Project Completion Report
2018-2021

Enhancing Agricultural Productivity and Rural Livelihoods through Scaling-up of Science-led Development in Odisha: Bhoochetana

Submitted to
Department of Agriculture & Farmers' Empowerment
Government of Odisha

ICRISAT DEVELOPMENT CENTER

ICRISAT INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

Contents

1. Executive Summary

The Government of Odisha supported the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) during 2018 to 2021 for the Odisha *Bhoochetana* project aimed at improving crop productivity and rural livelihoods through science-based management of natural resource in the State.

Under the project, a total of 40265 soil samples were collected representing 3957 villages in 310 blocks across the 30 districts of the state by using stratified random sampling method along with GPS coordinates. Analysis has been carried out by using the state-of-the-art infrastructure. Soil health cards were also prepared in the local languge and distributed on the occasion of World's Soil Health Day i.e. 5 December, 2019. Based on soil analyses results, Atlas of soil nutrient status for Odisha is published with online GIS maps. For ICT enabled dissemination, 90 Tablets loaded with analysis results and recommendation are to be handed over to department of agriculture. To cater to the the state's need for precision analysis of large number of soil, water, fertilizer and plant samples in a short time, two referral soil testing laboratories are successfully upgraded at Bhubaneshwar and Sambalpur, Odisha and guided by ICRISAT team for successful operations. Hon'ble Minister for Agriculture and Farmers' Empowerment, Govt. of Odisha inaugurated Bhubaneshwar laboratory on 05 Dec 2020, and also other laboratory in Sambalpur was inaugurated virtually the same day by the minister.

As a part of the productivity enhancement demonstrations, a total of 9387 demonstrations covering an area of 5190 acres were conducted across 30 districts during 2018-19 and 2019-20. During *kharif* 2018, 1762 demonstrations covering an area of 1292 acres and during *rabi 2018-19,* 2624 demonstrations covering 1350 acres were organized. Similarly, during kharif 2020, 1920 demonstrations covering an area of 1006 acres and during rabi 2019-20, 3081 demonstrations covering an area of 1542 acres were organized. The majority of the demonstrations focused on evaluation of application of deficient micronutrients and improved crop cultivars

In view of widespread deficiencies of micro nutrients viz. boron (B) and zinc (Zn), the demonstrations on application of deficient micronutrients were conducted extensibly across 30 districts of the state. The applications of deficient B and Zn recorded a productivity benefit between 10-66% with major crops like paddy, maize, pigeonpea, groundnut and finger millets during kharif seasons. While during rabi seasons, the micronutrient applcations recorded the yield benefit to the tune of 7-50% with major crops like paddy, blackgram, greengram, chickpea, maize and mustard. In demonstrations of improved varieities during kharif seasons, a significant yield benefit was observed with improved varieties over the prevailing local ones. In case of finger millet, the per cent increase in yield was 34-39% with cultivars like GPU 28, GPU 48 and MR 1. In groundnut Devi cultivar, the yield benefit over the local variety was 40%. Similarly, in maze, the % yield increase was 20%-68% with HT 5402, VNR 4343 and Adventapac 751 Elite cultivars. In case of paddy cultivars, the yield advantage varied between 9% (CR 1018) and 32% (Ranidhan). Similarly, during rabi seasons, the improved varieties of important crops like pady, blackgram, greengram, chickpea, groundnut and mustard were evaluated. There was a yield benefit of around 35% with blackgram cultivar PU 31; 13-39% with

greengram cultivars like IPM 2-14, IPM 2-3; 10%-36% with chickpea cultivars like JAKI 9218, JG 11, JG 14 and NBeG 3; 27% with groundnut cultivar Devi; 26% to 37% with mustard cultivars like Anuradha, DRMR 1153-12, DRMR 150-35; and 17% to 28% with paddy cultivars like Lalat, Parijat and MTU 1001.

As a part of capacity building efforts, two Master Trainer training programs were conducted at ICRISAT for the 60 senior officials across 30 districts in 2 batches during 8-10 July 2019 and 15-17 July 2019. With the support of oriented/trained 60 DoA officials, district level training programs were conducted for DoA officials a total of 2576 officials were oriented/trained across 30 districts during September-December 2019. For upradation of laboratories, a five-day training cum exposure program was organized during 27 to 31 August 2018 at CRAL laboratory, ICRISAT for six participants from soil testing laboratories in Bhubaneswar and Sambalpur along with two professors from OUAT. ICRISAT team also conducted 4-day trainings during 5-8 April 2021 for both laboratory staff at the respective places in Bhubaneshwar and Sambalpur for smooth operations in both laboratories. In the pilot sites across 30 districts, around 29000 farmers' capacities were strengthened on improved management practices like need-based nutrient management and improved crop varieities.

2. Introduction

The project was designed with a aim to establish representative pilots to demonstrate crop productivity improvement and rural livelihoods through science-based Natural Resource Management in the State of Odisha. Soil health mapping through the collection of 40,265 representative soil samples by stratified sampling methods across 30 districts provides a sound base for precise nutrient management, not only for nitrogen (N), Phosphorous (P) and Potassium (K) but also for the deficiciencies in secondary and micronutrients. It also envisages economic and environmental benefits by avoiding indiscriminate use of NPK fertilizers. The two laboratories upgraded in the State to state-of-the-art referral laboratories of international standards are state assets to cater to future requirements of swift and precise quality analyses of a sizeable number of soil, water, fertilizer, and plant samples.

3. Objectives

The specific objectives of the project were;

- To assess the nutrient status of soils in 30 districts of Odisha
- Identify the best management options to increase productivity through demonstrations in pilot sites and scaling up in partnership with DoA and other partners through convergence
- To concurrently monitor, evaluate, assess and document the impacts of the scaling up approach in order to enable mid-course corrections

- To build the capacity of DoA staff in undertaking soil analysis, handling data and consortium partners including farmers for scaling up science-led holistic development strategy using ICT tools
- To upgrade two existing soil analytical laboratories in the State to serve as referral laboratories and run them efficiently with government support

4. Project Launch and Team Building

A state-level workshop was organized to deliberate on Orissa Bhoochetana on 23 June 2018 at Bhubaneswar. Around 170 delegates representing the Department of Agriculture & Farmers Empowerment, NGOs, OUAT, and ICRISAT participated. Officials like Mr Sourabh Garg (Principal Secretary, Government of Odisha), Mr Muthu Kumar (Director, Department of Agriculture, Odisha), Prof S Pasupalak (Vice Chancellor, OUAT), Dr SP Wani (former Director-RP Asia), Dr S Dixit (Head –IDC), senior scientists from ICRISAT & OUAT, senior DoA officials (DDAs, DAOs & officersof head offices) heads of local NGOs from districts participated in the workshop.

The workshop served to sensitize the key partners in Odisha, including the State Agriculture University and staff of agriculture departments in the districts. It was highlighted that the main objective of the project was to rejuvenate the soils and improve crop yields. It was suggested to encourage students to get involved in field work like soil sampling as a learning exercise, and also take demonstrations in non-rice cropping systems. The importance capacity building programs was highlighted for achieving the project objectives.

Plate 4.1. Participants during project launch and tea building st Bhubaneshwar.

5. Soil Sampling and Analysis of Odisha Soils

5.1. Soil sampling

As part of the Bhoochetana project, before the start of *kharif* 2018, soil sample collection was initiated in all the 30 districts. A stratified random composite soil sampling methodology was

followed that combines a number of discrete samples collected from a single field homogenized into a single sample for analysis. A total of 40265 soil samples were collected from across 310 blocks in 3957 villages (Table 5.1). All the soil samples numbering 40265 were analyzed at the CRAL laboratory at ICRISAT and results shared with Department of Agriculture, Odisha. OUAT students were trained in soil sampling methods and were involved along with NGO partners.

Plate 5.1: Left: Soil sampling in Barkote block in Deogarh district; Right: Training of OUAT students in soil sampling & participation in soil sample collection in Khorda district.

Table 5.1. Soil samples collected from across Odisha

S. No.	District	Blocks (No)	Villages (No.)	No. of soil samples collected & analyzed
1	Angul	8	104	1020
2	Balasore	12	156	1550
3	Bargarh	12	156	1550
4	Bhadrak	7	91	910
5	Balangir	14	182	1819
6	Boudh	3	39	370
7	Cuttack	14	182	1820
8	Deogarh	3	39	390
9	Dhenkanal	8	104	1030
10	Gajapati	7	91	939
11	Ganjam	22	280	2810
12	Jagatsinghpur	8	104	1040
13	Jajpur	10	130	1300
14	Jharsuguda	5	78	650
15	Kandhamal	12	156	1554
16	Kalahandi	13	114	1670
17	Kendrapara	9	117	1150
18	Keonjhar	13	169	1540
19	Khurda	10	127	1300

20	Koraput	11	137	1769
21	Malkangiri	7	90	937
22	Mayurbhanj	26	338	3317
23	Nabarangpur	10	108	1213
24	Nayagarh	8	104	1040
25	Nuapada	5	63	647
26	Puri	11	139	1420
27	Rayagada	11	143	1430
28	Sambalpur	9	117	1170
29	Sonepur	6	78	780
30	Sundargarh	16	221	2130
	Total	**310**	**3957**	**40265**

5.2. Analysis Results

The analysis results of 40,265 soil samples at ICRISAT laboratory showed low organic carbon in most of the farmers fields and and acidic nature of Odisha soils in general. Amongst the primary nutrients, phosphorus deficiency (>50%) was found dominant and widespread whereas, amongst the secondary nutrients, Sulphur was found deficient (>50%) in soils of majority of the blocks of Odisha. Out of the micronutrients, boron (> 80 %) was found highly deficient and widespread followed by zinc (> 40%) across all the blocks in Odisha.

District wise results

5.2.1 Soil pH

The analysis of the data on pH indicated that more than 80% of the soils in the districts are acidic in nature (Table 5.2.1; Figure 5.2.1). In case of Jharsuguda 100% samples have shown acidic reaction followed by Kendrapara, Mayurbhanj and Jagatsinghpur, while only 44% of samples in Nuapada shown acidity. Twenty two percent of samples from Naupada reported to be alkaline in nature followed by Balangir (16%), Kalahandi (14%), Boudh (14%), Angul (11%) and Sonepur (10%). Further, 34% of samples from Nuapada shown to be neutral in reaction followed by Boudh (29%), Balangir (26%), Kalahandi (25%) and Sonepur (22%).

Table 5.2.1 District wise extent of acidic, neutral and alkaline soils in Odisha (% of soil samples)

District	Acidic	Neutral	Alkaline
Jharsuguda	95	5	0
Kendrapara	98	2	0
Mayurbhanj	97	3	0
Jagatsinghpur	96	3	0
Puri	96	3	1
Koraput	96	3	1

Kandhamal	95	5	0
Sundergargh	94	5	1
Nabrangpur	94	5	1
Bhadrak	94	5	1
Gajapti	93	3	4
Jajpur	94	4	2
Keonjhar	93	6	1
Khurda	92	6	2
Malkangiri	90	9	1
Sambalpur	90	7	4
Cuttack	88	9	4
Deogarh	87	12	1
Balasore	86	13	1
Dhenkanal	83	14	3
Rayagada	81	15	4
Bargarh	80	15	5
Nayagarh	74	19	7
Ganjam	70	22	8
Angul	69	20	11
Sonepur	68	22	10
Kalahandi	61	25	14
Balangir	58	26	16
Boudh	57	29	14
Nuapada	44	34	22
Total	85	11	4

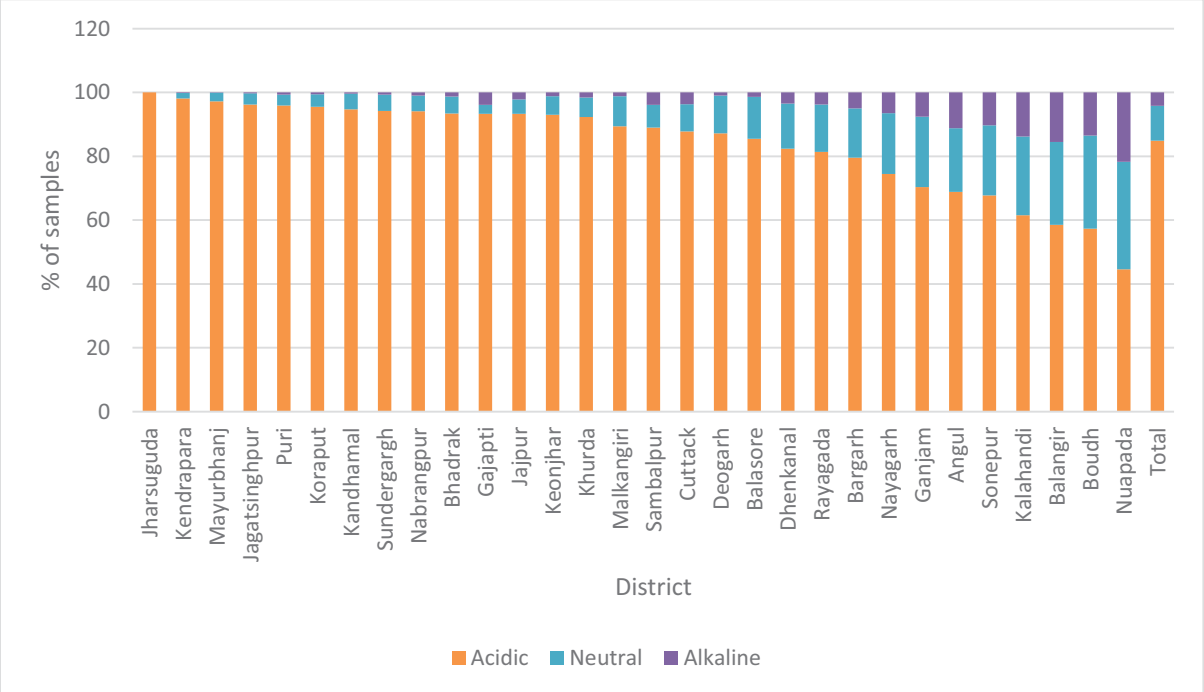


Figure 5.2.1: District wise details of acidic, neutral and alkaline soils in Odisha.

5.2.2 Electric conductivity

The soil analysis data showed normal that majority of samples (99.6%) have normal electric conductivity while it was found to be at injurious level in Sundergarh (1.36%) followed by Kendrapara (1.22%) and Ganjam (1.07%). The details of the same is given in Table 5.2.2 and Figure 5.2.2.

Table 5.2.2. District wise EC in the soil of Odisha (% of soil samples).

District	Injurious to all crops	Normal
Angul	0.00	100.00
Balangir	0.00	100.00
Boudh	0.00	100.00
Deogarh	0.00	100.00
Dhenkanal	0.00	100.00
Gajapti	0.00	100.00
Jharsuguda	0.00	100.00
Kalahandi	0.00	100.00
Kandhamal	0.00	100.00
Keonjhar	0.00	100.00
Khurda	0.00	100.00
Koraput	0.00	100.00
Malkangiri	0.00	100.00
Nabrangpur	0.00	100.00
Nayagarh	0.00	100.00
Nuapada	0.00	100.00
Rayagada	0.00	100.00
Sonepur	0.00	100.00
Cuttack	0.11	99.89
Mayurbhanj	0.12	99.88
Bargarh	0.19	99.81
Jagatsinghpur	0.38	99.62
Puri	0.42	99.58
Balasore	0.52	99.48
Sambalpur	0.68	99.32
Bhadrak	0.88	99.12
Ganjam	1.07	98.93
Kendrapara	1.22	98.78
Sundergarh	1.36	98.64
Jajpur	4.00	96.00
Total	0.45	99.55

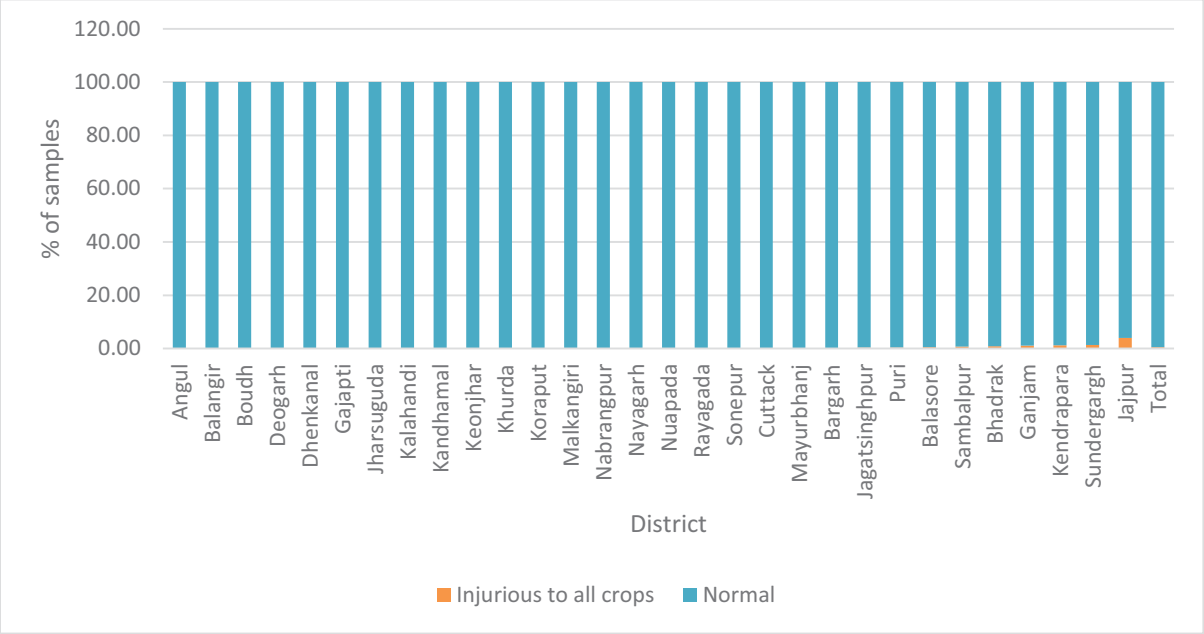


Figure 5.2.2: District wise EC levels in Odisha.

5.2.3 Organic Carbon

The data on organic carbon is presented in (Table 4.4; Figure 4.3). The data showed that the organic carbon content is low in 43% of soils, while it was medium in 39% and high in 18% of soil samples. The organic carbon levels were highest in the samples of Koraput district (41%) while, it was found lowest in case of Khurda, Gajapati and Nayagarh district (8%).

Table 5.2 .3 District wise soil organic carbon in the samples (% of total samples).

District	High	Medium	Low	Total
Koraput	41	35	24	100
Nuapada	34	44	22	100
Deogarh	28	43	29	100
Sonepur	27	38	35	100
Malkangiri	24	34	42	100
Kandhamal	23	35	42	100
Bargarh	23	41	36	100
Kendrapara	22	51	27	100
Sambalpur	22	39	39	100
Angul	22	45	33	100
Nabrangpur	20	42	38	100
Rayagada	19	28	53	100
Balangir	17	36	47	100
Cuttack	17	46	37	100
Dhenkanal	17	51	32	100
Keonjhar	16	37	47	100
Ganjam	16	39	45	100

Mayurbhanj	16	39	45	100
Balasore	15	33	52	100
Puri	14	42	44	100
Kalahandi	14	35	51	100
Jajpur	14	37	49	100
Bhadrak	14	45	41	100
Sundergargh	13	39	48	100
Jharsuguda	13	48	39	100
Boudh	13	36	51	100
Jagatsinghpur	12	44	44	100
Gajapati	8	29	63	100
Nayagarh	8	38	54	100
Khurda	8	31	61	100
Total	18	39	43	100

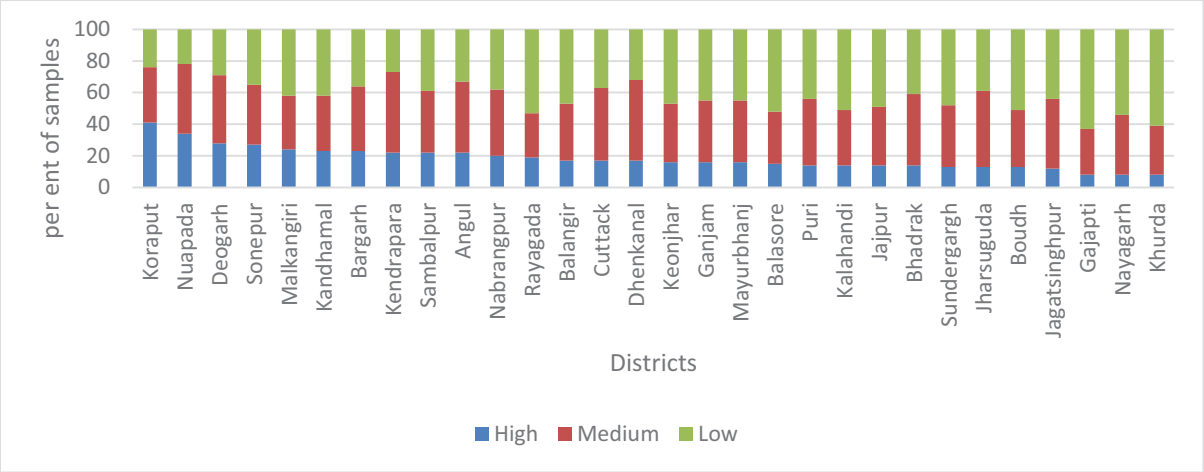


Figure 5.2.3 Soil organic carbon levels in various districts in Odisha state.

5.2.4 Phosphorus

The data on phosphorus content showed that majority of soils i.e. 53% across the district are found to contain lower levels of phosphorus, while it was medium in 30% and high in 17% of the soils in the state (Table 4.5; Figure 4.4). The soils in Rayagada district found to contain higher levels of phosphorus (48%), while the 75% of soils in Mayurbhanj are found to be contain lower levels of phosphorus.

Table 5.2.4. Status of soil phosphorus in various districts (%			
District	High	Medium	Low
Mayurbhanj	9	16	75
Sundergargh	10	17	73
Keonjhar	13	19	68
Balangir	9	24	67
Malkangiri	14	19	67
Kalahandi	10	23	67

Nuapada	9	27	64
Deogarh	9	27	64
Nabrangpur	13	26	61
Dhenkanal	13	31	56
Sonepur	13	31	56
Ganjam	16	28	56
Sambalpur	18	29	53
Jharsuguda	19	28	53
Boudh	12	37	51
Khurda	18	31	51
Kandhamal	26	24	50
Gajapti	21	30	49
Balasore	13	38	49
Angul	16	35	49
Nayagarh	17	40	43
Kendrapara	10	47	43
Koraput	22	36	42
Bhadrak	19	40	41
Bargarh	24	39	37
Jajpur	26	37	37
Cuttack	27	38	35
Jagatsinghpur	22	46	32
Puri	27	44	29
Rayagada	48	28	24
Total	17	30	53

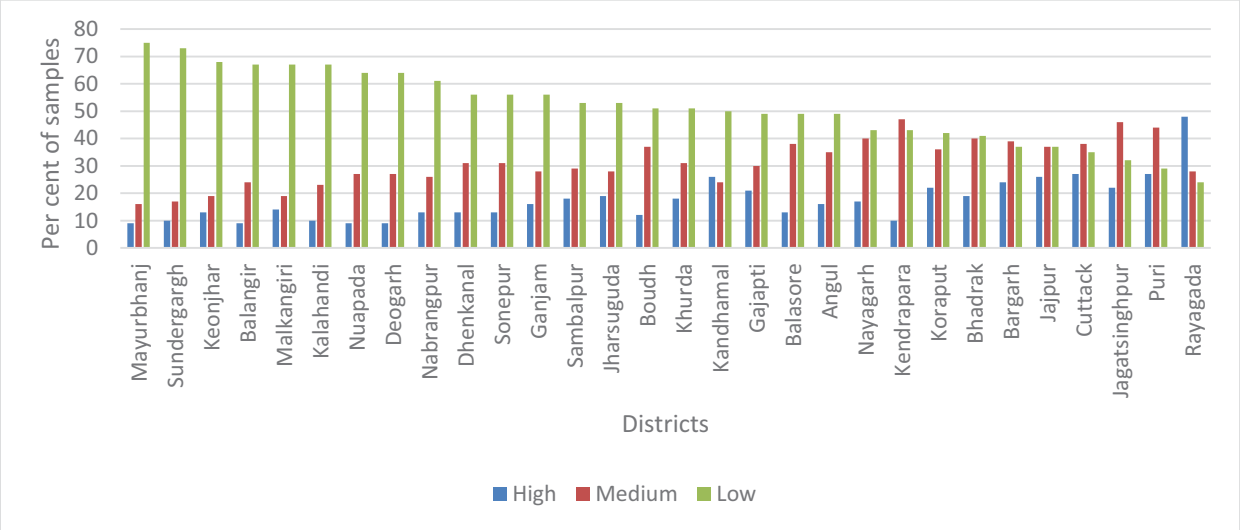


Figure* 5.2.4: *Percentage of samples showing levels of phosphorus in the soil.

