Half Yearly Progress Report
April – September 2019

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

Submitted to
Department of Agriculture & Farmer Empowerment
Government of Odisha

ICRISAT DEVELOPMENT CENTER

ICRISAT INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

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1. Executive Summary

The Odisha Bhoochetana Project has the mandate of improving crop productivity and rural livelihoods through science-based Natural Resource Management in the State. The objectives of the project include assessment of nutrient status of soils in 30 districts through stratified random sampling, identification of best bet soil, water and crop management practices to increase the productivity, upgrading of two laboratories as referral labs, capacity building of Dept. of Agriculture staff and consortium partners including farmers and concurrently monitor, evaluate, assess and document the impacts for mid-term corrections.

With regard to setting up of referral laboratories at Bhubaneswar and Sambalpur, the laboratory in Bhubaneswar and Sambalpur is nearing commencement stage and installation of equipment is in progress. Renovation buildings, electric, water and drainage, installation of air conditioners, procurement of equipment is completed.

A total of 2307 demonstrations were conducted in an area of 1174 acres across all the 30 districts during Rabi, 2018-19. Untimely cyclone FANI afftected the crop performance in Puri, Khurda, Kendrapara, Jagitsinghpur, Keonjohar and other districts. Majority of the demonstrations were laid out to showcase crop diversification options, improved cultivars, application of micronutrient viz. zinc and boron and adding of humic acid. The crops choosen for demonstrations include paddy, finger millet, maize, sorghum, chickpea, blackgram, greengram, cowpea, groundnut, mustard etc.

The average increase in crop yield in ranged from 17 to 107% and highest obtained in cowpea (107%) followed by chickpea (43%), groundnut and paddy (17%). Among technologies, improved cultivars, soil test based application of NPK along with boron and zinc and line sowing and nipping gave higher yield response compared to farmers practice.

More than 1800 demonstration covering a area of 890 acres have been laid out during kharif, 2019 on paddy, finger millet, maize, pigeonpea and groundnut across 30 districts in the state. Various technologies that are intended to be demonstrated during the period are climate smart cultivars recommended for location specific conditions, management of micro-nutrient deficiencies viz. zinc and boron, application of humic acid and integrated pest management.

In order to strengthen the capacity of farmers, 200 capacity building courses were conducted during April-September 2019 in all the 30 districts covering 4249 farmers (3189 men and 1371 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.

As part of the project, two Master Trainer (MT) training programmes have been conducted during July, 2019 involving 60 district levels officials two from each district. The objective behind these MT programmes is to conduct Capacity Building (CB) programmes at the respective districts involving more than hundreds of Department of Agriculture (DoA) staff. In commensurate its objectives, IDC, ICRISAT embarked upon mammoth task of conducting district level CB commencing from September, 2019. At the end of September, 2019, district level CB programmes for Officers and VAW have been organized in 19 district covering covering 1501 DoA staff (495 officials and 1006 VLWs).

In order to monitor the interventions, build good working relationships with line departments, national institutions, agricultural university and to converge the facilities and resources of participating agencies, visits were undertaken by the scientist of ICRISAT across 30 districts during 2018-19. The scientists also visited and interacted with the farmers to orient them about conducting demonstrations of improved technologies viz. improved cultivars, soil test based nutrient application and management of micronutrients deficiencies during kharif.

2. Introduction and Objectives

The specific objectives

- 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 to increase productivity through demonstrations in pilot sites and scalingup in partnership with DoA and other partners through convergence.
- To assess the nutrient status of soils in the 30 districts of Odisha through stratified soil sampling.
- To build the capacity of DoA staff in undertaking soil analysis, handling data and that of other consortium partners including farmers for scalingup science-led holistic development strategy using ICT tools.
- To concurrently monitor, evaluate, assess and document the impacts of the scalingup approach in order to enable mid-course corrections.

3. Detailed Digital Soil Health Mapping and Recommendation

3.1. Delineation of nutrient deficiencies and development of digital maps and recommendations

The key input required to plan and implement balanced nutrient application strategy across the state is knowing the nutrient status in the soil. The results of soil analysis are either available to individual farmer in form of soil health card or tabulated summary at village / block / district level, which may limit the full utilization of such enormous data on soil nutrient across the country. In Bhoochetana project, soil nutrient maps were developed to facilitate policy maker and department officials to understand the spatial patterns on nutrient status in the state. These maps can be used to frame the policy on subsidy or resource mobilization to address the issue of large scale deficiencies of nutrients especially the micronutrients that are widely deficient across blocks and districts in the state.

Digital Soil Mapping

Digital Soil Mapping (DSM) or predictive soil mapping provides option to generate soil property surfaces at fine resolution with the uncertainty of prediction. Three steps procedure was adopted in preparation of digital soil maps that include 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. Although the DSM products have some prediction uncertainties, but it provide the spatial information at much higher resolution and at lesser costs.

The methodology adopted in developing soil maps is given in Figure 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 and is being used in DSM product preparation. 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. These bio-climatic variables were average for years 1970-2000. The Random Forest Model was used to prepare 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.

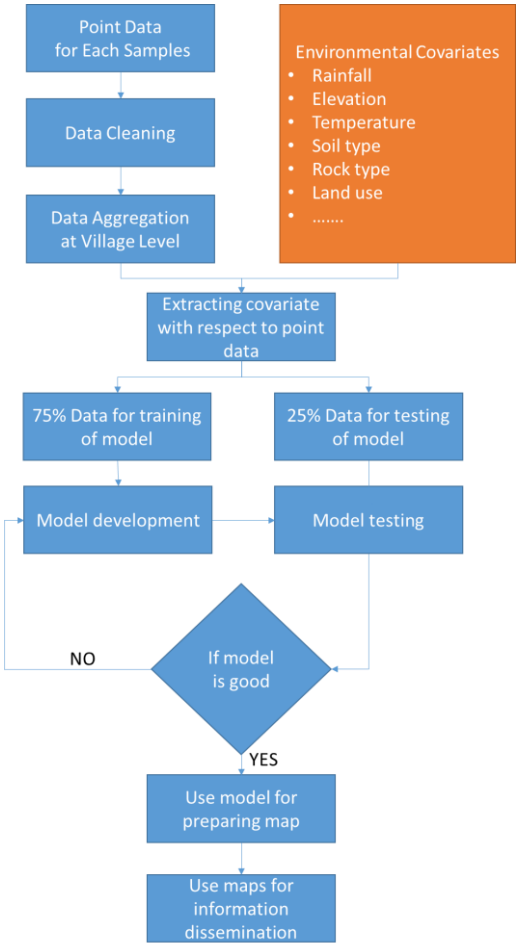

Figure 1. Methodology followed for developing the soil nutrient maps for Odisha state

Soil nutrient maps

Three types of maps were prepared for better interpretation of results. They are 1) map on soil parameter values at 118 x 118 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 1.

Table 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

3.2. ICT-enabled dissemination and scaling-up through tablets

One of the important outputs from Bhoochetana project is the soil nutrients maps for state of Odisha India. The data sets from the project is being used to develop the web app. The soil analysis data of 40000 soil samples collected across 30 districts in the state of Odisha was used as data base for developing the soil fertility indices. This database is being used to develop the crop wise fertilizer recommendation up to village level and issuing of soil health cards to individual farmers with whom the soil samples were collected. The printed soil health cards not only have a limited reach but also involves huge cost and efforts for their printing and distribution. Thus, a web-based application is being envisaged to be developed to provide soil health and fertility information at village, block, or district level in a seamless and cost effective manner.

Application is developed using combination of PHP: Hypertext preprocessor and MYSQL environments. PHP is an open-source server-side scripting language, which can be embedded into an HTML document. MYSQL is 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 different 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 being hosted on ICRISAT server.

4. Demonstration of Improved Practices – Crop Responses during Rabi 2018-19

As part of the Bhoochetana project, ICRISAT has committed to carry out 1600 crop trials per year covering all 30 districts of the state. Based on results of soil samples analyzed, trials were laid out in farmer-participatory mode during rabi, 2018 (Table 2). Nearly 2307 trials/demos covering an area of 1174 acres were conducted across 30 districts in clusters of villages to develop sites of learning in each district. Majority of the trials were laid out for evaluation of crop diversification options and improved cultivars covering micronutrient and humic acid application. In view of growing long duration paddy during kharif and no scope for taking second crop, emphasis was laid on growing short duration pulses viz. green gram, black gram and and chickpea in rice fallow situation under STBR + Cropping System category of technology. To facilitate production of more number of auxillary flower bearing branches and to overcoming the apical dominance, nipping of apical bud using simple devise is being demonstrated in chickpea. In view of wide spread deficiency of organic carbon and low productivity, demonstration were also organized on apploication Humic Acid wherever applicable. Majority of the soils being acidic in nature and higher prevalence of micro-nutrient deficiencies like zinc and boron, demonstrations were organized with a combination of micronutrients and soil test based nutrient management practices. Wherever farmers have the practice using low yielding varieties, demonstrations on improved cultivars that are responsive to nutrients and showing tolerance to abiotic stress like submergence, moisture stress and pest and disease infestation were organized according to location specific situation. Trials were conducted in 0.5 - 1.0 acre fields.

Table 2. Details of demonstration conducted in Rabi, 2018-19

District	Crop	No. of demons.	Area (Acre)
Angul	Black Gram	8	6.2
	Chickpea	35	7
	Total	**43**	**13.2**
Balangir	Chickpea	30	15.03
	Total	**30**	**15.03**
Balasore	Brinjal	4	1.4
	Chickpea	20	6.76
	Green Gram	9	29.02
	Paddy	10	15
	Total	**43**	**52.18**
Bargarh	Green Gram	30	15
	Paddy	50	25
	Total	**80**	**40**
Bhadrak	Black Gram	14	7
	Paddy	35	17.5
	Total	**49**	**24.5**
Boudh	Black Gram	4	5
	Chickpea	18	10
	Green Gram	4	5
	Total	**26**	**20**
Cuttack	Black Gram	9	4.5
	Green Gram	30	15
	Total	**39**	**19.5**
Deogarh	Black Gram	40	12.5
	Chickpea	112	24.35
	Green Gram	49	17.5
	Total	**201**	**54.35**
Dhenkanal	Black Gram	7	3.5
	Chickpea	5	2.5
	Green Gram	16	8
	Total	**28**	**14**
Gajapathi	Finger Millet	66	33
	Total	**66**	**33**
Ganjam	Black Gram	20	17
	Chickpea	35	14
	Finger Millet	18	12
	Green Gram	21	16.75
	Maize	8	2.75
	Total	**102**	**62.5**
Jajpur	Black Gram	45	48.1
	Green Gram	57	44.5
	Total	**102**	**92.6**

District	Crop	No. of demons.	Area (Acre)
Jharsuguda	Black Gram	16	5.5
	Chickpea	16	3.2
	Green Gram	25	10.5
	Mustard	16	9.5
	Total	**73**	**28.7**
Kalahandi	Black Gram	13	6.5
	Green Gram	13	6.5
	Maize	30	15
	Total	**56**	**28**
Kendrapara	Black Gram	5	1.25
	Green Gram	10	2.5
	Total	**15**	**3.75**
Keonjhar	Black Gram	81	45.7
	Chickpea	74	37
	Green Gram	34	18.2
	Sorghum	13	3.43
	Total	**202**	**104.33**
Khandamal	Chickpea	46	12.04
	Total	**46**	**12.04**
Koraput	Chickpea	191	96.5
	Cowpea	189	58.31
	Finger Millet	21	6
	Total	**401**	**160.81**
Khorda	Chickpea	20	10
	Green Gram	19	9.5
	Total	**39**	**19.5**
Malkangiri	Groundnut	60	30
	Total	**60**	**30**
Mayurbhanj	Chickpea	43	45.7
	Maize	20	13.95
	Total	**63**	**59.65**
Nabarangapura	Chickpea	50	15
	Total	**50**	**15**
Nayagarh	Chickpea	34	11
	Total	**34**	**11**
Nuapada	Chickpea	30	16.5
	Total	**30**	**16.5**
Puri	Black Gram	18	9.35
	Chickpea	3	0.6
	Green Gram	39	19.91
	Paddy	25	13.54
	Total	**85**	**43.4**
Rayagada	Maize	40	20

District	Crop	No. of demons.	Area (Acre)
	Maize (Sweet Corn)	10	5
	Paddy	20	20
	Sunflower	30	15.75
	Total	**100**	**60.75**
Sambalpur	Black Gram	20	7.75
	Chickpea	10	2.33
	Green Gram	20	20
	Mustard	10	2.85
	Total	**60**	**32.93**
Sonepur	Black Gram	8	8
	Green Gram	8	10
	Paddy	5	5
	Total	**21**	**23**
Sundergarh	Black Gram	41	20.5
	Chickpea	95	50
	Green Gram	27	13.5
	Total	**163**	**84**
	Grand Total	**2307**	**1174.22**

Figure 2. Crop demonstrations across districts of Odisha

4.1 Response of crops to various technologies

There is a varied response of crops to improved technologies viz. improved cultivar, soil test based nutrient management, application of mircro-nutirients (boron and zinc) across various districts in Odisha. Highest yield response was obtained in cowpea followed by chickpea, groundnut, mustard, green gram, finger millet, maize, black gram and paddy (Figure 3).

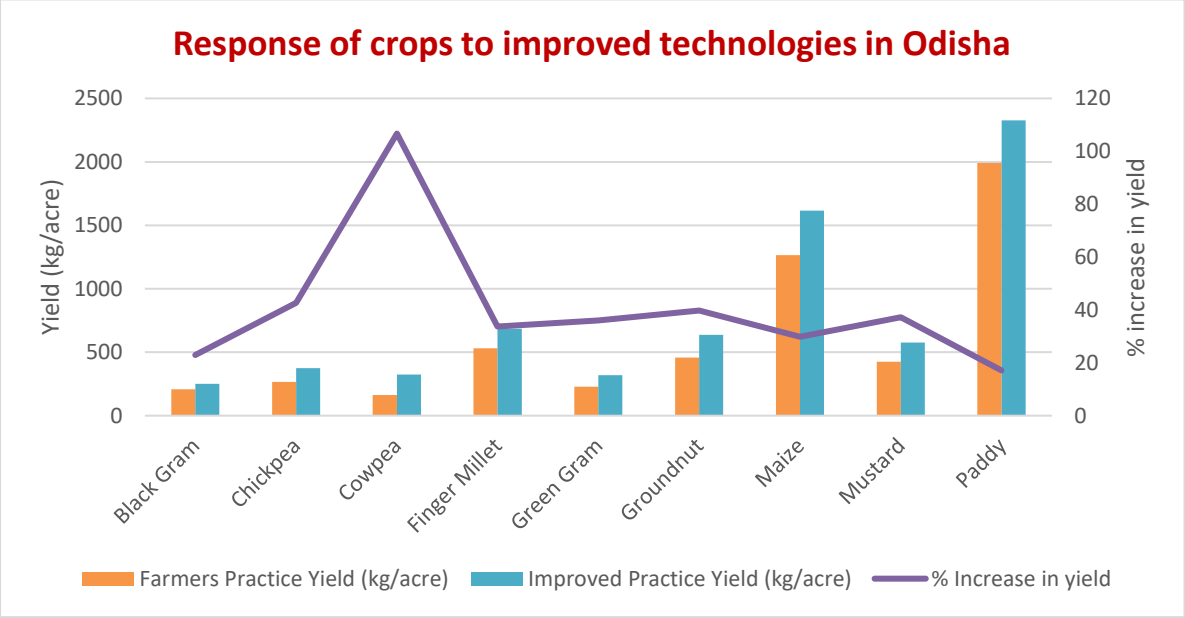

Figure 3. Highest yield response of crops to various technologies

4.2 Responses to soil test-based nutrient management

Application of nutrients as per the soil test values gave increased yields across various districts in Odisha (Table 3). In case of black gram application of Zinc + boron gave higher yield (48%) compared to application of either boron or zinc alone. Similar yield response was noticed in case of green gram where application of zinc + boron gave higher yield (37%) compared to application of either boron on zinc alone. In case of chickpea application of nutrients as per soil test values gave higher yields to the extent of 31%. In case of finger millet application of humic acid alone gave slightly higher yield (25%) compared to application of zinc + boron. Soil test based application of nutrients along with zinc gave higher yield (32%) compared to application of nutrients along with boron. In case of maize application of zinc and boron gave higher yield response to the tune of 29%.

Table 3. Response of crops to soil test-based nutrient management practices

Crop/Technology	Yield (kg/acre)		Average of % Increase
	Farmers Practice	Improved Practice	
Black Gram			
Boron Application	219	243	11
Zinc + Boron	190	273	48
Zinc Application	203	223	10
Chickpea			
STBR + Boron	473	606	31
Finger Millet			
Humic Acid	661	825	25

Crop/Technology	Yield (kg/acre)		Average of % Increase
	Farmers Practice	Improved Practice	
Zinc + Boron	669	824	23
Green Gram			
Boron Application	211	238	14
Zinc + Boron	167	234	37
Zinc Application	191	193	1
Maize			
Zinc + Boron	1569	2008	29
Paddy			
STBR + Boron	1956	2145	10
STBR + Zinc	1939	2553	32

4.3 Responses to improved crop cultivars

Improved crop cultivars along with nutrient management practices influenced the crop yield in the state of Odhisha. Improved cultivar along with soil test based application of nutrients along with zinc and boron gave higher yield (44%) compared to improved cultivar alone or in combination with boron alone in case of black gram (Figure 4). In case of chick improved cultivar with soil test based nutrient management and boron gave a higher response (58%) compared to improved cultivar alone or improved cultivar + boron (Figure 5). Improved cultivar along with application of boron gave higher yield (55%) compared to cultivation of improved cultivar alone in case of green gram (Figure 6). In case of paddy improved cultivars along with application of boron gave higher yield by 15% compared to growing of improved cultivar and application of humic acid (Figure 7).

