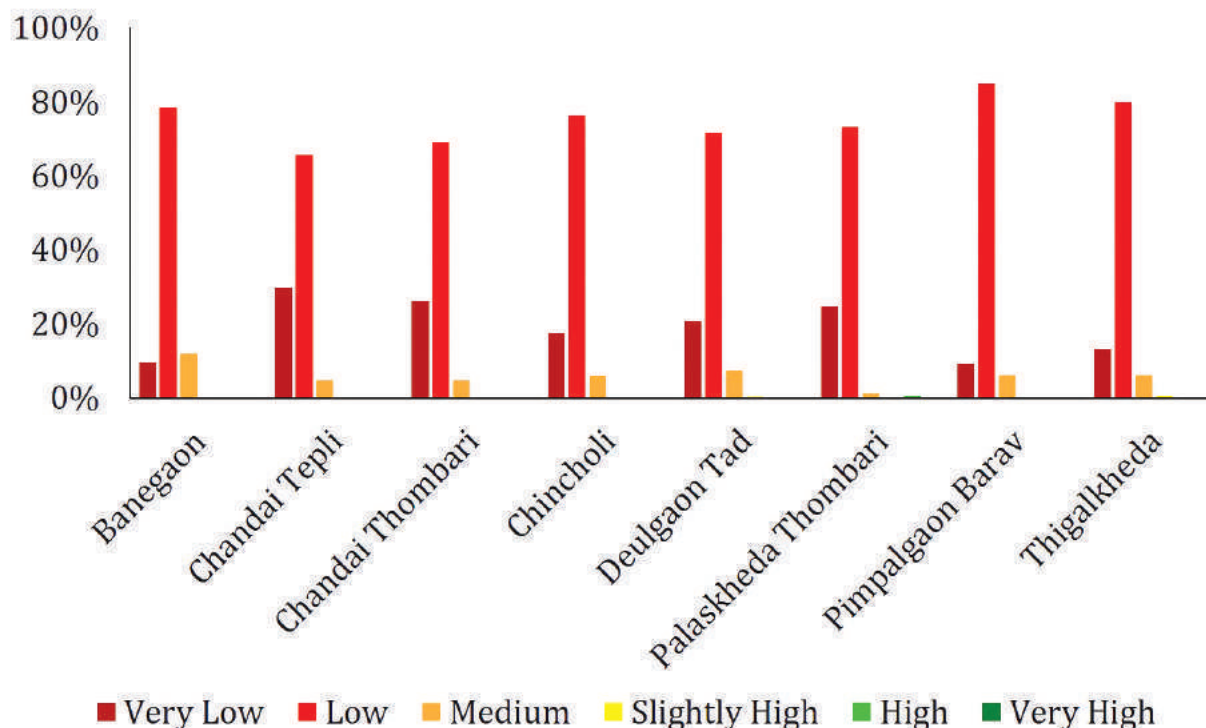


Figure 20: Village wise representation of soil samples (%) based on soil Nitrogen availability in Bhokardan cluster

## Soil Phosphorous (P)

The available phosphorous in the soil samples collected from Bhokardan cluster ranges between 0.1 to 94.9 kg/ha with an average value of 22.3 kg/ha. About 44.19% samples reported slightly high to very high phosphorous availability while about 41.34% soil samples showed low to very low soil phosphorous category. More than 50% Soil samples from Chandai Thombari and Deulgaon Tad reported low to very low soil phosphorous while about 44% soil samples from Banegaon reported very high levels of soil phosphorous.

Table 17: Village wise categorization of soil samples (%) based on available soil Phosphorous in Bhokardan cluster

Villages	Soil Available Phosphorus (%)					
	Very Low	Low	Medium	Slightly High	High	Very High
Banegaon	7.23	13.25	10.84	9.64	14.46	44.58
Chandai Tepli	20.61	26.69	12.16	12.16	5.41	22.97
Chandai Thombari	31.72	20.90	15.67	9.33	8.96	13.43
Chincholi	20.37	19.91	15.28	13.43	12.50	18.52
Deulgaon Tad	24.03	26.18	14.59	9.44	6.01	19.74
Palaskheda Thombari	26.71	22.36	14.91	11.80	8.07	16.15
Pimpalgaon Barav	10.90	15.64	18.96	18.01	12.32	24.17
Thigalkheda	10.96	21.91	12.92	14.04	9.55	30.62
Bhokardan Cluster	19.57	21.77	14.47	12.45	9.10	22.64

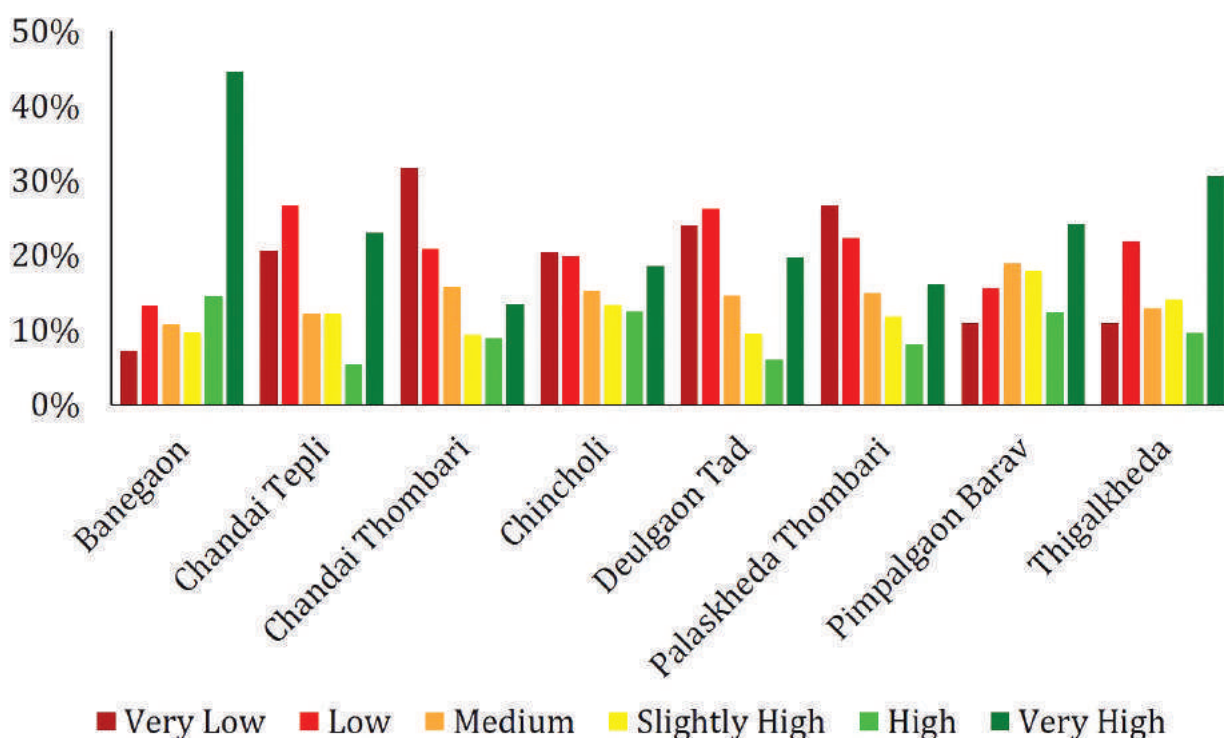


Figure 21: Village wise representation of soil samples (%) based on soil Phosphorous availability in Bhokardan cluster



## Soil Potassium (K)

The available potassium in the soil samples collected from Bhokardan cluster ranges between 107.3 to 1344.0 kg/ha with an average value of 448.8 kg/ha. Most of the soil samples from all the villages in the Bhokardan cluster reported slightly high to very high availability of potassium in the soil. About 71.22% samples reported very high potassium availability while about 8.11% and 9.38% soil samples showed high and slightly high soil potassium. No soil sample from the cluster reported in very low category while, soil samples from Chandai Thombari and Palaskheda Thombari reported highest availability of Potassium with above 80% soil samples reported in very high potassium category.

Table 18: Village wise categorization of soil samples (%) based on available soil Potassium in Bhokardan cluster

Villages	Soil Available Potassium (%)					
	Very Low	Low	Medium	Slightly High	High	Very High
Banegaon	0.00	0.00	12.05	19.28	16.87	51.81
Chandai Tepli	0.00	7.09	15.54	8.78	6.76	61.82
Chandai Thombari	0.00	1.12	3.73	5.97	4.48	84.70
Chincholi	0.00	3.70	11.11	11.57	11.57	62.04
Deulgaon Tad	0.00	2.15	7.73	8.58	5.15	76.39
Palaskheda Thombari	0.00	1.24	0.62	4.35	4.97	88.82
Pimpalgaon Barav	0.00	3.32	6.16	11.37	13.27	65.88
Thigalkheda	0.00	2.25	8.43	10.39	8.15	70.79
Bhokardan Cluster	0.00	2.96	8.33	9.38	8.11	71.22

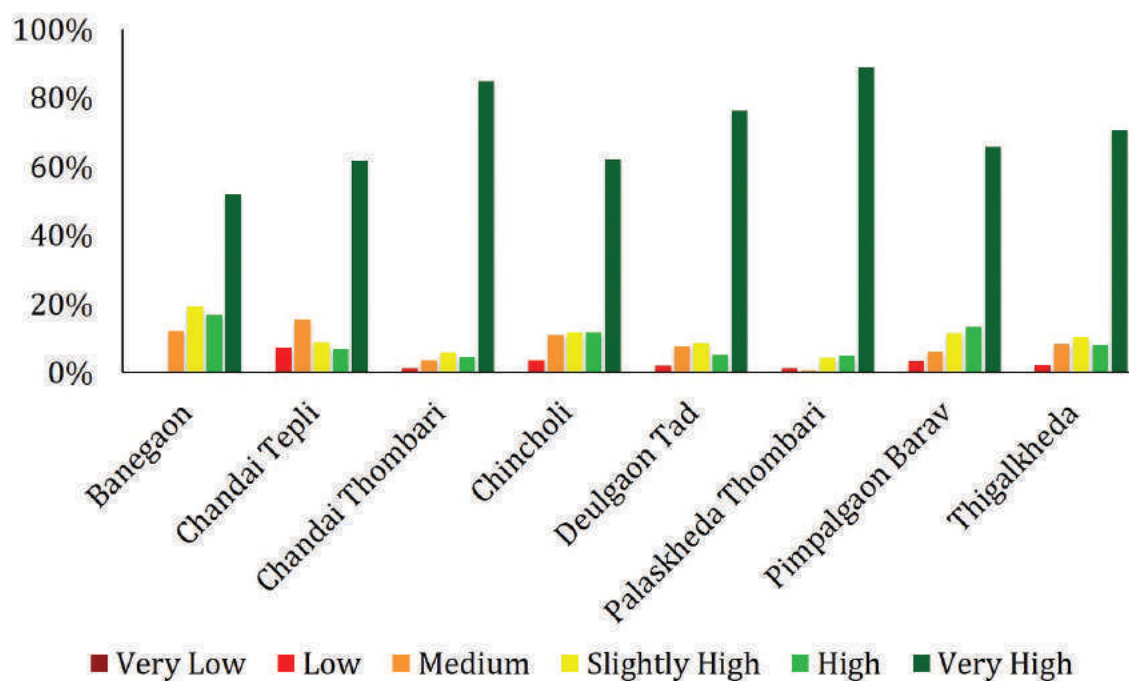


Figure 22: Village wise representation of soil samples (%) based on soil Potassium availability in Bhokardan cluster

## Sulphur (S)

The available Sulphur in the soil samples collected from Bhokardan cluster ranges between 6.16 to 95.40 mg/kg with an average value of 26.53 mg/kg. About 60.29% samples reported sufficient Sulphur availability while about 36.15% soil samples showed average soil Sulphur.

