Systematic Planning for The Construction and Impact of Water Harvesting Structure Near the Forest Village for The Sustainable Livelihood and Wildlife Support in BASTAR Region

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Abstract: - This project focuses on addressing the critical issue of traditional forest bunds in the Bastar region, leading to deforestation, wildlife habitat loss, and reduced water resources. Through systematic planning, the project transforms these areas into multifunctional water harvesting structures, benefiting wildlife and tribal communities. The project encompasses the following key aspects.

Identification of forest Bunds: The project identifies areas on forest bunds and replaces them with well-engineered water harvesting structures, restoring ecological balance and water resources.

I context to Wildlife Conservation, Extensive ecological assessmentsensure water harvesting structures meet wildlife needs, fostering biodiversity conservation and supporting local ecosystems. Sustainable Income through Fish Farming: The project introduces responsible fish farming practices, creating a consistent income source for locals. Micro-Irrigation Implementation to enhance agricultural productivity, promoting sustainable farming practices. Community Participation and Empowerment by involvement and training programs ensure ownership and responsibility for project goals. Monitoring and Evaluation to Robust assess the project's impact on wildlife, water availability, and tribal communities, informing future strategies. Detailed Studies in the project's socioeconomic influence on Kanger Nala and the INRM technique, GIS based integrated planning, groundwater, vadose zone moisture, silt control, vegetation moisture, catchment capacity, and water recharge potential are analyzed. Social and economic advantages of completed tasks are also considered.

This project successfully addresses deforestation and encroachment challenges in Bastar, benefiting both the environment, biodiversity, ecological balance and local communities through sustainable practices and careful planning.

Keywords: Data gathering, Research, analysis, planning, and decision-making.

I. INTRODUCTION

This study's primary goal is to combat deforestation in Chhattisgarh's Bastar region, known for its ancient forests and biodiversity. Encroached bunds, driven by socio-economic factors and paddy cultivation incentives, threatens these forests and leads to human-wildlife conflicts. Bastar is a remote district plagued by Left-Wing Extremism and irrigation deficits, face heightened forest encroachment in some area. The government launched the Narva Garva Ghurva and Badi project in 2019, focusing on watershed conservation, in this head Forest Division initiated Soil Moisture Conservation to convert some of the old encroached tribal land into water-harvesting ponds to mitigate deforestation.

Persisting challenges include low agricultural productivity, chemical use, climate-resilience gaps, wetland mismanagement, water scarcity, and poor inter-departmental coordination.

The study's core objective is to comprehensively address forest bund , deforestation, and environmental degradation. It aims to improve livelihoods through sustainable practices, boost soil carbon content, conserve water, and enhance

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irrigation with Rivulet Restoration. This includes mitigating soil and groundwater depletion, revitalizing rivulets, and benefiting farmers, wildlife, and the ecosystem.

The study also aims to assess the detailed impact on the Kanger Nala Arrandwal Cluster by analyzing various parameters including waterflow status, soil erosion, open well data, agriculture plot survey results, soil moisture and NDVI data's impact on plantation, silt monitoring, increased water harvesting potential and increased recharge potential survey.

No	Division	Structure	Village	Status	Catchment	LAT - LONG
1	Bastar	WHS ECD	Arrandwal	Integrated activity	Kanger Nala Rivulet	19.0035238 , 81.84531891 . 19.003384 , 81.835777 18.996552° , 81.833363°

Table -.1 Basic Information about area

II. RESEARCH METHODOLOGY

For a effective Water harvesting in the required area it is not possible to make a stand alone activity it must be in the combination with the natural resource management in forest areas, principles like prioritizing ecosystem integrity, promoting minimal intervention, and addressing degradation's root causes are followed. Geographic Information Systems (GIS) and satellite mapping are essential tools for spatial data analysis and decision-making in watershed management. The advantages of GIS in forest NRM include enhanced spatial analysis, efficient resource management, and stakeholder engagement. Applications of GIS cover planning, climate resilience, environmental impact assessment, and more. However, GIS has limitations, requiring ground truthing and addressing dynamic geographical conditions. Stream reclamation uses GIS-based analysis and ground confirmation for creek restoration. Collecting baseline data is crucial for assessing mitigation impacts, including water flow and soil erosion. Forest resource assessment and ground truthing validate GIS data. Calculations like the Rational Method and Dickens formula estimate surface runoff. In summary, sustainable soil moisture conservation and watershed management rely on data, GIS, ground truthing, and calculations."