5.2.5 Potassium

The data on soil potassium content across various districts in the state is given in Table 4.6; Figure 4.5. The analysis showed that majority of the soils (47%) are found to be medium in potassium while 28% and 25% of the soils have higher and lower levels of potassium. About 65% of the soils in Rayagada and Nuapada shown to have higher potassium compared to Khurda where only 8% of the samples were found to have higher potassium. In contrast majority of soils i.e. more than 30% of the soils in Balasore, Mayurbhanj, Jajpur, Khurda, Malkangiri, Puri, Keonjhar and Cuttack found to be lower potassium content compared to Nuapada, Rayagada, Gajapati district where less than 10% of the soils were found to have lesser levels of potassium.

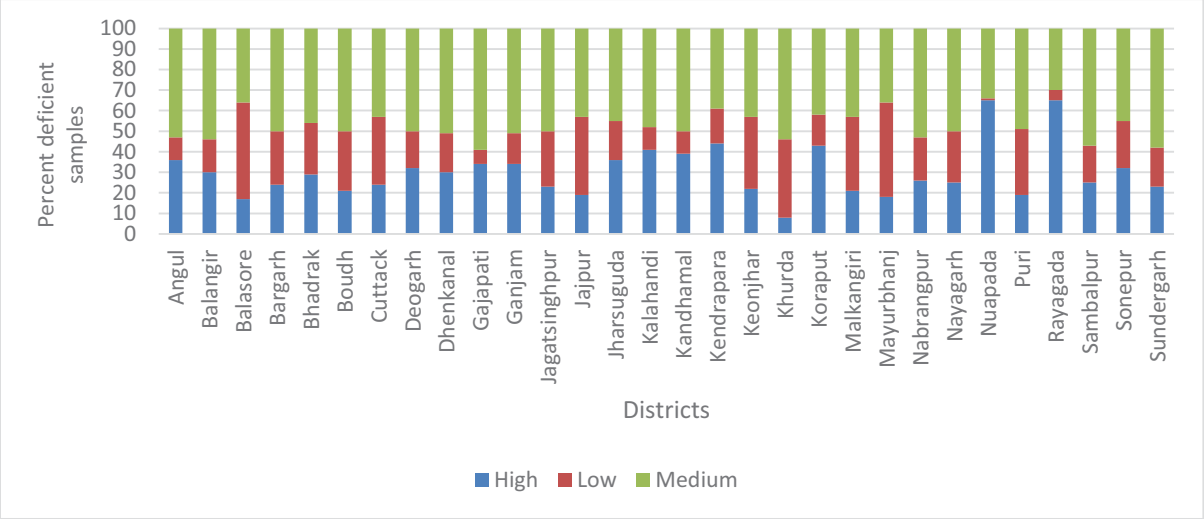


Figure 5.2.5: Soil potassium levels in various districts in Odisha.

Table *5.2.5*. District wise details of soil potassium levels in Odisha (% of samples)				
District	High	Low	Medium	Total
Angul	36	11	53	100
Balangir	30	16	54	100
Balasore	17	47	36	100
Bargarh	24	26	50	100
Bhadrak	29	25	46	100
Boudh	21	29	50	100
Cuttack	24	33	43	100
Deogarh	32	18	50	100
Dhenkanal	30	19	51	100
Gajapati	34	7	59	100
Ganjam	34	15	51	100
Jagatsinghpur	23	27	50	100
Jajpur	19	38	43	100
Jharsuguda	36	19	45	100
Kalahandi	41	11	48	100

Kandhamal	39	11	50	100
Kendrapara	44	17	39	100
Keonjhar	22	35	43	100
Khurda	8	38	54	100
Koraput	43	15	42	100
Malkangiri	21	36	43	100
Mayurbhanj	18	46	36	100
Nabrangpur	26	21	53	100
Nayagarh	25	25	50	100
Nuapada	65	1	34	100
Puri	19	32	49	100
Rayagada	65	5	30	100
Sambalpur	25	18	57	100
Sonepur	32	23	45	100
Sundergarh	23	19	58	100
Total	28	25	47	100

5.2.6 Calcium

Results of soil analysis showed that 90% of soils in Odisha state were found to be sufficient in soil calcium levels. Gajapati soils were most deficient in calcium levels (40%) as compared to rest of the district soils. (Table 4.7; Figure 4.6).

Table 5.2.6. Status of calcium in soils of Odisha (% samples).

District	Deficient	Sufficient	Total
Kendrapara	1	99	100
Nuapada	1	99	100
Bhadrak	2	98	100
Cuttack	2	98	100
Jagatsinghpur	2	98	100
Kalahandi	3	97	100
Nayagarh	4	96	100
Dhenkanal	4	96	100
Balangir	4	96	100
Deogarh	5	95	100
Boudh	5	95	100
Ganjam	5	95	100
Sonepur	6	94	100
Jajpur	6	94	100
Angul	6	94	100
Rayagada	7	93	100
Bargarh	7	93	100
Kandhamal	8	92	100
Puri	10	90	100
Malkangiri	10	90	100

Balasore	11	89	100
Nabrangpur	12	88	100
Sambalpur	13	87	100
Khurda	13	87	100
Sundergarh	15	85	100
Koraput	15	85	100
Keonjhar	18	82	100
Jharsuguda	18	82	100
Mayurbhanj	26	74	100
Gajapati	40	60	100
Total	10	90	100

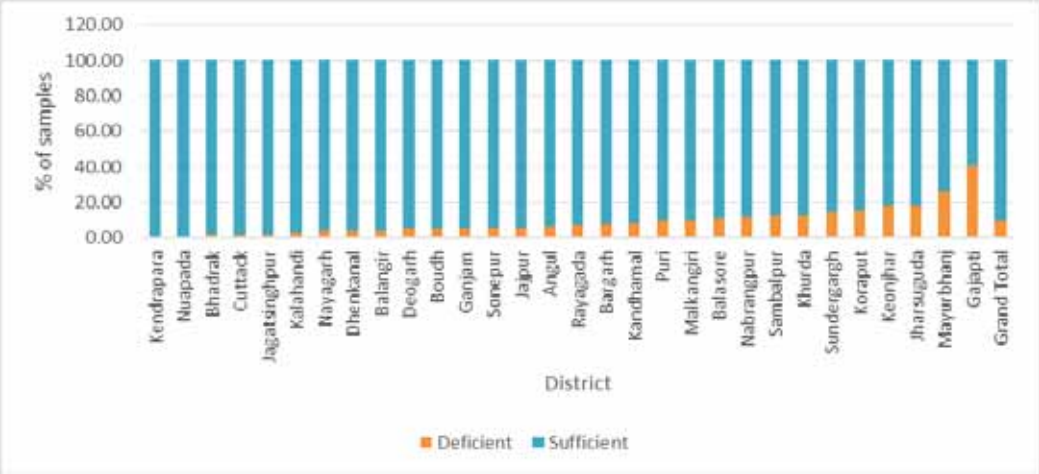


Figure* 5.2.6*: Soil calcium levels in various districts of Odisha.

5.2.7 Magnesium

In general, more than 70% of soil samples collected across Odisha have sufficient levels of magnesium (Table 4.8; Figure 4.7). Data from the analysis suggest soils of Kendrapara, Jagitsinghpur, Bhadrak, Nuapada, and Cuttack have higher magnesium levels (> 90 per cent) whereas soils of Gajapati, Kandhamal, Mayurbhanj, Koraput, Keonjhar and Malkangiri have higher deficiency levels of magnesium (> 40 per cent).

Table 5.2.7. District wise details of magnesium levels in Odisha (% of samples)

District	Deficient	Sufficient
Kendrapara	1	99
Jagatsinghpur	3	97
Bhadrak	4	96
Nuapada	4	96
Cuttack	8	92
Nayagarh	13	87
Puri	14	86
Dhenkanal	17	83

Kalahandi	18	82
Jajpur	18	82
Boudh	21	79
Ganjam	21	79
Deogarh	21	79
Balangir	21	79
Angul	24	76
Sonepur	25	75
Khurda	27	73
Balasore	31	69
Rayagada	34	66
Sambalpur	35	65
Nabrangpur	37	63
Sundergargh	37	63
Bargarh	38	62
Jharsuguda	38	62
Malkangiri	40	60
Keonjhar	42	58
Koraput	46	54
Mayurbhanj	50	50
Kandhamal	54	46
Gajapati	76	24
Total	28	72

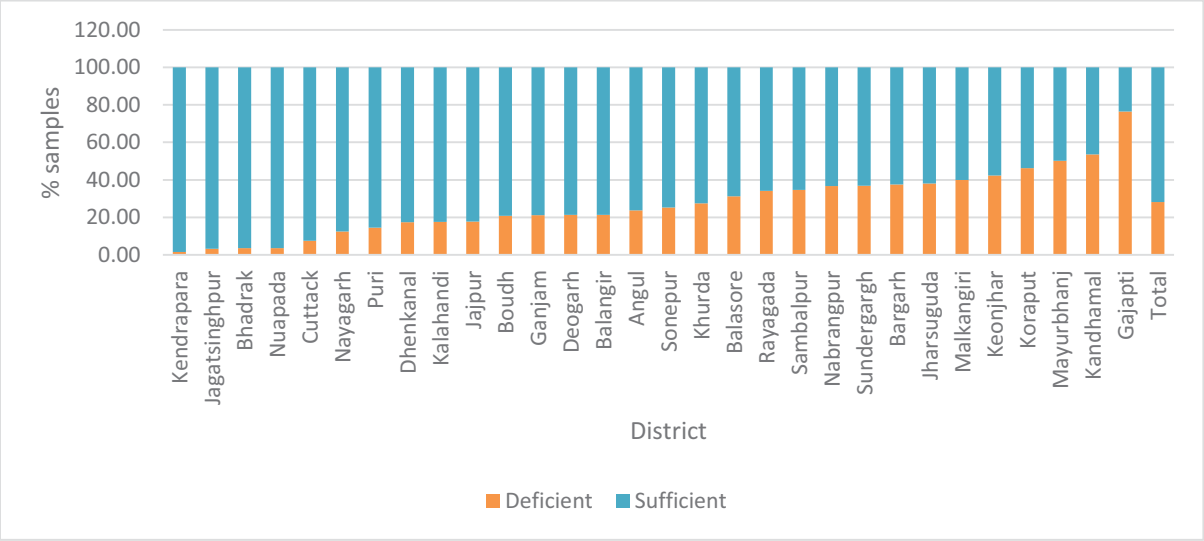


Figure* 5.2.7*: Magnesium levels in soils of Odisha.

5.2.8 Sulphur

The district wise details of Sulphur levels in the state of Odisha is presented in Table 4.9; Figure 4.8. The soil analysis showed that the sufficiency level of Sulphur range from 13 to 75% with average value of 49% across the state. Similarly, the deficiency level range for 25 to 87% with

an average value of deficiency of 51% across the state. More than 70% of the soils in Sonepur, Nuapada and Bargarh found to have sufficient levels of Suphur.

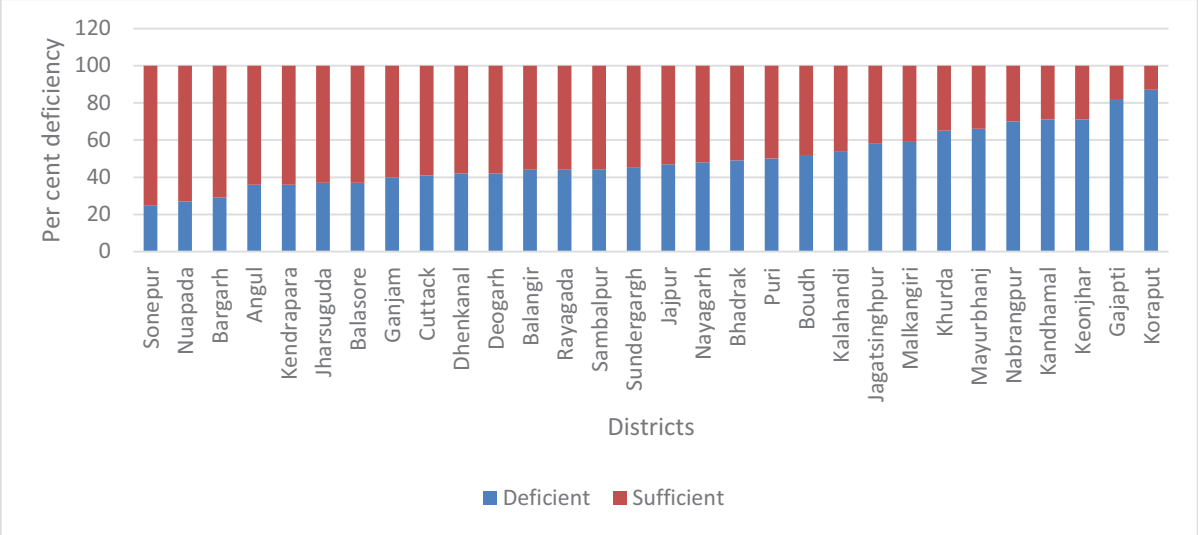


Figure* 5.2.8*: District wise sulphur levels in Odisha (%).

Table 5.2.8. District wise Sulphur content in Odisha (% samples)

District	Deficient	Sufficient	Total
Sonepur	25	75	100
Nuapada	27	73	100
Bargarh	29	71	100
Angul	36	64	100
Kendrapara	36	64	100
Jharsuguda	37	63	100
Balasore	37	63	100
Ganjam	40	60	100
Cuttack	41	59	100
Dhenkanal	42	58	100
Deogarh	42	58	100
Balangir	44	56	100
Rayagada	44	56	100
Sambalpur	44	56	100
Sundergarh	45	55	100
Jajpur	47	53	100
Nayagarh	48	52	100
Bhadrak	49	51	100
Puri	50	50	100
Boudh	52	48	100
Kalahandi	54	46	100
Jagatsinghpur	58	42	100

Malkangiri	59	41	100
Khurda	65	35	100
Mayurbhanj	66	34	100
Nabrangpur	70	30	100
Kandhamal	71	29	100
Keonjhar	71	29	100
Gajapati	82	18	100
Koraput	87	13	100
Total	51	49	100

5.2.9 Zinc

The data on zinc levels showed that deficiency of about 43% of the soils were deficient in zinc. The zinc deficiency is very much prevalent in Balangir followed by Nuapada, Boudh, Sonepur and Kalahandi (Table 4.10; Figure 4.9). In contrast, the soils in Cuttack followed by Dhenkanal, Kendrapara and Jharsuguda found to have sufficient levels of zinc.

Table 5.2.9. District wise details of zinc in Odisha (% samples)

District	Deficient	Sufficient	Total
Balangir	76	24	100
Nuapada	72	28	100
Boudh	66	34	100
Sonepur	64	36	100
Kalahandi	63	37	100
Angul	61	39	100
Nabrangpur	59	41	100
Keonjhar	55	45	100
Jagatsinghpur	55	45	100
Deogarh	55	45	100
Bargarh	53	47	100
Malkangiri	52	48	100
Koraput	49	51	100
Gajapti	42	58	100
Nayagarh	42	58	100
Balasore	41	59	100
Sambalpur	41	59	100
Kandhamal	41	59	100
Sundergarh	39	61	100
Mayurbhanj	39	61	100
Bhadrak	38	62	100
Ganjam	32	68	100
Puri	30	70	100
Rayagada	28	72	100
Khurda	25	75	100

Jajpur	25	75	100
Jharsuguda	21	79	100
Kendrapara	19	81	100
Dhenkanal	19	81	100
Cuttack	18	82	100
Total	43	57	100

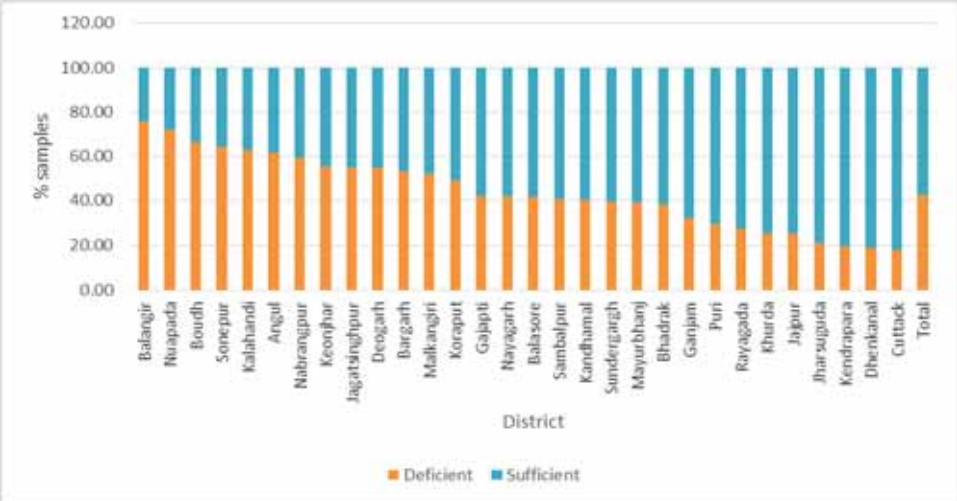


Figure* 5.2.9*: Deficiency and sufficiency levels zinc in various districts in Odisha.

5.2.10 Boron

The district wise details of boron are presented in Table 4.11; Figure 4.10. The data reveals that more than 80% of soils across the districts are deficient in boron. In case of Jharsuguda, Nabrangapur, Sundergarh, Boudh, Gajapati, Sambalpur, Balangir, Malkangiri, Mayurbhanj, Bargarh and Sonepur more than 90% of the soils are deficient in boron, while 43 and 64% soils in Bhadrak and Kendrapara were found to have sufficient in boron content.

Table 5.2.10. District wise levels of boron in Odisha (% samples)

District	Deficient	Sufficient	Total
Kendrapara	36	64	100
Bhadrak	57	43	100
Jagatsinghpur	63	37	100
Puri	63	37	100
Ganjam	64	36	100
Balasore	68	32	100
Dhenkanal	74	26	100
Deogarh	76	24	100
Jajpur	77	23	100
Rayagada	80	21	100
Angul	80	20	100
Nuapada	80	20	100
Nayagarh	81	19	100
Cuttack	83	17	100

Khurda	83	17	100
Koraput	83	17	100
Kalahandi	87	13	100
Kandhamal	87	13	100
Keonjhar	90	10	100
Sonepur	90	10	100
Bargarh	90	10	100
Mayurbhanj	92	8	100
Malkangiri	92	8	100
Balangir	92	8	100
Sambalpur	92	8	100
Gajapati	93	7	100
Boudh	94	6	100
Sundergarh	95	5	100
Nabrangpur	95	5	100
Jharsuguda	98	2	100
Total	81	19	100

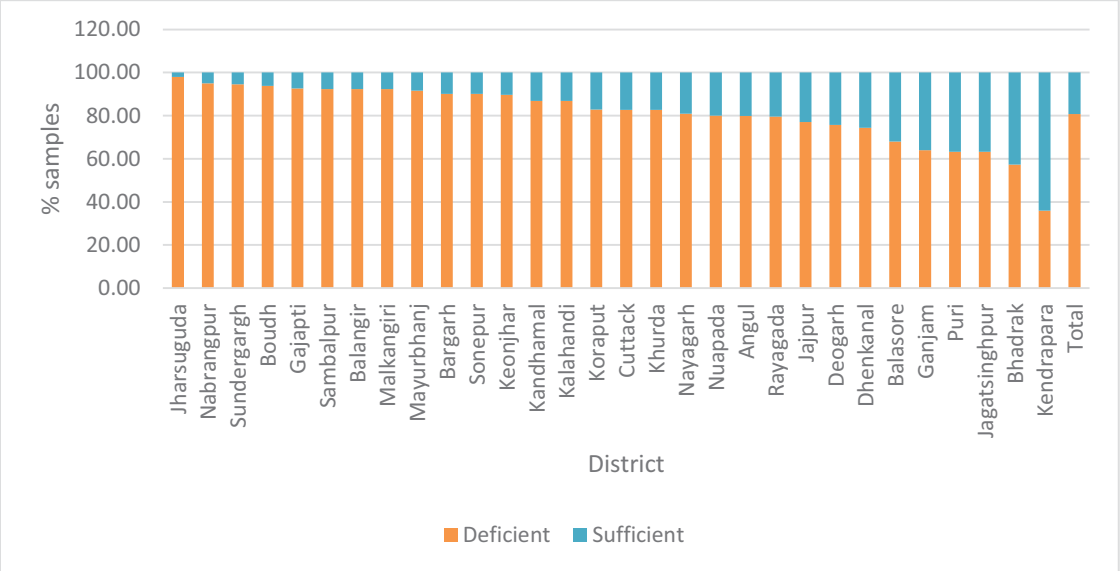


Figure* 5.2.10*: District wise boron deficiency and sufficiency levels in Odisha (%).

5.2.11 Iron

The district wise deficiency levels of iron are presented in Table 4.12; Figure 4.11. The data revealed that the iron levels in the soils across the districts is sufficient with no deficiency in seven districts viz. Jagatsinghpur, Koraput, Nabrangpur, Puri, Khurda, Kendrapara and Jharsuguda.

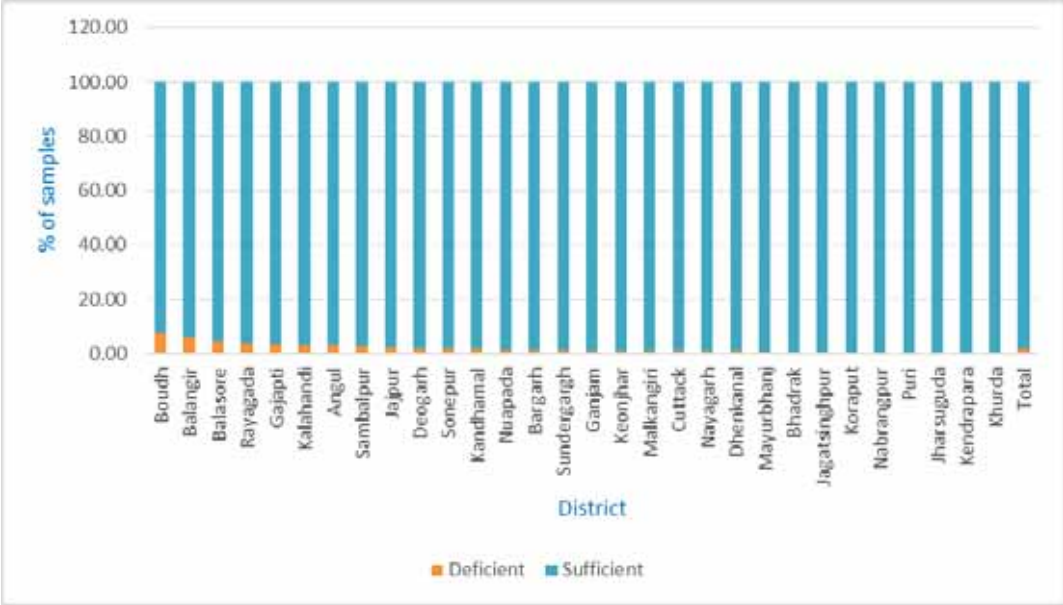


Figure* 5.2.11*: Ferrous deficiency levels in Odisha soils.