Table 19: Village wise categorization of soil samples (%) based on available soil Sulphur in Bhokardan cluster

Villages	Soil Available Sulphur (%)		
	Low	Average	Sufficient
Banegaon	4.29	30.00	65.71
Chandai Tepli	3.60	48.92	47.48
Chandai Thombari	1.67	28.33	70.00
Chincholi	1.41	40.14	58.45
Deulgaon Tad	2.06	34.02	63.92
Palaskheda Thombari	1.89	30.19	67.92
Pimpalgaon Barav	4.88	32.32	62.80
Thigalkheda	5.06	33.46	61.48
Bhokardan Cluster	3.56	36.15	60.29

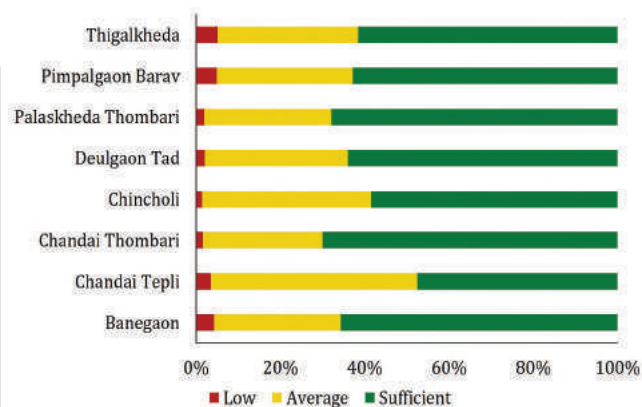


Figure 23: Village wise representation of soil samples (%) based on soil Sulphur availability in Bhokardan cluster

## Iron (Fe)

The available Iron in the soil samples collected from Bhokardan cluster ranges between 0.11 to 38.10 mg/kg. with an average value of 6.68 mg/kg. About 38.55% samples reported low Iron availability while 40.39% soil samples showed average soil Iron.

Table 20: Village wise categorization of soil samples (%) based on available soil Iron in Bhokardan cluster

Villages	Soil Available Iron (%)		
	Low	Average	Sufficient
Banegaon	42.86	35.71	21.43
Chandai Tepli	58.46	35.38	6.15
Chandai Thombari	31.37	39.22	29.41
Chincholi	29.55	48.48	21.97
Deulgaon Tad	52.87	34.48	12.64
Palaskheda Thombari	30.23	48.84	20.93
Pimpalgaon Barav	33.97	38.46	27.56
Thigalkheda	32.68	41.63	25.68
Bhokardan Cluster	38.55	40.39	21.06

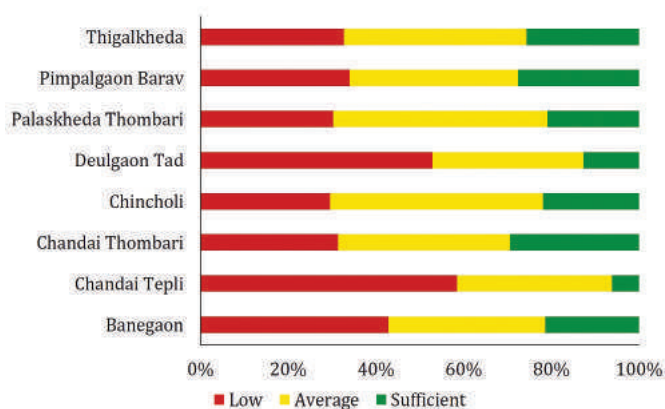
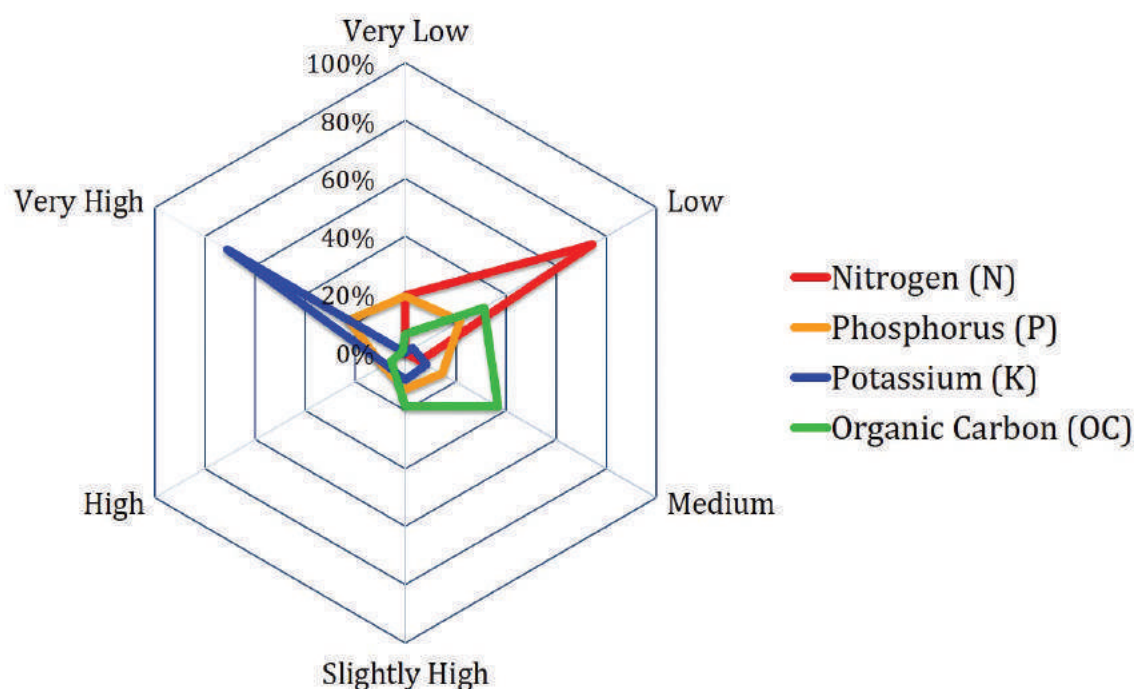


Figure 24: Village wise representation of soil samples (%) based on soil Iron availability in Bhokardan cluster



## Overall soil health status of Bhokardan Cluster

Soils in the selected villages of Bhokardan block are slightly to moderately alkaline in reaction with normal range of soluble salt content (EC). The organic carbon content of the region ranges between low to slightly high. Soils were predominantly low in available Nitrogen, low to very high in Phosphorus and very high in Potassium. The secondary nutrient like Sulphur is also available in sufficient quantity while micronutrient like Iron is available in low to average levels.



**RADAR CHART REPRESENTING THE OVERALL SOIL HEALTH STATUS OF BHOKARDAN CLUSTER**

### Reclamation of Soils in Bhokardan Cluster

Overall the percentage of alkali (sodic soils) are higher in Bhokardan cluster, therefore the reclamation measures for alkali soils are given below:

- 1) Application of gypsum is recommended to reclaim the Alkali (sodic) soils.
- 2) The alkali soils that contain free Calcium carbonate can be effectively reclaimed by addition of Sulphur, Sulphuric acid, Iron and Aluminium sulphate, Green manure etc. If Calcium carbonate is not present in the soil, it should be added artificially when Sulphur is used for reclamation.
- 3) The addition of organic matter increases acidity, thus, helps in lowering the pH. Organic matter is especially helpful where Sulphur is added to correct alkalinity. The organic matter supply food for the bacteria that stimulates the oxidation of Sulphur to the Sulphate form.
- 4) Addition of molasses in the soil facilitates fast growth of soil micro-organisms which on fermentation produce organic acid and reduce soil alkalinity.
- 5) In alkali soils, crop can be selected based on their ability to tolerate the soil sodicity.