Following where the major challenges that need to be mitigated from the cluster area. which are as follows -

Survey Process -

To ensure on quality of collected information, ease on coordination between the entire survey team and also to timely complete the entire process like the basic area information then the validation by the Note Cam mobile application have been used to undertake the significant portion of surveys. This was followed by a GPS based survey and series of consultations to validate the collected information and further to build upon the realistic recommendation. Surveyors having prior experience of undertaking app-based surveys were identified for two-full day training workshops and field testing. Based on surveyor feedback and our developed understanding; the following information compiled.

Kanger Nala, with Milli-watershed Codes 4E1D3A2, 4E1D3A1, and 4E1D3A3, is the focus of a comprehensive project. This area encompasses a vast catchment of 15,986 hectares, including both forested and revenue areas. The project involves multiple Gram Panchayats and Joint Forest Management Committees. A significant portion of 3,145 hectares within this area is designated for treatment. The project area covers an observation area of 408 hectares within the Arandwal Village Cluster, with 1,637 compartments. The drainage line extends for 29.9 kilometers, with varying widths across high, mid, and low-land sections. The average slope of the drainage line is 1.9%. The project involves various benchmark points and benefits both wildlife and 408 Scheduled Tribe households.

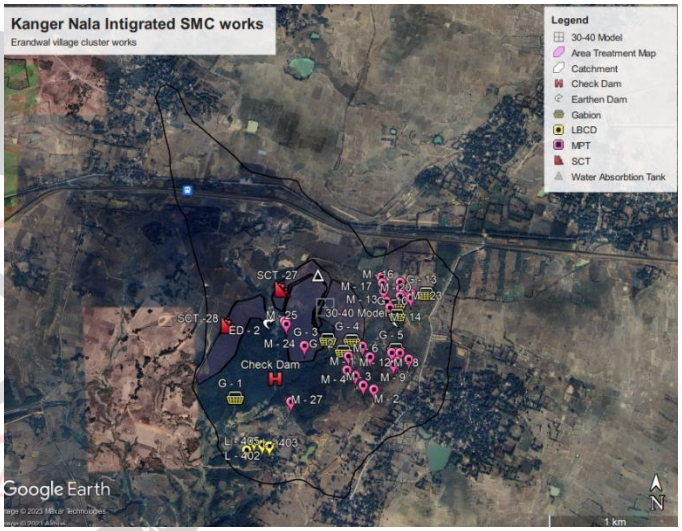

Fig-1. Mitigation planning to address the problem under the Arrandwal catchment area.

No	Activity under the Arrandwal Cluster	Number
1	Staggard Contour trench	6671
2	30-40 Modal	440
3	Water Absorption Trench	198
4	Loose Boulder Check Dam	4
5	Mini Percolation Tank	27
6	Gabion	8
7	Check Dam	1
8	Earthen Dam	3
		7352

Table – 2 , List of the Treatment plan .

GIS and Field Problems findings from the cluster

Drainage data analysis : Three primary fourth-order drainage lines flow from NW to SW in the catchment. First-

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order drainage lines originate from the forest land. Area treatment needed for private agricultural land and forested areas.

Land Use Land Cover data analysis: Some encroachment and erosion in the central part of the catchment. Focus on treating forest areas and second/third-order streams. Habitation is visible near the site location.

Soil Erosion data analysis: Rill erosion predominant in major part of the catchment. Correlation with the drainage line map suggests the need for area treatment.

Lineament data analysis: No visible lineaments near intervention areas. Means no major recharge through cracks.

Groundwater Potential data analysis: Most of the catchment falls under the 20 LDPE yield area.

Slope data analysis: Various slopes visible in the catchment, indicating potential for area and drain treatment.