Table 5.2.11. District wise details of ferrous in the Odisha (% samples)			
District	Deficient	Sufficient	Total
Boudh	8	92	100
Balangir	6	94	100
Balasore	5	95	100
Rayagada	4	96	100
Gajapti	4	96	100
Kalahandi	3	97	100
Angul	3	97	100
Sambalpur	2	98	100
Jajpur	2	98	100
Deogarh	2	98	100
Sonepur	2	98	100
Kandhamal	2	98	100
Nuapada	2	98	100
Bargarh	1	99	100
Sundergargh	1	99	100
Ganjam	1	99	100
Keonjhar	1	99	100
Malkangiri	1	99	100
Cuttack	1	99	100
Nayagarh	1	99	100
Dhenkanal	1	99	100
Mayurbhanj	1	99	100
Bhadrak	1	99	100
Jagatsinghpur	0	100	100
Koraput	0	100	100

Nabrangpur	0	100	100
Puri	0	100	100
Jharsuguda	0	100	100
Kendrapara	0	100	100
Khurda	0	100	100
Total	2	98	100

5.2.12 Copper

The data on copper showed that the soils in Odisha are sufficient in copper content in all the districts (Table 4.13; Figure 4.12). In case of Jharsuguda, Kendrapara, Ganjam, Jagatsinghpur, Dhenkanal, Cuttack, Nayagarh, Bhadrak, Khurda 100% of samples showed no deficiency of copper.

Table 5.2.12. District wise copper deficiency and sufficiency levels (% samples).

District	Deficient	Sufficient	Total
Jharsuguda	0	100	100
Kendrapara	0	100	100
Ganjam	0	100	100
Jagatsinghpur	0	100	100
Dhenkanal	0	100	100
Cuttack	0	100	100
Nayagarh	0	100	100
Bhadrak	0	100	100
Khurda	0	100	100
Gajapti	1	99	100
Jajpur	1	99	100
Koraput	1	99	100
Deogarh	1	99	100
Nuapada	1	99	100
Mayurbhanj	1	99	100
Kalahandi	1	99	100
Nabrangpur	1	99	100
Sambalpur	1	99	100
Boudh	2	98	100
Sonepur	2	98	100
Malkangiri	3	97	100
Rayagada	3	97	100
Bargarh	3	97	100
Angul	3	97	100
Balasore	3	97	100
Keonjhar	3	97	100
Puri	4	96	100
Sundergargh	5	95	100
Balangir	5	95	100

Kandhamal	6	94	100
Total	2	98	100

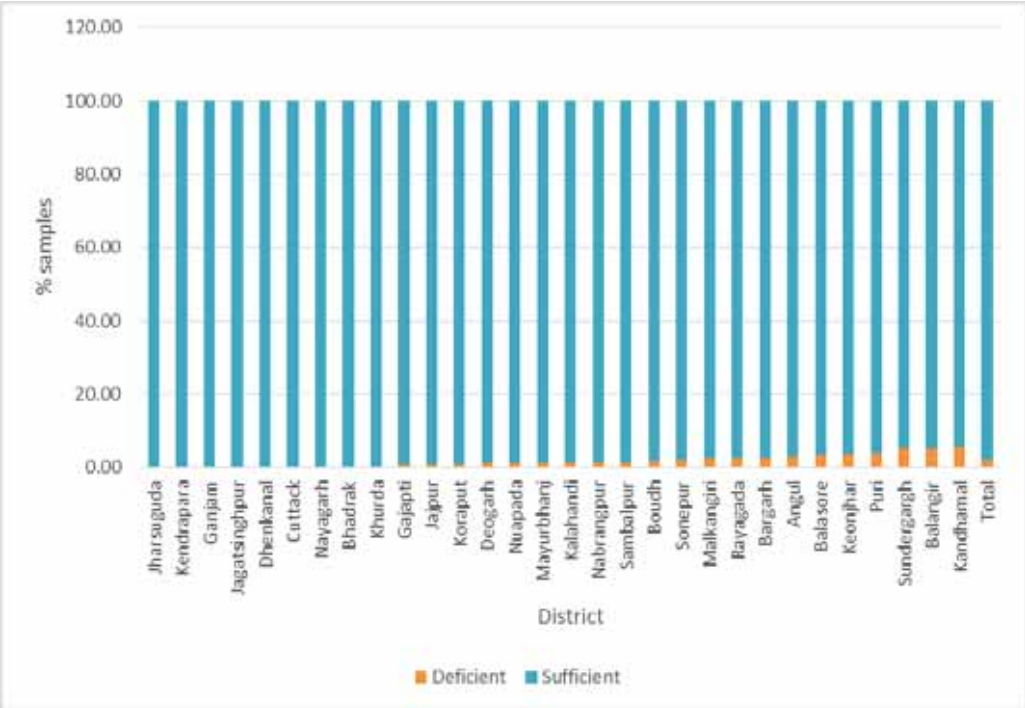


Figure* 5.2.12*: Copper deficiency and sufficiency levels in Odisha.

5.2.13 Manganese

The details of manganese deficiency and sufficiency levels is presented in Table 4.14; Figure 4.13. The data showed that 97% of the soils across all districts are sufficient in manganese.

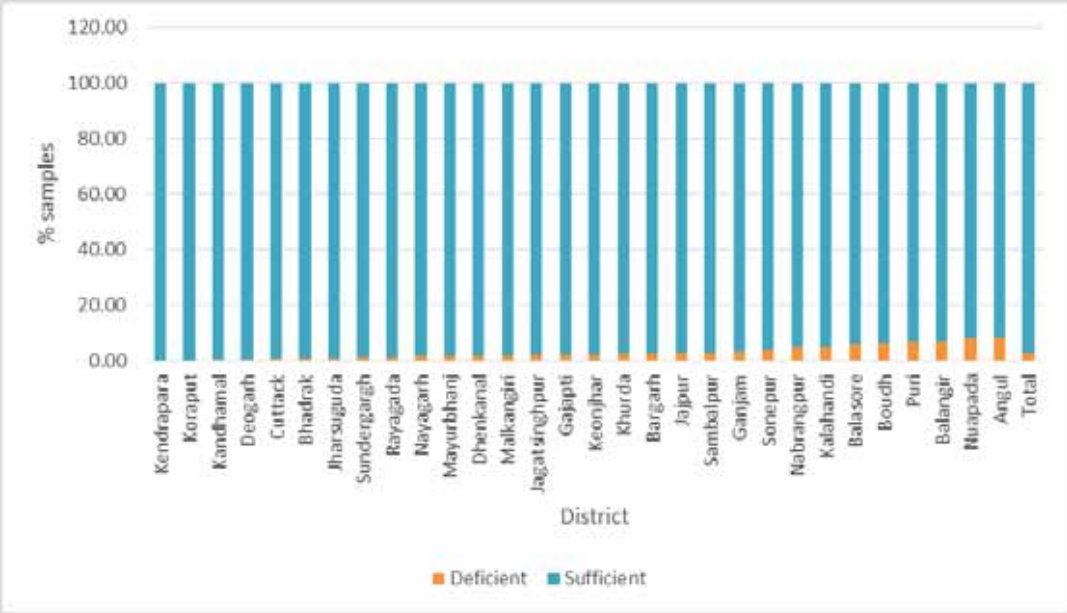


Figure* 5.2.13*: Manganese status in the soils of Odisha.

Table 5.2.13. District wise manganese sufficiency and deficiency levels in Odisha (% samples).			
District	Deficient	Sufficient	Total
Kendrapara	0	100	100
Koraput	0	100	100
Kandhamal	0	100	100
Deogarh	1	99	100
Cuttack	1	99	100
Bhadrak	1	99	100
Jharsuguda	1	99	100
Sundergarh	1	99	100
Rayagada	1	99	100
Nayagarh	1	99	100
Mayurbhanj	2	98	100
Dhenkanal	2	98	100
Malkangiri	2	98	100
Jagatsinghpur	2	98	100
Gajapti	2	98	100
Keonjhar	2	98	100
Khurda	2	98	100
Bargarh	3	97	100
Jajpur	3	97	100
Sambalpur	3	97	100
Ganjam	3	97	100
Sonepur	4	96	100
Nabrangpur	5	95	100

Kalahandi	5	95	100
Balasore	6	94	100
Boudh	6	94	100
Puri	7	93	100
Balangir	7	93	100
Nuapada	8	92	100
Angul	8	92	100
Total	3	97	100

5.2.14. Block-wise results

Block wise results indicate that 100% of soils across ten blocks in Mayurbhanj are acidic in nature, while only 28% of soils in Khariar block in Nuapada district show acidic in nature. In so far as soil alkalinity is concerned, highest percent of soils i.e. 44 % of the soils in Khariar block in Nuapada are alkaline in nature. Majority of the soils across all the block in the state shown tolerance EC except for Ganjam block in Ganjam district where 29% of soils have higher levels of EC that are injurious to crop growth. Highest deficiency of organic carbon (95%) was noticed in Krushnaprasad, Puri followed by Bolagarh in Khurda (95%), Bonapur, Khurda (91%) and Rasuloour, Jajpur (87%). The deficiency of available P ranged from 6% in Laxmipur, Koraput to 95% in Bolagarh, Khurda. Available calcium was found to be deficient in Krushnaprasad, Puri (80%) followed by R. Udayagiri, Gajapati (66%), Baripada, Mayurbhanj 7(54%). The deficiency of magnesium ranged from 0% in Rajkanika and Rajanagar, Kendrapara to 94% in Rayagada, Gajapati district. The sulphur deficiency ranged from 4% in Athgarh, Cuttack to 97% in Dasmanpur, Koraput. Majority (>80%) of the blocks in Balangir found to be deficient in zinc while Banki-Dampada block in Cuttack shown to have no deficiency. Majority of soils in all the blocks (>80%) are found to be deficiency in boron while in Kendrapara, Ganjam and Bhadrak are found to have lesser deficiency levels. Krushnaprasad block in Puri district registered highest level of deficiency of manganese.

Please see Annexure 12.1-12.30 for block wise soil data.

5.3. State Consultations and Need-Based Fertilizer Recommendations

As a part of Odisha Bhoochetana project, a state level consultation program was organized on 22 February 2019 at ICRISAT, Hyderabad with to harness and converge the best expertise in the fields of soil science and agronomy from ICAR, OUAT and DoA in achieving precision and efficiency in decision making in recommending soil test based nutrient management systems. The experts include Dr. Antaryami Mishra and Dr. Rabindra Naik, Associate Professors, Soil Science, OUAT, Bhubaneswar; Dr. Sanjay Kumar Ray, Head, Jorhat Centre, ICAR-NBSSLUP; Dr. B. N. Ghosh, Principal Scientist, Kolkata Centre, ICAR-NBSSLUP; Shri Sharada Prasanna Kar, Soil Chemist, STL, Govt. of Odisha, Bhubaneswar; Dr Girish Chander and Dr Pushpajeet from ICRISAT. The consultations were facilitated by Dr. Pooran Gaur and Dr. Sreenath Dixit and Dr P. Mishra. All the participants actively participated in the discussion on improvement of soil health card leading to a format that was as need upon. The consultation programme concluded with soil test-based nutrient recommendation and soil

health management as such. The following are the recommendations/outcomes of the consultation:

- Conducting of trial/demonstration to address the issue of soil acidity in the pilot sites of the project
- Setting up crop demonstrations during *kharif* season in those farmer's fields where the soil samples have already been analyzed
- Analyze the amendments especially the Paper Mill Sludge (PMS) for heavy metal prior to its application
- Recommendation on application of 25 per cent higher N, P and K over and above RDF if the nutrient status is low and 25 per cent lesser if soil status is high
- Recommendation on reintroduction of PMS as an amendment to correct soil acidity on a larger scale
- Recommendation on soil application of boron @ 1kg per ha every year
- Recommendation on application of sulphur @ 30 kg per ha (200 kg gypsum) for cereals and 45 kg per ha for oilseeds in deficient soils
- Recommendation on application of 5 kg Zn/ha/year (25 kg $ZnSO_4$) in case of paddy and 2.5 kg /ha/year for pulses and other cereals and 2 kg Zn/ha/year for oilseeds in deficient soils
- Recommended the usage of biofertilizers like Azospirillum, Azatobacter, PSB, Rhizobium
- Promoting the seed priming with 1 % zinc sulphate heptahydrate and 1 % KH_2PO_4 in acidic soils
- Promoting application of well decomposed poultry manure @ 2.5 t/ha in furrows as a substitute of lime in management of acid soil
- Incentivizing and promotion of large scale production of aerobic composting both on individual and community basis
- Making mandatory the digital soil maps to be the reference point for soil fertility and crop recommendations.
- Finalized the critical soil limits for Odisha soils
- Low cost PMS could be considered as second best options for management of acid soils.
- Chemical liming materials could be considered particularly for the soils where the pH is below <5.0 in alternate year with INM to reduce cost of liming materials.
- Recommendation that PMS dose of 50% of lime requirement (LR) is highly desirable option in the state of Odisha.

5.4. Soil Health card distribution:

Soil health cards were prepared for all the collected 40265 samples in the local language i.e Oria for the use by the farmers. The soil test cards were distributed on the occasion of World's Soil Health Day i.e. 5 December, 2019. On the occasion, the CDAO's of the respective districts facilitated distribution of soil health by involving various dignitaries viz. Hon'ble Ministers, districts collectors, people's representative's viz. Members of Parliament/Members of

Legislative Assembly etc. The district wise distribution of soil health cards is presented in Table 5.4.

Table 5.4 District-wise distribution of soil health cards in Odisha		
S. No.	**District**	**Number of SHC**
1	Angul	1020
2	Balangir	1819
3	Balasore	1550
4	Bargarh	1550
5	Bhadrak	910
6	Boudh	370
7	Cuttack	1820
8	Deogarh	390
9	Dhenkanal	1030
10	Gajapati	939
11	Ganjam	2810
13	Jagatsingpur	1040
12	Jajpur	1300
14	Jharsuguda	650
15	Kalahandi	1670
16	Kandhamal	1554
17	Kendrapara	1150
18	Keonjhar	1540
19	Khurda	1300
20	Koraput	1769
21	Malkangiri	937
22	Mayurbhanj	3317
23	Nabarangpur	1213
24	Nayagarh	1040
25	Nuapada	647
26	Puri	1420
27	Rayagada	1430
28	Sambalpur	1170
29	Sonepur	780
30	Sundargarh	2130
	Total	40265

6. Benchmarking of Project Sites

Agriculture is the mainstay of Odisha is the key to the overall development of the state. It has a total cultivable land area of 6.18 million ha (65% rainfed and 35% irrigated supporting a population of 50 million) out of which 2.91 million ha (47%) is highland, 1.75 million ha (28%) midland and 1.51 million ha (25%) is lowland. According to the statistics the land under agricultural use is nearly 36%, forest area by 16.45%, the area under non-agricultural use by 12.18%, current fallows by 9.41% and remaining area by others classes. Demographic profile of the respondents shows that the majority of funded farms are located in the younger and mature phases of the life cycle. Nearly 8 percent of respondents are illiterates and 37.3 percent of respondents are literates who have a formal education (lower education) 10.4 percent have completed their education levels more than 10^{th}. The total number of families is differentiated into 40 percent male, 38 percent female, and children 22 percent. The adult male to female ratio is almost 1:1 and the children's ratio is 1:1.25 per household indication that one or two children lived in the family. The Worker Population Ratio (WPR) signifies that 50 percent of persons aged 15 years and above were employed in the State and 60 percent of the workforce was constituted by the male population. The primary occupation of the majority of respondents is agriculture and in 63 percent of districts the respondents reported that their secondary occupation is farm-labor.

Operational holdings is highly skewed with more than 80 percent of those belonging to small and marginal categories and 20 percent belongs to medium and large categories. The share of area under two prominent seasons of Odisha indicates that kharif (rainy season) is the major season for the farmers in the state where it occupies 97% of the total cropped area of a farmer in year. The area under the rabi season is nearly 22% indicating the dependency of farming on rains and other climatic factors. Odisha is primarily a food grain-growing state, and 88 percent of the area in kharif is occupied by food grain crops. Oilseeds and pulses are mainly grown in the rabi season. Paddy is a very prominent crop (85%) of this season and occupies 85 percent of total sown area. Vegetables are third most important crop during the kharif season occupying 2 percent of the cropped area. Cotton is the next to ragi occupying nearly 1 percent of the cropped area in kharif.

The productivity levels of all major crops grown in the state below national statistics indication the need for adopting best management practices. One of the main reasons for low productivity can be attributed to low SRR and climatic vagaries. Other reason could be low nitrogen application than the recommended dosage.

The average gross returns per hectare rice production is Rs 26500 per hectare with cost of cultivation amounted to Rs. 13647 and price per quintal is Rs 1347/quintal. The average benefit-to-cost ratio is around 1:2, which means farmer are getting 2 rupees for every onerupee investment. As the cropping intensity is only 119% virtually minimal rabi area, government to focus on rice-fallows. This not only improves the economic sustainability of farmer but also adds to gross income to government.

7. Digital Soil Mapping for Odisha

7.1. Soil nutrient maps

Site-specific nutrient management based on the soil nutrient status is necessary for improving crop productivity, optimizing the available resources, and reducing soil degradation. High-resolution soil nutrient maps will be key information to decide the policy and planning related to nutrient usage in agriculture. The analysis of 40,265 georeferenced soil samples from across 30 districts were collected and analyzed in ICRISAT's Charles Renard Analytical Laboratory. Soil analysis data was used to develop soil prediction models and maps through geostatistical modeling.

Digital Soil Mapping (DSM) or predictive soil mapping provides options to generate soil property surfaces at fine resolution. There are three steps involved in the preparation of digital soil maps: 1) collection of legacy soil data or field and laboratory measurement of soil properties and development of the base maps from the available data including climatic information, land cover, terrain and geological variables; 2) estimation of soil properties by using quantitative relationship between point wise measured data and that of spatial maps that were prepared in the step one; 3) estimated soil properties were further used to derive more difficult-to-measure soil properties such as soil water storage, carbon density, and phosphorus fixation[1]. Although the DSM products have some prediction uncertainties, but they provide spatial information at much higher resolution and at lesser costs.

The methodology adopted in developing soil maps is given in Figure 7.1. The key variables used to develop the model for Odisha soils were soil type, agro ecological zones, elevation, precipitation, and temperature. The Digital Elevation Model (DEM) acquired from the Shuttle Radar Topographic Mission (SRTM) with spatial resolution of 90 m around the study area was downloaded for Odisha state. The global raster data of WorldClim Bioclimatic variables for WorldClim version 2 was used to extract the bioclimatic variables with respect to point wise data[2]. These bio-climatic variables were average for years 1970-2000. The Random Forest model was used to develop predictive soil model and maps using Bhoochetana data. While modelling, data partitioned into 75% points for calibration and 25% points for validation of the model. Calibrated models were used to prepare soil nutrient maps.

[1] Sanchez et al. (2009). Digital Soil Map of the World. Science 325, 680.

[2] Fick, S. E., and Hijmans, R. J. (2017). WorldClim 2: New 1-km spatial resolution climate surfaces for global land areas. Int. J. Climatol 37, 4302-4315.

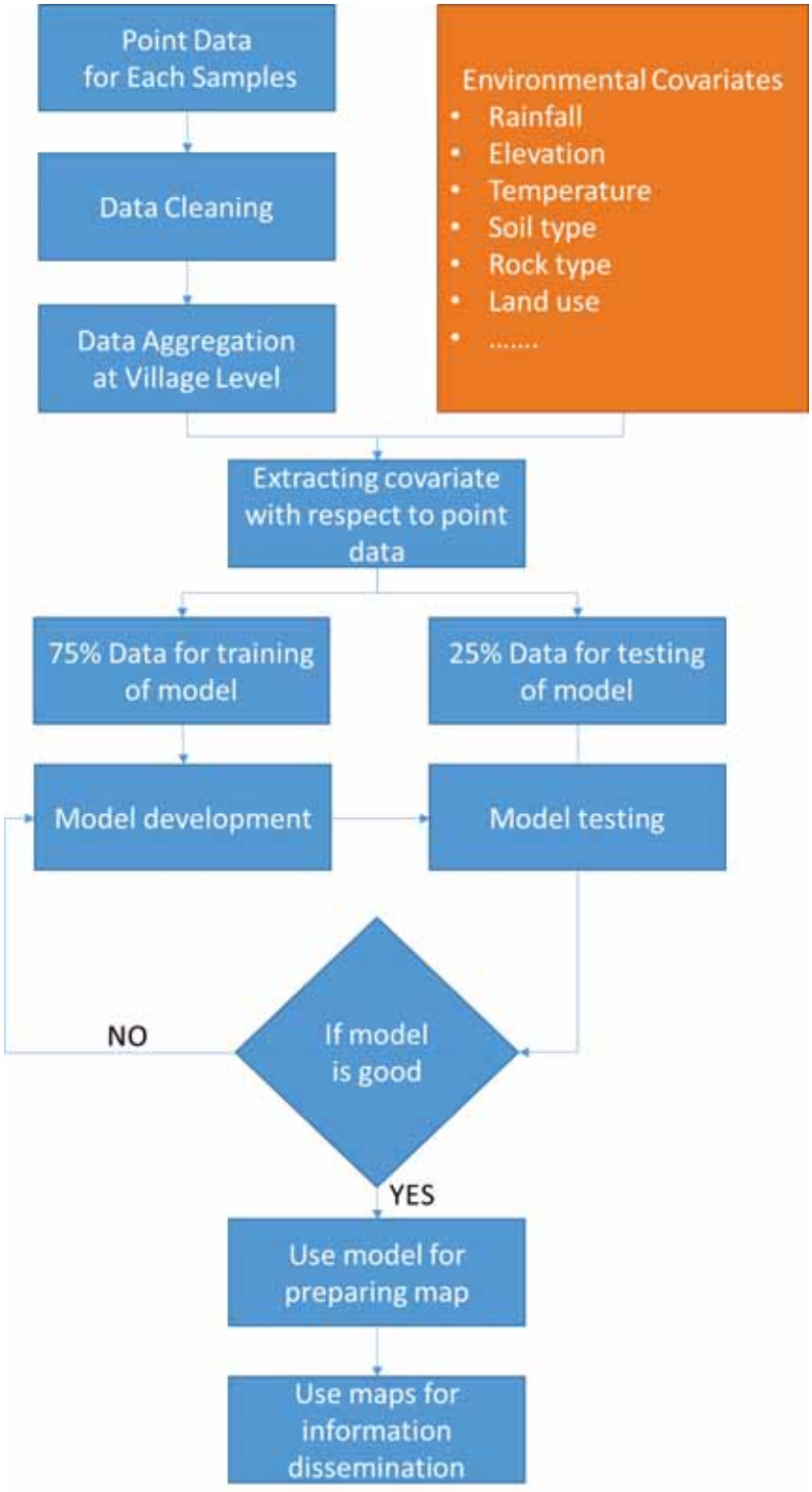


Figure 7.1 Methodology adopted for developing the soil nutrient maps for Odisha state.

Three types of maps were prepared for better interpretation of results. They are 1) map on soil parameter values at 250 x 250 m resolution (pixel level map), 2) map on soil parameter values classified as per fertility indices (classified map) and 3) map on classified soil parameters aggregated to block level. These three types of maps were prepared for pH, electrical conductivity (dS/m), organic carbon (%), exchangeable potassium (mg/kg) and for available nutrients viz. phosphorous (mg/kg), sulphur (mg/kg), boron (mg/kg) and zinc (mg/kg). The pixel level and classified maps were also prepared for each district. The rules used for classification are presented in Table 7.1.

Table 7.1. Ranges of soil parameter values for classification.