# OVERALL SOIL HEALTH STATUS OF BHOKARDAN CLUSTER

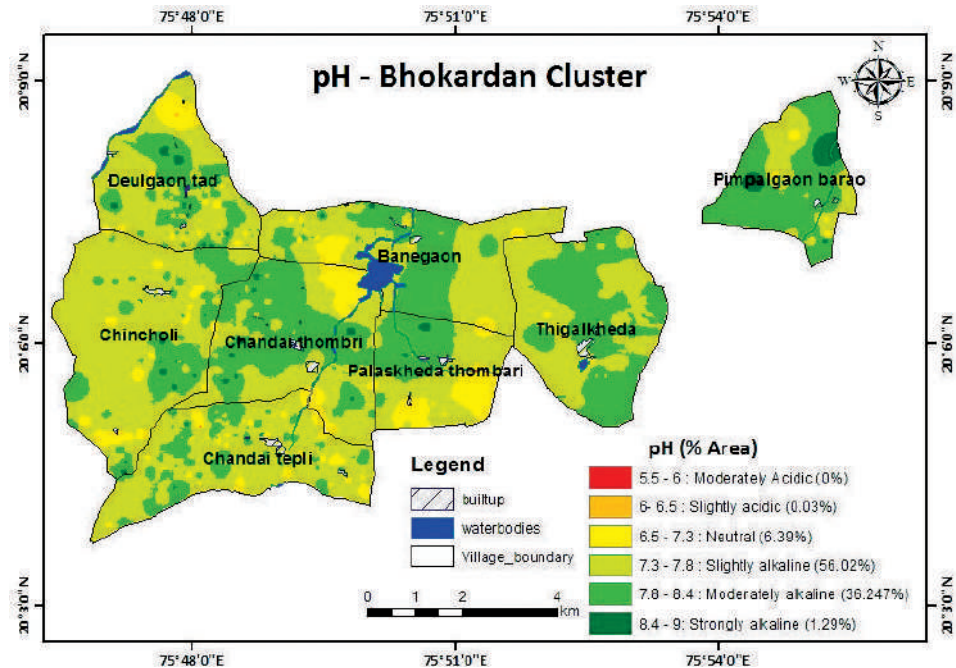


Figure 25: Status of pH in the soils of Bhokardan Cluster

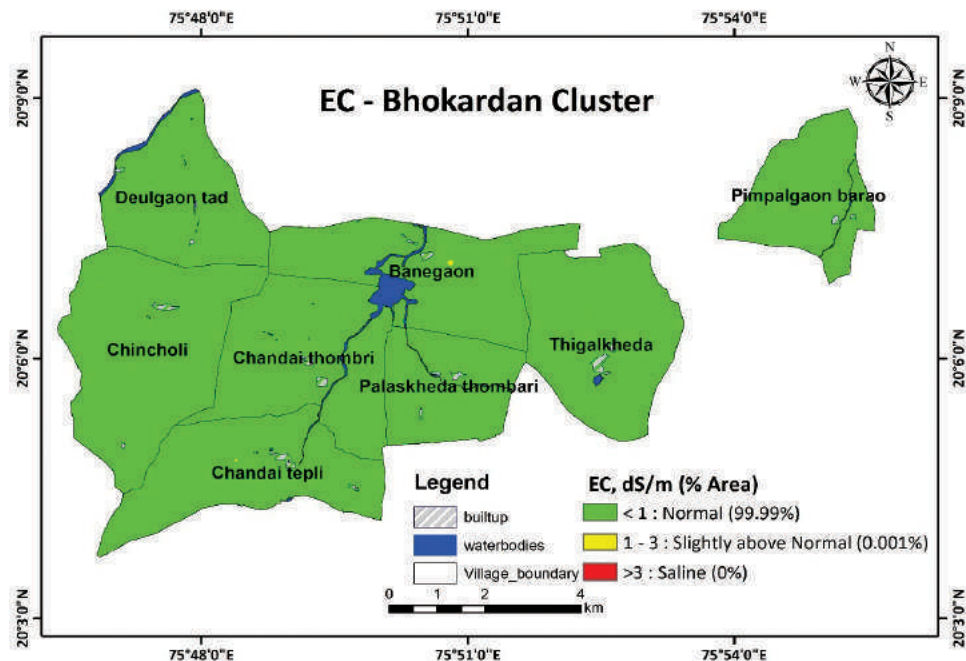


Figure 26: Status of electrical conductivity in the soils of Bhokardan Cluster



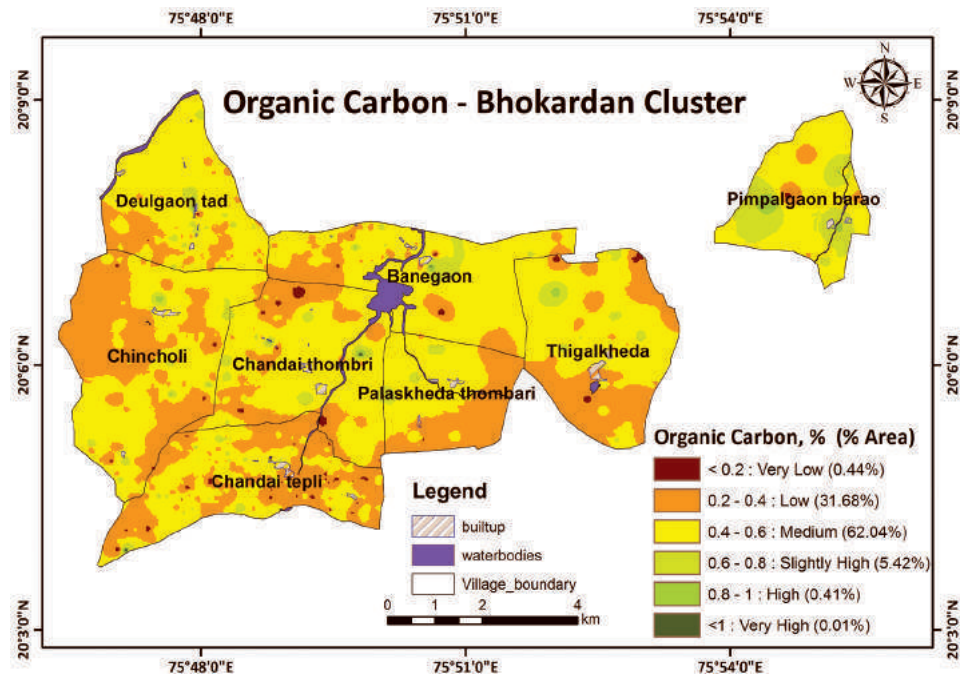


Figure 27: Status of Organic Carbon in the soils Bhokardan Cluster

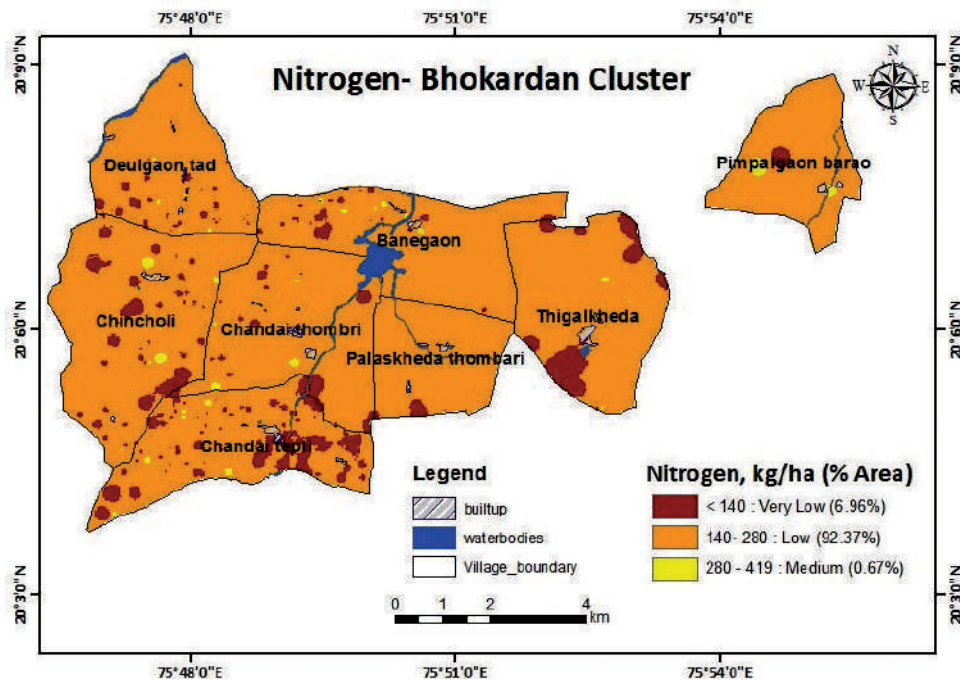


Figure 28: Status of available Nitrogen in the soils of Bhokardan Cluster

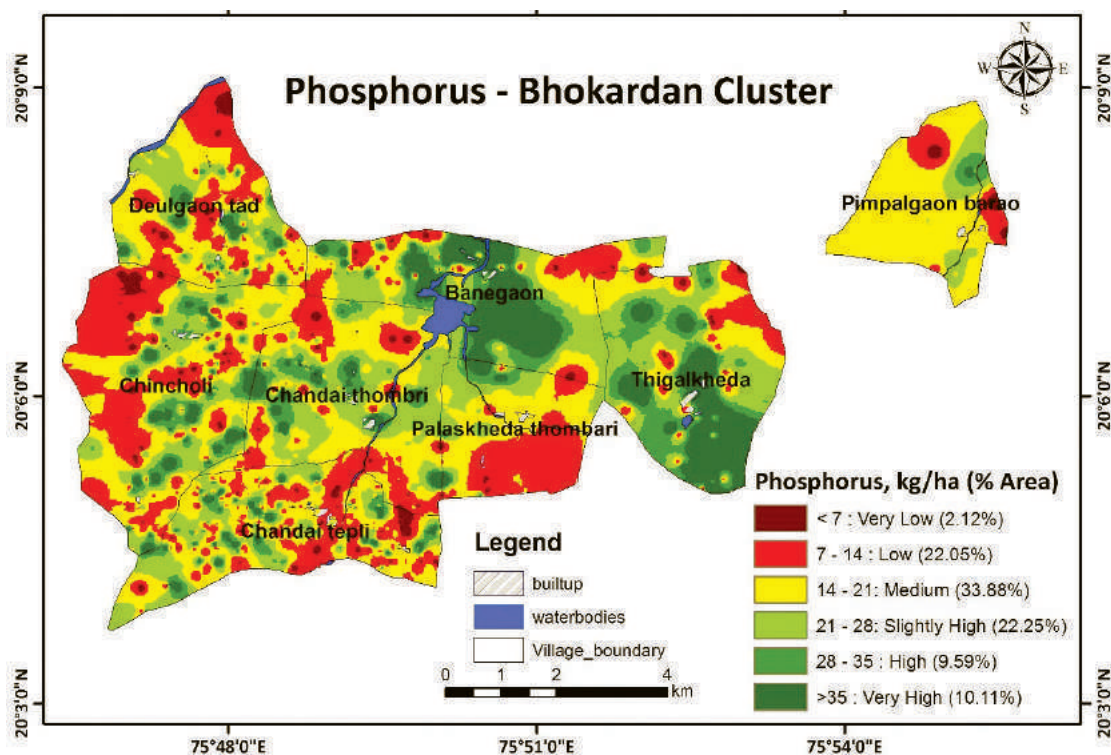


Figure 29: Status of available Phosphorus in the soils of Bhokardan Cluster

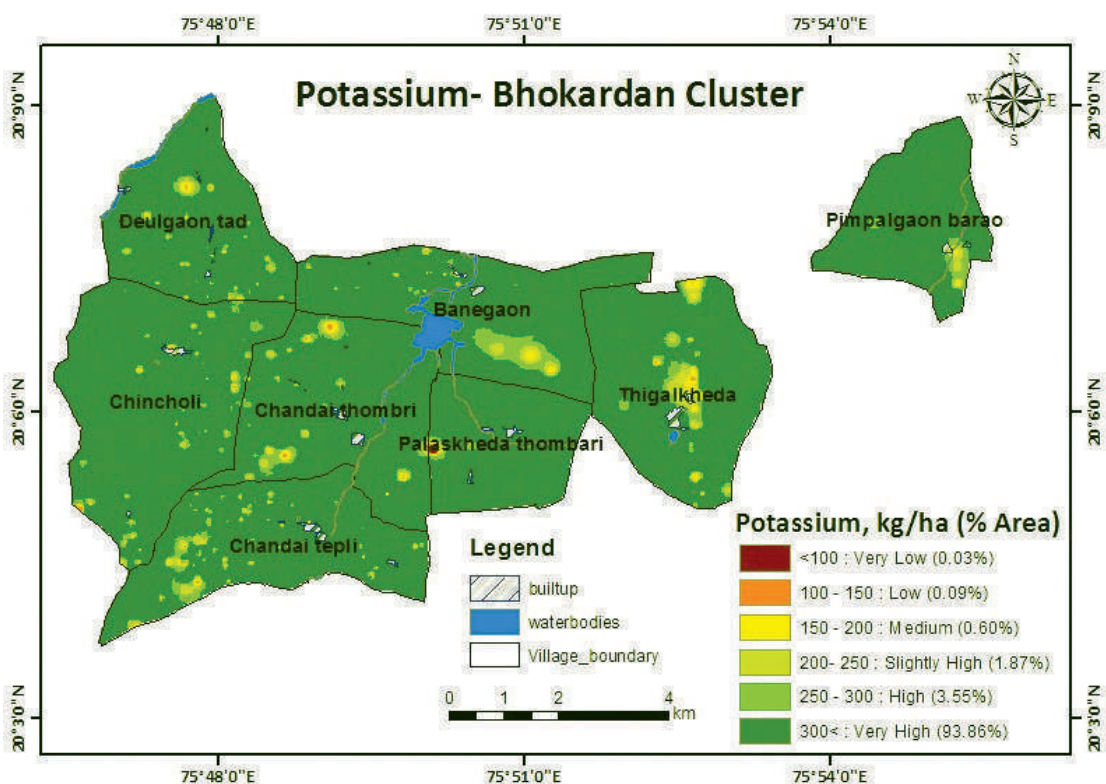


Figure 30: Status of available Potassium in the soils of Bhokardan Cluster



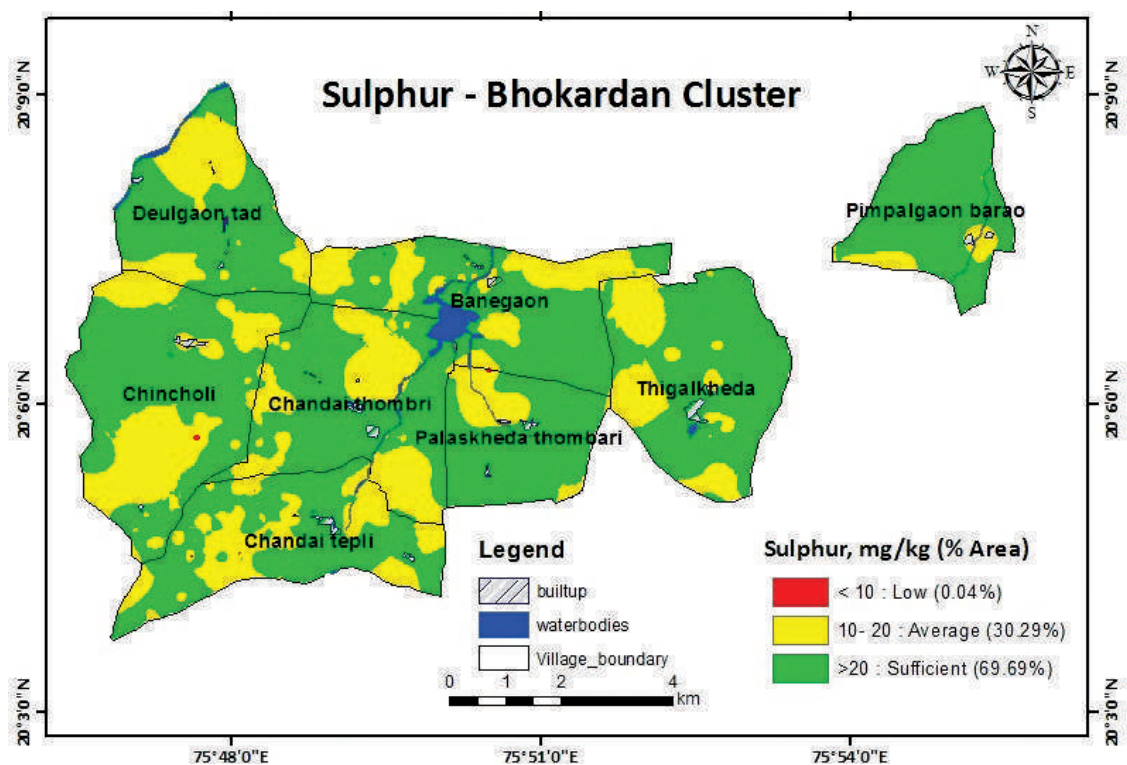


Figure 31: Status of available Sulphur in the soils of Bhokardan Cluster

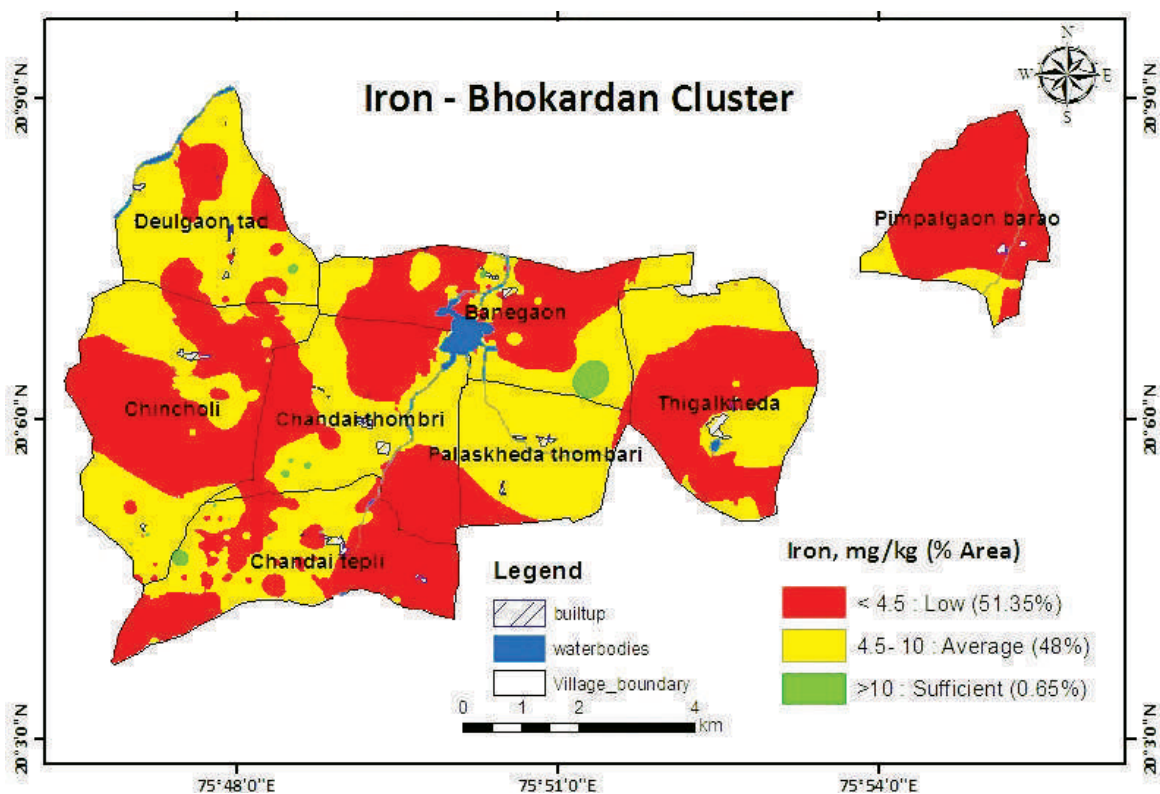


Figure 32: Status of available Iron in the soils of Bhokardan Cluster

# Soil Health Status of Bhalwani Cluster of Parner

Seven villages from Parner block in Ahmednagar district, which cover an area of 5861 hectares, were selected for the project. Table 21 provides the area, total no. of households and no. of soil samples tested from each of the project village in the cluster.

Table 21: Village wise area, households and the soil samples tested from the Bhalwani cluster

Sr. No.	Villages	Area (Ha)	Total No. of Households	No. of Soil Samples tested
