सत्यमेव जयते

National Technical Guidelines (NTG) for Improved Watershed Management

under

Rejuvenating Watersheds for Agricultural Resilience through Innovative Development (REWARD) Programme

National Rainfed Area Authority (NRAA)
Department of Agriculture & Farmers Welfare
Ministry of Agriculture and Farmers Welfare

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Executive summary

"WATERSHED DEVELOPMENT" is a key strategy for resource conservation, increased agricultural production, protecting livelihoods, especially in fragile ecosystems. It is a holistic approach for managing land, water and other natural resources within the watershed while maintaining ecological balance. It is central to addressing land degradation, sustainable agriculture, livelihood security and climate change.

In its initial phases watershed development was focused on soil and water conservation, and natural resource regeneration through various initiatives and programmes. In subsequent phases, emphasis was laid on community participation, ecological sustainability and improved governance. However, several inherent challenges like, poor implementation, limited involvement of local communities, and lack of convergence among various schemes could not be addressed satisfactorily. The latest phase adopted science-based approaches with modern technologies, which introduced significant policy reforms and promoted integration with climate-resilient agriculture to improve overall effectiveness and sustainability of watersheds under WDC-PMKSY 2.0 (WDC 2.0) which started in 2021-22. The WDC 2.0 guidelines however focused in a limited way on technical aspects, post project management, and dissemination of science and technology to the communities, *etc*. It is in this backdrop, to supplement WDC 2.0, a new generation watershed development programme known as *Rejuvenating Watersheds for Agricultural Resilience through Innovative Development (REWARD)* was envisaged. It is a "P for R" (Programme for Results) Programme being implemented in the States of Karnataka and Odisha during 2021-26 with the support from the World Bank, DoLR, and State governments. The primary objective of the REWARD is "to strengthen capacities of national and State institutions to adopt improved watershed management for increasing farmers' resilience and support value chains in selected watersheds of participating States". Based on the valuable lessons learnt from the REWARD interventions, the draft *'National Technical Guidelines (NTG)'* have been developed to support future watershed development programmes in the country.

Five key domains

The NTG covers *Five key domains* for overall watershed development; these are Remote Sensing and Geographic Information System (RS&GIS); Land Resource Inventory (LRI); Hydrology; Community Engagement, Social Mobilization & Livelihoods; and Monitoring & Evaluation (M&E).

Remote Sensing and Geographic Information System (RS&GIS)

It provides an optimized framework based on lessons learnt from the REWARD States, aimed at supporting other States in adopting RS&GIS-based data, products, and tools in the entire span of watershed development, *i.e.*, pre-planning, planning, implementation, and post-implementation. The application of RS&GIS technology is recommended in the guidelines across *three focal areas*, LRI, Hydrology, and M&E.

Based on experiences gained from Karnataka and Odisha, NTG recommends, the use of optimized and standardized remote sensing products and tools to strengthen watershed planning and management. The implementing States are using high-resolution satellite imagery with a spatial resolution of 0.5 m. For base map preparation, such as delineating watershed & field boundaries, identifying the locations of permanent features (such as well, soil conservation and water harvesting structures, etc.) preference should be given to satellite data with *sub-meter* spatial resolution. However, for the preparation of thematic layers, or for M&E purposes, a spatial resolution of 1 to 10 meters is recommended. It is also suggested to use cadastral maps superimposed on satellite imagery at a mapping scale between 1:4,000 and 1:8,000 for the micro-watershed level, and between 1:15,000 and 1:25,000 for the sub-watershed level. High-resolution Digital Elevation Models (DEMs) with approximately 1-meter spatial resolution, generated from stereo satellite imagery like Pleiades or WorldView series are recommended for slope analysis, drainage mapping, and hydrological modelling.

Land Resource Inventory

LRI is a structured assessment of soil, topography, landforms, land use, cropping systems, and socioeconomic conditions at the cadastral scale. It enables region-specific management recommendations, improving land productivity, resilience, and planning efficiency. LRI activities follow a structured sequence of *pre-field, field, and post-field stages* to support the systematic collection and interpretation of data. During the *pre-field stage,* the existing cadastral layers are integrated with satellite imagery for analysing the landforms, geology, physiography, and slope, for generating base layers to delineate Land Management Units (LMUs) and for planning targeted field data collection. In the *field phase,* NTG prescribes field activities to be carried out in a structured manner, starting with the validation of physiography and landform maps through field verification of slopes, drainage, erosion, and visible soil features, etc. Detailed soil-site characterization should be based on soil profiles excavated up to 200 cm or the bedrock layer along the representative transects. Morphological features such as colour, texture, depth, gravel content, slope, and drainage should be recorded to classify soils into appropriate series and phases. Subsequently, horizon-wise soil sampling should be conducted, ensuring collection of undisturbed bulk density samples and adequate coverage of spatial variability. Mapping units may then be delineated by transect walk using auger, small pits, or visible surface changes, and should be accurately marked on updated cadastral maps. A grid-based approach (320 m for rainfed areas and 160 m for irrigated areas) for soil fertility sampling is followed by overlaying village cadastral maps with composite samples collected for fertility analysis. The methodology followed for soil profiling is based on the guidelines outlined in the *Field Guide and Handbook of Land Resource Inventory (LRI)* under the REWARD Odisha Project, prepared by ICAR–NBSS&LUP, Regional Centre, Kolkata. The laboratory-based soil analyses recommended in these guidelines follow internationally accepted standard analytical methods, as ICAR–NBSS&LUP is an ISO-certified organization. Additional field data including cropping patterns, vegetation types, land management practices, and locations of water structures should also be documented. Lastly, a structured socio-economic survey should be undertaken using field interviews and existing records to capture demographics, infrastructure, irrigation, and market access information. *In the post-field stage,*