Parameter	Value range	Class
pH	<4.4	Extreme to Ultra acidic
	4.5-5.5	Strong to very strong acidic
	5.6-6.5	Slight to moderately acidic
	6.6-7.3	Neutral
	7.4-8.4	Slight to moderate alkaline
	>8.4	Strong to very strong alkaline
Electrical conductivity (dS/m)	<0.8	Normal
	0.8-1.6	Critical to salt sensitive crops
	1.6-2.5	Critical to salt tolerant crops
	>2.5	Injurious to crop
Organic carbon (%)	<0.5	Low
	0.5-0.75	Medium
	>0.75	High
Available phosphorous (mg/kg)	<5	Low
	5-10	Medium
	>10	High
Exchangeable potassium (mg/kg)	<50	Low
	50-100	Medium
	>100	High
Available sulphur (mg/kg)	<10	Deficient
	>=10	Sufficient
Available boron (mg/kg)	<0.58	Deficient
	>=0.58	Sufficient
Available zinc (mg/kg)	<0.75	Deficient
	>=0.75	Sufficient

Digital maps of soil fertility attributes: pH, electrical conductivity, organic carbon (OC), available phosphorous (P), exchangeable potassium (K), available sulfur (S), available boron (B), and available zinc (Zn) for Odisha state were prepared. The key finding from data analysis was soils from the majority area (95%) of the state are acidic with pH values less than 6.5,

thus required a strategic policy for acid soil management. Moreover soils from 50, 95, and 65% of state area are deficient in S, B, and Zn, respectively. This information is collated into a form of soil fertility atlas for the state of Odisha[3] as well as an interactive geo-portal[4] providing information on soil nutrient status and nutrient requirements (Figure 7.2). This publication will be of great use to policymakers, administrators, block-level officials, extension workers and farmers as a ready reckoner to devise and implement nutrient application practices across various agricultural production systems at the block, district and state levels.

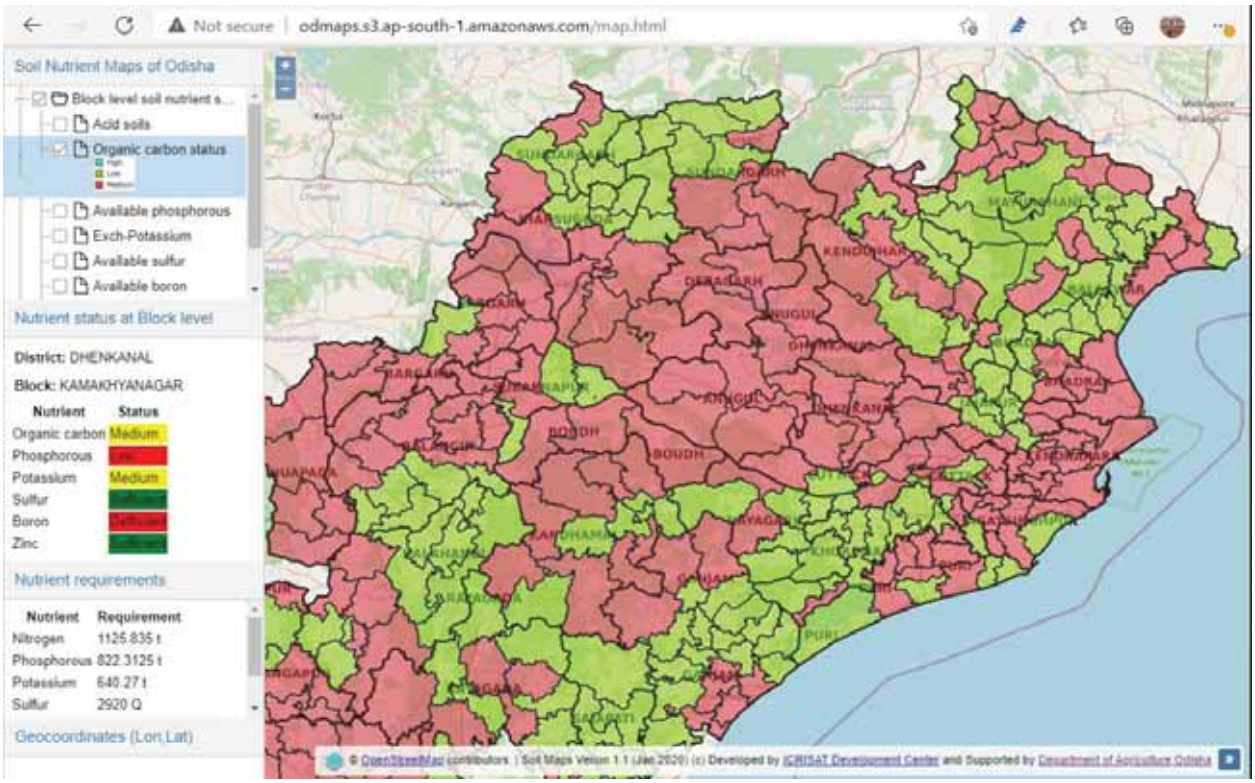


Figure 7.2 Geo-portal developed for providing information on soil nutrient status and nutrient requirement

7.2. Online application for soil test-based fertilizer recommendation

The creation of soil nutrient maps has been a critical output of the Bhoochetana project in Odisha. Data from the analysis of 40,265 soil samples collected across 30 districts was used as a database to develop soil fertility indices. The database was used to develop crop-wise fertilizer recommendations down to the village level and issue soil health cards to farmers. Since the printed soil health cards have limited reach and also involve huge cost and effort, a web-based application was envisaged to provide soil fertility information at village, block, or

[3] Dixit S, Mishra PK, Muthukumar M, Reddy KM, Padhee AK and Mishra A (Eds.). 2020. Mapping the nutrient status of Odisha's soils. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and Department of Agriculture, Government of Odisha. 342 pp.

[4] Mukund D Patil. 2020. Soil Maps Version 1.1 http://odmaps.s3.ap-south-1.amazonaws.com/map.html

district levels in a seamless and cost-effective manner. The data sets from the project were used to develop the web and mobile applications.

The application was developed using a combination of PHP, an open-source server-side scripting language that can be embedded into an HTML document and MYSQL, an open-source data management system. During development stage, open-source software WAMP (version 2.2) was used as a testing environment on a local computer. WAMP is a bundle of softwares including apache web server (version 2.2.21), PHP processor (version 5.3.8), and MYSQL server (version 5.5.16). The existing web application is hosted on an ICRISAT server[5]. Apart from the application for soil test-based fertilizer recommendations, this application also includes the information on good agricultural practices that referred from the Karif and Rabi Manual published by Department of Agriculture Government of Odisha (7.3). Similarly, mobile applications were developed for android platform, which will be distributed through the tablet devices.

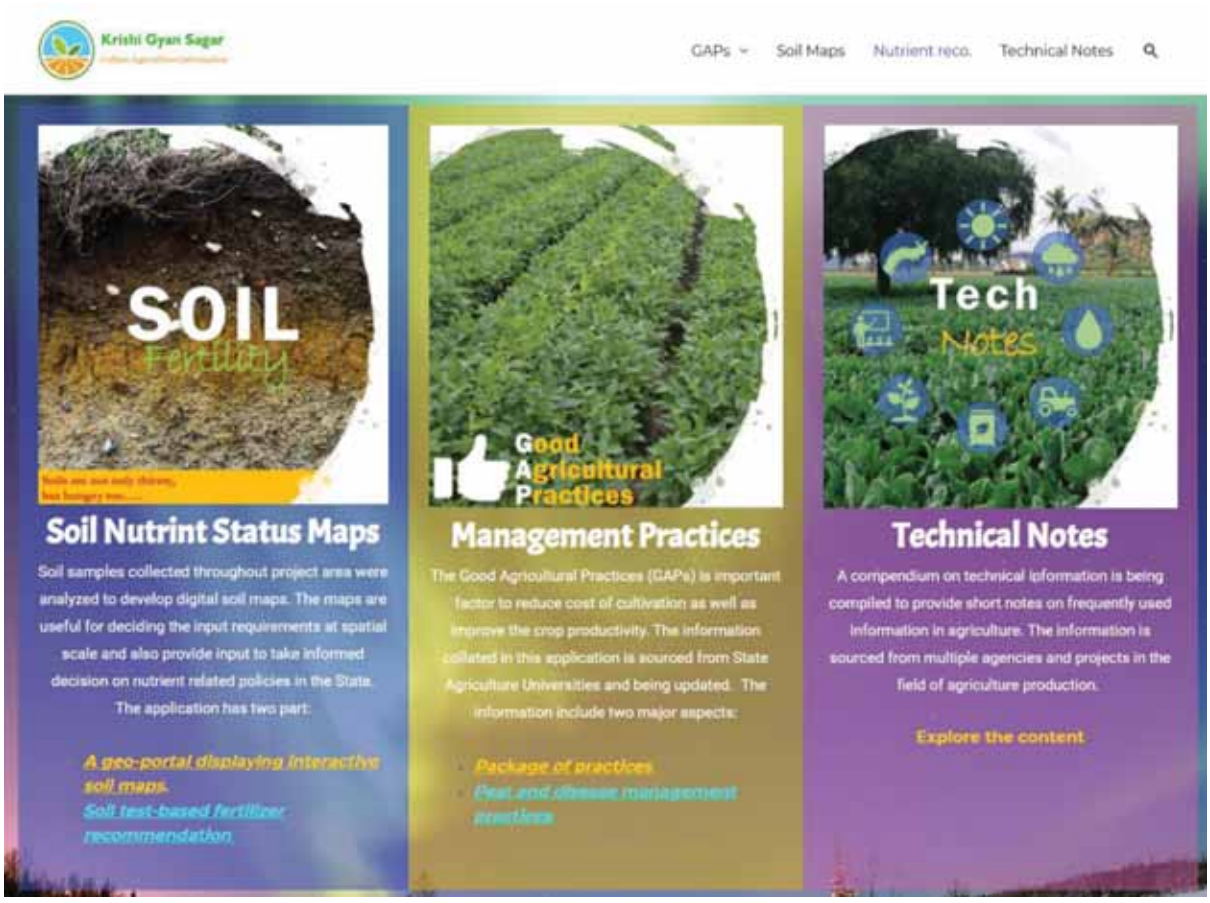


Figure 7.3. Web application for sharing the information on soil test-based fertilizer management and good agricultural practices.

[5] http://111.93.2.168/kgsodisha/

8. Demonstrations of Improved Management Practices

As a part of the productivity enhancement demonstrations, a total of 9387 demonstrations covering an area of 5190 acres were conducted across 30 districts during 2018-19 and 2019-20 (**Table 8.1**). During *kharif* 2018, 1762 demonstrations covering an area of 1292 acres and during *rabi 2018-19,* 2624 demonstrations covering 1350 acres were organized. Similarly, during kharif 2020, 1920 demonstrations covering an area of 1006 acres and during rabi 2019-20, 3081 demonstrations covering an area of 1542 acres were organized. The majority of the demonstrations focused on evaluation of application of deficient micronutrients and improved crop cultivars. The important crops for demonstrations during kharif season includeded paddy, finger millet, maize and groundnut, while chickpea, blackgram, greengram, groundnut and mustard during *rabi* season.

Table 8.1. Season and district-wise demonstration conducted in pilot sites

District	Kharif-2018-19		Rabi-2018-19		Total-2018-19		Kharif-2019-20		Rabi-2019-20		Total-2019-20		Grand Total-2018-20	
	Area (acre)	No. of Demos	Area (acre)	No. of Demos	Area (acre)	No. of Demos	Area (acre)	No. of Demos	Area (acre)	No. of Demos	Area (acre)	No. of Demos	Area (acre)	No. of Demos
Angul	77	153	13	43	90	196	11	29	24	47	35	76	125	272
Balangir	65	66	15	30	80	96	0	60	38	76	38	136	118	232
Balasore	42	54	23	34	65	88	30	60	77	153	107	213	172	301
Bargarh	54	109	41	81	95	190	30	59	84	169	114	228	209	418
Bhadrak	20	40	0	49	20	89	33	68	30	59	63	127	83	216
Boudh	18	28	20	26	38	54	24	50	46	92	70	142	108	196
Cuttack	30	30	20	39	50	69	23	45	20	40	43	85	93	154
Deogarh	52	49	54	201	106	250	49	104	72	145	121	249	227	499
Dhenkanal	69	69	16	31	85	100	23	45	19	38	42	83	127	183
Gajapathi	33	66	31	62	64	128	67	142	67	133	134	275	198	403
Ganjam	100	104	92	126	192	230	43	60	43	85	86	145	278	375
Jagatsinghpur	31	31	30	60	61	91	38	75	83	166	121	241	182	332
Jajpur	0	50	45	87	45	137	40	80	31	62	71	142	116	279
Jharsuguda	47	54	65	98	111	152	57	70	51	103	108	173	219	325
Kalahandi	6	12	18	56	24	68	30	60	49	98	79	158	103	226
Kandhamal	58	74	12	46	70	120	15	30	10	20	25	50	95	170

District	Kharif-2018-19		Rabi-2018-19		Total-2018-19		Kharif-2019-20		Rabi-2019-20		Total-2019-20		Grand Total-2018-20	
	Area (acre)	No. of Demos	Area (acre)	No. of Demos	Area (acre)	No. of Demos	Area (acre)	No. of Demos	Area (acre)	No. of Demos	Area (acre)	No. of Demos	Area (acre)	No. of Demos
Kendrapara	45	60	95	193	140	253	43	85	83	166	126	251	266	504
Keonjhar	0	1	105	203	105	204	64	128	62	124	126	252	231	456
Khorda	60	60	14	69	74	129	25	50	80	160	105	210	179	339
Koraput	14	27	161	401	174	428	24	48	50	100	74	148	248	576
Malkangiri	40	40	30	60	70	100	39	60	75	150	114	210	184	310
Mayurbhanj	62	91	60	63	122	154	35	70	96	192	131	262	253	416
Nabarangpur	70	162	15	50	85	212	14	28	60	120	74	148	159	360
Nayagarh	42	60	16	55	58	115	47	70	20	40	67	110	125	225
Nuapada	58	58	17	30	74	88	0	60	38	76	38	136	112	224
Puri	49	49	47	89	96	138	15	30	49	98	64	128	160	266
Rayagada	38	60	14	30	52	90	15	30	30	60	45	90	97	180
Sambalpur	60	60	29	80	89	140	66	66	48	95	114	161	203	301
Sonepur	5	10	23	21	28	31	30	60	45	90	75	150	103	181
Sundargarh	50	35	232	211	282	246	76	98	62	124	138	222	420	468
Total	1292	1762	1350	2624	2642	4386	1006	1920	1542	3081	2548	5001	5190	9387

8.1. Demonstrations of soil test-based micronutrient application

Kharif season crops

During kharif seasons, demonstrations were conducted with major crops like paddy, maize, pigeonpea, groundnut and finger millets. The applications of deficient micronutrients viz. boron (B) and zinc (Zn) recorded a productivity benefit between 10%-66% (Figures 8.1.1 to 8.1.5).

Figure 8.1.1. Response of finger millet to nutrient management in kharif

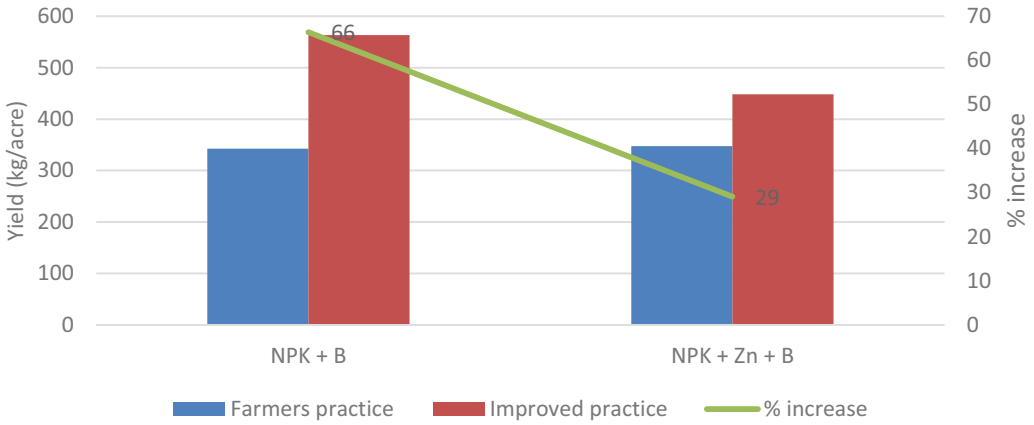


Figure 8.1.2. Response of groundnut to nutrient management practices in *kharif*

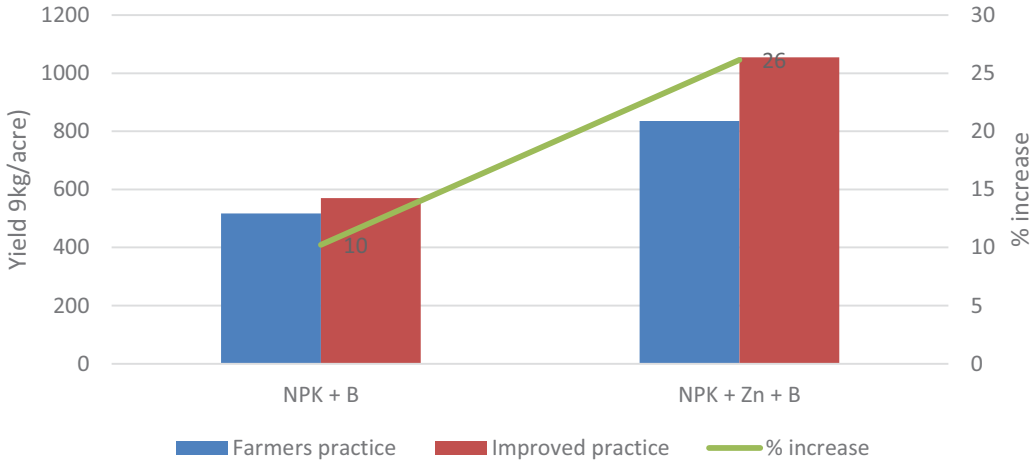


Figure 8.1.3. Response of maize to nutrient management in *kharif*

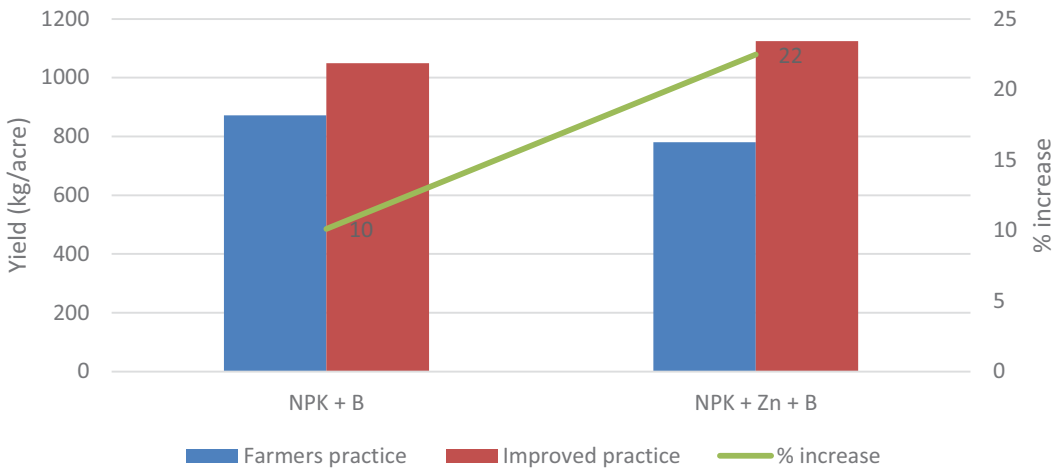
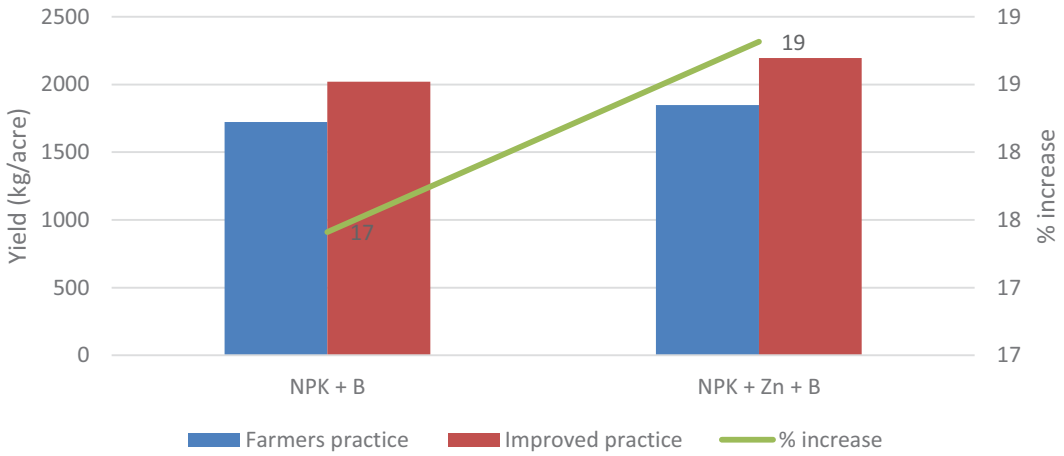


Figure 8.1.4. Response of paddy to improved nutrient management in *kharif*



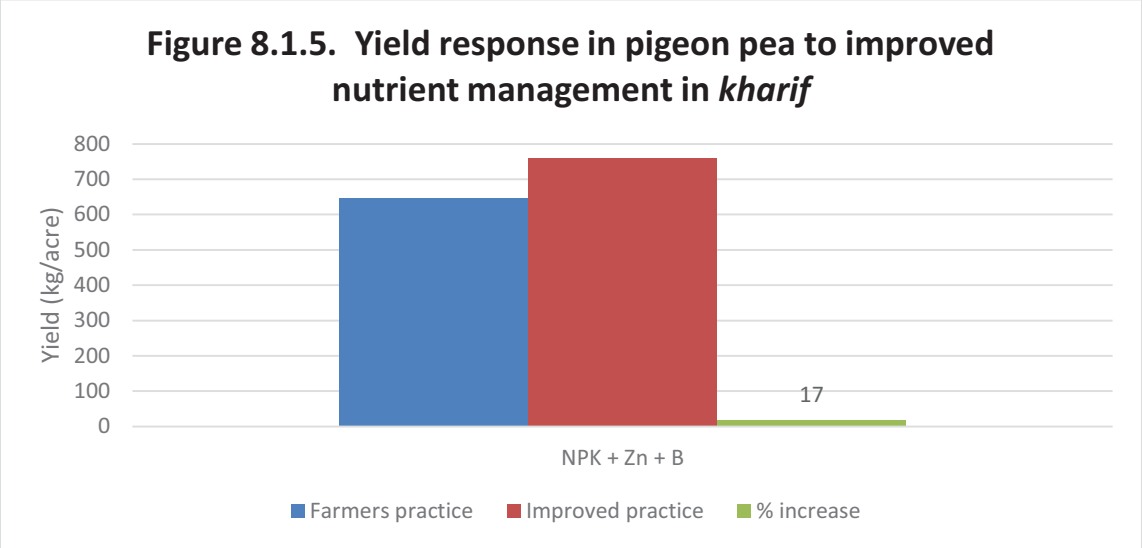


Plate 8.1.1. Crop demonstration with pigeonpea crop in Nuapada district.

Rabi season crops

During the rabi seasons, the demonstrations were conducted with major crops like paddy, blackgram, greengram, chickpea, maize and mustard. The applications of deficient micronutrients viz. boron (B) and zinc (Zn) recorded a productivity benefit between 7%-50% (Figures 8.1.6 to 8.1.11).

