Annual Progress Report
2020–21

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 major activities for the third year of the Bhoochetana project were completed and reported in the half-yearly progress report. Rabi 2019-20 demonstrations were completed and datasets collected, showing that a total of 1717 demonstrations were conducted over an area of 934 acres across all the 30 districts. Majority of the demonstrations were laid out to showcase the benefits accruing from the application of deficient micronutrients (zinc and boron) as well as improved cultivars and humic acid. The crops chosen for the demonstrations included rice, finger millet, chickpea, black gram, green gram, groundnut, mustard and sunflower. The application of deficient micronutrients Zn and B along with NPK increased crop yields by 13% to 53% over only NPK application. Humic acid also proved effective in increasing crop yields by 8% to 19%; while in combination with B and Zn, the benefits were in the range of 28% to 54% over only NPK. Improved cultivars introduced proved effective in increasing crop yield over the prevailing local varieties. In the case of black gram, PU 31 gave significantly higher yield benefit (89%) in Subarnapur compared to nondescript local cultivars. Improved green gram cultivar IPM 02-14 showed varied yield responses (10-111% increase) over local ones across the districts, with the highest being in Subarnapur (111%). Similarly, yields responses varied across districts for improved chickpea cultivars, the highest increase over local ones being in variety NBeG 3 in Boudh (54%) followed by JG 11 in Kalahandi (52%), JAKI 9218 in Nabarangpur (41%), JG 14 in Khorda (28%), JAKI 9218 in Jharsuguda (26%), and NBeG 3 in Koraput (20%). Among oilseed crops, groundnut cultivar Devi showed varied yield responses across the districts (5-37% increase), and the highest response over local varieties was noticed in Malkangiri (37%). Among mustard cultivars, DRMR 1153-12 gave higher yield improvement (38%) followed by DRMR 150-35 (37%) and Anuradha (26%). In finger millet, GPU 48 performed better (53% increase) compared to a nondescript local cultivar. Similarly in rice, the highest yield response was obtained with Parijit in Kandhamal (28%), followed by Lalat in Bargarh (23%) and Balasore (17%), and Swarna (17%), MTU 1010 (16%), Puja (13%), and Jamuna (10%), all in Sambalpur.

The referral laboratories – one at Bhubaneswar and the other at Sambalpur – were inaugurated by Dr Arun Kumar Sahu, Minister for Agriculture & Farmers' Empowerment on 5 December 2020. Also released by the Minister on this occasion was a publication, *Mapping the Nutrient Status of Odisha's Soils,* detailing the results of an analysis of 40,265 soil samples from Odisha. For wider dissemination of the findings from two years of the project work, a story was published in ICRISAT's Newsletter, Happenings (23 July 2020 - https://www.icrisat.org/drought-prone-landscape-turns-green/).

2. Introduction

ICRISAT has been collaborating with the Government of Odisha since 2018, and initiated a mission mode project called *Odisha Bhoochetana* with the mandate of improving crop productivity and rural livelihoods through science-based natural resource management. ICRISAT worked with more than 20 local NGO partners, Odisha University of Agriculture & Technology (OUAT), and Department of Agriculture in the state.

Under the project, efforts were directed towards providing the best bet management practices to increase crop productivity in 30 districts, along with an assessment of the nutrient

status of soils, soil health mapping, and upgradation of two soil testing laboratories into referral laboratories.

3. Objectives

The specific objectives are to:

- Upgrade two existing soil analytical laboratories in the state to serve as referral laboratories and run them efficiently with government support;
- Identify the best soil, crop, water and nutrient management options for sustainable intensification of major crops in different agro-ecoregions in order to increase productivity through demonstrations in pilot sites and scale up in partnership with DoA and other partners through convergence;
- Assess the nutrient status of soils in the 30 districts through stratified soil sampling;
- Build the capacity of DoA staff to undertake soil analysis, handle data, and that of other consortium partners including farmers to scale up the science-led holistic development strategy using ICT tools; and
- Concurrently monitor, evaluate, and document the impacts of the scaling up approach in order to enable mid-course corrections.

4. Demonstration of Improved Practices – Crop Responses during Rabi 2019-20

ICRISAT has committed to carry out 1600 crop trials per year covering all the 30 districts of the state. Based on soil test results, farmer participatory demonstrations were conducted on application of deficient micronutrients and improved cultivars and application of humic acid during rabi (postrainy) season 2019-20 (Table 1). A total of 1717 demonstrations covering 934 acres were conducted in clusters of villages to develop sites of learning in each district. Majority of the trials were laid out to evaluate the benefits of deficient micronutrients application. Since long duration rice was grown during kharif (rainy season) with no scope for a second crop, the emphasis was on growing short- duration pulses such as chickpea, green gram and black gram in rice fallows. To facilitate the growth of a greater number of auxiliary flower-bearing branches and to overcome apical dominance, nipping of the apical bud using a simple device was demonstrated in chickpea.