NTG prescribes that the analysed data should be used to generate thematic outputs such as soil series maps, erosion risk assessments, land capability classifications, fertility status maps, and crop suitability maps at the cadastral scale, which should be compiled in an LRI Atlas. Subsequently, LRI cards should be prepared to provide actionable insights for the use of farmers, planners, and policymakers.

Hydrology

Watershed management programme faces long-term and real-time measured hydrological data limitations. Therefore, emphasis has been laid in REWARD programme on real time measured hydrological data collection, including soil moisture. The hydrological data obtained from manual sources and automatic/sensor-based tools at micro-watershed level complemented by secondary data obtained from remote sensing and institutional sources, should be used for watershed planning. The key components for hydrology assessment should be monitored and analysed using weather and climate parameters, soil moisture (surface and profile), evaporation rates, and crop data. Automatic Weather Stations (AWS), soil moisture sensors (TDRs, Theta probes), evaporation pans, Bowen flux towers, and runoff measuring equipment (weirs, flumes, DIVERs) can collect high-frequency, site-specific data, while groundwater can be monitored using piezometers or manually in wells. However, it is recommended that hydrological gauging stations should be established depending on the locations and availability of funds, at multiple scales, 5 ha (field/HRU/LMU), 50 ha (topo-sequence), and 500 ha (micro-watershed). The historical datasets from India Meteorological Department (IMD), Central Ground Water Board (CGWB), National Remote Sensing Centre (NRSC), National Institute of Hydrology (NIH), and State water/agriculture departments can also be used to assess seasonal demand and supply. It is further advised to measure evapotranspiration, infiltration rates, groundwater table, runoff, and sediment loads at watershed outlets (covering catchments of 500–700 hectares), and the assessment of groundwater potential zones. Additionally, it is recommended to identify suitable sites for soil and water conservation structures using Multi Criteria Decision Making tools (MCDM), prepare a water balance using hydrological modelling, and crop planning based on water availability. Finally, the development of a hydrological atlas is prescribed to provide spatial and temporal visualizations of key hydrological components, which will help identify water-stressed areas and recharge zones, thereby guiding the prioritization of interventions.

Integration of LRI and Hydrological data

After generation of LRI and hydrology atlases, the NTG envisages integration of LRI data with hydrological modelling to strengthen water resource planning and cost effective soil and water conservation design through scientific assessments of year-round water availability, inflows, outflows, and seasonal variations. These outputs are integrated through web portal into Decision Support Systems (DSSs) and Management Information System (MIS) to facilitate designing of cost-effective and site-specific interventions viz. bunding, trenching, appropriate crop selection, etc. This requires, the DSS module to be structured to leverage soil and water conservation planning, crop selection, land capability classification, nutrient management and soil health, surface runoff estimation, farm pond and check dam design, crop water requirements, and water budgeting etc.

Costing scenarios of LRI and hydrological activities

The cost of LRI process for three scenarios of plain regions are proposed as Rs 684/ha for completely new sites; Rs 574/ ha with only RS&GIS facilities; and Rs 454/ha with RS&GIS, soil testing labs, and domain experts *etc*. Similarly, for three scenarios of hilly regions, the proposed cost is Rs 784/ha for completely new sites; Rs 714/ ha with only RS&GIS facilities; and Rs 474/ha with RS&GIS, soil testing labs, and domain experts *etc*. For hydrology monitoring, an additional amount of Rs 35/ha is proposed for the rainfed area of the country taking 10 benchmark sites from each agro-climatic zone.

Community engagement, social mobilization and livelihood

Community engagement, social mobilization, and livelihoods are vital to the success and long-term sustainability of watershed development, which involve inclusive participation of women, youth, vulnerable groups, weaker sections and landless. Watershed management necessitates improvement of project-level people's institutions like User Groups (UGs), Gram Panchayats (GPs), Self-Help Groups (SHGs), and Farmer Producer Organizations/Companies (FPOs/FPCs), which are instrumental in planning, implementing, and sustaining project interventions. In addition to the existing community engagement activities in WDC 2.0, NTG prescribes demystification of science-based watershed management approach (LRI, Hydrology, crop plans, DPR, *etc.*) for the local communities through capacity building in terms of handling instruments, data collection, maintenance of records and instrument, etc. The community consultation process has been elaborated separately in a step-wise manner starting from preparatory to validation, and to consolidation stages. The NTG envisions capacity building based on local needs and realities, integrating traditional knowledge with scientific recommendations drawn from LRI and hydrological analysis.

