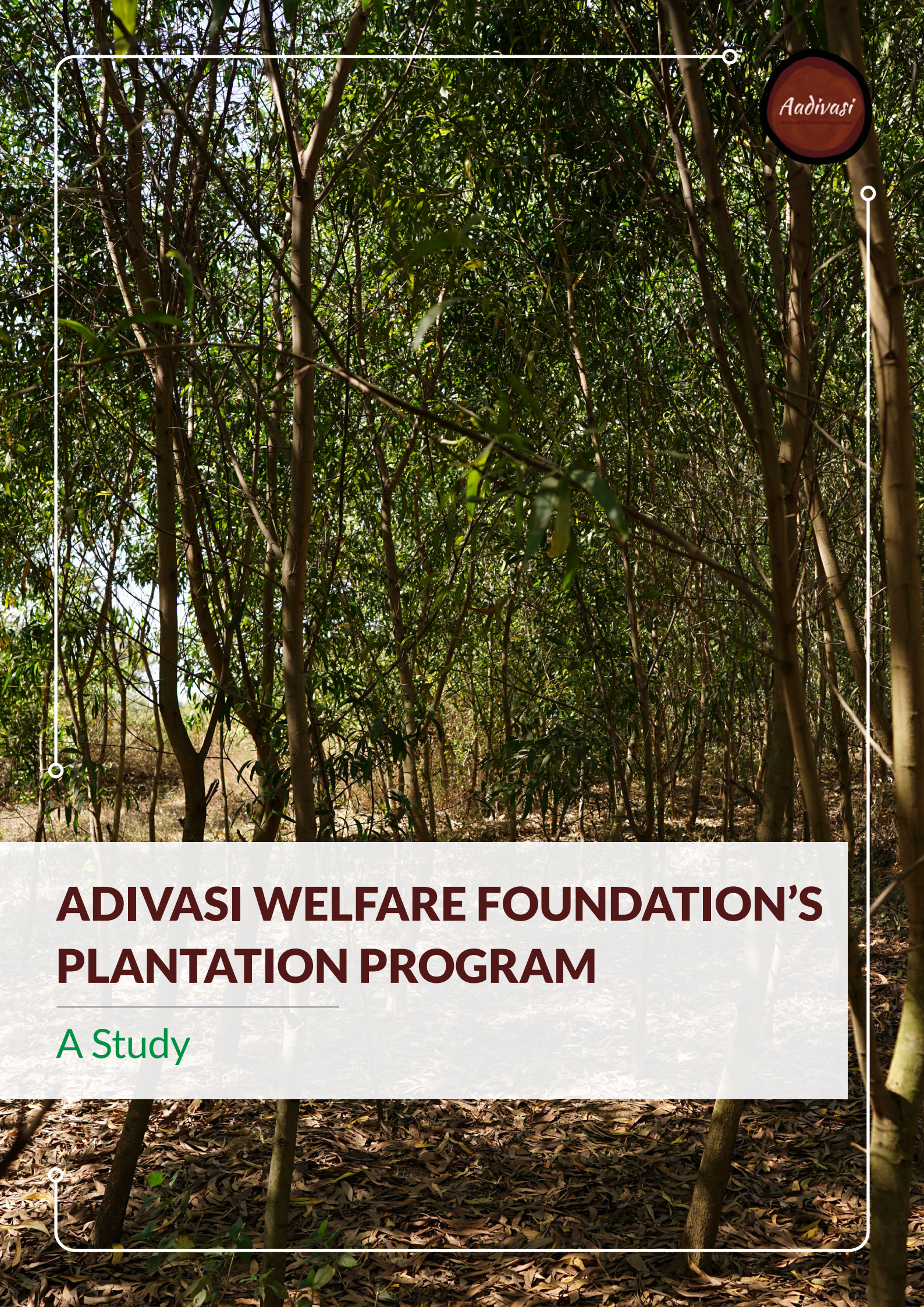


ADIVASI WELFARE FOUNDATION'S PLANTATION PROGRAM

A Study

TABLE OF CONTENTS

ABBREVIATIONS

AR	Afforestation/ Reforestation	**GBH**	Girth at Breast Height
AWF	Adivasi Welfare Foundation	**GIS**	Geographic Information System
BCM	Billion Cubic Meters	**ha**	Hectare
C	Celsius	**kg**	kilogram
CDM	Clean Development Mechanism	**m**	meter
CGWB	Central Ground Water Board	**MAI**	Mean Annual Increment
cm	centimeter	**mm**	millimeter
CO2	Carbon Dioxide	**NTFP**	Non-Timber Forest Produce
CSR	Corporate Social Responsibility	**OECD**	The Organization for Economic Cooperation and Development
DAC	Development Assistance Committee	**RS**	Remote Sensing
DBH	Diameter at Breast Height	**sq. km.**	square kilometer
FGD	Focussed Group Discussion	**tCO2**	Tons of Carbon dioxide
FY	Financial Year	**VNV**	Value Network Ventures

LIST OF TABLES

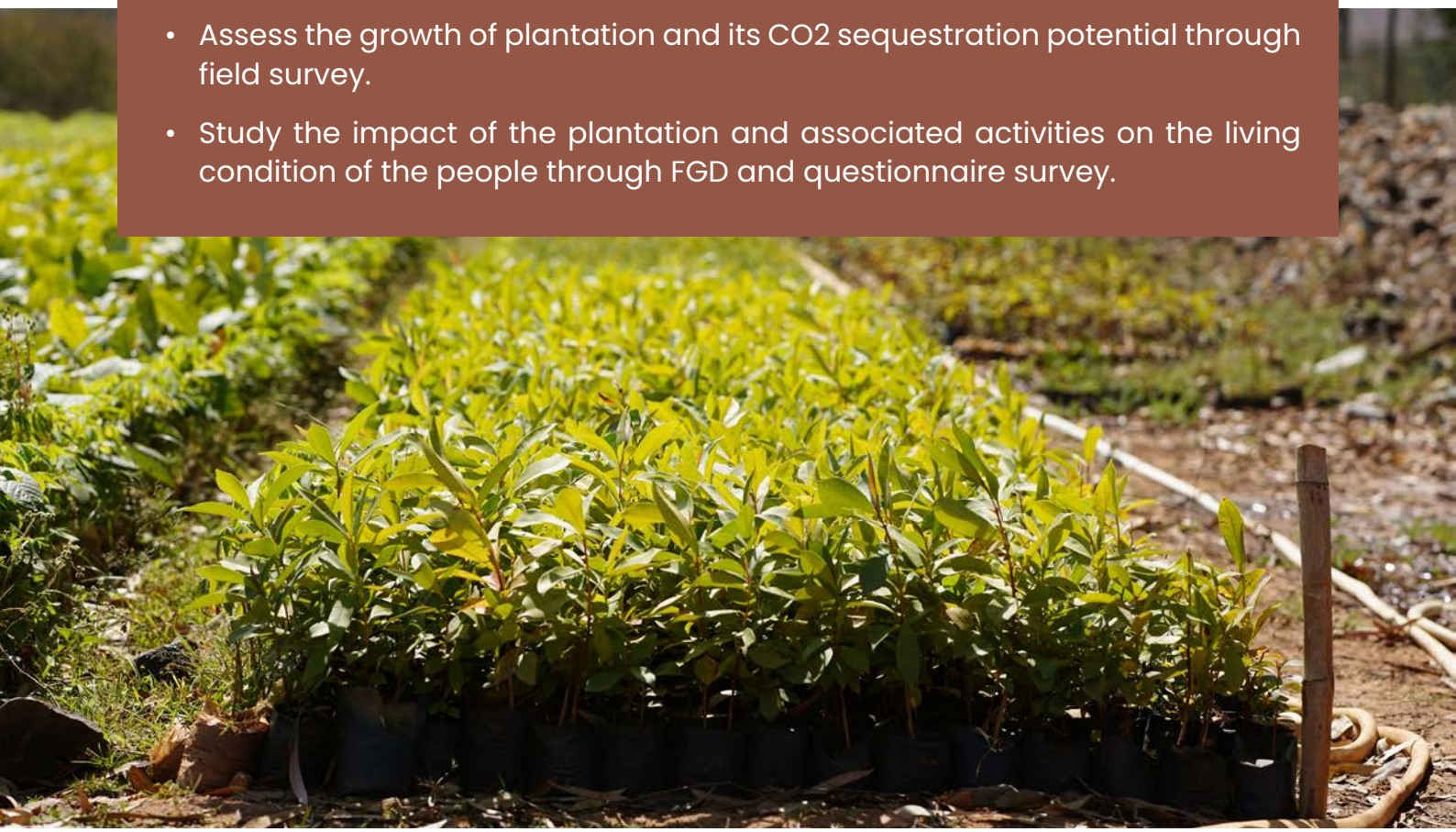
1. INTRODUCTION

Adivasi Welfare Foundation (AWF), a non-profit organization, carried out tree plantation program in remote areas of East Singhbhum and Saraikela- Kharsawan districts of Jharkhand, Mayurbhanj and Puri in Odisha and Buxar in Bihar since 2018. The plantation activity has been undertaken to reclaim deforested and degraded patches, control soil erosion, improve moisture conservation, enhance water table in the region, prevent severe drought and flood conditions of the region and forest fires. Nearly 1000 ha has been replanted in East Singhbhum and more than 100 ha in Saraikela- Kharsawan district of Jharkhand. In Mayurbhanj, around 1000 ha have been replanted whereas more than 100 ha in Puri. In Buxar, Bihar 20 ha have been replanted.

The plantation was done on waste land owned by the community or farmers as part of a CSR initiative supported by Impact Guru so that it would also help marginalised rural/Tribal people's livelihoods in addition to the rehabilitation of degraded land.

Under this backdrop, VNV Advisory worked with AWF to evaluate the socio-economic and environmental impacts of the plantation and associated activities with the following objectives:

- Determine the baseline environmental conditions through literature review.
- Estimate the change in green cover in all the sites through RS/GIS.
- Assess the growth of plantation and its CO2 sequestration potential through field survey.
- Study the impact of the plantation and associated activities on the living condition of the people through FGD and questionnaire survey.



2. METHODOLOGY

2.1. SAMPLING

Stratified purposive sampling was used for the study. Stratification was based on,

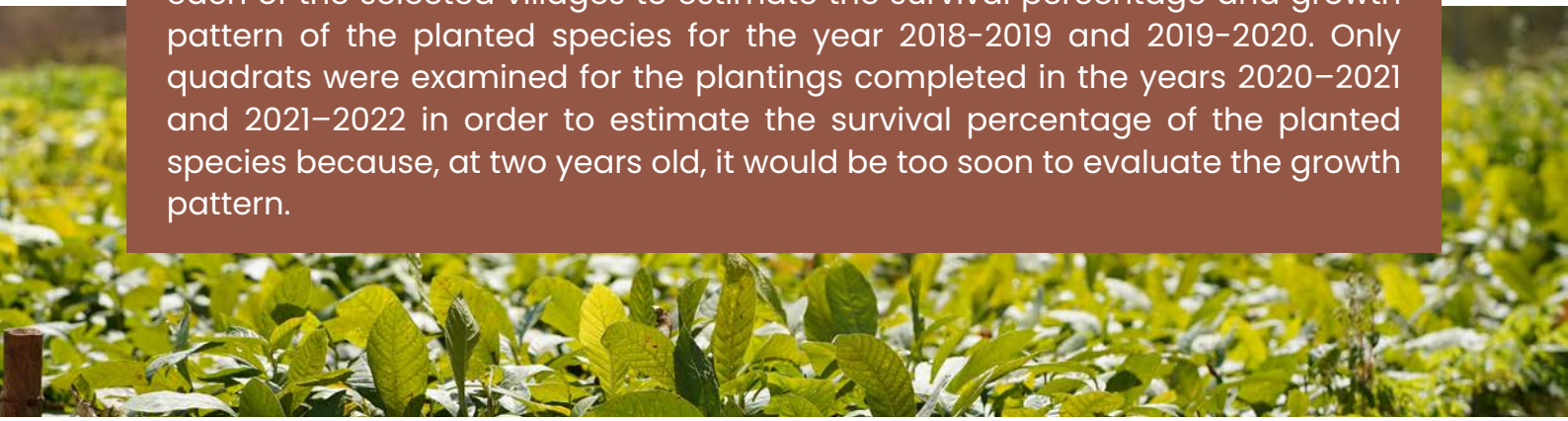
i. The year of plantation
ii. Districts from each plantation year

East Singhbhum district in Jharkhand and Mayurbhanj in Odisha had been studied as plantation activities are undertaken every year since 2018 in East Singhbhum and 2019 in Mayurbhanj. One village from each plantation year was studied for upto 10 villages. Where the number of villages where plantation was done, were more than 10, two villages were studied in each of these two districts. The sampling of the study sites is presented in Table 1.

Table 1: Sampling of the study sites

Year	State	Districts	No. of Blocks	No. of villages	No. of villages selected as per the criteria
2018	Jharkhand	East Singhbhum	1	1	1
2019	Odisha	Mayurbhanj	1	1	1
2019	Jharkhand	East Singhbhum	1	4	1
2020	Odisha	Mayurbhanj	1	6	1
2020	Jharkhand	East Singhbhum	4	11	2
2021	Odisha	Mayurbhanj	3	17	2
2021	Jharkhand	East Singhbhum	3	7	1

Purposive sampling was used for the selection of villages. The villages were selected in discussion with AWF considering the topographical area and the planted species. One quadrat of 0.1 ha was studied in the plantation area in each of the selected villages to estimate the survival percentage and growth pattern of the planted species for the year 2018-2019 and 2019-2020. Only quadrats were examined for the plantings completed in the years 2020–2021 and 2021–2022 in order to estimate the survival percentage of the planted species because, at two years old, it would be too soon to evaluate the growth pattern.



2.2. TOOLS FOR DATA COLLECTION

2.2.1. PRIMARY DATA COLLECTION

1. Quadrat Study

A quadrat of size 36.2 m X 36.2 m covering 0.1 ha was laid to measure the survival rate and growth of the trees. Areas where quadrat could not be laid due plot dimension, a diagonal transact was laid and studied. Format was developed to record the data. The growth data from the measured trees in the sample plots would be extrapolated to the total plantation area to get an estimate of the amount of carbon sequestered and its potential for sequestration.

2. Personal Interviews

Questionnaires were developed to collect primary data through personal interviews based on the impact of plantation and other activities on livelihood, agricultural practices, crop production, NTFP collection and its value addition, annual returns, assets generated during the project tenure and such others. Successful case studies were documented. Primary data were collected from the farmers/beneficiaries who were involved in the plantation activity.

3. Focussed Group Discussion (FGD)

One FGD was conducted where plantation was on community land. Questions on the procedures followed for the plantation, the assets made and the opportunities it created for employment were covered.

2.2.2. SECONDARY DATA COLLECTION

Secondary data was collected from Government Departments and websites on climatic conditions (temperature and rainfall), land use pattern, and others such.

2.3. DATA ANALYSIS

The analysis of the quadrat has been done using the Excel and that of Personal Interview and FGDs has been done using the OECD DAC evaluation framework. The OECD DAC Network on Development Evaluation (EvalNet) has defined six evaluation criteria – relevance, coherence, effectiveness, efficiency, impact and sustainability. These criteria provide a normative framework used to determine the merit or worth of an intervention. They serve as the basis upon which evaluative judgements are made. The findings of the study based on the framework are presented in Table No. 5 and 6.

3. STUDY SITES

3.1. EAST SINGHBHUM

The district East Singhbhum is in south-eastern extreme of Jharkhand in the mineral rich Chotanagpur range. It is covered with natural forests and undulating hills. Subarnarekha is the main river flowing from west to south-east of the district. The geographical location of East Singhbhum is between 22° 12′ N to 23° 01′ N latitude and 84° 04′ E to 86° 54′ E longitude. It has 11 blocks, 231 Panchayats, 1810 villages and 13 towns.[1]

3.1.1. SOCIO-ECONOMIC STATUS

*Table 2: Socio-economic status of East Singhbhum district**

DEMOGRAPHY	
Estimated Population (2011)	22,91,032 [1]
Geographical area	3,533 Sq. kms. [1]
Population density	648 (Per Sq.Km) [1]
Male	11,75,696 [1]
Female	11,15,336 [1]
Working age population	People living in East Singhbhum depend on multiple skills, total workers are 837,167 out of which men are 616,249 and women are 220,918 [6]
Work participation rate (2017-18)	41.44% [7]
Socio-economic distribution	Major tribes: Santhals, Ho, Munda, Kharwar, Lohra, Kharia[8]

Poverty in the district (2011)	Poverty rate is high. 37.3 % of households lives under the poverty line. [9]
Sex ratio (2011)	949 females for every 1000 males [1]
Literacy rate by gender (2016)	Male – 84.51% [1]
	Female – 67.33% [1]
Major enterprises	Agriculture [7]
HEALTH, SANITATION, SAFETY & ACCESS TO ELECTRICITY & EDUCATION	
Population (female) age 6 years and above who ever attended school (2016)	70.1% [10]
Women with 10 or more years of schooling (2016)	43.3% [10]
Crime rate in the district	173.85 [7]
Households with electricity (2016)	91.5% [10]
Households using improved sanitation facility (2016)	43.4% [10]
Households using clean fuel for cooking (2016)	40.4% [10]
Households with any usual member covered by a health scheme or health insurance (2016)	19.8% [10]
GEOGRAPHY, LAND, AGRICULTURE & NATURAL RESOURCES	
Dominant tree species	Shorea robusta, Dalbergia sissoo, Diospyros sps., Azadirachta indica, Bassia latifolia, Bombax mori, Schleichera trijuga, Phylanthus emblica [3]
Total forest area (2021)	1080.69 Sq.Km [7]
Total cultivable land	28,00,000 hectares [4]
Total cropped area (2011)	74,064 ha [7]
Cropping intensity	114% [3]
Major Crops Grown	Field Crops – Rice, Paddy, wheat, maize, mung, arhar, horsegram, til [4]
	Horticulture crops - Cashew, Lemon, Guava, Banana [4]
	Vegetables – Chilli, Potato, Cauliflower, Tomato, Potato, Brinjal, Peas. [4]
Groundwater status	The net annual ground water availability of the district is 27155 ham. The gross ground water draft for all uses of the district is 5633.00 ham. The net ground water availability for future irrigation development for the district is 19843.85 ham. Out of 9 blocks, one block falling under over exploited and rest of the eight blocks of the district falling under "Safe" category. The stage of ground water development varies from 6.84% to 131.39%. [3]
SOCIAL ISSUES	
Malnourishment, high rural poverty and subsistence-based agriculture.	

3.1.2. ENVIRONMENTAL CONDITIONS

The climate of the district is humid to sub humid tropical. Annual rainfall is between 1200-1400 mm. This comes under the part of South –West monsoon so, sometimes it receives heavy rain during July to September. During summer season maximum temperature goes up to 40° - 45° C, whereas in winter it has recorded a minimum of 8° C.

3.1.3. LAND USE PATTERN

The Land Use/ Land Cover in Jharkhand is presented in Table 2.

Table 3: Land Use/ Land Cover in Jharkhand

Type of land	Area in sq.km.
Crop land	914.95
Fallow	812.48
Plantation	1.40
Barren Rocky	8.09
Scrub Land	192.07
Deciduous Forest	1063.45
Evergreen/Semi evergreen	0.05
Forest Plantation	5.52
Scrub Forest	162.57
River/Stream/Canals	77.27
Water bodies	24.26

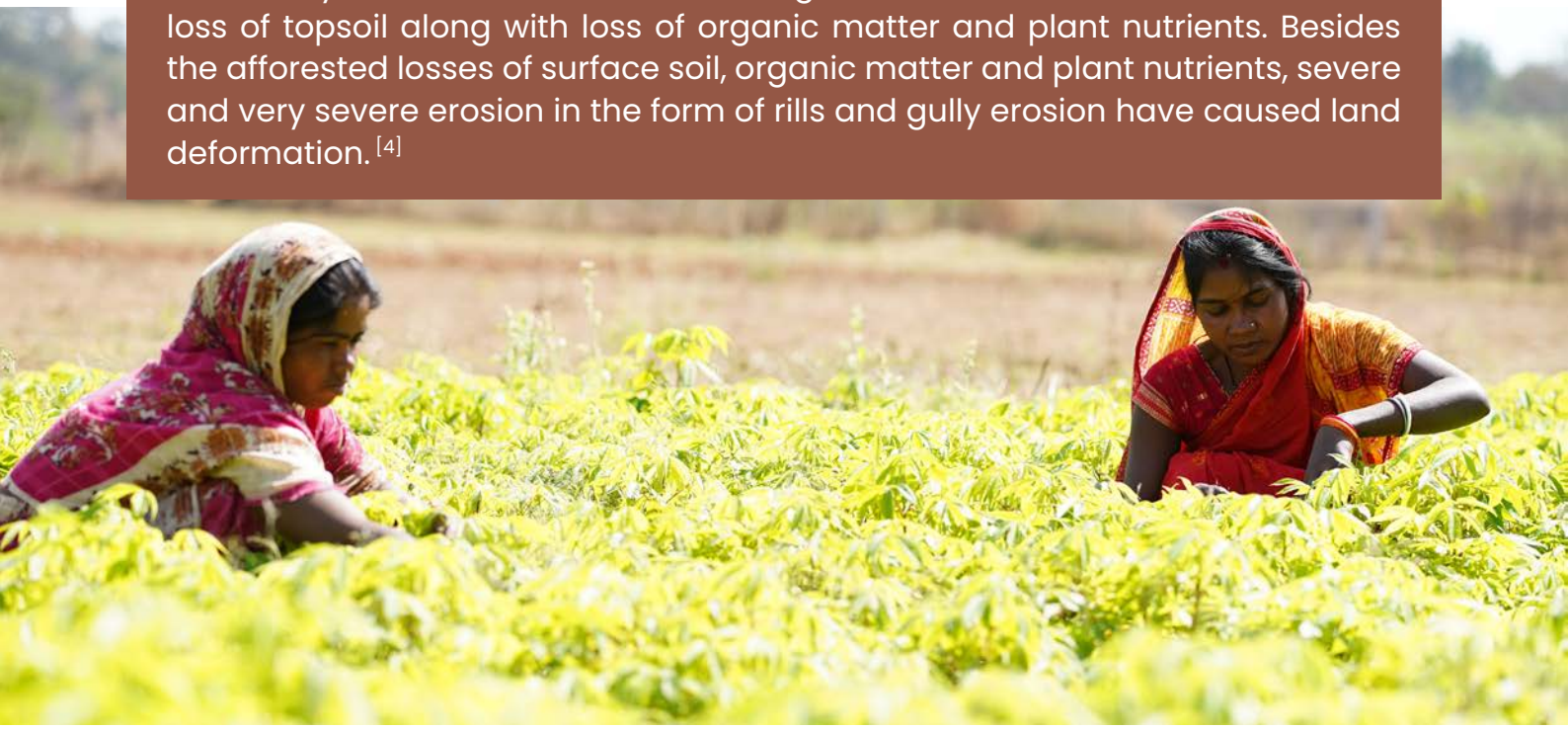
3.1.4. VEGETATION PATTERN IN JHARKHAND

Natural vegetation of dry thorny type predominates on rocky hill slopes, whereas moist deciduous forest, which tends to become dry deciduous on ridges and exposed spurs with southern aspect is of common occurrence. The granitic hillocks on plateaus have sal or mixed forest with bamboo. Most of the hill ranges have dense forests; the predominant species of which are *Shorea robusta, Dalbergia sissoo, Diospyros sps., Azadirachta indica, Bassia latifolia, Bombax mori, Schleichera trijuga,* and *Phylanthus emblica*.[3]

3.1.5. SOIL QUALITY AND FERTILITY

East Singhbhum district is mainly rocky. Soil texture varies from zone to zone. The soil is acidic lateritic and red soil (morum) in nature. Soil fertility status is not so bad, but water retention capacity is poor. Weather is dry-hot in summer (maximum temperature 48° C recorded) and very cold in winter (minimum temperature 8° C recorded). The area under irrigated farming is found to be approximately 3%. The total area under crop in the zone is approximately 3.70% lakh ha. The principal crops grown in descending order are paddy, vegetables, Maize, Linseed, Niger, Wheat, Moong, Gram, Kalai, Marua, Bajra and Arhar.

The soil degradation shows that an area of 2,13,288.10 ha corresponding to nearly 60 per cent of the total geographical area of the district is affected by various soil degradation problems. Although the soils of the area, owing to natural factors of rainfall and topography are appreciably leached and deprived of bases and plant nutrients, reflected in low pH values and low base saturation, water erosion is the major soil degradation problem in the district caused by human intervention. Soil degradation due to erosion has caused loss of topsoil along with loss of organic matter and plant nutrients. Besides the afforested losses of surface soil, organic matter and plant nutrients, severe and very severe erosion in the form of rills and gully erosion have caused land deformation. [4]



3.1.6. CROP PRODUCTIVITY

Rice dominates the present cropping pattern, with more than 80 per cent of the gross cropped area under this single crop followed by pulses, maize, wheat, and oil seeds. Due to lack of irrigation facilities and traditional management practices, crop yields are very poor. Most farmers cultivate only one crop in a year for lack of resources.

The paddy productivity goes up to 24.07 q/ha, while wheat is produced at 10.50 q/ha. Some other crops such as maize, arhar and til can reach rates of 11.33 q/ha, 8.18 a/ha and 6.61 a/ha respectively.[5]

3.2 MAYURBHANJ

Mayurbhanj is a land locked district with a total geographical area of 10418 sq.km. and is situated in the Northern boundary of the state with district headquarters at Baripada. The district is bounded in the North-East by Medinipur district of West Bengal, Singhbhum district of Jharkhand in the North-west, Baleshwar district in the South-East and by Kendujhar in the South-West. More than 39% of total geographical area (4049 sq. km.) is covered with forest and hills.[6]

3.2.1. SOCIO-ECONOMIC STATUS

Table 4: Socio-economic status of Mayurbhanj district

DEMOGRAPHY	
Estimated Population (2011)	2519738 [1]
Geographical area	10,418 Sq. kms. [1]
Population density	213 (Per Sq.Km) [1]
Male	1256213 [1]
Female	1263525 [1]
Working age population	Main Work (Employment or Earning more than 6 Months) - 44.8%[3]
	Marginal Activity (providing livelihood for less than 6 months) - 55.2% [3]
Work participation rate (2017-18)	51.22% [4]
Socio-economic distribution	Major tribes: Santal, Kolha, Bathudi, Bhumij, Munda, Gond, Saunti, Hill Kharia, Mahali [5]
	Minor tribes: Mankirdia, Lodha, Kol, Kisan, Baiga, Holva[5]
Poverty in the district (2011)	Poverty rate is high. 32.6 % of the population lives under the poverty line as per 2011 census.[6]
Sex ratio (2011)	1006 females for every 1000 males [2]
Literacy rate by gender (2016)	Male – 73.76% [2]
	Female – 52.71% [2]

Major enterprises	Agriculture, Mining.
HEALTH, SANITATION, SAFETY, ACCESS TO ELECTRICITY AND EDUCATION	
Population (female) age 6 years and above who ever attended school (2016)	59.3% [7]
Women with 10 or more years of schooling (2016)	23.6% [7]
Crime rate in the district	233.12 [8]
Households with electricity (2016)	73.9% [7]
Households using improved sanitation facility (2016)	18.1% [7]
Households using clean fuel for cooking (2016)	9.5% [7]
Households with any usual member covered by a health scheme or health insurance (2016)	39.9% [7]
GEOGRAPHY, LAND, AGRICULTURE AND NATURAL RESOURCES	
Dominant tree species	Sal, teak, bamboo [9]
Total forest area (2011)	4049 Sq.Km [10]
Total cultivable land	4,47,214 hectares [11]
Total cropped area (2011)	5,62,733 hectares [12]
Cropping intensity	74.80% [12]
Major Crops Grown	Field Crops - Paddy, wheat, maize, mung, biri, horsegram, til [12]
	Horticulture crops - Cashew, Onion, Tomato
	Vegetables – Chilli, Potato, Cauliflower
Groundwater status	As per Central Ground Water Board (CGWB), all the blocks of Mayurbhanj district are in the safe limits of ground water utilization. In the district the draft, recharged and gap of ground water are 0.17455, 0.371 and 0.19645 BCM respectively. [7]
SOCIAL ISSUES	
• Despite government help in the form of MGNREGA, most villagers are unemployed. Some don't have enough capital to leave the village and go to a bigger city for livelihood • Gender inequality in education • Scarcity of water in the area has led farmers to create their own water bodies	

3.2.2. ENVIRONMENTAL CONDITIONS

The climate of Mayurbhanj is sub-tropical marked by high humidity and rainfall during the Monsoon. The Simlipal Hills influence the weather substantially and exhibit higher rainfall and lower maximum temperatures than the rest of the district. The average annual rainfall is around 164 cm. Summer temperatures in Baripada can occasionally cross 45^0 Celsius but thunderstorms in the evening are common which have a moderating influence. Minimum temperature in winter can go down to 8^0. Fog occurs occasionally during winters.

Being away from the coastal belt, the district experiences a sub-tropical climate with a hot summer, chilling winter with good precipitation.

Odisha is prone to severe cyclonic storm and faced its worst ever tropical cyclone in 2019. Since then, the State Forest Department along with other line departments have started the plantation drive in 6000 ha of land in five years. The State Forest Department promoted plantation of Acacia auriculiformis as cyclone- resilient trees, along with other species.[8]

3.2.3. LAND USE PATTERN

The Land Use/ Land Cover in Mayurbhanj is presented in Table 5.