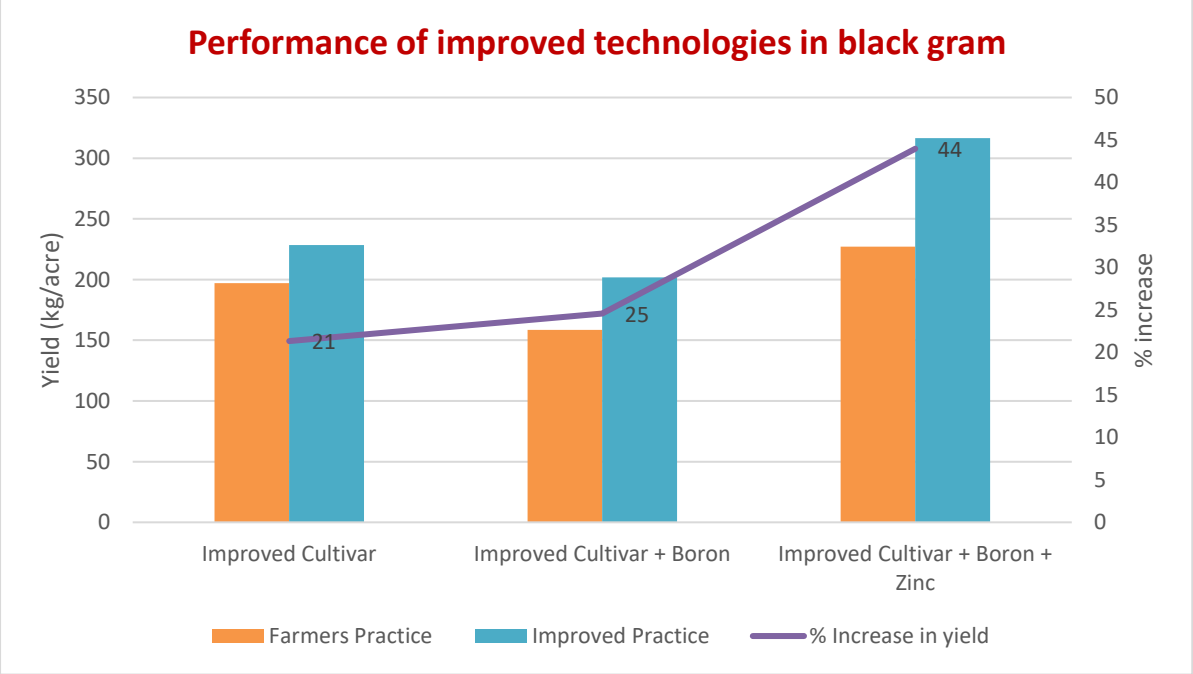

Figure 4. Performance of improved technologies in Black gram

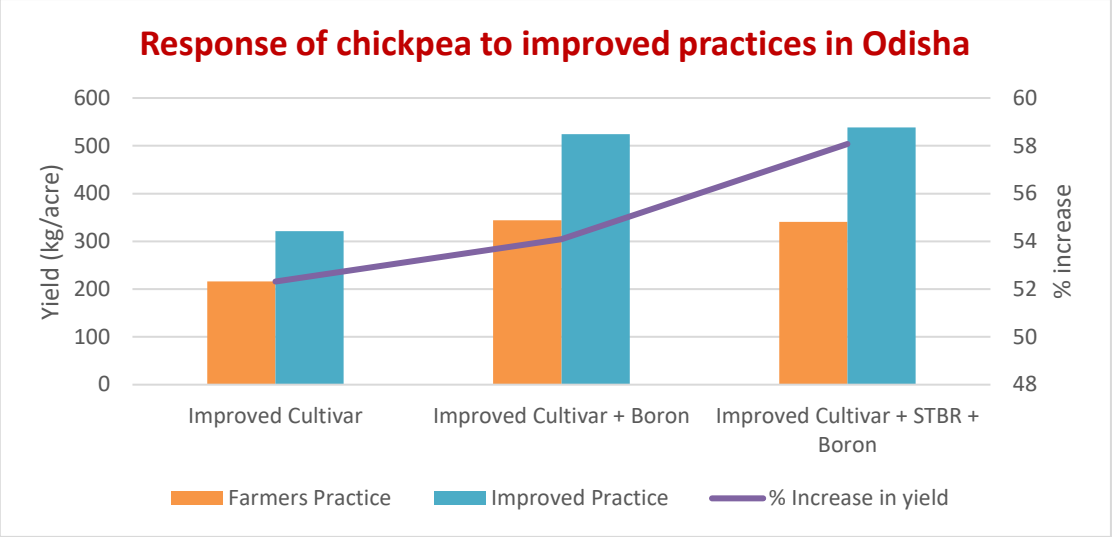

Figure 5. Performance of improved practices in Chickpea

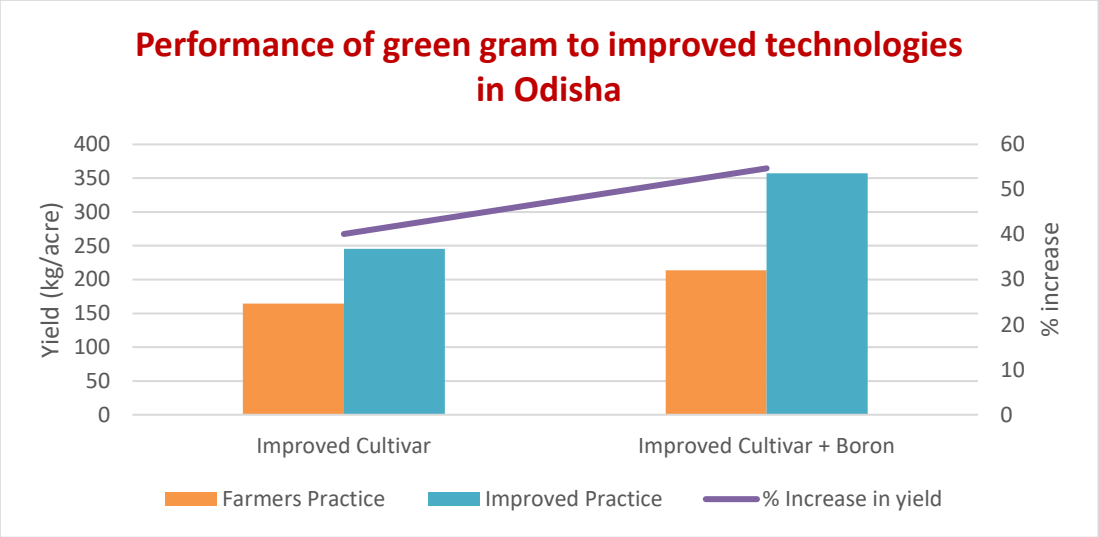

Figure 6. Performance of improved technologies in Greengram

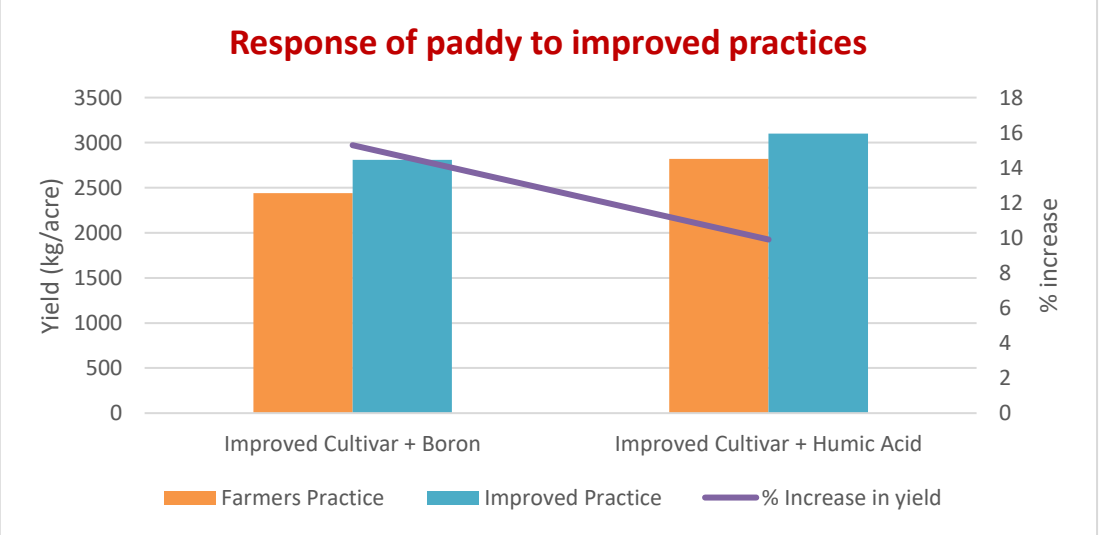

Figure 7. Performance of improved practices in Paddy

4.4 Other best practices

Other best practices that influenced the yield in rabi crops include line sowing and nipping. Line sowing in cowpea increased the crop yield by 107% compared to broadcasting of seeds followed by finger millet and chickpea (Figure 8).

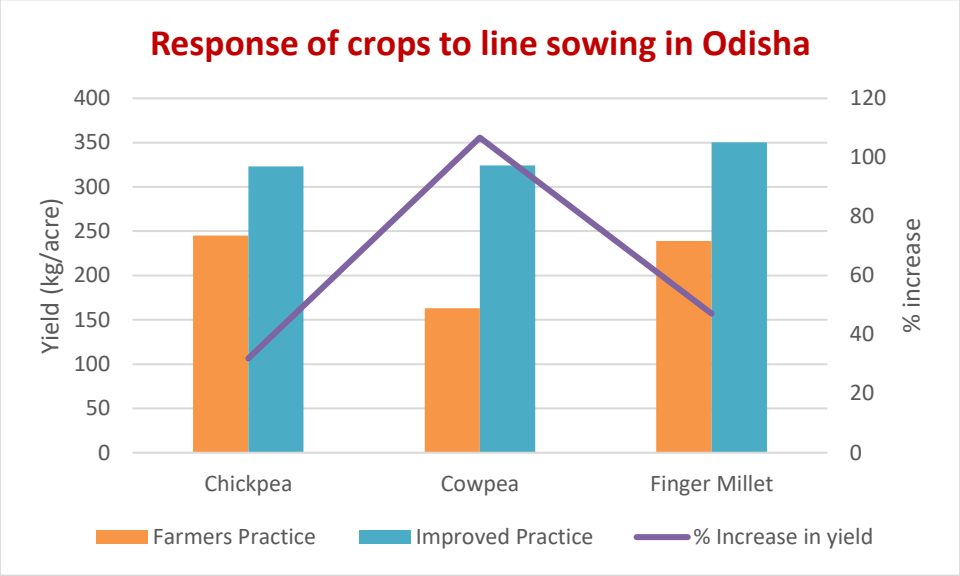

Figure 8. Response of crops to line sowing

5. Demonstration of Improved Practices during Kharif 2019

The district wise details of demonstration planned to be conducted during kharif, 2019 is furnished in Table 4. A total of 1800 demonstration covering an area of 890 acres on paddy, finger millet, pigeonpea and groundnut is envisaged to be conducted across 30 districts in the state of Odisha. Various technologies that are intended to be demonstrated during the period are climate smart cultivars recommended for location specific conditions, management of micro-nutrient deficiencies viz. zinc and boron, application of humic acid and integrated pest management.

Table 4. District-wise action plan for interventions during Kharif, 2019

District	Crop	Technology	Area (acres)	Demonstrations (No.)
Angul	Groundnut	Improved Cultivar	10	20
		Zn + B	7.5	15
	Pigeonpea	Improved Cultivar	7.5	15
		Zn + B	5	10
Balangir	Paddy	Improved Cultivar	10	20
		Zn + B + Humic Acid	20	40
Balasore	Paddy	Improved Cultivar	15	30
		Zn + B + Humic Acid	15	30
Baragarh	Paddy	Improved Cultivar	15	30
		Zn + B	15	30
Bhadrak	Paddy	Improved Cultivar	10	20
		Zn + B	20	40

District	Crop	Technology	Area (acres)	Demonstrations (No.)
Boudh	Paddy	Improved Cultivar	7.5	15
		Zn + B + Humic Acid	15	30
	Pigeonpea	Improved Cultivar	7.5	15
Cuttack	Paddy	B + Humic Acid	15	30
		Improved Cultivar	15	30
Deogarh	Groundnut	B	5	10
		Improved Cultivar	12.5	25
	Pigeonpea	Improved Cultivar	12.5	25
Dhenkanal	Paddy	B + Humic Acid	15	30
		Improved Cultivar	15	30
Gajapathi	Finger millet	Improved Cultivar	5	10
		Zn + B	7.5	15
	Paddy	Improved Cultivar	10	20
		Zn + B	7.5	15
Ganjam	Paddy	Improved Cultivar	10	20
		Zn + B	20	40
Jagatsinghpur	Paddy	Improved Cultivar	10	20
		Zn + B + Humic Acid	20	40
Jajpur	Paddy	B	10	40
		Improved Cultivar	10	20
Jarsuguda	Paddy	Improved Cultivar	10	20
		Zn + B	20	40
Kalahandi	Paddy	Improved Cultivar	10	20
		Zn + B	20	40
Kandhamal	Paddy	B	30	60
Kendrapada	Paddy	Improved Cultivar	10	20
		Zn + B + Humic Acid	20	40
Keonjhar	Paddy	Improved Cultivar	7.5	15
		Zn + B	15	30
	Pigeonpea	Improved Cultivar	7.5	15
Khurda	Paddy	Improved Cultivar	10	20
		Zn + B + Humic Acid	20	40
Koraput	Finger millet	Improved Cultivar	5	10
		Zn + B + Humic Acid	5	10
	Paddy	Improved Cultivar	7.5	15
		Zn + B + Humic Acid	7.5	15
	Pigeonpea	Improved Cultivar	5	10
Malkangiri	Finger millet	Improved Cultivar	5	10
		Zn + B + Humic Acid	5	10
	Paddy	Improved Cultivar	10	20
		Zn + B + Humic Acid	10	20
Mayurbhanj	Paddy	Improved Cultivar	10	20
		Zn + B + Humic Acid	20	40
Nabrangpur	Paddy	Improved Cultivar	10	20
		Zn + B	10	20

District	Crop	Technology	Area (acres)	Demonstrations (No.)
	Pigeonpea	Improved Cultivar	5	10
		Zn + B	5	10
Naupada	Groundnut	Improved Cultivar	5	10
		Zn + B + Humic Acid	5	10
	Paddy	Improved Cultivar	10	20
		Zn + B + Humic Acid	10	20
Nayagarh	Paddy	B	30	60
Puri	Paddy	Improved Cultivar	10	20
		Zn + B	20	40
Rayagada	Paddy	Improved Cultivar	10	20
		Zn + B	20	40
Sambalpur	Paddy	Improved Cultivar	10	20
		Zn + B	20	40
Sonepur	Paddy	Improved Cultivar	10	20
		Zn + B + Humic Acid	20	40
Sundergarh	Paddy	Improved Cultivar	10	20
		Zn + B	15	30
	Pigeonpea	Improved Cultivar	5	10
Grand Total			**890**	**1800**

Figure 9. Installation of Pheromone traps at batemura block, Sambalpur; Yellow Sticky Trap to control socking pest in ground crop at Athamalik, Angul.

6. Capacity Building 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, 200 capacity building courses were conducted during April-September 2019 in all the 30 districts (Table 5) covering 4249 farmers (3189 men and 1371 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.

Figure 10. Capacity Building of Farmers in Mayurbhanj & Bhadrak

Table 5. Details of capacity building programmes organized for farmers

District	No. of programmes	Number of farmers		
		Male	Female	Total
Angul	3	51	12	63
Balangir	5	39	119	158
Balasore	6	189	45	234
Bargarh	5	57	4	61
Bhadrak	21	351	81	432
Cuttack	7	90	7	97
Deogarh	3	25	14	39
Dhenkanal	13	324	-	324
Gajapathi	3	55	12	67
Ganjam	6	97	41	138
Jagatsinghpur	12	179	0	179
Jajpur	14	272	15	287
Jharsuguda	7	140	50	190
Kalahandi	6	79	13	92
Kandhamal	5	105	152	257
Kendrapara	6	128	0	128
Khordha	6	124	52	176
Koraput	16	150	42	192
Malkangiri	6	114	10	124
Mayurbhanj	12	219	108	327
Nabarangpur	9	47	264	311
Nayagarh	6	68	8	76
Nuapada	9	60	179	239
Rayagada	3	29	47	76
Sambalpur	11	197	96	293
	200	**3189**	**1371**	**4249**

7. Capacity Building of DoA Officials

7.1 Capacity building of Master Trainers

The Capacity Building (CB) program is an integral component of the Odisha B.C project. Collaborative organizations such as DoA, State Agricultural Universities (SAUs), Krishi Vigyan Kendras (KVK), Civil Society organizations will be the other stakeholders in the area of capacity building. IDC of ICRISAT proposed to the DoA, Government of Odisha (GoO) that at least two officials from each district may be trained as Master Trainers (MT) for scaling up the Capacity Building program as envisaged in the Project Document to the level Assistant Agricultural Officer Officers (AAOs) and Village Level Workers (VLW) in each district in a time bound manner. Accordingly DoA was requested to nominate officials for this Master Trainer program. IDC appreciates the prompt action by DoA, Government of Odisha (GoO) and the first batch comprising of soil science officials participated from 8-10 July at ICRISAT center. The 2nd batch of officials from Odisha participated in the program from 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

Figure 11. Capacity building of Master Trainers at ICRISAT campus on 8-10 & 15-17 July

The program

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 list of participants is appended as **Annexure 1**.