Since most soils are acidic in nature with high prevalence of zinc and boron deficiencies, demonstrations were organized with a combination of NPK (Nitrogen, phosphorus & potassium) fertilizers, a common farmers practice, plus application of deficient micronutrients as per the Soil Test-based Recommendations (STBR). In places where farmers continued to use low input responsive varieties, demonstrations on improved cultivars that are responsive to nutrients and showing tolerance to abiotic stress like submergence, moisture stress and pest and disease infestations were organized, based on location-specific situations. Demonstrations were also organized on the application of humic acid. Trials were conducted on 0.5-1.0-acre fields.

Table 1. Details of demonstrations on soil test-based micronutrient application, improved varieties and humic-acid evaluation conducted during *rabi* 2019-20

District	Crop	Area (acres)	No. of demos
Angul	Finger millet	3.50	10
	Groundnut	7.90	19
	Total	**11.40**	**29**
Balangir	Chickpea	14.82	30
	Total	**14.82**	**30**
Balasore	Black gram	6.50	13
	Green gram	6.50	13
	Mustard	5.00	10
	Rice	9.50	19
	Total	**27.5**	**55**
Bargarh	Green gram	6.00	12
	Rice	19.00	38
	Total	**25.00**	**50**
Bhadrak	Black gram	15.00	40
	Green gram	5.00	20
	Total	**20.00**	**60**
Boudh	Black gram	5.00	10
	Chickpea	5.00	10
	Green gram	5.00	10
	Total	**15.00**	**30**
Cuttack	Black gram	10.00	20
	Green gram	10.00	20
	Total	**20.00**	**40**
Deogarh	Groundnut	25.00	70
	Total	**25.00**	**70**
Dhenkanal	Black gram	10.00	20
	Green gram	9.00	18
	Total	**19.00**	**38**
Gajapathi	Black gram	15.50	31
	Total	**15.50**	**31**
Ganjam	Black gram	12.50	27
	Green gram	11.25	23
	Total	**23.75**	**50**
Jagatsinghpur	Black gram	18.00	31
	Green gram	23.00	33
	Total	**41.00**	**64**
Jajpur	Black gram	4.75	19
	Green gram	14.25	39
	Total	**19.00**	**58**
Jharsuguda	Black gram	8.50	16
	Chickpea	9.50	19

	Green gram	15.75	30
	Mustard	7.30	11
	Total	**41.05**	**76**
Kalahandi	Chickpea	10.00	20
	Green gram	10.00	20
	Rice	10.00	20
	Total	**30.00**	**60**
Kandhamal	Rice	45.00	90
	Total	**45.00**	**90**
Kendrapara	Black gram	10.00	20
	Green gram	58.50	61
	Total	**68.50**	**81**
Keonjhar	Chickpea	64.40	83
	Total	**64.40**	**83**
Khordha	Black gram	9.00	18
	Chickpea	16.50	33
	Green gram	3.00	6
	Total	**28.50**	**57**
Koraput	Chickpea	12.50	25
	Total	**12.50**	**25**
Malkangiri	Groundnut	70.00	100
	Total	**70.00**	**100**
Mayurbhanj	Chickpea	28.80	72
	Groundnut	8.20	20
	Mustard	14.00	15
	Total	**51.00**	**107**
Nabarangpur	Chickpea	30.00	60
	Total	**30.00**	**60**
Nayagarh	Green gram	12.50	39
	Rice	46.50	70
	Total	**59.00**	**109**
Nuapada	Chickpea	14.82	30
	Total	**14.82**	**30**
Puri	Black gram	10.50	21
	Green gram	9.50	19
	Total	**20.00**	**40**
Rayagada	Sunflower	30.00	60
	Total	**30.00**	**60**
Sambalpur	Black gram	9.25	15
	Green gram	11.50	20
	Mustard	10.00	8
	Rice	12.00	24
	Total	**42.75**	**67**
Subarnapur	Black gram	7.50	15

	Green gram	7.50	15
	Total	**15.00**	**30**
Sundargarh	Chickpea	34.50	37
	Total	**34.50**	**37**
Grand Total		**933.99**	**1717**

4.1 Response to nutrient management

The application of micronutrients as per soil test results led to significantly increased yields across the districts (Table 2). The application of humic acid added to the benefits. In the case of black gram, the application of zinc + boron + humic acid along with NPK resulted 48% higher yield over the farmers practice of application of only NPK. In green gram, a yield increase of 51% was observed with the application of NPK + zinc + boron + humic acid compared to the application of NPK alone. In case of chickpea, the benefit with combined application of NPK + zinc + boron + humic acid over only NPK was to the tune of 54% higher yield. In finger millet, the application of NPK + zinc + boron resulted 53% higher yield over farmers practice of NPK alone. In groundnut, the application of NPK + Zn + B + Humic acid resulted 30% higher yield over only NPK, while in mustard, it led to a 37% higher yield. A similar beneficial yield response was noticed with the application of NPK + zinc + boron + humic acid in rice (28% increase). In sunflower, the application of NPK + boron increased yield by 29% compared to farmers' practice of sole application of NPK.

Table 2. Response of crops to soil test-based nutrient management.