Table 5: Land Use/ Land Cover in Mayurbhanj

Type of land	Area in sq. km.
Crop land	5121.15
Fallow	97.21
Plantation	10.37
Barren Rocky	75.50
Gullied / Ravinous Land	2.33
Scrub Land	243.17
Deciduous Forest	3829.92
Forest Plantation	54.29
Inland Wetland	0.44
River/Stream/Canals	97.29
Water bodies	61.19

3.2.4. VEGETATION PATTERN

Mayurbhanj's geography is defined by the Simlipal National Park located in the centre of the district. Covering more than a fourth of the district's area, these forests surround the Simlipal Hills, which form the watershed for the district. Mayurbhanj occupies a unique position being endowed with lush green vegetation, different fauna, and rich cultural heritage. The indigenous vegetation consisted of pure Sal forests which have now been replaced by paddy cultivation. The district has a rich mineral base and is home to the Similipal Biosphere.

3.2.5. SOIL QUALITY AND FERTILITY

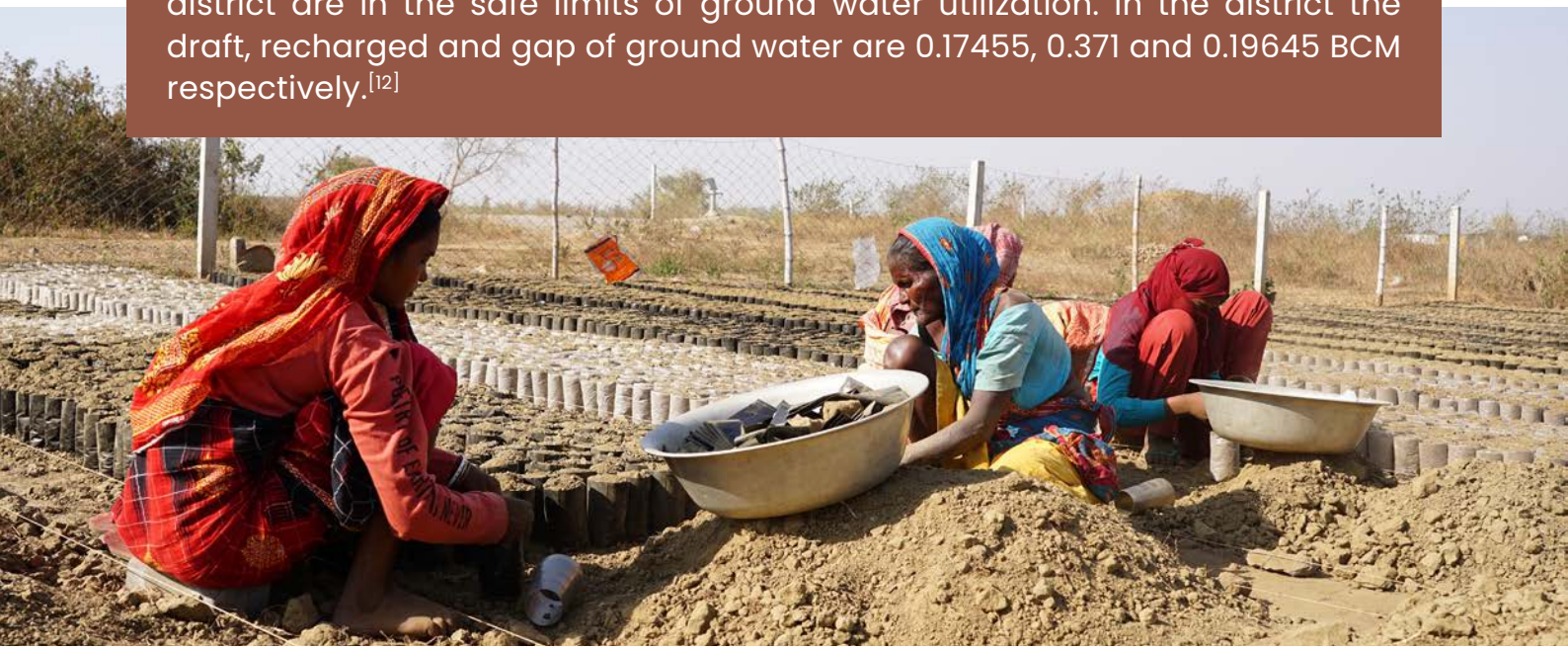
The soil of the district may be broadly classified into Matured Red and Lateritic soil (Alfisols), Mixed Grey Soil (Inceptisols) and Unalted Soils with coarse parent materials (Entosols). Typical red soil is found mostly in the hills of Bamanghaty and Panchpir sub-divisions and is suitable mainly for paddy, millets, sabai grass and other minor crops. Red loamy soil, which is found near riverbanks, is suitable for early variety paddy, groundnut, til, caster, black mung and kulthi. The clay- loam type is found in the sub-divisions of Kaptipada and Baripada. Medium and late varieties of paddy are grown on this soil. The land remains fallow after the first harvest. However, in some areas gram, linseeds etc. are cultivated. Laterite soil is found in the hill and plateau region. Two types of laterites namely, Laterite morrum and laterite rocks have so far been identified in the district. These serve no productive value for agricultural purposes.[10]

Soil erosion occurs when soil is removed through the action of wind and water at a great rate than it is formed. Concentrated high rainfall in monsoon period with sufficient surface gradient and uncovered crop fields are observed to be the major causes of land degradation in the area. As porous soil, they have poor moisture retention capacity and are subject to heavy runoff soil erosion.

3.2.6. CROP PRODUCTIVITY

The total production and productivity of major crops (kharif) of the district are 1609977061 quintals/yr and 645583 kg/ha respectively. Similarly, for rabi crops, the production is 696825506 quintals/year and productivity is 546735 kg/ha. For horticulture and plantation, the total production is 134627 quintals/year. The net irrigated area in Karanjia and Jashipur is 2964 ha and 2933 ha.[11]

As per Central Ground Water Board (CGWB), all the blocks of Mayurbhanj district are in the safe limits of ground water utilization. In the district the draft, recharged and gap of ground water are 0.17455, 0.371 and 0.19645 BCM respectively.[12]



4. FINDINGS

The findings of the study have been divided into five sections viz.:

1. Change in tree cover
2. Growth pattern of the plants
3. CO2 Sequestration Potential of the plantation
4. Analysis of the findings/observations using OECD.DAC framework
5. Case study

4.1. CHANGE IN TREE COVER

4.1.1. COMPARISON ANALYSIS OF SATELLITE IMAGERY OF THE PLANTATION

The assessment of plantation was on 83 different tree plantation plots distributed across Odisha and Jharkhand. The purpose of the study was to determine the changes that took place over the time in the intervention areas.

While enrichment plantation was done on community land in most of the sites, fewer sites were fully reforested. The saplings were availed from private nurseries. The assessment was performed using Remote Sensing and GIS technique and the changes observed were categorized into the following:

- Increased tree cover
- No change in tree cover
- Reduced tree cover

Open-source satellite images are used for interpretation and analysis for the year of 2018 and 2022.

- Satellite Data: Sentinel 2B with 10m X 10m spatial resolution has been used.
- Google Earth Imagery: GE Imagery for 2018 and 2022 has been used to visualize changes in true colour imagery.

4.1.2. METHODOLOGY

A visual interpretation has been done to understand the changes across the plots from the year 2018 to 2022. The satellite images are represented using FCC (False -Colour- Composite), where the vegetation cover varies in shades of red. The Google Earth Images are represented in Natural Colours and can be used for reference and understanding.

The satellite image (Fig.1) is an overview of a False Colour Composite Satellite Image to understand the tone, texture and colour of the natural and man-made features to interoperate a particular satellite image for any location representing the following features:

- Forest/ Woody Vegetation
- Agriculture Lands
- Settlements/ Built-up land
- Road/ linear manmade features
- Trees outside forest/ Bund Plantation/ Roadside Plantation
- Waterbody/ Reservoirs/ Rivers

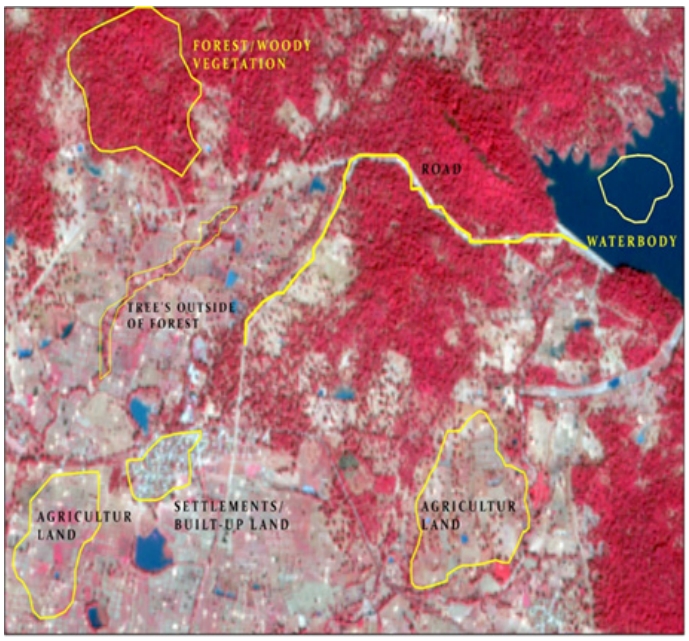


Figure 1: Overview of false colour composite satellite image

The report's Annexure 2 contains the satellite images of 83 plantation plots. The details of the plantation plots is provided in Table 6 below which has been colour coded to understand their status. The following are the colour codes used:

- Increased tree cover
- No change in tree cover
- Reduced tree cover

4.1.3. INFERENCE

Based on visual image interpretation analysis using natural and false composite colour data having 10*10-meter sentinel (false colour composite) and Google Earth Imagery (True Colour Composite), it can be stated that out of 48 plantation plots studied in Jharkhand, 16 plantation plots exhibited increased tree cover, 26 plantation plots showed no change in tree cover while reduced tree cover was noticed in six plantation plots. In Odisha, one out of 27 plantation plots, exhibited in increased tree cover while 26 plantation plots showed no change from 2018 to 2022 (Table 6).

4.2. GROWTH PATTERN OF THE PLANTS

Quadrat study was done to assess the growth pattern of the plants. The Girth at Breast Height (GBH) and Height (H) of the trees were measured for the plantation for the year 2019-20 and 2020-21 and their respective Diameter at Breast Height (DBH) were calculated. Only those trees were measured whose GHB was ≥ 10 cm. The no. of trees attaining 10 cm GBH in the villages of Karanjia Block of Odisha and Boram and Potamda Blocks of East Singhbhum were significantly low, so its growth parameters were not recorded. The data of trees in quadrat and transact in studied plots is presented in Table 7.

Table 6: Details and status of the plantation plots in Jharkhand and Odisha.

FID	Name of the plantation plots	Plantation date	No. of trees planted	Latitude	Longitude
JHARKHAND					
1	New Jamakeshwar 3	2020-12-20	5536	22.004976	86.06304
2	New Jamakeshwar 4	2020-12-20	10000	22.005957	86.06023
3	New Jamakeshwar 5	2020-12-20	5000	22.007936	86.059074
4	New Jamakeshwar 7	2020-12-20	30000	21.99986	86.05912
5	New Jamakeshwar 8	2020-12-20	20000	22.002272	86.05589
6	New Jamakeshwar 9	2020-12-20	12000	22.003002	86.05784
7	New Jamakeshwar 10	2020-12-21	10000	22.005068	86.05275
8	New Jamakeshwar 13	2020-12-21	15000	21.988958	86.04435
9	New Jamakeshwar 15	2020-12-21	5000	21.986889	86.03293
10	New Jamakeshwar 16	2020-12-22	1553	21.983273	86.017075
12	New Jamakeshwar 19	2020-12-21	10000	22.029287	86.07838
13	New Jashipur 24	2021-01-08	19000	22.00196	86.05966
15	New Jashipur 26	2021-01-08	2000	22.010973	86.052635
16	New Kumhari 14	2020-12-08	25000	22.889307	86.293686
17	New Kumhari 15 (Babita)	2020-12-08	5000	22.889164	86.29481
18	New Kumhari 29 @(R)Binota	2020-12-30	10000	22.885231	86.29177
19	New Luabasa 18	2020-12-12	12000	22.742052	86.28336
20	New Luabasa 20	2020-12-12	1553	22.746283	86.27532
21	New Luabasa Khairbani 19	2020-12-12	24000	22.73632	86.28274
22	New Lubasa 25	2020-12-27	25000	22.76331	86.29408
23	New Lylam 23 (near panchyat)	2020-12-15	10000	22.861847	86.28148
24	New Lylam Dungri 22 (Near Lake)	2020-12-13	10000	22.856113	86.2866
25	New Lylam Dungri 30	2020-12-30	2553	22.86846	86.2816
26	New Nutandhi Bhatta 9	2020-12-06	5000	22.848906	86.290276
27	New Nutandhi Jangal 1	2020-12-05	20000	22.849897	86.32177
28	New Nutandhi Jangal 2	2020-12-05	5000	22.849648	86.32242

29	New Nutandhi Jangal 3	2020-12-05	20000	22.850637	86.31157
30	New Nutandhi Jangal 4	2020-12-05	12000	22.852543	86.30563
31	New Nutandhi Jangal 6	2020-12-06	15000	22.845219	86.29623
32	New Nutandhi Jangal 7	2020-12-06	5000	22.84567	86.297935
34	New Pagda 31	2021-01-02	5000	22.878038	86.28692
35	New Phunsha 12	2020-12-07	24000	22.855822	86.27998
36	New Phunsha 13	2020-12-07	5000	22.854208	86.284546
37	New Rapacha 25 @Ambuj	2020-12-30	12000	22.893332	86.29946
38	New Santhaltola 16	2020-12-10	25000	22.893215	86.288765
39	Resolve new Again Lylam Dungri 21	2020-12-13	5536	22.855755	86.29203
40	Resolve New Dholadhi 17	2020-12-11	15000	22.66481	86.20181
41	Resolve New Jamakeshwar 11	2020-12-21	1553	21.991993	86.04586
42	Resolve New Jamakeshwar 18	2020-12-21	2553	22.027653	86.07402
43	Resolve New Jamakeshwar 21	2020-12-20	10000	22.012897	86.05569
44	Resolve New Jamakeshwar 23	2020-12-20	10000	21.990896	86.04624
45	Resolve New Kumhari 26@ Milan	2021-02-26	10000	22.888746	86.29338
46	Resolve New Lylam Dungri 21	2020-12-13	-5536	22.854618	86.29106
47	Resolve New Lylam Panchyat 10	2021-02-25	1553	22.865978	86.287
48	Resolve New Nutandhi Jangal 1	2020-12-05	20000	22.844898	86.299446
49	Resolve New Pagda 32	2021-01-02	12000	22.87486	86.29358
50	Resolve New Phunsha 11	2020-12-07	10000	22.854424	86.28357
52	Resolve New Shanthaltola 28	2020-12-31	10000	22.890583	86.28743
ODISHA					
2	Jammukeshwar/AWF/A3	2021-10-27	50000	21.866611	86.00439
3	Jammukeshwar/AWF/A6	2021-10-27	50000	21.872494	86.01235
4	Jammukeshwar/AWF/A7	2021-10-27	100000	21.871508	86.01554
5	Jammukeshwar/AWF/A8	2021-10-27	70000	21.878254	86.01349
6	Jammukeshwar/AWF/A11	2021-10-27	19500	21.87546	86.018906
7	Jammukeshwar/AWF/A12	2021-10-27	50000	22.023027	86.06277
8	Jammukeshwar/AWF/A14	2021-10-28	10000	21.893959	86.050064
9	Jammukeshwar/AWF/DT33	2021-10-29	90000	22.084963	86.0905
10	Jammukeshwar/AWF/DT34	2021-10-29	225000	22.076838	86.10219
12	Jammukeshwar/AWF/K16	2021-10-28	50000	21.888626	86.052956
13	Jammukeshwar/AWF/k20	2021-10-28	50000	21.883411	86.05579
14	Jammukeshwar/AWF/M23	2021-10-28	40000	21.876535	86.050896
15	Jammukeshwar/AWF/M24	2021-10-28	20000	21.876791	86.05167
16	Jammukeshwar/AWF/P17	2021-10-28	50000	21.885128	86.051704
17	Jammukeshwar/AWF/P18	2021-10-28	10000	21.884817	86.049225
18	Jammukeshwar/AWF/P19	2021-10-28	30000	21.884142	86.04673
19	Jammukeshwar/AWF/P20	2021-10-28	10000	21.883131	86.04088

20	Jammukeshwar/AWF/R22	2021-10-28	260000	21.884974	86.06085
21	Jammukeshwar/AWF/R29	2021-10-29	80000	21.924414	86.00546
22	Jammukeshwar/AWF/RK30	2021-10-29	100000	21.941607	85.97856
23	Jammukeshwar/AWF/RK31	2021-10-29	15000	21.941349	85.978485
24	Jammukeshwar/AWF/RK32	2021-10-29	5000	21.94426	85.9788
25	Jammukeshwar/AWF/T13	2021-10-28	40000	21.89398	86.05056
26	Jammukeshwar/AWF/T25	2021-10-28	50000	21.879417	86.06644
27	Jammukeshwar/AWF/T26	2021-10-28	5000	21.879478	86.06658
28	Jammukeshwar/AWF/T27	2021-10-28	50000	21.881254	86.06846
29	Jammukeshwar/AWF/T28	2021-10-28	15000	21.883806	86.06888

Table 7: Data of trees in quadrat and transact in studied plots.

FY	Block	Village	Species	Total no. of planted trees in quadrat	Average GBH (cm)	Average DBH (cm)	Average Height (m)
MAYURBHANJ, ODISHA							
2019-20	Jashipur	Kumbhapandugandi	*A. auriculiformis*	705	12.92	4.11	4.9
2020-21		Manada	*A. auriculiformis*	793	10.62	3.38	4.5
			T. grandis	19	10.40	3	4.7
2021-22	Karanjia	Tulasiposi	*A. auriculiformis*	454			
			T. grandis	429			
		Raitalia	*A. auriculiformis*	209			
			T. grandis	204			
EAST SINGHBHUM, JHARKHAND							
2018-19	Boram	Laylam	*Dalberigia sissoo*	53			
			Citrus limon	78			
			Syzygium cumini	8			
			A. auriculiformis	3			
2019-20		Santhaltola	*A. auriculiformis*	758			

2020-21	Patamda	Kumari	*A. auriculiformis*	68			
		Nutandih	*A. auriculiformis*	71			
			Psidium guajava	1			
			Syzygium cumini	1			
2021-22		Garigram	*A. auriculiformis*	34			

**P.S. Total has been counted of all plants in the quadrat placed. Measurements of GBH and H only taken for plants greater than 10 cm GBH*

Survival rate of the species in the study sites could not be calculated due to lack of data of the number of trees initially planted in that area. The growth data of the trees, on the basis of which CO2 sequestration potential have been calculated, is annexed in Annexure 1.

4.3. CO2 SEQUESTRATION POTENTIAL OF THE PLANTATION

4.3.1. THE CO2 SEQUESTRATION POTENTIAL OF ACACIA IN VILLAGE KUMBHARPANDUGANDI, JASHIPUR BLOCK, ODISHA

Mean Annual Increment DBH(cm/year)(D)	1.03	4.12 cm/4 year = 1 cm/year MAI
Mean Annual Increment height(m/year)(H)	1.23	4.9 cm/4year = 1.22 m/year MAI
Root to Shoot ratio	0.25	CDM AR Tool[13]
Carbon Fraction	0.47	
C to CO2 conversion factor	3.142	
Equation for Above Ground Biomass(AGB)	-1.974+0.827lnD^2H[14]	
Wood Density(ρ)	0.50 kg/m^3 [15]	

Table 8: Calculation for CO2 Sequestration Potential of Acacia in Kumbharpandugandi village, Block Jashipur, Odisha

Year	DBH (cm)	Height (m)	AGB (kg/ tree)	BGB (kg/ tree)	Total Biomass (kg/tree)	Total carbon (kgC/ tree)	Total Carbon (kgCO2/ tree)	Total CO2 (tCO2/ tree)	Total number of surviving trees	Total tCO2/year
2023	4.11	4.94	5.40	1.35	6.75	3.17	11.63	0.01	133500	1551.95
2024	5.14	6.17	9.39	2.35	11.73	5.51	20.22	0.02	132165	2672.53
2025	6.17	7.40	14.76	3.69	18.44	8.67	31.79	0.03	130830	4158.60
2026	7.20	8.63	21.63	5.41	27.04	12.71	46.59	0.05	129495	6033.60
2027	8.23	9.86	30.12	7.53	37.66	17.70	64.89	0.06	128160	8316.59
2028	9.26	11.09	40.35	10.09	50.43	23.70	86.92	0.09	126825	11023.02
2029	10.29	12.32	52.40	13.10	65.50	30.79	112.88	0.11	125490	14165.24
2030	11.32	13.55	66.38	16.59	82.97	39.00	142.99	0.14	124155	17752.92
2031	12.35	14.78	82.37	20.59	102.96	48.39	177.44	0.18	122820	21793.38
2032	13.38	16.01	100.47	25.12	125.58	59.02	216.42	0.22	120150	26002.85

4.3.2. THE CO2 SEQUESTRATION POTENTIAL OF TEAK IN VILLAGE MANADA, JASHIPUR BLOCK, ODISHA

Mean Annual Increment DBH(cm/year)(D)	1.12	3.38 cm/3year = 1 cm/year MAI
Mean Annual Increment height(m/year)(H)	1.5	4.52 m/3year = 1.50 m/year MAI
Root to Shoot ratio	0.25	CDM AR Tool[16]
Carbon Fraction	0.47	
C to CO2 conversion factor	3.142	
Equation for Above Ground Biomass(AGB)	-1.974+0.827lnD^2H[17]	
Wood Density(ρ)	0.50 kg/m^3 [18]	

Table 9: Calculation for CO2 Sequestration Potential of Acacia in Manada Village, Jashipur Block, Odisha

Year	DBH (cm)	Height (m)	AGB (kg/ tree)	BGB (kg/ tree)	Total Biomass (kg/tree)	Total carbon (kgC/ tree)	Total Carbon (kgCO2/ tree)	Total CO2 (tCO2/ tree)	Total number of surviving trees	Total tCO2/year
2023	3.38	4.52	3.62	0.91	4.53	2.13	7.81	0.01	133500	1042.27
2024	4.50	6.02	7.37	1.84	9.22	4.33	15.89	0.02	132165	2099.69
2025	5.62	7.52	12.80	3.20	16.00	7.52	27.58	0.03	130830	3608.44
2026	6.74	9.02	20.10	5.03	25.13	11.81	43.30	0.04	129495	5607.11
2027	7.86	10.52	29.44	7.36	36.80	17.29	63.41	0.06	128160	8126.87
2028	8.98	12.02	40.97	10.24	51.21	24.07	88.26	0.09	126825	11192.97
2029	10.10	13.52	54.84	13.71	68.56	32.22	118.14	0.12	125490	14825.85
2030	11.22	15.02	71.20	17.80	89.00	41.83	153.37	0.15	124155	19041.77
2031	12.34	16.52	90.16	22.54	112.70	52.97	194.21	0.19	122820	23853.41
2032	13.46	18.02	111.85	27.96	139.81	65.71	240.94	0.24	120150	28948.62

4.3.3. THE CO2 SEQUESTRATION POTENTIAL OF TEAK IN VILLAGE MANADA, JASHIPUR BLOCK, ODISHA

Mean Annual Increment DBH(cm/year)(D)	1.1	3.31cm/3 year = 1.1 cm/year MAI
Mean Annual Increment height(m/year)(H)	1.57	4.70cm/3 year = 1.57 cm/year MAI
Root to Shoot ratio	0.25	CDM AR Tool[19]
Carbon Fraction	0.47	
C to CO2 conversion factor	3.667	
Equation for Above Ground Biomass(AGB)	0.06 p(ΠD2 /4)H[17]	
Wood Density(ρ)	0.65 kg/m^3 [21]	

Table 10: Calculation for CO2 Sequestration Potential of Teak in Manada Village, Jashipur Block, Odisha

Year	DBH (cm)	Height (m)	AGB (kg/ tree)	BGB (kg/ tree)	Total Biomass (kg/tree)	Total carbon (kgC/ tree)	Total Carbon (kgCO2/ tree)	Total CO2 (tCO2/ tree)	Total number of surviving trees	Total tCO2/year
2023	3.31	4.70	1.58	0.39	1.97	0.93	3.40	0.00	320000	1087.55
2024	4.41	6.27	3.74	0.93	4.67	2.19	8.05	0.01	316800	2549.45
2025	5.51	7.84	7.29	1.82	9.11	4.28	15.71	0.02	313600	4926.02
2026	6.61	9.41	12.60	3.15	15.74	7.40	27.13	0.03	310400	8421.77
2027	7.71	10.98	19.99	5.00	24.99	11.75	43.07	0.04	307200	13231.64
2028	8.81	12.55	29.84	7.46	37.30	17.53	64.28	0.06	304000	19540.90
2029	9.91	14.12	42.48	10.62	53.10	24.96	91.51	0.09	300800	27525.21
2030	11.01	15.69	58.26	14.57	72.83	34.23	125.51	0.13	297600	37350.61
2031	12.11	17.26	77.54	19.38	96.92	45.55	167.03	0.17	294400	49173.49
2032	13.21	18.83	100.66	25.16	125.82	59.14	216.83	0.22	288000	62446.78

Table 11: Total carbon sequestered in Acacia and Teak

Year	Acacia auriculiformis			Tectona grandis		
	Average CO2 (tCO2 /tree)	**Total number of surviving trees**	**Total tCO2**	**Average CO2 (tCO2 /tree)**	**Total number of surviving trees**	**Total tCO2**
2023	0.01	133500	1297.11	0.00	320000	1087.55
2024	0.02	132165	2386.11	0.01	316800	2549.45
2025	0.03	130830	3883.52	0.02	313600	4926.02
2026	0.04	129495	5820.35	0.03	310400	8421.77
2027	0.06	128160	8221.73	0.04	307200	13231.64
2028	0.09	126825	11108.00	0.06	304000	19540.90
2029	0.12	125490	14495.54	0.09	300800	27525.21
2030	0.15	124155	18397.34	0.13	297600	37350.61
2031	0.19	122820	22823.39	0.17	294400	49173.49
2032	0.23	120150	27475.73	0.22	288000	62446.78

**Note: Average tCO2/tree has been derived from the total tCO2/tree of Acacias in Kumbharpandugandi and Manada.*

The safest survival percentage is considered as 90% since the species are grown on community/ farmers land, both the species are non- palatable, hardy and drought resistant. The research report for considering 90% survival of both species is cited below (Reference No. 22 and 23).

4.4. ANALYSIS

To analyse the findings of the study of the plantation activity carried out by AWF, OECD.DOC criteria for impact evaluation has been used. The findings of the study are based on the focussed group discussion with the community members, personal interview of the farmers and field observations.

Table 12: Findings/ Observations of East Singhbhum field sites

Criteria	Parameters of Assessment	Findings/ Observations
RELEVANCE (Is the Intervention doing the right things?)	How plantation is relevant to that area?	The area is facing severe land degradation. Around 60% of the geographical area of the district is affected by soil degradation. The pH values of the soil are low indicating that the soil is leached and deprived of bases and nutrients. Plantation in such an area is relevant as it would help in building up soil organic matter and thereby arresting land degradation and help in soil and moisture conservation.
	Are the chosen species native and conducive to the climate and geography of that region?	*Acacia auriculiformis* is mostly planted in the area. Since the district is mainly rocky with poor water retention capacity, the species is apt for the area. The species is capable to adapt in almost all soil conditions, improving the same by adding nitrogen and organic matter at a faster rate and mitigating soil erosion by its dense root system. However, the species produces prolific leaf litter and does not allow other species to grow with it.
	Has the plantation brought in a profit in income to the beneficiaries as compared to earlier?	• The plantation of *Acacia* is too young to bring profit to the beneficiaries. However, when it matures, it can be used timber production, bark for tanning material. Its branches and leaves are source of fuelwood. The flowers are the source of pollen for honey production. • The fruit trees, though planted less in number, would be used for self-consumption to fulfil their nutritional requirements rather than selling it in the market, the communities informed.
	Has the plantation created employment opportunities?	• Women members from the villages were involved in pit digging and plantation of saplings. • It created employment opportunities during the COVID 19 lockdown when they could not go to distant places for labour.

COHERENCE (How well does the intervention fit?)	Steps initiated to scout land for plantation	Gram Panchayats were engaged to identify the community/ farmers waste land. Species were selected keeping in view the species promoted by the Forest Department of Jharkhand. Village women were engaged as labours for pit digging and plantation.
	Raising saplings in nursery	Two nurseries were established in the Laylam Gram Panchayat to supply saplings for plantation.
	Has the plantation helped in the betterment of water table of the village?	Most farmers reported scarcity of water to irrigate lands. Water table has also remained the same as reported by farmers.
	Women employment through project and government schemes	Women engaged as labourers are also engaged in MGNREGA. Therefore, the intervention fits properly in creating employment opportunities addressing empowerment of rural women.
	Documentation of activities	There were no records of the events. The names of the species planted as mentioned in the Annual Report were not found on the plots. Despite the creation of polygons representing the plantation sites, some of the polygons had errors.
	Does the intervention create more profit to farmers than present income?	• The plantation is too young to create any profit. Plantation of *Acacia* would create a profitable income if the farmers were duly informed on its management practices and marketing channels. It was observed that most of the farmers are unaware of its management practices as well as its marketability. • Ponds created under the project is utilised for pisciculture. The fishes were sold in the village haats creating a source of earning for the community members.
EFFECTIVENESS (Is the intervention achieving its objectives?)	Conserving environment through afforestation activities	The plantation would fulfil the community needs, thereby, reducing the anthropogenic pressure on forest and conserving local biodiversity. It would also help in stabilising land degradation through soil erosion. It would also increase the ground water table.
	Increase in local community produce	• The plantation would increase fuelwood and timber and fruits along with the production of fishes in ponds created under the project. • The leaves of *Acacia* are a good source of fuel because of its high calorific value and less smoke production.
	Change in tree cover	The RSGIS imagery exhibited increased tree cover in 16 out of 48 plantation plots. However, in 26 plantation plots there were no change in tree cover while in six plots reduced tree cover was noticed. It may be due to anthropogenic activities, grazing or natural calamities.
	Increase in soil fertility and moisture retention	Soil fertility and moisture retention capacity of the soil would improve. *Acacia* being planted majorly in the plots, will not allow other plants to grow in its vicinity due to its allelopathic effect (as also reported by farmers).