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 session plan for the 2nd batch is appended.

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.

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. A blank questionnaire is appended.

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.

Documentation

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.

Performance evaluation

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 %

Way forward

This program is the precursor of the larger program which will cover all the 30 districts of Odisha and we believe it will cover about 3000 staff including VLWs. This will be the scaling up exercise as far as CB program is concerned in the project objectives. It is planned to have a workshop in the second half of August where the design and delivery mechanisms will be decided. The training team at each district will comprise of two participants who came to ICRISAT in July and the Scientific Officers (SO) of the district and/or the personnel from the NGO partner. The District Coordinator of each district will be the part of the team for handholding the exercise. This will be a big challenge for all the concerned to effectively conduct the programs for a long lasting impact in the area of capacity building as well as productivity enhancement initiative.

7.2 District-level capacity building of DoA officials

Consequent upon organizing Master Traininer's Training programmes during July, 2019 and as envisaged in the project document, IDC, ICRISAT has takenup 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. So far the capacity building have been organized in 19 districts covering about 1501 DoA staff (495 officials and 1006 VLWs) by the end of the September, 2019. The district wise participation of officials and the dates of the CB programmes is appended below.

Figure 12. District-level capacity building of DoA officials at Balasore, Balangir, Jajpur &

Table 6. District-level capacity building of DoA officials

S. No.	District	AAO	VAWs	Total	Date (AAO)	Date (VAW)
1	Sonepur	22	84	106	12.9.2019	12.9.2019
2	Boudh	9	46	55	18.9.2019	18.9.2019
3	Puri	39	58	97	11.09.2019	13.09.2019
4	Bhadrak	19	60	79	12.9.2019	12.9.2019
5	Jajpur	22	56	78	13.9.2019	13.9.2019
6	Gajapathi	18	18	36	17.9.2019	18.9.2019
7	Angul	23	50	73	25.9.2019	26.9.2019
8	Deogarh	9	37	46	13.9.2019	13.9.2019
9	Cuttack	50	50	100	24.9.2019	25.9.2019
10	Dehanknal	35	65	100	18.9.2019	19.9.2019

S. No.	District	AAO	VAWs	Total	Date (AAO)	Date (VAW)
11	Nabrangpur	21	73	94	23.9.2019	24 & 25.9.2019
12	Balasore	30	60	90	24.9.2019	25.9.2019
13	Mayurbhanj	50	51	101	26.9.2019	27.9.2019
14	Balangir	25	55	80	12.9.2019	13.9.2019
15	Nuapada	12	67	79	16 & 17.9.2019	16 & 17.9.2019
16	Kalahandi	22	40	62	20.9.2019	21.9.2019
17	Rayagada	28	51	79	17.9.2019	18.9.2019
18	Jagatsingpur	28	44	72	24.9.2019	25.9.2019
19	Kendrapara	33	41	74	26.9.2019	27.9.2019
	Total	**495**	**1006**	**1501**		

7.3 Publications

Soil health atlas describing detailed methodology, soil analysis results, and GIS interpolation into soil health maps is under publication.

8. Upgradation of Referral Laboratories

In commensurate with the project document IDC, ICRISAT has committed establishment of two referral laboratories at Bhuhaneswar and Sambalpur with the state-of-the-art facilities. In this regard, the renovation of buildings, furniture, airconditioning of the lab, electric fitting, water and drainage pipelines works have been completed. The imported equipment has been transported to the respective places and installation of the equipment is under progress.


Figure 13. Establishment of two referral laboratories at Bhuhaneswar and Sambalpur

9. Detailed Benchmarking of Project Sites

A benchmark socioeconomic survey was carried out in the cluster of villages under the project "Enhancing Agricultural Productivity and Rural Livelihoods through Scaling-up of Science-led Development in Odisha: Bhoochetana." The survey was conducted in all the 30 districts of Odisha in selected blocks and villages within. The survey was conducted using a structured questionnaire developed by ICRISAT. The questionnaire has seven modules, and it covered household-level information on demographic details, literacy, household resource base, cropping pattern, utilization, and consumption of staples. The data collected pertains to the crop year 2017-18, i.e., the year before the start of the collaboration with ICRISAT.

The framework for the identification of blocks and villages for conducting a baseline survey is followed from the soil sample collection strategy adopted by the ICRISAT for assessing the nutrient status. The different strata identified for the soil sampling are; Topo-Sequence, Soil

Types, Cropping Pattern, and Farmer Type. Table 7 gives the sampling framework for the baseline survey.

Table 7. Sampling framework for the baseline survey

S.No	District	Blocks	No of Villages	Number of Villages Selected for soil sampling	Number of Villages selected for Primary Survey	Number of HH selected for Primary Survey
1	Cuttack	14	1950	182	18	180
2	Dhenkanal	8	1215	104	10	100
3	Khurda	10	1551	130	13	130
4	Puri	11	1715	143	14	140
5	Bhadrak	7	1311	91	9	90
6	Jajpur	10	1778	130	13	130
7	Balasore	12	2952	156	15	150
8	Mayurbhanj	26	3950	338	33	330
9	Jagatsingpur	8	1288	104	10	100
10	Kendrapara	9	1540	117	11	110
11	Bargarh	12	1207	156	15	150
12	Jharsuguda	5	348	65	6	60
13	Sambalpur	9	1322	117	11	110
14	Sonepur	6	959	78	7	70
15	Koraput	14	2028	182	18	180
16	Malkangiri	7	1045	91	9	90
17	Kalahandi	13	2236	169	16	160
18	Nawarangpur	10	901	130	13	130
19	Rayagada	11	2667	143	14	140
20	Angul	8	1910	104	10	100
21	Deogarh	3	875	39	4	40
22	Boudh	3	1186	39	4	40
23	Nayagarh	8	1695	104	10	100
24	Kandhamal	12	2546	156	15	150
25	Keonjhar	13	2122	169	16	160
26	Sundargarh	17	1764	221	22	220
27	Gajapati	7	1619	91	9	90
28	Ganjam	22	3212	286	28	280
29	Nawapara	5	663	65	6	60
30	Balangir	14	1794	182	18	180
Total	30	314	51349	4082	397	3970

The state of Odisha is having 51349 villages spread across 314 blocks and 30 districts. All the 314 blocks from the state are selected for the study and the number of sampled villages selected for the soil sampling (4082) forms the base for the selection of villages for the household survey. All the soil sampled villages from each block were listed and first, and 10 percent of the villages were randomly selected. From each selected village 10 farmers were selected for whom the soil samples were collected from their fields. The sample for the survey constitutes 30 districts, 314 blocks, 397 villages, and 3970 households.

9.1. Methods

All the resulted are tabulated and presented in either in absolute numbers or in percentages. The methods for developing the indicators were obtained from Rana and Rana (2011)[1]

a) Multiple Cropping Index or Multiple Cropping Intensity (MCI)

It was proposed by Dalrymple (1971). It is the ratio of the total area cropped in a year to the land area available for cultivation and expressed in percentage (sum of area planted to different crops and harvested in a single year divided by total cultivated area times 100).

$$MCI = \frac{\sum_{i=1}^{n} a_i}{A} * 100$$

Where, n is total number of crops, a_i is area occupied by ith crop and A is total land area available for cultivation.

It is similar to cropping intensity.

$$MCI = \frac{a_1 + a_2 + \cdots + a_n}{A} * 100$$

Where $a_1 + a_2 + \ldots + a_n$ is the gross cropped area and A the net cultivated area.

b) Control Charts

The control chart is a graph used to study how a process changes over time. Data are plotted in time order or by process/units. A control chart always has a central line for the average, an upper line for the upper control limit, and a lower line for the lower control limit. These lines are determined from historical data. The Top Advantages of Statistical Process Control: helps reduce the margin of error. Because control charts reveal what's going on in a process in real-time, they allow the researcher to detect and correct issues before they cause deeper problems in processes and products.

The average in a control chart can be a system generated or can be inputed by a researcher by obtained best management practices. The study considers state and national averages reference points for intra and inter comparison between state and national statistics.

[1] Rana S S and M C Rana. 2011. Cropping System. Department of Agronomy, College of Agriculture, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, 80 pages.

9.2. Results and Discussion

9.2.1. Land use pattern

The study of land use is important not only in agriculturally dominated, overpopulated developing regions because of its relationship with different human phenomena. It's important also increased during the population pressure and decreasing man and land ratio, increasing demand for food and raw materials they need for optimum utilization of land in an integrated manner has assumed greater relevance.

Some land is for a specific use depending mostly on the physical characteristics of the land to its suitability for a particular use is related. Five major categories of land use are noted in the season and crop report for Odisha state which are:

1. Area under forest
2. Land not available for cultivation including
    i) Barren and uncultivated land
    ii) Land put to non-agricultural uses
3. Other pastures and grazing land including
    i) Cultivable waste land
    ii) Permanent pasture and grazing land
    iii) Land under miscellaneous tree crops and groves.
4. Fallow lands including
    i) Current fallow
    ii) Other fallow
5. Cropped area including
    i) Net sown area (NSA)
    ii) Area sown more than once
    iii) Gross cropped area (GCA)

The general land use pattern of Odisha state is discussed here and statistics for the years 2016 to 2017 have been abstracted from the Statistical Abstracts prepared by the Directorate of Economics and Statistics. The total geographical area of the state is 155.71 lakh ha and reporting area under total LUS in the year 2016-17 was 115.35 lakh hectares. 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 (Figure 14).

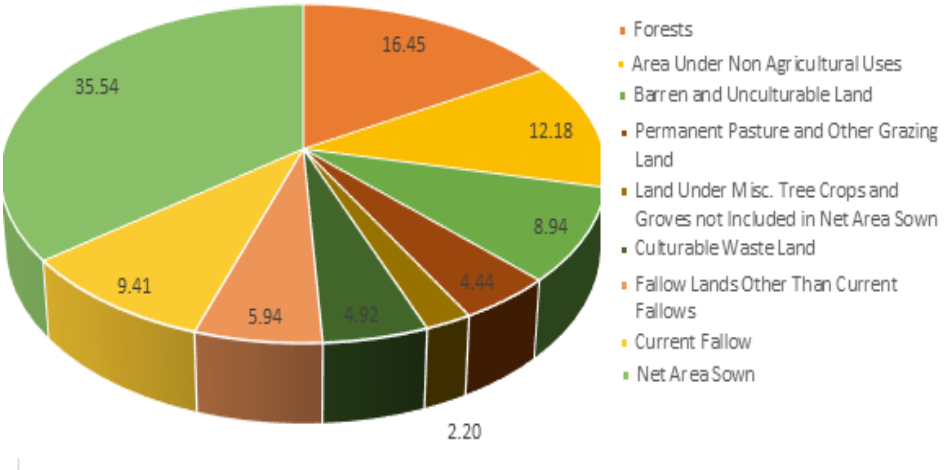

Figure 14. Land-use utilization pattern of Odisha – 2016-17

The comparative analysis of land utilization patterns among districts is presented in Figure 15. The values (percentages) represents a share in the districts' geographical area (Appendix 1). The distributional pattern of forest shows that the area under forest is lowest in Bhadrak (0.42% of district geographical area) and highest in Deogarh (40.88%). The 36% of the districts (Bhadrak, Jagatsinghapur, Baleshwar, Balangir, Puri, Kendrapara, Bargarh, Cuttack, Sonepur, Ganjam, Jajpur) have forest area less than 10% and 33% of districts have forest area up to 20% of their geographical area and remaining districts above 20% of their geographical area.

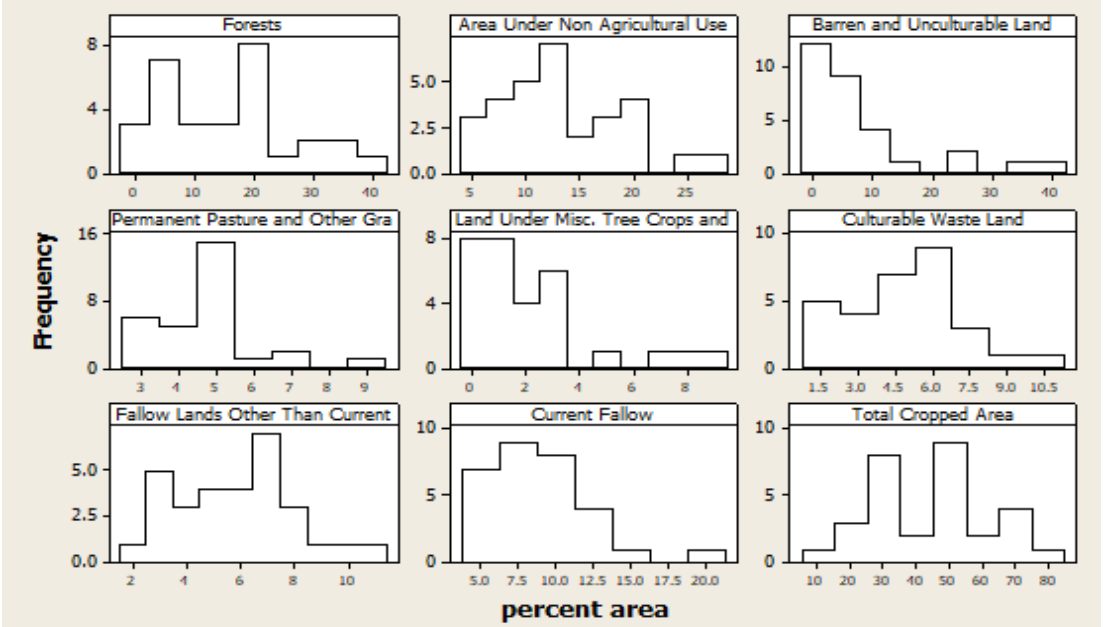

Figure 15. Distribution of land-use utilization pattern by districts of Odisha

The current fallows in the state are nearly 10% and thirty percent of the districts (Ganjam, Kalahandi, Jharsuguda, Puri, Kendujhar, Nuapada, Anugul, Dhenkanal and Balangir) have current fallows more than 10% of their respective geographical area. Farmers leave land fallow because of several other reasons including lack of resources, poor irrigation facilities, extreme weather conditions, and soil erosion. The culturable wasteland is highest in Dhenkanal (11.1%) and remaining districts have culturalble wasteland less than 10% and the permanent pasture and other grazing land is highest in Boudh (9.4%). The total cropped area is highest in Sonepur district (80%) and 63% of the districts in the state have a total cropped area less than 50%.

9.2.2. Profile of Households

Age of the Respondent

As far as the demographic profile is concerned, the majority of funded farms are located in the younger and mature phases of the life cycle (Figure 16). The respondent's age ranges between 20 and 80 are over-represented in this survey sample, and the average age of the respondents is around 46 years. The inter-quartile range of data-set shows that the age of the respondents is between 39 and 54 years indicating that 50% of farmers (respondents) of Odisha are middle-aged.

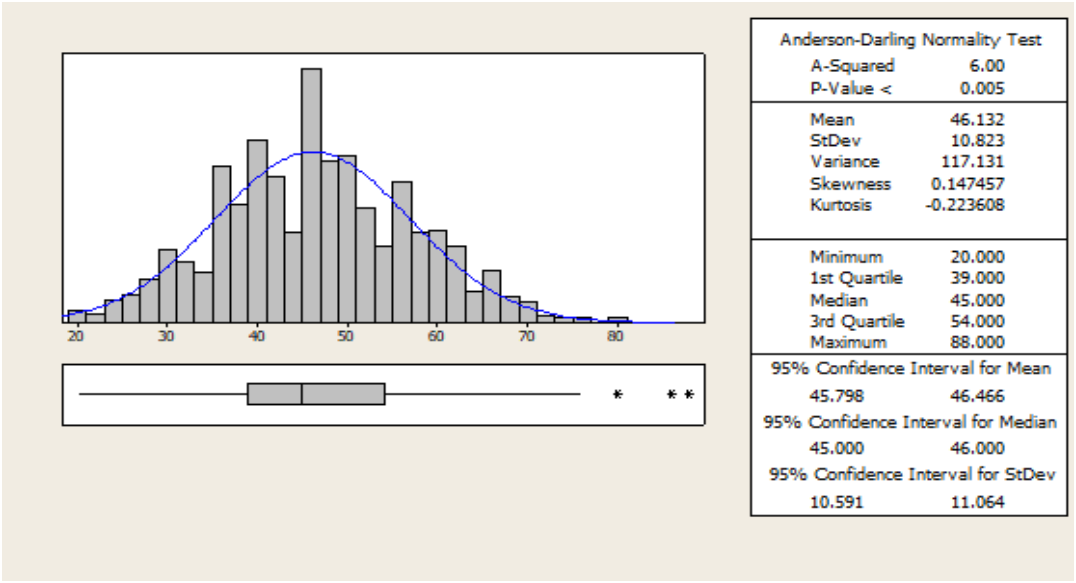

Figure 16. Distribution of respondent's age

The average age of the respondents by districts is presented in Figure 17, and it shows that the age of the respondents ranges between 40-50 years across the districts.