CLART data analysis: Moderate recharge zone in most of the catchment. Suitable for groundwater recharge. Focus on green patches for area and drain treatment.

Contour Line data analysis: Various slopes visible in the catchment, suggesting potential for area and drain treatment.

Lithology data analysis (Source-FMIS): Most of the area is composed of shale rocks.

Forest Cover data analysis: Most of the catchment is categorized as open forest and moderate forest.

Soil Depth data analysis: Most of the soil area has a depth of 8 cm, indicating heavy soil erosion.

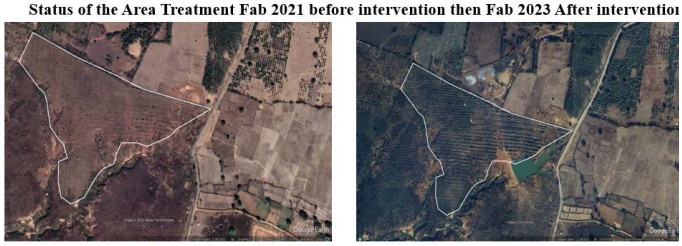
Soil Color data analysis: Catchment area predominantly falls under the yellowish-brown color.

Soil pH value data analysis: soil pH value of 5.32, indicating an acidic category.

Impact study after the completion of the proposed works

Following are the Satellite image of the impact of the work completed under the proposed target –

Status of the Area Treatment Fab 2021 before intervention then Fab 2023 After intervention



Status of the plantation Fab 2021 before intervention then Fab 2023 After Intervention

Fig-2. Mitigation Impact in Arrandwal catchment area.

Encroachment mitigation measures empower communities through alternative livelihoods, enhance agricultural productivity, promote human-wildlife coexistence, ensure responsible water resource management, preserve wetlands, and support sustainable forest resource utilization. This collaborative effort for conservation leads to community cohesion and shared responsibility, safeguarding our vital ecosystems, climate resilience, and the well-being of future generations.

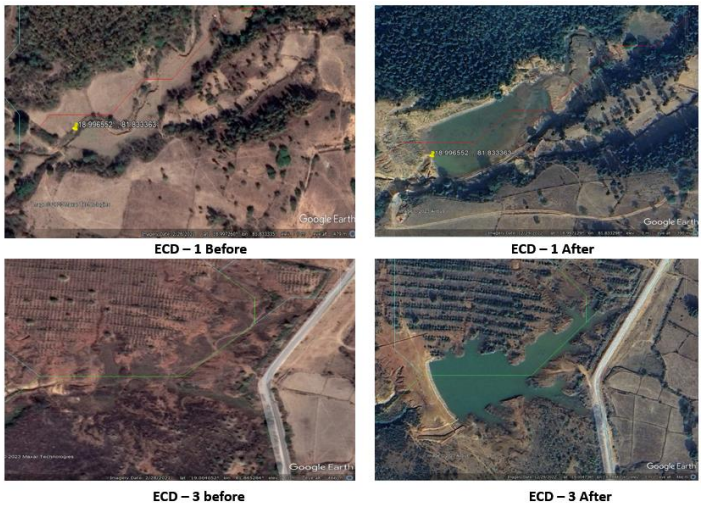


Fig-3. Mitigation Impact in Arrandwal catchment area. In water bodies

III. RESULTS AND DISCUSSION

Integrated planning and execution of the construction of water harvesting structures in ridge to valley treatment approach which aims to provide water to wildlife and support sustainable tribal income through fish farming and micro-irrigation. It is a significant and multifaceted initiative. Results obtained from the implementation of the project from the year 2021 and its impact. The results are mentioned in the following steps

Soil Erosion Status Data

Category	High – H	Moderate – M	Low - L
Gully formation	More than 10 Gullies	5 – 10 Gullies	0 to 5 Gullies

Table 3 Category of Gullies formation.