EFFICIENCY (How well are the resources being used?)	Formation of village level collectives	Village level collectives were not formed
	Capacity building for plantation management	Capacity building activities of beneficiaries were not undertaken
	Resource created under the plantation program	• Nurseries are established for providing saplings for plantation. • Water harvesting structures such as ponds are created under the plantation program which would be utilised for irrigating the plantation site as well as the farmers land. It has also created an opportunity for aquaculture for the villagers. • The leaves of *Acacia* serves as a source of fuel.
	Resource provided by organisation	Fertiliser, saplings, meetings were provided by NGO, but villagers also complained of water scarcity.
	Local human resource for labour	Women members from the villages were involved in pit digging and plantation creating employment opportunities during the COVID 19 lockdown when they could not go to distant places for labour
IMPACT (What difference does the intervention make?	Reduced anthropogenic pressure in the forest	The anthropogenic pressure on the nearby forest area is due to collection of firewood, small timber for house construction and fruits for self-consumption. Though the plantation of *Acacia* is young, however, when it matures, it would fulfil the requirements of firewood and small timber.
	Erosion control	Its spreading, superficial and densely matted root system makes *A. auriculiformis* suitable for stabilizing eroded land.
	Reduced vulnerability	The plantation serves as an asset to the beneficiaries. Various parts of the planted trees are of economic importance reducing the climate vulnerability of the communities.
	Improved social bonds	Provided social support through creating employment opportunities bringing social cohesion among the community members.
SUSTAINABILITY (Will the benefits last?)	Project Documents have not been provided (due to confidentiality clause) to study the sustainability aspect and therefore, cannot be commented upon.	

Table 13: Findings/ Observations from Mayurbhanj field sites

Criteria	Parameters of Assessment	Findings/ Observations
RELEVANCE (Is the Intervention doing the right things?)	How plantation is relevant to that area?	Although being a home to Simlipal Biosphere Reserve and having a lush green vegetation, Mayurbhanj faces soil erosion due to heavy rainfall during monsoon. Plantation in such an area would aid in halting land degradation due to soil erosion. Plantation is, therefore, pertinent to that area. The locals reported that the activity has reduced their impact on forests for fire and fuelwood. Now, they use dry litter, leaves and wood from the plantation for fuelwood.
	Are the chosen species native and conducive to the climate and geography of that region?	Odisha is vulnerable to powerful cyclonic storms. Due to the cyclone resistance nature of acacia, the plantation is well suited for the place.
	Has the plantation brought in a profit in income to the beneficiaries as compared to earlier?	Profits from sale of NTFP has been expected but as of now plantation is very young to harvest NTFP.v
	Has the plantation created employment opportunities?	The project created opportunities for women employment. They were tasked with the responsibility to dig pits, raise the saplings in nursery and plant the same.
	Has the plantation created employment opportunities?	The plantation is too young to create any profit. Plantation of *Acacia* would create a profitable income if the farmers were duly informed on its management practices and marketing channels. It was observed that most of the farmers are unaware of its management practices as well as its marketability.
COHERENCE (How well does the intervention fit?)	Increase in soil fertility	Fertility increased in earlier barren lands where plantation is done due to manure and irrigation
	Catchment areas such as ponds, lakes	As water is scarce, villagers reported creation of artificial ponds for irrigation, raising ducks, aquaculture for self-sustenance and sale as well.
	Has the plantation helped in the betterment of water table of the village?	Most farmers reported lack and scarcity of water to irrigate lands. Water table has also remained the same.
	Women employment through project and government schemes	• Most women are in agriculture, and Mission Shakti which advocates independence and empowerment of women also helps them in securing work, roles in community and even employment in the village. Therefore, the intervention fits properly in addressing empowerment of rural women. • Employment has been created under the intervention such as labourers, nursery caretakers etc and fit into the larger perspective of MGNREGA. However, the village needs much more employment in winter season where crops are not in good abundance due to lack of winter cash crops.

	Documentation of activities	There were no records of the events. The names of the species planted as mentioned in the Annual Report were not found on the plots. Despite the creation of polygons representing the plantation sites, some of the polygons had errors.
	Does the intervention create more profit to farmers than present income?	• The plantation is too young to create any profit. Plantation of *Acacia* would create a profitable income if the farmers were duly informed on its management practices and marketing channels. It was observed that most of the farmers are unaware of its management practices as well as its marketability. • Ponds created under the project is utilised for pisciculture. The fishes were sold in the village haats creating a source of earning for the community members.
EFFECTIVENESS (Is the intervention achieving its objectives?)	Conserving environment through afforestation activities	The plantation would fulfil the community needs, thereby, reducing the anthropogenic pressure on forest and conserving local biodiversity. It would also help in stabilising land degradation through soil erosion. It would also increase the ground water table.
	Increase in local community produce	• The plantation would increase fuelwood and timber and fruits along with the production of fishes in ponds created under the project. • The leaves of *Acacia* are a good source of fuel because of its high calorific value and less smoke production.
	Change in tree cover	Increased tree cover was observed only in one of the plantation plots. Rest all the 26 plantation plots did not show any change since the plantation was too young and it was hard to detect any change.
	Increase in soil fertility and moisture retention	Soil fertility increased due to organic manure applied during plantation and irrigation contributed to moisture retention. However, due to recent climate change impacts in terms of low rainfall, the farmers were having a tough time gaining profit from their cash crops, rice, as less rain meant declining production.
EFFICIENCY (How well are the resources being used?)	Formation of village level collectives	SHGs were formed in the villages and were responsible for taking care of plantation.
	Capacity building for plantation management	Capacity building activities of beneficiaries were not undertaken. Meetings were conducted prior to plantation activities however they did not contribute anything in training.
	Resource created under the plantation program	• Nurseries are established for providing saplings for plantation. • Water harvesting structures such as ponds are created under the plantation program which would be utilised for irrigating the plantation site as well as the farmers land. It has also created an opportunity for aquaculture for the villagers.
	Resource provided by organisation	Fertiliser, saplings, meetings were provided by NGO, but villagers also complained of water scarcity.
	Local human resource for labour	Women members from the villages were involved in pit digging and plantation creating employment opportunities during the COVID 19 lockdown when they could not go to distant places for labour.

IMPACT (What difference does the intervention make?	Improvement of air quality	Villagers reported more cleaner air in surroundings of the plantations.
	Change in employment numbers in village	Employment has increased few folds in the last 10 years.
	New jobs were created at the time of plantation	Plantation brought jobs such as care takers, nursery management, and labour for preparation of plantation activities
	Increase in sale of NTFP in community	Old plantations reaped benefits such as fruits (kaju, lemon etc) and they were used to sale and benefit the farmers
	Increase in soil fertility	Fertility increased in earlier barren lands where plantation is done due to manure and irrigation
	Catchment areas such as ponds, lakes	As water is scarce, villagers reported creation of artificial ponds for irrigation, raising ducks, aquaculture for self-sustenance and sale as well.
	Profit from plantation	More margin of profit needs to be given as complained by villagers
SUSTAINABILITY (Will the benefits last?)	Project Documents have not been provided (due to confidentiality clause) to study the sustainability aspect and therefore, cannot be commented upon.	

4.5. CASE STUDIES

4.5.1. PONDS (AQUACULTURE)

Villages surveyed in Mayurbhanj district were found to have ponds which were used for the sale, consumption and breeding of fishes and ducks. There are many types of fishes that the villagers preferred, such as Rohu, Catla, Magur, Pongas and Kou (Hybrid and Desi). The ponds in each village were of the nature of household ponds or community ponds. In household ponds, the family owning the pond would harvest the fishes mainly for self-consumption and sustenance purposes. But, in community ponds, the entire village would come together, bring in some money collectively, dig out land and make a pond, which they would then use to breed fishes mainly for its sale and profit making of the village. Self-help groups present in each of the villages would take primary responsibility in the collection of funds, maintenance of ponds and fishes, and sale of the same.

Ponds as big as 60X60 feet were present, and villagers would sell fishes at a discounted wholesale price of Rs. 160/kg, whereas the market rate would soar up to Rs. 200/kg. Villages in Mayurbhanj suffered from shortage of water, due to low groundwater, decrease in rainfall and inadequate access to water. And therefore, it is imperative to note that most community ponds faced water scarcity due to this reason and were only functional in the monsoon season. When it comes to water for irrigation purposes, few panchayats of villages in collaboration created community ponds, whereby rainwater and runoff water from the hills would be collected. Canals were made from the pond to the agricultural fields, whereby water would flow into the fields thus fulfilling irrigation and moisture retention needs of the crops.

4.5.2. NURSERY

Under the AWF project, a nursery of 5 acres was also set up in Kumbharpandugandi in 2021, to supply planting material, saplings, fertilizers, etc. in all nearby villages. The community of the village is responsible in maintaining, handling and care taking of the nursery, whereas the funding of the same is being undertaken by AWF. All the species that were planted under this project are present in the nursery, such as Teak, Acacia, Karanj, Mango, Cashew etc. AWF is also responsible for setting up of targets of production and release of saplings each year, and the saplings go out to each village keeping in mind the target involved. For example, 20 lakhs and 10 lakhs of saplings went out in the first and second year of the nursery. The nursery refrains from the sale of saplings to private entities or individuals but is only capable of delivering to the project needs.

4.6. LIMITATIONS OF THE STUDY

A few limitations (listed below) in the study did have an impact on how it was conducted.

- Most of the plots in both the districts studied had *Acacia auriculiformis* monocultures. As a result, it was impossible to capture the growth information for the other species stated in the annual report.
- Record on species wise no. of saplings planted in each of the plots were unavailable. Besides, records on plot wise no. of saplings planted and size of each plot were also unavailable. This impacted the study as we could not determine the survival rate.
- Land ownership was unclear. The land claimed to be of farmers was encroached land as informed by AWF team. The farmers were unaware of the no. of *Acacia* saplings planted in their plot. Survival rate could not be determined.
- The operations carried out in the plantation programme were not documented due to the lockdown during the COVID 19 epidemic. No documents/ field records were available for reference.

- Land for plantations was located through Gram Panchayats. Other species that were planted on the area included *Dalbergia sissoo, Azadirachta indica, Citrus limon, Anacardium occidentale* and others. It was challenging to see the planted species because of the proliferation of weeds and grasses. The plantation on community land lacked supervision.
- As there was no engagement with the locals, the community lacked a sense of responsibility for the maintenance and management of the plantation.
- It is difficult to identify the changes in plantation since the plants are very new and planted in 2018.
- Weather conditions play a pivotal role in the growth of the trees. Hence, some areas are arid, and some areas have too much greenness.
- Though satellite imagery of the same time frame has been taken. But, due to climate change, the vegetation character has changed, which has hampered the accuracy of the data.

5. CONCLUSION

Plantation program carried out by AWF as a part of CSR initiative funded by Impact Guru, is an attempt to revegetate the degraded land. Plantation activities are done since 2019 with the involvement of Gram Panchayats in identification of degraded land.

Most of the plots visited in East Singhbhum and Mayurbhanj had *A. auriculiformis* growing in monoculture. The number of other species planted such as *Tectona grandis, Dalbergia sissoo, Azadirachta indica* etc. were few. The sites visited in Mayurbhanj showed better growth of trees. The trees planted in 2019 and 2020 have attained 10 cm GBH. Tree growth was seen to be slow in the East Singhbhum district. The number of trees attaining 10 cm GBH were significantly low.

For the supply of saplings in the plantation plots, nurseries were established in both districts. Women were used as labourers for plantation work and digging pits. The project's excavation of ponds gave the locals in the area the chance to engage in pisciculture and earn more money by selling fish at the local haats. Although the Gram Panchayats in both districts were found to be involved and engaged with the plantation initiative, community involvement with the implementing organisation was found to be low. The planting programme established nurseries for growing saplings and built ponds for aquaculture, providing chances for the village work force to increase their source of earning.

The species planted have the potential to reduce soil erosion-driven land degradation and revitalise the degraded locations. The plantation's products would be sold as well as used to meet the requirements of the local community. The satellite imagery of the plantation sites shows that out of 48 plantation plots studied in Jharkhand, 16 plantation plots exhibited increased tree cover, 26 plantation plots showed no change in tree cover while reduced tree cover was noticed in six plantation plots. In Odisha, one out of 27 plantation plots, exhibited in increased tree cover while 26 plantation plots showed no change from 2018 to 2022.

The survival rate of the species could not be calculated due to lack of data. The sequestration potential of *A. auriculiformis* and *T. grandis* in Mayurbhanj was estimated ex ante, considering 90% survival since the species are grown on community/farmers land, non- palatable and drought resistant. The carbon sequestration potential of auriculiformis and *T. grandis* is 27475.73 tCO2 and 62446.78 tCO2 respectively. The sample size of *T. grandis* is too small and the ER number may vary in future.

6. WAY FORWARD

- All field-related records and papers must be maintained and kept up to date.
- For management of the plantation sites, capacity building of the farmers and the communities is required on adoption of technologies, timely availability of inputs, access to markets etc. to develop a sense of ownership and maximise benefits form the plantation.
- To lower the risk of pest infestation, the practise of raising mixed plantations must be applied. Besides, Acacia tree leaves make excellent fuel. The leaves on the ground could catch fire, putting the entire crop in danger.
- Stakeholders at multiple levels from local, regional to national level must be engaged to maximise plantation benefits.
- Various government departments viz. Department of Water Resources, Department of Forests, Environment and Climate Change, Department of Rural Development, and others like may be approached for availing the benefits of the plantation schemes.
- The plantation's sustainability aspect needs to be addressed.

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8. ANNEXURE

Table 14: Growth data of A. auriculiformis in Kumbharpandugandi village, Odisha

Sl. No.	GBH (cm)	DBH (cm)	MAI DBH (cm/year)	Height (m)	MAI H (m/year)
1	13	4.14	1.03	6.32	1.58
2	20	6.37	1.59	7.5	1.875
3	19	6.05	1.51	8	2
4	16	5.09	1.27	7.1	1.775
5	12	3.82	0.95	11	2.75
6	10	3.18	0.80	4.6	1.15
7	11	3.50	0.88	5.1	1.275
8	17	5.41	1.35	6.9	1.725
9	18	5.73	1.43	7.4	1.85
10	15	4.77	1.19	6.8	1.7
11	10	3.18	0.80	5.8	1.45
12	14	4.46	1.11	6.8	1.7
13	15	4.77	1.19	7.1	1.775
14	14	4.46	1.11	5.6	1.4
15	13	4.14	1.03	5.2	1.3
16	10	3.18	0.80	4.8	1.2
17	10	3.18	0.80	4.1	1.025
18	10	3.18	0.80	3.8	0.95
19	11	3.50	0.88	5	1.25
20	10	3.18	0.80	3	0.75
21	11	3.50	0.88	3.5	0.875
22	12	3.82	0.95	4.1	1.025
23	11	3.50	0.88	4.3	1.075
24	16	5.09	1.27	5	1.25
25	13	4.14	1.03	4.6	1.15
26	15	4.77	1.19	6.9	1.725
27	11	3.50	0.88	5.3	1.325
28	16	5.09	1.27	6	1.5
29	11	3.50	0.88	5.4	1.35
30	18	5.73	1.43	6.9	1.725
31	14	4.46	1.11	5.5	1.375
32	12	3.82	0.95	5.7	1.425

33	13	4.14	1.03	5.9	1.475
34	15	4.77	1.19	6	1.5
35	14	4.46	1.11	6.1	1.525
36	19	6.05	1.51	7.4	1.85
37	17	5.41	1.35	7.2	1.8
38	13	4.14	1.03	6.8	1.7
39	14	4.46	1.11	6	1.5
40	16	5.09	1.27	7.3	1.825
41	16	5.09	1.27	6.2	1.55
42	11	3.50	0.88	5.6	1.4
43	15	4.77	1.19	6	1.5
44	11	3.50	0.88	5.2	1.3
45	10	3.18	0.80	5	1.25
46	14	4.46	1.11	6.2	1.55
47	15	4.77	1.19	6.4	1.6
48	14	4.46	1.11	5.5	1.375
49	10	3.18	0.80	4.6	1.15
50	10	3.18	0.80	5	1.25
51	12	3.82	0.95	5.2	1.3
52	10	3.18	0.80	3.8	0.95
53	12	3.82	0.95	5.1	1.275
54	14	4.46	1.11	5	1.25
55	10	3.18	0.80	5.1	1.275
56	10	3.18	0.80	5.2	1.3
57	12	3.82	0.95	5	1.25
58	13	4.14	1.03	5.3	1.325
59	11	3.50	0.88	5.3	1.325
60	15	4.77	1.19	5.3	1.325
61	12	3.82	0.95	5.2	1.3
62	18	5.73	1.43	5.4	1.35
63	10	3.18	0.80	5.1	1.275
64	11	3.50	0.88	5.2	1.3
65	10	3.18	0.80	5.2	1.3
66	15	4.77	1.19	5.4	1.35
67	20	6.37	1.59	7	1.75
68	14	4.46	1.11	5.8	1.45

69	12	3.82	0.95	5.2	1.3
70	14	4.46	1.11	5.6	1.4
71	10	3.18	0.80	5.3	1.325
72	16	5.09	1.27	5.7	1.425
73	10	3.18	0.80	5.5	1.375
74	15	4.77	1.19	6	1.5
75	10	3.18	0.80	5	1.25
76	17	5.41	1.35	6.9	1.725
77	14	4.46	1.11	7	1.75
78	16	5.09	1.27	6.9	1.725
79	10	3.18	0.80	5.2	1.3
80	12	3.82	0.95	5.6	1.4
81	14	4.46	1.11	6.1	1.525
82	11	3.50	0.88	6.3	1.575
83	11	3.50	0.88	5.3	1.325
84	15	4.77	1.19	5.4	1.35
85	14	4.46	1.11	5.3	1.325
86	11	3.50	0.88	5.9	1.475
87	13	4.14	1.03	6	1.5
88	11	3.50	0.88	5.8	1.45
89	12	3.82	0.95	5.2	1.3
90	14	4.46	1.11	6	1.5
91	10	3.18	0.80	5.4	1.35
92	15	4.77	1.19	5.2	1.3
93	13	4.14	1.03	5.3	1.325
94	17	5.41	1.35	7.1	1.775
95	13	4.14	1.03	4.2	1.05
96	14	4.46	1.11	5.6	1.4
97	12	3.82	0.95	5.4	1.35
98	17	5.41	1.35	6.2	1.55
99	28	8.91	2.23	8.1	2.025
100	13	4.14	1.03	6.9	1.725
101	23	7.32	1.83	7.2	1.8
102	20	6.37	1.59	7.3	1.825
103	12	3.82	0.95	7.1	1.775
104	19	6.05	1.51	7.3	1.825

105	12	3.82	0.95	5.9	1.475
106	13	4.14	1.03	5.6	1.4
107	16	5.09	1.27	7	1.75
108	14	4.46	1.11	6.1	1.525
109	22	7.00	1.75	8	2
110	10	3.18	0.80	5.2	1.3
111	13	4.14	1.03	5.4	1.35
112	12	3.82	0.95	6.2	1.55
113	20	6.37	1.59	8	2
114	21	6.68	1.67	7.1	1.775
115	20	6.37	1.59	7.8	1.95
116	16	5.09	1.27	6.1	1.525
117	18	5.73	1.43	6.3	1.575
118	16	5.09	1.27	6.2	1.55
119	14	4.46	1.11	5.2	1.3
120	13	4.14	1.03	5.2	1.3
121	11	3.50	0.88	5	1.25
122	11	3.50	0.88	3.5	0.875
123	22	7.00	1.75	6.9	1.725
124	21	6.68	1.67	7	1.75
125	15	4.77	1.19	6	1.5
126	12	3.82	0.95	5.8	1.45
127	13	4.14	1.03	6.1	1.525
128	11	3.50	0.88	5.2	1.3
129	12	3.82	0.95	5.3	1.325
130	17	5.41	1.35	5.2	1.3
131	11	3.50	0.88	5.2	1.3
132	13	4.14	1.03	5.8	1.45
133	15	4.77	1.19	5.3	1.325
134	12	3.82	0.95	5.4	1.35
135	12	3.82	0.95	5.3	1.325
136	14	4.46	1.11	5.4	1.35
137	17	5.41	1.35	6.2	1.55
138	14	4.46	1.11	5.6	1.4
139	14	4.46	1.11	5	1.25
140	11	3.50	0.88	4.2	1.05

141	10	3.18	0.80	3	0.75
142	10	3.18	0.80	4	1
143	10	3.18	0.80	3.2	0.8
144	10	3.18	0.80	3	0.75
145	11	3.50	0.88	4	1
146	10	3.18	0.80	3	0.75
147	14	4.46	1.11	5.5	1.375
148	10	3.18	0.80	3	0.75
149	10	3.18	0.80	2.8	0.7
150	12	3.82	0.95	5	1.25
151	12	3.82	0.95	4.9	1.225
152	17	5.41	1.35	6	1.5
153	18	5.73	1.43	6.2	1.55
154	12	3.82	0.95	5.3	1.325
155	12	3.82	0.95	5.4	1.35
156	11	3.50	0.88	5.6	1.4
157	10	3.18	0.80	5.3	1.325
158	20	6.37	1.59	5.8	1.45
159	12	3.82	0.95	5.6	1.4
160	10	3.18	0.80	5.4	1.35
161	11	3.50	0.88	5.3	1.325
162	11	3.50	0.88	5.6	1.4
163	20	6.37	1.59	6	1.5
164	19	6.05	1.51	5.9	1.475
165	16	5.09	1.27	6	1.5
166	10	3.18	0.80	5.8	1.45
167	14	4.46	1.11	5.7	1.425
168	12	3.82	0.95	5.3	1.325
169	11	3.50	0.88	5.8	1.45
170	16	5.09	1.27	5.9	1.475
171	10	3.18	0.80	5.8	1.45
172	17	5.41	1.35	6	1.5
173	11	3.50	0.88	5.5	1.375
174	12	3.82	0.95	5.3	1.325
175	13	4.14	1.03	5.5	1.375
176	12	3.82	0.95	5.8	1.45

177	15	4.77	1.19	6	1.5
178	13	4.14	1.03	5.4	1.35
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180	11	3.50	0.88	5.6	1.4
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184	17	5.41	1.35	5.3	1.325
185	10	3.18	0.80	4.8	1.2
186	15	4.77	1.19	5.2	1.3
187	10	3.18	0.80	4.8	1.2
188	10	3.18	0.80	4.7	1.175
189	11	3.50	0.88	4.8	1.2
190	18	5.73	1.43	6	1.5
191	14	4.46	1.11	4.7	1.175
192	13	4.14	1.03	5.3	1.325
193	13	4.14	1.03	4.7	1.175
194	12	3.82	0.95	4.8	1.2
195	11	3.50	0.88	4.4	1.1
196	16	5.09	1.27	5.2	1.3
197	11	3.50	0.88	5	1.25
198	10	3.18	0.80	4.6	1.15
199	13	4.14	1.03	5	1.25
200	10	3.18	0.80	4.7	1.175
201	11	3.50	0.88	4.8	1.2
202	15	4.77	1.19	4.5	1.125
203	12	3.82	0.95	3.8	0.95
204	10	3.18	0.80	4.5	1.125
205	10	3.18	0.80	4.7	1.175
206	13	4.14	1.03	5	1.25
207	12	3.82	0.95	4.9	1.225
208	15	4.77	1.19	5.5	1.375
209	14	4.46	1.11	5.5	1.375
210	12	3.82	0.95	5.2	1.3
211	10	3.18	0.80	5.2	1.3
212	10	3.18	0.80	5.1	1.275

213	11	3.50	0.88	5.3	1.325
214	15	4.77	1.19	5.9	1.475
215	14	4.46	1.11	6	1.5
216	10	3.18	0.80	5.4	1.35
217	16	5.09	1.27	5.2	1.3
218	12	3.82	0.95	5.8	1.45
219	12	3.82	0.95	5.4	1.35
220	13	4.14	1.03	5.5	1.375
221	11	3.50	0.88	5.1	1.275
222	10	3.18	0.80	4.8	1.2
223	11	3.50	0.88	5	1.25
224	10	3.18	0.80	5.2	1.3
225	15	4.77	1.19	4.8	1.2
226	15	4.77	1.19	5	1.25
227	10	3.18	0.80	4.8	1.2
228	14	4.46	1.11	4.9	1.225
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232	12	3.82	0.95	4.8	1.2
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236	10	3.18	0.80	4.2	1.05
237	10	3.18	0.80	4.2	1.05
238	11	3.50	0.88	5.2	1.3
239	12	3.82	0.95	5.7	1.425
240	12	3.82	0.95	5.2	1.3
241	11	3.50	0.88	4.6	1.15
242	13	4.14	1.03	4.8	1.2
243	11	3.50	0.88	5	1.25
244	14	4.46	1.11	4.8	1.2
245	14	4.46	1.11	5	1.25
246	10	3.18	0.80	4.2	1.05
247	14	4.46	1.11	5.2	1.3
248	13	4.14	1.03	5.1	1.275

249	10	3.18	0.80	5.2	1.3
250	13	4.14	1.03	4.7	1.175
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252	16	5.09	1.27	5.1	1.275
253	10	3.18	0.80	4.8	1.2
254	12	3.82	0.95	4.9	1.225
255	12	3.82	0.95	5	1.25
256	12	3.82	0.95	5	1.25
257	13	4.14	1.03	5.1	1.275
258	11	3.50	0.88	4.6	1.15
259	11	3.50	0.88	12	3
260	11	3.50	0.88	5	1.25
261	11	3.50	0.88	4.5	1.125
262	10	3.18	0.80	4.1	1.025
263	10	3.18	0.80	4.7	1.175
264	13	4.14	1.03	4.2	1.05
265	10	3.18	0.80	4.7	1.175
266	13	4.14	1.03	5.2	1.3
267	14	4.46	1.11	4.8	1.2
268	12	3.82	0.95	4.7	1.175
269	12	3.82	0.95	4.8	1.2
270	13	4.14	1.03	5.2	1.3
271	12	3.82	0.95	4.9	1.225
272	10	3.18	0.80	4.7	1.175
273	10	3.18	0.80	4.6	1.15
274	10	3.18	0.80	3.9	0.975
275	12	3.82	0.95	3.8	0.95
276	10	3.18	0.80	4.2	1.05
277	10	3.18	0.80	4.1	1.025
278	11	3.50	0.88	4.7	1.175
279	10	3.18	0.80	5.3	1.325
280	12	3.82	0.95	4.2	1.05
281	16	5.09	1.27	4.8	1.2
282	12	3.82	0.95	4.6	1.15
283	11	3.50	0.88	3	0.75
284	10	3.18	0.80	4	1

285	10	3.18	0.80	4.2	1.05
286	12	3.82	0.95	4.6	1.15
287	10	3.18	0.80	4	1
288	10	3.18	0.80	4.2	1.05
289	12	3.82	0.95	4.6	1.15
290	10	3.18	0.80	4	1
291	14	4.46	1.11	4.8	1.2
292	11	3.50	0.88	4.9	1.225
293	11	3.50	0.88	4.1	1.025
294	10	3.18	0.80	3.3	0.825
295	12	3.82	0.95	3.8	0.95
296	10	3.18	0.80	3.8	0.95
297	14	4.46	1.11	3.8	0.95
298	11	3.50	0.88	4.8	1.2
299	11	3.50	0.88	4.8	1.2
300	22	7.00	1.75	6.2	1.55
301	11	3.50	0.88	3.6	0.9
302	10	3.18	0.80	3.4	0.85
303	10	3.18	0.80	4	1
304	10	3.18	0.80	2.6	0.65
305	11	3.50	0.88	4.8	1.2
306	10	3.18	0.80	4.7	1.175
307	13	4.14	1.03	5.2	1.3
308	10	3.18	0.80	4.8	1.2
309	11	3.50	0.88	3.6	0.9
310	11	3.50	0.88	4.2	1.05
311	19	6.05	1.51	4.8	1.2
312	10	3.18	0.80	4	1
313	17	5.41	1.35	5.5	1.375
314	12	3.82	0.95	4.8	1.2
315	11	3.50	0.88	4.8	1.2
316	14	4.46	1.11	5.2	1.3
317	11	3.50	0.88	5.2	1.3
318	16	5.09	1.27	5.2	1.3
319	12	3.82	0.95	4.9	1.225
320	11	3.50	0.88	4.5	1.125

321	10	3.18	0.80	4.3	1.075
322	12	3.82	0.95	4.7	1.175
323	13	4.14	1.03	5	1.25
324	11	3.50	0.88	5	1.25
325	10	3.18	0.80	4.2	1.05
326	10	3.18	0.80	4.3	1.075
327	10	3.18	0.80	3.8	0.95
328	11	3.50	0.88	3.6	0.9
329	10	3.18	0.80	3.5	0.875
330	12	3.82	0.95	4	1
331	10	3.18	0.80	3.8	0.95
332	15	4.77	1.19	5	1.25
333	10	3.18	0.80	4.8	1.2
334	12	3.82	0.95	4.9	1.225
335	10	3.18	0.80	5	1.25
336	10	3.18	0.80	4.8	1.2
337	14	4.46	1.11	4.8	1.2
338	12	3.82	0.95	4.2	1.05
339	10	3.18	0.80	4.1	1.025
340	15	4.77	1.19	5	1.25
341	11	3.50	0.88	4.1	1.025
342	14	4.46	1.11	4.8	1.2
343	15	4.77	1.19	5.2	1.3
344	11	3.50	0.88	4.9	1.225
345	10	3.18	0.80	4.8	1.2
346	11	3.50	0.88	4.2	1.05
347	14	4.46	1.11	3.9	0.975
348	11	3.50	0.88	4.2	1.05
349	15	4.77	1.19	4	1
350	15	4.77	1.19	4.8	1.2
351	16	5.09	1.27	5.2	1.3
352	16	5.09	1.27	4.8	1.2
353	10	3.18	0.80	5	1.25
354	14	4.46	1.11	5.2	1.3
355	20	6.37	1.59	6.2	1.55
356	10	3.18	0.80	5.2	1.3