Figure 8.1.6. Response of black gram to micronutrients in *rabi*

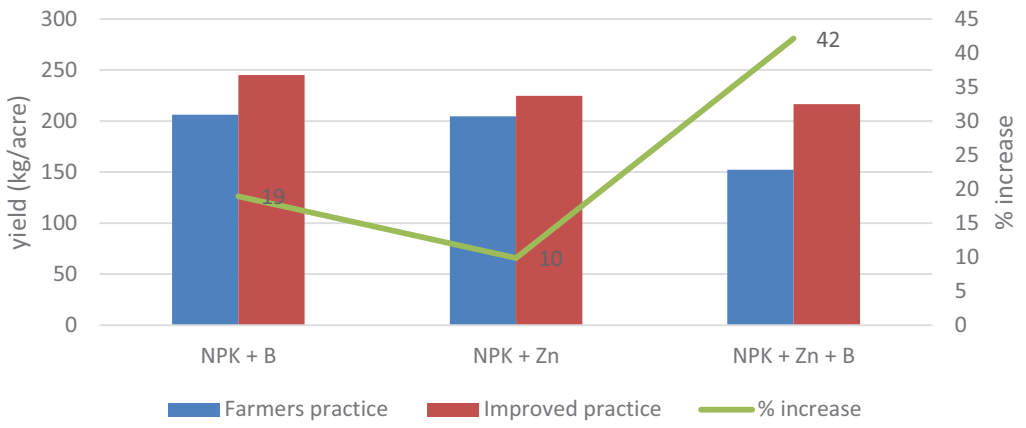


Figure 8.1.7. Response of green gram to micronutrient application in *rabi*

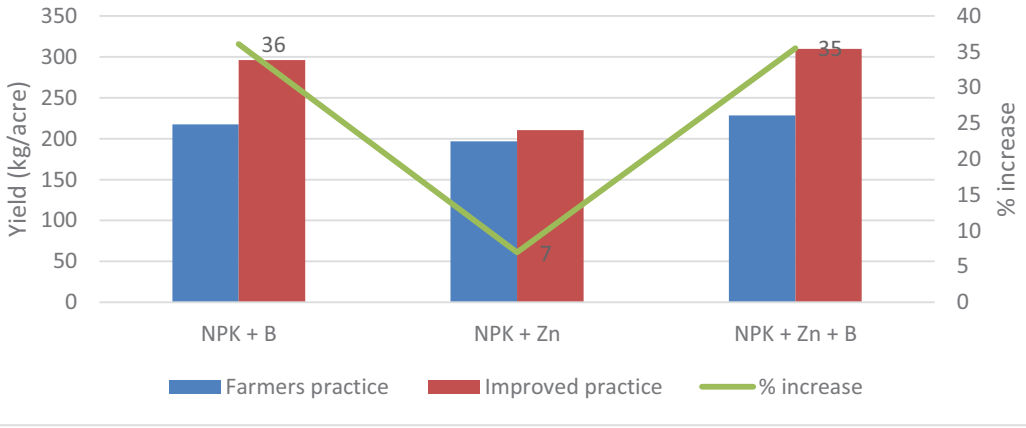


Figure 8.1.8. Response of chickpea to micronutrient application in *rabi*

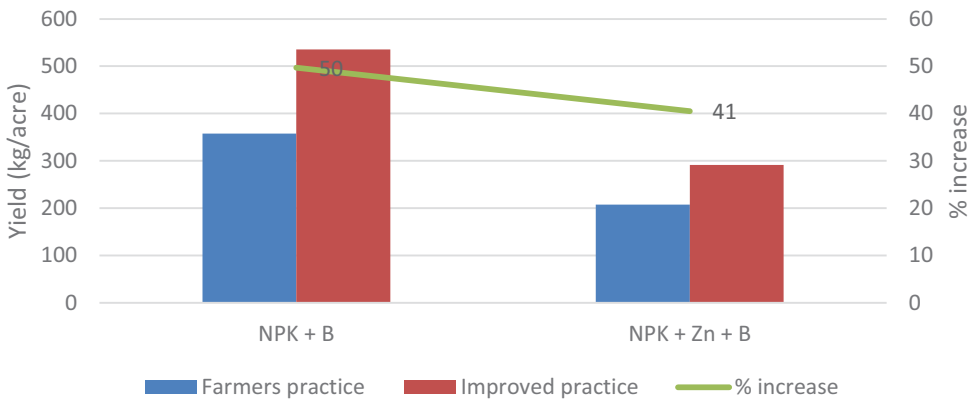


Figure 8.1.9. Response of maize to micronutrient application in *rabi*

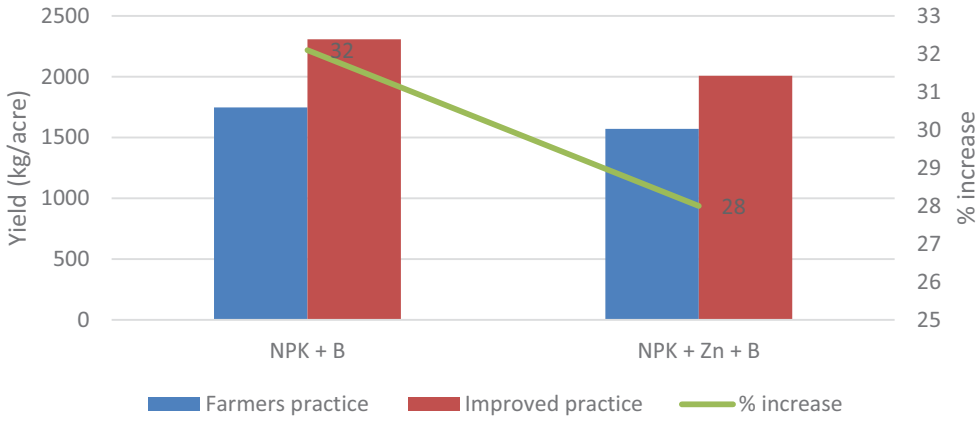


Figure 8.1.10. Response of mustard to micronutrient application in *rabi*

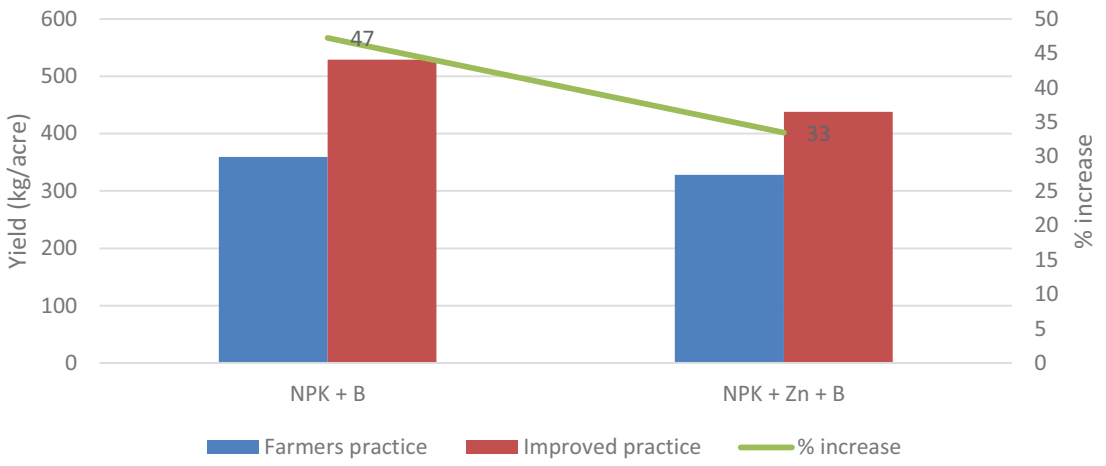
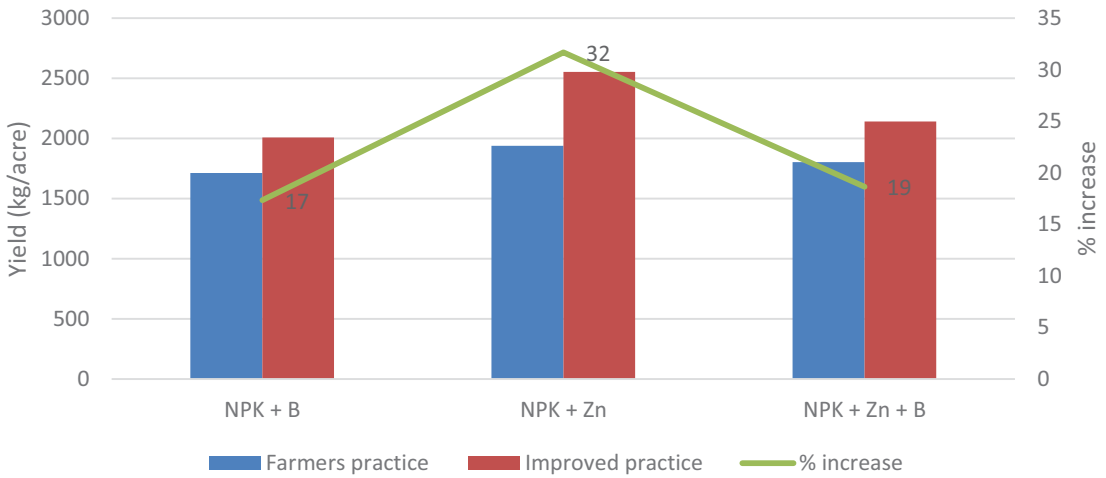


Figure 8.1.11. Response of paddy to micronutrients in *rabi*



8.2. Demonstrations of improved cultivars

Kharif season crops

During the kharif seasons, the improved varieties of important crops like pady, finger millet, groundnut and maize were evaluated. The results showed a significant yield benefit with improved varieties over the prevailing local ones (Figures 8.2.1 to 8.2.4). In case of finger millet, the per cent increase in yield was 34%-39% with cultivars like GPU 28, GPU 48 and MR 1. In groundnut Devi cultivar, the yield benefit over the local variety was 40%. Similarly, in maze, the % yield increase was 20%-68% with HT 5402, VNR 4343 and Adventapac 751 Elite cultivars. In case of maize cultivars, the yield advantage varied between 32% with Ranidhan and 9% with CR 1018.

Figure 8.2.1. Performance of improved finger millet cultivars in *kharif*

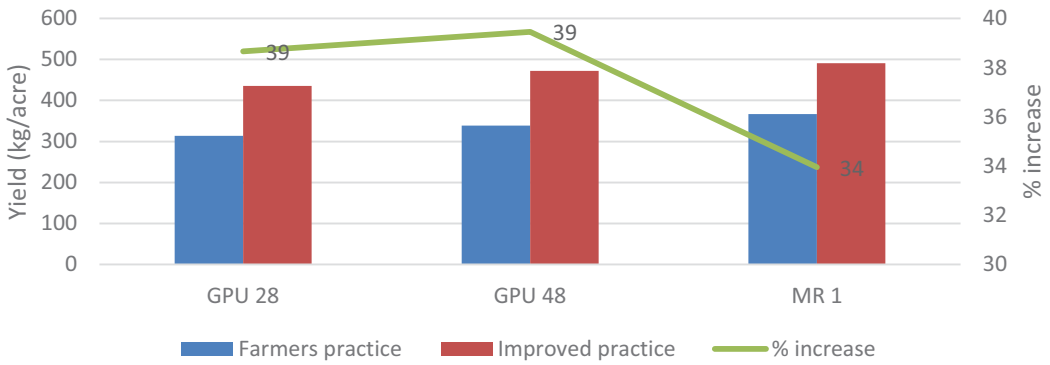
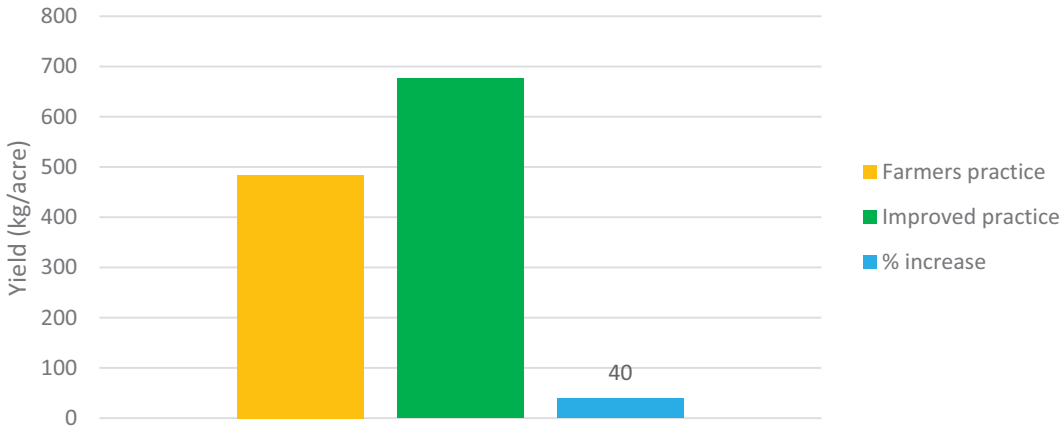


Figure 8.2.2. Performance of Devi variety of groundnut in *kharif* season



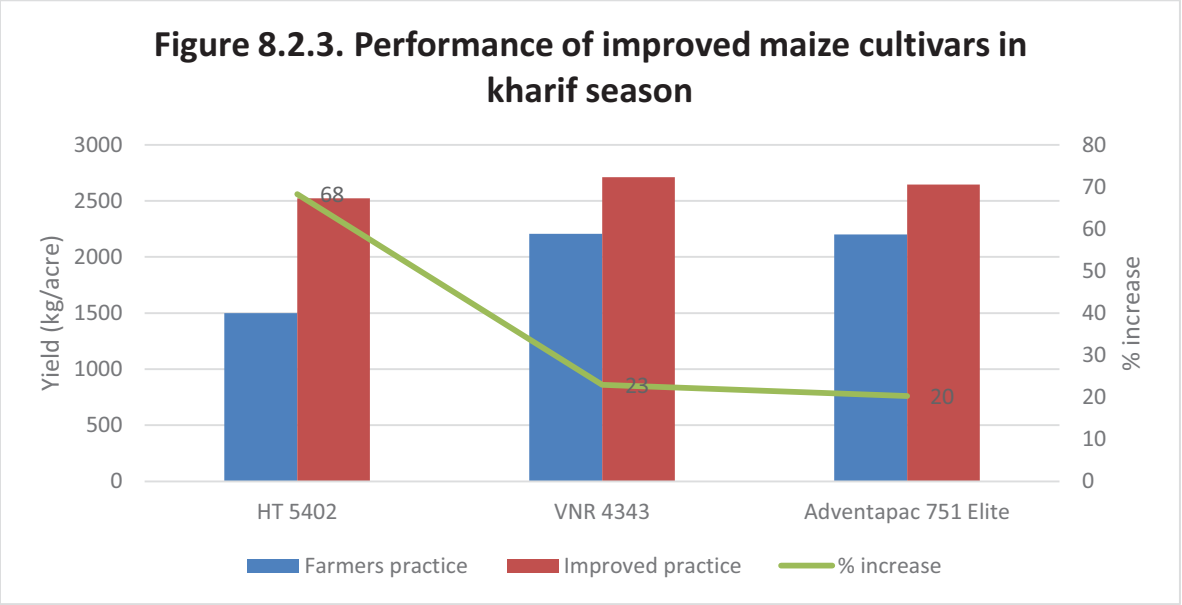


Plate 8.2.1 Crop demonstration with maize crop in Kalahandi district.

Figure 8.2.4. Performance of improved paddy cultivars in *kharif* season

Rabi season crops

During the rabi seasons, the improved varieties of important crops like pady, blackgram, greengram, chickpea, groundnut and mustard were evaluated. The results showed a significant yield benefit with improved varieties over the prevailing local ones (Figures 8.2.5 to 8.2.10). There was a yield benefit of around 35% with blackgram cultivar PU 31; 13%-39% with greengram cultivars like IPM 2-14, IPM 2-3; 10%-36% with chickpea cultivars like JAKI 9218, JG 11, JG 14 and NBeG 3; 27% with groundnut cultivar Devi; 26% to 37% with mustard cultivars like Anuradha, DRMR 1153-12, DRMR 150-35; and 17% to 28% with paddy cultivars like Lalat, Parijat and MTU 1001.

Figure 8.2.5. Performance of black gram cultivar PU 31 in rabi season

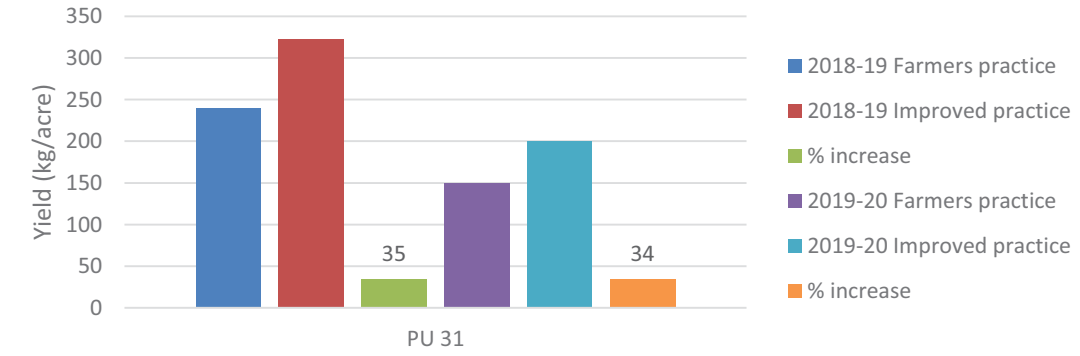


Figure 8.2.6. Performance of green gram cultivars in *rabi*

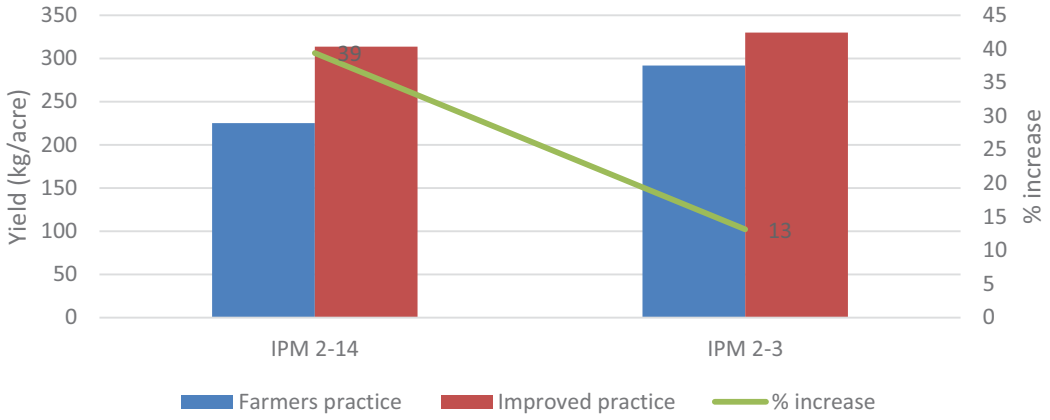


Figure 8.2.7. Performance of chickpea cultivars in rabi

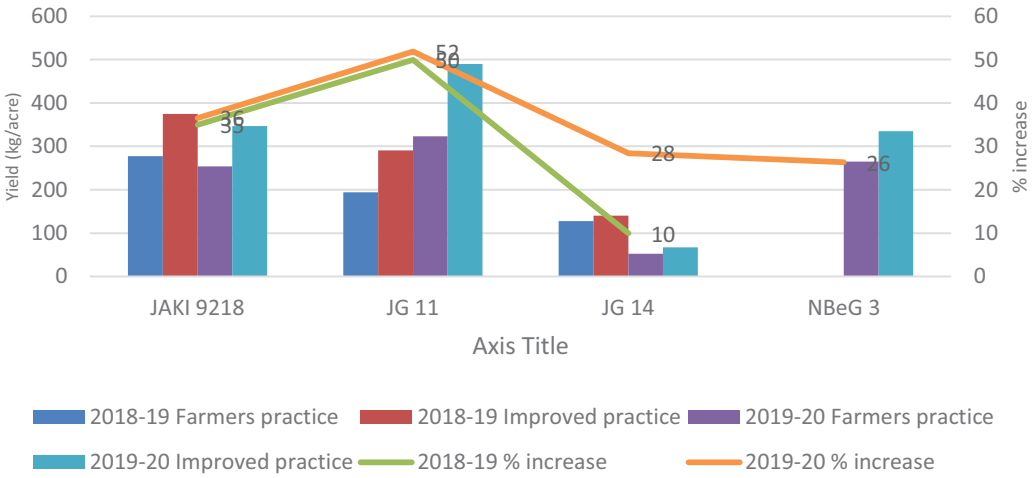


Figure 8.2.8. Performance of Devi variety of groundnut in *rabi*

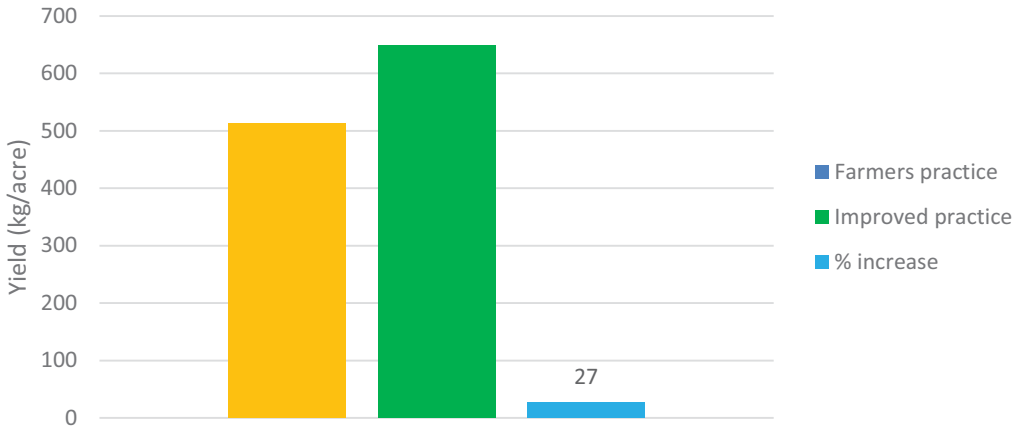


Figure 8.2.9. Performance of mustard varieties in *rabi*

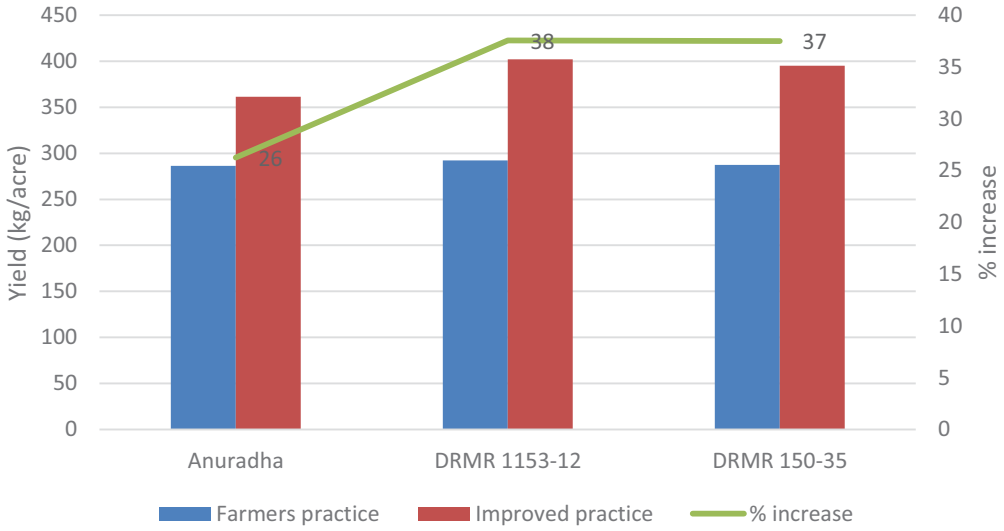
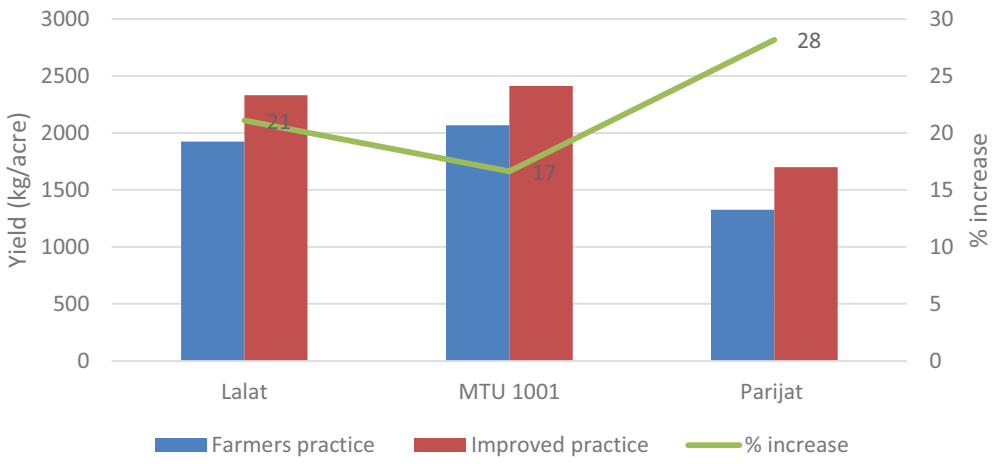


Figure 8.2.10. Performance of improved cutlivars of paddy in *rabi*



9. Upgradation of soil laboratories

In commensurate with the project document IDC, ICRISAT has committed establishement of two referral laboratories at Bhuhaneswar and Sambalpur with the state-of-the-art facilities. In this regard, the renovation of buildings, furniture, air-conditioning of the lab, electric fitting, water and drainage pipeline works have been completed. The shipment of MPAES and other equipment's mentioned in the final list has been completed. The committed high end equipments viz., MPAES, UV spectrophotometer, glass-ware and chemicals to support analysis of 10,000 samples for 14 parameters at each site have been successfully deployed and installed at both the referral labs with due acknowledgement from ADAs of respective referral laboratories. CRAL team conducted the dry run of referral laboratory equipments at both the sites and now the labs are functional to analyse the soil, plant and water samples with high precision. Hands-on trainings to handle instruments by staff at respective laboratories are again provided by CRAL ICRISAT team during 5-8 April 2021.