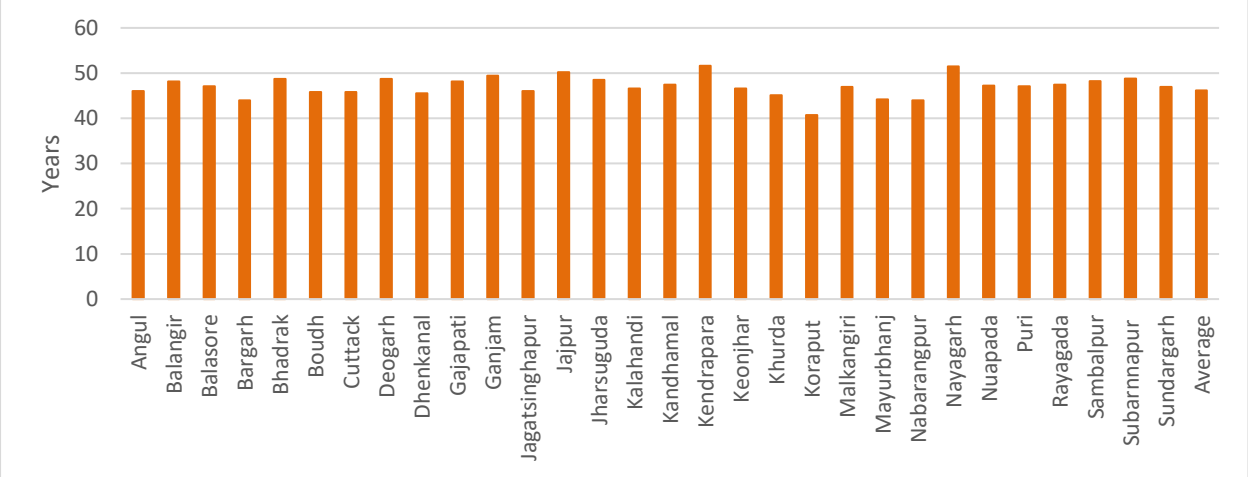

Figure 17. Average age of the respondents by districts

Education

The data reveals that 7.4 percent of respondents in the study are illiterates (Figure 18) and 37.3 percent of respondents (**Annexure 2**) are literates who have a formal education (lower education). 9.4 percent of respondents were completed their upper primary, 35.5% High primary and remaining 10.4 percent have completed their education levels more than 10th.

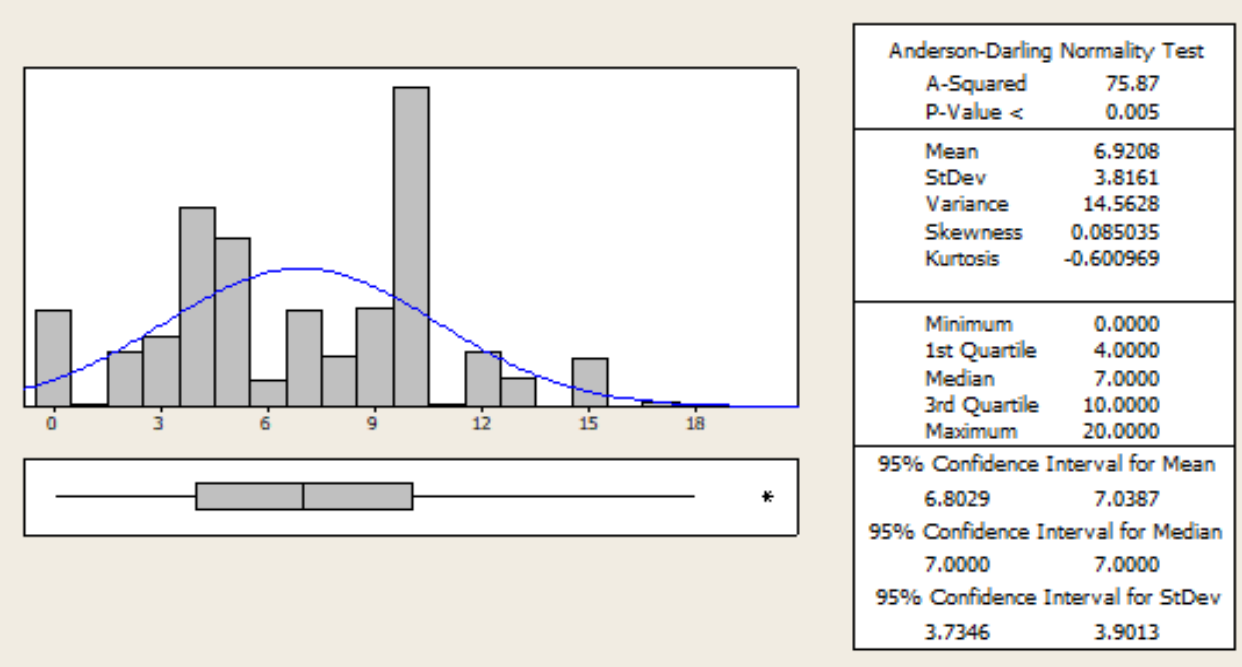

Figure 18. Distribution of respondents' education

Average levels of education by district were shown in Figure 19 and average levels of education of respondents in the districts range from 5-10 years. The 43% of the districts (Cuttack, Mayurbhanj, Jharsuguda, Deogarh, Nayagarh, Sambalpur, Khurda, Bargarh, Balasore, Jajpur, Dhenkanal, Kendrapara and Bhadrak) have farmers with high primary completed. The education pattern by district shows that the respondent farmers are fairly educated but there is way ahead in this digital era and government initiatives are need of the hour to improve the education levels among the farming community.

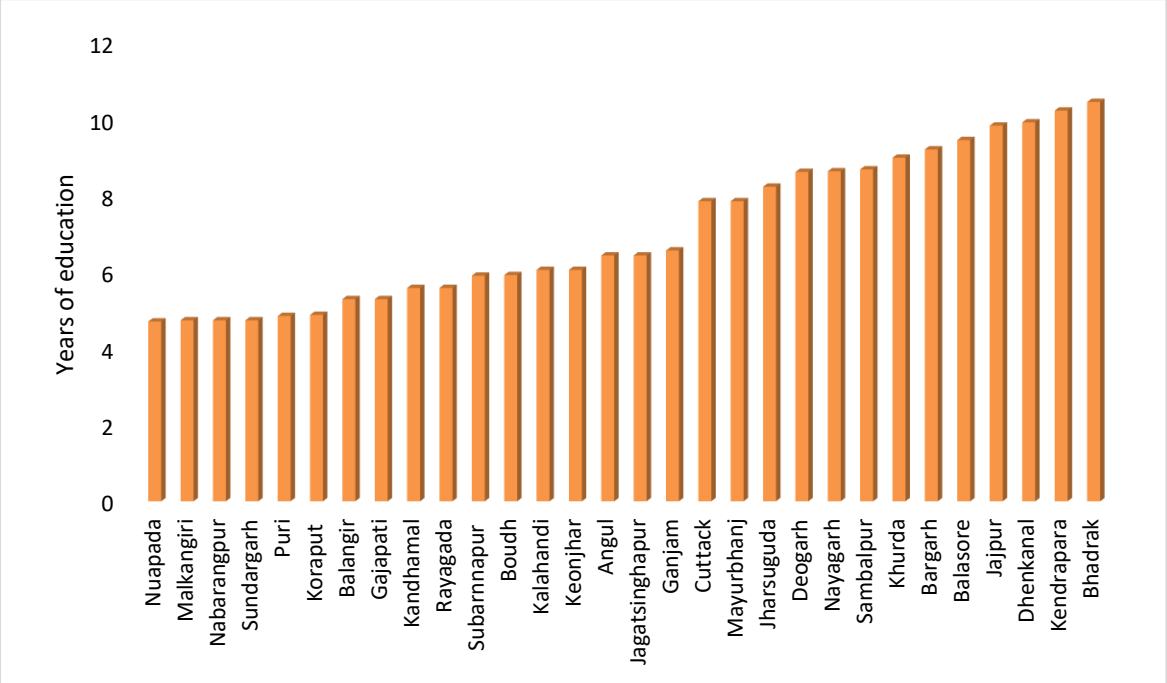

Figure 19. Average years of education of the respondents-by district

Family Composition

The household, defined as a group of persons who make common provision of food, shelter and other essentials for living, is a fundamental socioeconomic unit in human societies. Households are the centers of demographic, social and economic processes. Understanding the patterns of household size and composition can thus inform efforts towards the achievement for sustainable development. The study analyses the composition of the family and the composite distribution is presented in Figure 20. 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 presence of children in the household has major implications for a household's priorities, particularly with respect to the demand for food, allocation of resources, education and health care.

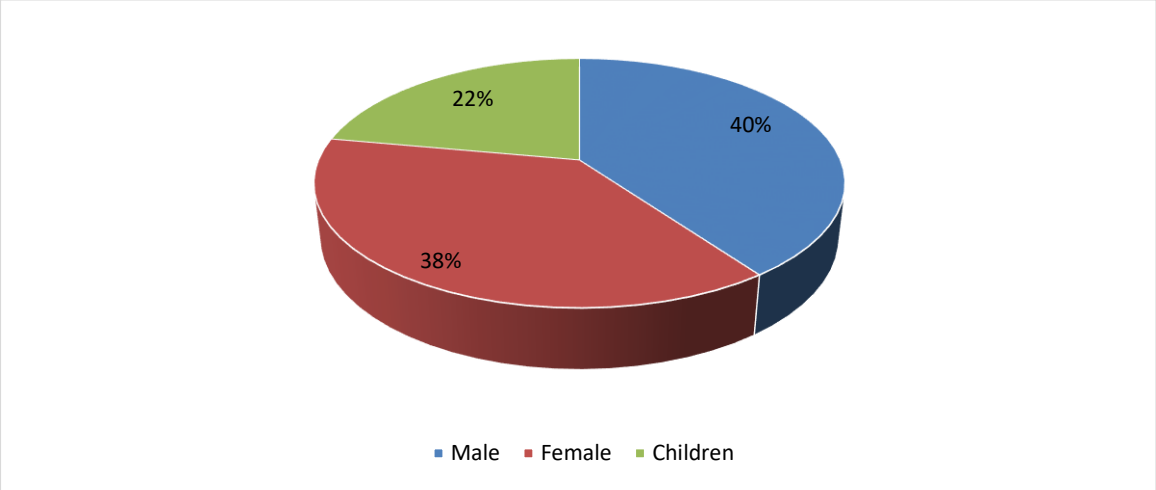

Figure 20. Family composition-state

The family composition by the district is presented in Figure 21. In districts like Cuttack and Koraput a substantial majority of households (40%) have children of less than 15 years of age. By contrast, in Jajpur and Nabrangapur have less number of children per household.

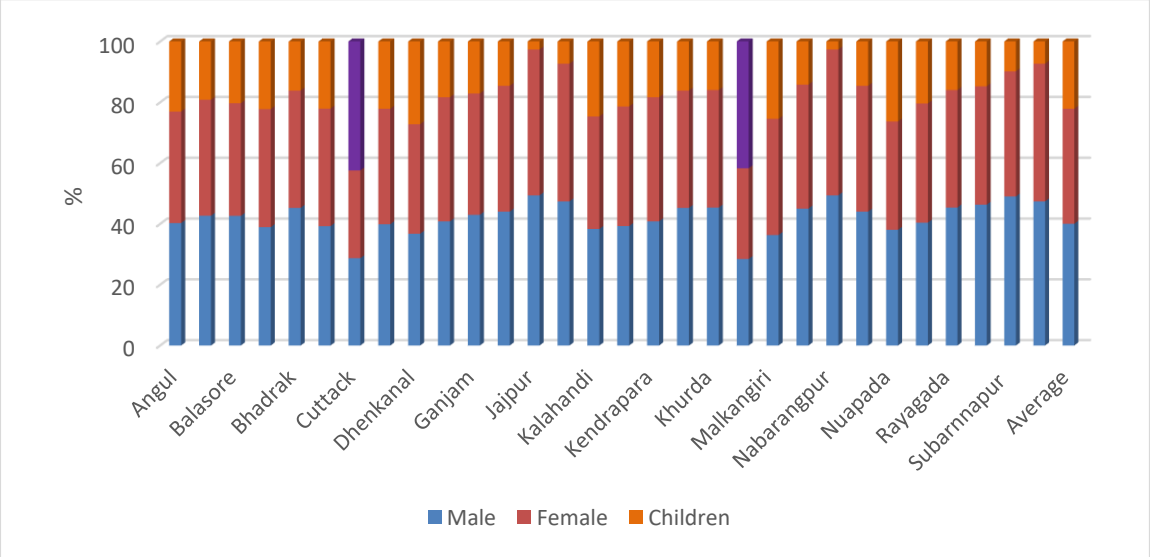

Figure 21. Family composition by district

Household workforce- Worker Population Ratio (WPR)

Rural households understood as a household that combines family, farm, and commercial activity, and on-family farms labor division has generally been based on complementarity between persons of different gender and generations, resulting in specific male and female spheres and tasks. As per the Government of Odisha's Economic Survey 2017-18, 48.8% of workers (aged 15 and above as per Usual Principal and Subsidiary Status (UPSS) are engaged in agriculture and allied activities. This sector is a major source of employment, especially in rural areas; 56% of the total rural workers are employed in the agriculture sector. The results of the primary survey on worker population ratio are presented in Figure 22, and it displays the proportion of labour force in the total population obtained from the sample survey. The Worker Population Ratio (WPR) signifies the proportion of workers/ employed persons in the total population for a specific age group. It was estimated at 50 percent for Odisha, which means 50 percent of persons aged 15 years and above were employed in the State (Figure 22) and 60 percent of the workforce was constituted by the male population.

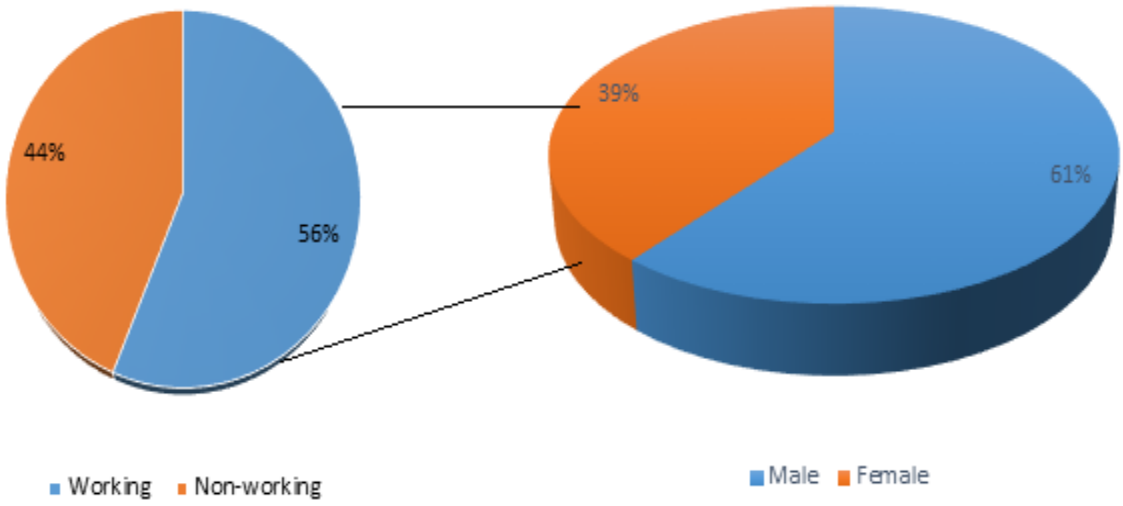

Figure 22. Workforce by gender

There can be great diversity in the family workforce and uniform categorization will not yield a unique definition of family farming. Nevertheless, a concept of family farming exists and its important role in rural development and in the agricultural sector has been and continues to be recognized across all regions in the country. In the next part, a gender-wise split of workforce across the districts was presented (Figure 23). The district Puri has shown highest number of male workforce and no gender disparity is observed in Jharsiguda.

Figure 23. District wise workforce by gender

Occupational pattern

According to Fuller (1991), "full-time farming is the aberration and in modern farming history multiple jobs holding among farm households are the norm". In the agrarian context, the days' time is mainly divided between a combination of agricultural activity (farm and off-farm) with other forms of gainful employment. The primary occupation of the majority of respondents is agriculture and in 63 percent of districts (Figure 24) the respondents reported that their secondary occupation is farm-labor. Only Kendrapada has shown a significant pluri-activity and to some extent the Naupada.Pluri-activity entails allocation of an individual's time in multiple activities; here activities with economic benefits are preferred so as to maximize the returns.