Technology evaluated as improved practice	Yield (kg/acre)		% Increase over Farmers' Practice
	Farmers' practice (NPK)	Improved practice	
Black gram			
NPK + B	167	192	15
NPK + Zn	97	110	13
NPK + Zn + B	117	151	26
NPK + Humic Acid	99	118	19
NPK + Zn + B + Humic Acid	173	256	48
Chickpea			
NPK + Zn + B	208	293	41
NPK + Humic Acid	412	444	8
NPK + Zn + B + Humic Acid	175	269	54
Finger millet			
NPK + Zn + B	393	602	53
Green gram			
NPK + Zn + B	221	299	35
NPK + Humic Acid	107	128	19

Technology evaluated as improved practice	Yield (kg/acre)		% Increase over Farmers' Practice
	Farmers' practice (NPK)	Improved practice	
NPK + B + Humic Acid	177	195	10
NPK + Zn + B + Humic Acid	167	253	51
Groundnut			
NPK + Zn + B	523	656	25
NPK + Zn + B + Humic Acid	427	556	30
Mustard			
NPK + Zn + B	287	371	29
NPK + Zn + B + Humic Acid	290	398	37
Rice			
NPK + Zn + B	1803	2139	19
NPK + Zn + B + Humic Acid	1327	1700	28
Sunflower			
NPK + B	180	232	29

Figure 1. A demonstration of boron application in sunflower in Rayagada.

4.2 Performance of improved crop cultivars

Improved cultivars introduced proved effective over the prevailing local varieties. In the case of black gram, PU 31 gave significantly higher yield (89%) in Subarnapur compared to nondescript local cultivars (Figure 3). Improved green gram cultivar IPM 02-14 showed varied yield responses across the districts (Figures 4 and 6), with the highest being in Subarnapur (111%) followed by Boudh (51%), Kalahandi (39%), Jharsuguda (38%), Ganjam (25%), Bargarh

(20%), Cuttack and Khorda (19%), Balasore (15%), and Nayagarh (10%). Yields varied across districts for improved chickpea cultivars (Figure 5), the highest being in variety NBeG 3 in Boudh (54%) followed by JG 11 in Kalahandi (52%), JAKI 9218 in Nabarangpur (41%), JG 14 in Khorda (28%), JAKI 9218 in Jharsuguda (26%), and NBeG 3 in Koraput (20%) (Figures 7 and 8).

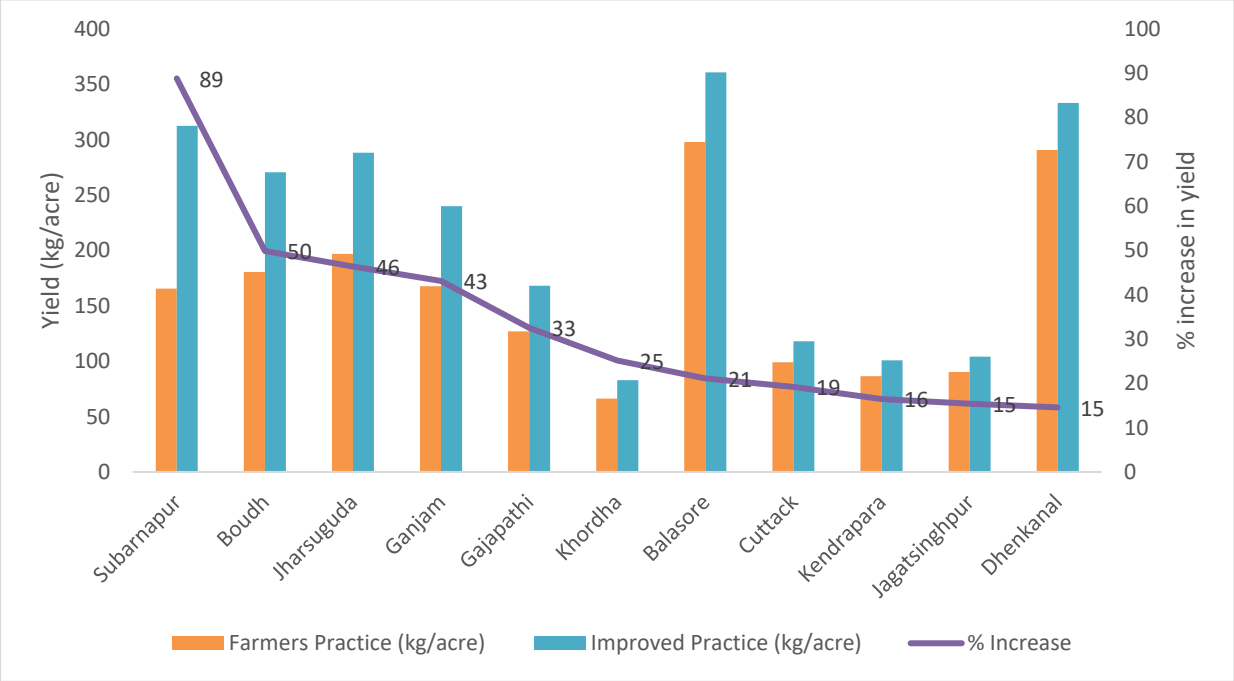


Figure 2. The performance of black gram variety PU 31 in Odisha during Rabi, 2019-20.