The referral laboratory at Bhubaneshwar was inaugurated in person by Dr Arun Kumar Sahu, Hon'ble Minister of Agriculture & Farmers empowerment, Fisheries and Animal Resources Development & Higher Ecucation and Dr Muthu Kumar, DoA in the presence of government high ups of Odisha on 5 Dec 2020. While referral laboratory at Sambalpur was inaugurated virtually by the minister Dr Sahoo (Plate 9.1).

Please see Annexure-12.31 for details of chemicals and other lab items sent to each of the laboratory at Bhubaneshwar and Sambalpur

Please Annexure-12.32 & 12.33 for details of all equipments installed/sent till date at Bhubaneshwar and Sambalpur sites

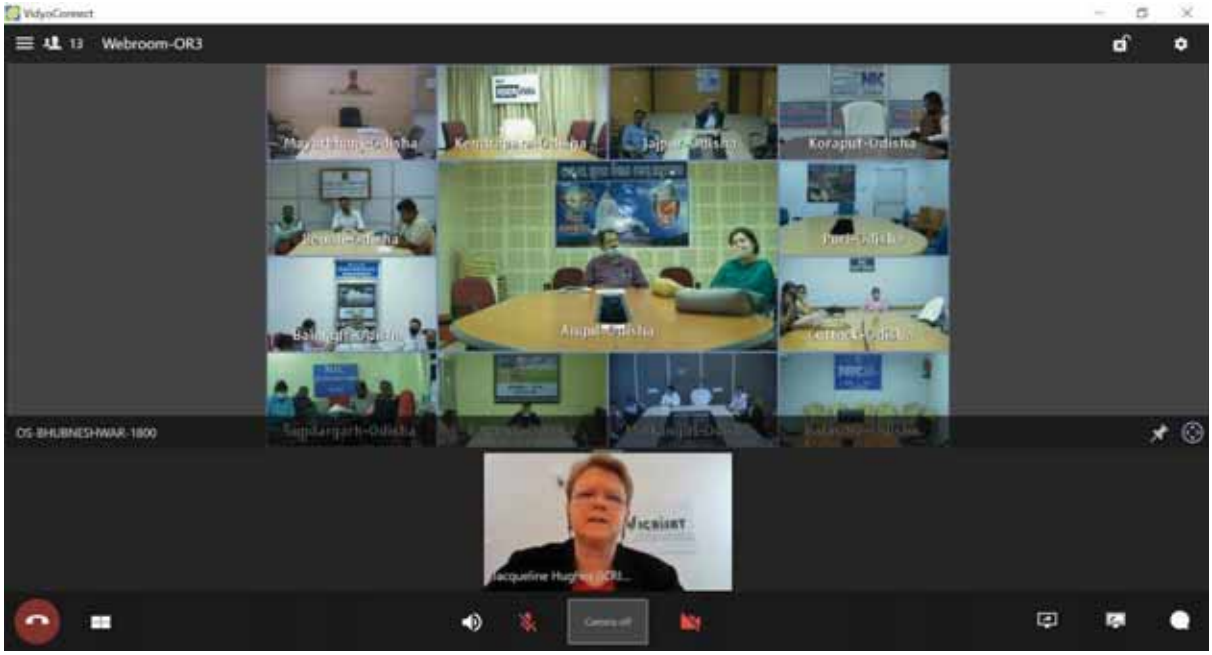


Plate 9.1. Inaugural of 2 referral laboratories in Odisha on 05 Dec 2020.

10. Capacity development

10.1. Capacity development of Odisha laboratory staff at ICRISAT

As part of this process, five-day training cum exposure program was organized during 27 to 31 August 2018 at CRAL laboratory, ICRISAT for six participants from Soil Testing Laboratories (Bhubaneswar and Sambalpur) along with two professors from OUAT (Table 10.1), Bhubaneshwar with the following insights-

- *Hands on training for sophisticated equipments viz .,MPAES*
- *Standard soil analysis procedures*
- *Safety guidelines*
- *Service engineers from Agilent Technologies guided the participants in maintenance, service and floor plans*
- *Distributed soil laboratory manual for better understanding of SOP's used in analysis*

Table 10.1. Participants of the training program for referral laboratory staff

Sr no	Participant	Designation	Location
1	Dr. Antaryami Mishra	Professor (Soil Science)	College of Agriculture, OUAT, Bhubaneshwar
2	Dr. R.K. Nayak	Associate Professor (Soil Science)	College of Agriculture, OUAT, Bhubaneshwar
3	Mr. Babajee Charan Sethy	Soil Chemist, STL Sambalpur	Director of Agriculture & Food Production, Odisha.
4	Ms. Mamatarani Tripathy	AAO, STL Sambalpur	Director of Agriculture & Food Production, Odisha.

5	Ms. Laxmi Dei	AAO, STL Sambalpur	Director of Agriculture & Food Production, Odisha.
6	Ms. Sharada Prasanna Kar	Soil Chemist, STL Bhubaneshwar	Director of Agriculture & Food Production, Odisha.
7	Mr. Sarat Kumar Das	AAO, STL Bhubaneshwar	Director of Agriculture & Food Production, Odisha.
8	Ms. Geetarani Nanda	AAO, STL Bhubaneshwar	Director of Agriculture & Food Production, Odisha.

Plate 10.1: (L) Hands-on training in handling laboratory equipment and (R) participants receive certificates following the training to upgrade laboratories in Odisha.

10.2. Capacity development of senior DoA Officials at ICRISAT

The Capacity Building program was conducted for 60 senior officials (2 from each district) across 30 districts at ICRISAT campus in Hyderabad. It was conducted in 2 batches. The first batch comprised of soil science officials who participatedduring 8-10 July 2019 at ICRISAT center. The 2nd batch of officials from Odisha participated in the program during 15-17 July, 2019. The following were the objectives of the programme:

- Train officials from the districts of Odisha as MTs in science led scaling up of the Odisha Bhoochetna project and make them aware in the major themes of the project
- Empower the MTs in the principles and methods of training
- Practice designing and delivery of training programs

Plate 10.2.1: Pictures of DoA officials trainings at ICRISAT

Since the 1st batch participants were all the officials from soil testing laboratories, the curriculum focused on soil health management and plant nutrient management. The program for the 2nd batch covered the areas of cropping systems management, integrated pest and disease management apart from the main area of soil health and nutrient management. The program started with an overview of the Bhoochetna Project by Dr. Girish Chander, State Coordinator from IDC. The program was designed to focus on Odisha Bhoochetna rather than general production initiatives as the main component and create an awareness among the participants of the project objectives which should facilitate the scaling up the project which is a challenge to all stakeholders.

Apart from training attending the sessions in the conference hall, the participants were taken around the ICRISAT fields where they visited various facilities and units viz. the Heritage Watersheds, Aerobic Composting area, techniques of transplanting pigeon pea and waste water utilization and demonstration unit.

The Training Pedagogy session had group exercises where participants were asked to design the program in detail for taking this program to the district level. The groups did a very good job and the inputs given were very helpful when the participants sat down and designed the actual program for rolling out the CB programmes at district level.

Delegates of the 1st batch comprising the Soil Chemists also deliberated on the proforma to capture the status report of soil testing laboratories in the districts, which all agreed to submit

soon. This information will facilitate in identifying the critical constraints in each and every laboratory, and take appropriate decisions at policy-makers level for infrastructure development and operation for precise analysis of large number of samples in the state.

A manual was developed in a modular form so that any tailor-made program can be organized depending on the need of stakeholders. The contents have been developed by ICRISAT scientists who has also developed tools for presentations for a program. It has a section on "Adult Learning Principles" (Andragogy) for equipping trainers for an appropriate training methodology - often ignored or little understood. Following are the major themes of the program:

- Climate and weather, climate change impacts, adaptation and mitigation strategies
- Soil fertility and soil health, Integrated nutrient management
- Fertilizer calculation, fertilizer application, fertigation
- Cropping system diversification
- Crop care, gap filling, weed management
- Integrated pest and disease management (IPDM), pest surveillance, concept of ETL
- Field practical on Soil, sampling, farm machinery, RWH structures, dual purpose rain gauge, calibration of sprayers
- Methodologies of training, participatory training, developing training tools, protocols for conducting and designing training programs- group exercise, case studies, Andragogy

A hard copy of the manual was given to all participants. All the presentations were also given to participants in digital format loaded in a pen drive.

As a standard practice of any customized training program, it is an important exercise to evaluate the extent of knowledge the participants may had before the program and the knowledge gained after the course. This was done through a pre and post course evaluation. Unfortunately, due to late arrival of several participants, the session plan had to change and the pre-course evaluation for the first batch could not be held. The salient findings are:

- Average percentage marks of the first batch was 61%
- Range varied from 45 % to 85 %
- 2nd batch showed an average of 59% at the pre-training evaluation and showed 69% at the post- training evaluation a gain of ten percentile
- Highest gain was recorded from 64 % to 94 %
- Group range – 47 % to 94 %
- Maximum gain showed from 36 % to 72 %

This program served as the precursor of the larger program which followed to cover all the 30 districts of Odisha

10.3. Capacity development of DoA officials in the districts

Consequent upon organizing Master Traininer's Training programmes during July, 2019 and as envisaged in the project document, IDC, ICRISAT took the mamooth task of conducting capacity building to DoA staff including VLW's at district level beginning from the 2nd week of September, 2019 onwards to create large scale awareness on science led scaling up of the Odisha Bhoochetna project among the officials across the districts. Based on the feedback received during MT training programme, the training manual was simplified and the PowerPoint presentations were revised in order to make the sessions more interesting and interactive in nature. The concerned District Coordinators laised with the the Deputy Director of Agriculture and MT of the respective districts with regard to planning, ensuring the attendance of the officials and logistics. Separate sessions were organized for officers and VAW on different dates and whereever there is meagre strength of the officials in the districts, the sessions were combined. A total of 2576 officials have been trained across 30 districts during September-December, 2019. The district wise participation of officials and the dates of the CB programmes is given in Table 10.3.1.

Figure 10.3.1: Pictures of DoA officials trainings at district level in Odisha

Table 10.3.1. Details of capacity building programmes organized for DoA officers

District	Dates	Number of officers
Angul	25-26. Sept. 2019	75
Balasore	24-25 Sept. 2019	90
Bargarh	30-31 Oct. 2019	63
Bhadrak	12 Sept. 2019	80
Bholangir	12-13 Sept. 2019	79
Boudh	18 Sept. 2019	66
Cuttack	24-25 Sept. 2019	97
Deogarh	13th Sept 2019	45
Dhenkanal	18-19 Sept. 2019	93
Gajapati	17-18 Sept. 2019	38
Ganjam	15-16 Nov. 2019	98
Jagatsinghpur	26-27 Sept. 2019	91
Jajpur	13 Sept. 2019	78
Jharsuguda	14 Nov. 2019	54
Kalahandi	20-21 Sept. 2019	63

Kandhamal	5-6 Nov. 2019	83
Kendrapara	24-25 Sept. 2019	87
Kendujhar	18-19 Nov. 2019	98
Khorda	23-24 Oct. 2019	100
Koraput	13 Nov. 2019	95
Malkanagiri	30 Oct. 2019	77
Mayurbhanj	26-27 Sept. 2019	101
Nabarangpur	23-24 and 25 Sept. 2019	94
Nayagarh	7-8 Nov. 2019	63
Nuapada	16-17 Sept. 2019	80
Puri	11-13 Sept. 2019	95
Rayagada	17-18 Sept. 2019	79
Sambalpur	27-28 Oct. 2019	80
Sonepur	12-13 Sept. 2019	105
Sundargarh	20 Oct. 2019	229
	Total	2576

10.4. Capacity development of farmers in pilot sites

There is no better way to integrate capacity building with agricultural development other than equipping farmers with the skills to adopt best agricultural practices. As part of the Bhoochetana project, 615 capacity building courses were conducted during April-March 2019-20 in all the 30 districts (Table 8) covering 16115 farmers (11338 men and 4777 women). The courses varied from training in soil fertility assessment, fertilizer and micronutrient application, using of improved tolls and equipment, crop management and management of pests and diseases. Scientists provided handholding support to line department staff (Table 10.4.1).

Table 10.4.1. Details of capacity building of farmers

Year	No. of programmes	No. of participants		
		Male	Female	Total
2018-19	321	8944	4324	13268
2019-20	615	11338	4777	16115
Total	936	20282	9101	29383

11. Publications

11.1. Odisha soil atlas

The soil analysis results of all 40265 soil samples from Odisha are compiled and published as Soil atlas entitled, 'Mapping the Nutrient Status of Odisha's Soils', as a guide for extension functionaries in the state. The soil atlas was released officially by Dr Arun Kumar Sahu, Hon'ble

Minister of Agriculture & Farmers empowerment, Fisheries and Animal Resources Development & Higher Ecucation and Dr Muthu Kumar, DoA in the presence of government high ups of Odisha on 5 December 2020 (Plate 11.1.1).
Soil Atlas comprises of 6 chapters as under;

1. Bhoochetana: Reviving Soils for Agriculture
2. Soil Sampling and Analysis
3. Developing Soil Test-based Fertilizer Recommendations
4. Management of Acidic Soils
5. Developing Soil Nutrient Maps of Odisha using Digital Soil Mapping Techniques
6. Online Application for Soil Test-based Fertilizer Recommendation

Soil Atlas can be accessed at;

http://idc.icrisat.org/idc/wp-content/uploads/2020/12/Odisha%20Soil%20Atlas%20dated%202.12.2020.pdf

Plate 11.1.1. Release of Odisha Soil Atlas by Dr Arun Kumar Sahu, Hon'ble Minister of Agriculture & Farmers empowerment, Fisheries and Animal Resources Development & Higher Ecucation on 05 December 2020.

11.2. ICRISAT Happenings Newsletter story

For wider dissemination of the findings of 2 years of Bhoochetana work, the *Odisha Bhoochetana* project story was published in ICRISAT Happenings Newsletter (23 July 2020). The article is called **Soil health key priority for better livelihoods of Odisha farmers** and can be accessed at *https://www.icrisat.org/soil-health-key-priority-for-better-livelihoods-of-odisha-farmers/* (Plate 11.2.1).

Natural resource management

Soil health key priority for better livelihoods of Odisha farmers

A field demonstration in Boudh district, Odisha.

Under an extensive soil health mapping program in Odisha state, India, over 40,200 soil samples from farmers' fields across 309 blocks in 30 districts were collected and analyzed, and recommendations made in response to the micronutrient deficiencies in the soil. Also, best management practices for increasing crop productivity were shared via 8,000 demonstrations, and two soil testing laboratories were upgraded into referral laboratories for the entire state. Based on the learnings from the pilots in the state, it is estimated that if improved nutrient management is scaled out in even 50% of the cultivated areas, the state's agricultural productivity will increase by at least 10%.

All this was done under the project Bhoochetana – a multi-stakeholder project with more than 20 local NGO partners, the Odisha University of Agriculture and Technology (OUAT), the state's Department of Agriculture, and ICRISAT. It has a mandate of improving crop productivity and rural livelihoods through scientific natural resource management.

Soil mapping and identification of nutrient deficiencies

The soil health mapping initiative revealed widespread deficiencies of micronutrients and secondary nutrients; about 80% fields were deficient in boron, 42% in zinc, 51% in sulphur, 28% in magnesium and 49% in carbon (Figure 1). Therefore, recommendations were developed to include deficient micronutrients and secondary nutrients, and optimize macronutrients. This

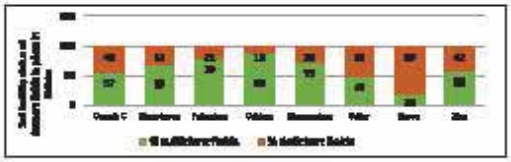


Figure 1. Soil fertility status of farmers' fields.

information was shared with agriculture officials, who in turn, shared it with farmers through Soil Health Cards.

Moreover, tools such as online GIS maps along with block-level inputs and relevant calculations, and tablets loaded with analysis and recommendations were readied for officials to help them make effective decisions. (http://odmaps.s3.ap-south-1.amazonaws.com/map.html; http://111.93.2.168/odsoil/).

Farm demonstrations of best practices

Additionally, over 8,000 demonstrations were carried out in 30 pilot sites (each site comprising 500-1000 ha in each district) to highlight that the adoption of need-based input management or improved varieties can help increase crop productivity by 20-50%, resulting in higher profits for smallholder farmers (Figure 2). In the process, more than 25,000 farmers were taught how to implement the code of fertilizers.

Development of referral labs

The Odisha state government reviewed the status of the soil testing laboratories in the state and collaborated

Plate 11.2.1. Snapshot of Odisha Bhoochetana project outcome story published in ICRISAT Happenings Newsletter (23 July 2020).

12. Annexures.

Annexure 12.1. Block level deficiency data of major and micro nutrients and soil conditions for Koraput district

District	Block/Taluk	No of samples	% fields under various pH conditions			% fields under normal EC conditions	% deficient										
			Acidic	Neutral	Alkaline		OC	P	K	Ca	Mg	S	Zn	B	Fe	Cu	Mn
Koraput	Koraput	140	98	2	0	100	21	42	15	2	16	91	36	87	1	1	0
	Kotpad	210	99	1	0	100	22	61	24	1	43	93	59	94	0	1	0
	Kundura	100	100	0	0	100	28	50	28	2	69	78	58	89	0	0	0
	Lamtaput	189	97	3	1	100	13	37	5	2	51	85	44	78	0	2	0
	Laxmipur	100	60	34	6	100	8	6	0	0	17	48	3	41	2	0	0
	Nandapur	450	99	1	0	100	27	58	6	1	50	92	51	78	0	1	0
	Pattangi	100	98	2	0	100	37	19	1	3	20	81	41	58	0	3	0
	Semliguda	100	98	2	0	100	38	37	3	2	65	92	58	80	0	0	0
	Borigumma	220	100	0	0	100	26	47	27	1	44	92	60	89	0	1	0
	Dasamantpu	60	97	3	0	100	20	32	8	2	53	97	63	97	0	0	0
	Joypore	100	100	0	0	100	4	72	24	6	39	89	32	93	1	0	0

Annexure 12.2 **Block level deficiency data of major and micro nutrients and soil conditions for Angul district**

District	Block/Taluk	No. of samples	% fields under various pH conditions			% fields under normal EC conditions	% deficient										
			Acidic	Neutral	Alkaline		OC	P	K	Ca	Mg	S	Zn	B	Fe	Cu	Mn
Angul	Angul	150	51	29	21	100	42	45	7	0	11	46	62	7	3	0	7
	Athmalik	130	47	31	22	100	37	42	9	5	24	28	55	7	2	0	2
	Banarpal	90	44	30	26	100	39	39	1	0	9	13	56	7	3	1	16
	Chhendipad	100	60	22	18	100	33	43	13	9	34	24	82	7	1	7	23
	Kaniha	150	93	5	1	100	34	49	25	11	35	33	76	8	1	2	17
	Kishornagar	150	80	15	5	100	27	65	12	9	25	34	72	9	4	12	4
	Pallahara	150	93	6	1	100	33	60	7	9	26	69	47	9	0	0	1
	Talcher	100	65	33	2	100	24	37	12	4	23	23	37	6	1	0	3

Annexure 12.3. **Block level deficiency data of major and micro nutrients and soil conditions for Deogarh district**

District	Block/Taluk	No of samples	% fields under various pH conditions			% fields under normal EC conditions	% deficient										
			Acidic	Neutral	Alkaline		OC	P	K	Ca	Mg	S	Zn	B	Fe	Cu	Mn
Deogarh	Barkote	90	98	2	0	100	23	87	33	12	29	70	61	93	2	1	1
	Reamal	200	81	18	2	100	28	65	12	1	13	33	50	65	1	1	1
	Tileibani	100	90	9	1	100	35	43	16	7	32	37	59	82	3	2	0

Annexure 12.4. **Block level deficiency data of major and micro nutrients and soil conditions for Jagatsinghpur district**

District	Block/Taluk	No of samples	% fields under various pH conditions			% fields under normal EC conditions	% deficient										
			Acidic	Neutral	Alkaline		OC	P	K	Ca	Mg	S	Zn	B	Fe	Cu	Mn
Jagatsinghpur	Balikuda	200	99	1	1	100	44	29	15	1	3	59	53	35	0	0	1
	Biridi	80	99	1	0	100	53	33	49	0	6	38	70	75	0	0	1
	Erasama	150	92	7	1	99	63	65	21	7	4	47	57	39	2	0	10
	Jagatsinghpur	150	92	8	0	100	43	42	30	3	4	65	68	81	1	1	3
	Kujanga	100	99	1	0	97	30	19	9	0	1	49	23	50	0	0	0
	Naugaon	80	96	4	0	100	50	15	23	3	4	68	40	79	0	0	0
	Raghunathpur	80	94	6	0	100	48	35	43	0	3	89	91	96	0	0	0
	Tirtol	200	99	2	0	100	33	15	39	0	2	56	50	79	0	0	0

Annexure 12.5.Block level deficiency data of major and micro nutrients and soil conditions for Kendrapara district

District	Block/Taluk	No of samples	% fields under various pH conditions			% fields under normal EC conditions	% deficient										
			Acidic	Neutral	Alkaline		OC	P	K	Ca	Mg	S	Zn	B	Fe	Cu	Mn
Kendrapara	Aul	100	100	0	0	100	64	76	18	0	0	19	28	15	0	0	0
	Derabish	140	99	1	0	100	33	9	36	2	9	25	6	90	0	0	0
	Garadpur	100	92	8	0	100	57	9	46	0	0	71	59	85	0	0	0
	Kendrapada	100	91	7	2	98	18	54	23	0	1	45	26	51	0	0	0
	Mahakalap	200	100	0	0	96	10	47	6	0	0	28	4	4	0	0	0
	Marshaghai	100	99	1	0	100	37	45	41	3	4	67	48	80	0	0	0
	Pattamund	100	99	1	0	100	18	53	4	0	0	60	10	31	0	0	0
	Rajanagar	220	99	1	0	98	23	51	0	0	0	24	13	0	0	0	0
	Rajkanika	90	100	0	0	100	7	32	0	0	0	16	6	19	0	0	0

Annexure 12.6. **Block level deficiency data of major and micro nutrients and soil conditions for Khurda district**