Role of FPOs/FPCs

The major emphasis on FPOs/FPCs has been laid with an aim to increase at least 25% business turnover by forming/strengthening the existing FPOs as a starting activity. The existing FPOs should be screened based on the Pitch competition method and may preferably be within 10 kms from the watershed villages for operational effectiveness. FPOs screening should be based on the steps *viz.* landscaping (sampling size), committee formation (Screening Committee and Pitch Evaluation Committee), shortlisting, pitch competition and finalisation. Regular orientation sessions should be organized for FPO staff, Board members, and Community Resource Persons. FPO is proposed to develop an effective business plan by integrating LRI outputs, crop suitability & nutrient recommendations, potential value addition, and market linkages, etc. NTG also envisages partnering with agri-tech start-ups and support agencies to develop digital platforms for marketing by capacity building of youth and FPO staff. Today's vibrant social media marketing can play a catalytic role in achieving the overall objective. The guidelines also suggest enabling eco-systems for tie-ups with institutional buyers, trade exposure (expos and buyer seller meet, etc.) for harnessing the benefits of stable markets.

'Sustainability': An important element of watershed management

Sustaining and expanding project outcomes, maintaining physical assets, and managing Watershed Development Funds (WDF) are key post-project priorities. Post-project maintenance is proposed to be handed over to GP/ Watershed Committee/ FPO through a MoU. A dedicated Maintenance Committee (Maximum Ten member team comprising of Gram Pradhan, concerned department representative, representative from existing NGO and FPO, Champion Farmers (2)/ Opinion leaders/ Rural youth, etc.) responsible for Operation and Maintenance (O&M) of the created assets under a project is proposed to be formed. NTG also envisages 12-month post-project handholding for the Committee and depositing approximately 1% of the total watershed budget in WDF. Creation of an additional local O&M fund has also been envisaged in NTG by receiving contributions from UGs, GPs, and various schemes. The community is supposed to undertake an annual assessment of the assets created and submit the report to the GP and District PIA for necessary interventions. After all achieving sustainability in watershed development depends on a holistic, inclusive, and participatory approach that integrates scientific understanding with local additional knowledge and strengthens community ownership.

Monitoring & Evaluation

Technology-enhanced Monitoring & Evaluation (M&E) is a scientific process to assess effectiveness of the watershed programme and supports good governance by ensuring transparency, accountability, and trust among stakeholders. The M&E framework emphasises continuous monitoring of the progress, performance of the project activities and institutional monitoring to enhance responsiveness and real-time decision-making. *Progress monitoring* conducted quarterly involves 100% coverage of physical and financial achievements. *Performance monitoring* carried out quarterly on a 20% sample of completed works focuses on quality and outcomes. Likewise *Institutional monitoring* tracks the functioning of SHGs, Watershed Committees, and FPOs on a quarterly basis. For technically intensive activities, such as trenching or resilient agriculture, high-density monitoring is conducted on 10% of the beneficiaries to ensure precision and accountability. The NTG recommends the use of, both primary and secondary data collection methods, employing a range of appropriate tools. *Primary data collection* should include field observations with GPS and geo-tagging, household surveys conducted through mobile applications, Focus Group Discussions (FGDs), Key Informant Interviews (KIIs), and Participatory Rural Appraisal (PRA) techniques. *Secondary data sources*, such as satellite imagery and datasets from NRSC, should be used to supplement and validate the primary data collected. The evaluation process may be structured in *three phases: baseline, midline, and endline.* The baseline survey should cover 100% of households to establish clear benchmarks. Midline and endline surveys should be conducted using a 25% representative sample to monitor progress and outcomes. It is also strongly recommended to collect data from 10% sample of farmers in nearby untreated villages to serve as a *control group*. The evaluation framework should include parameters and indices spanning key areas like *biophysical, ecological, economic, social, institutional, and sustainability*. NTG recommends integration of Management Information System (MIS) with M&E framework (to the extent possible) to get advantage of real-time data entry, dashboards, and analytical tools across all project phases, thereby enhancing data-driven decision-making and reporting. To

ascertain the economic viability of the project, it is suggested to analyse Cost-Benefit Ratio (CBR). This analysis should account for benefits generated in agriculture, livestock, agroforestry, employment, and livelihoods *etc*., using a 10-year project life and 8% discount rate as standard assumptions.