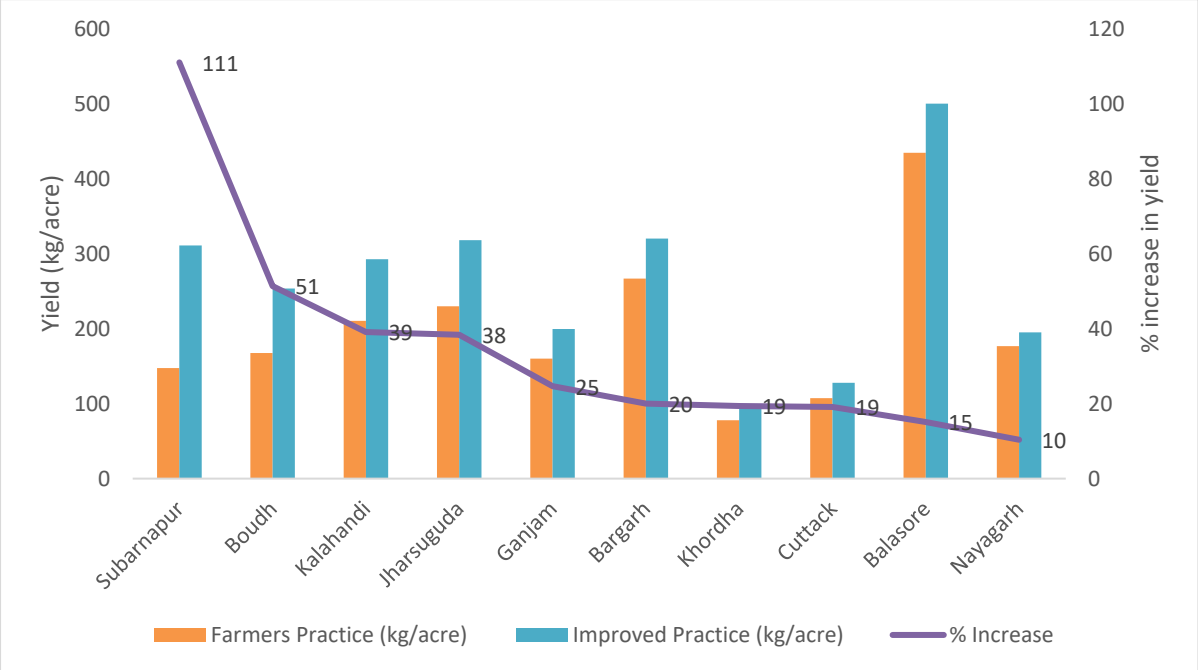


Figure 3. The performance of green gram cultivar IPM 02-14 in Odisha during Rabi, 2019-20

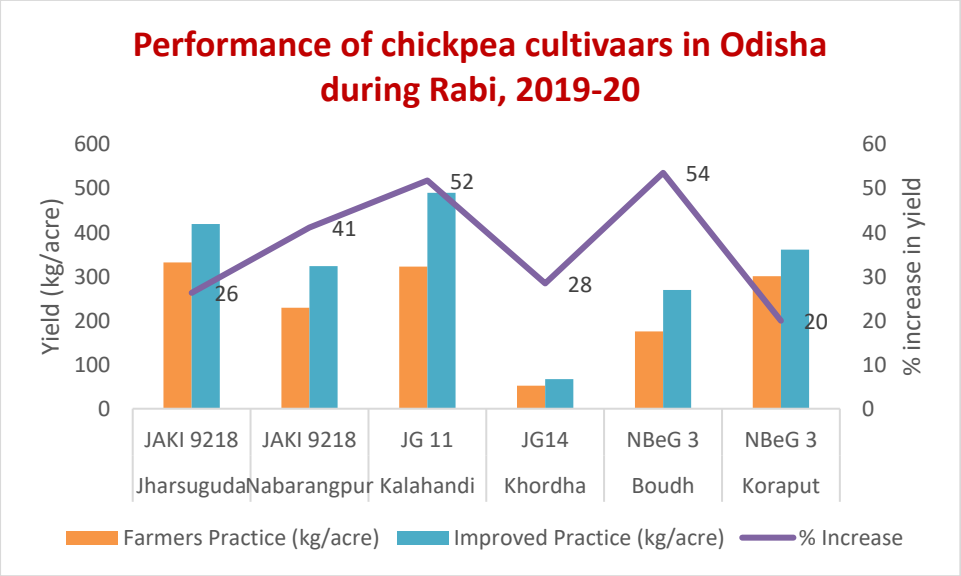


Figure 4. The performance of chickpea cultivars in Odisha during Rabi, 2019-20.

Figure 5. Green gram demonstration of IPM 02-14 in Nayagarh.

Figure 6. Demonstration of chickpea cultivar JAKI 9218 in Jharsuguda.

Figure 7. Crop cutting experiments in chickpea in Nuapada.

Among oilseed crops, groundnut cultivar Devi showed varied yield across the districts (Figure 9), and the highest response was noticed in Malkangiri (37%) followed by Mayurbhanj (30%), Deogarh (21%) and Angul (4%). Among mustard cultivars (Figure 10), DRMR 1153-12 gave high yield (38%) followed by DRMR 150-35 (37%) and Anuradha (26%).