District	Block/Taluk	No of samples	% fields under various pH conditions			% fields under normal EC conditions	% deficient										
			Acidic	Neutral	Alkaline		OC	P	K	Ca	Mg	S	Zn	B	Fe	Cu	Mn
Khurda	Balianta	100	91	7	2	100	69	16	34	0	14	62	25	97	0	0	0
	Balipatna	120	97	3	1	100	35	14	25	3	10	57	33	70	0	1	1
	Banapur	150	98	2	0	100	91	11	83	13	15	88	47	95	0	1	6
	Begunia	150	93	3	4	100	41	59	45	33	48	63	13	93	0	0	9
	Bhubaneswar	100	89	10	1	100	45	33	7	19	36	42	24	82	0	0	0
	Bolagarh	200	99	1	0	100	95	95	11	1	4	95	10	99	0	0	0
	Chilika	130	88	8	4	100	32	63	28	8	24	35	39	48	0	0	2
	Jatni	100	98	2	0	100	65	61	43	10	55	45	11	67	0	0	0
	Khurda	100	81	14	5	100	66	71	53	15	40	63	21	79	0	0	3
	Tangi	150	84	16	0	100	58	54	53	25	44	68	35	83	0	0	3

Annexure 12.7. **Block level deficiency data of major and micro nutrients and soil conditions for Kandhamal district**

District	Block/Taluk	No of samples	% fields under various pH conditions			% fields under normal EC conditions	% deficient										
			Acidic	Neutral	Alkaline		OC	P	K	Ca	Mg	S	Zn	B	Fe	Cu	Mn
Kandhamal	Daringbadi	140	98	2	0	100	34	54	6	17	68	79	36	88	0	4	1
	G.Udayagiri	100	94	5	1	100	32	62	5	12	74	80	23	89	0	1	0
	K. Nuagaon	100	97	3	0	100	36	30	5	17	68	80	26	84	2	4	0
	Khajuripada	150	89	11	0	100	41	47	15	5	45	65	41	86	6	6	1
	Kotagarh	100	98	2	0	100	21	37	3	1	33	54	44	68	1	26	0
	Phulbani	150	98	2	0	100	81	49	15	7	58	73	56	95	0	9	3
	Raikia	110	98	2	0	100	40	63	15	12	69	56	34	90	1	5	0
	Tikabali	106	85	14	1	100	64	40	4	7	48	59	37	91	4	2	0
	Tumudibandh	150	95	3	1	100	43	68	30	1	33	93	52	94	2	1	0
	Balliguda	149	93	6	1	100	36	54	5	9	51	64	35	90	3	4	0
	Chakapad	100	95	5	0	100	35	28	13	11	55	66	24	84	0	5	0
	Phiringia	199	97	7	1	100	25	57	7	2	38	74	53	80	2	2	0

Annexure 12.8. **Block level deficiency data of major and micro nutrients and soil conditions for Nayagarh district**

District	Block/Taluk	No of samples	% fields under various pH conditions			% fields under normal EC conditions	% deficient										
			Acidic	Neutral	Alkaline		OC	P	K	Ca	Mg	S	Zn	B	Fe	Cu	Mn
Nayagarh	Bhapur	100	92	5	3	100	66	58	35	11	20	53	59	90	0	0	0
	Dasapalla	200	63	29	9	100	49	32	15	2	10	40	53	73	3	1	1
	Gania	100	76	17	6	100	33	50	10	0	6	53	51	89	0	0	2
	Khandapad	120	93	7	0	100	55	58	18	7	27	52	31	92	0	0	0
	Nayagarh	100	66	23	10	100	57	35	23	0	1	42	46	75	4	0	3
	Nuagaon	120	62	32	7	100	41	40	18	3	9	40	35	75	0	1	1
	Odagaon	150	72	18	10	100	53	41	18	0	0	45	41	73	0	0	1
	Ranpur	150	79	15	5	100	77	37	57	9	27	61	23	88	0	0	3

Table 12.9. Block level deficiency data of major and micro nutrients and soil conditions for Kalahandi district

District	Block/Taluk	No of samples	% fields under various pH conditions			% fields under normal EC conditions	% deficient										
			Acidic	Neutral	Alkaline		OC	P	K	Ca	Mg	S	Zn	B	Fe	Cu	Mn
Kalahandi	Bhawanipatna	200	48	31	22	100	63	58	2	3	12	54	77	82	7	4	5
	Dharmgarh	100	68	22	10	100	26	64	17	0	4	43	59	83	2	0	0
	Golamunda	100	60	30	10	100	36	45	7	5	18	32	70	80	10	1	0
	Jaipatna	80	71	24	5	100	36	44	6	3	18	58	18	74	6	0	0
	Junagarh	150	82	15	3	100	59	83	7	1	31	43	31	94	1	0	3
	Kalampur	50	90	10	0	100	28	78	28	0	0	82	26	10	0	0	0
	Karlamunda	60	43	40	17	100	73	80	27	0	3	68	87	95	2	0	8
	Kesinga	90	44	23	32	100	62	81	2	1	17	50	76	91	1	1	16
	Koksara	70	71	23	6	100	43	84	6	1	7	46	63	86	0	0	4
	Lanjigarh	240	72	22	6	100	57	63	12	1	22	63	38	71	1	0	1
	M.Rampur	250	60	30	10	100	56	68	14	6	27	55	61	89	1	3	2
	Narla	100	48	27	25	100	36	64	10	5	15	30	84	70	3	0	11
	Thuamul	180	38	56	4	100	11	17	1	2	5	38	11	33	0	0	0

Annexure 12.10. **Block level deficiency data of major and micro nutrients and soil conditions for Nabrangpur district**

District	Block/Taluk	No of samples	% fields under various pH conditions			% fields under normal EC conditions	% deficient										
			Acidic	Neutral	Alkaline		OC	P	K	Ca	Mg	S	Zn	B	Fe	Cu	Mn
Nabrangpur	Chandahandi	100	72	20	8	100	30	67	5	2	12	25	65	83	1	2	7
	Dabugam	148	95	5	0	100	63	80	31	11	35	82	71	99	0	0	0
	Jharigan	101	95	5	0	100	27	69	22	4	26	76	63	93	0	0	0
	Kosagumund	119	99	1	0	100	34	66	18	19	50	76	58	97	0	0	0
	Nabarangpur	20	65	35	0	100	10	60	30	0	0	60	75	10	0	0	0
	Nabrangpur	70	90	10	0	100	30	57	23	4	21	79	44	10	0	0	0
	Nandahandi	88	98	2	0	100	24	55	25	17	41	66	38	94	0	3	2
	Papadahandi	100	99	1	0	100	24	43	23	7	28	58	45	90	0	1	0
	Raighar	161	96	2	2	100	54	75	30	21	58	84	86	99	1	1	31
	Sanmasigan	10	90	10	0	100	0	70	30	0	0	50	20	10	0	0	0
	Tentuli	198	97	3	0	100	32	53	10	7	29	68	48	95	0	0	0
	Umarkote	98	99	0	1	100	58	35	23	27	66	82	59	96	1	9	0

Annexure 12.11. **Block level deficiency data of major and micro nutrients and soil conditions for Rayagada district**

District	Block/Taluk	No of samples	% fields under various pH conditions			% fields under normal EC conditions	% deficient										
			Acidic	Neutral	Alkaline		OC	P	K	Ca	Mg	S	Zn	B	Fe	Cu	Mn
Rayagada	Bissamcuttack	130	90	8	2	100	42	42	3	8	46	51	2	6	1	2	1
	Chandrapur	100	91	8	1	100	37	53	1	3	21	54	3	9	0	1	1
	Gudari	100	72	21	7	100	47	34	8	6	24	44	5	7	7	4	2
	Kalyansingpur	130	91	8	2	100	55	15	5	4	38	54	1	8	2	2	0
	Kolnara	100	94	4	2	100	68	8	2	7	30	32	1	8	0	0	0
	Muniguda	200	89	11	1	100	62	18	6	1	41	50	2	8	1	7	0
	Padmapur	100	49	38	13	100	80	21	2	5	23	44	5	7	1	1	2
	Rayagada	180	74	21	6	100	35	14	0	9	32	32	1	6	4	1	3
	Kashipur	200	100	0	0	100	42	62	8	5	28	99	7	5	8	1	0
	Gunpur	190	81	18	2	100	57	53	1	3	26	62	5	7	4	2	4

Annexure 12.12. **Block level deficiency data of major and micro nutrients and soil conditions for Dhenkanal district**

District	Block/Taluk	No of samples	% fields under various pH conditions			% fields under normal EC conditions	% deficient										
			Acidic	Neutral	Alkaline		OC	P	K	Ca	Mg	S	Zn	B	Fe	Cu	Mn
Dhenkanal	Bhuban	100	99	1	0	100	42	38	45	6	23	55	33	90	0	0	1
	Dhenkanal(Sadar)	150	90	9	1	100	49	51	15	9	37	68	24	84	1	0	0
	Gondia	150	93	7	0	100	31	63	16	1	17	47	19	79	0	0	0
	Hindol	150	56	36	8	100	25	40	5	1	3	10	23	53	3	1	7
	Kamakhyanagar	100	86	9	5	100	20	68	22	2	4	47	16	80	0	0	1
	Kankadahad	140	91	7	1	100	24	69	37	8	28	60	16	69	1	0	4
	Odapada	100	83	16	1	100	23	38	6	2	17	23	6	75	2	0	0
	Parjang	140	66	24	10	100	39	74	9	0	8	24	13	71	0	0	0

Annexure 12.13. **Block level deficiency data of major and micro nutrients and soil conditions for Puri district**

District	Block/Taluk	No of samples	% fields under various pH conditions			% fields under normal EC conditions	% deficient										
			Acidic	Neutral	Alkaline		OC	P	K	Ca	Mg	S	Zn	B	Fe	Cu	Mn
Puri	Astarang	100	94	6	0	99	63	29	29	3	3	46	12	5	0	0	1
	Brahmagiri	150	96	3	1	100	49	29	41	29	33	45	36	6	1	7	19
	Delang	90	89	10	1	100	33	36	41	2	13	42	17	6	0	0	3
	Gop	150	98	2	0	100	32	26	22	1	1	73	28	3	0	0	1
	Kakatpur	100	98	0	2	100	58	39	43	0	1	79	45	8	0	0	0
	Kanas	150	95	5	0	97	31	47	7	0	3	31	13	3	0	0	0
	Krushnaprasad	100	90	9	1	100	95	19	74	80	89	72	45	9	0	40	62
	Nimapada	180	98	2	0	100	18	20	16	0	0	43	33	5	0	0	0
	Pipili	150	97	3	0	100	43	11	49	3	15	40	30	8	0	0	1
	Purisadar	100	96	1	3	100	49	37	51	7	14	43	48	6	0	1	2
	Satyabadi	150	99	0	1	100	39	29	39	0	5	44	24	7	0	0	0

Annexure 12.14. **Block level deficiency data of major and micro nutrients and soil conditions for Bhadrak district**

District	Block/Taluk	No of samples	% fields under various pH conditions			% fields under normal EC conditions	% deficient										
			Acidic	Neutral	Alkaline		OC	P	K	Ca	Mg	S	Zn	B	Fe	Cu	Mn
Bhadrak	Basudevpur	150	91	9	0	99	39	15	43	6	13	29	52	50	0	1	3
	Bhadaripokh	120	98	0	2	100	66	55	20	0	0	80	58	78	1	0	0
	Bhadrak	100	76	15	9	99	37	38	31	5	11	59	35	83	4	0	4
	Bonth	150	90	10	0	100	46	59	25	0	1	77	35	70	0	0	0
	Chandabali	150	98	1	1	97	19	45	4	0	0	13	36	6	0	0	0
	Dhamanagar	120	100	0	0	100	38	40	32	0	0	60	33	84	0	0	0
	Tihidi	120	98	2	0	100	43	38	19	0	0	33	15	47	0	0	0

Annexure 12.15. Block level deficiency data of major and micro nutrients and soil conditions for Jajpur district

District	Block/Taluk	No of samples	% fields under various pH conditions			% fields under normal EC conditions	% deficient										
			Acidic	Neutral	Alkaline		OC	P	K	Ca	Mg	S	Zn	B	Fe	Cu	Mn
Jajpur	Barchana	150	94	1	4	100	28	27	11	1	6	45	25	63	3	3	3
	Bari	100	95	4	1	100	59	49	55	6	21	59	44	83	1	3	0
	Binjharpur	100	99	1	0	100	41	61	51	4	8	59	43	84	0	2	0
	Dangadi	100	93	6	0	100	42	76	47	3	15	84	13	90	0	0	0
	Dasaratpur	150	78	13	9	80	20	44	19	2	3	28	9	25	13	0	15
	Dharmasala	150	95	5	0	100	56	24	45	1	15	44	25	77	0	0	0
	Jajpur	150	100	0	0	100	39	9	3	0	0	10	1	81	0	1	0
	Korei	150	95	3	1	100	75	35	63	19	53	59	27	89	0	0	1
	Rasulour	150	100	0	0	87	87	10	71	13	38	55	42	97	0	0	1
	Sukinda	100	81	13	6	98	43	65	25	5	16	47	35	95	6	0	8

Annexure 12.16. **Block level deficiency data of major and micro nutrients and soil conditions for Jharsuguda district**

District	Block/Taluk	No of samples	% fields under various pH conditions			% fields under normal EC conditions	% deficient										
			Acid	Neutral	Alkaline		OC	P	K	Ca	Mg	S	Zn	B	Fe	Cu	Mn
Jharsuguda	Laikera	100	100	0	0	100	39	53	19	18	38	37	21	98	0	0	1
	Lakhanpur	200	94	7	0	100	49	53	38	17	42	58	39	92	2	1	1
	Jharsuguda	150	89	11	1	100	30	36	7	24	46	15	13	84	0	1	1
	Kirmira	100	99	1	0	100	48	61	47	23	57	61	44	10	0	1	4
	Kolabira	100	97	3	0	100	55	67	22	17	45	42	43	89	1	2	1

Annexure 12.17. **Block level deficiency data of major and micro nutrients and soil conditions for Sambalpur district**

District	Block/Taluk	No of samples	% fields under various pH conditions			% fields under normal EC conditions	% deficient										
			Acidic	Neutral	Alkaline		OC	P	K	Ca	Mg	S	Zn	B	Fe	Cu	Mn
Sambalpur	Bamara	150	87	9	3	97	57	56	15	12	30	40	41	84	7	3	3
	Dhankauda	100	99	1	0	100	33	44	48	20	59	27	31	96	1	1	9
	Jamankira	250	94	4	2	98	42	62	14	10	29	48	45	96	3	2	1
	Jujumura	100	84	2	14	100	35	59	17	8	40	43	46	89	7	0	12
	Kuchinda	100	92	7	1	100	53	32	9	17	48	61	58	91	2	1	3
	Maneswara	100	87	9	4	100	48	43	9	2	17	36	56	98	0	1	1
	Nakatideula	150	90	7	3	100	25	53	23	19	34	47	31	93	0	0	1
	Rairakhola	150	76	17	7	100	17	61	15	9	26	41	25	95	1	3	1
	Rengali	70	93	6	1	100	56	56	26	20	49	60	39	84	0	3	1

Annexure 12.18. **Block level deficiency data of major and micro nutrients and soil conditions for Boudh district**

District	Block/Taluk	No of samples	% fields under various pH conditions			% fields under normal EC conditions	% deficient										
			Acidic	Neutral	Alkaline		OC	P	K	Ca	Mg	S	Zn	B	Fe	Cu	Mn
Boudh	Boudh	130	57	26	17	100	54	5	3	6	29	5	7	9	7	2	11
	Harabhang	90	62	28	9	100	53	4	2	0	8	5	5	8	8	0	4
	Kantamal	150	54	33	13	100	47	4	2	7	21	4	6	9	8	3	3

Annexure 12.19. **Block level deficiency data of major and micro nutrients and soil conditions for Sonepur district**

District	Block/Taluk	No of samples	% fields under various pH conditions			% fields under normal EC conditions	% deficient										
			Acidic	Neutral	Alkaline		OC	P	K	Ca	Mg	S	Zn	B	Fe	Cu	Mn
Sonepur	Binka	90	97	2	1	100	52	57	43	14	48	17	28	99	0	12	0
	Birmaharajp	130	67	22	11	100	33	56	16	1	16	28	63	85	5	0	3
	Dunguripali	100	74	19	7	100	22	56	40	3	39	6	45	93	2	0	3
	Sonepur	120	68	24	8	100	40	50	25	8	34	34	72	92	1	2	2
	Tarbha	140	38	37	25	100	36	74	16	1	4	28	88	95	2	1	7
	Ullunda	200	73	21	7	100	34	47	15	8	24	27	69	84	1	1	5

Annexure 12.20. **Block level deficiency data of major and micro nutrients and soil conditions for Bargarh district**

District	Block/Taluk	No of samples	% fields under various pH conditions			% fields under normal EC conditions	% deficient										
			Acidic	Neutral	Alkaline		OC	P	K	Ca	Mg	S	Zn	B	Fe	Cu	Mn
Bargarh	Ambabhona	160	85	15	0	100	23	17	15	3	33	23	34	79	0	0	0
	Atabira	150	94	5	1	100	37	23	51	5	45	21	53	97	0	1	4
	Bargarh	90	74	12	13	100	37	21	41	6	68	21	37	96	1	7	4
	Barpali	100	85	14	1	99	34	33	39	5	33	28	60	94	2	4	2
	Bhatli	100	96	4	0	100	51	15	46	22	82	23	45	98	0	6	1
	Bheden	100	88	12	0	98	49	31	46	8	44	29	52	88	1	1	4
	Bijepur	150	88	10	2	100	39	44	18	12	46	23	49	86	1	2	3
	Gaisilat	100	59	27	14	100	34	42	12	6	17	22	58	85	2	1	1
	Jharabandh	100	53	29	17	100	28	53	14	3	12	31	64	92	4	2	2
	Padampur	200	74	20	6	100	32	47	14	7	23	36	64	91	2	6	3
	Paikamal	150	74	19	7	100	30	62	9	2	20	49	51	89	3	1	1
	Sohela	150	77	18	5	100	47	42	27	13	46	31	69	92	1	3	4

Annexure 12.21. **Block level deficiency data of major and micro nutrients and soil conditions for Balangir district**

District	Block/Taluk	No of samples	% fields under various pH conditions			% fields under normal EC conditions	% deficient										
			Acidic	Neutral	Alkaline		OC	P	K	Ca	Mg	S	Zn	B	Fe	Cu	Mn
Balangir	Agalpur	100	66	18	16	100	75	76	12	14	35	43	92	97	26	23	10
	Bangomun	150	41	31	28	100	52	60	9	2	10	38	73	91	10	5	9
	Belpada	100	82	15	3	100	36	82	18	7	30	59	75	100	1	6	0
	Balangir	120	48	34	18	100	32	58	11	0	5	34	64	87	3	0	5
	Degaon	149	58	28	14	100	47	68	19	3	23	50	92	97	3	3	3
	Gudbhela	100	58	20	22	100	37	52	9	0	11	48	72	96	7	4	6
	Khaprakhol	150	61	23	15	100	34	73	12	2	9	60	85	98	3	3	6
	Loisinga	100	29	41	30	100	36	54	21	1	10	23	69	89	10	2	6
	Muribahal	150	80	15	5	100	46	72	27	7	39	64	75	95	4	8	1
	Patnagarh	150	65	26	9	100	49	73	15	6	24	47	82	97	8	5	2
	Puintala	150	37	33	29	100	37	65	15	1	3	27	82	78	9	1	29
	Saintala	150	83	13	4	100	61	81	21	11	38	61	86	97	1	10	4
	Titilagarh	150	61	27	12	100	57	59	15	3	46	31	45	88	4	8	4
	Tureikela	100	42	41	17	100	42	81	15	1	9	18	67	84	0	0	13

Annexure 12.22. **Block level deficiency data of major and micro nutrients and soil conditions for Nuapada district**

District	Block/Taluk	No of samples	% fields under various pH conditions			% fields under normal EC conditions	% deficient										
			Acidic	Neutral	Alkaline		OC	P	K	Ca	Mg	S	Zn	B	Fe	Cu	Mn
Nuapada	Boden	100	42	33	25	100	24	80	0	0	3	31	71	91	2	1	3
	Khariar	100	28	28	44	100	18	56	1	0	2	15	61	69	1	1	13
	Komna	150	41	40	19	100	29	63	1	1	1	25	67	81	3	0	7
	Nuapada	147	60	27	13	100	21	69	3	2	10	18	84	89	1	3	12
	Sinapali	150	47	37	16	100	20	58	0	0	2	43	74	71	1	0	4

Annexure 12.23. **Block level deficiency data of major and micro nutrients and soil conditions for Balasore district**

District	Block/Taluk	No of samples	% fields under various pH conditions			% fields under normal EC conditions	% deficient										
			Acidic	Neutral	Alkaline		OC	P	K	Ca	Mg	S	Zn	B	Fe	Cu	Mn
Balasore	Bahanoga	100	100	0	0	100	65	55	77	10	44	55	72	91	0	0	1
	Balasore	150	98	2	0	99	32	60	51	17	30	44	33	61	2	1	4
	Baliapal	150	55	43	1	99	42	23	31	7	23	20	44	32	19	6	9
	Basta	100	70	29	1	99	13	28	12	7	9	12	49	15	3	0	3
	Bhogarai	160	79	17	4	100	51	44	43	29	35	19	34	39	1	6	19
	Jaleswar	150	85	15	0	100	44	27	18	5	9	41	10	49	7	0	0
	Khaira	200	93	7	1	100	71	55	61	5	47	48	43	90	3	2	2
	Nilagiri	100	96	4	0	100	53	70	46	10	27	40	32	98	1	3	2
	Oupada	100	90	10	0	100	44	53	46	18	37	53	35	90	1	10	0
	Remuna	140	89	11	0	99	59	56	63	16	34	38	46	85	2	0	6
	Simulia	100	87	4	9	100	75	62	51	3	27	38	75	93	9	8	11
	Soro	100	90	9	1	98	73	69	65	6	50	44	46	93	4	3	11

Annexure 12.24. **Block level deficiency data of major and micro nutrients and soil conditions for Mayurbhanj district**

District	Block/Taluk	No of samples	% fields under various pH conditions			% fields under normal EC conditions	% deficient										
			Acidic	Neutral	Alkaline		OC	P	K	Ca	Mg	S	Zn	B	Fe	Cu	Mn
Mayurbhanj	Badasahi	200	99	1	0	100	47	50	44	5	24	40	25	81	0	1	1
	Bahalda	90	97	3	0	100	49	76	61	20	46	60	47	96	0	4	9
	Bangriposi	200	92	7	2	99	33	72	17	4	13	38	34	82	2	1	1
	Baripada	100	100	0	0	100	64	85	68	54	69	79	33	97	0	0	6
	Betnati	250	100	0	0	100	71	84	82	45	79	80	46	98	0	3	1
	Bijatala	100	99	1	0	100	29	64	36	17	29	72	34	89	0	0	0
	Bisoi	150	98	2	0	100	29	69	36	29	40	71	54	89	0	2	0
	Gopobandhun	100	100	0	0	100	39	70	41	15	62	77	33	96	0	1	0
	Jamda	50	100	0	0	100	52	92	50	24	38	80	62	96	0	2	6
	Jashipur	200	100	1	0	100	53	88	32	18	44	88	64	10	1	4	3
	Kaptipada	100	100	0	0	100	32	84	49	35	49	80	49	98	0	0	0
	Karanjia	140	99	1	0	100	36	81	48	23	69	85	42	98	0	2	0
	Khunta	100	98	2	0	99	15	86	31	24	45	81	17	97	0	0	0
	Kuliana	200	99	1	0	100	57	86	54	37	51	75	39	84	0	1	2
	Kusumi	99	96	4	0	100	39	84	36	14	24	76	32	90	0	0	0
	Morada	150	99	1	0	100	70	75	72	45	67	65	47	97	0	1	5
	Rairangpur	90	100	0	0	99	36	87	61	32	58	77	46	94	0	0	0
	Raruan	100	100	0	0	100	27	66	25	18	35	46	30	83	1	2	0
	Rasgobindopu	150	99	1	0	100	31	57	68	41	71	51	32	88	0	0	1
	Samakhunta	99	97	3	0	100	41	81	56	13	34	76	37	97	2	0	1
	Saraskana	150	97	3	0	100	47	77	42	9	45	53	53	97	0	0	1
	Sukruli	79	100	0	0	100	41	62	44	28	68	70	29	97	0	0	0