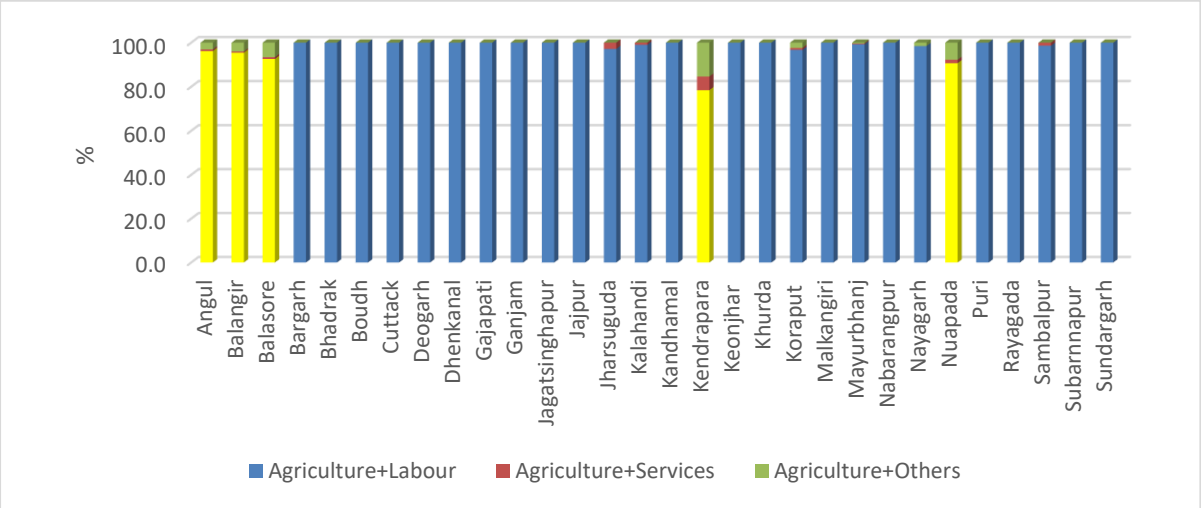

Figure 24. Occupational pattern of respondents-by district

9.2.3. Agriculture

Agriculture is the mainstay of Odisha's economy providing employment and sustenance directly or indirectly to more than 50 percent of the state's total workforce. According to Odisha's Economic Survey Report 2017-18, the state has a cultivated area of 61.80 lakh hectares, and agriculture accounted for 60 percent of Agricultural GVA in 2017-18 and 2018-19. Rice is the lead crop in the state, with almost half the share of gross cropped area.

Pulses are the second-largest crop group in the State. Mango, banana, and guava are the major fruit crops grown in the state; among vegetables, brinjal is the leading crop with a gross cropped area of 117'000 ha. Yield in rice has been low (1.74 qt/ha) in Odisha compared to national average (2.78 qt/ha) due to high dependence on rainwater for irrigation. As the objective of the project is the assessment of nutritional status of the soils in the state and improve the productivity of major crops, the study is confined to these parameters, and the baseline results are presented in below sub-chapters.

Land Ownership

The pattern of 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 (Figure 25)

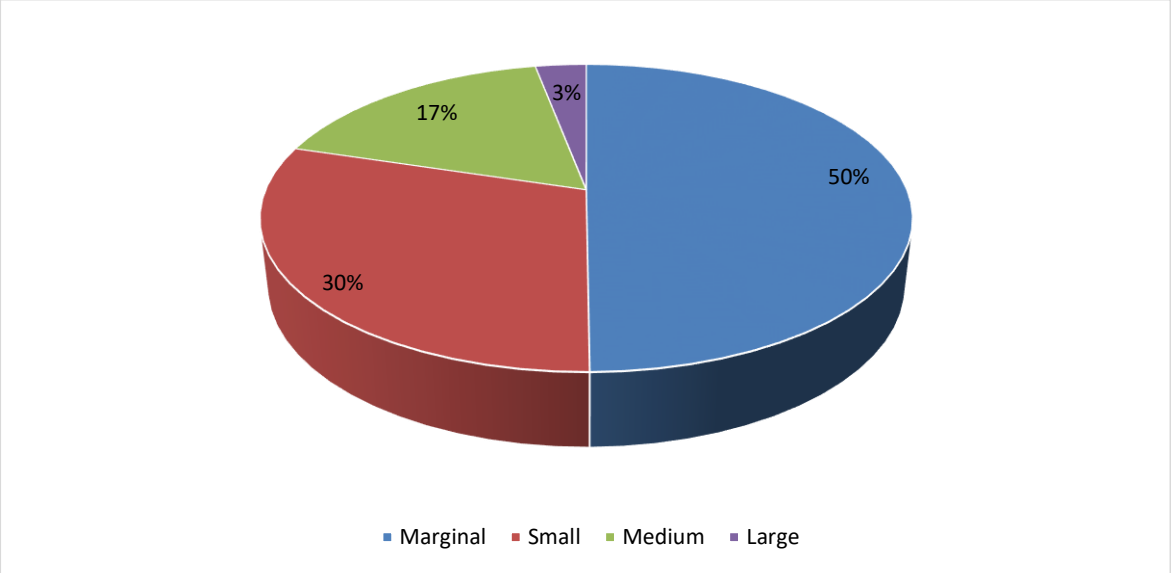

Figure 25. Farmers' classification by type

District wise distributional pattern of farmers by size of holding is presented in Figure (26). The figure shows that the distribution pattern of farmers' types is more or less same across the districts except in Rayagada (93%) and Malkangiri (91%) districts where the percentage of marginal farmers is more than 90 percent. However the share of marginal farmers is lowest in Sambalpur (9%) and Gajapati (12%). The highest number of large farmers are observed in Bargarh (27%) and medium farmers are in Sambalpur (46%).

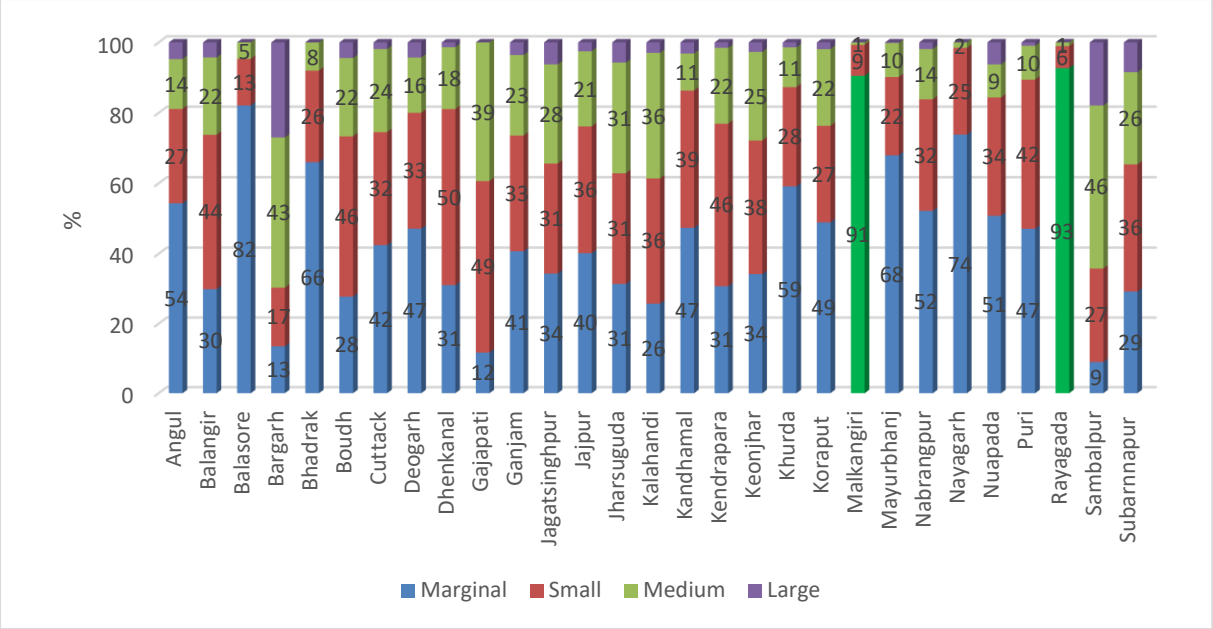

Figure 26. Farmers' classification across the districts by type

Cropping pattern

Cropping pattern indicates the proportion of area under various crops at a point of time whereas the crop combination indicates to grow different types of crops under the same agriculture field. Cropping pattern and combination are also part of the behavioral approach in geography because it reflects the performance of the farmer for various crops sown in an agricultural field. The share of area under two prominent seasons of Odisha is presented in Figure 27, and it 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.

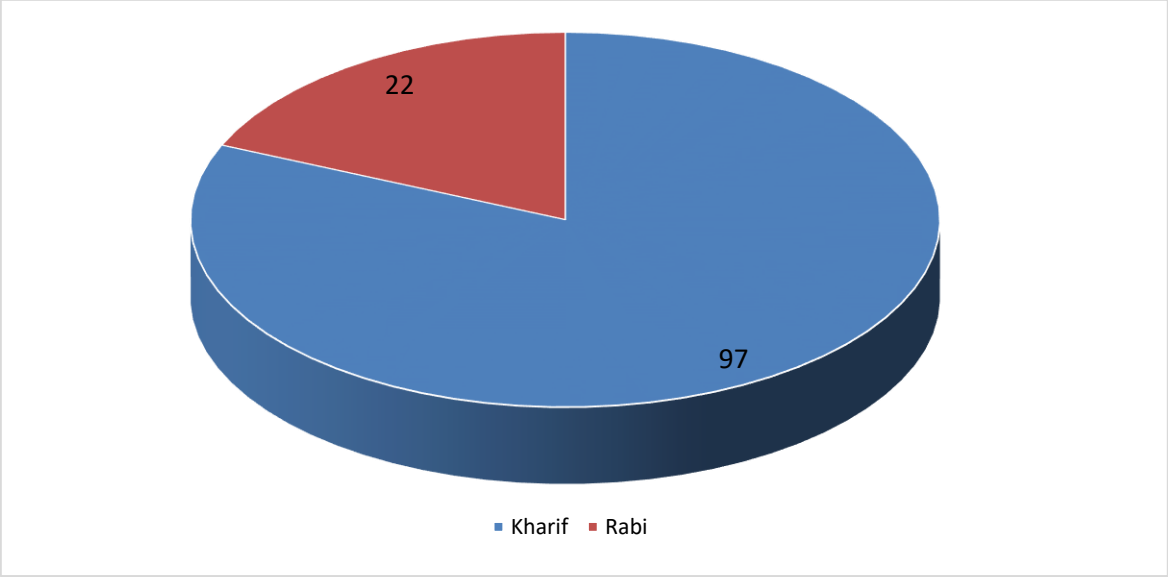

Figure 27. Season wise share of cropped area

District wise share of the cropped area by season is presented in Figure 28 and it is evident that the share of kharif area to total available crop area of a farmer is 100 percent, which

means all the cultivable land of a farmer is brought into cultivation during the study year except in the Malkangiri district. This can be probably due to a lack of rainfall during the season in the district. However, the pattern reverses in rabi season where the Malkangiri has shown show highest area (96%). The cropped area in rabi season is nearly 20% in majority of districts indicating the need a policy on kharif fallows.

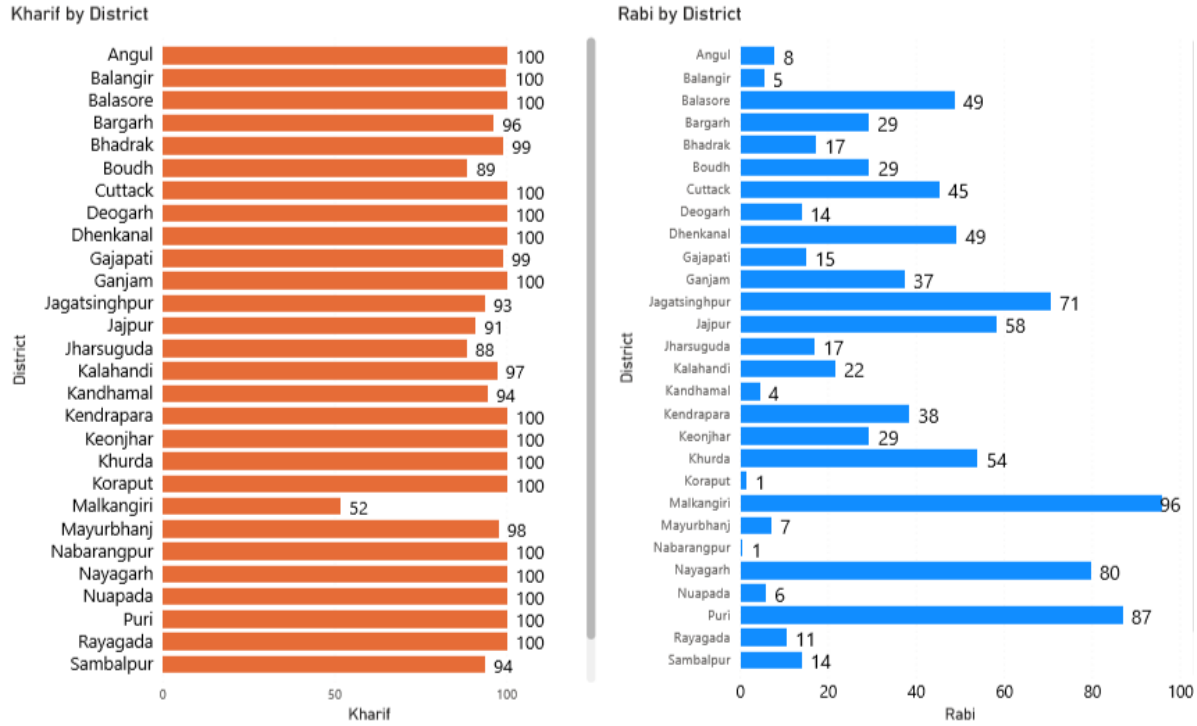

Figure 28. District and season wise share of cropped area

Crops by season

Odisha is primarily a food grain-growing state, and 88 percent of the area in kharif is occupied by food grain crops (Figure 29). Oilseeds and pulses are mainly grown in the rabi season (Figure 30). Kharif is a very important cropping season during June to October. It occupies more than rabi cropped area. 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

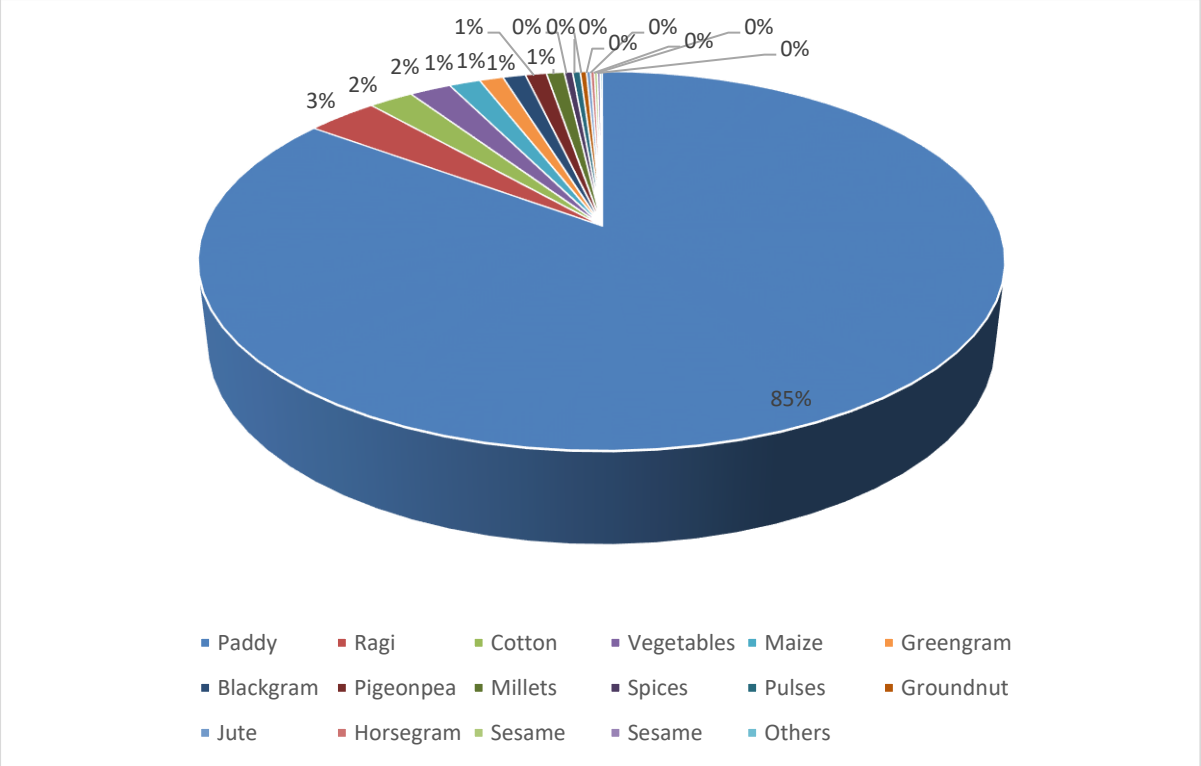

Figure 29. Kharif season crops

The Rabi crops are cultivated with the advent of the winter season, generally from the end of October to beginning of November. The main Rabi crops are paddy, greengram, blackgram, chickpea, and commercial crops like groundnut also grown this season.