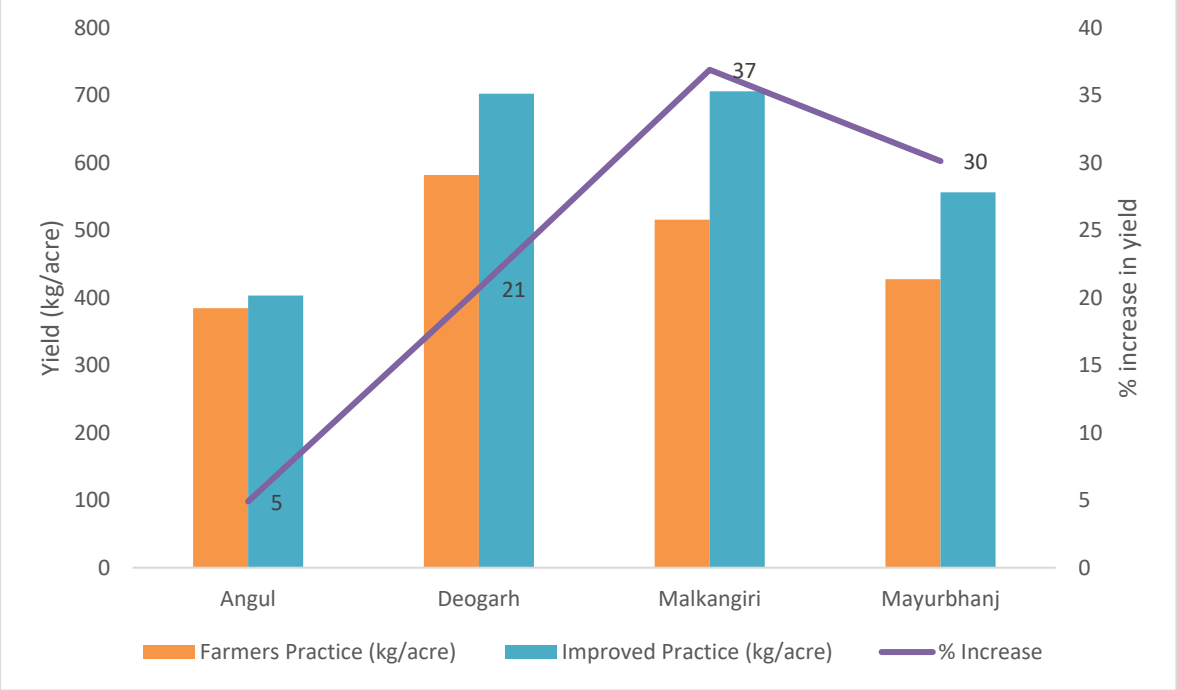


Figure 8. The performance of groundnut cultivar Devi in Odisha during Rabi, 2019-20

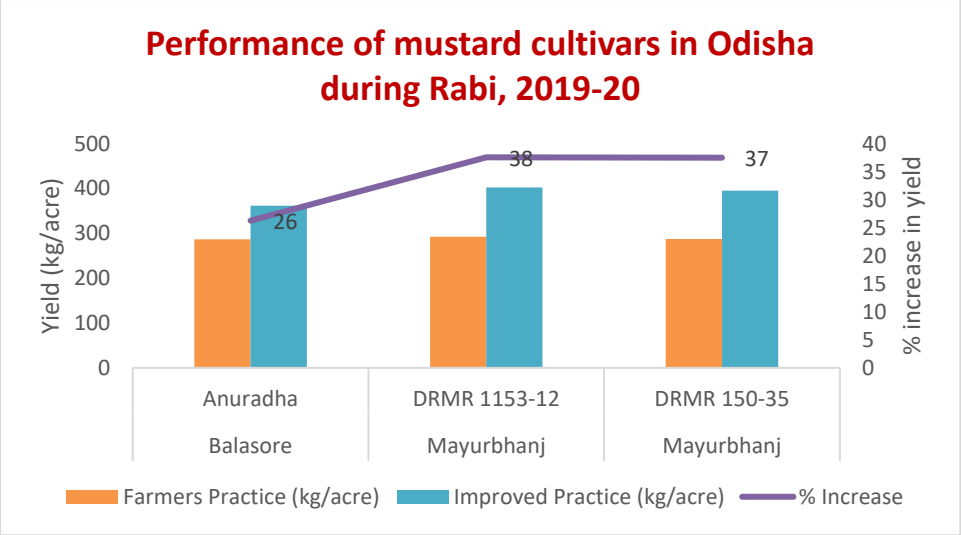


Figure 9. The performance of mustard cultivars in Odisha during Rabi, 2019-20

Demonstrations on improved cultivars of finger millet and rice were organized. In finger millet, GPU 48 performed better (53%) compared to a nondescript local cultivar. Similarly in rice (Figure 11), the highest yield response was obtained with Parijit in Kandhamal (28%), followed by Lalat in Bargarh (23%) and Balasore (17%), and Swarna (17%), MTU 1010 (16%), Puja (13%), and Jamuna (10%), all in Sambalpur.