357	14	4.46	1.11	5	1.25
358	18	5.73	1.43	5	1.25
359	13	4.14	1.03	5.2	1.3
360	12	3.82	0.95	5.1	1.275
361	10	3.18	0.80	4.8	1.2
362	12	3.82	0.95	4.7	1.175
363	10	3.18	0.80	5.1	1.275
364	12	3.82	0.95	4.8	1.2
365	10	3.18	0.80	4.9	1.225
366	10	3.18	0.80	4.4	1.1
367	11	3.50	0.88	4.5	1.125
368	15	4.77	1.19	5.6	1.4
369	14	4.46	1.11	5	1.25
370	10	3.18	0.80	4.8	1.2
371	12	3.82	0.95	4.6	1.15
372	13	4.14	1.03	4.4	1.1
373	10	3.18	0.80	4	1
374	11	3.50	0.88	4	1
375	12	3.82	0.95	3.8	0.95
376	13	4.14	1.03	5	1.25
377	11	3.50	0.88	4.4	1.1
378	13	4.14	1.03	5.1	1.275
379	11	3.50	0.88	5.4	1.35
380	10	3.18	0.80	3.3	0.825
381	11	3.50	0.88	3.8	0.95
382	14	4.46	1.11	5.5	1.375
383	12	3.82	0.95	3.8	0.95
384	14	4.46	1.11	5.6	1.4
385	11	3.50	0.88	3	0.75
386	19	6.05	1.51	5.1	1.275
387	21	6.68	1.67	5.1	1.275
388	17	5.41	1.35	5.2	1.3
389	16	5.09	1.27	5.1	1.275
390	11	3.50	0.88	4.8	1.2
391	19	6.05	1.51	5.3	1.325
392	21	6.68	1.67	5.2	1.3

393	12	3.82	0.95	4	1
394	13	4.14	1.03	5.3	1.325
395	10	3.18	0.80	4.9	1.225
396	18	5.73	1.43	5.2	1.3
397	13	4.14	1.03	5.2	1.3
398	13	4.14	1.03	4.7	1.175
399	11	3.50	0.88	4.8	1.2
400	10	3.18	0.80	3	0.75
401	17	5.41	1.35	5	1.25
402	18	5.73	1.43	5.3	1.325
403	17	5.41	1.35	5	1.25
404	18	5.73	1.43	5.3	1.325
405	17	5.41	1.35	5	1.25
406	16	5.09	1.27	4.8	1.2
407	10	3.18	0.80	4.6	1.15
408	11	3.50	0.88	3.8	0.95
409	12	3.82	0.95	4.2	1.05
410	23	7.32	1.83	5.4	1.35
411	11	3.50	0.88	3.6	0.9
412	11	3.50	0.88	3.9	0.975
413	13	4.14	1.03	5	1.25
414	12	3.82	0.95	4.8	1.2
415	10	3.18	0.80	3.6	0.9
416	10	3.18	0.80	3.2	0.8
417	12	3.82	0.95	5	1.25
418	10	3.18	0.80	3.1	0.775
419	10	3.18	0.80	3.2	0.8
420	12	3.82	0.95	3.8	0.95
421	10	3.18	0.80	3.6	0.9
422	14	4.46	1.11	3.9	0.975
423	10	3.18	0.80	4	1
424	10	3.18	0.80	3.6	0.9
425	10	3.18	0.80	3.4	0.85
426	10	3.18	0.80	3.2	0.8
427	10	3.18	0.80	3	0.75
428	10	3.18	0.80	3.2	0.8

429	14	4.46	1.11	4.2	1.05
430	10	3.18	0.80	3.6	0.9
431	11	3.50	0.88	3.8	0.95
432	13	4.14	1.03	5	1.25
433	11	3.50	0.88	4	1
434	13	4.14	1.03	4.2	1.05
435	15	4.77	1.19	4.4	1.1
436	16	5.09	1.27	5.4	1.35
437	17	5.41	1.35	5.6	1.4
438	13	4.14	1.03	4.8	1.2
439	15	4.77	1.19	4.9	1.225
440	10	3.18	0.80	5.1	1.275
441	12	3.82	0.95	4.8	1.2
442	15	4.77	1.19	5.1	1.275
443	20	6.37	1.59	5.3	1.325
444	20	6.37	1.59	5.4	1.35
445	10	3.18	0.80	4.8	1.2
446	12	3.82	0.95	5.4	1.35
447	12	3.82	0.95	4	1
448	11	3.50	0.88	4.1	1.025
449	10	3.18	0.80	3.8	0.95
450	10	3.18	0.80	3.6	0.9
451	13	4.14	1.03	3.9	0.975
452	10	3.18	0.80	4	1
453	14	4.46	1.11	4.2	1.05
454	22	7.00	1.75	5.4	1.35
455	11	3.50	0.88	5	1.25
456	13	4.14	1.03	3.8	0.95
457	14	4.46	1.11	4.8	1.2
458	14	4.46	1.11	4.1	1.025
459	21	6.68	1.67	6	1.5
460	10	3.18	0.80	4	1
461	13	4.14	1.03	5.3	1.325
462	15	4.77	1.19	6.2	1.55
463	20	6.37	1.59	6.2	1.55
464	23	7.32	1.83	6.2	1.55

465	17	5.41	1.35	6	1.5
466	10	3.18	0.80	3.6	0.9
467	10	3.18	0.80	3.8	0.95
468	21	6.68	1.67	6.1	1.525
469	15	4.77	1.19	4.2	1.05
470	14	4.46	1.11	4	1
471	10	3.18	0.80	5	1.25
472	14	4.46	1.11	5.2	1.3
473	16	5.09	1.27	5.1	1.275
474	12	3.82	0.95	4.9	1.225
475	16	5.09	1.27	5.1	1.275
476	20	6.37	1.59	6.3	1.575
477	17	5.41	1.35	5.8	1.45
478	21	6.68	1.67	6	1.5
479	12	3.82	0.95	5	1.25
480	13	4.14	1.03	5.1	1.275
481	12	3.82	0.95	5.2	1.3
482	19	6.05	1.51	6	1.5
483	10	3.18	0.80	3	0.75
484	24	7.64	1.91	6	1.5
485	11	3.50	0.88	3.9	0.975
486	13	4.14	1.03	4.9	1.225
487	14	4.46	1.11	5.1	1.275
488	10	3.18	0.80	3.6	0.9
489	10	3.18	0.80	4.1	1.025
490	10	3.18	0.80	4.2	1.05
491	13	4.14	1.03	5	1.25
492	10	3.18	0.80	5	1.25
493	12	3.82	0.95	5.1	1.275
494	10	3.18	0.80	4.8	1.2
495	11	3.50	0.88	4.6	1.15
496	11	3.50	0.88	4.4	1.1
497	11	3.50	0.88	4.8	1.2
498	10	3.18	0.80	4.6	1.15
499	14	4.46	1.11	4.8	1.2
500	13	4.14	1.03	4.9	1.225

501	10	3.18	0.80	4.2	1.05
502	14	4.46	1.11	5.1	1.275
503	11	3.50	0.88	4.9	1.225
504	24	7.64	1.91	5.9	1.475
505	13	4.14	1.03	4.6	1.15
506	14	4.46	1.11	4.8	1.2
507	12	3.82	0.95	4.3	1.075
508	11	3.50	0.88	5	1.25
509	22	7.00	1.75	5.6	1.4
510	11	3.50	0.88	5.1	1.275
511	12	3.82	0.95	3.6	0.9
512	23	7.32	1.83	5.4	1.35
513	11	3.50	0.88	4.6	1.15
514	13	4.14	1.03	5.1	1.275
515	13	4.14	1.03	5.2	1.3
516	16	5.09	1.27	4.2	1.05
517	16	5.09	1.27	5.2	1.3
518	15	4.77	1.19	5.4	1.35
519	11	3.50	0.88	4	1
520	13	4.14	1.03	5	1.25
521	10	3.18	0.80	4.1	1.025
522	17	5.41	1.35	5.3	1.325
523	10	3.18	0.80	3.6	0.9
524	10	3.18	0.80	4.1	1.025
525	15	4.77	1.19	5.4	1.35
526	10	3.18	0.80	3.3	0.825
527	14	4.46	1.11	5.8	1.45
528	13	4.14	1.03	5.6	1.4
529	10	3.18	0.80	4	1
530	10	3.18	0.80	4.1	1.025
531	10	3.18	0.80	3.2	0.8
532	11	3.50	0.88	3	0.75
533	12	3.82	0.95	4.6	1.15
534	10	3.18	0.80	3.7	0.925
535	10	3.18	0.80	3.2	0.8
536	10	3.18	0.80	4.1	1.025

537	12	3.82	0.95	4.6	1.15
538	10	3.18	0.80	4.1	1.025
539	10	3.18	0.80	4	1
540	10	3.18	0.80	4.2	1.05
541	11	3.50	0.88	4.3	1.075
542	13	4.14	1.03	5.1	1.275
543	13	4.14	1.03	4.9	1.225
544	10	3.18	0.80	4	1
545	12	3.82	0.95	5	1.25
546	10	3.18	0.80	4.2	1.05
547	14	4.46	1.11	4.8	1.2
548	10	3.18	0.80	3.8	0.95
549	10	3.18	0.80	3.8	0.95
550	10	3.18	0.80	3.6	0.9
551	11	3.50	0.88	4.2	1.05
552	16	5.09	1.27	3.9	0.975
553	16	5.09	1.27	5.4	1.35
554	17	5.41	1.35	5.2	1.3
555	11	3.50	0.88	5.3	1.325
556	18	5.73	1.43	5.3	1.325
557	10	3.18	0.80	5.1	1.275
558	15	4.77	1.19	4.8	1.2
559	19	6.05	1.51	5.3	1.325
560	17	5.41	1.35	5.7	1.425
561	12	3.82	0.95	5.8	1.45
562	19	6.05	1.51	5.2	1.3
563	19	6.05	1.51	3.5	0.875
564	11	3.50	0.88	3.5	0.875
565	14	4.46	1.11	4.6	1.15
566	11	3.50	0.88	4.9	1.225
567	10	3.18	0.80	4.6	1.15
568	11	3.50	0.88	5.2	1.3
569	20	6.37	1.59	6.2	1.55
570	12	3.82	0.95	4.1	1.025
571	12	3.82	0.95	4.2	1.05
572	12	3.82	0.95	5.2	1.3

573	14	4.46	1.11	5.1	1.275
574	10	3.18	0.80	4	1
575	15	4.77	1.19	5	1.25
576	12	3.82	0.95	4.8	1.2
577	11	3.50	0.88	4.6	1.15
578	19	6.05	1.51	6.1	1.525
579	10	3.18	0.80	3.4	0.85
580	10	3.18	0.80	3.2	0.8
581	11	3.50	0.88	3	0.75
582	12	3.82	0.95	4	1
583	12	3.82	0.95	4.8	1.2
584	11	3.50	0.88	3.6	0.9
585	10	3.18	0.80	3.1	0.775
586	12	3.82	0.95	4.7	1.175
587	13	4.14	1.03	4.8	1.2
588	10	3.18	0.80	3.3	0.825
589	11	3.50	0.88	3.4	0.85
590	12	3.82	0.95	4.1	1.025
591	11	3.50	0.88	3.9	0.975
592	11	3.50	0.88	4	1
593	11	3.50	0.88	3.6	0.9
594	10	3.18	0.80	3.8	0.95
595	10	3.18	0.80	3.3	0.825
596	10	3.18	0.80	3.1	0.775
597	14	4.46	1.11	3.2	0.8
598	12	3.82	0.95	4.9	1.225
599	10	3.18	0.80	3.8	0.95
600	11	3.50	0.88	4	1
601	11	3.50	0.88	3.6	0.9
602	10	3.18	0.80	3.8	0.95
603	10	3.18	0.80	3.3	0.825
604	10	3.18	0.80	3.1	0.775
605	14	4.46	1.11	3.2	0.8
606	12	3.82	0.95	4.9	1.225
607	10	3.18	0.80	3.8	0.95
608	13	4.14	1.03	4	1

609	15	4.77	1.19	4.9	1.225
610	15	4.77	1.19	5.3	1.325
611	14	4.46	1.11	4.6	1.15
612	14	4.46	1.11	5.1	1.275
613	17	5.41	1.35	5.3	1.325
614	14	4.46	1.11	4.9	1.225
615	13	4.14	1.03	4.8	1.2
616	17	5.41	1.35	5.2	1.3
617	14	4.46	1.11	4.8	1.2
618	11	3.50	0.88	4.6	1.15
619	15	4.77	1.19	4.8	1.2
620	14	4.46	1.11	5.2	1.3
621	10	3.18	0.80	4.2	1.05
622	13	4.14	1.03	4.8	1.2
623	12	3.82	0.95	4.6	1.15
624	16	5.09	1.27	5.1	1.275
625	14	4.46	1.11	4.8	1.2
626	16	5.09	1.27	4.7	1.175
627	13	4.14	1.03	4.2	1.05
628	13	4.14	1.03	4.8	1.2
629	16	5.09	1.27	5.1	1.275
630	15	4.77	1.19	4.9	1.225
12.92	**4.11**	**1.03**	**4.94**	**1.23**	

Table 15: Growth data of A. auriculiformis in Manada village, Odisha

Sl. No.	GBH (cm)	DBH (cm)	MAI DBH (cm/year)	Height (m)	MAI H (m/year)
1	10	3.183	1.06	4.4	1.47
2	10.5	3.342	1.11	4.3	1.43
3	11	3.501	1.17	4	1.33
4	11	3.501	1.17	4.1	1.37
5	10	3.183	1.06	3.8	1.27
6	10	3.183	1.06	4.2	1.40
7	10	3.183	1.06	4.3	1.43
8	10	3.183	1.06	3.8	1.27
9	10	3.183	1.06	3.9	1.30
10	10	3.183	1.06	5	1.67
11	11.5	3.661	1.22	5	1.67
12	11	3.501	1.17	4.9	1.63
13	11.5	3.661	1.22	5.1	1.70
14	11.1	3.533	1.18	4.4	1.47
15	10	3.183	1.06	4.2	1.40
16	10	3.183	1.06	4.8	1.60
17	10	3.183	1.06	4.5	1.50
18	10.5	3.342	1.11	4	1.33
19	10	3.183	1.06	4.6	1.53
20	10	3.183	1.06	4.2	1.40
21	10	3.183	1.06	4.1	1.37
22	10.5	3.342	1.11	4.4	1.47
23	10.5	3.342	1.11	3.9	1.30
24	10.5	3.342	1.11	4	1.33
25	12	3.820	1.27	4.7	1.57
26	10.5	3.342	1.11	4.5	1.50
27	11	3.501	1.17	4.7	1.57
28	10	3.183	1.06	3.8	1.27
29	13.9	4.425	1.47	5	1.67
30	10.5	3.342	1.11	4.9	1.63
31	13	4.138	1.38	5.2	1.73
32	10	3.183	1.06	4.8	1.60
33	10	3.183	1.06	4.9	1.63
34	10.5	3.342	1.11	4.6	1.53
35	10	3.183	1.06	4.6	1.53
36	11.1	3.533	1.18	4.9	1.63

37	14	4.456	1.49	5.2	1.73
38	10.8	3.438	1.15	4.8	1.60
39	10.1	3.215	1.07	4.4	1.47
40	10	3.183	1.06	3.8	1.27
41	10.4	3.310	1.10	4.5	1.50
42	10	3.183	1.06	4.2	1.40
43	10.1	3.215	1.07	4.7	1.57
44	10	3.183	1.06	4.3	1.43
45	10.5	3.342	1.11	4.5	1.50
46	11	3.501	1.17	5.3	1.77
47	10.5	3.342	1.11	3.8	1.27
48	10.1	3.215	1.07	4.3	1.43
49	10	3.183	1.06	4.4	1.47
50	10.5	3.342	1.11	4.9	1.63
51	11	3.501	1.17	4.8	1.60
52	10	3.183	1.06	4.3	1.43
53	10.2	3.247	1.08	4.7	1.57
54	12	3.820	1.27	5	1.67
55	11	3.501	1.17	5.3	1.77
56	10	3.183	1.06	4.7	1.57
57	10	3.183	1.06	4.8	1.60
58	11	3.501	1.17	4.8	1.60
59	11.6	3.692	1.23	5	1.67
60	10	3.183	1.06	4.3	1.43
Average	10.62	3.38	1.13	4.52	1.51

Table 16: Growth parameters of T. grandis in Manada village, Odisha

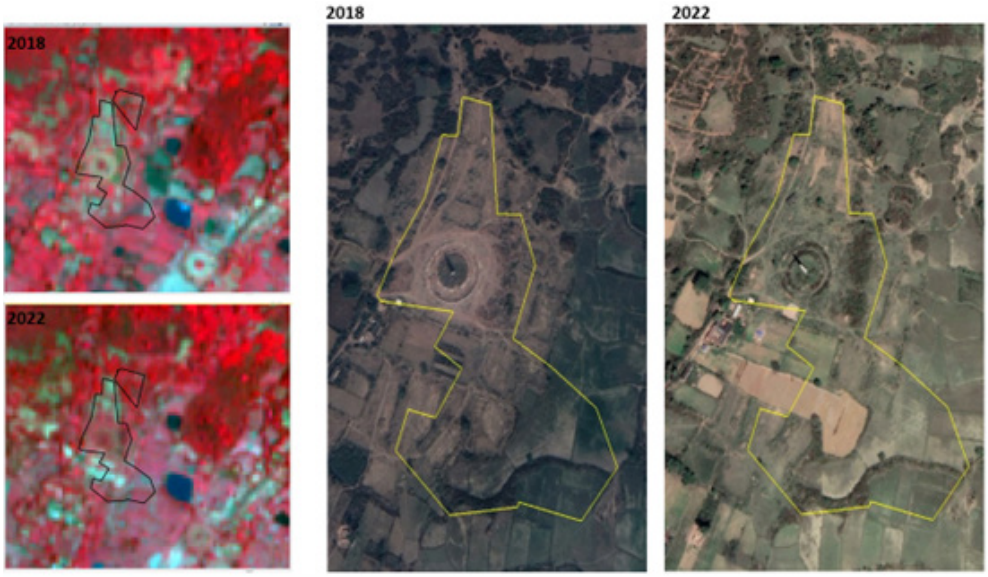
Sl. No.	GBH (cm)	DBH (cm)	MAI DBH (cm/year)	Height (m)	MAI H (m/year)
1	10.6	3.374	1.12	4.7	1.57
2	10	3.183	1.06	5	1.67
3	11	3.501	1.17	4.8	1.60
4	10	3.183	1.06	4.3	1.43
Average	10.14	3.31	1.10	4.70	1.57

**The sample size is too small and ER number may vary in future.*

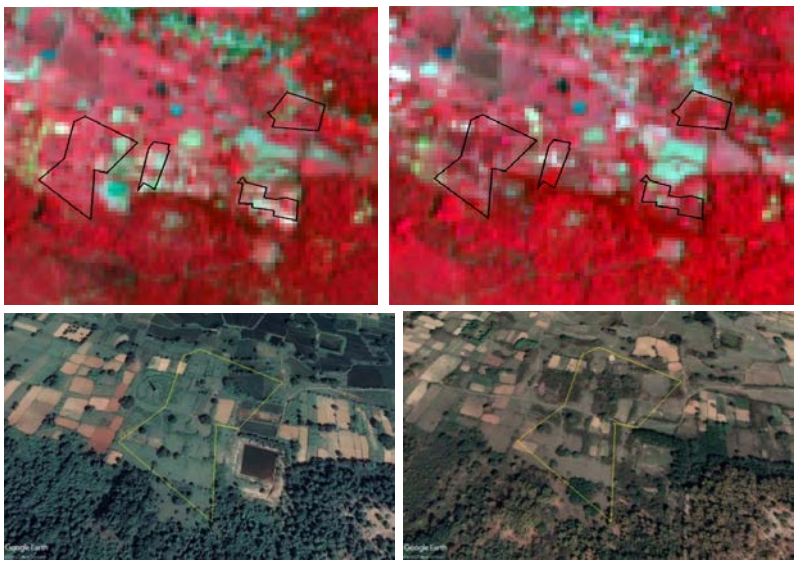
8.1. PICTORIAL REPRESENTATION OF THE PLANTATION PLOTS