Conclusion

The NTG addresses the challenges encountered during implementation of the watershed projects under REWARD and outlines the steps needed for its nationwide adoption and effective use by stakeholders. The NTG is designed to serve as the scientific basis of implementation of watershed programme throughout the country. This will effectively address the degraded rainfed areas of India and support livelihood-based economic models customized as per the composite index of available resources and skills of local population. The NTG will also support national commitments for sustainable development and environmental protection, by contributing towards Land Degradation Neutrality (LDN), Nationally Determined Contributions (NDC) and Sustainable Development Goals (SDG) in longer run.

Abbreviations

AG	Area Group
AHP	Analytic Hierarchy Process
APD	Assistant Project Director
APFAMGS	Andhra Pradesh Farmer Managed Groundwater Systems
APTELP	Andhra Pradesh Tribal Empowerment and Livelihoods Project
AWS	Automatic Weather Stations
CB	Capacity Building
CBO	Community Based Organization
CBSA	Capacity Building Support Agency
COE	Centre of Excellence
CRP	Community Resource Person
CSO	Civil Society Organization
CWR	Crop Water Requirement
DDP	Desert Development Programme
DEM	Digital Elevation Model
DGPS	Differential Global Positioning System
DLI	Disbursement Linked Indicator
DPAP	Drought Prone Area Programme
DPR	Detailed Project Report
DSS	Decision Support System
EPA	Entry Point Activity
FPO	Farmer Producers Organization
GP	*Gram Panchayat*
GS	*Gram Sabha*
ICAR	India Council of Agricultural Research
IFS	Integrated Farming System
IGA	Income Generating Activity
IGWDP	Indo-German Watershed Development Programme
IVA	Independent Verification Agency
IWDP	Integrated Wasteland Development Programme
JICA	Japan International Cooperation Agency
KPI	Key Performance Indicator
KSNDMC	Karnataka State Natural Disaster Monitoring Committee
KSRSAC	Karnataka State Remote Sensing Application Centre
KVK	*Krishi Vigyan Kendra*
KWDP	Karnataka Watershed Development Projects
LAI	Leaf Area Index
LDN	Land Degradation Neutrality
LMU	Land Management Unit
LRI	Land Resource Inventory
M&E	Monitoring and Evaluation
MCDM	Multi-Criteria Decision Making
MGNREGS	Mahatma Gandhi National Rural Employment Guarantee Scheme
MIS	Management Information System
MoU	Memorandum of Understanding
NBSS&LUP	National Bureau of Soil Survey and Land Use Planning
NDC	Nationally Determined Contributions
NGO	Non-Government Organization

NLNA	National Level Nodal Agency
NLND	National Level Nodal Department
NLSC	National Level Steering Committee
NLTC	National Level Technical Committee
NWDPRA	National Watershed Development Project for Rain-fed Areas
O&M	Operation and Maintenance
OUAT	Odisha University of Agriculture and Technology
PD	Project Director
PIA	Project Implementing Agency
PMKSY	*Pradhan Mantri Krishi Sinchayee Yojana*
PO	Producer Organization
PRA	Participatory Rural Appraisal
RO	Resource Organization
RS&GIS	Remote Sensing and Geographic Information System
RVP	River Valley Projects
SDG	Sustainable Development Goals
SHG	Self-Help Group
SLNA	State Level Nodal Agency
SLND	State Level Nodal Department
SLTL	Soil Loss Tolerance Limit
SLSC	State Level Sanctioning Committee
SOI	Survey of India
SWC	Soil and Water Conservation
TDR	Time Domain Reflectometers
TNA	Training Need and Analysis
TOT	Trainer of Trainers
UAS	University of Agricultural Science
UG	User Group
VRG	Vulnerability Reduction Grant
WC	Watershed Committee
WCDC	Watershed Cell cum Data Centre
WDC	Watershed Development Component
WDD	Watershed Development Department
WDF	Watershed Development Fund
WDT	Watershed Development Team
WEC	Watershed Executive Committee
WGDP	Western Ghat Development Programme
WMT	Watershed Management Team
WORLP	Western Odisha Rural Livelihoods Project

1. Overview of watershed development in India

Watershed development is a key strategy for resource conservation, increased agricultural production and protecting livelihoods especially in fragile ecosystems. It is a holistic approach to manage land, water, and natural resources within the watershed, while maintaining ecological balance. It is central to addressing climate change, land degradation, poverty, sustainable agriculture, and livelihood security. The watershed development in initial phases focused on soil and water conservation, and natural resource regeneration through programmes such as the River Valley Projects (RVP), Drought Prone Area Programme (DPAP), Desert Development Programme (DDP), Integrated Wasteland Development Programme (IWDP), and National Watershed Development Project for Rain-fed Areas (NWDPRA) which was implemented under the WARASA–*Jan Sahbhagita* guidelines (Ministry of Agriculture, Government of India). In the subsequent phases, the emphasis shifted towards community participation, ecological sustainability, and improved governance through initiatives such as the *Hariyali* guidelines by Ministry of Rural Development (MoRD), Common guidelines for watershed development projects by National Rainfed Area Authority (NRAA), Integrated Watershed Management Programme (IWMP), and the Watershed Development Component (WDC) under the *Pradhan Mantri Krishi Sinchayee Yojana* (PMKSY). However, several challenges remained, including poor implementation, limited involvement of local communities, and lack of convergence among various schemes. In response, the recent phases adopted science-based approaches with modern technologies which introduced significant policy reforms, and promoted integration with climate-resilient agriculture to improve the overall effectiveness and sustainability of watershed initiatives, in the guidelines for new generation watershed development project i.e., WDC-PMKSY 2.0 (NRAA & Department of Land Resources).