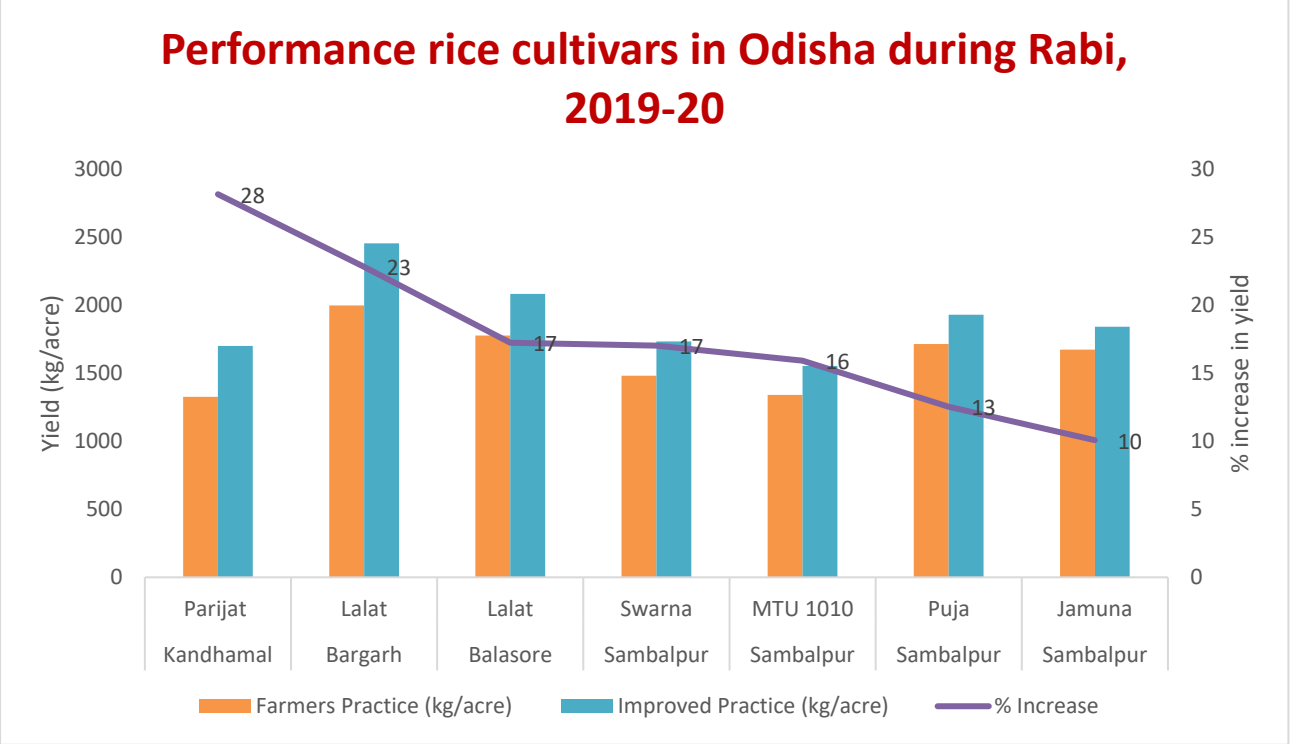


Figure 10. The performance of rice cultivars in Odisha during Rabi, 2019-20.

5. Upgradation and Inauguration of Referral Laboratories

In keeping with the project, IDC-ICRISAT was committed to the establishment of two referral laboratories at Bhubaneswar and Sambalpur with state-of-the-art facilities. In this regard, the renovation of buildings, furniture, air conditionings, electric fittings, water and drainage pipeline works have been completed. The shipment of Microwave Plasma Atomic Emission Spectrometer (MP-AES) and other equipment have been completed. The high end equipment, MPAES, UV spectrophotometer, glassware and chemicals to support the analysis of 10,000 samples for 14 parameters at each site have been successfully installed at both the laboratories, with due acknowledgement from Assistant Director of Agriculture (ADA) of the respective laboratory. ICRISAT's CRAL team conducted a dry run of the equipment at both the sites, which are now functional for analysing soil, plant and water samples with high precision. Hands-on trainings on handling instruments by staff at respective laboratories will be provided again by the CRAL team during 5-7 April 2021.

The laboratory at Bhubaneswar was inaugurated in person by Dr Arun Kumar Sahu, Minister of Agriculture & Farmers' Empowerment, Fisheries and Animal Resources Development & Higher Education, and Dr Muthu Kumar, DoA, on 5 December 2020 while the one at Sambalpur was inaugurated virtually by Dr Sahu (Figure 12).

See Annexure 7.1 for details of chemicals and other items sent to each of the laboratories.

See Annexures 7.2 & 7.3 for details of all the equipment installed/sent to date to both laboratories.

Figure 12. Inauguration of the two referral laboratories in Odisha.

6. Publications

6.1. Odisha Soil Atlas

The soil analysis results of all 40,265 soil samples from Odisha were compiled and published as a soil atlas titled 'Mapping the Nutrient Status of Odisha's Soils', as a guide for extension functionaries in the state. The publication was released by Dr Arun Kumar Sahu, Minister of Agriculture & Farmers' Empowerment, Fisheries and Animal Resources Development & Higher Education and Dr Muthu Kumar, DoA, in the presence of leading government officials of Odisha on 5 December 2020 (Figure 13).