1	Sutarwadi	712	121	343
2	Gawadewadi and Waghwadi	990	156	226
3	Bhanagadewadi	1,199	240	281
4	Hanumanwadi	280	65	151
5	Hiwarekorda	1,327	407	462
6	Kutewadi	880	107	294
7	Ranmala	473	94	208
	Total	5,861	1,190	1,965

\* Waghwadi is a hamlet of Gawadewadi so its data on area and population are not available separately and hence it is merged in this table. However, soil sample analysis is reported separately in this report.

Figure 33 shows the location of cluster villages within Ahmednagar district. Ranmala, Sutarwadi, Gawadewadi, Kutewadi and Hanumanwadi are hamlets of village Dhavalpuri. Hence they are represented by the name Dhavalpuri in the Figure 33

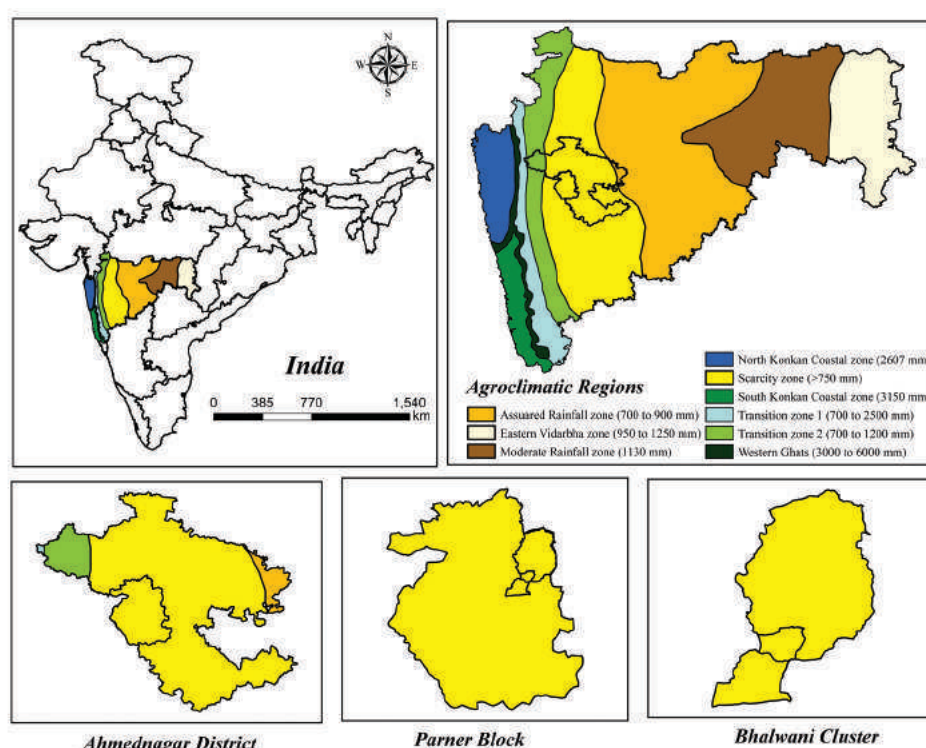


Figure 33: GIS based map showing geographical location of the Bhalwani cluster in Ahmednagar, Maharashtra



The soil samples collected from Bhalwani cluster are categorized in various categories on the basis of soil nutrient availability and soil test results (Table 22 to Table 28).

## Soil pH

The soil pH of Bhalwani cluster ranges between 6.78 to 9.35 with an average soil pH of 8.37. Less than 3% soil samples reported neutral soil pH while all the other soil samples reported slight to very high alkalinity in the soil. About 90.64% soils samples were found moderately (49%) to strongly alkaline category (41%) while, about 6% samples were found to be slightly alkaline. Less than 1% soil samples reported as very strongly alkaline.