In addition to the various initiatives undertaken by the GoI, several state-specific programs have also embraced the watershed approach. Notable examples include the Karnataka Watershed Development Projects (KWDP), *Arvari Pani Sansad*, and *Mukhya Mantri Jal Swavlamban Abhiyan* in Rajasthan; the Mid-Himalayan Watershed Development Projects in Himachal Pradesh; the *Jal Samruddhi Yojana* in Maharashtra; the Andhra Pradesh Farmer Managed Groundwater Systems (APFAMGS); and the Western Ghat Development Programme (WGDP) in Kerala, Tamil Nadu, and Goa. Apart from these, various national and international organizations have also contributed to watershed development. Key examples include World Bank-supported Sujala projects (KWDP I and II) in Karnataka, Watershed Development Fund by NABARD, Indo-German Watershed Development Programme (IGWDP), IFAD-supported Andhra Pradesh Tribal Empowerment and Livelihoods Project (APTELP), UNDP supported Integrated Watershed Development Project, Japan International Cooperation Agency (JICA)-funded Odisha Forestry Sector Development Project, and DFID-supported Western Odisha Rural Livelihoods Project (WORLP). Collectively, these programs have played a key role in achieving the objectives of water conservation, reducing land degradation, promoting sustainable agricultural practices, and reducing poverty. Among these initiatives, the World Bank-supported Sujala Projects (KWDP I and II) in Karnataka have emerged as a model of scientific, participatory, and sustainable watershed development. Building on this legacy, the REWARD program was launched to scale up best practices and promote data-driven watershed management in Karnataka and Odisha.

2. Need for National Technical Guidelines (NTG) for watershed management

Based on past learnings, a science led watershed development programme known as Rejuvenating Watersheds for Agricultural Resilience through Innovative Development (REWARD) was envisaged. It is a "P for R" (Programme for Results) Programme which is being implemented in the states of Karnataka and Odisha during 2021-26 with the support from World Bank, DoLR, MoRD and state governments. The primary objective of REWARD is "to strengthen the capacities of national and state institutions to adopt improved watershed management for increasing farmers' resilience and support value chains in selected watersheds of participating states". The REWARD programme has following six Disbursement Linked Indicators (DLIs) that were fixed by DoLR and the World Bank.

DLI#1: Percentage of Watershed Committees and *Gram Panchayats* which demonstrate satisfactory watershed management as measured through a performance rating system

DLI#2: Land area treated with science-based watershed management technologies

DLI#3: Number of farmers who adopt resilient agriculture technologies and practices

DLI#4: Farmer Producer Organizations with 25 percent increase in business turnover relative to baseline

DLI#5: Number of professionals who complete certified training on improved watershed management provided by National Center of Excellence on Watershed Management

DLI#6: National Technical Guidelines for improved watershed management.

The first five DLIs are the responsibility of the participating states. DLI 6 has been assigned to the NRAA, due to its vast experience in developing national guidelines for watershed development in the country.

The NTG initiative draws on valuable lessons learnt from the REWARD interventions and recognizing that the existing approach to watershed development lacks scientific rigor and application of modern technologies. Therefore, it was necessary to develop NTG to effectively guide future watershed development programs in the country. The following points highlight the key reasons for developing NTG:

- Existing guidelines lack detailed technical instructions, highlighting the need for a more comprehensive and actionable framework.
- Existing watershed development projects lack scientific elements, limiting their effectiveness and sustainability.
- Need to guide state governments in transitioning towards a science-based approach to watershed management.
- Promoting consistency in implementation across diverse regions and enhancing the overall impact of watershed development initiatives nationwide by incorporating standardized protocols and best technological packages from the experiences gained through REWARD programme.

3. Purpose and scope of NTG

3.1 Purpose

The purpose of the NTG is to provide a comprehensive, optimised, and science-based framework using modern tools and techniques for the planning, implementation, monitoring, evaluation and post- project maintenance of watershed development programs across the country. NTG aims at:

- To provide science-based technical guidelines for creating climate-resilient watershed management plans that address land degradation, soil and water conservation, water scarcity, and climate change impact.
- To boost agricultural growth while sustaining ecology and improving farmers' livelihoods, guided by the principles of Science, Scale, and Sustainability.
- To optimize science-based framework with modern tools and techniques for consistent watershed management through data-driven decisions, community-science integration, efficient resource use, and technology-enabled monitoring, evaluation as well as post project sustenance.
- To support national commitments for sustainable development and environmental protection, by achieving Land Degradation Neutrality (LDN), Nationally Determined Contributions (NDC) and Sustainable Development Goals (SDG).