8.1.1. PLANTATION PLOTS WITH INCREASED TREE COVER

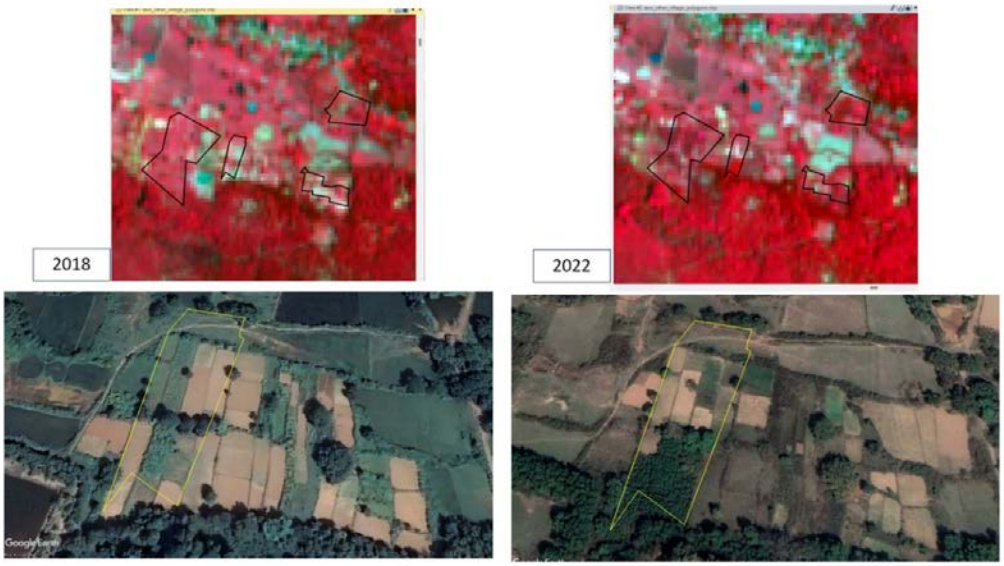
1. NEW RAPACHA 25



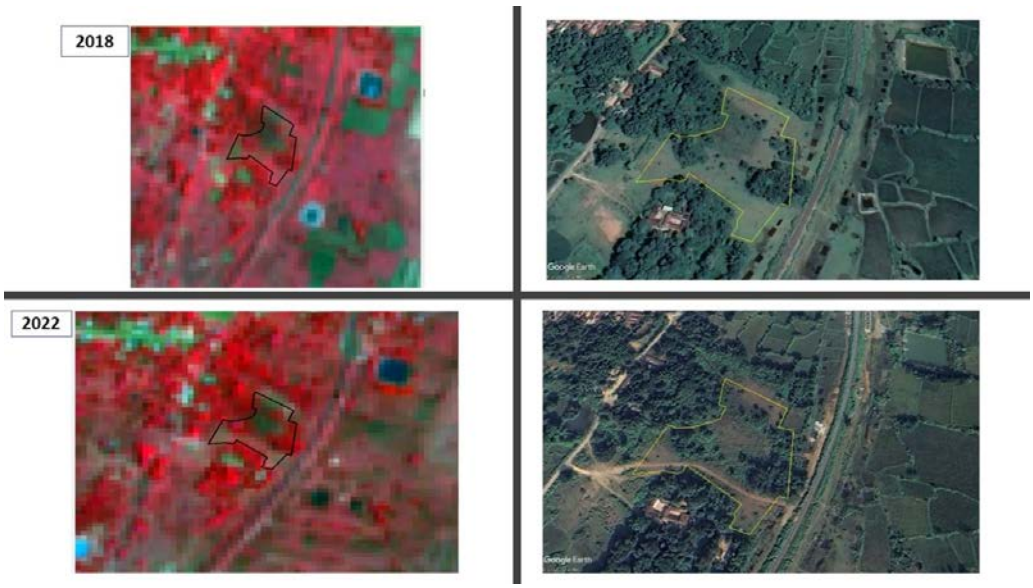
2. NEW NUTANDHI JANGAL 6



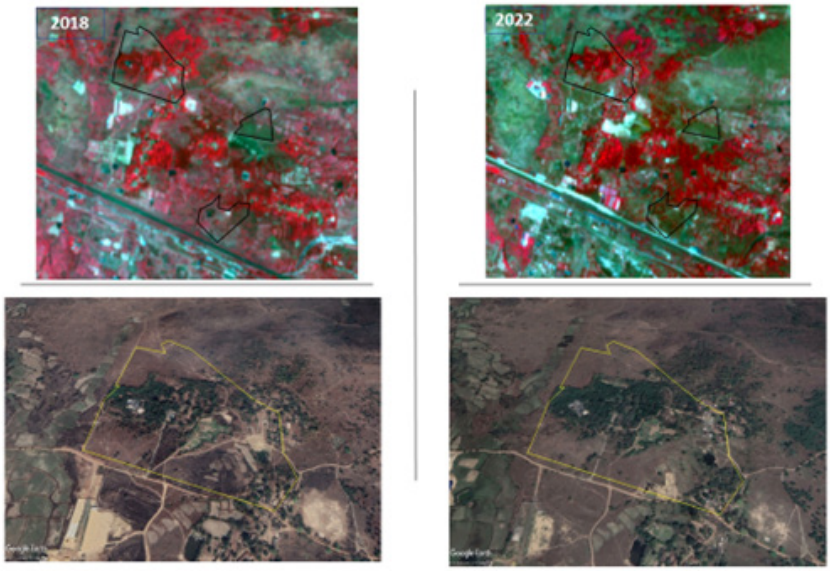
3. NEW NUTANDHI JANGAL



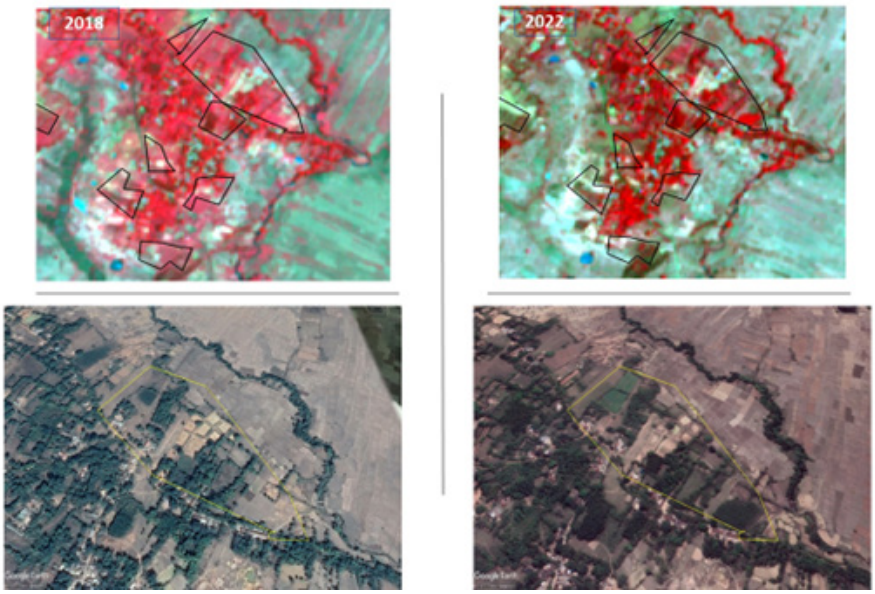
4. RESOLVE NEW DHOLADHI 17



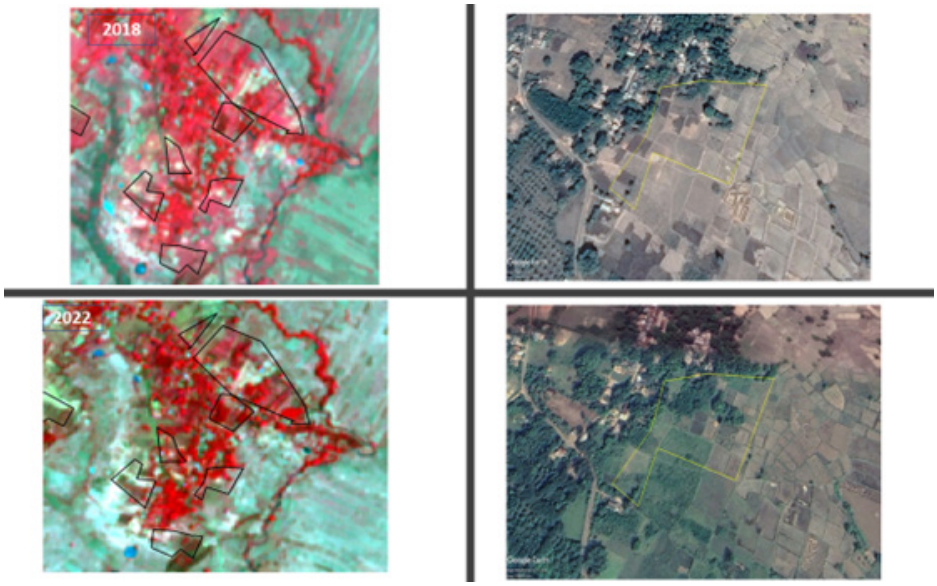
5. NEW LUABASA 20



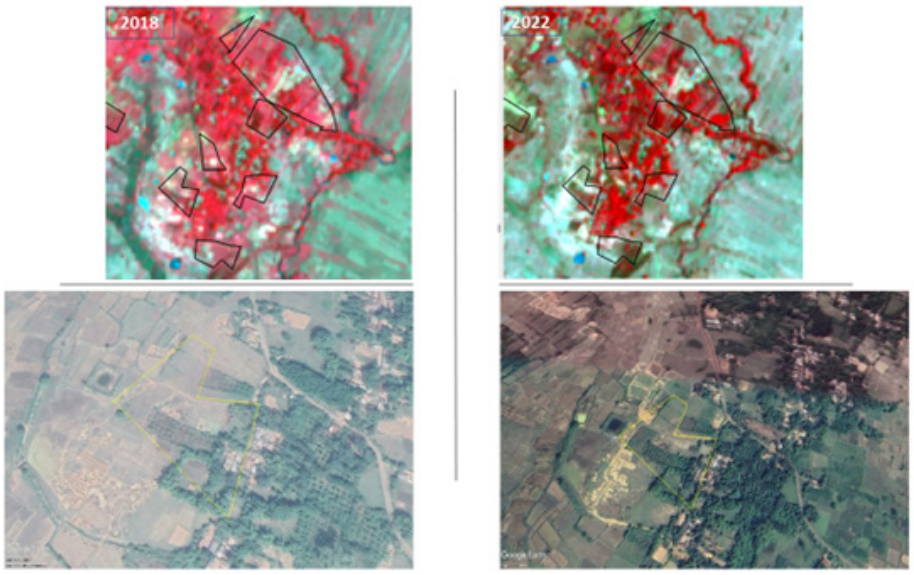
6. NEW JAMAKESHWAR 3



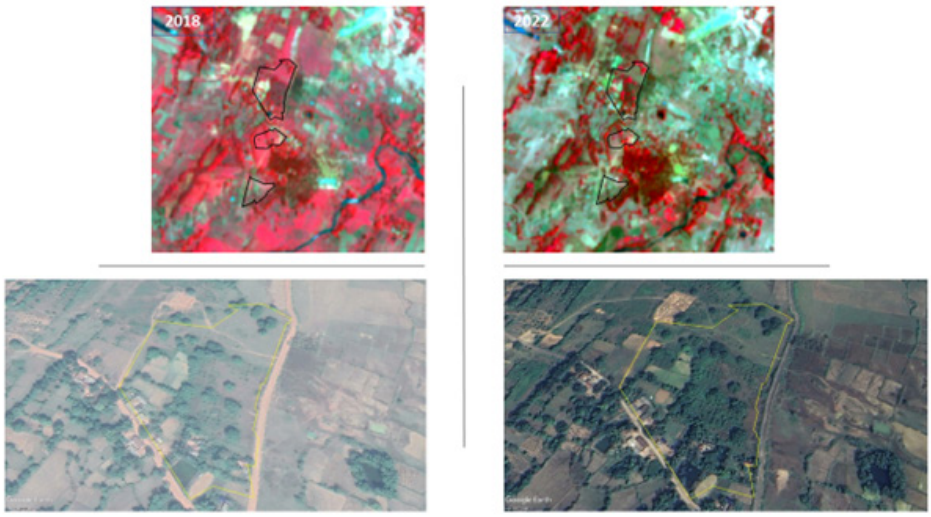
7. NEW JASHIPUR 24



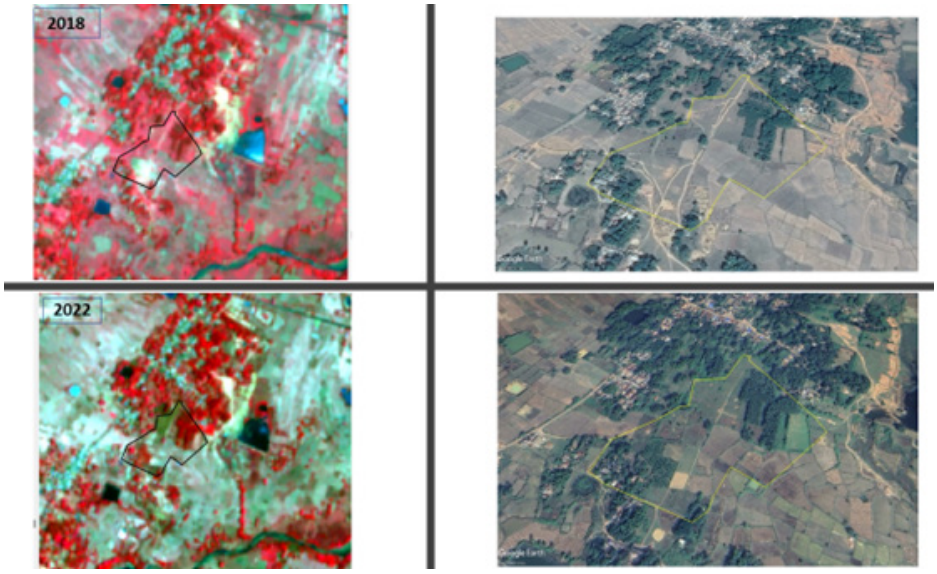
8. NEW JAMAKESHWAR 8



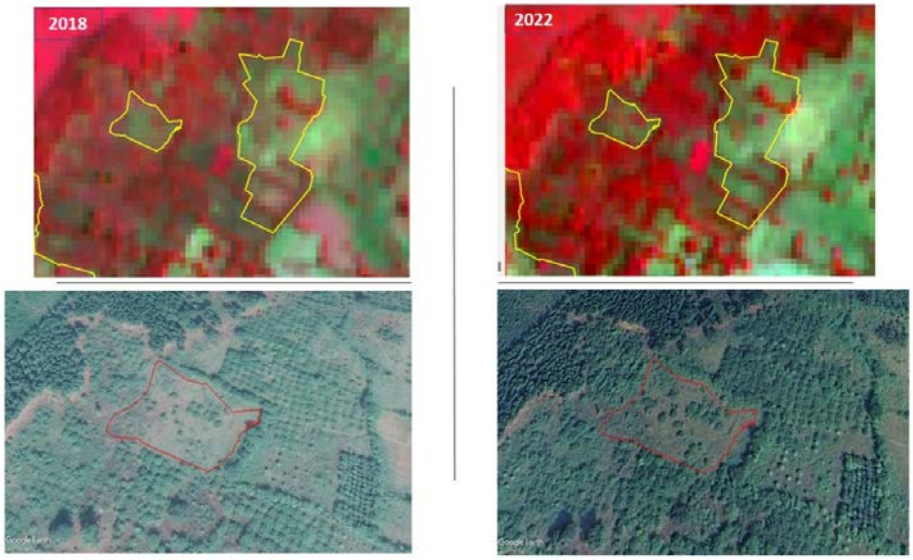
9. RESOLVE NEW JAMAKESHWAR 11



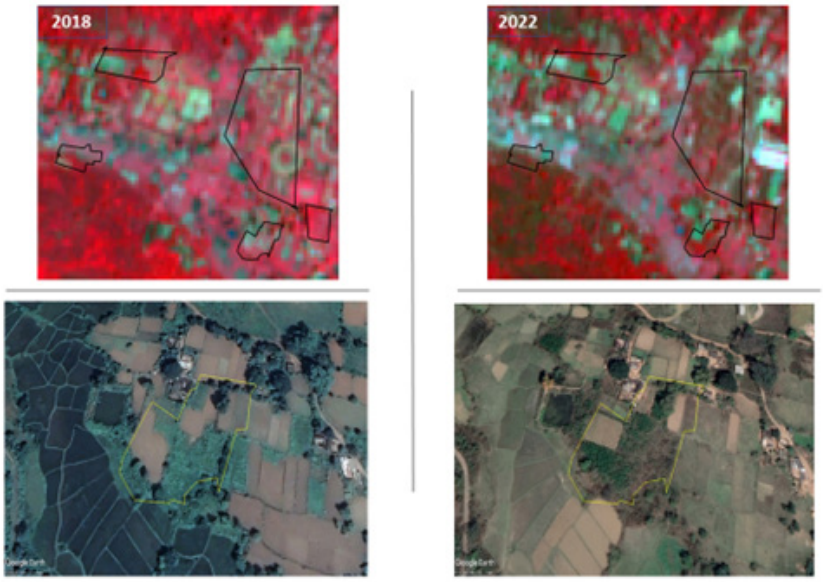
10. NEW JAMAKESHWAR 16



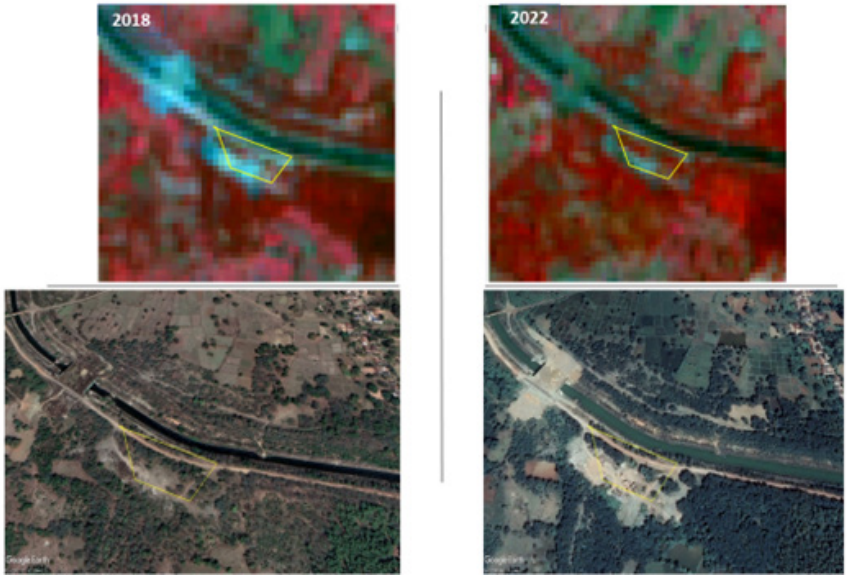
11. JAMMUKESHWAR/AWF/P18



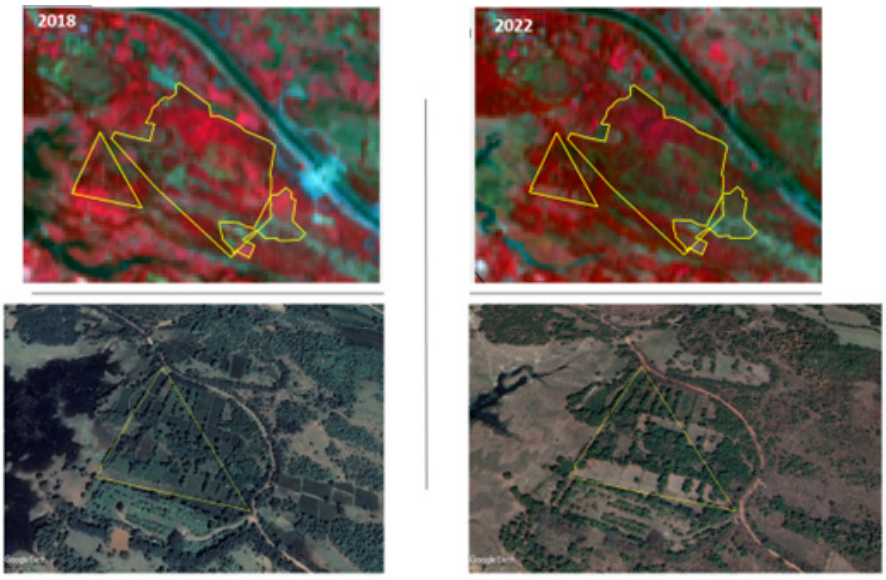
12. NEW KUMHARI 26



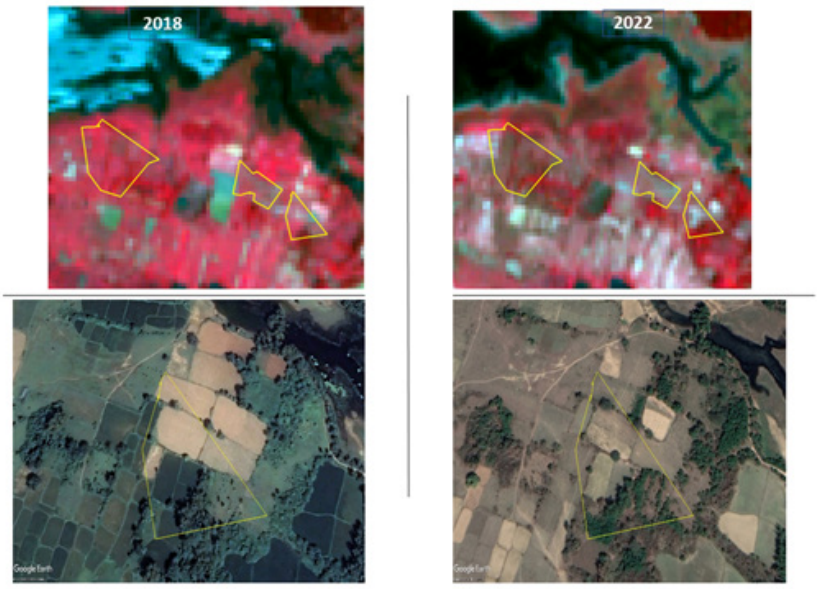
13. NEW LYLAM 23 (NEAR PANCHYAT)