Table 22: Village wise categorization of soil samples (%) based on soil pH in Bhalwani cluster

Villages	Soil pH						
	Moderately acidic	Slightly acidic	Neutral	Slightly alkaline	Moderately alkaline	Strongly alkaline	Very strongly alkaline
Sutarwadi	0.00	0.00	0.87	13.99	40.82	43.73	0.58
Gawadewadi	0.00	0.00	0.65	6.49	53.25	39.61	0.00
Bhanagadewadi	0.00	0.00	1.07	6.05	41.99	50.53	0.36
Hanumanwadi	0.00	0.00	1.99	3.31	63.58	31.13	0.00
Hiwarekorda	0.00	0.00	1.52	4.33	59.09	35.06	0.00
Kutewadi	0.00	0.00	5.44	7.48	43.20	43.54	0.34
Ranmala	0.00	0.00	1.44	3.85	50.48	43.27	0.96
Waghwadi	0.00	0.00	12.50	2.78	43.06	40.28	1.39
Bhalwani Cluster	0.00	0.00	2.29	6.72	49.47	41.17	0.36

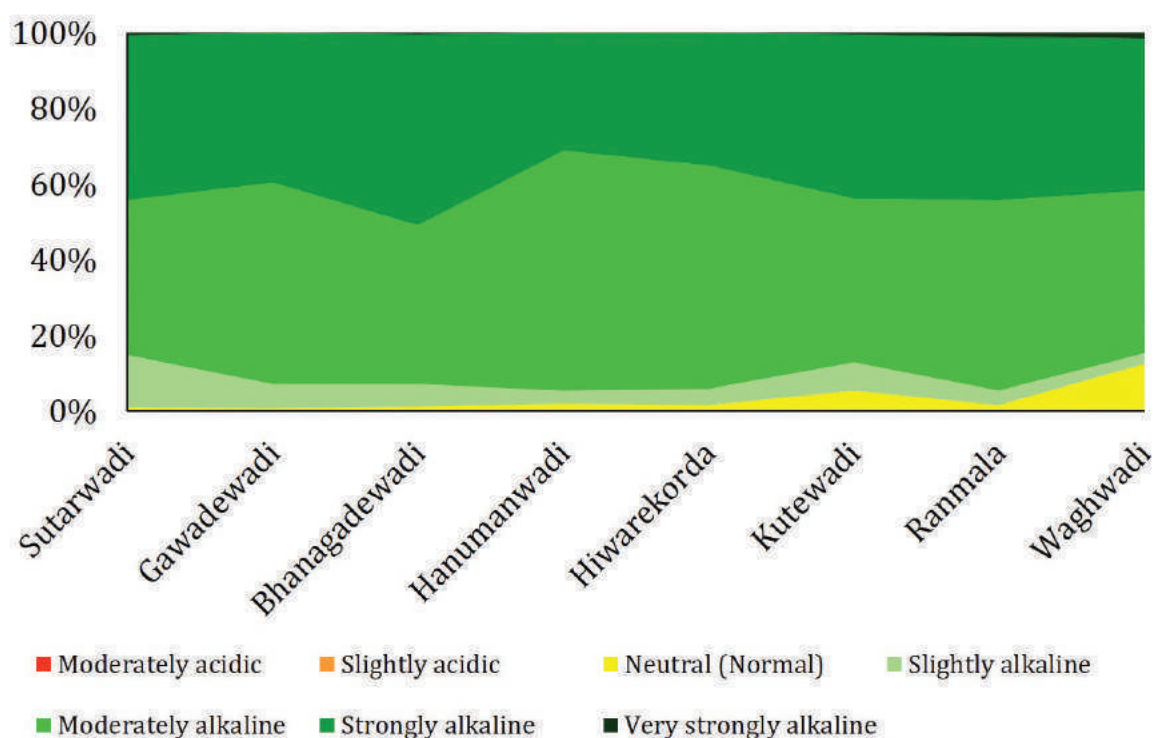


Figure 34: Village wise representation of soil samples (%) based on soil pH in Bhalwani cluster

## Soil Electrical Conductivity (EC)

The electrical conductivity of soil samples collected from Bhalwani cluster ranges between 0.05 to 2.80 with an average value of 0.29. Almost all the soil samples (99.49%) from the Bhalwani cluster are in normal range of their soluble salt content (i.e. EC below 1).

## Soil Organic Carbon (OC)

The organic carbon in the soil samples collected from Bhalwani cluster ranges between 0.08 to 0.98% with an average value of 0.52%. About 62.75% of collected soil samples from all the villages in the Bhalwani cluster reported medium to low availability of organic carbon in the soil while, about 36% soil samples reported slightly high to high levels of organic carbon (Table 5). No soil samples was found in the very high category of organic carbon. More than 40% soil samples from Sutarwadi showed low content of available soil organic carbon.

Table 23: Village wise categorization of soil samples (%) based on available soil organic carbon in Bhalwani cluster

Villages	Soil Organic Carbon(%)					
	Very Low	Low	Medium	Slightly High	High	Very High
Sutarwadi	2.04	40.52	34.40	18.37	4.66	0.00
Gawadewadi	0.65	35.06	24.68	31.82	7.79	0.00
Bhanagadewadi	1.78	15.66	36.65	34.88	11.03	0.00
Hanumanwadi	0.00	10.60	25.83	47.68	15.89	0.00
Hiwarekorda	0.22	23.38	36.15	31.60	8.66	0.00
Kutewadi	0.34	26.87	47.28	19.05	6.46	0.00
Ranmala	3.85	28.37	35.10	25.48	7.21	0.00
Waghwadi	0.00	33.33	45.83	15.28	5.56	0.00
Bhalwani Cluster	1.17	26.62	36.13	27.89	8.19	0.00

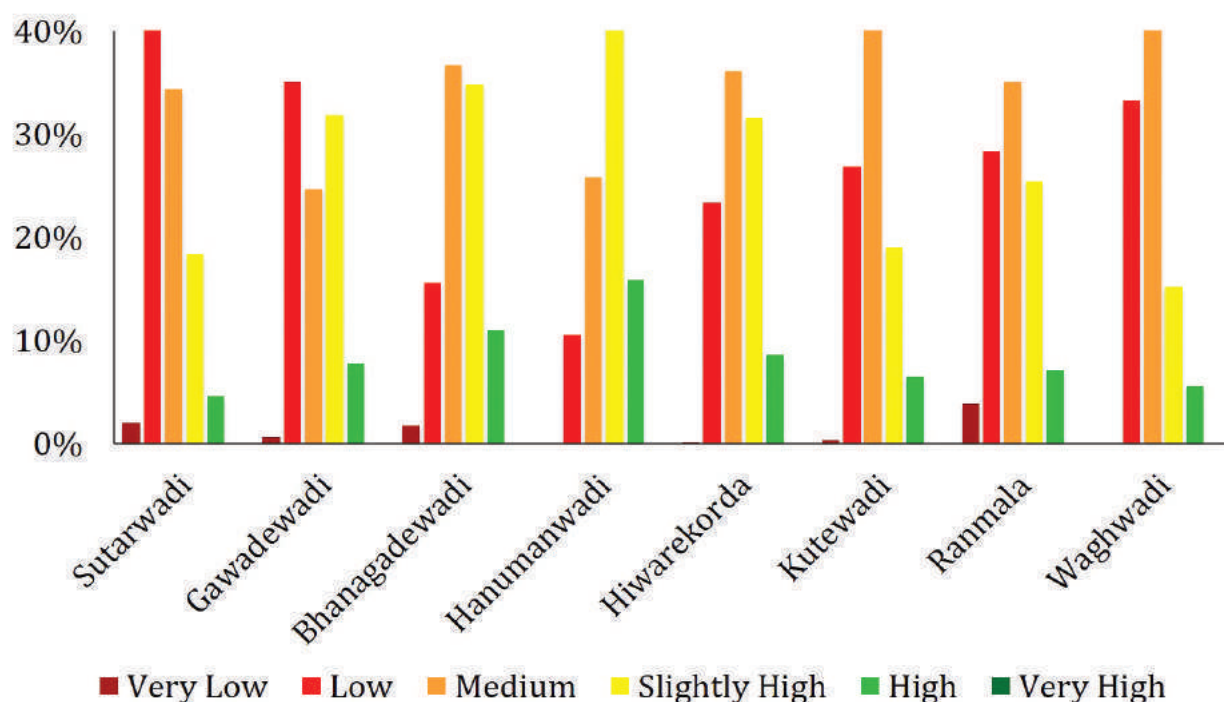


Figure 35: Village wise representation of soil samples (%) based on soil organic carbon availability in Bhalwani cluster

## Soil Nitrogen (N)

The available nitrogen in the soil samples collected from Bhalwani cluster ranges between 118.7 to 404.4 kg/ha with an average value of 259.51 kg/ha. Most of the soil samples from all the villages in the Bhalwani cluster reported low nitrogen in the soil. About 63.87% samples reported low nitrogen while about 34.66% soil samples showed average nitrogen availability in the soil. No soil sample from the cluster reported above medium nitrogen level. Soil samples from Waghwadi, Hanumanwadi and Ranmala villages showed higher nitrogen deficiency (above 70%).

Table 24: Village wise categorization of soil samples (%) based on available soil Nitrogen in Bhalwani cluster

Villages	Soil Available Nitrogen (%)					
	Very Low	Low	Medium	Slightly High	High	Very High
Sutarwadi	1.17	60.64	38.19	0.00	0.00	0.00
Gawadewadi	11.69	53.90	34.42	0.00	0.00	0.00
Bhanagadewadi	0.36	65.48	34.16	0.00	0.00	0.00
Hanumanwadi	0.00	82.78	17.22	0.00	0.00	0.00
Hiwarekorda	0.00	66.88	33.12	0.00	0.00	0.00
Kutewadi	1.36	46.26	52.38	0.00	0.00	0.00
Ranmala	0.96	70.19	28.85	0.00	0.00	0.00
Waghwadi	0.00	88.89	11.11	0.00	0.00	0.00
Bhalwani Cluster	1.48	63.87	34.66	0.00	0.00	0.00

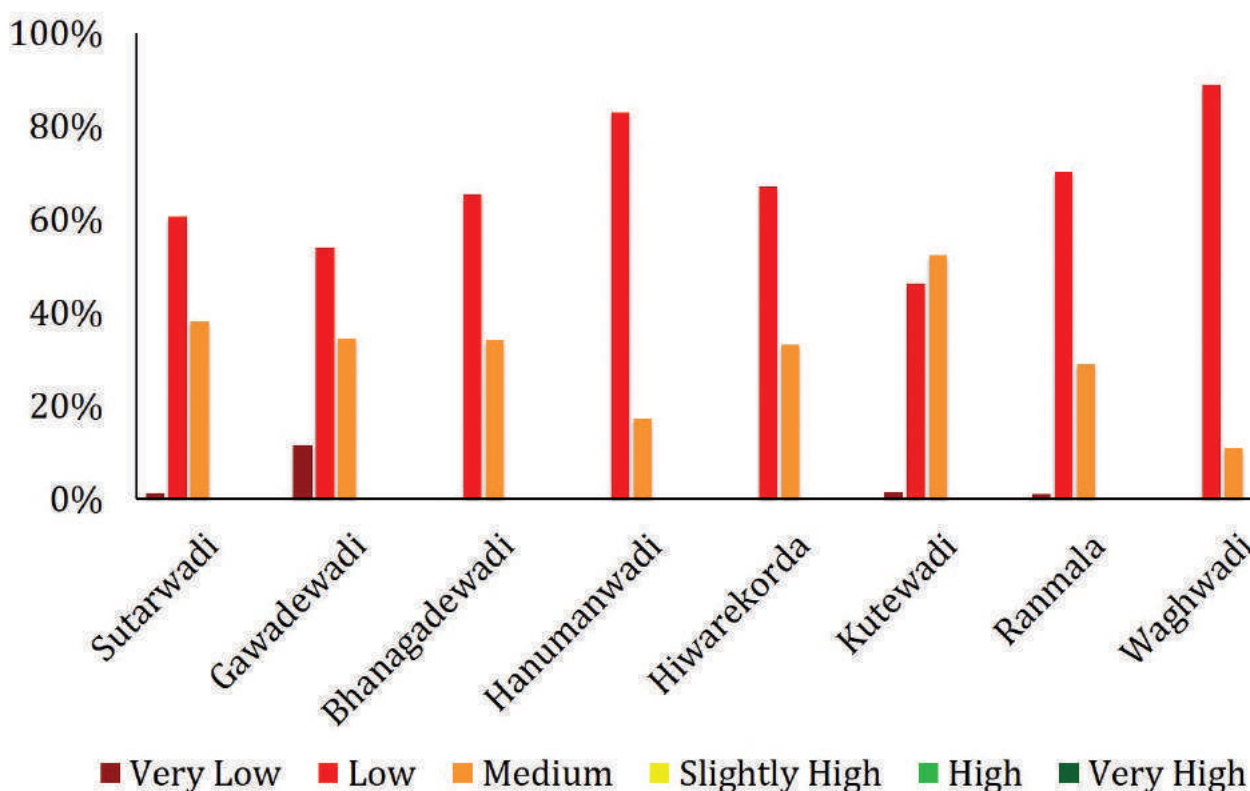


Figure 36: Village wise representation of soil samples (%) based on soil Nitrogen availability in Bhalwani cluster



## Soil Phosphorous (P)

The available phosphorous in the soil samples collected from Bhalwani cluster ranges between 4.15 to 134.0 kg/ha with an average value of 27.39 kg/ha. About 56.64% samples reported slightly high to very high phosphorous availability while about 21.58% soil samples showed low to very low soil phosphorous category (Table 5). Most of the soil samples from all the villages in the Bhalwani cluster reported slightly high to very high availability of phosphorous in the soil except Hanumanwadi (Figure 2 and Figure 3). About 53% samples from Hanumanwadi reported low to very low phosphorous.