3.2 Scope

- The NTG draws on the experiences from the REWARD programme, which has been implemented in Karnataka and Odisha States with diverse climate, topography vegetation, landscapes and socio-economic status of stakeholders. The REWARD program has successfully addressed water scarcity challenges in Karnataka and Odisha. Therefore, the NTG is designed for its adoption in other states having diverse agro-ecological zones, climatic conditions, and socio-economic contexts across India. It offers flexibility while maintaining core principles of science-based watershed management along with equitable sharing of resources.
- It encourages the adoption of modern tools, processes and technologies such as Remote Sensing and Geographic Information System (RS&GIS), Land Resource Inventory (LRI), hydrological instruments for real-time monitoring, and development of Decision Support System (DSS). It also provides a framework for integrating modern scientific techniques with the traditional knowledge and practices of local communities.
- It covers the entire lifecycle of watershed management, from planning to implementation, monitoring, and evaluation. This will optimise project duration while minimizing the cost and human resources.
- It emphasizes the importance of creating climate-resilient watershed management plans that address land degradation, water scarcity, and the impacts of climate change.
- The guidelines include provisions for capacity building and skill development, along with mechanisms for multi-stakeholder engagement to ensure active participation from local communities, government agencies, and NGOs in planning and implementation.

- This guideline provides a robust and technology driven monitoring and evaluation frameworks to study the climate resilient watershed management impacts.

- The NTG may be leveraged to support the watershed programme which will create opportunities to scientifically treat more watersheds in the country ensuring livelihood security to the stakeholders, during as well as post-project periods.
- The NTG emphasizes the convergence and linkages of other central/state government programmes for watershed development covering soil and water conservation activities, water management, crop diversification, agro-forestry, Integrated Farming Systems (IFS), and rural livelihoods.

4. Key focal areas for developing guidelines for watershed development

Building on the experiences drawn from REWARD programme, the NTG is developed for wider adoption across various states. It encompasses key aspects of watershed management from planning to post-implementation, focusing on the following key focal areas:

- Remote Sensing and Geographic Information System (RS&GIS)
- Land Resource Inventory (LRI)
- Hydrology and water balance models
- Community engagement, social mobilization, and livelihoods
- Technology-enhanced monitoring and evaluation

4.1 Remote Sensing and Geographic Information System

Remote Sensing (RS) is a technology used to obtain information about features on the Earth's surface from a distance without any physical contact using platforms such as airplanes, satellite, and drones. On the other hand, Geographic Information System (GIS) provide tools for organizing and visualizing data about the Earth's properties by analyzing and mapping location-based information. Over the past few years, the use of this technology in targeted focal areas such as LRI and hydrology has accelerated significantly because of its spatial context and decision-making capabilities.

The NTG provides an optimized framework based on lessons learnt from the REWARD states, aimed at supporting other states in adopting RS&GIS-based data, products, and tools across all phases of watershed development i.e. pre-planning, planning, implementation and post-implementation. The application of RS&GIS technology is recommended in the guidelines across four focal areas such as LRI, hydrology, monitoring and impact assessment.

a. Land Resource Inventory (LRI)

Following activities should be carried out under LRI using RS&GIS:

Pre-planning: Base map preparation based on satellite data and cadastral maps.

Planning: Delineation of micro-watershed boundaries, generation of spatial grids to carry out the soil proofing, collection and validation of additional features such as landform, and well.

Implementation: Finalization of resource conservation plans and spatial models for soil and water conservation, land capability classification, nutrient management, runoff and soil loss estimation.

b. Hydrology

Following activities should be carried out under hydrology using RS&GIS:

Pre-planning: Demarcation of drainage network, existing water management structures.

Planning: Analysis of hydrological data for estimation and spatial modelling of soil moisture, evapotranspiration, water balance, identification of sites for intervention, use of DSS for suitable planning *etc*.

Implementation: Development of hydrological atlas and execution of proposed interventions.

c. Monitoring

Monitoring of interventions using multi-temporal satellite data and geo-tagging of assets.

d. Impact assessment

Satellite-based impact assessment using land use and land cover change, watershed health indicators and vegetation indices.

4.1.1 Learnings from REWARD on application of RS&GIS

The REWARD states (Karnataka and Odisha) have utilized the following datasets and tools for base map preparation and modelling in LRI and hydrology domains (Table 1).