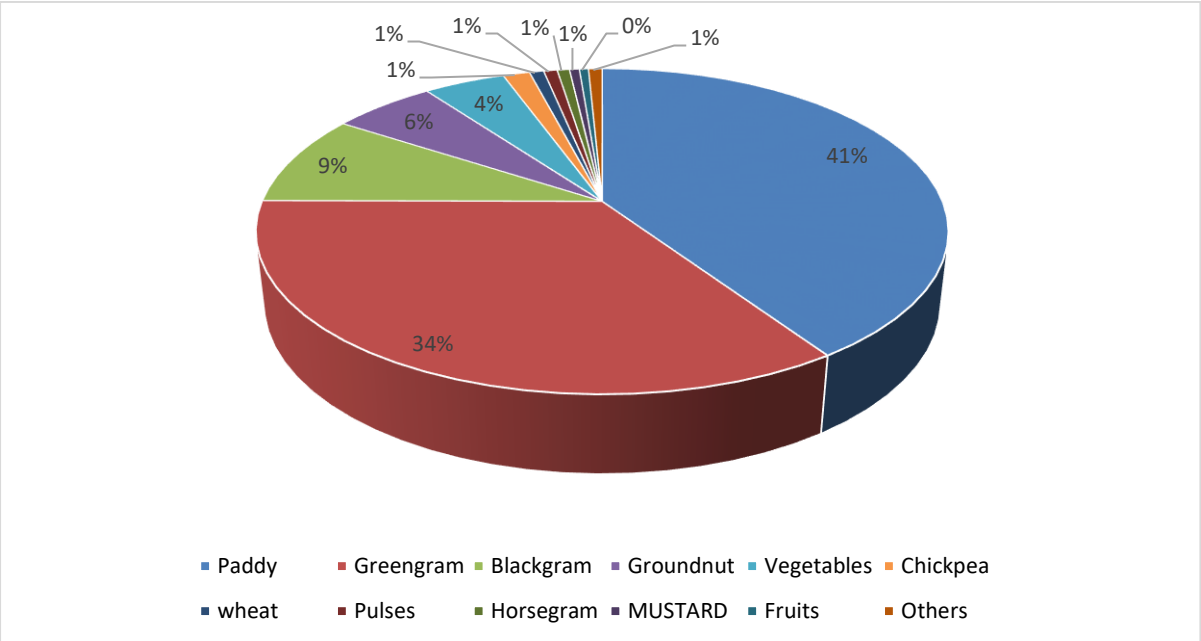

Figure 30. Rabi season crops

Cropping Intensity

There are only two ways to satisfy the increasing food and other demands of the country's rising population—either expanding the net area under cultivation or intensifying cropping over the existing area. Thus, higher cropping intensity means that a higher proportion of the net sown area is being cropped more than once during one agricultural year. This also implies higher productivity per unit of arable land during one agricultural year.

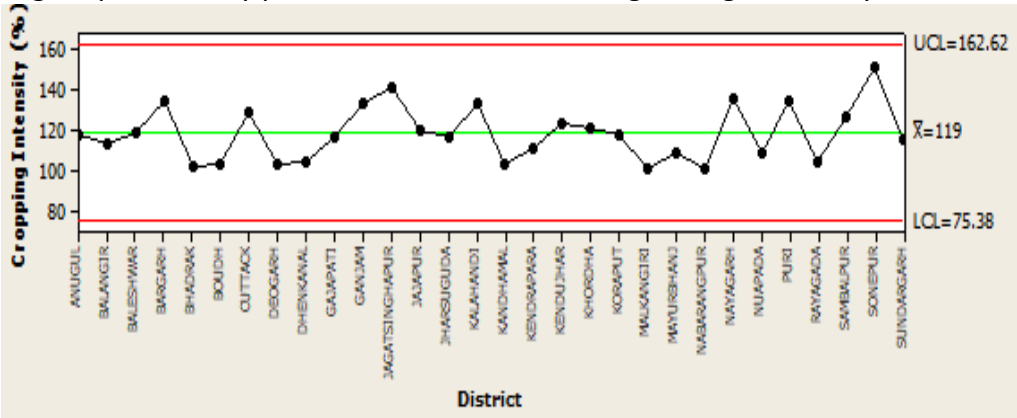

Figure 31. Cropping intensity by district (values in %)

Figure 31 shows that the average cropping intensity of state (sample respondents) is 119 percent, and around seven districts have a cropping intensity of around 100 percent indication the dependency of farmers on rainfall and scope for bringing more land under cultivation either in kharif season or rabi.

Productivity

Crop productivity is the quantitative measure of crop yield in a given measured area of field. The use of new crop varieties and the efficient application of agrochemicals immensely contributed to increased plant productivity. Following sub-sections provides an insight into the productivity of major crops grown in the state.

Paddy

The Figure 32 provides a comparative analysis of district wise productivity of paddy with state and nations average. A comparision with nation's productivity shows that, except two districts (Cuttack and Angul), 93 percent of the districts fall below the national average. This indicates the need and scope for improvement. The list districts as per the serial number is provided in **Annexure 3.**

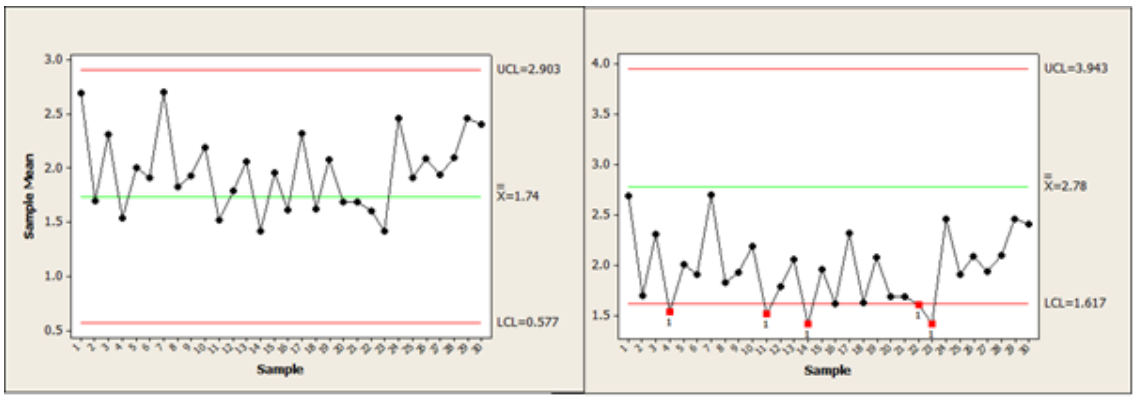

Figure 32. Average productivity of paddy by district (tonnes/ha)

Maize

The sample survey shows that maize is predominantly grown in 17 districts in the state (**Annexure 4**). The average productivity of maize at state and national levels is 2.51 and 2.56 tonnes/ha. However, Figure 33 shows that except two districts (Jharsuguda and Nabarangapur) average productivity of remaining districts is lower than the state and nation's estimates.

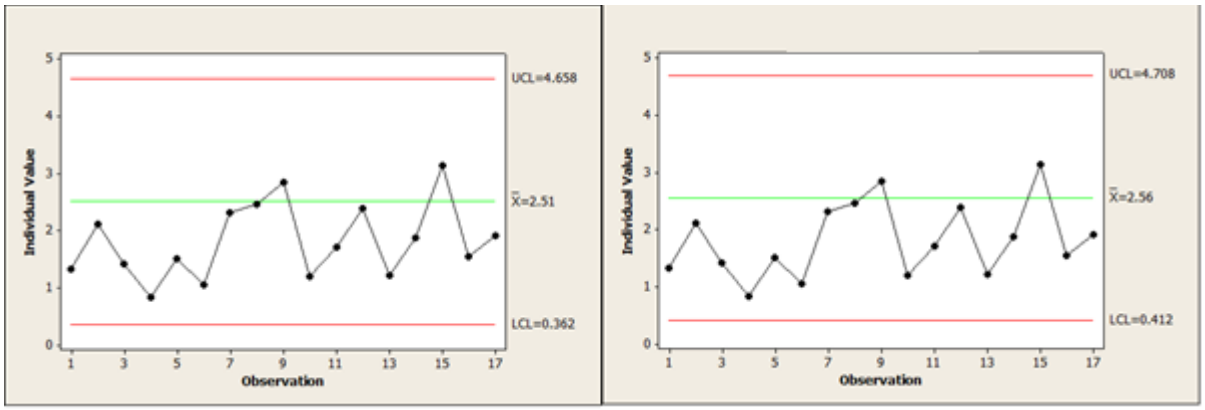

Figure 33. Average productivity of maize by district (tonnes/ha)

Finger Millet

The sample survey shows that finger millet is predominantly grown in 5 districts in the state (Koraput, Rayagada, Malkangiri, Kalahandi, and Gajapati). The average productivity of maize at state and national levels is 0.77 and 1.7 tonnes/ha. However, Figure 34 shows that except in two districts (Gajapati and Koraput) average productivity of remaining districts is lower than the state and nation's estimates. List of districts is provided in **Annexure 5.**

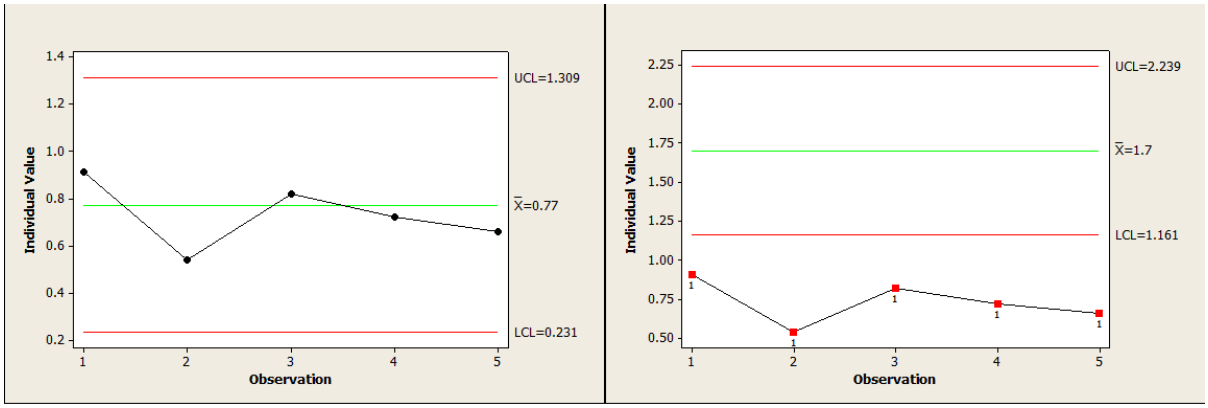

Figure 34. Average productivity of Finger Millet in 5 district (tonnes/ha)

Greengram

Greengram is the second most important crop next to paddy is grown across all the districts in the state. The average productivity of greengram at the state and national level is 0.39 and 0.46 tonnes/ha. However the Figure 35 shows that except in 7 districts (**Annexure 6**) average productivity of remaining districts is higher than the state average. A comparison with nation's estimates shows that only 33% of the districts are above the nation's average.

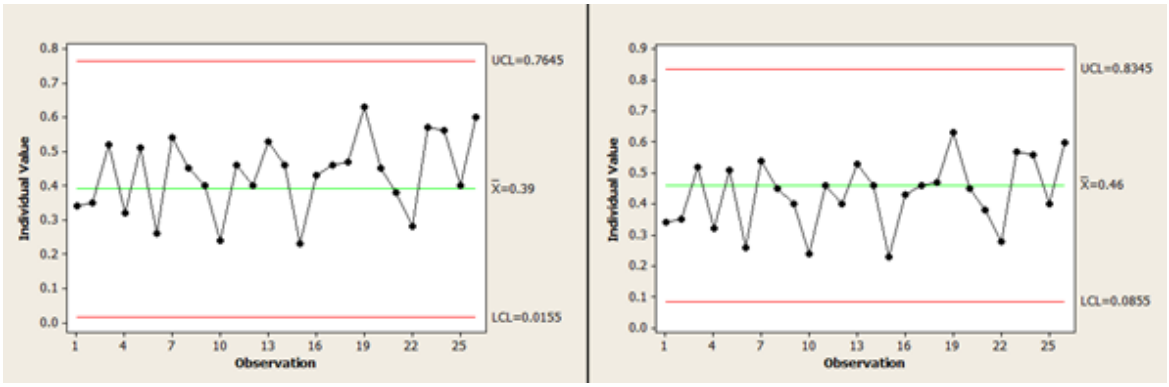

Figure 35. Average productivity of greengram (tonnes/ha)

Blackgram

Blackgram is an important pulse crop next to greengram and grown across all the districts in the state. The average productivity of blackgram at state and national level is 0.37and 0.57 tonnes/ha. However the Figure 36 shows that except in 12 districts (**Annexure 7**) average productivity of remaining districts is higher than the state average. A comparison with nation's estimates shows that except (Jharsiguda and Sambalpur) the productivity below the nation's average.

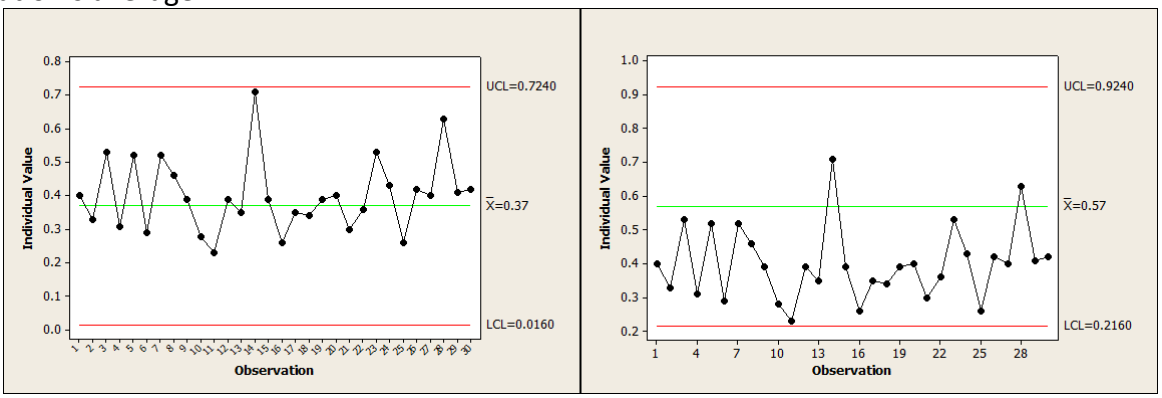

Figure 36. Average productivity of blackgram by district (tonnes/ha)

Horsegram

Horsegram is majorly grown in Sundargarh and have its presence 7 districst of the state (**Annexure 8**). The average productivity of horsegramat state and national level is 0.41and 0.48 tonnes/ha. The Figure 37 shows that except 2 districts (Kalhandi and Balangir) the productivity levels are on par with state average. The average productivity of Nabarangpur district is higher than the national average.

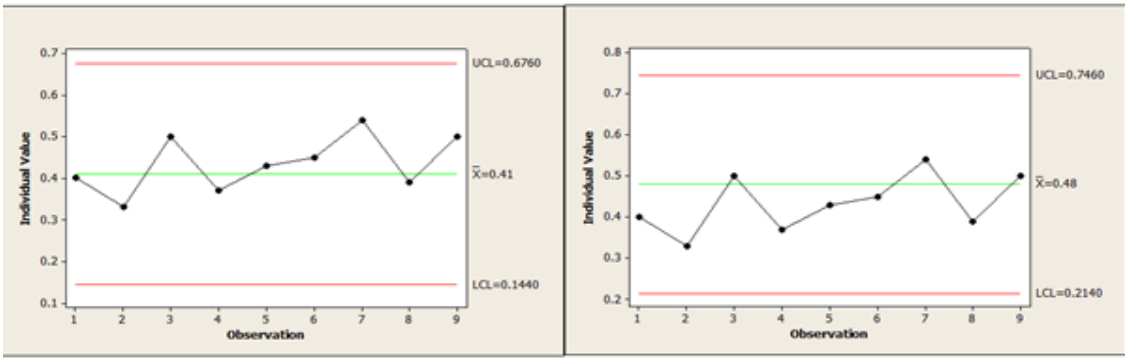

Figure 37. Average productivity of blackgram by district (tonnes/ha)

Groundnut

Groundnut is the major oilseed crop grown in 11 out 30 districts in the state (Annexure 9). The average productivity of the crop at state and national level is and 1.13 and 1.71 tonnes/ha. The Figure 38 shows that the farmers of Malkangiri has reaped highest productivity per hectare (3.04 tonnes/ha) during the study period reason for 3 standasrd deviation from the mean. However excluding the Malkangiri, the productivity levels of remaining districts lesser than the nation's average.