Table 25: Village wise categorization of soil samples (%) based on available soil Phosphorous in Bhalwani cluster

Villages	Soil Available Phosphorus (%)					
	Very Low	Low	Medium	Slightly High	High	Very High
Sutarwadi	1.17	16.62	21.87	16.03	17.78	26.53
Gawadewadi	5.84	8.44	26.62	14.29	20.13	24.68
Bhanagadewadi	3.56	18.51	24.56	16.73	18.15	18.51
Hanumanwadi	16.56	35.76	11.26	11.26	17.22	7.95
Hiwarekorda	1.52	17.53	14.72	12.34	19.05	34.85
Kutewadi	2.38	12.24	21.43	16.33	23.13	24.49
Ranmala	5.29	14.90	32.69	9.13	15.87	22.12
Waghwadi	5.56	31.94	37.50	5.56	11.11	8.33
Bhalwani Cluster	3.92	17.66	21.78	13.69	18.63	24.33

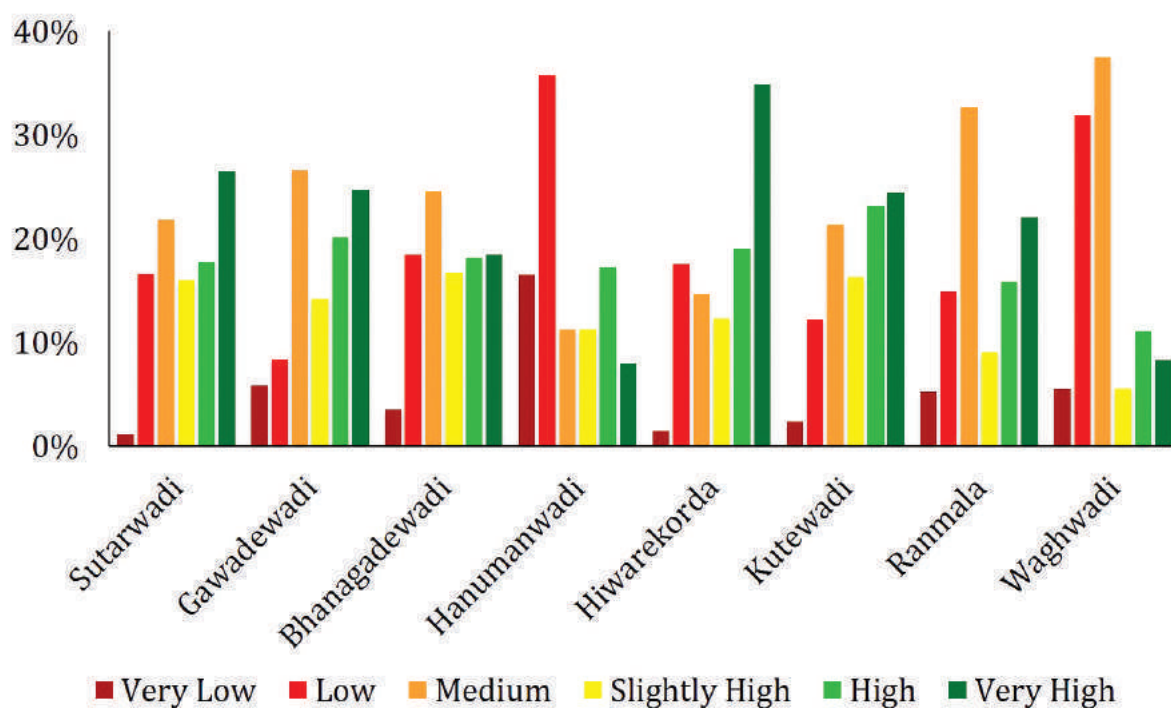


Figure 37: Village wise representation of soil samples (%) based on soil Phosphorous availability in Bhalwani cluster

## Soil Potassium (K)

The available potassium in the soil samples collected from Bhalwani cluster ranges between 100.50 to 900.80 kg/ha with an average value of 248.79 kg/ha. Most of the soil samples from all the villages in the Bhalwani cluster reported slightly high to very high availability of potassium in the soil. About 59.80% samples reported slightly high to very high potassium availability while about 16.13% soil samples showed low soil potassium. No soil sample from the cluster reported in very low category while, soil samples from Ranmala reported highest availability of Potassium with more than 40% soil samples reported in very high potassium category.

Table 26: Village wise categorization of soil samples (%) based on available soil Potassium in Bhalwani cluster

Villages	Soil Available Potassium (%)					
	Very Low	Low	Medium	Slightly High	High	Very High
Sutarwadi	0.00	20.41	25.07	10.20	19.83	24.49
Gawadewadi	0.00	16.23	22.08	16.88	9.74	35.06
Bhanagadewadi	0.00	17.44	24.91	24.91	22.78	9.96
Hanumanwadi	0.00	13.91	20.53	18.54	10.60	36.42
Hiwarekorda	0.00	15.80	25.97	19.91	16.45	21.86
Kutewadi	0.00	19.05	27.21	11.90	24.49	17.35
Ranmala	0.00	10.10	21.15	15.87	12.50	40.38
Waghwadi	0.00	2.78	11.11	22.22	38.89	25.00
Bhalwani Cluster	0.00	16.13	24.07	17.05	18.58	24.17

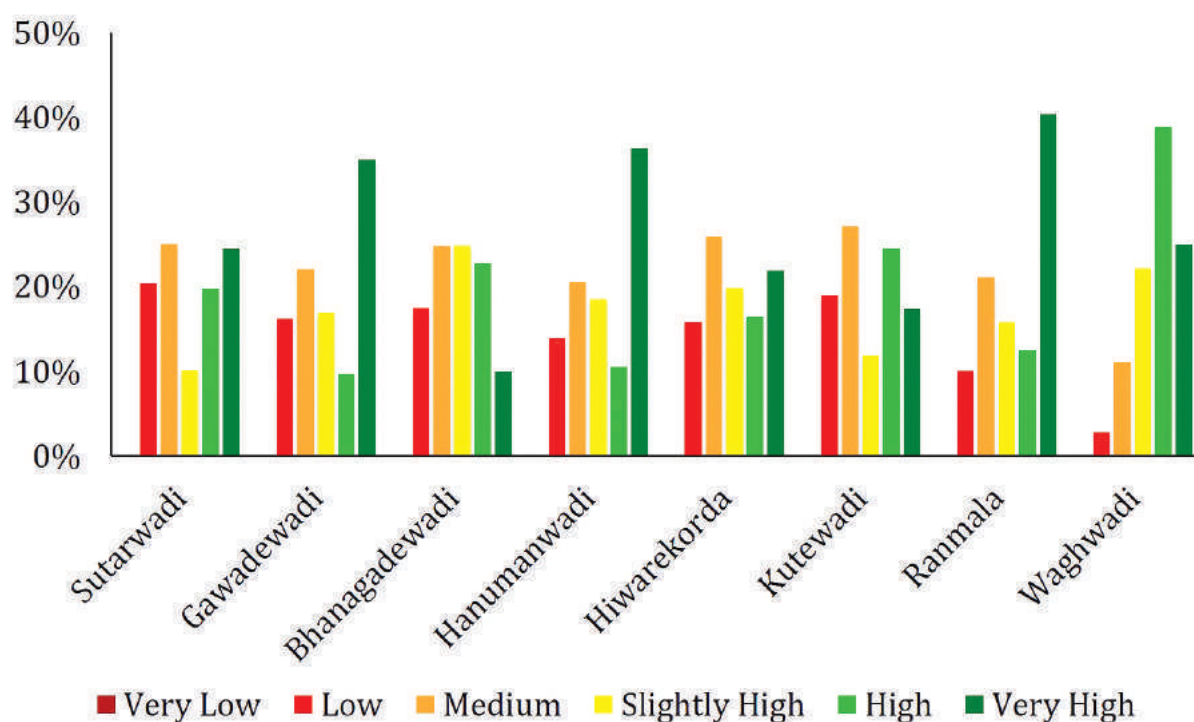


Figure 38: Village wise representation of soil samples (%) based on soil Potassium availability in Bhalwani cluster

## Sulphur (S)

The available Sulphur in the soil samples collected from Bhalwani cluster ranges between 3.78 to 148.0 mg/kg with an average value of 24.27 mg/kg. About 46.91% samples reported sufficient Sulphur availability while about 39.17% soil samples showed average soil Sulphur (Table 5).

Table 27: Village wise categorization of soil samples (%) based on available soil Sulphur in Bhalwani cluster

Villages	Soil Available Sulphur (%)		
	Low	Average	Sufficient
Sutarwadi	20.76	30.70	48.54
Gawadewadi	16.88	51.95	31.17
Bhanagadewadi	8.26	47.11	44.63
Hanumanwadi	21.19	33.77	45.03
Hiwarekorda	8.87	41.13	50.00
Kutewadi	13.61	32.99	53.40
Ranmala	12.02	34.13	53.85
Waghwadi	18.06	63.89	18.06
Bhalwani Cluster	13.92	39.17	46.91

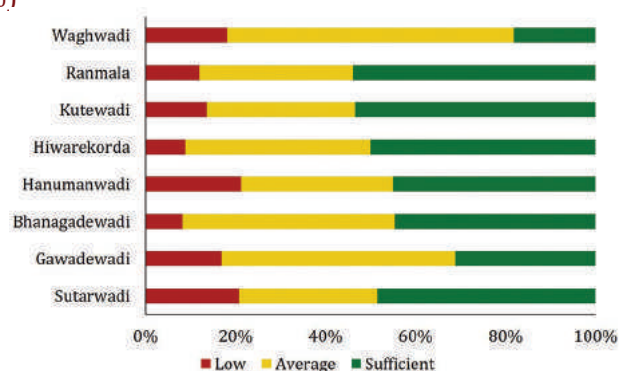


Figure 39: Village wise representation of soil samples (%) based on soil Sulphur availability in Bhalwani cluster

## Iron (Fe)

The available Iron in the soil samples collected from Bhalwani cluster ranges between 0.56 to 40.0 mg/kg with an average value of 8.08 mg/kg. About 38.48% samples reported low Iron availability while 40.34% soil samples showed average soil Iron (Table 5).