Table 1. Differences in geospatial data utilized in REWARD states

S. No.	Datasets	Karnataka	Odisha
1	Cadastral map (Land parcel boundaries and ownership)	1:4000 to 1:8000 (at micro-watershed level)	1:4000 to 1:8000 (at micro-watershed level)
		1: 15,000 to 1:25,000 (at sub-watershed level)	1: 15,000 to 1:25,000 (at sub-watershed level)
2	Satellite Imagery	Worldview II Mono product (Spatial resolution=50cm); CARTOSAT–I (Spatial resolution=2.5m),	Worldview II Stereo products (Spatial resolution=50cm); CARTOSAT–I (Spatial resolution=2.5m),
3	Digital Elevation Model (DEM)	CARTOSAT-II (Spatial resolution= 1m)	Generated from Stereo Product (with 1 m spatial resolution)
4	Survey of India (SOI) Toposheet (Delineation of physiographic regions)	1:50,000 scale	1:50,000 scale
5	Nodal RS&GIS Agency	Karnataka State Remote Sensing Center (KSRAC), Bangalore	Odisha Space Applications Centre (ORSAC), Bhubaneswar
6	Software requirement	ArcGIS, ERDAS, QGIS	ArcGIS, ERDAS, QGIS

4.1.2 Guidelines on utilization of geospatial products and tools

Based on the experiences gained from the states, the guideline recommends the use of optimized or standardized remote sensing products and tools. The implementing state may adopt these products and tools.

- For base map preparation, such as delineating watershed & field boundaries, identifying the locations of permanent features (such as well, soil conservation and water harvesting structures, etc.) preference should be given to satellite data with sub-meter spatial resolution. However, for the preparation of thematic layers, or for M&E purposes, a spatial resolution of 1 to 10 meters is recommended.
- It is also suggested to use cadastral maps superimposed on satellite imagery at a mapping scale between 1:4,000 and 1:8,000 for the micro-watershed level, and between 1:15,000 and 1:25,000 for the sub-watershed level.
- For slope analysis, drainage mapping, and hydrological modelling, high-resolution DEMs (which can be generated from stereo imagery such as Pleiades, WorldView-II, and WorldView-III) with approximately 1 m spatial resolution are essential.
- Utilize Survey of India topographical sheets of 1:50,000 or large if available.
- Implementing states may use a combination of proprietary and open-source tools (*e.g.* ArcGIS, ERDAS, QGIS, ENVI, and Google Earth Engine).
- A dedicated organisation should be designated to coordinate watershed geospatial work and ensuring data integration (*e.g.* state space application centres).

4.2 Land Resource Inventory

LRI is a structured assessment of soil, land use, topography, and hydrological conditions at the cadastral scale. It enables region-specific management recommendations, improving land productivity, resilience, and planning efficiency. Karnataka pioneered LRI through Sujala III project (1.4 million ha), now extended under REWARD to new watershed areas in both Karnataka and Odisha states. It feeds into digital libraries, Decision Support Systems (DSS), LRI atlases, Hydrology atlases and LRI cards, making complex land data accessible for farmers and planners.

4.2.1 Guidelines for LRI from the REWARD experiences

A comprehensive range of spatial and non-spatial datasets at the field, watershed, and village levels, along with secondary information from various sources should be compiled.

Key components

- Physiography and geology (landforms, elevation, contours, rock types, composition, *etc*.)
- Landscape topography (slope, erosion, drainage, and soil conditions)
- Soil type (soil texture, soil structure, soil depth, soil retention, bulk density, nutrient status, pH, *etc*.)
- Land use (forest, wasteland, agriculture, settlement, water bodies)
- Cropping systems (major crops, single and double cropping, fallow lands and management practices, crop coverage)

- Existing irrigation system and water resources (sources, types, functionality, usage extent)
- Demographic and socio-economic details (population, livestock, socio-economic data, marketing, and infrastructure)
- Programs and schemes (ongoing initiatives and schemes in the area)

LRI stepwise guide

Creating above LRI databases involve several key steps, including pre-field, field, and post-field activities. However, the existing databases on soil properties and Standard Operating Protocols (SOP) developed by ICAR-NBSS&LUP may also be used to save time for developing the LRI atlas. The specific parameters may vary based on location and objectives, certain standard parameters must consistently be collected during each stage, as outlined below:

a. Pre-field activities

Step 1: Use cadastral maps overlaid with satellite imagery and contours to prepare base maps.
Step 2: Image interpretation & tentative physiography and landform mapping.

- *Sub-watershed level*: Identify geological formations and major landforms.
- *Micro-watershed level*: Refine units based on slope, land use, drainage, erosion, and salinity.

Step 3: Make the field team and plan with equipment, transportation, and safety gear.

b. Field activities

Step 1: Physiography and landform map validation

- Conduct field verification of preliminary physiography-landform units using road cuts, slopes, and visible soil features.
- Update maps based on slope, erosion, drainage, and surface features.

Step 2: Soil-site characterization and soil profile study

- Open soil profiles (up to 200 cm or up to bed rock layer) across representative transects.
- Record morphological features (color, texture, depth, gravel, erosion, slope, and drainage).
- Classify soils into series and phases.

Step 3: Soil sampling (profile-wise)

- Collect horizon-wise samples from each representative pedon after soil series identification.
- Use core samplers to collect undisturbed bulk density samples.
- Ensure coverage of spatial variability within dominant series.