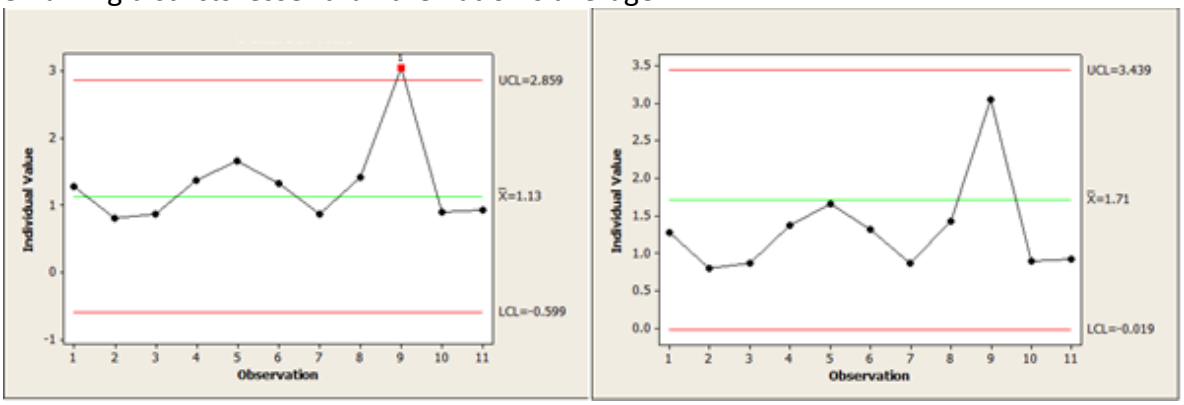

Figure 38. Average productivity of groundnut by district (tonnes/ha)

Sesame

Sesame is the majorly grown in three districts (Angul, Malkangiri and Rayagada) and the average of sample survey is much lesser than state and national estimates (Figure 39)

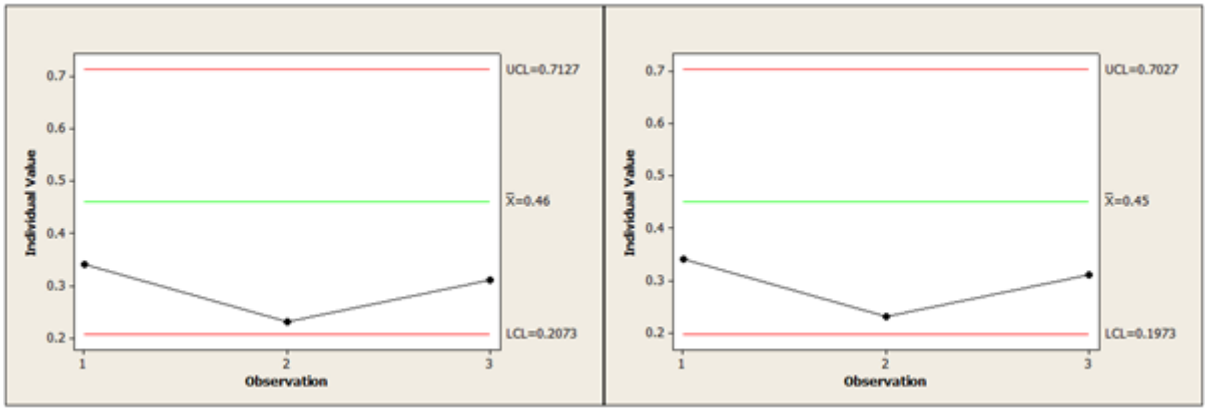

Figure 39. Average productivity of sesame by district (tonnes/ha)

Seed Replacement Rate

Seed systems are the vehicle through which farmers get a high-quality seed of the new crop varieties they want and need. Effective seed systems have the potential to increase production quickly and economically. They give farmers access to good-quality seed and knowledge of improved practices, and their harvests can rise dramatically.

Informal seed systems models are not delivering with the efficiency and effectiveness needed. For example, farmers often rely on seed distribution from their fellow farmers, which is just too slow for new varieties to have a major impact. In parallel, formal seed systems tend to focus on a few profitable seed crops such as maize and vegetable seed, leaving less profitable crops by the wayside.

From Figure 40 it was evident that the Seed Replacement Rate (SRR) of paddy in case of Odisha is very low (18%), and farmers are using old seed year by year. The majority (74%) of farmers have replaced their seed within three years and 18 percent of farmers reported that they never replaced their seed. This may result in gradual decrease in yield and eventually income per unit of land.

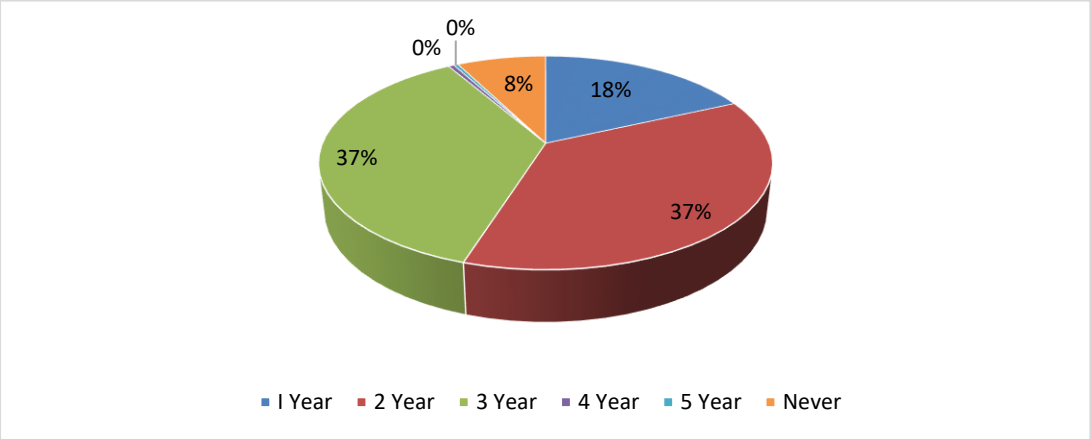

Figure 40. Seed replacement rate of paddy

The SRR for other crops like ragi and pulses (Greengram, Blackgram) is very minimal but hybrids like cotton and maize have 100 percent SRR.

Soil Nutrient Status

Odisha Bhoochetana project aims at improving and sustaining crop productivity and rural livelihoods through science-based natural resource management (soil management in particular) in the state of Odisha. This will provide a sound base for precise fertilizer management not only for NPK but also deficient secondary and micro-nutrients. Declining soil health is often cited as one of the reasons for stagnating or declining yields. The limiting nutrients do not allow the full expression of other nutrients, lower the fertilizer response and crop productivity. The constraints of emerging S, Zn, Mn and B deficiencies in specific cropping systems/ regions also need to be alleviated to enhance soil-crop productivity.

Preliminary soil analysis results for pilot sites have shown multi-nutrient deficiencies of secondary and micro-nutrients like sulphur (S), boron (B) and zinc (Zn) along with nitrogen (N), phosphorus (P) and potassium (K). The imbalanced and sole use of high analysis NPK fertilizers coupled with declining use of organic manures in the past decades has resulted in soil fertility degradation through developing negative balances of secondary and micronutrients and low carbon (C) levels. The deficiencies will further aggravate when we attempt increasing crop productivity without resorting to proper soil fertility management practices.

To understand the soil nutrient status of Odisha State, 40000 soil samples were collected from all the 30 districts and results are presented in (**Annexure 10**).

Outcomes of Odisha Bhoochetana soil analysis

- More than 82 percent of analyzed soils are acidic in nature with low soluble salts
- Organic carbon is deficient (41%) in most of the analyzed soil samples

- Exchangeable bases followed the deficiency order: Ca > K > Mg
- Sulphur deficiency (48%) was also prominent in analyzed soils
- Boron (80%) was the most limiting amongst all micro-nutrient followed by zinc (43%)
- Micronutrient deficiency followed the order: Zn > Fe >Mn> Cu

Fertilizer Consumption pattern – Paddy

Chemical fertilizers enable farmers to increase farm production and get higher returns to their expenditure on various agricultural activities. The use of chemical fertilizers has been one of the significant factors in bringing about great improvements in the productivity of agriculture. The study pointed out that the 41 percent of soils of Odisha are deficient in OC which means existence of N deficiency. To overcome this use of chemical fertilizers nitrogen, phosphorus and potassium (N+P+K) is one of the vital inputs in increasing the farm production. The Figure 41 shows that nitrogen (N) application in paddy fields is lesser than the recommended dosage. However the dosage of other major nutrients as per the recommendation.

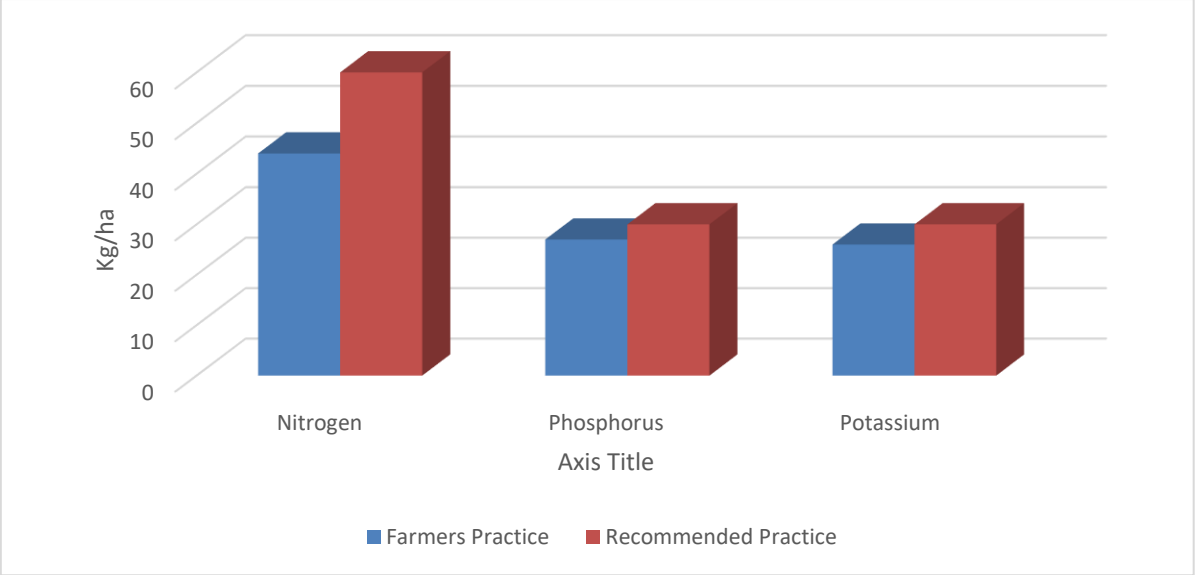

Figure 41. Farmer and Recommended practices of nutrient management

Economics of Production-Paddy

Figure 42 discusses about cost benefit analysis of per hectare of rice production at different districts of Odisha. The average gross returns per hectare rice production is Rs 26500 and highest returns was observed in Angul and lowest in Khandamal. The average cost of cultivation amounted to Rs. 13647 per hectare and price per quintal is Rs 1347/quintal. However the highest Benefit Cost Ratio (BCR) was observed in Boudh compared to other districts due to low cost of cultivation. To improve the BCR across the districts, awareness about the best management practices in paddy should be given to farmers.

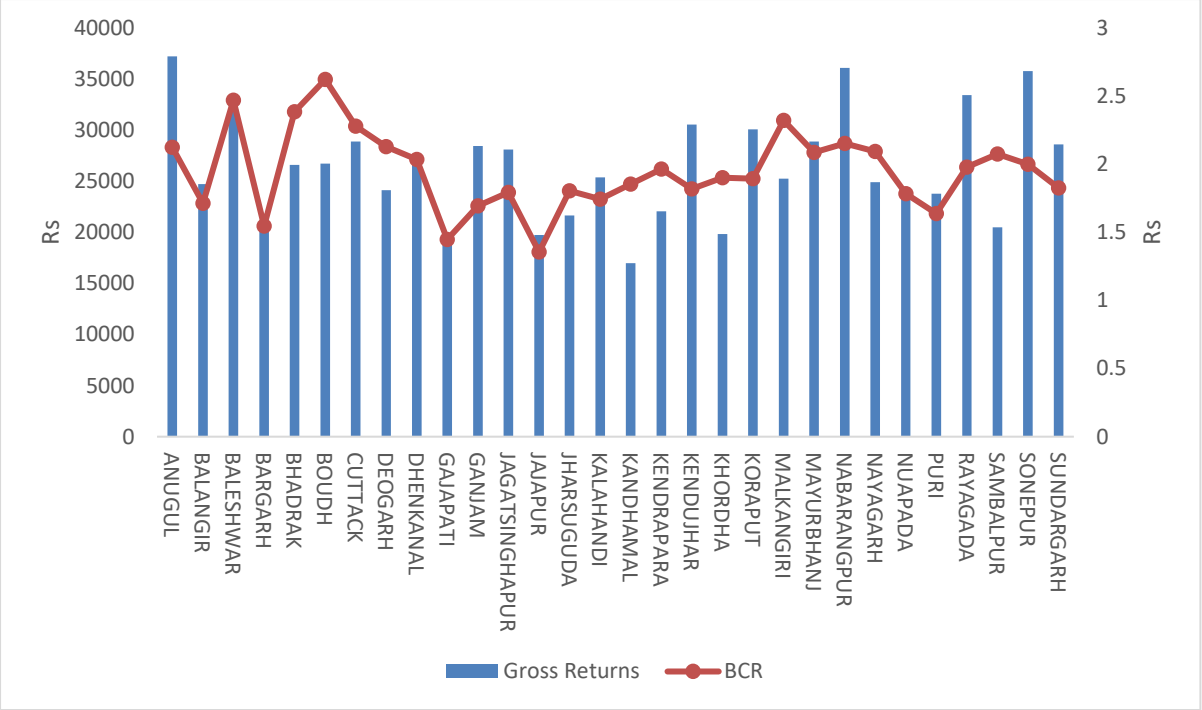

Figure 42. Benefit-Cost ratio of paddy cultivation across the districts

9.2.4. Consumption pattern

The food consumption is also a marker of social status and indicates the presence of social diversity and inequality. Food often becomes an important aspect of the boundaries between groups and shows significant variations across geographies. As the economic activity levels increases the consumption pattern changes. The study also presents the consumption pattern of major food items like cereals pulses, oils and milk (Figure 43). The per capita consumption of cereals per months is around 8 kg/month, pulses 1.31 kg/month, meat/fish 0.64 kg/month, eggs nearly 3/month, oils 0.4 litres and vegatables 3 kg/month. Among the districts, highest cereal consumption was observed in Jagatsighpur and Balasore; pulses consumption in Dhenkanal (Figure 44).

Consumption of different food items varies among socio-economic groups and regions. Persons with better incomes, belonging to 'higher' social class, having small families and working as self employed show higher intake of almost all food items and also exhibit diet diversity which make them nutritionally more secure and healthy. These variations caused by different factors may lead to inequality in nutrition and resultant health behaviour across different groups. Hence government should take necessary steps minimize inequalities across the groups