Table 28: Village wise categorization of soil samples (%) based on available soil Iron in Bhalwani cluster

Villages	Soil Available Iron (%)		
	Low	Average	Sufficient
Sutarwadi	38.31	40.30	21.39
Gawadewadi	35.14	39.64	25.23
Bhanagadewadi	48.04	29.61	22.35
Hanumanwadi	42.86	41.18	15.97
Hiwarekorda	30.84	48.13	21.03
Kutewadi	27.13	44.19	28.68
Ranmala	45.06	40.12	14.81
Waghwadi	41.43	37.14	21.43
Bhalwani Cluster	38.48	40.34	21.18

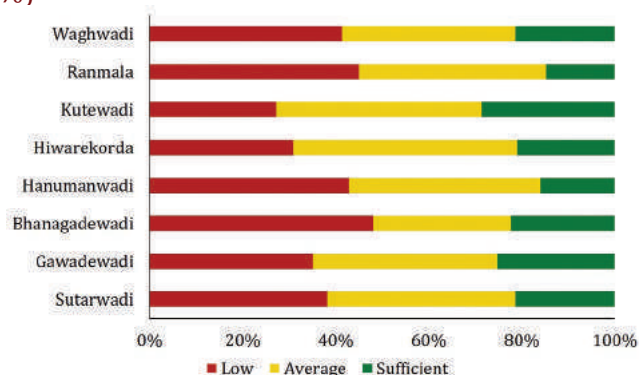
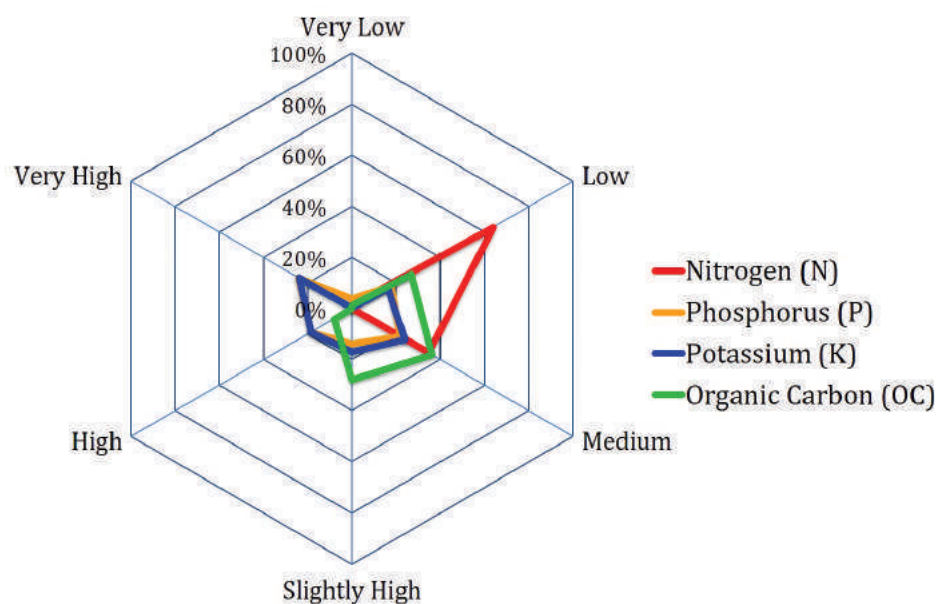


Figure 40: Village wise representation of soil samples (%) based on soil Iron availability in Bhalwani cluster



## Overall Soil health status of Bhalwani Cluster

Soils in the selected villages of Parner block are moderately to strongly alkaline in reaction with normal range of soluble salt content (EC). The organic carbon content of the region ranging between low to high. Soils were predominantly low in available Nitrogen, medium to very high in Phosphorus and Potassium. The secondary nutrient like Sulphur is also available in average to sufficient ranges while micronutrients like Iron are available in low to average levels.



**RADAR CHART REPRESENTING THE OVERALL SOIL HEALTH STATUS OF BHALWANI CLUSTER**

## Reclamation measures for soils in Bhalwani Cluster

As majority soils in Bhalwani cluster are alkali (sodic), therefore, the reclamation measures for alkali soils are:

- 1) Application of gypsum is recommended to reclaim the Alkali (sodic) soils.
- 2) The alkali soils that contain free Calcium carbonate can be effectively reclaimed by addition of Sulphur, Sulphuric acid, Iron and Aluminium sulphate, Green manure etc.
- 3) The addition of organic matter increases acidity, thus, helps in lowering the pH. Organic matter is especially helpful where Sulphur is added to correct alkalinity.
- 4) Addition of molasses in the soil facilitate fast growth of soil micro-organisms which on fermentation produce organic acid and reduce soil alkalinity.
- 5) In alkali soils, crop can be selected based on their ability to tolerate the soil sodicity.

In villages like Sutarwadi and Waghwadi the area surrounding the water storage structures, have major water logging problem. Therefore, the reclamation measures for waterlogged soils are given below:

- 1) The soil saturated with excess / free / gravitational water for a sufficiently long time are called water-logged soil. It is necessary to make provision to drain such excess water from the field.
- 2) Provisions for surface drainage, sub-surface drainage, mole drainage, side trenches etc. are helpful in facilitating the drainage of excess water from the field.
- 3) Leveling of land in many cases helps to reduce water logging problem by managing the runoff.
- 4) Using appropriate amount of irrigation water and following irrigation intervals helps to reduce the waterlogging incidences due to excessive irrigation.
- 5) In the water-logging area sowing should be done on ridges and furrows and select crop varieties which are tolerant to the waterlogging conditions