S. No.	Zone	Left side of main Nala		Right side of main Nala		Total Reading on Aug 2021	Reading on Jun 2022	Reading on Mar 2023
		No. of Gully	Category	No. of Gully	Category			
1	Upper Catchment zone	9	M	4	L	13	10	9
2	Middle Catchment zone	6	M	9	M	15	13	11

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3	Lower Catchment zone	2	L	5	M	7	5	4

Table 4 Category of the no of the Gullies formation.

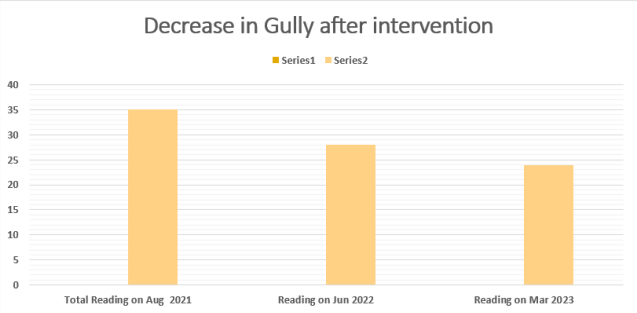

Chart – 1 Graph showing the change in the gully formation after the work intervention.

IV. DISCUSSION AND FINDINGS

Formation of the gullies is the clear indicator of the erosion status of any area but after the intervention the decrease in the number of the gully is the clear indicator of the gully erosion is checked by the SMC works.

Intervention results on Open Well under the catchment area –

Following the Result analysis of the work impact on open well of the cluster.

Open Well Observation Data sheet								1st reading in June 21		2nd reading in Oct 21		3rd reading in Fe	
WC	Name of Beneficiary (Observation well)	Latitude (in Decimal)	Longitude (in Decimal)	Elevation (m)	D, Diameter of Well (in m)	P, Height of Parapit from Ground (in m)	H, Total depth of Well from parapit (in m)	WL, Depth of water in Well (in m)	Total Depth of Water in Well = (H-WL)	WL, Depth of water in Well (in m)	Total Depth of Water in Well = (H-WL)	WL, Depth of water in Well (in m)	Total Dept Wate Well (H-W
OW -1	Sukharam maurya	Arendwal	18.996722	81.848036	6.5	0.5	8.5	6	2.5	2	6.5	3.4	5
OW -2	Sukharam maurya	Arendwal	18.996651	81.848038	7	0.4	9	5.8	3.2	1.8	7.2	3.7	5
OW -3	Lachhin	Arendwal	19.004951	81.849306	7	0.4	8	5.5	2.5	3	5	3.2	4
Avg of the Water Level									2.73		6.23		5
								1st reading in June 22		2nd reading in Oct 22		3rd reading in Fe	
OW -1	Sukharam maurya	Arendwal	18.996722	81.848036	6.5	0.5	8.5	5.8	2.7	1.1	7.4	2.8	5
OW -2	Sukharam maurya	Arendwal	18.996651	81.848038	7	0.4	9	5.5	3.5	1.2	7.8	2.8	6
OW -3	Lachhin	Arendwal	19.004951	81.849306	7	0.4	8	5.7	2.3	1.4	6.6	2.4	5
Avg of the Water Level									2.83		7.27		5
								1st reading in June 23		2nd reading in Oct 23		3rd reading in Fe	
OW -1	Sukharam maurya	Arendwal	18.996722	81.848036	6.5	0.5	8.5	5.3	3.2				
OW -2	Sukharam maurya	Arendwal	18.996651	81.848038	7	0.4	9	5.5	3.5				
OW -3	Lachhin	Arendwal	19.004951	81.849306	7	0.4	8	3.1	4.9				
Avg of the Water Level									3.87				

Table 5 Open well data analysis of the recording .

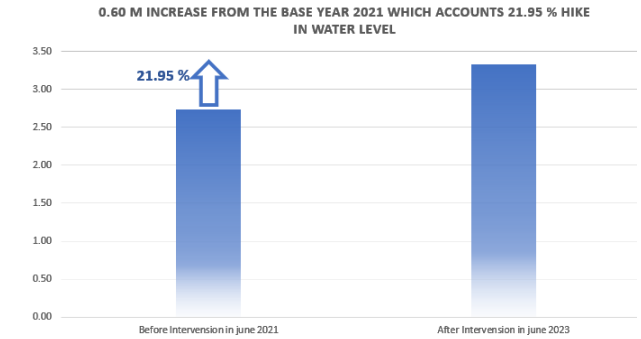

Chart – 2. Figure showing the increase in the water level in the sample open well.