	Suliapada	170	75	25	1	100	45	56	37	26	59	48	23	87	9	0	0
	Thakurmunda	150	98	2	0	100	47	68	31	35	69	69	33	87	1	1	1
	Tiring	50	100	0	0	100	56	78	48	42	56	46	36	94	0	0	10
	Udala	50	100	0	0	100	56	72	28	30	54	72	40	84	0	0	0

Annexure 12.25. **Block level deficiency data of major and micro nutrients and soil conditions for Gajapati district**

District	Block/Taluk	No of samples	% fields under various pH conditions			% fields under normal EC conditions	% deficient										
			Acidic	Neutral	Alkaline		OC	P	K	Ca	Mg	S	Zn	B	Fe	Cu	Mn
Gajapati	Gosani	100	82	8	10	100	86	76	10	45	75	91	67	93	10	0	5
	Gumma	150	95	4	1	100	56	58	13	28	67	75	41	93	0	1	3
	Kasinagar	80	99	1	0	100	68	45	13	28	48	66	48	84	0	3	5
	Nuagada	159	97	3	1	100	33	44	3	14	68	69	28	82	1	4	0
	R.Udayagiri	140	89	4	7	100	79	56	2	66	83	84	54	92	8	2	0
	Rayagada	120	99	1	0	100	45	14	3	33	94	73	21	98	0	0	1
	Mohana	190	94	5	1	100	35	59	4	16	45	61	38	74	1	2	1

Annexure 12.26. Block level deficiency data of major and micro nutrients and soil conditions for Ganjam district

District	Block/Taluk	No of samples	% fields under various pH conditions			% fields under under EC conditions	% deficient										
			Acidic	Neutral	Alkaline		OC	P	K	Ca	Mg	S	Zn	B	Fe	Cu	Mn
Ganjam	Aska	100	80	11	9	100	52	72	35	1	9	68	55	73	4	0	2
	Beguniapad	150	86	13	1	100	54	71	26	13	47	29	43	81	0	1	5
	Bellaguntha	80	88	9	4	100	48	28	11	0	28	64	23	79	0	0	0
	Bhanjanagar	150	86	11	3	100	33	75	9	5	18	59	23	82	0	0	0
	Buguda	100	82	12	6	100	48	58	17	0	26	46	17	77	0	1	2
	Chhatrapur	100	79	13	8	100	51	51	33	4	42	31	18	47	0	0	1
	Chikiti	100	72	15	13	100	34	53	16	15	29	25	30	53	0	0	10
	Dharakote	160	72	21	7	100	50	51	19	8	18	56	43	79	0	0	7
	Digapahandi	200	62	34	4	100	41	83	11	0	11	27	39	73	0	0	3
	Ganjam	100	34	48	18	71	53	31	3	1	6	8	13	6	0	0	9
	Hinjilicut	50	60	28	12	98	70	46	32	18	28	42	44	52	0	0	0
	J.N.Prasad	250	79	16	4	100	34	63	11	9	27	52	28	76	0	0	6
	K.S.Nagar	50	68	16	16	100	58	62	24	2	16	32	26	64	2	0	2
	Khalikote	100	85	10	5	100	53	86	29	12	30	32	15	66	1	0	3
	Kukudakhan	100	72	22	6	100	39	45	11	6	25	20	4	50	2	0	2
	Patrapur	250	60	28	12	100	58	61	10	1	16	43	23	65	0	0	2
	Polasara	100	78	19	3	100	18	80	20	3	14	40	49	73	0	0	1
	Purusottam	100	85	14	1	100	50	16	15	0	24	29	22	58	0	0	9
	Rangeilunda	100	71	24	5	100	35	50	17	4	15	12	40	20	2	0	1
	Sanakhemu	100	61	30	9	100	44	49	16	9	25	45	47	67	2	0	1
	Sheragada	100	41	43	16	100	60	23	1	0	1	30	34	27	2	0	0
	Surada	270	58	29	13	100	40	39	4	6	18	50	49	71	6	0	4

Annexure 12.27. **Block level deficiency data of major and micro nutrients and soil conditions for Keonjhar district**

District	Taluk	No of samples	% fields under various pH conditions			% fields under normal EC conditions	% deficient										
			Acidic	Neutral	Alkaline		OC	P	K	Ca	Mg	S	Zn	B	Fe	Cu	Mn
Keonjhar	Sadar	100	77	10	12	100	45	52	28	15	41	62	54	87	4	0	8
	Anandapur	120	89	10	1	100	34	56	43	3	18	59	53	85	0	3	2
	Banspal	150	97	3	0	100	12	66	10	3	13	81	59	85	1	1	0
	Champua	120	97	2	2	100	49	70	33	32	66	64	57	91	1	3	0
	Ghasipura	120	80	19	1	100	63	57	17	12	19	58	39	83	1	1	0
	Ghatagaon	110	95	5	1	100	65	82	45	32	63	74	63	94	0	3	5
	Harichandan	200	96	5	0	100	39	76	40	13	40	69	59	90	1	2	2
	Hatadihi	150	96	4	0	100	71	67	51	16	40	81	53	91	2	5	5
	Jhumpura	120	91	9	0	100	65	63	26	43	77	73	59	91	3	25	0
	Joda	50	94	6	0	100	22	66	12	10	22	60	38	82	2	2	0
	Patna	100	94	6	0	100	68	74	57	28	74	77	73	98	0	3	4
	Saharpada	100	98	0	2	100	41	92	65	22	63	92	84	10	0	1	3
	Telkoi	100	97	3	0	100	44	84	26	11	25	78	39	96	0	0	0

Annexure 12.28. Block level deficiency data of major and micro nutrients and soil conditions for Sundergarh district

District	Taluk	No of samples	% fields under various pH conditions			% fields under normal EC conditions	% deficient										
			Acidic	Neutral	Alkaline		OC	P	K	Ca	Mg	S	Zn	B	Fe	Cu	Mn
Sundergarh	Badagaon	100	98	2	0	70	61	53	18	15	34	55	61	98	0	4	1
	Balisanka	100	79	14	7	100	46	57	9	8	43	39	51	90	2	6	4
	Bonigarh	100	100	0	0	100	38	72	17	9	21	35	20	86	0	0	0
	Birsa	300	92	7	0	100	53	81	25	8	25	50	38	96	0	1	2
	Hemgir	240	95	5	0	100	38	79	27	21	48	55	43	97	0	3	2
	Koira	10	100	0	0	100	10	70	20	60	60	70	60	70	0	0	0
	Kuarmun	250	97	3	0	100	70	90	17	41	65	41	62	98	4	31	0
	Kutra	190	97	3	0	100	35	72	11	19	44	44	34	97	3	4	0
	Gurundia	10	90	10	0	100	90	90	0	0	10	90	90	10	10	0	0
	Lahunipa	200	100	0	0	100	25	83	16	5	31	77	20	99	0	0	0
	Lathikata	100	92	7	1	100	40	80	17	15	39	41	40	95	0	1	2
	Lephripar	130	90	6	2	100	51	65	16	2	20	28	38	98	0	1	2
	Rajangpu	100	87	12	1	100	54	81	14	5	29	28	40	93	3	2	3
	Subdega	100	98	1	1	100	61	63	14	10	28	50	45	97	1	3	1
	Sadar	100	100	0	0	100	65	57	32	13	43	37	39	96	0	1	1
	Tangarpal	100	97	3	0	100	41	57	20	5	24	16	19	90	1	0	0

Annexure 12.29. Block level deficiency data of major and micro nutrients and soil conditions for Cuttack district.

District	Block/Taluk	No of samples	% fields under various pH conditions			% fields under normal EC conditions	% deficient										
			Acidic	Neutral	Alkaline		OC	P	K	Ca	Mg	S	Zn	B	Fe	Cu	Mn
Cuttack	Athgarh	200	50	30	20	100	49	8	4	1	7	4	16	64	1	0	1
	Banki	120	99	1	0	100	28	8	18	3	8	62	3	96	0	0	0
	Banki-Dampada	100	96	4	0	100	39	25	52	12	19	43	0	85	0	1	1
	Baramba	50	82	18	0	100	34	60	24	0	2	54	40	86	0	0	0
	Baranga	80	98	2	0	100	64	44	43	1	11	60	31	96	0	0	0
	Choudwar	160	98	2	0	100	47	56	21	4	13	38	1	89	1	0	1
	Cuttack Sadar	100	94	6	0	98	44	19	50	0	9	36	10	90	0	0	0
	Kantapada	100	92	0	8	100	29	60	45	1	6	67	12	90	8	1	7
	Mahanga	200	98	2	0	100	18	24	23	0	0	26	8	69	0	0	0
	Narsinghpur	200	69	22	9	100	23	35	9	1	11	43	14	79	1	0	1
	Niali	100	97	3	0	100	46	39	47	1	7	79	17	94	0	0	0
	Nishantakoili	200	94	4	2	100	36	49	59	1	4	46	51	84	1	0	1
	Salepur	160	96	4	0	100	46	43	66	0	7	38	33	84	0	0	0
	Tigiria	50	98	2	0	100	34	42	38	0	10	34	16	88	2	0	0

Annexure 12.30. Block level deficiency data of major and micro nutrients and soil conditions for Malkangiri district

District	Block/Taluk	No of samples	% fields under various pH conditions			% fields under normal EC conditions	% deficient										
			Acidic	Neutral	Alkaline		OC	P	K	Ca	Mg	S	Zn	B	Fe	Cu	Mn
Malkangiri	Kalimela	129	76	22	1	100	43	60	36	8	19	51	48	97	1	2	2
	Khairiput	100	97	2	1	100	27	63	16	11	31	64	40	98	1	7	3
	Korkunda	148	95	4	1	100	34	61	30	2	26	39	38	97	1	3	1
	Mathili	200	95	5	1	100	49	70	50	11	57	55	57	88	1	2	2
	Podia	60	88	10	2	100	32	73	15	13	37	72	53	85	0	0	0
	Chitrakond	300	39	34	27	100	31	83	28	1	9	23	33	45	0	1	0

Annexure 12.31. Details of chemicals and other lab items sent to each of the laboratory at Bhubaneshwar and Sambalpur.

S.No	Chemicals Items List	Manufacturer	Grade	Unit	Total items sent	Purpose
1	Nitric acid	Qualigens	ExcelaR	no	10	Lab common use
2	Ammonium Fluoride	Qualigens	SQ	500 gm	150	Phosphorous analysis (Brays)
3	Ammonium Acetate	Qualigens	ExcelaR	500 gm	100	Macro nutrients (K,Ca,Mg and Na) analysis
4	Potassium Dichromate	Qualigens	ExcelaR	500 gm	100	Organic Carbon analysis
5	Hydrochloric Acid (SQ)	Qualigens	SQ	5 litre	10	Glassware washing
6	Sodium Hydrogen carbonate	Qualigens	ExcelaR	500 gm	100	Phosphorous analysis (Olsen's)
7	Triethanolamine	Qualigens	SQ	500 ml	20	Micro nutrients (Fe,Cu,Mn and Zn) analysis
8	Labolene	Qualigens	SQ	5 ltr	5	Labware washing
9	Potassium chloride ER	Qualigens	ER	500 gm	10	Mineral-N analysis
10	Phenanthroline monohydrate ER	Qualigens	ER	25 gm	15	Organic Carbon analysis
11	Powder free purple nitrile Gloves (M,L)	Fisher	N/A	pack	3M+3L	Safety
12	Sulphuric Acid	Qualigens	ER	2.5 ltr	100	Organic Carbon analysis
13	Solar Hand operated bottle top titrator	Hirshmann	N/A	no	1	Organic Carbon analysis
14	EM-Dispenser pp	Hirshmann	N/A	no	3	To dispense reagents
15	Ammonium Ferrous Sulphate	Qualigens	ExcelaR	500 gm	200	Organic Carbon analysis
16	Sample Container	Tarsons	N/A	Pack		Filtration
17	Potassium Sulphate	Qualigens	ER	500 gm	3	Sulphur analysis
18	Ammonium molybdate	Qualigens	ER	500 gm	5	Phosphorous analysis
19	potassium dihydrogen orthophosphate	Qualigens	ER	500 gm	3	Phosphorous analysis
20	sodium chloride	Qualigens	ER	500 gm	5	Lab common use
21	Spatulas	Fisher	N/A	pack	2	Lab tool, To weigh the samples and chemicals

S.No	Chemicals Items List	Manufacturer	Grade	Unit	Total items sent	Purpose
22	Diethylenetriaminepentacetic acid(DTPA)	Qualigens	AR	500 gm	10	Micro nutrients (Fe,Cu,Mn and Zn) analysis
23	Ferrous Sulphate	Qualigens	ER	500 gm	10	Organic Carbon analysis
24	Barium chloride	Qualigens	ER	500 gm	10	Sulphur analysis
25	L-Ascorbic Acid	Qualigens	SQ	250 gm	20	Phosphorous analysis
26	Antimony Potassium tartrate	Qualigens	SQ	500 gm	5	Phosphorous analysis
27	Boric Acid	Qualigens	ER	500 gm	5	Boron analysis
28	Sodium Hydroxide pellets	Qualigens	ER	500 gm	5	Lab common use
29	Calcium chloride dihydrate	Merck	EMPARTA ACS	500 gm	25	Boron and Sulphur analysis
30	Hydrochloric Acid	Qualigens	ER	2.5 ltr	5	Lab common use
31	Thermo Fisher brand flask 150ml	Fisher	N/A	no	300	Sample preparation (Filtration)
32	Conical Flask 250ml	Fisher	N/A	no	300	Sample preparation (Titration)
33	Volumetric flask 1000ml	Fisher	class A	no	5	Reagents and standards preparation
34	Volumetric flask 200ml	Fisher	class A	no	3	Reagents and standards preparation
35	Volumetric flask 2000ml	Fisher	class A	no	2	Reagents and standards preparation
36	Volumetric flask 500ml	Fisher	class A	no	5	Reagents and standards preparation
37	Volumetric flask 50ml	Fisher	class A	no	20	Reagents and standards preparation
38	Volumetric flask 100ml	Fisher	class A	no	50	Reagents and standards preparation
39	Volumetric flask 5ml	Fisher	class A	no	6	Reagents and standards preparation
40	Volumetric flask 25ml	Fisher	class A	no	20	Reagents and standards preparation
41	Measuring Cylinder 100ml	Fisher	class A	no	5	Reagents preparation
42	Measuring Cylinder 10ml	Fisher	class A	no	5	Reagents preparation
43	Measuring Cylinder 50ml	Fisher	class A	no	5	Reagents preparation
44	Measuring Cylinder 500ml	Fisher	class A	no	2	Reagents preparation
45	Measuring Cylinder 1000ml	Fisher	class A	no	2	Reagents preparation

S.No	Chemicals Items List	Manufacturer	Grade	Unit	Total items sent	Purpose
46	Beakers 10ml	Fisher	spout	no	10	Reagents preparation
47	Beakers 5ml	Fisher	spout	no	10	Reagents preparation
48	Beakers 50ml	Fisher	spout	no	50	Reagents preparation
49	Beakers 100ml	Fisher	spout	no	20	Reagents preparation
50	Beakers 250ml	Fisher	spout	no	20	Reagents preparation
51	Beakers 500ml	Fisher	spout	no	8	Reagents preparation
52	Beakers 1000ml	Fisher	spout	no	6	Reagents preparation
53	Carboy Stop 25ltr	Tarsons	N/A	no	5	Distilled water storage
54	Wide Mouth Bottles 125ml	Tarsons	N/A	no	6	Sample preparation (Shaking)
55	Narrow Mouth Bottle 125ml	Tarsons	N/A	no	6	Sample preparation (Shaking)
56	Powder funnel 100mm	Tarsons	N/A	no	30	Sample preparation (Filtration)
57	Tarsons Volumetric flask 100ml	Tarsons	N/A	no	20	Reagents and standards preparation
58	Measuring Cylinder 1000ml	Tarsons	N/A	no	4	Reagents and standards preparation
59	Dropping Bottle 125ml	Tarsons	N/A	no	1	Reagents and standards preparation
60	SS Lab Jack 6*6	Tarsons	N/A	no	1	Titration and lab common use
61	Magnetic Retriever 30cm	Tarsons	N/A	pack	1	Titration and lab common use
62	U V Safety googles	Tarsons	N/A	no	5	Safety
63	Poly Magnetic stirring bar 8*22mm	Tarsons	N/A	no	4	Reagents preparation and titration
64	Round Magnetic Stiring Bar 12.7*76mm	Tarsons	N/A	no	2	Reagents preparation and titration
65	Poly Magnetic stirring bar 8*22mm	Tarsons	N/A	no	2	Reagents preparation and titration
66	PH Buffer capsules	Merck	N/A	pack	1	pH meter standard
67	wash bottles 500ml	Tarsons	N/A	pack	1	Distilled water storage
68	Wash bottles 1000ml	Tarsons	N/A	pack	1	Distilled water storage
69	Tube Rack 50ml	Tarsons	N/A	no	2	Lab common use

S.No	Chemicals Items List	Manufacturer	Grade	Unit	Total items sent	Purpose
70	Utility tray	Tarsons	N/A	no	3	Lab common use
71	Draining Tray	Tarsons	N/A	no	3	Lab common use
72	Spint Magnetic stirer 18*18cm	Tarsons	N/A	no	1	Lab common use
73	Measuring Beakers handle 500ml	Tarsons	N/A	no	5	Reagents preparation
74	Measuring Beakers handle 5000ml	Tarsons	N/A	no	5	Reagents preparation
75	Measuring Beakers handle 2000ml	Tarsons	N/A	no	5	Reagents preparation
76	Zinc Standard	Alfa aesar/Merck	Std	500 ml	4	Calibration standard
77	Magnesium	Alfa aesar/Merck	Std	500 ml	5	Calibration standard
78	Calcium	Alfa aesar/Merck	Std	500 ml	5	Calibration standard
79	Iron	Alfa aesar/Merck	Std	500 ml	5	Calibration standard
80	Sodium	Alfa aesar/Merck	Std	500 ml	5	Calibration standard
81	Potassium	Alfa aesar/Merck	Std	500 ml	5	Calibration standard
82	Manganese	Alfa aesar/Merck	Std	500 ml	4	Calibration standard
83	Copper	Alfa aesar/Merck	Std	500 ml	3	Calibration standard
84	Boron	Alfa aesar/Merck	Std	500 ml	1	Calibration standard
85	Eppendorf TIPS 0.2-5ml	Eppendorf	N/A	pack	3	Standard preparation
86	Eppendorf TIPS 0.5-5ml	Eppendorf	N/A	pack	1	Standard preparation
87	Micro pipettes100-1000	Eppendorf	N/A	no	1	Standard preparation
88	Micro Pipettes 1-10ml	Eppendorf	N/A	no	1	Standard preparation
89	Micro pipettes 0.5-10ml	Eppendorf	N/A	no	1	Standard preparation
90	Eppendorf tips 50-1000ml	Eppendorf	N/A	pack	1	Standard preparation
91	Eppendorf tips 0.5-5ml	Eppendorf	N/A	pack	1	Standard preparation
92	Fisher brand thermo bottle 500ml	Fisher	N/A	no	5	Reagent storage
93	Fisher brand thermo bottle 1000ml	Fisher	N/A	no	5	Reagent storage

S.No	Chemicals Items List	Manufacturer	Grade	Unit	Total items sent	Purpose
94	Munsell soil chart	Munsell	N/A	no	1	Soil color and type identification chart
95	Glycerol anhydrous for analysis	Merck	EMPARTA ACS	2.5 ltr	6	Sulphur analysis
96	Lab Stools	Messung	N/A	no	10	Lab common use
97	Filter papers 1.NO	Whatman	Grade 1	no	200	Filtration
98	Filter paper 42.No	Whatman	Grade 42	no	300	Filtration
99	Bulb Condensors	Local	N/A	no	70	Boron analysis
100	Trolleys	Local	N/A	no	6	Lab common use
101	pH meter with electrodes	Elico	N/A	no	1	pH analysis (Sambalpur pending)
102	EC meter with electrodes	Elico	N/A	no	1	EC analysis (Sambalpur pending)
103	Island Table	Cassia Siamia Technologies	N/A	no	1	To place millipore distilled water unit

Annexure 12.32. Details of all equipments installed at Bhubaneshwar

S.No	Item Description	Manufacturer	Quantity	Remarks
1	Shakers	CASSIA SIAMIA	1	Plug and play
2	MP-AES Instrument	Agilent	1	Installation under process
3	Nitrogen Generator	Agilent	1	Installation under process
4	MP-AES Dryer	Trident	1	Installation under process
5	Compresser Tank	Hitachi	1	Installed
6	HITACHI Compresser	Hitachi	1	Installed
7	Suction Motor For MP-AES	Agilent	1	Installed
8	UPS Battery Black Steel Stand	Agilent	1	Installed
9	Muffle Furnace	CASSIA SIAMIA	1	Plug and use
10	CPU	Dell	1	Plug and use
11	Monitor	Dell	1	Plug and use
12	Nitric Acid MP-AES Standards	Merck	1	Can be used once analysis starts
13	Water Purification System Milli-Q(Reference 10 Kit)	Milli-Q	1	Will be installed soon
14	Water Purification System Milli-Q(Synergy Kit)	Milli-Q	1	Will be installed soon
15	MP-AES Accessory kit	Agilent	1	Under installation
16	UPS-HITACHI	Hitachi	1	Under installation
17	RO Protector,Argon Bottle,MilliPore Filter	Millipore	1	Will be installed soon
18	UV-Spectrometer	Lab India	1	Plug and use
19	Shimadzu Analytical Balance	Shimadzu	1	Plug and use
20	MP-AES Auto Sampler	Agilent	1	Under installation
21	Digital Hot Plate	Sapphire Scientific	1	Plug and use
22	FOSS Digestor	Foss	1	Demo displayed
23	FOSS Tubes Straight 2 BOX,Tube Rack,FOSS Material	Foss	1	Demo displayed

S.No	Item Description	Manufacturer	Quantity	Remarks
24	Oven	CASSIA SIAMIA	1	Plug and use
25	Battery-20 Piece	Exide	1	Under installation
26	Weighing Balance Top load	Shimadzu	1	Plug and use

Annexure 12.33. Details of all equipments installed at Sambalpur

S.NO	Item Description	Manufacturer	Quantity	Remarks
1	Shakers	CASSIA SIAMIA	1	Plug and play
2	MP-AES Instrument	Agilent	1	Installation under process
3	Nitrogen Generator	Agilent	1	Installation under process
4	MP-AES Dryer	Trident	1	Installation under process
5	Compresser Tank	Hitachi	1	Installed
6	HITACHI Compresser	Hitachi	1	Installed
7	Suction Motor For MP-AES	Agilent	1	Installed
8	UPS Battery Black Steel Stand	Agilent	1	Installed
9	Muffle Furnace	CASSIA SIAMIA	1	Plug and use
10	CPU	Dell	1	Plug and use
11	Monitor	Dell	1	Plug and use
12	Nitric Acid MP-AES Standards	Merck	1	Can be used once analysis starts
13	Water Purification System Milli-Q(Reference 10 Kit)	Milli-Q	1	Will be installed soon
14	Water Purification System Milli-Q(Synergy Kit)	Milli-Q	1	Will be installed soon
15	MP-AES Accessory kit	Agilent	1	Under installation
16	UPS-HITACHI	Hitachi	1	Under installation
17	RO Protector,Argon Bottle,MilliPore Filter	Millipore	1	Will be installed soon
18	UV-Spectrometer	Lab India	1	Plug and use
19	Shimadzu Analytical Balance	Shimadzu	1	Plug and use
20	MP-AES Auto Sampler	Agilent	1	Under installation
21	Digital Hot Plate	Sapphire Scientific	1	Plug and use
22	FOSS Digestor	Foss	1	Demo displayed
23	FOSS Tubes Straight 2 BOX,Tube Rack,FOSS Material	Foss	1	Demo displayed

S.NO	Item Description	Manufacturer	Quantity	Remarks
24	Oven	CASSIA SIAMIA	1	Plug and use
25	Battery-20 Piece	Exide	1	Under installation
26	Weighing Balance Top load	Shimadzu	1	Plug and use