14. NEW LYLAM DUNGRI 22 (NEAR LAKE)

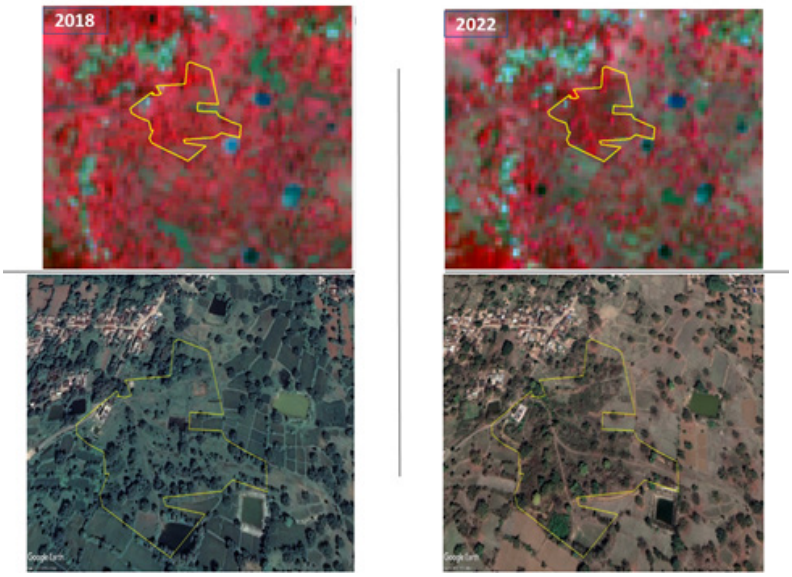


15. NEW PHUNSHA 13

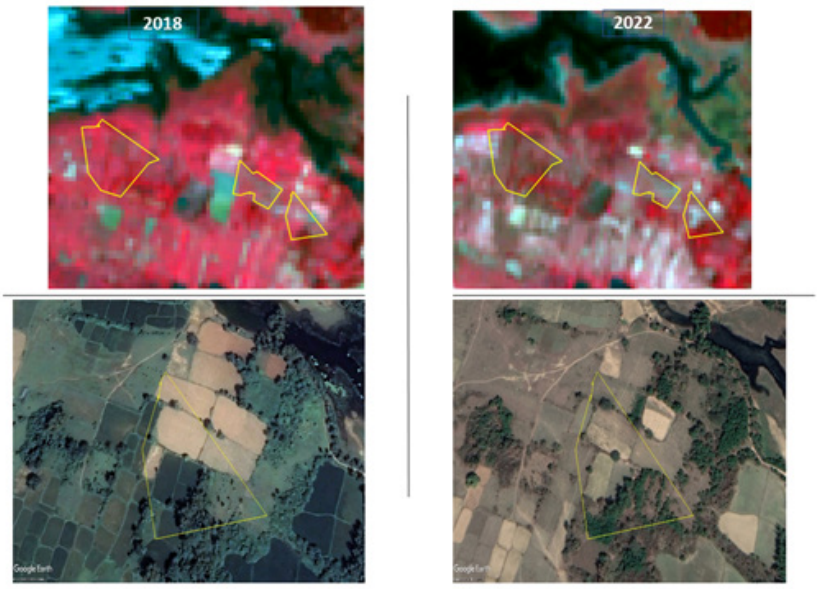


16. RESOLVE NEW NUTANDHI JANGAL 1

17. RESOLVE NEW LYLAM PANCHYAT 10

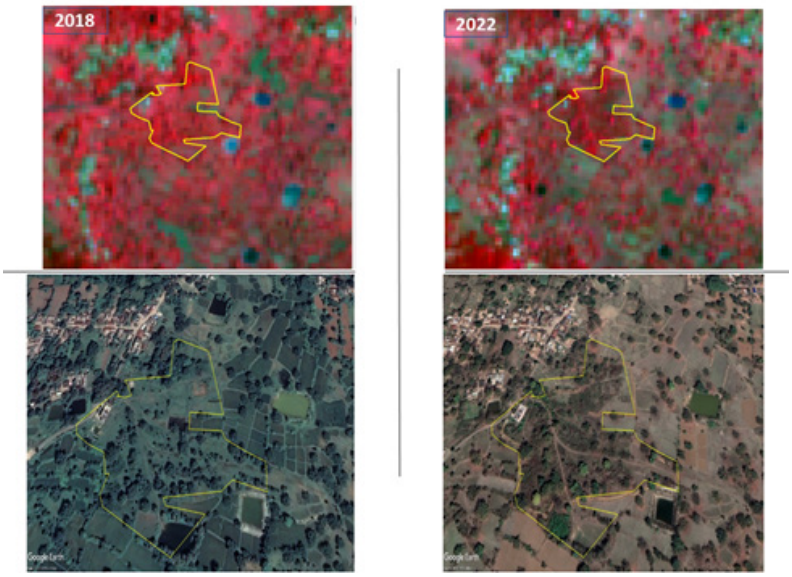


15. NEW PHUNSHA 13



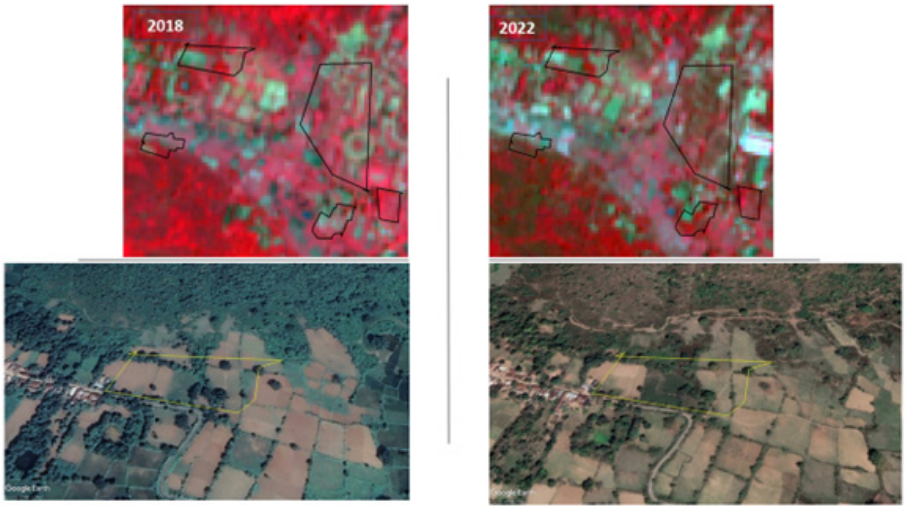
16. RESOLVE NEW NUTANDHI JANGAL 1

17. RESOLVE NEW LYLAM PANCHYAT 10

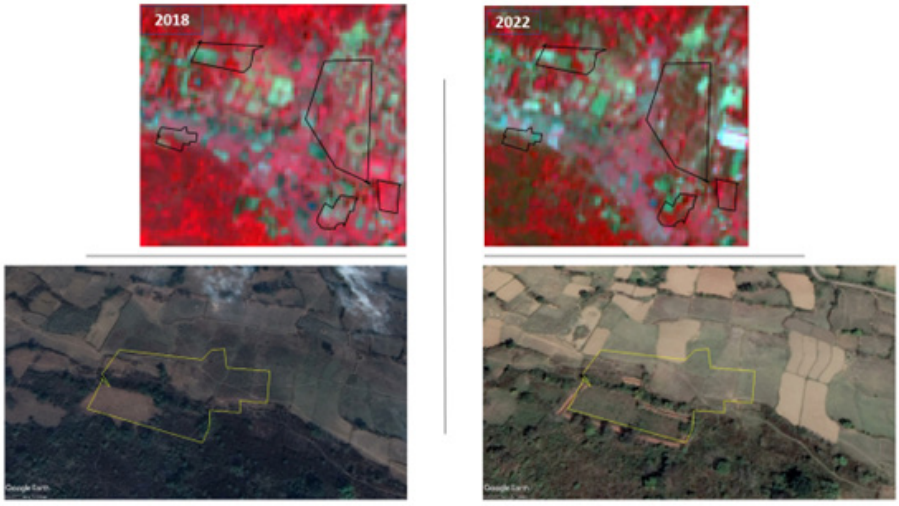


8.1.2. PLANTATION PLOTS WITH NO CHANGE IN TREE COVER

1. NEW SANTHALTOLA 16

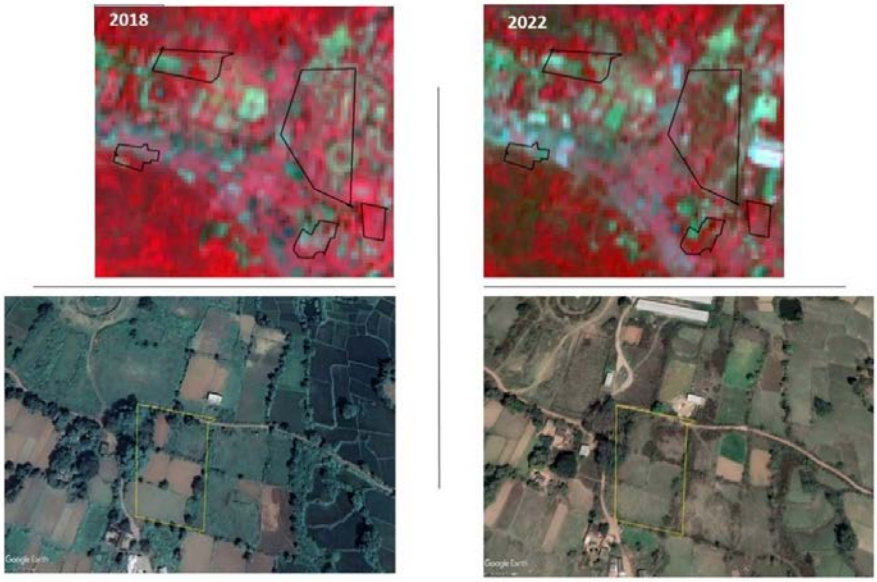


2. RESOLVE NEW SHANTHALTOLA 28

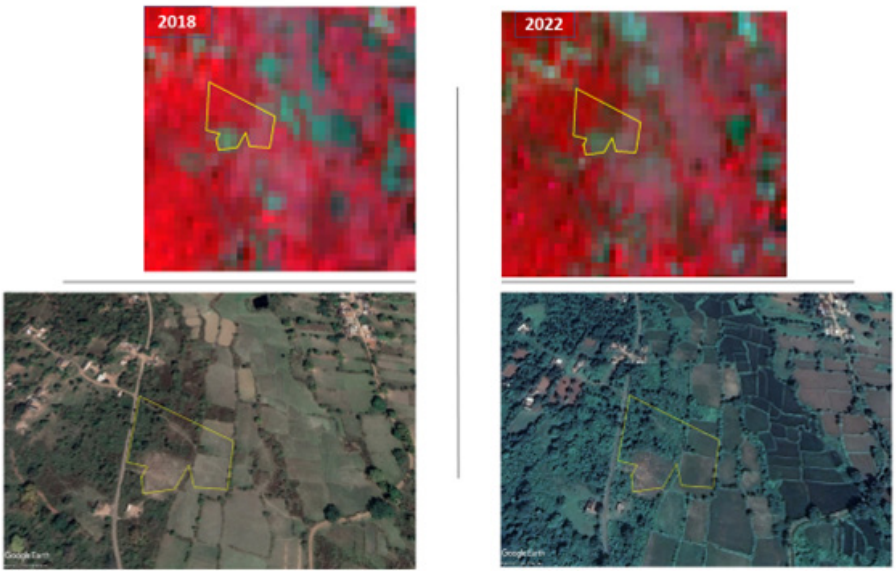


3. NEW KUMHARI 14

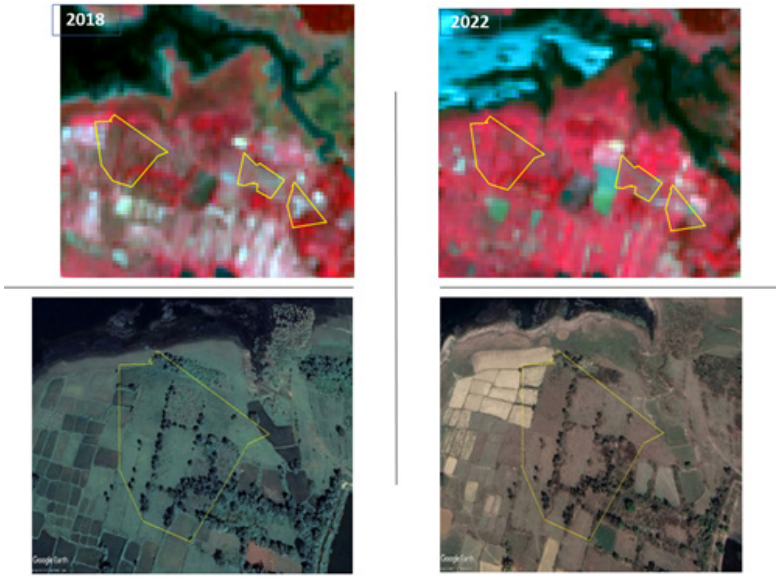
4. NEW KUMHARI 15



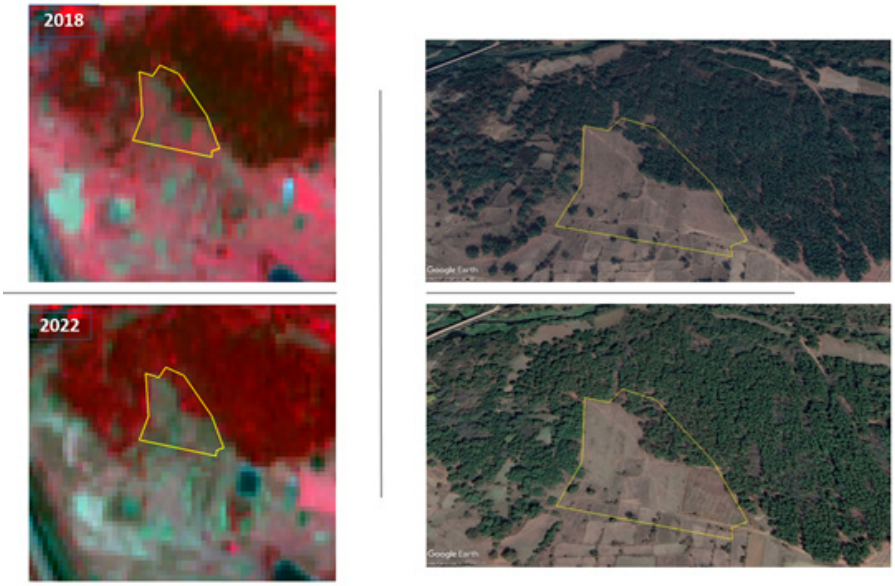
5. NEW KUMHARI 29



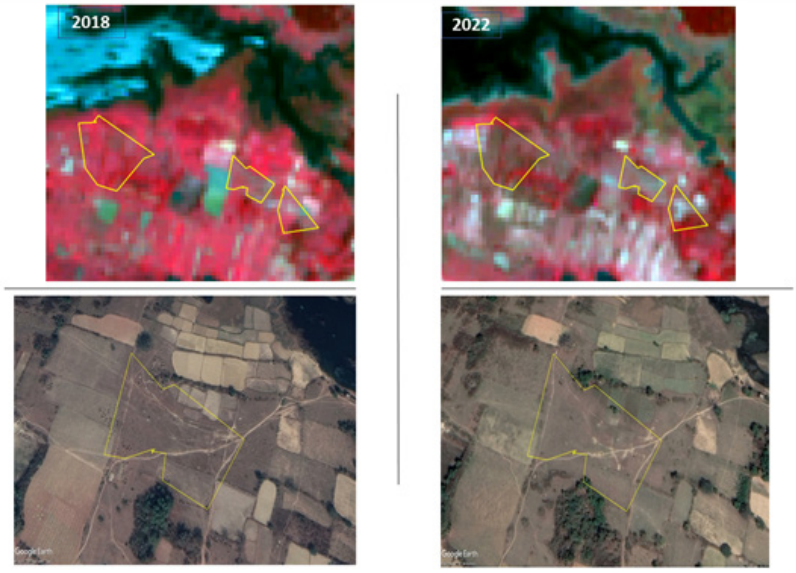
6. NEW PHUNSHA 12



7. NEW LYLAM DUNGRI 30

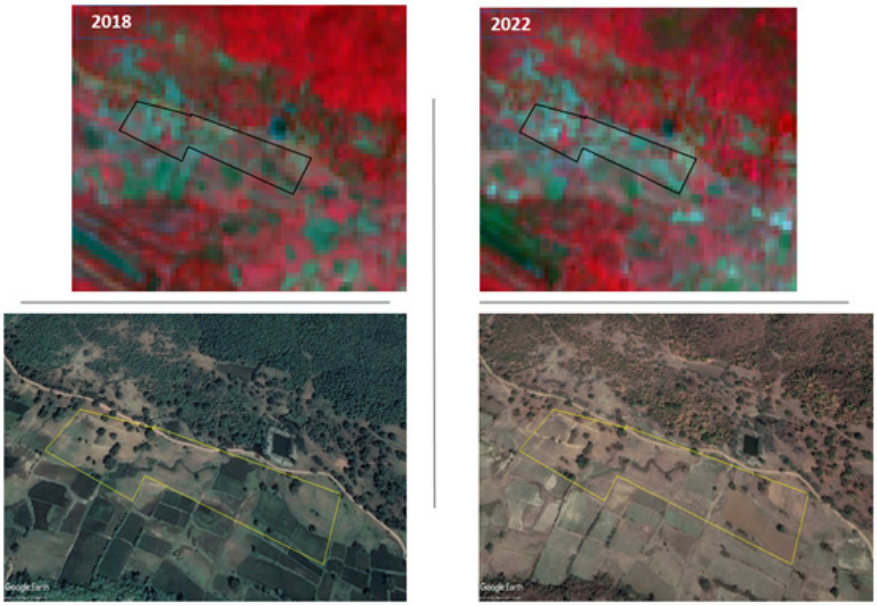


8. RESOLVE NEW PHUNSHA 11

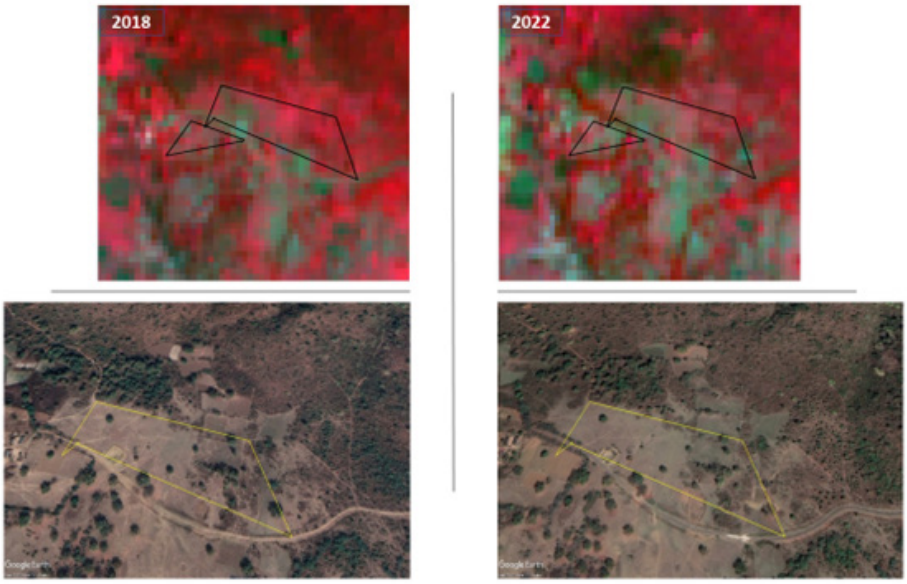


9. NEW NUTANDHI JANGAL 4

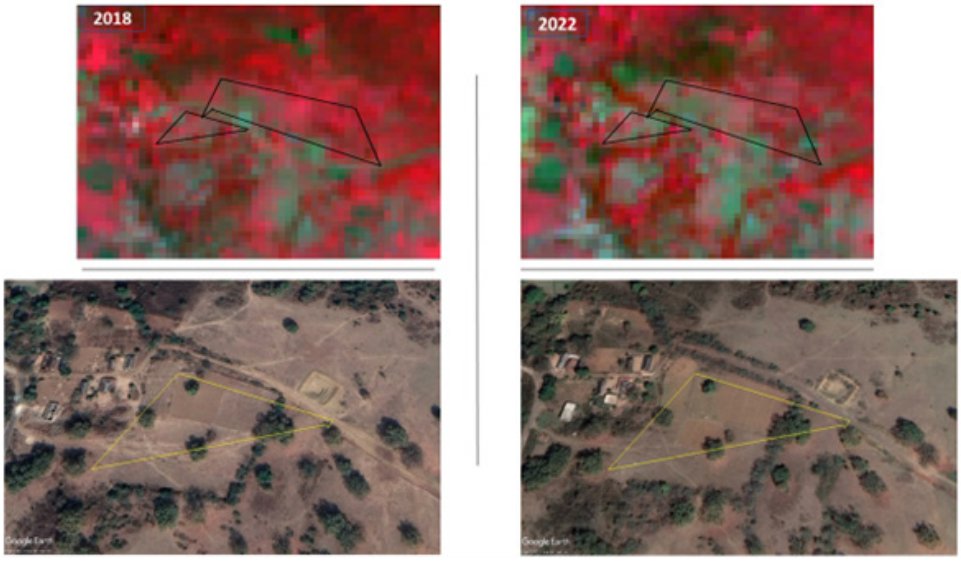
10. NEW NUTANDHI JANGAL 3



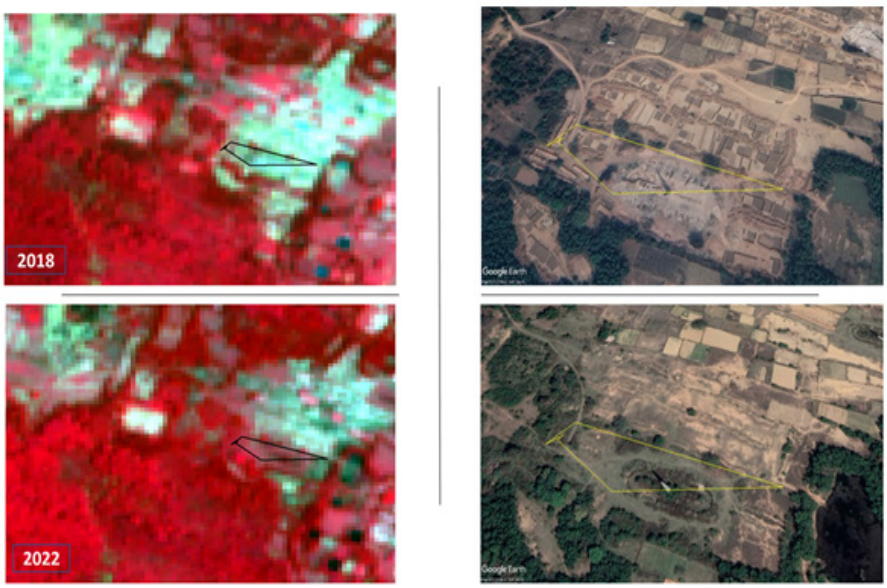
11. NEW NUTANDHI JANGAL 1



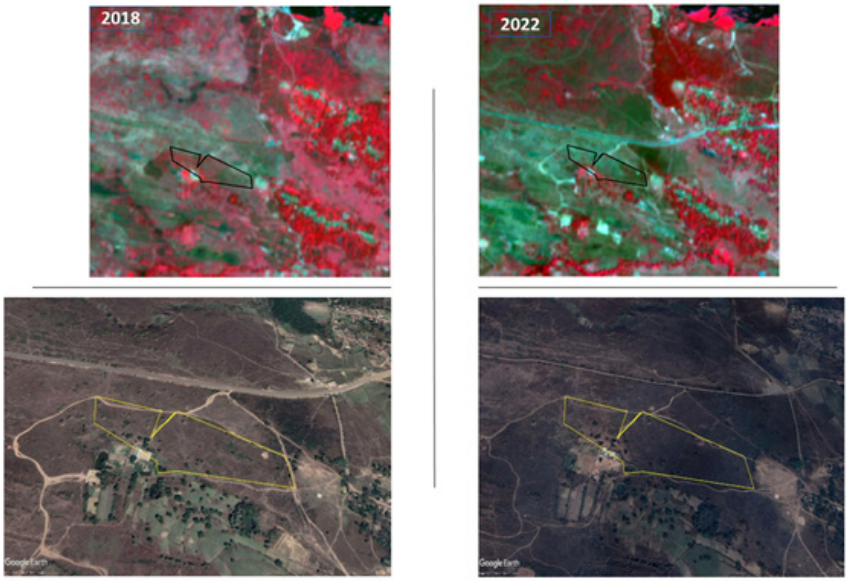
12. NEW NUTANDHI JANGAL 2



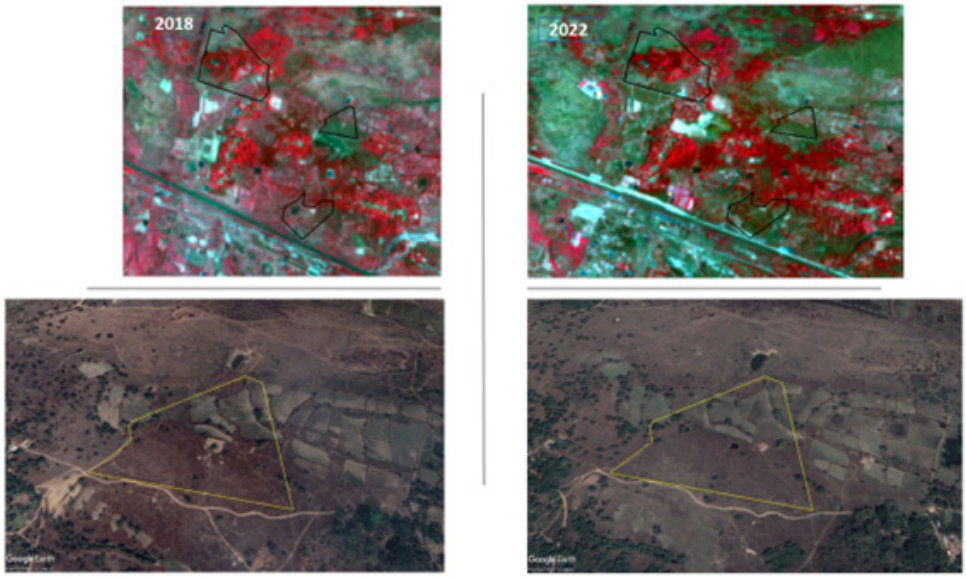
13. NEW NUTANDHI BHATTA 9



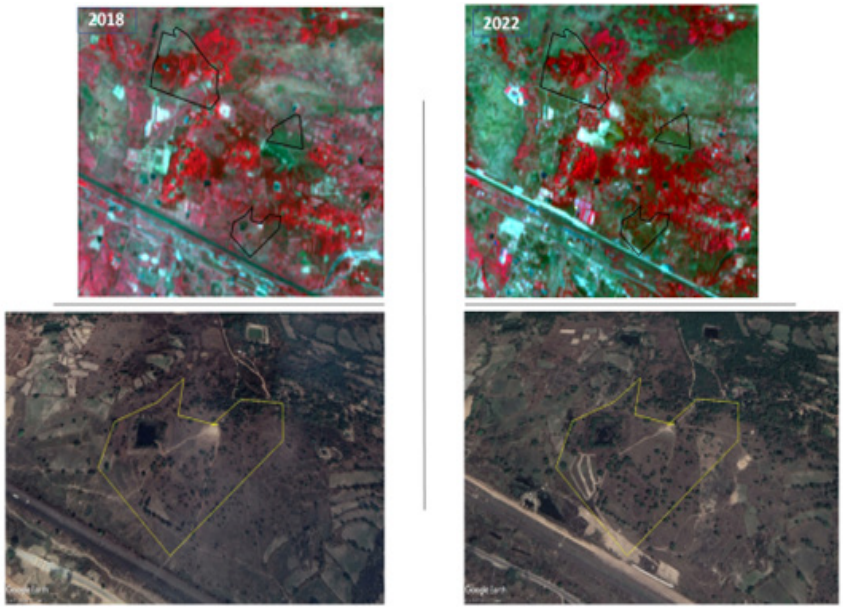
14. NEW LUBASA 25



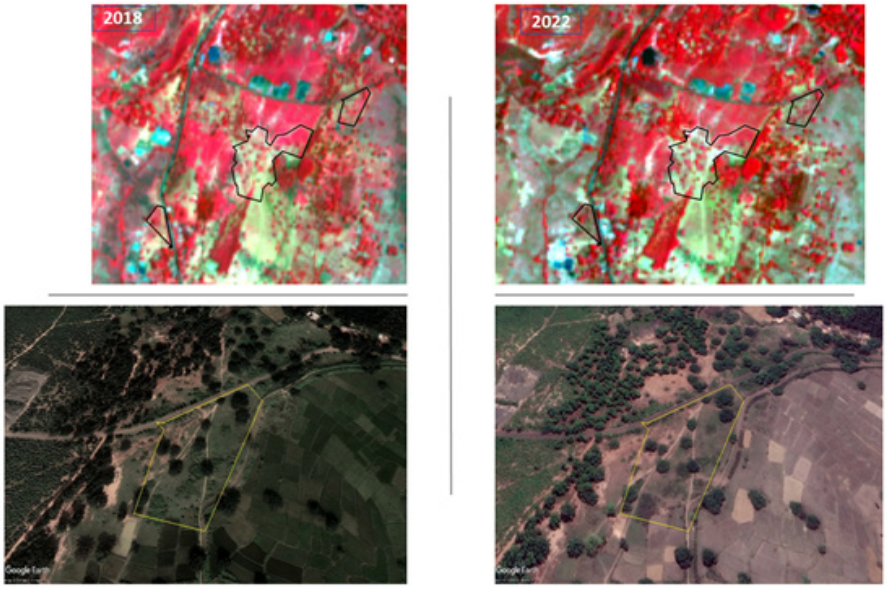
15. NEW LUABASA 18



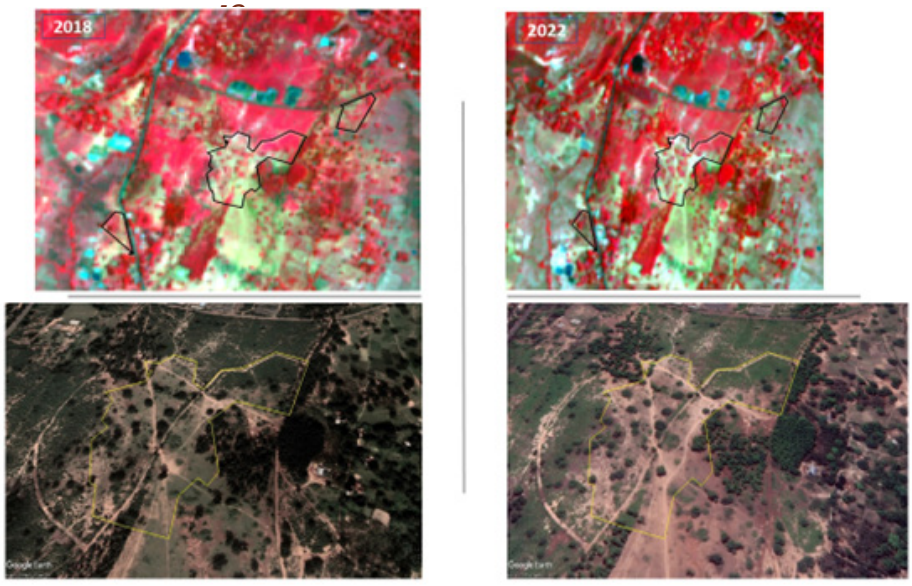
16. NEW LUABASA KHAIRBANI 19



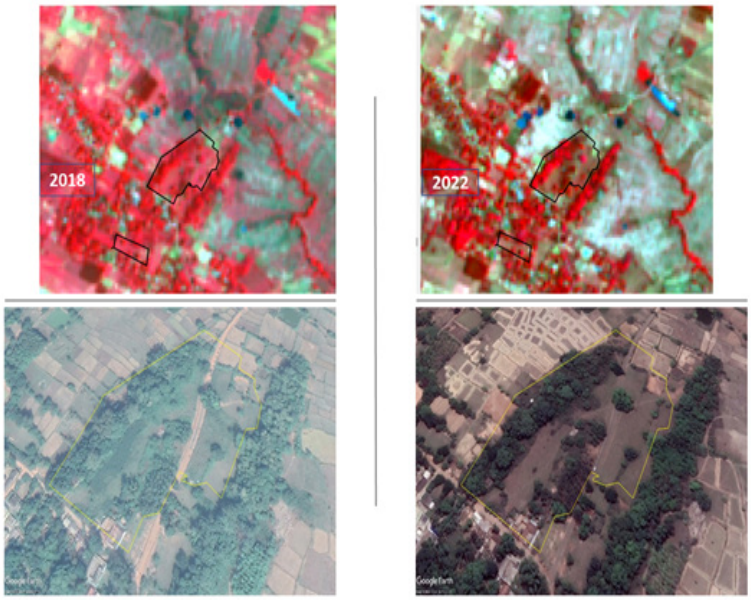
17. NEW JAMAKESHWAR 19



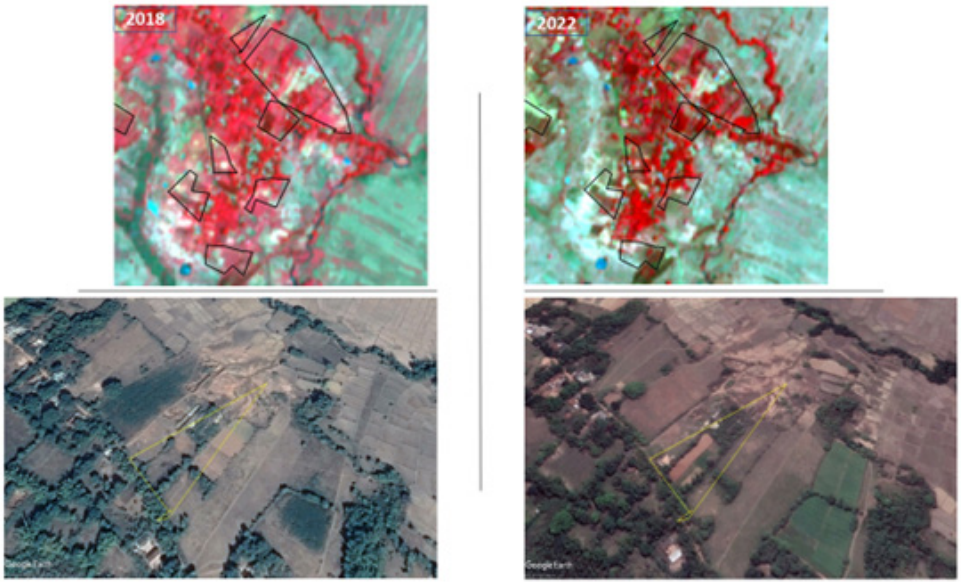
18. RESOLVE NEW JAMAKESHWAR



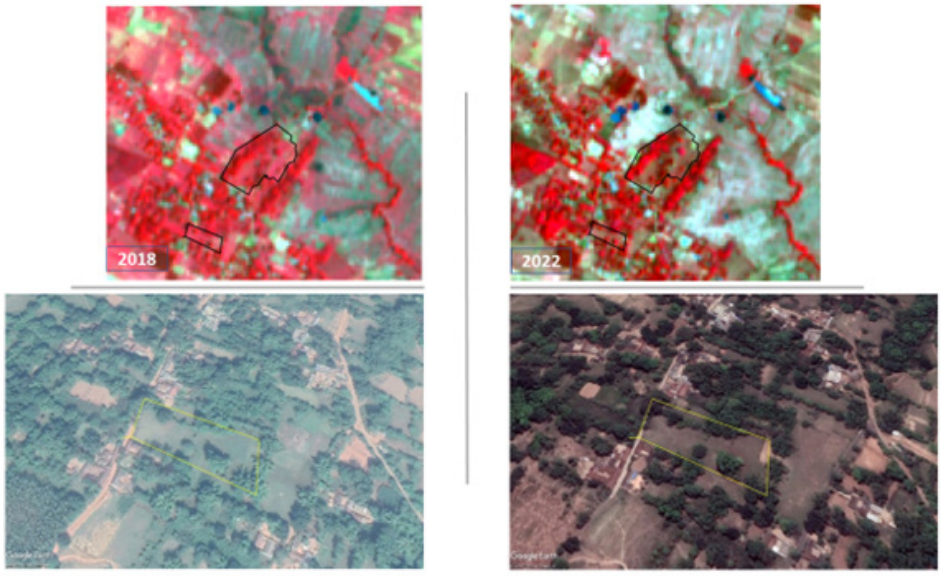
19. RESOLVE NEW JAMAKESHWAR 21



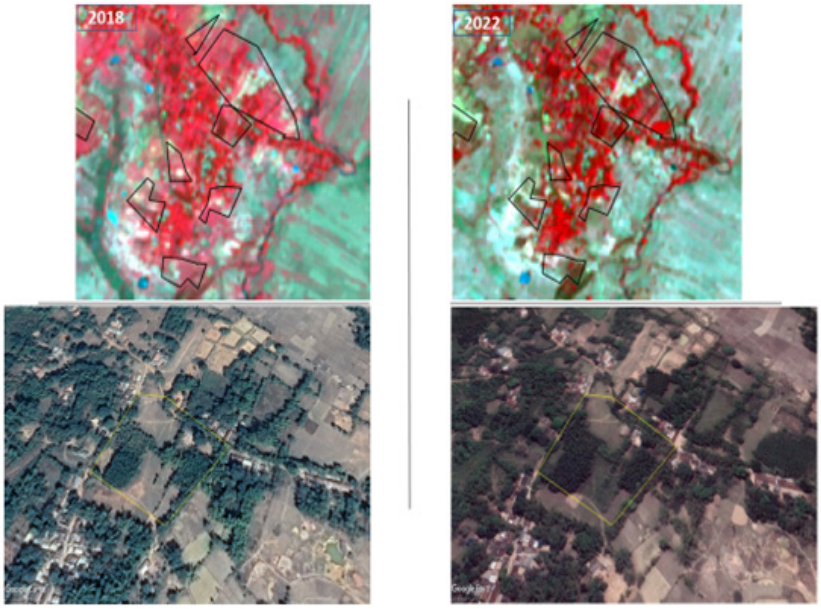
20. NEW JASHIPUR 26