The soil atlas comprises six chapters:

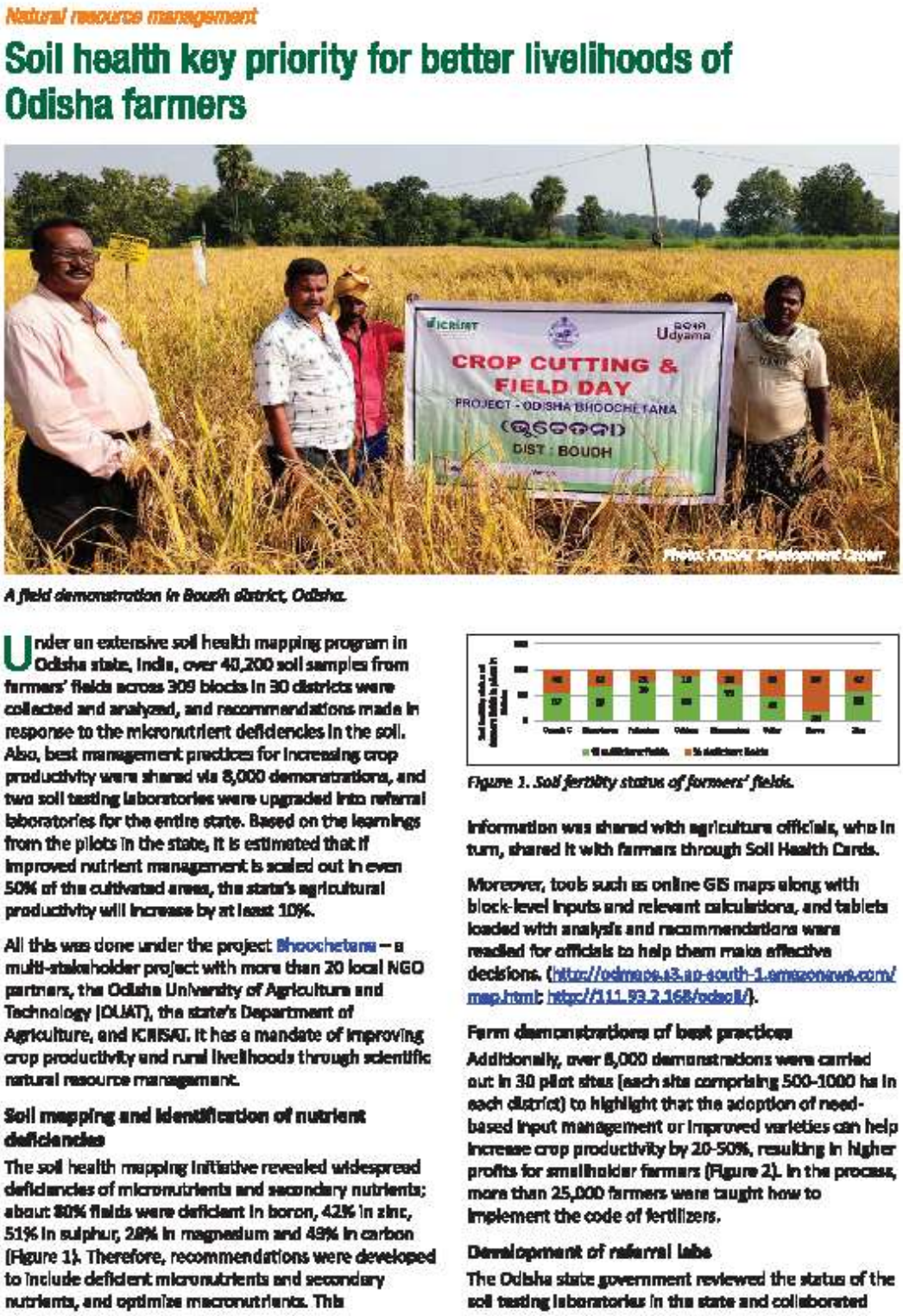
1. Bhoochetana: Reviving Soils for Agriculture
2. Soil Sampling and Analysis
3. Developing Soil Test-based Fertilizer Recommendations
4. Management of Acidic Soils
5. Developing Soil Nutrient Maps of Odisha using Digital Soil Mapping Techniques
6. Online Application for Soil Test-based Fertilizer Recommendation.

Figure 13. Release of the Odisha soil atlas by Dr Arun Kumar Sahu, Minister of Agriculture & Farmers' Empowerment, Fisheries and Animal Resources Development & Higher Education on 5 December 2020.

6.2. ICRISAT Happenings Newsletter Story

For wider dissemination of the findings of two years of Bhoochetana work, the *Odisha Bhoochetana* project story was published in ICRISAT Newsletter, Happenings (23 July 2020).

The article, 'Soil health key priority for better livelihoods of Odisha farmers' can be accessed at *https://www.icrisat.org/soil-health-key-priority-for-better-livelihoods-of-odisha-farmers/* (Figure 14).



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://odimaps.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

Figure 14. Snapshot of *Odisha Bhoochetana* project outcome story published in ICRISAT Happenings Newsletter (23 July 2020).

7. Annexures

Annexure 7.1. Details of chemicals and other items sent to the laboratories at Bhubaneshwar and Sambalpur.