Discussion and findings – It is clear from the data that all SMC work and WHS provide a good impact on the selected OW, which is the success indicator of the work.

Simultaneously, we have surveyed the hand pump and borewell levels of the nearby area, which also show a gradual increase. However, no scientific data has been periodically collected for the same.

Observation and Result analysis of soil moisture changes, NDVI Data and its impact in plantation:

The following are the collected grid data's:

	Sampling on 2021			Sampling on 2022			Sampling on 2023		
Wet sample	On June 2021	Difference	Moisture %	21-Jun	Difference	Moisture %	21-Jun	Difference	Moisture %
200	189	11	5.5	174	26	13	168	32	16
200	191	9	4.5	156	44	22	143	57	28.5
Avg Moisture			5.00			17.5			22.3

Table 6 Data showing Average moisture changes.

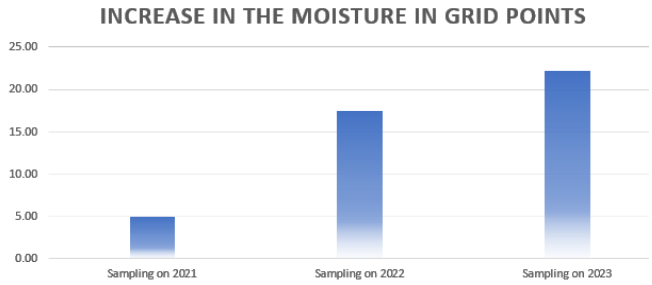

Chart – 3 . Figure showing the increase in moisture.

• Based on the analysis of satellite data NDWI & SMI the main findings are given below:
• Change matrix in pre & post monsoon surface water body cover :-

Post monsoon surface water body cover GIS area in Hectares			
Year	17 Nov 2019	11 Nov 2022	Increase / Decrease in surface water body cover area (GIS Area in hectares)
GIS area in hectares	15.62	17.96	+ 2.33

Pre monsoon surface water body cover GIS area in Hectares			
Year	07 March 2019	16 March 2022	Increase / Decrease in surface water body cover area (GIS Area in hectares)
GIS area in hectares	6.56	6.03	- 0.53

• Change matrix in pre monsoon soil moisture category GIS area in hectares :-

Soil Moisture Index (SMI) Category	SMI 31 March 2019	SMI 07 March 2022	Increase / Decrease in soil moisture (GIS Area in hectares)
Low soil moisture	5649.12	5372.37	- 276.75
Moderate soil moisture	9500.94	8738.82	- 762.12
High soil moisture	777.6	1816.47	+ 1038.87
Total GIS Area	15927.66	15927.66	

• Change matrix in pre monsoon based on the analysis of satellite data NDVI value in % for estimation vegetation health the main findings are given NDVI percent (%) Increase / Decrease GIS area in hectares :-

NDVI Category	NDVI 31 March 2019	NDVI 07 March 2022	Increase / Decrease in NDVI % Category (GIS Area in hectares)
Water body	6.56	6.03	- 0.53
Less than 10 %	23.50	0.40	- 23.10
10 % - 40 %	13684.85	9704.24	- 3980.62
40 % - 70 %	2210.86	6191.61	+ 3980.75
70 % Above	1.89	25.38	+ 23.49
Total GIS Area	15927.66	15927.66	

Table 7 Data showing NDVI comparative values .