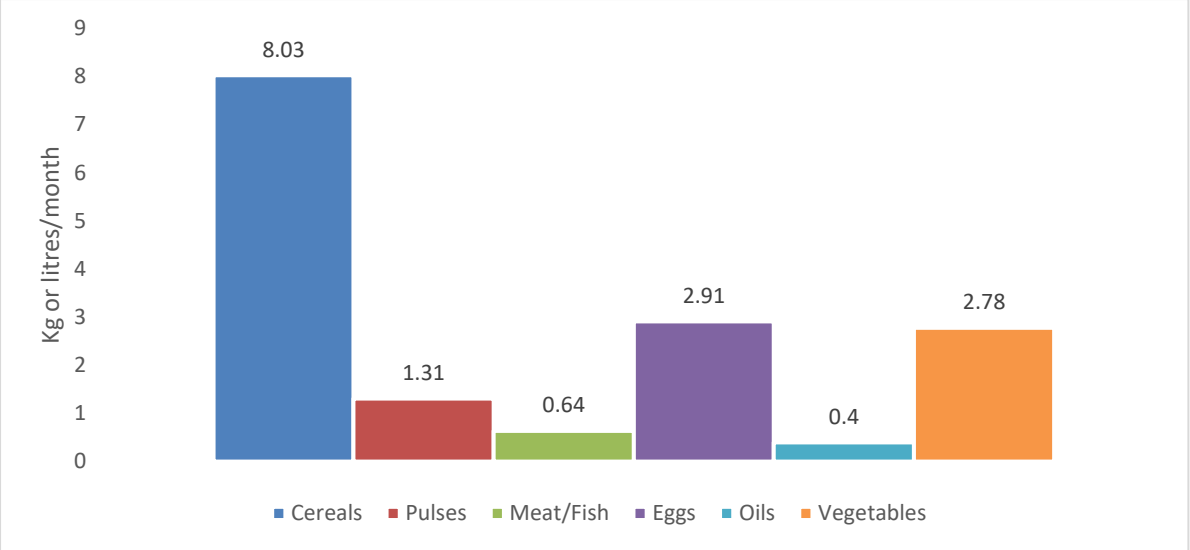

Figure 43. Per capita consumption of food

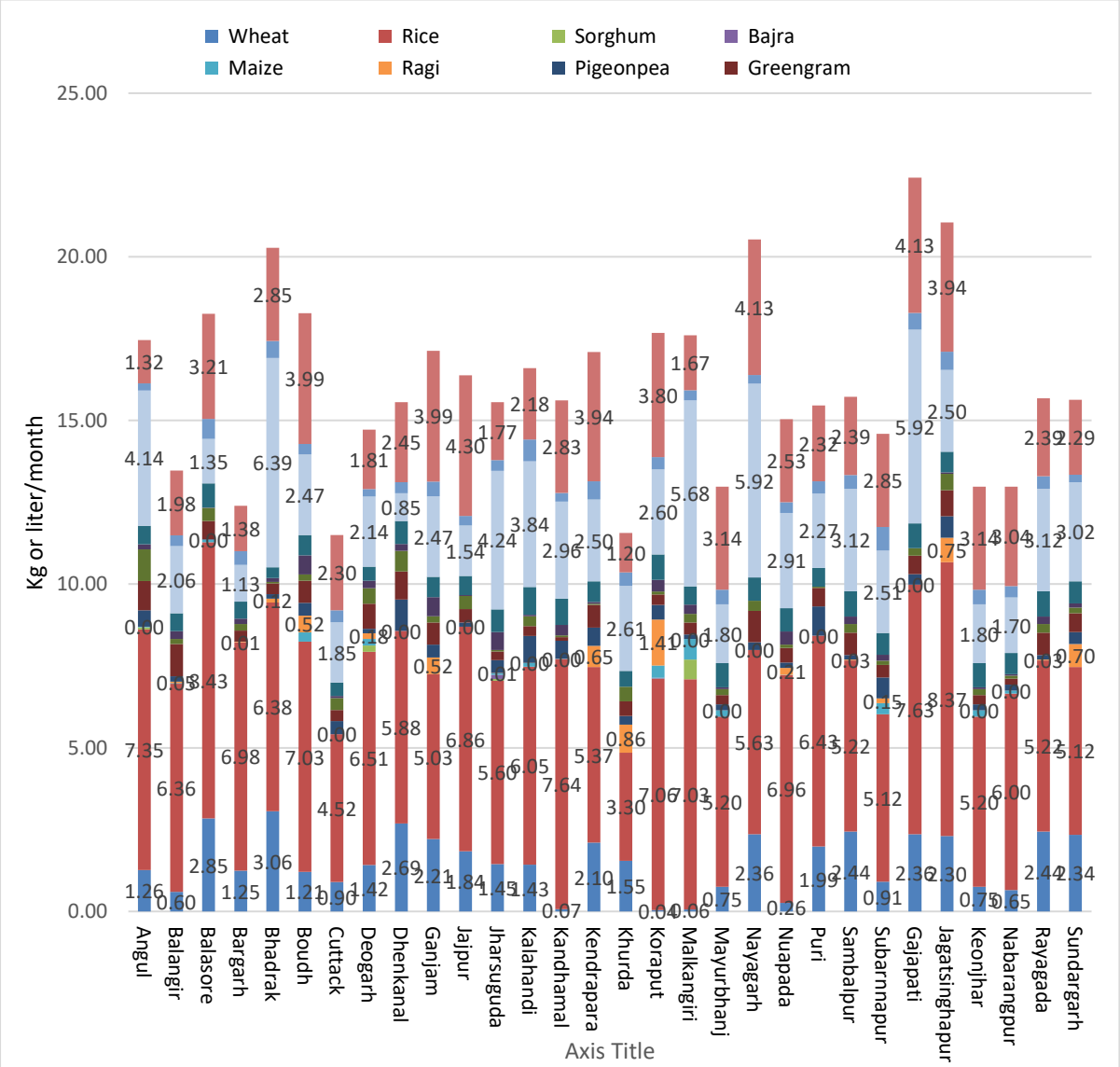

Figure 44. Per capita consumption of food by district

9.2.5. Summary and Conclusions

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 reason 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 one rupee investment. As the cropping intensity is only 119% virtually minimal rabi area, government to focus on rice-fallows. This not improves the economic sustainability of farmer but also adds to gross income to government.

10. Technical backstopping and Team-strengthening

a. Visits by scientists and scientific officers

In order to monitor the field activities and guide the farmers, regular vistis by the concerned scientists and scientific officers is being done as a regular practice. The District Coordinator's of concerned districts conducted field visits on once in a month basis and the Scientific Officer in-charge of the district on a weekly basis. The RT's in the concerned block and partnering NGOs on daily basis monitor the filed activities and build the capacity of farmers on various aspects of crop practices.

b. Strengthening of ground team

It is being endeavoured to place atleat one Scientific Officer per district basis and where ever there is a shortfall due to attrition, recruitment is being undertaken on a regular basis to strengthen the filed activity and giving regular advices to the farmers in the project area.

c. Collaboration with OUAT

To improve the technical competency of the field staff and farmers, efforts are being made to collaborate with Scientists of OUAT by associating them in the capacity building programmes and identification of best bet improved practices across the districts. In this regard one day capacity building programme for RTs and SOs on Kharif, 2019 interventions was organized on 24th June, 2019 under the aegis of the OUAT and ICRISAT scientists. Similarly, the sourcing of seed for the kharif, 2019 demonstrations has been done with the activie association of various seed farms under the abled guidance of Dr. T. K. Mishra, ADR (Seeds), OUAT, Bhubaneswar.

Annexure 1. Details of participants from Capacity building of Master Trainers program at ICRISAT campus on 8-10 & 15-17 July 2019.

S.No	District	Name	Designation	Email	Phone number
1	Angul	Lopamudra Sahoo	AAO	daoangul.dag@nic.in	8763306621
		Hemanta Ku Padihari	Soil Chemist	sc-angul.od@nic.in	9437908081
2	Balasore	Harihar Nayak	AAO	hariharsabita@gmail.com	7684095984
		Dhruva Charan Mahunta	Soil Chemist	scbls.dag@nic.in	9437129037
3	Bargarh	Rajib Lochan Mishra	AAO	mishrarajib2k1@rediffmail.com	9437310232
		Jajati Keshari Jena	Soil Chemist	jajati1987@rediffmail.com	8895728552
4	Bhadrak	Manoj Kumar Pradhan	AAO	manojpradhanaao@gmail.com	9438015857
		Meera Parichha	Soil Chemist	meeradashparichh9@gmail.com	9658956492
5	Bholangir	Sudhakar Nanda	AAO	nanda.sudhakar98@gmail.com	8328922043
		Sunanda Sahu	Soil Chemist	kuni.sunanda@gmail.com	9437764958
6	Boudh	Sanjiv Kumar Mudali	AAO	mudalisk1964@gmail.com	9437245305
		Rabi Narayan Panda	Soil Chemist	rabipanda.1962@gmail.com	9438377945
7	Cuttack	Satyabrat Sardar Singh	AAO	satyabratasardarsingh@gmail.com	8249786399
		Hiranmayee Sarangi	Soil Chemist	scctc.dag@nic.in	9438179097
8	Deogarh	Manjubala Naik	AAO	manjubala.naik@gmail.com	9937214723
		Lingaraj Pradhan	Soil Chemist	lingaraj.agrico@gmail.com	9439540473
9	Dhenkanal	Chinmaya Behera	AAO	cb9393@gmail.com	9124070819
		Bhangni Nabanita	Soil Chemist	bnabanita250@gmail.com	8763839036
10	Gajapati	Firoz Ara	AAO	arafiroz786@gmail.com	8093741303
		K Madhav Rao	Soil Chemist	kotinamadhavarao@gmail.com	9861579078
11	Ganjam	Sisir Kumar Padhi	AAO	sisira34@rediffmail.com	9437179607
		Pramod Ku. Mohapatra	Soil Chemist	scbmp.dag@nic.in	9437194125
12	Jagatsinghpur	Pradeep Kumar Beura	AAO	pradeepbeura69@gmail.com	7978233085
		Prachi Parichita	Soil Chemist	prachi10parichita@gmail.com	8763427230
13	Jajpur	Baikunthanath Behera	Agronomist	beherabaikunthanaik1964@gmail.com	9438266234
		Abhipsa Priyadarshini	Soil Chemist	aao.badachana@gmail.com	7537950118
14	Jharasuguda	Tillotoma Mahakuda	Soil Chemist	anvitilottama@gmail.com	8093115640
		Hemanta Prasad Dalei	AAO	aaosamasingha@gmail.com	8895688631
15	Kalahandi	Narendra Kumar Panda	AAO	narendrapanda950@gmail.com	9437725987
		Birendra nath Mishra	Soil Chemist	scbhpatna.dag@nic.in	9437223506
16	Kandhamal	Abhiseka Dash	AAO	abhisekadash1@gmail.com	9938147583
17	Kendrapara	Harekrishna Pradhan	AAO	aaojadupur@gmail.com	8895349143

S.No	District	Name	Designation	Email	Phone number
		Jyotirmayee Behera	Soil Chemist	jyotiita2014@gmail.com	8984477790
18	Keonjhar	Satyabrata Dash	JQCI	satyabratadash1969@gmail.com	9437232151
		Hemanta Ku. Samal	Soil Chemist	soilchemist.keoajhar@gmail.com	9937327989
19	Khurda	Tushar Kanti Tunga	PPO	tktunga@gmail.com	9437104031
		Sarada Prasan Kar	Soil Chemist	sharada_prasanna@rediffmail.com	7504140224
20	Koraput	Annapurna Behera	AAO	annapurnabehera06@gmail.com	7735278277
		G V Reddy	Soil Chemist	sckoraput.dag@nic.in	9438221663
21	Malakanagiri	Rashmi Ranjan Moharana	AAO	rashmiranjanmoharana@gmail.com	8763039069
		Chandra Sekhar Bhumia	Soil Chemist	cs.royal38@gmail.com	9438077562
22	Mayurbhanj	Purna Chandra Shaw	Agronomist	purnasha65@gmail.com	9437248062
		Malaya Dwari	Soil Chemist	sebaripada.dag@nic.in	9437084892
23	Nawarangpur	Manas Ranjan Naik	AAO	manas.ssdodish@gmail.com	9853985388
		M Anand Rao	Soil Chemist	anand.anandkumar33@gmail.com	7008620245
24	Nayagarh	Ashish Kumar Meher	AAO	ameher91@gmail.com	9776334858
		Truptimayee Nahak	Soil Chemist	scnayagarh@gmail.com	9439021540
25	Nuapada	Sudhanshu Sekhar Sahu	AAO	agricozsudhansu@gmail.com	9439264695
		Rakesh Pandey	Soil Chemist	rakesh_cac@rediffmail.com	9938933008
26	Puri	Piusha Pallav Parida	FMS	pallavpiyush45@gmail.com	9439890223
		Sunita Mishra	Soil Chemist	sunitamishra898@yahoo.in	9437968897
27	Rayagada	Tirupati Sinipini	AAO	stirupati95@gmail.com	9163796905
		Gyanaranjan Panigrahi	Soil Chemist	gnyana.panigrahi@gmail.com	7750000847
28	Sambalpur	Rabinarayan Senapati	JQCI	ddasambalpur.dag@nic.in	9437084797
		Babaji Charan Sethy	Soil Chemist	scsbprag@nic.in	9437564637
29	Subarnpur	Prakash Chandra Pani	AAO	clicktoprakash2014@gmail.com	9438536303
		Anil Ku. Praharaj	Soil Chemist	anilkp66@gmail.com	9861446566
30	Sundargarh	Prafulla Kumar Naik	AAO	prafullakumarnaik258@gmail.com	9438514976
		Manoj Barik	Soil Chemist	manojbarik2007@gmail.com	8327759599

Annexure 2. Literacy details of respondents in baseline study.

Education	Years of Education	Number	Percentage
Illiterate	Illiterate	296	7.4
Lower Primary	1	6	0.1
	2	169	4.2
	3	213	5.3
	4	605	15.0
	5	511	12.7
Upper Primary	6	81	2.0
	7	296	7.4
High Primary	8	152	3.8
	9	301	7.5
	10	974	24.2
High Secondary	11	5	0.1
	12	166	4.1
Higher Secondary	13	88	2.2
	14	0	0.0
	15	148	3.7
Post Graduation	16	1	0.0
	17	12	0.3
	18	1	0.0
	19	0	0.0
	20	2	0.0

Annexure 3. List of districts with paddy production below the nation's average.

S.No	District
1	ANUGUL
2	BALANGIR
3	BALESHWAR
4	BARGARH
5	BHADRAK
6	BOUDH
7	CUTTACK
8	DEOGARH
9	DHENKANAL
10	GANJAM
11	JAJAPUR
12	JHARSUGUDA
13	KALAHANDI
14	KANDHAMAL
15	KENDRAPARA
16	KHORDHA
17	KORAPUT
18	MALKANGIRI
19	MAYURBHANJ
20	NAYAGARH
21	NUAPADA
22	PURI
23	SAMBALPUR
24	SONEPUR
25	SUNDARGARH
26	GAJAPATI
27	JAGATSINGHAPUR
28	KENDUJHAR
29	NABARANGPUR
30	RAYAGADA

Annexure 4. List of districts where maize is predominantly grown.

1	ANUGUL
2	BALANGIR
3	BARGARH
4	BOUDH
5	DEOGARH
6	DHENKANAL
7	GAJAPATI
8	GANJAM
9	jHARSUGUDA
10	KANDHAMAL
11	KENDUJHAR
12	KORAPUT
13	MALKANGIRI
14	MAYURBHANJ
15	NABARANGPUR
16	RAYAGADA

Annexure 5. List of districts where Finger Millet is predominantly grown.

1	GAJAPATI
2	KALAHANDI
3	KORAPUT
4	MALKANGIRI
5	RAYAGADA

Annexure 6. List of districts where Greengram average productivity is higher than the state average.

1	ANGUL
2	BALANGIR
3	BALESHWAR
4	BARGARH
5	BHADRAK
6	BOUDH
7	CUTTACK
8	DEOGARH
9	DHENKANAL
10	GANJAM
11	JAGATSINGHAPUR
12	JAJAPUR
13	JHARSUGUDA
14	KALAHANDI
15	KANDHAMAL
16	KENDRAPARA
17	KENDUJHAR
18	KORAPUT
19	MAYURBHANJ
20	NABARANGPUR
21	NAYAGARH
22	NUAPADA
23	RAYAGADA
24	SAMBALPUR
25	SONEPUR
26	SUNDARGARH

Annexure 7. List of districts where Blackgram average productivity is higher than the state average.

1	ANUGUL
2	BALANGIR
3	BALESHWAR
4	BARGARH
5	BHADRAK
6	BOUDH
7	CUTTACK
8	DEOGARH
9	DHENKANAL
10	GAJAPATI
11	GANJAM
12	JAGATSINGHAPUR
13	JAJAPUR
14	JHARSUGUDA
15	KALAHANDI
16	KANDHAMAL
17	KENDRAPARA
18	KENDUJHAR
19	KHORDHA
20	KORAPUT
21	MALKANGIRI
22	MAYURBHANJ
23	NABARANGPUR
24	NAYAGARH
25	NUAPADA
26	PURI
27	RAYAGADA
28	SAMBALPUR
29	SONEPUR
30	SUNDARGARH

Annexure 8. List of districts where Horsegram in grown.

1	ANUGUL
2	BALANGIR
3	CUTTACK
4	KALAHANDI
5	KENDUJHAR
6	KORAPUT
7	NABARANGPUR
8	RAYAGADA
9	SUNDARGARH

Annexure 9. List of districts where Groundnut is the major oilseed crop grown.

1	ANUGUL
2	BALESHWAR
3	BARGARH
4	CUTTACK
5	DHENKANAL
6	GANJAM
7	JAJAPUR
8	KORAPUT
9	MALKANGIRI
10	NAYAGARH
11	NUAPADA

Annexure 10. Soil sample analysis

District	% fields with low C levels	% deficient fields in available nutrients									
		P	K	Ca	Mg	S	Zn	B	Fe	Cu	Mn
Koraput	25	42	15	15	46	87	49	83	0	1	0
Malkangiri	42	67	36	10	40	59	52	92	1	3	2
Angul	34	49	11	6	24	36	61	80	3	3	8
Deogarh	28	64	18	5	21	42	55	76	2	1	1
Jagatsinghpur	44	32	27	2	3	58	55	63	0	0	2
Kendrapara	27	42	17	1	1	36	19	36	0	0	0
Khorda	62	50	38	13	27	65	25	83	0	0	2
Kandhamal	42	50	11	8	54	71	41	87	2	6	0
Nayagarh	54	42	25	4	13	48	42	81	1	0	1
Kalahandi	51	67	11	3	18	54	63	87	3	1	5
Nabrangpur	38	61	21	12	37	70	59	95	0	1	5
Rayagada	53	24	5	7	34	44	28	80	4	3	1
Cuttack	37	34	33	2	8	41	18	83	1	0	1
Dhenkanal	32	56	19	4	17	42	19	74	1	0	2
Puri	44	29	35	10	14	50	30	63	0	4	7
Bhadrak	40	41	25	2	4	49	38	57	1	0	1
Jajpur	49	37	38	6	18	47	25	77	2	1	3
Jharsuguda	39	53	19	18	38	37	21	98	0	0	1
Jharsuguda	39	53	19	18	38	37	21	98	0	0	1
Sambalpur	39	54	18	13	35	44	41	92	2	1	3
Boudh	51	51	29	5	21	52	66	94	8	2	6
Sonepur	36	56	23	6	25	25	64	90	2	2	4
Bargarh	36	37	26	7	38	29	53	90	1	3	3
Balangir	46	68	16	4	21	44	76	92	6	5	7
Nuapada	22	64	1	1	4	27	72	80	2	1	8
Balasore	52	49	47	11	31	37	41	68	5	3	6
Mayurbhanj	45	74	47	26	50	66	39	92	1	1	2
Gajapti	63	49	7	40	76	82	42	93	4	1	2
Ganjam	45	56	15	5	21	40	32	64	1	0	3
Keonjhar	47	69	35	18	42	71	55	90	1	3	2
Sundergargh	47	73	19	15	37	45	39	95	1	5	1
Odisha total	**43**	**53**	**25**	**10**	**28**	**51**	**43**	**81**	**2**	**2**	**3**