S.No	Chemicals	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	Macronutrients (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	Micronutrients (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	Manufacturer	Grade	Unit	Total items sent	Purpose
22	Diethylenetriaminepentacetic acid (DTPA)	Qualigens	AR	500 gm	10	Micronutrient (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 150 ml	Fisher	N/A	no	300	Sample preparation (Filtration)
32	Conical flask 250 ml	Fisher	N/A	no	300	Sample preparation (Titration)
33	Volumetric flask 1000 ml	Fisher	class A	no	5	Reagents and standards preparation
34	Volumetric flask 200 ml	Fisher	class A	no	3	Reagents and standards preparation
35	Volumetric flask 2000 ml	Fisher	class A	no	2	Reagents and standards preparation
36	Volumetric flask 500 ml	Fisher	class A	no	5	Reagents and standards preparation
37	Volumetric flask 50 ml	Fisher	class A	no	20	Reagents and standards preparation
38	Volumetric flask 100 ml	Fisher	class A	no	50	Reagents and standards preparation
39	Volumetric flask 5 ml	Fisher	class A	no	6	Reagents and standards preparation
40	Volumetric flask 25 ml	Fisher	class A	no	20	Reagents and standards preparation
41	Measuring cylinder 100 ml	Fisher	class A	no	5	Reagents preparation
42	Measuring cylinder 10 ml	Fisher	class A	no	5	Reagents preparation
43	Measuring cylinder 50 ml	Fisher	class A	no	5	Reagents preparation
44	Measuring cylinder 500 ml	Fisher	class A	no	2	Reagents preparation
45	Measuring cylinder 1000 ml	Fisher	class A	no	2	Reagents preparation
46	Beakers 10 ml	Fisher	spout	no	10	Reagents preparation
47	Beakers 5 ml	Fisher	spout	no	10	Reagents preparation

S.No	Chemicals	Manufacturer	Grade	Unit	Total items sent	Purpose
48	Beakers 50 ml	Fisher	spout	no	50	Reagents preparation
49	Beakers 100 ml	Fisher	spout	no	20	Reagents preparation
50	Beakers 250 ml	Fisher	spout	no	20	Reagents preparation
51	Beakers 500 ml	Fisher	spout	no	8	Reagents preparation
52	Beakers 1000 ml	Fisher	spout	no	6	Reagents preparation
53	Carboy Stop 25 ltr	Tarsons	N/A	no	5	Distilled water storage
54	Wide mouth bottles 125 ml	Tarsons	N/A	no	6	Sample preparation (Shaking)
55	Narrow mouth bottle 125 ml	Tarsons	N/A	no	6	Sample preparation (Shaking)
56	Powder funnel 100 mm	Tarsons	N/A	no	30	Sample preparation (Filtration)
57	Tarsons volumetric flask 100 ml	Tarsons	N/A	no	20	Reagents and standards preparation
58	Measuring cylinder 1000 ml	Tarsons	N/A	no	4	Reagents and standards preparation
59	Dropping bottle 125 ml	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 30 cm	Tarsons	N/A	pack	1	Titration and lab common use
62	U V safety goggles	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*76 mm	Tarsons	N/A	no	2	Reagents preparation and titration
65	Poly magnetic stirring bar 8*22 mm	Tarsons	N/A	no	2	Reagents preparation and titration
66	PH buffer capsules	Merck	N/A	pack	1	pH meter standard
67	Wash bottles 500 ml	Tarsons	N/A	pack	1	Distilled water storage
68	Wash bottles 1000 ml	Tarsons	N/A	pack	1	Distilled water storage
69	Tube rack 50 ml	Tarsons	N/A	no	2	Lab common use
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

S.No	Chemicals	Manufacturer	Grade	Unit	Total items sent	Purpose
73	Measuring beakers handle 500 ml	Tarsons	N/A	no	5	Reagents preparation
74	Measuring beakers handle 5000 ml	Tarsons	N/A	no	5	Reagents preparation
75	Measuring beakers handle 2000 ml	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 -5 ml	Eppendorf	N/A	pack	3	Standard preparation
86	Eppendorf TIPS 0.5-5 ml	Eppendorf	N/A	pack	1	Standard preparation
87	Micro pipettes 100-1000	Eppendorf	N/A	no	1	Standard preparation
88	Micro Pipettes 1-10 ml	Eppendorf	N/A	no	1	Standard preparation
89	Micro pipettes 0.5-10 ml	Eppendorf	N/A	no	1	Standard preparation
90	Eppendorf tips 50-1000 ml	Eppendorf	N/A	pack	1	Standard preparation
91	Eppendorf tips 0.5-5 ml	Eppendorf	N/A	pack	1	Standard preparation
92	Fisher brand thermo bottle 500 ml	Fisher	N/A	no	5	Reagent storage
93	Fisher brand thermo bottle 1000 ml	Fisher	N/A	no	5	Reagent storage
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

S.No	Chemicals	Manufacturer	Grade	Unit	Total items sent	Purpose
99	Bulb condensers	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	IslandtTable	Cassia Siamia Technologies	N/A	no	1	To place millipore distilled water unit

Annexure 7.2. Equipment installed/sent to the Bhubaneshwar laboratory to date.

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 compressor	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
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 7.3. Details of all equipment installed/sent to date at the Sambalpur laboratory.

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 compressor	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
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