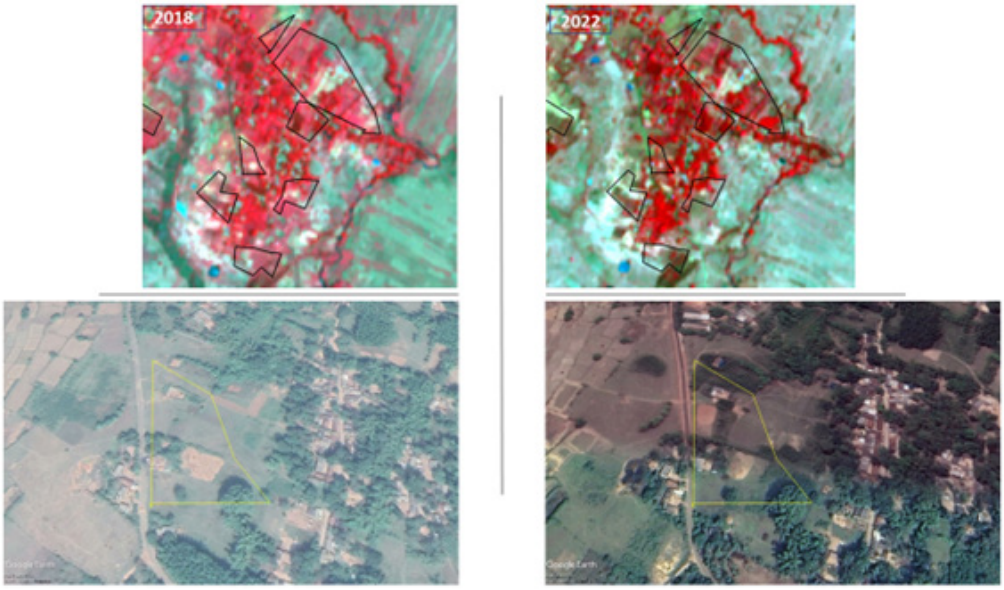
21. NEW JAMAKESHWAR 5



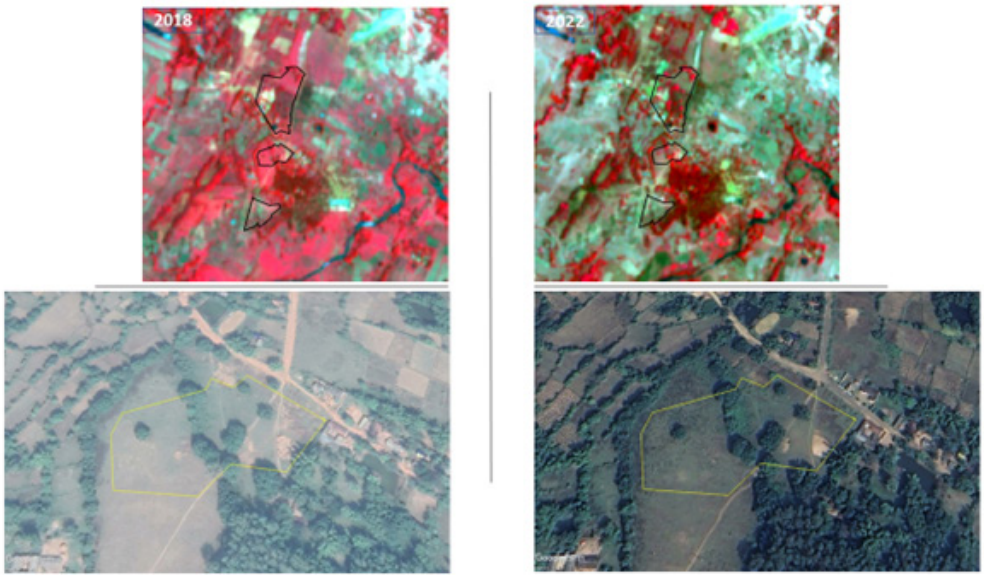
22. NEW JAMAKESHWAR 4



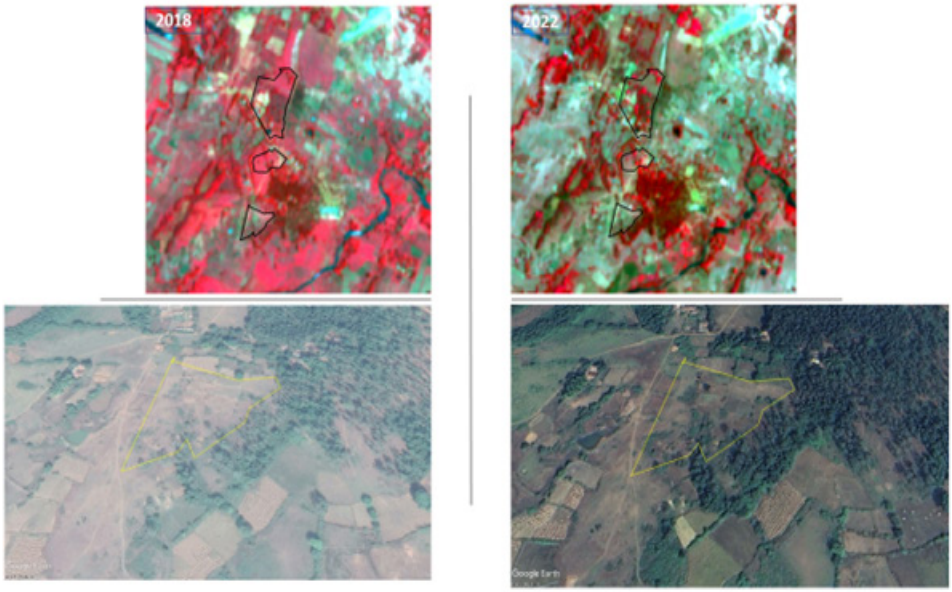
23. NEW JAMAKESHWAR 9



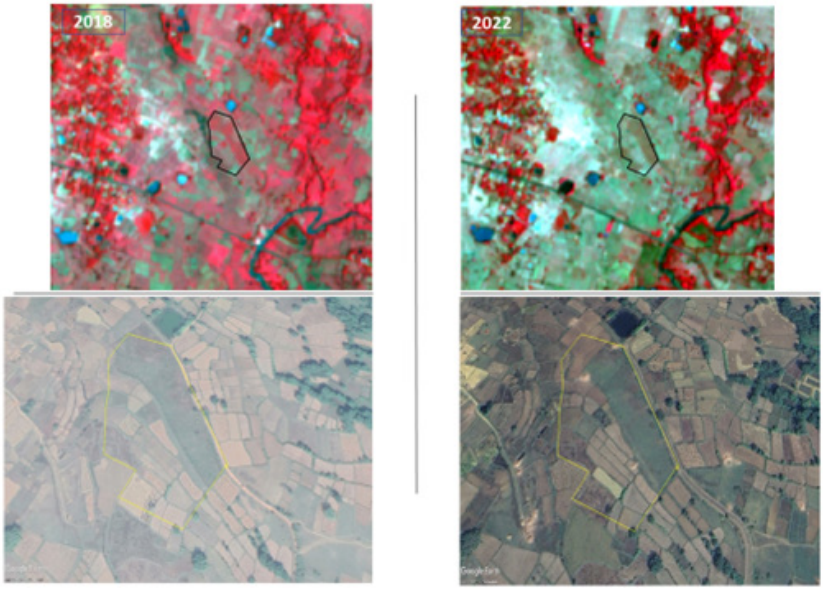
24. RESOLVE NEW JAMAKESHWAR 23



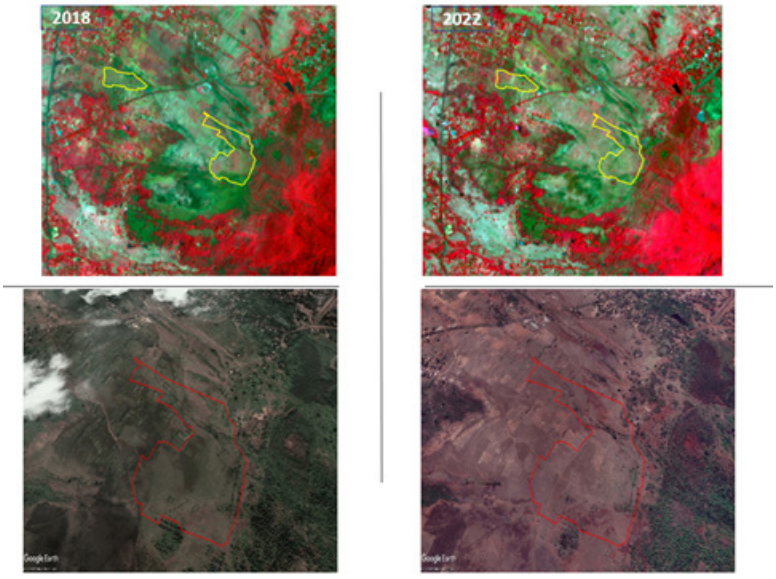
25. NEW JAMAKESHWAR 13



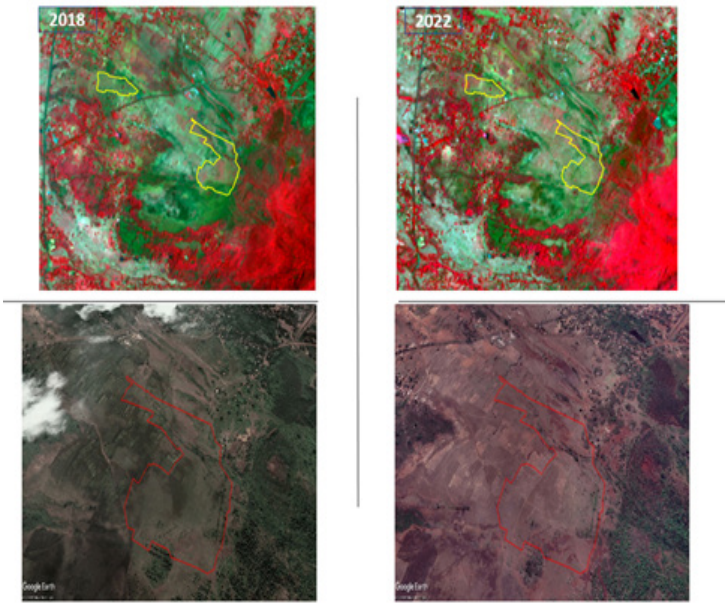
26. NEW JAMAKESHWAR 15



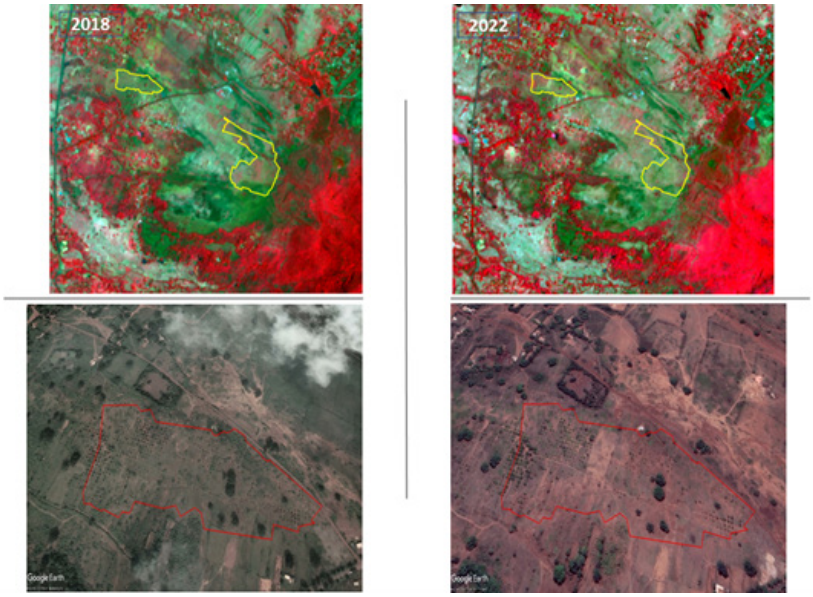
27. JAMMUKESHWAR/AWF/DT34



27. JAMMUKESHWAR/AWF/DT34

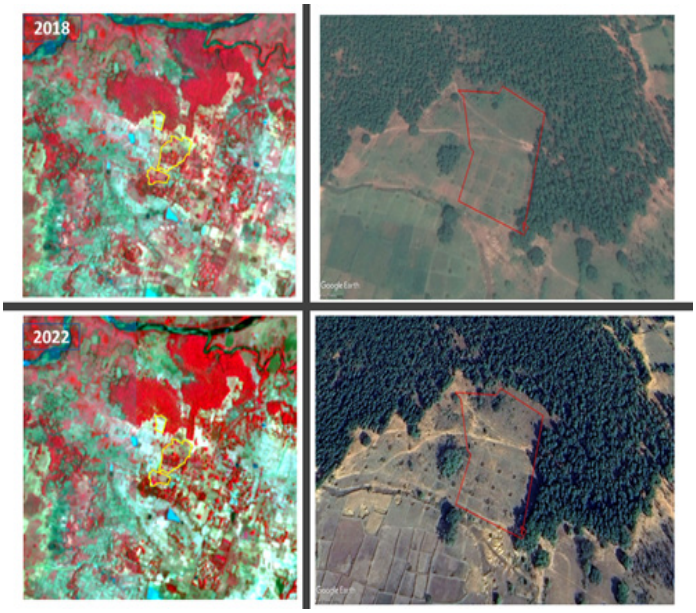


28. JAMMUKESHWAR/AWF/DT33

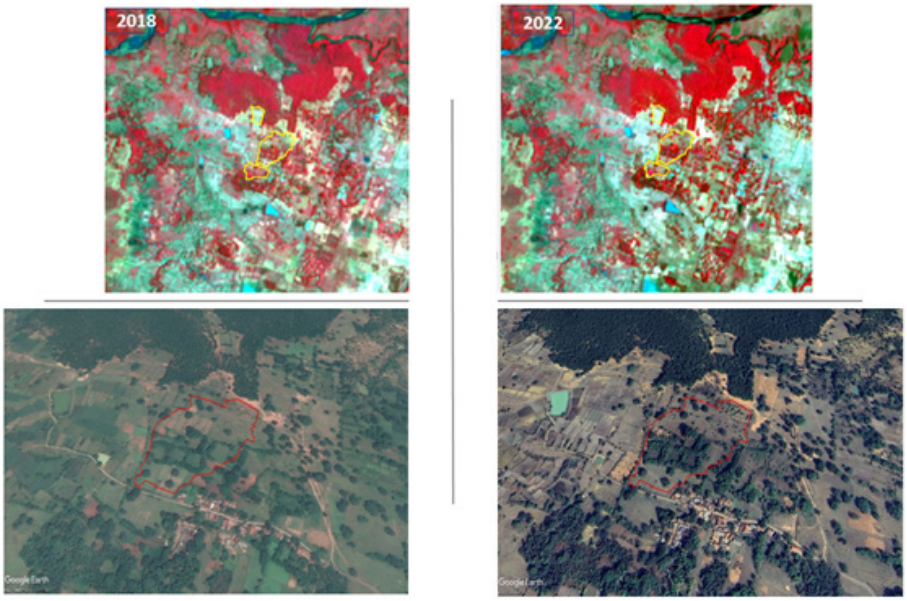


29. JAMMUKESHWAR/AWF/A12

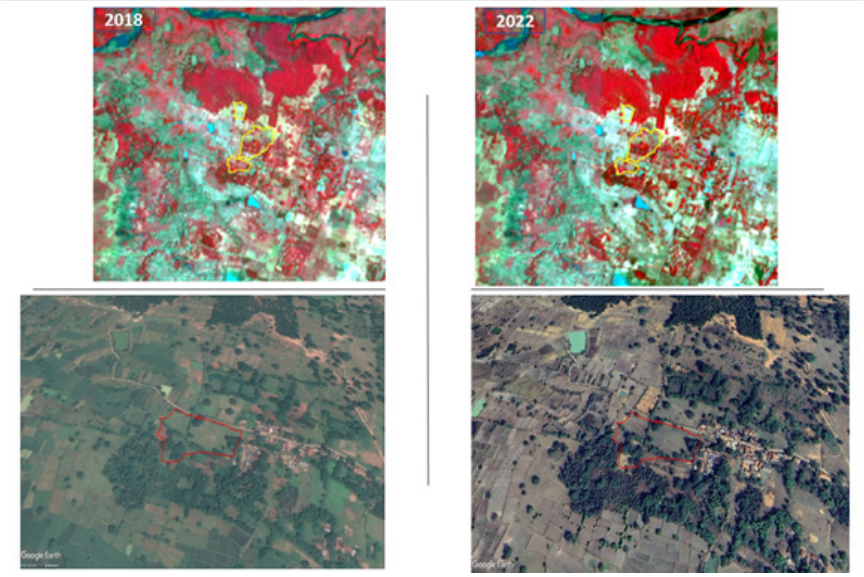
30. JAMMUKESHWAR/AWF/RK32



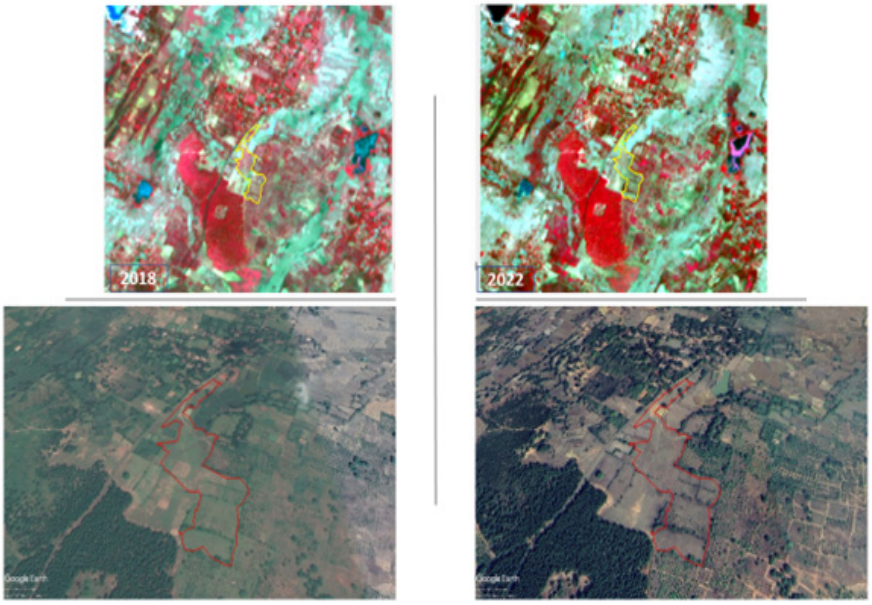
31. JAMMUKESHWAR/AWF/RK30



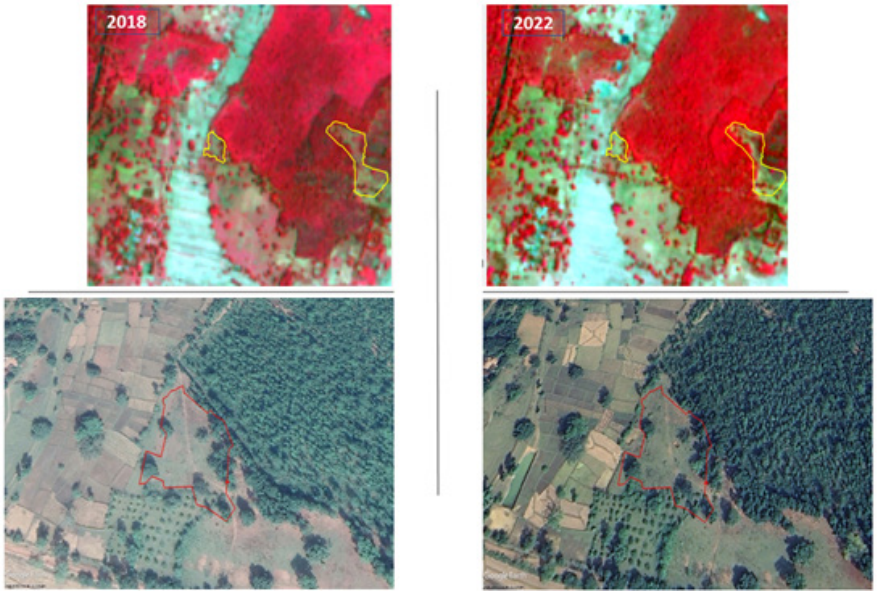
32. JAMMUKESHWAR/AWF/RK31



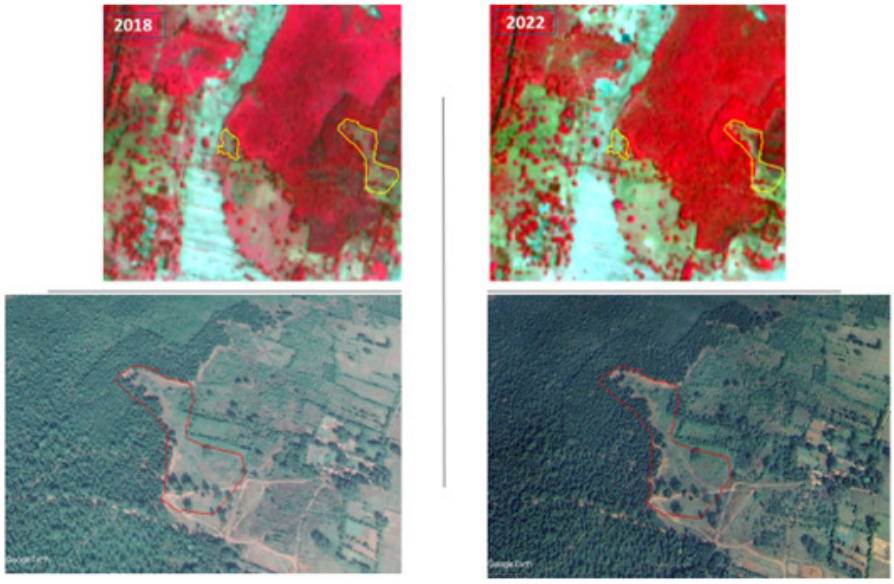
33. JAMMUKESHWAR/AWF/R29



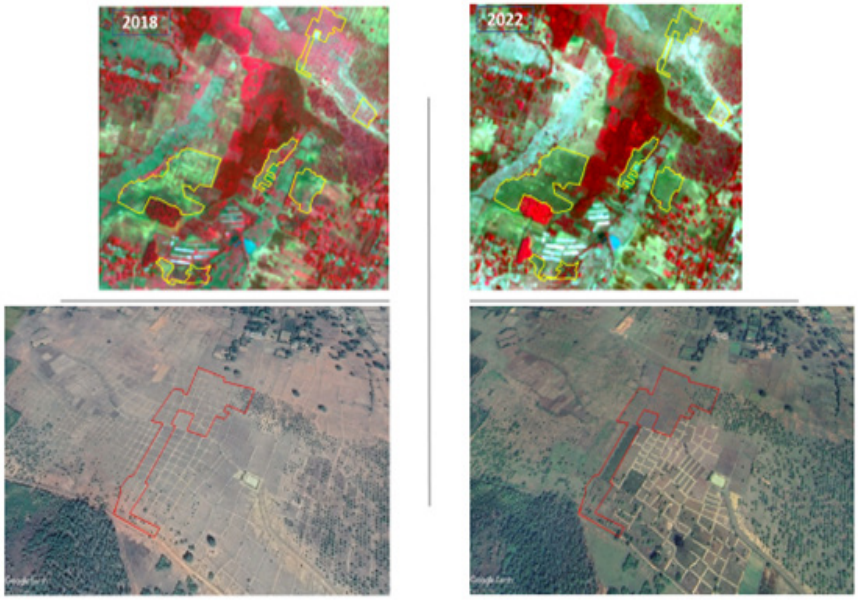
34. JAMMUKESHWAR/AWF/P20



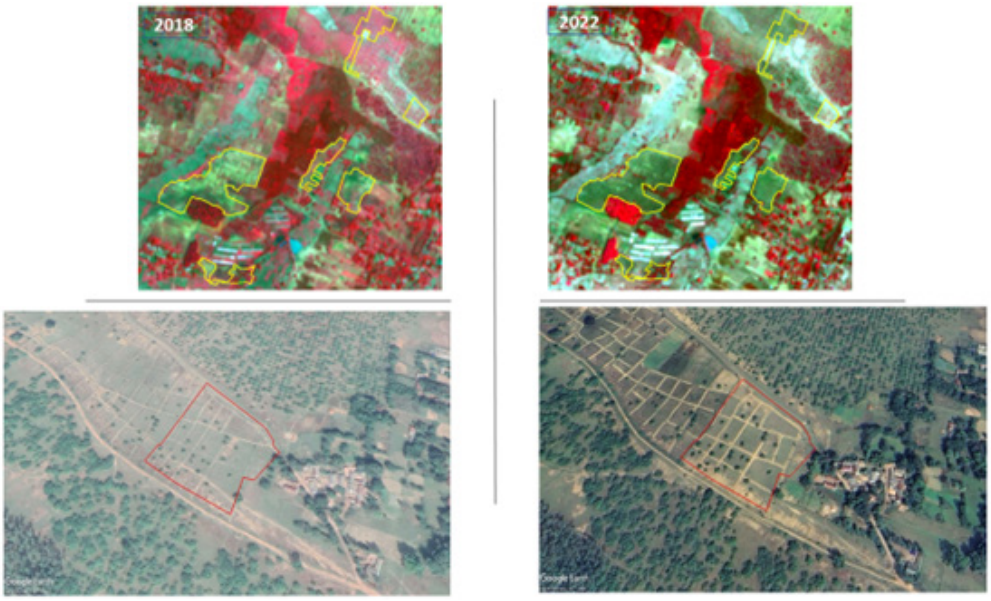
35. JAMMUKESHWAR/AWF/P19



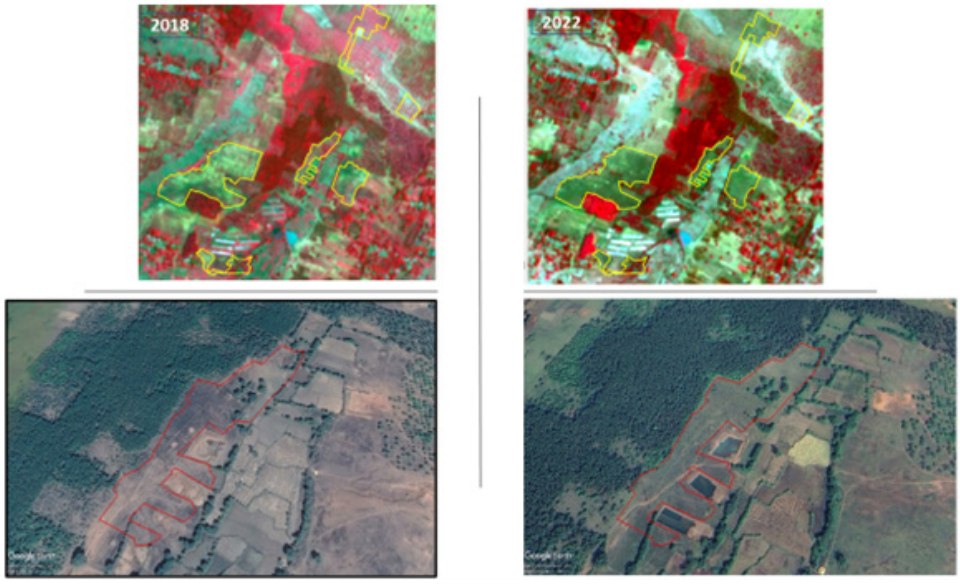
36. JAMMUKESHWAR/AWF/A8



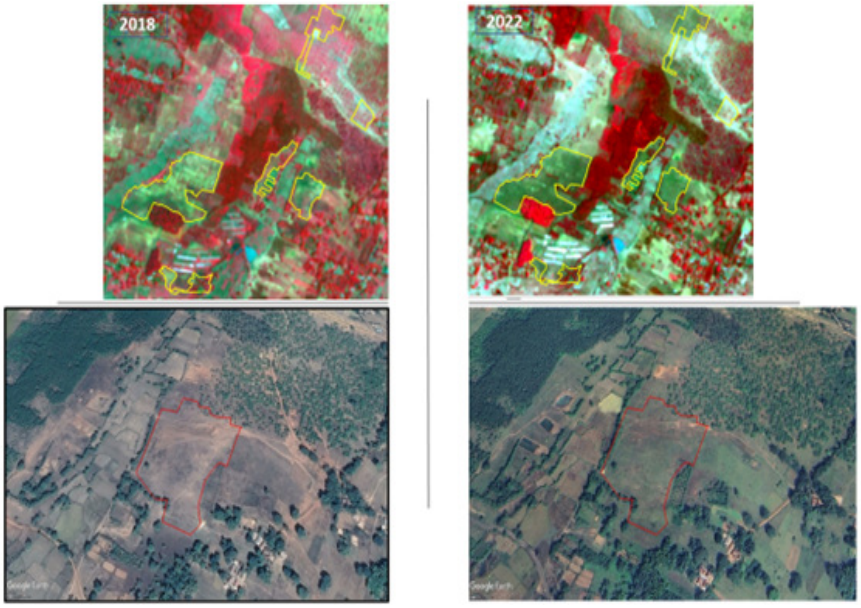
37. JAMMUKESHWAR/AWF/A11



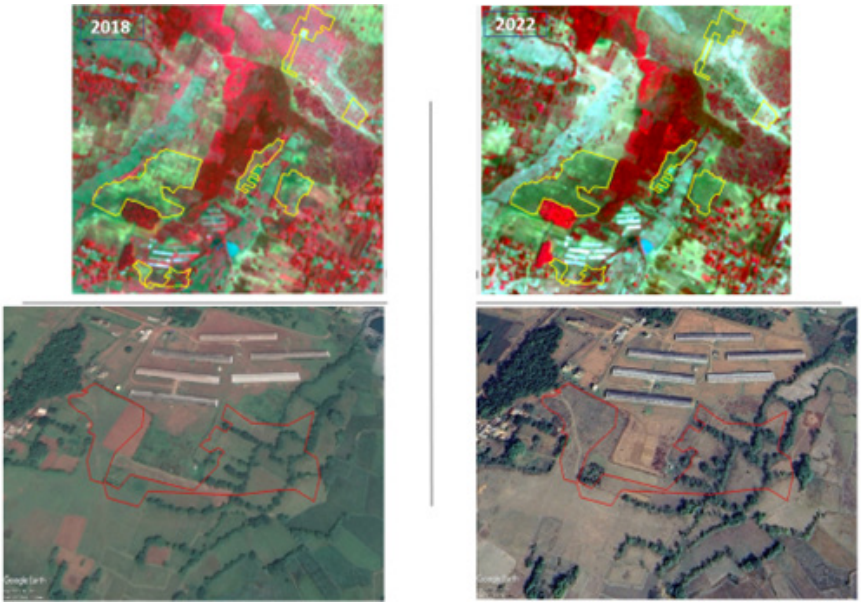
38. JAMMUKESHWAR/AWF/A6



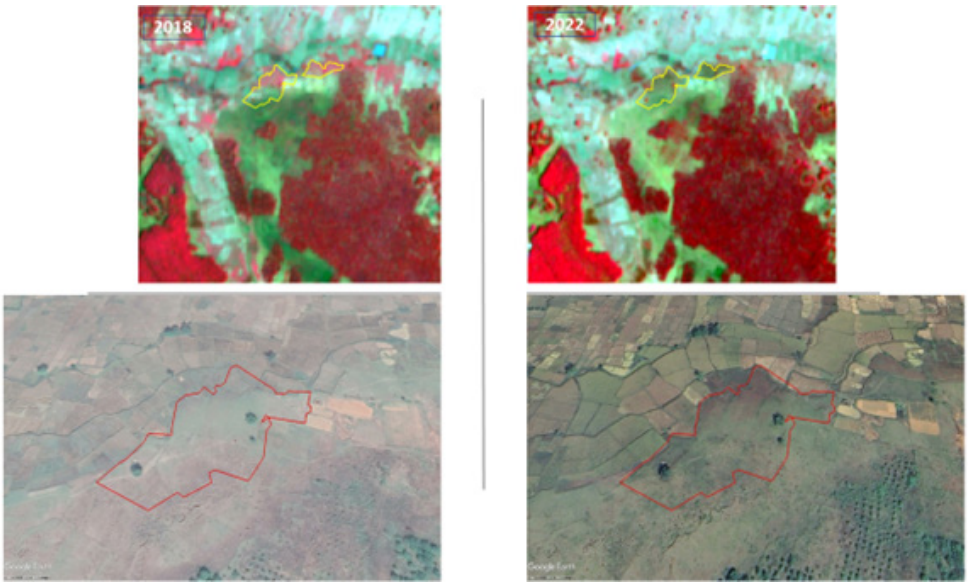
39. JAMMUKESHWAR/AWF/A7



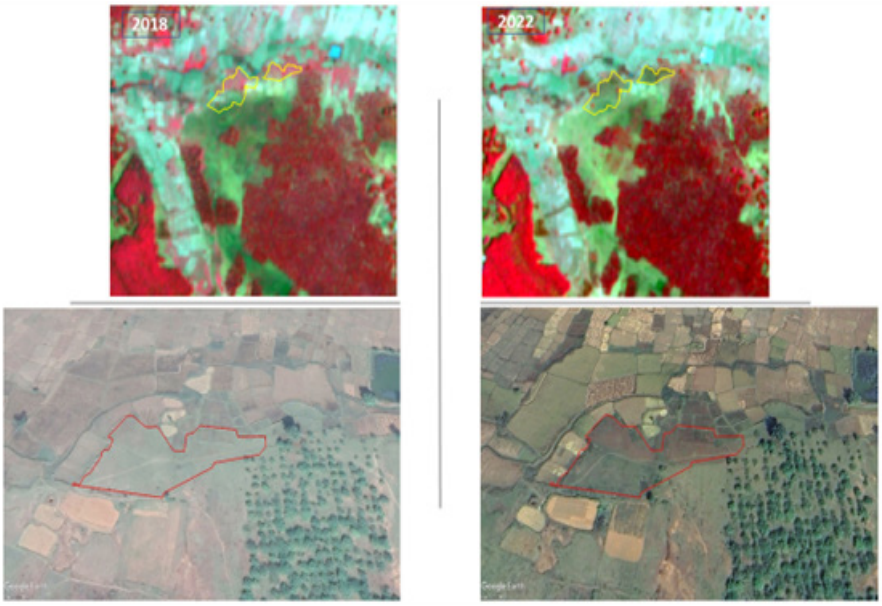
40. JAMMUKESHWAR/AWF/A3



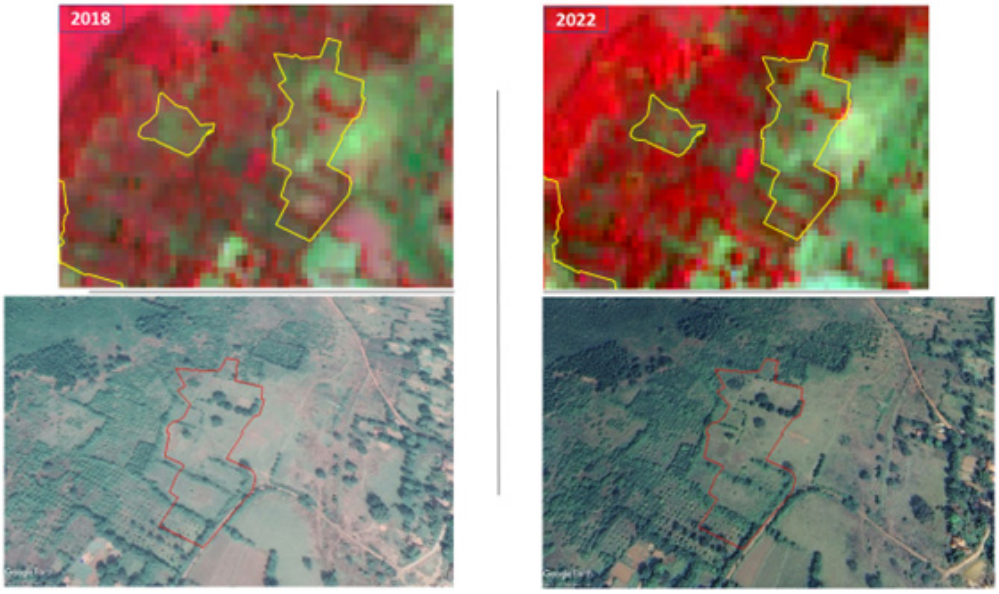
41. JAMMUKESHWAR/AWF/M23



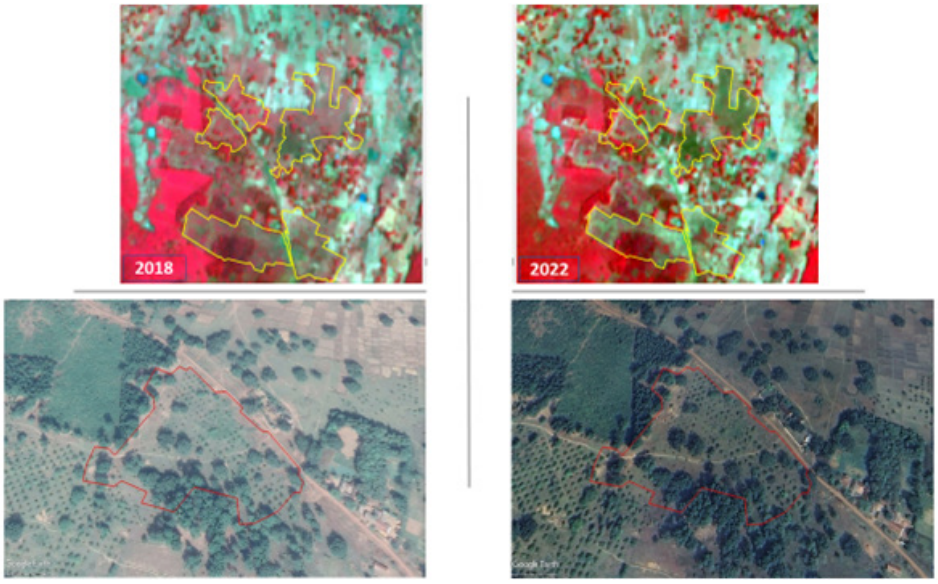
42. JAMMUKESHWAR/AWF/M24



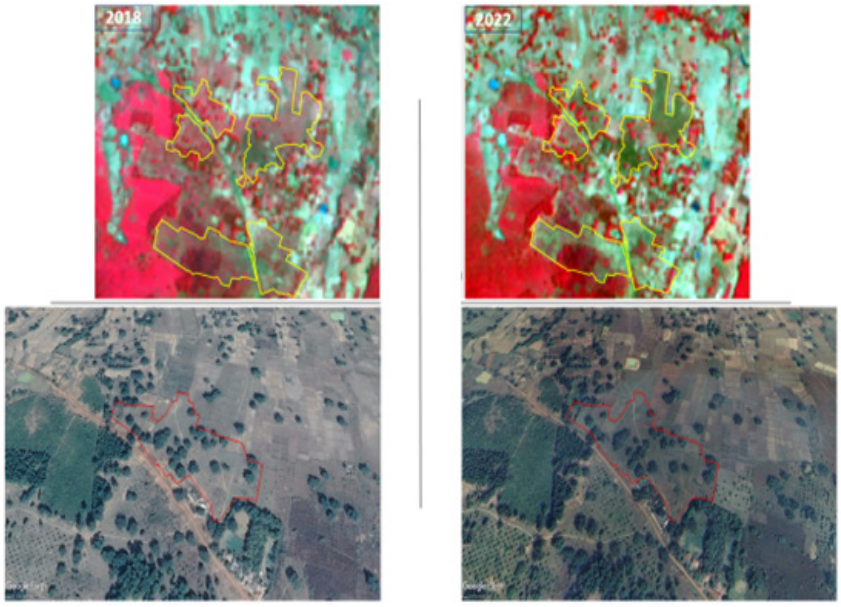
43. JAMMUKESHWAR/AWF/P17



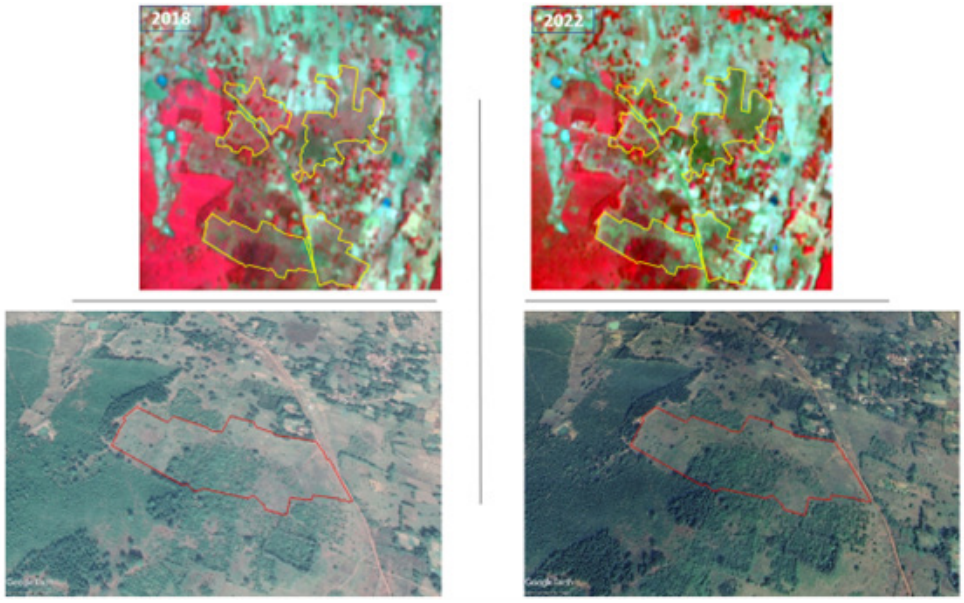
44. JAMMUKESHWAR/AWF/A14



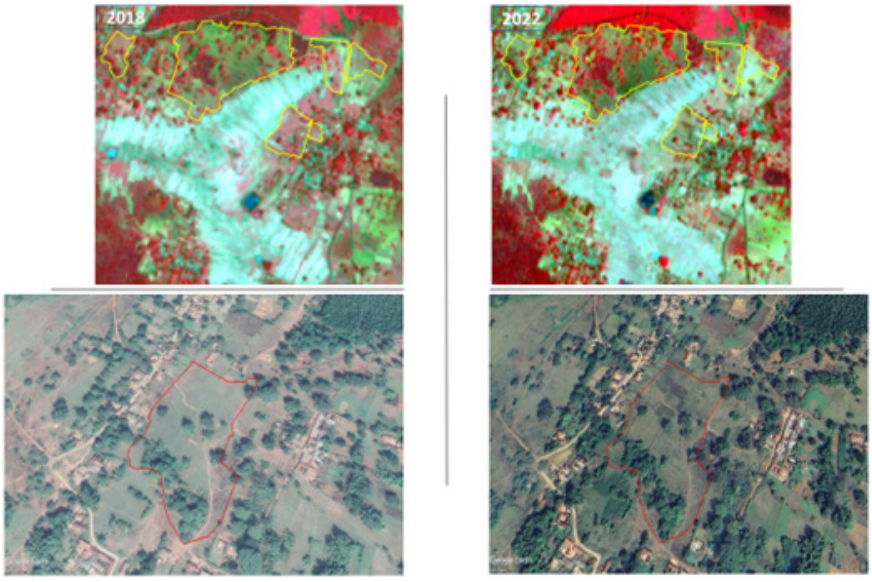
45. JAMMUKESHWAR/AWF/T13