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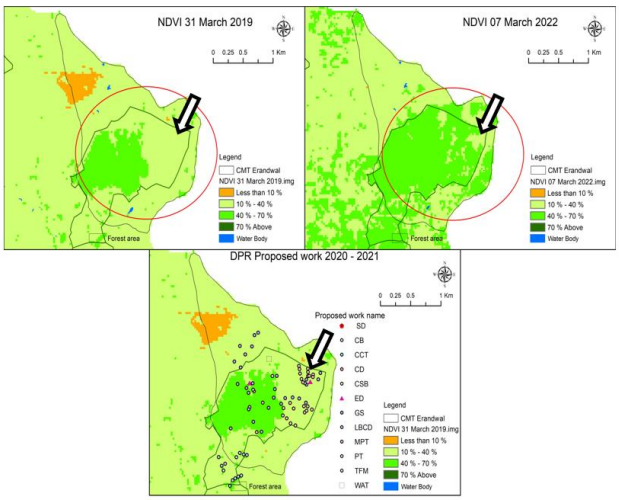

Fig - 4 . NDVI change analysis by the state FMIS office.

Discussion and findings.

The moisture levels at grid points are gradually increasing due to SMC work, positively impacting plantations, especially in the Arrandwal Cluster as seen in the NDVI data map from the State FMIS office. The FY 2019-20 CAMPA project-funded plantation initially had poor growth but has significantly improved with integrated SMC work, as evident in the figure.

Results in respect to the Water Harvesting Potential:

Within the catchment, there are 3 villages having only one major pond, which is also not perennial. The area is suffering from various water crises in the summer season. Now, under this project, we have created 3 major water harvesting structures that ensure a year-round water supply.

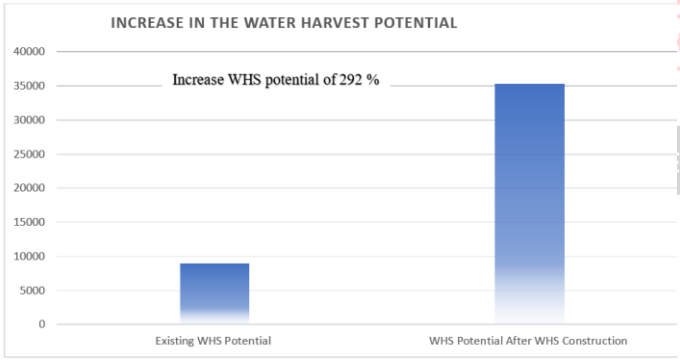

Chart – 4. Graph showing the Increase in the Water harvesting potential.

Discussion and findings: Due to Intervention the WHS potential increased to 292%.

Impact of WHS intervention work.

Note – In the Bastar region, we receive rain for 72 days. However, in a single day, we may experience 2-3 instances of rainfall, which means the pits may get filled three times. Our above-mentioned calculations for the structure design are based on the rainfall received in one hour. Therefore, on average, we consider only one instance of rainfall for one day.

Observation and Result analysis of WHS in the Agriculture land and fish farming income generation:

The following is the Impact and analytical report of the WHS construction and SMC work in the surrounding agriculture lands.