# OVERALL SOIL HEALTH STATUS OF BHALWANI CLUSTER

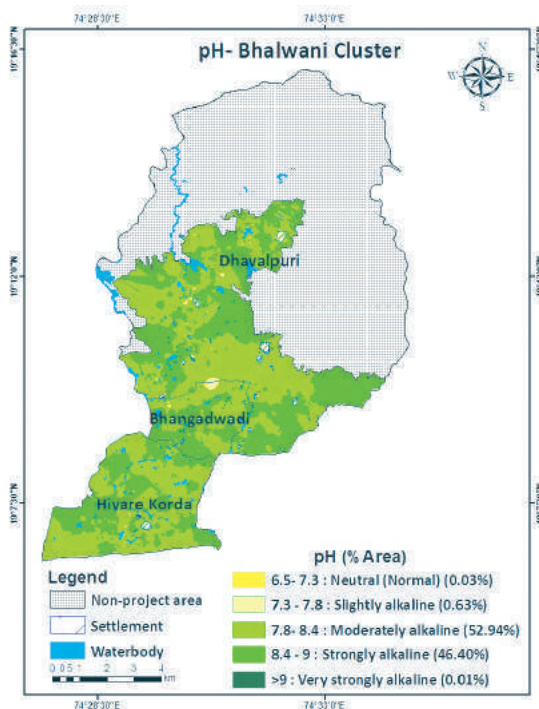


Figure 41: Status of pH in the soils of Bhalwani Cluster

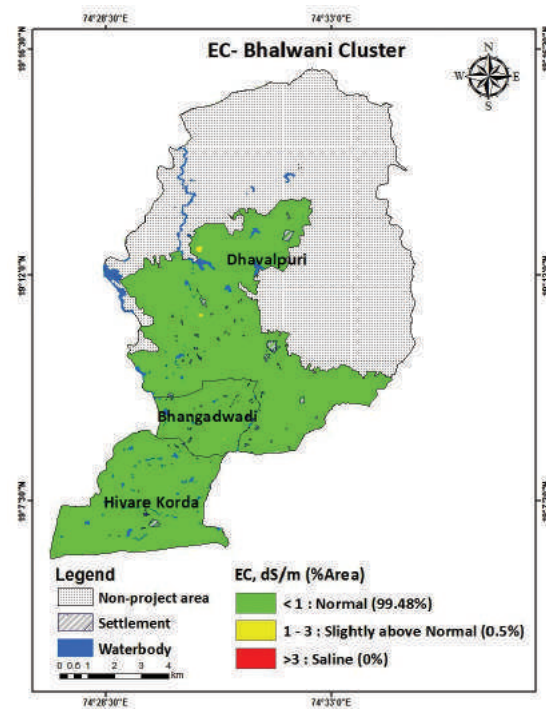


Figure 42: Status of electrical conductivity in the soils of Bhalwani Cluster

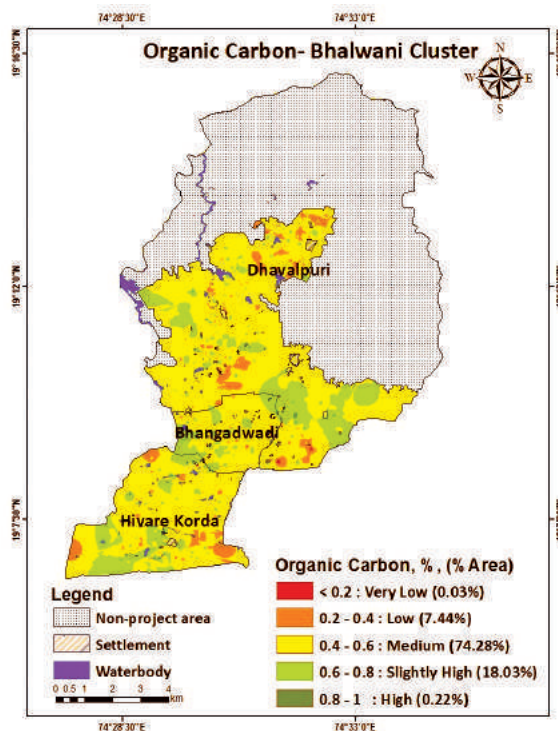


Figure 43: Status of Organic Carbon in the soils of Bhalwani Cluster

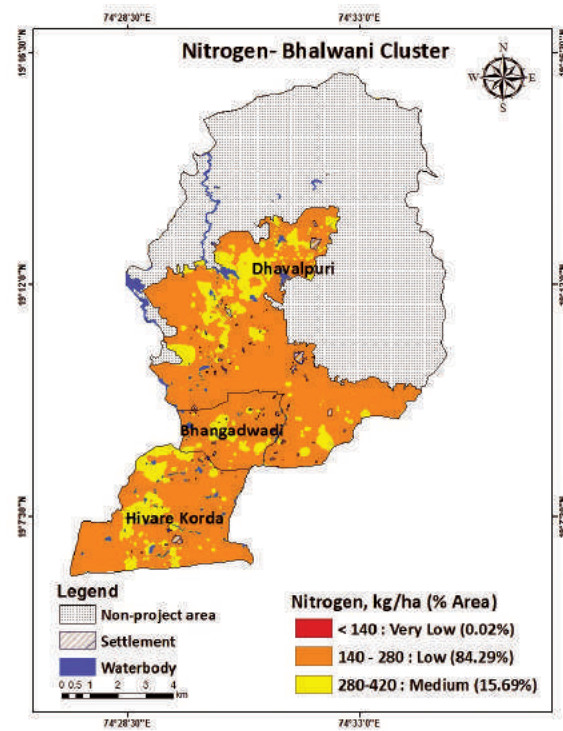


Figure 44: Status of available Nitrogen in the soils of Bhalwani Cluster



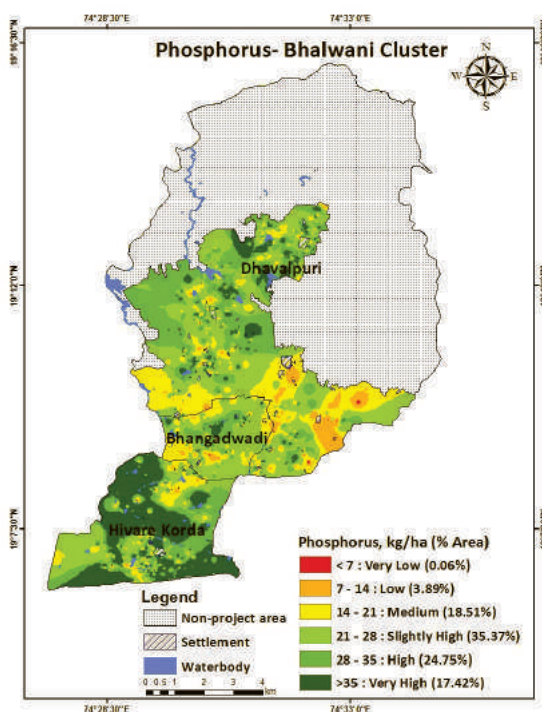


Figure 45: Status of available Phosphorous in the soils of Bhalwani Cluster

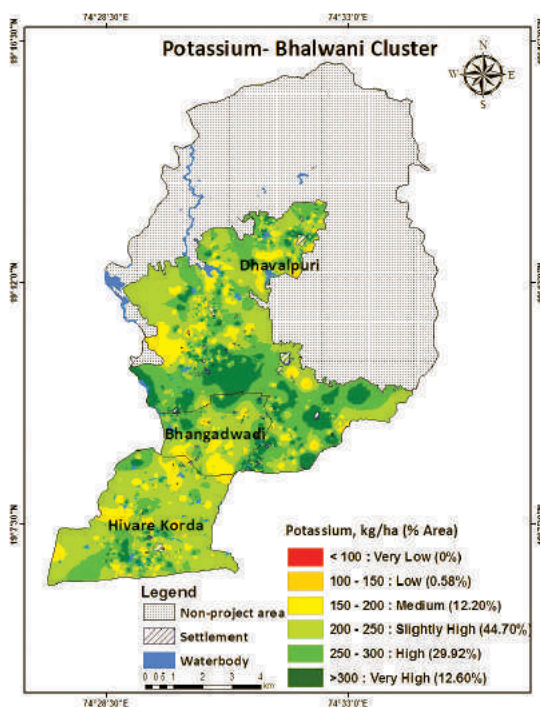


Figure 46: Status of available Potassium in the soils of Bhalwani Cluster

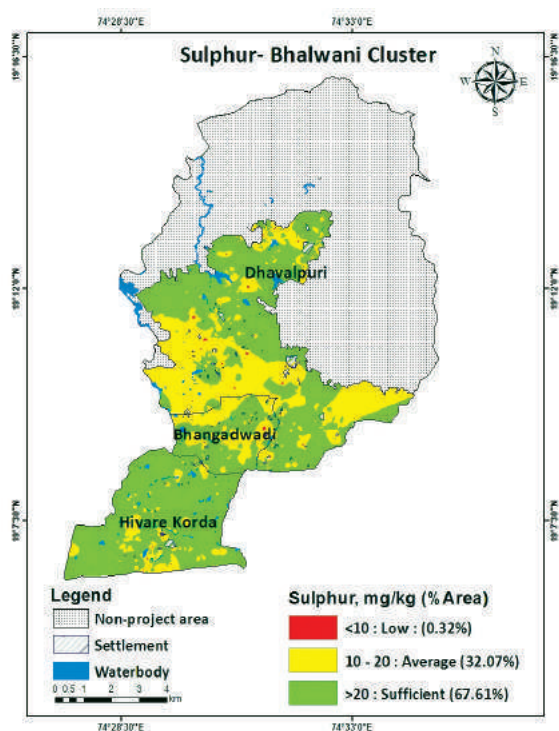


Figure 47: Status of available Sulphur in the soils of Bhalwani Cluster

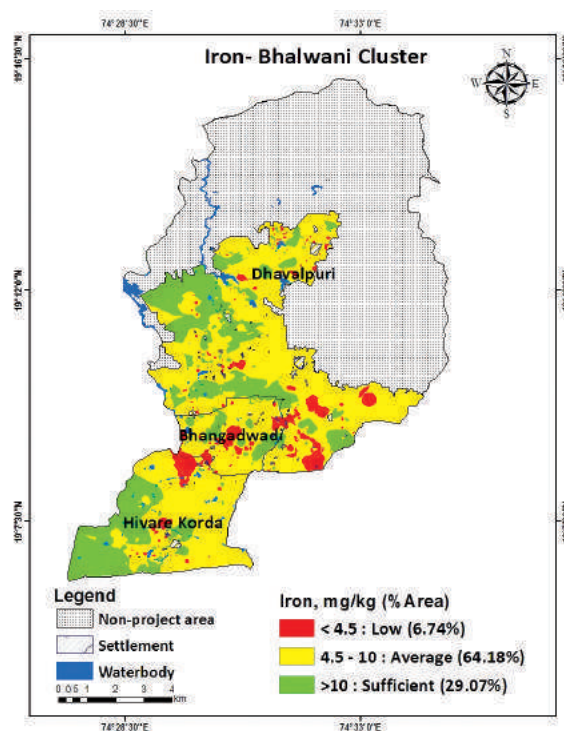


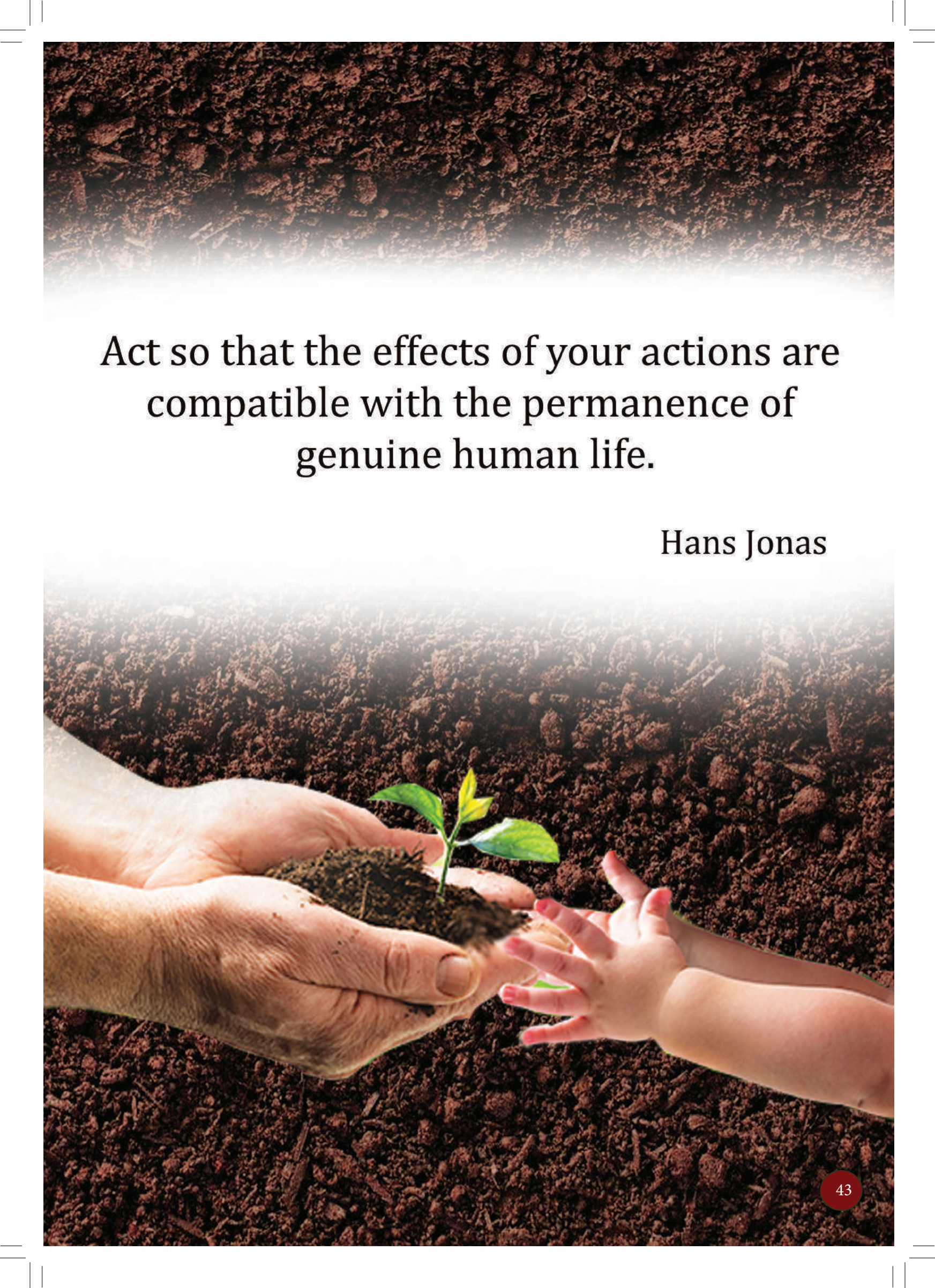
Figure 48: Status of available Iron in the soils of Bhalwani Cluster



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Act so that the effects of your actions are  
compatible with the permanence of  
genuine human life.

Hans Jonas





**Boron:** Discoloration of leaf buds. Breaking and dropping of buds

**Calcium:** Plant dark green. Tender leaves pale. Drying starts from the tips. Eventually leaf buds die

**Sulphur:** Leaves light green. Veins pale green, No spots

**Iron:** Leaves pale. No spots. Major veins green

**Manganese:** Leaves pale in color. Veins and venules dark green and reticulated

**Copper:** Pale pink between the veins. Wilt and drop

**Zinc:** Leaves pale narrow and short. Veins dark green. Dark spots on leaves and edges

**Molybdenum:** Leaves light green/lemon yellow/orange. Spots on whole leaf except veins. Sticky secretions from under the leaf

**Magnesium:** Paleness from leaf edges. No spots. Leaves dry and drop in extreme deficiency

**Potassium:** Small spots on the tips, edges of pale leaves. Spots turn rusty. Folds at tips.

**Phosphorus:** Plants short and dark green. In extreme deficiencies turn brown or black. Bronze color under the leaf

**Nitrogen:** Stunted growth. Extremely pale color. Upright leaves with light green/yellowish. Appear burnt in extreme deficiency

The color indicated here are indicative and they may vary from plant to plant.

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