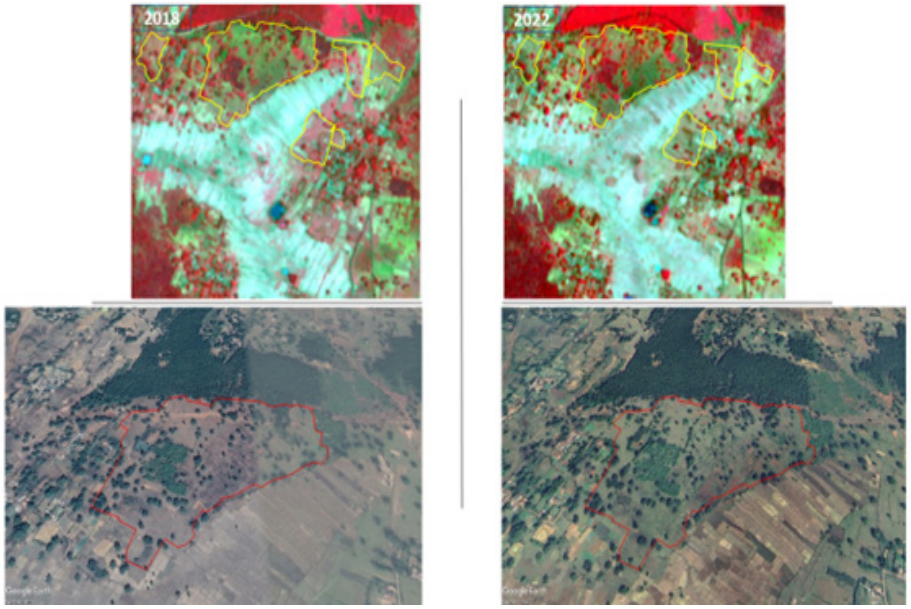
46. JAMMUKESHWAR/AWF/K16



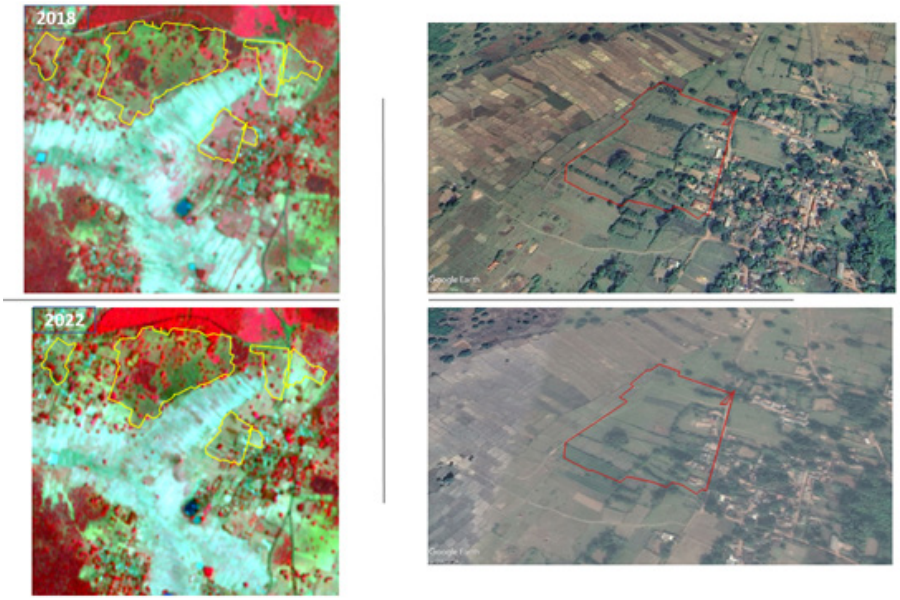
47. JAMMUKESHWAR/AWF/K20



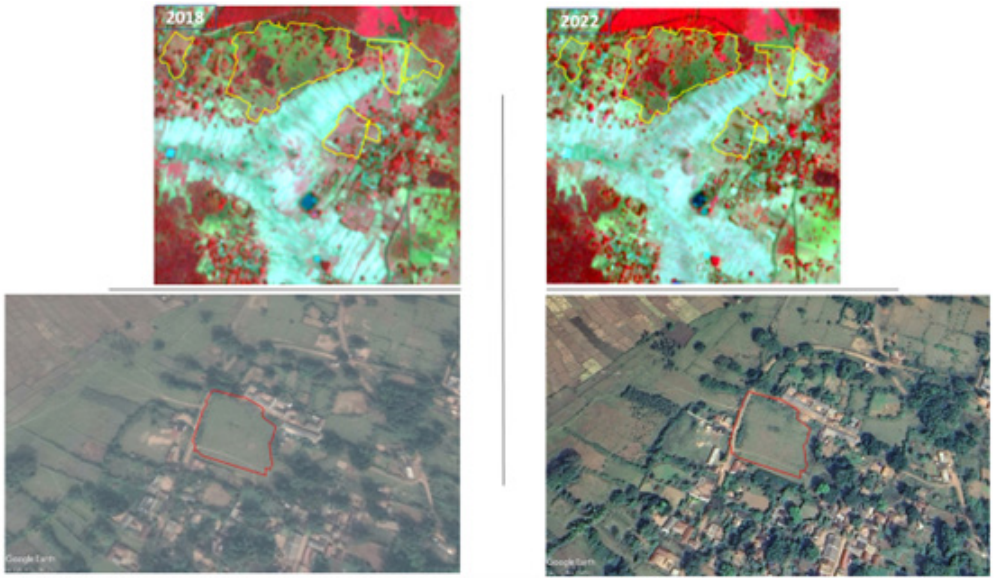
48. JAMMUKESHWAR/AWF/R22



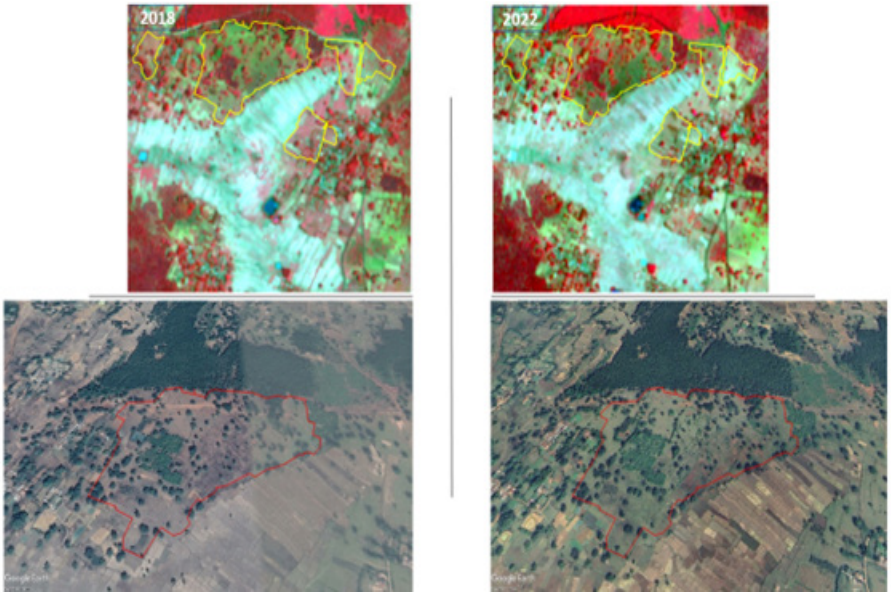
49. JAMMUKESHWAR/AWF/T25



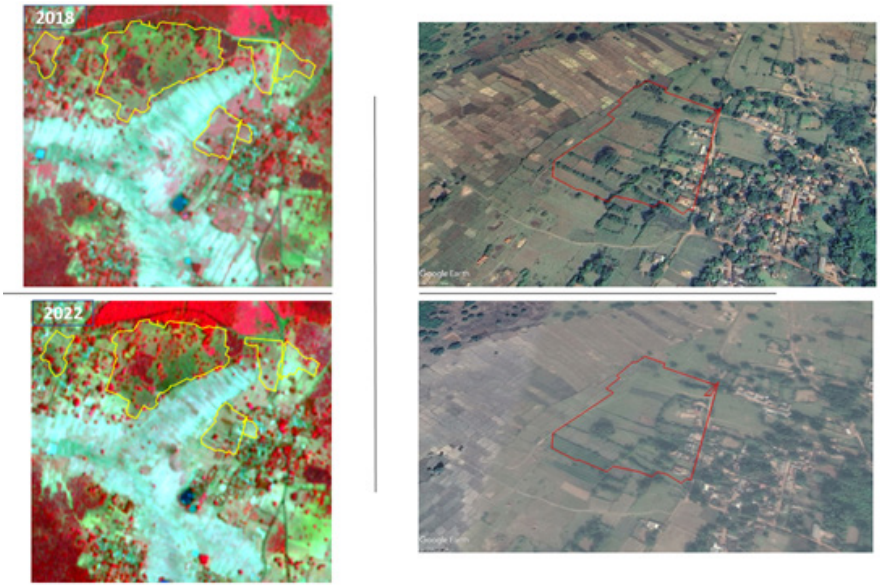
50. JAMMUKESHWAR/AWF/T26

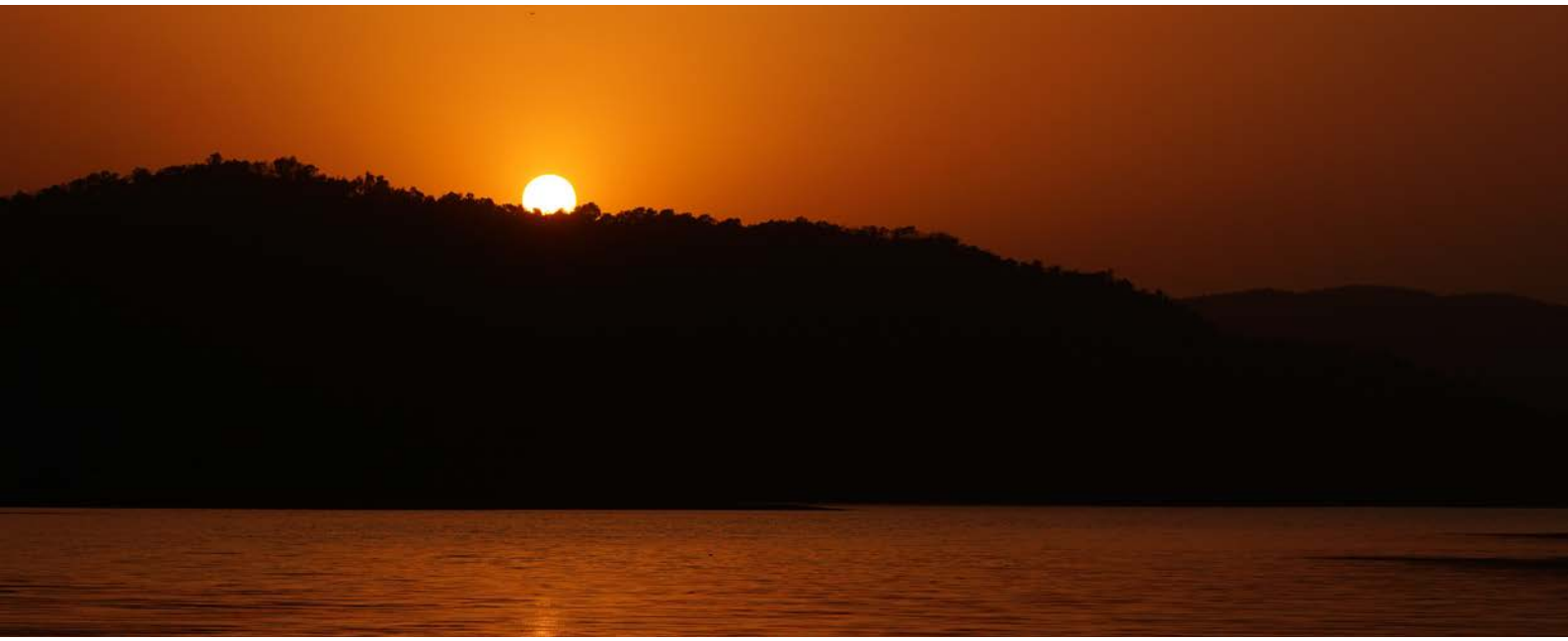


51. JAMMUKESHWAR/AWF/T27



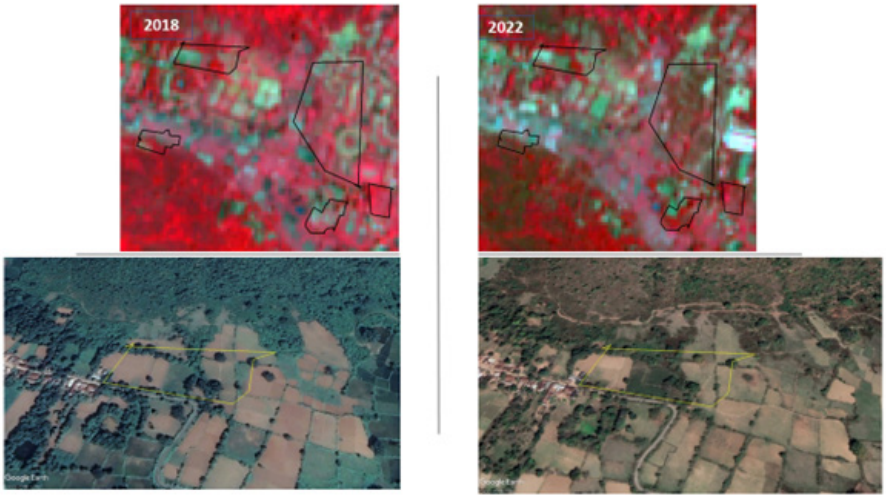
52. JAMMUKESHWAR/AWF/T28



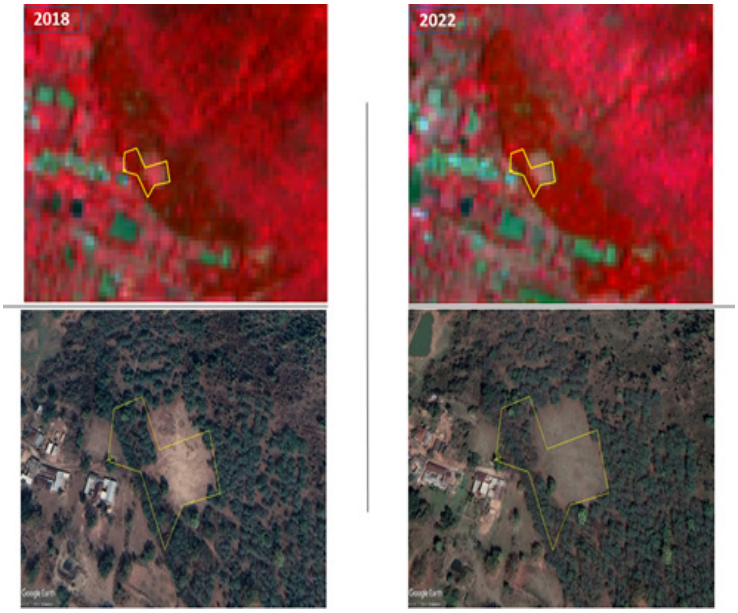


8.1.3. PLANTATION PLOTS WITH REDUCED TREE COVER

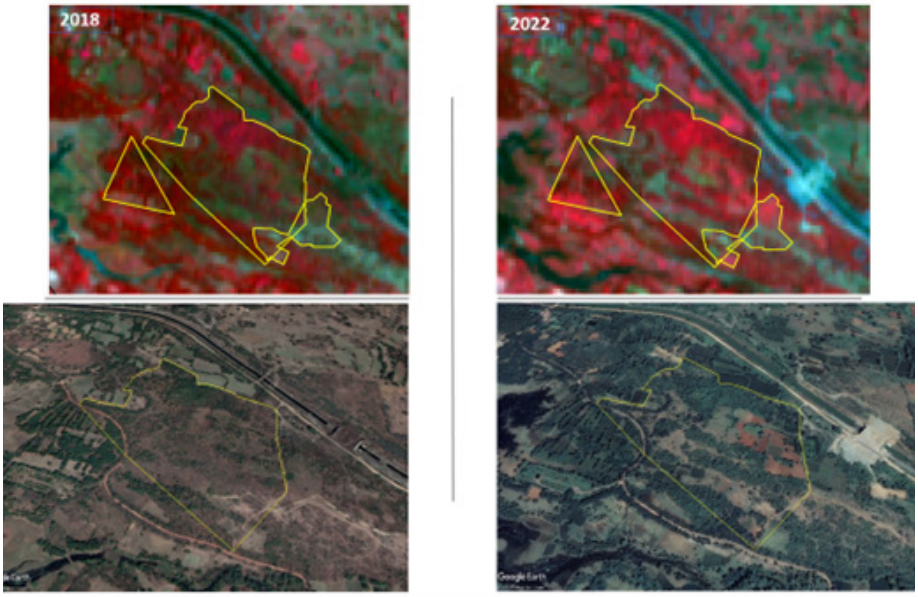
1. NEW SANTHALTOLA 16



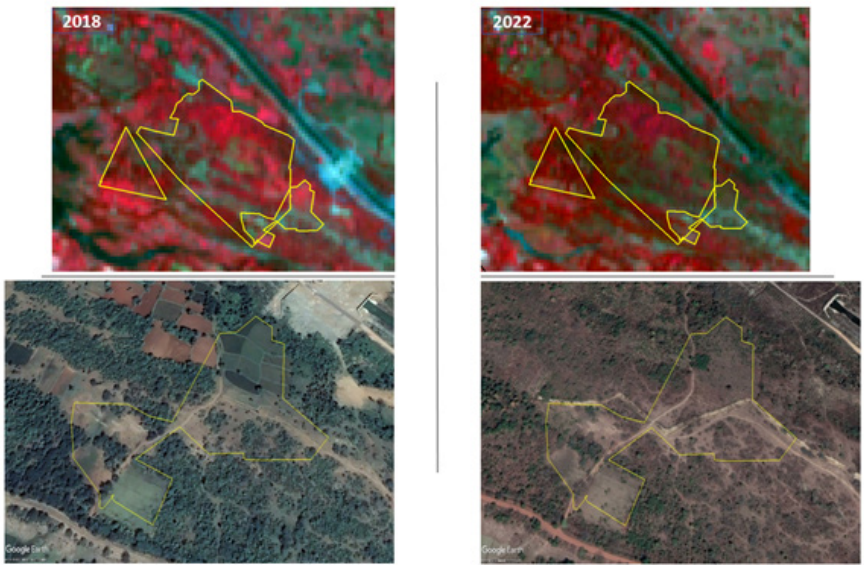
2. RESOLVE NEW PAGDA 32



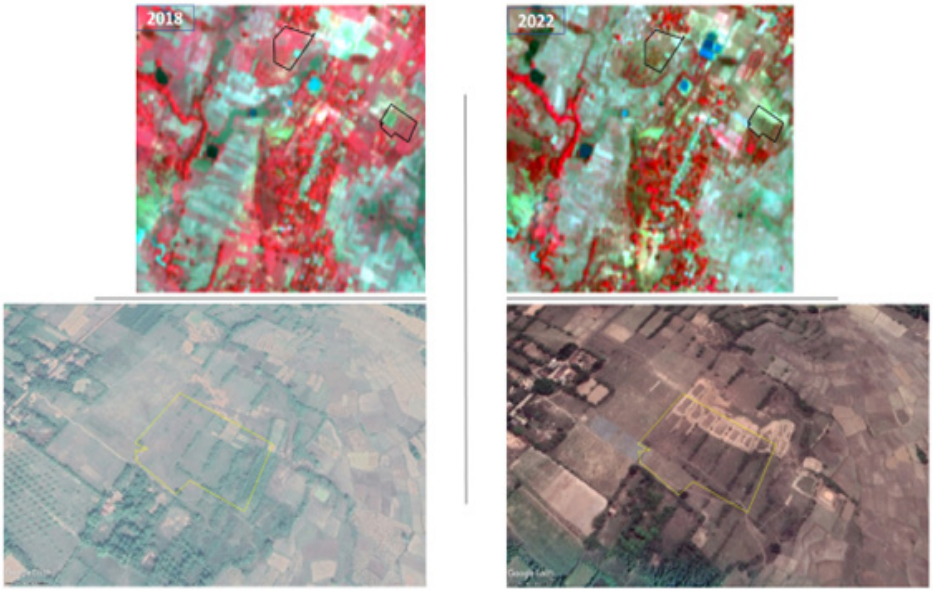
3. RESOLVE NEW AGAIN LYLAM DUNGRI 21



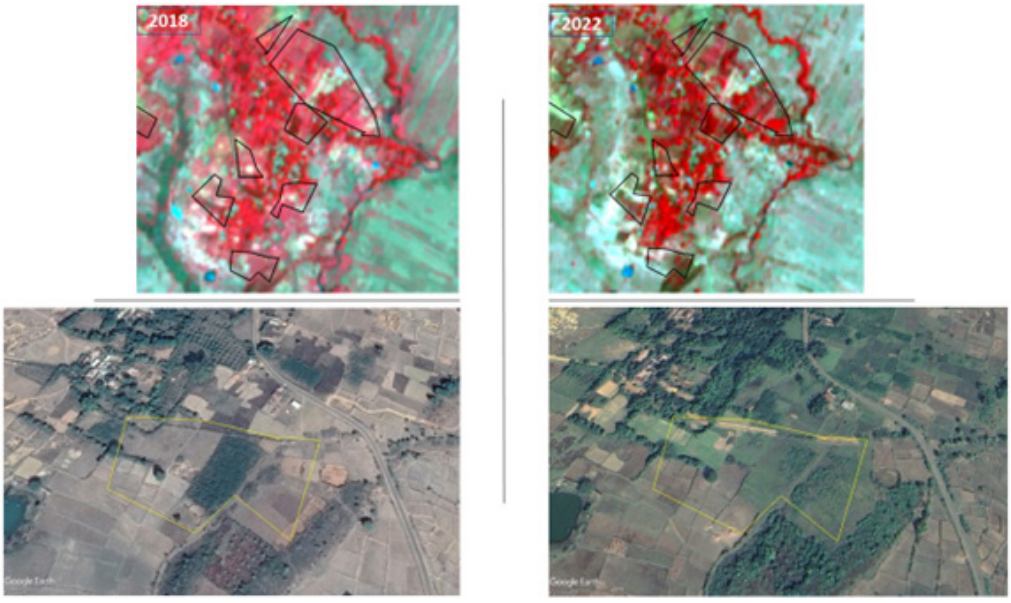
4. RESOLVE NEW LYLAM DUNGRI 21



5. NEW JAMAKESHWAR 10



6. NEW JAMAKESHWAR 7



8.2. SNAPSHOTS FROM FIELD

Plantation of A. auriculiformis on the farmer's land in Santhaltola, East Sighbhum

Field staff engaged in laying quadrats in Laylam village, East Singhbhum

Water stored in the pond constructed under the project used for irrigation in in village Tungburu, East Singhbhum

Women worked as labourers during plantation helping us in site selection for laying quadrat in Laylam, East Singhbhum

Polybags prepared in nursery for raising saplings in the nursery established in the project in East Singhbhum

Conducting FGD with the community members in Kumari, East Singhbhum

Acacia plantation in Manada, Mayurbhanj

Community Pond at Manada, used for aquaculture.

Community Pond in Tulasiposi, used for raising of ducks and selling their eggs.

Tree count of Acacia sapling in Raitalia village, Mayurbhanj.