No.	village	Name	structure name	Kharif Season					Rabi Season				
				Irrigation Source	Area (Acre)	Crop Name	Production (Quintal)	Remarks (Irrigated-I / Non Irrigated-NI)	Irrigation Source	Area (Acre)	Crop Name	Production (Quintal)	Remarks (Irrigated-I / Non Irrigated-NI)
1	Erendwal	Ramcharan/ Debari	Erandwal WHS	Rain Fed	2	Paddy	27	Non Irrigated	WHS				
2	Erendwal	Subar Amal/ Dhoti	Erandwal WHS	Rain Fed	1.5	Paddy	19.5	Non Irrigated	WHS				
3	Erendwal	Subaru/ Miri	Erandwal WHS	Rain Fed	1.5	Paddy	20	Non Irrigated	WHS				
4	Erendwal	Boti/ Guddi	Erandwal WHS	Rain Fed	2	Paddy	25	Non Irrigated	WHS	2	Maize	16	Irrigated by WHS
5	Erendwal	Ramnath/ Guddi	Erandwal WHS	Rain Fed	1	Paddy	13.5	Non Irrigated	WHS				
6	Erendwal	Tularam/	Erandwal WHS	Rain Fed	2	Paddy	22	Non Irrigated	WHS				
7	Erendwal	Bugal/ Udaral	Erandwal WHS	Rain Fed	3	Paddy	3.4	Non Irrigated	WHS	3	Maize	24	Irrigated by WHS
8	Erendwal	Vishnath/ Rainu	Erandwal WHS	Rain Fed	2	Paddy	26	Non Irrigated	WHS				
9	Erendwal	Dayalu/ Buchu	Erandwal WHS	Rain Fed	1.5	Paddy	19.5	Non Irrigated	WHS				
10	Erendwal	Dinshu/ Sukharam	Erandwal WHS	Rain Fed	1.5	Paddy	18	Non Irrigated	WHS				
11	Erendwal	Lakhu/ Budharam	Erandwal WHS	Rain Fed	1.5	Paddy	19.5	Non Irrigated	WHS				
12	Erendwal	Dhaniraghi/ Dharamsingh	Erandwal WHS	Rain Fed	2	Paddy	26	Non Irrigated	WHS				
13	Sodipara	Chaituram / magnu	Sodipara WHS	Rain Fed	3	Paddy	38	Non Irrigated	WHS				
14	Sodipara	pandru / mangdu	Sodipara WHS	Rain Fed	2	Paddy	23	Non Irrigated	WHS	1.5	Maize	12	Irrigated by WHS
15	Sodipara	sagnu / budhu	Sodipara WHS	Rain Fed	1.5	Paddy	19.5	Non Irrigated	WHS	1.5	Maize	11	Irrigated by WHS
16	Sodipara	prayalu / budhu	Sodipara WHS	Rain Fed	1	Paddy	14	Non Irrigated	WHS	1	Maize	9	Irrigated by WHS
17	Sodipara	somaru / dobha	Sodipara WHS	Rain Fed	1	Paddy	13	Non Irrigated	WHS				
18	Gudrapara	sukhram / dayaru	Gudrapara Pond	Rain Fed	2	Paddy	26	Non Irrigated	WHS	2	Maize	16	Irrigated by WHS
19	Gudrapara	aayatu / budhu	Gudrapara Pond	Rain Fed	1.5	Paddy	21	Non Irrigated	WHS	1.5	Maize	12	Irrigated by WHS
20	Gudrapara	bhadu / sannu	Gudrapara Pond	Rain Fed	1.5	Paddy	20	Non Irrigated	WHS	1.5	Maize	11	Irrigated by WHS
21	Gudrapara	musu / jhitru	Gudrapara Pond	Rain Fed	1.5	Paddy	19.5	Non Irrigated	WHS				

Table 8 Data analysis of the WHS in agriculture lands.

Discussion and findings – The yellow indicator in the agriculture beneficiary table is the increase in the production of the main rabi crops, which accounts for 12 acres of land under the second crop, resulting in a production increase of up to 95%. Additionally, locals have used almost 180 kg of fish seed, providing them with additional financial support.

V. CONCLUSION

Launched in 2021, the integrated water harvesting project aimed to benefit wildlife, support tribal income via fish farming and micro-irrigation, and tackle environmental challenges. Key findings encompass:

Positive impact on Main Kanger Nala's flow and SMC structures, potentially rendering it perennial despite a limited study area. Significant reduction in gully erosion post-project, demonstrating effective soil erosion control through SMC works. Ensured sustainability of selected Open Wells via SMC and water structures, accompanied by gradual improvements in nearby water sources. A remarkable 95% increase in main rabi crop production across 12 acres, with added income from fish farming benefiting the local community. Enhanced soil moisture and plantation growth, especially in the Arrandwal Cluster, through SMC work. Successful reduction of soil loss by 38% over a significant catchment area, with a 5-year maintenance-free life. Establishment of three major water harvesting structures ensuring year-round water supply, increasing potential by 292%.Contribution to groundwater recharge through rainwater storage in NRM structures, raising the groundwater table. Calculations indicate substantial water conservation, surpassing Benefit Cost Ratio expectations. In conclusion, this integrated project not only addressed environmental concerns but also uplifted tribal livelihoods, serving as a model for sustainable development and resource management in similar regions.

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