Step 4: Mapping unit delineation

- Delineate boundaries of soil series and phases through foot transects using auger bores, pits, or visible changes.

- Mark delineations and mapping unit codes on cadastral maps.

Step 5: Grid-based soil fertility sampling

- Prepare village cadastral map overlaid with a grid (320 m interval for rainfed; 160 m for irrigated).
- Collect composite samples from several points around each grid node.
- Extract a representative portion for fertility analysis.

Step 6: Collection of additional field data

- Make a record of cropping patterns, vegetation types, and management practices.
- Record locations of wells, bunds, ponds, check dams, *etc*.

Step 7: Socio-economic survey

- Use existing records and field-based structured surveys to gather information on demographics, infrastructure, irrigation, and market access.

c. Post-field activities

Step 1: Laboratory analysis:

- Analyze soil samples sent to the laboratory to determine essential soil parameters, including soil texture, bulk density, water retention characteristics (field capacity and permanent wilting point), soil pH, electrical conductivity, soil organic carbon, as well as macro- and micronutrients. Standard procedures should be followed for analyzing these parameters.

Step 2: Map generation

- Prepare thematic maps for soil series, slope, erodibility, erosion, drainage, fertility, land capability, and crop suitability.
- Classify parameters based on standard thresholds (**Annexure-I** depicts the categories and criteria defined to map LRI parameters)

Step 3: Database creation

- Store all spatial and tabular data in GIS-compatible formats

Step 4: Report compilation

- Summarize soil types, fertility, and land suitability for crops (LRI atlas)
- Prepare LRI cards for farmers and stakeholders

4.2.2 Technical soundness, scalability, and adoptability of LRI approaches

- The LRI methodology developed and implemented by the ICAR-NBSS&LUP, is technically robust and utilizes high-resolution remote sensing, GIS mapping, and standardized soil survey protocols.
- The methodology's scientific rigor and standardized data collection framework facilitate the preparation of cadastral-level soil maps, and thematic resource inventories.
- The experience of ICAR-NBSS&LUP confirms high-quality data standardization, making LRI a credible framework for site-specific soil health planning.
- The methodology followed for soil profiling is based on the guidelines outlined in the *Field Guide and Handbook of Land Resource Inventory (LRI)* under the REWARD Odisha Project, prepared by ICAR–NBSS&LUP, Regional Centre, Kolkata. The laboratory-based soil analyses recommended in these guidelines follow internationally accepted standard analytical methods, as ICAR–NBSS&LUP is an ISO-certified organization.
- Modern geospatial techniques and DSS modules further enhance its reliability and relevance across diverse agro-climatic zones.
- Site-specific fertilizer recommendations based on LRI may be followed to increase the yield and profit
- The modular approach of LRI ensures scalability and adoptability, allowing it to be customized according to physiography, climate, soil types, and land use patterns.

4.3 Hydrology and water balance models

Earlier watershed management programs faced long-term and real-time hydrological data limitations. REWARD integrates LRI data and hydrological modelling to improve water resource planning through scientific assessments of year round water availability, inflow, outflow and seasonal variations.

4.3.1 Guidelines for hydrology assessment from the REWARD experiences

Hydrological data from manual and automatic/sensor-based measurements at the field and micro-watershed levels, complemented by secondary data from remote sensing and institutional sources should be used for watershed planning.

Key components:

- Weather and climate data (precipitation, temperature, humidity, wind speed, solar radiation, potential evapotranspiration)
- Soil moisture (surface and profile moisture by sensors and gravimetric methods)
- Evaporation rate (Pan evaporimeter)
- Crop data (leaf area index and SPAD)
- Evapotranspiration (Bowen/EC flux tower and remote sensing)
- Infiltration rate and groundwater table
- Runoff and sediment load (at watershed outlets ranging from 500-700 ha catchment)
- Assessment of groundwater potential zones
- Citing of soil and water conservation structures
- Water balance using hydrological modelling
- Crop planning based on water availability
- Hydrological atlas (spatial/graphical visualization of hydrological components on a temporal scale)

Hydrology stepwise guidelines

Detailed descriptions of the steps involved in collecting, compiling, and understanding the hydrological processes in the field/micro-watershed/sub-watershed scale are as follows:

a. Field Activities

Step 1: Installation of weather and hydrological instruments

- Automatic Weather Stations (AWS) for rainfall, humidity, temperature, wind speed and wind direction (15-min interval)
- Bowen flux tower (Bowen ratio energy balance method)
- Class A Pan evaporimeter
- Soil moisture sensors (Time Domain Reflectometers (TDRs), Frequency Domain Reflectometers (FDRs), theta probe, *etc*.) and soil moisture stations for real-time profile moisture

- Weirs, flumes, notches, DIVERs, digital stage level recorder, digital current meter, and multi-slot devisor, *etc*. for runoff and silt monitoring
- Groundwater level recorder for weekly/monthly/seasonally water level measurement in selected wells
- Automatic groundwater level recording using water level loggers in piezometers
- Instruments for water quality characterisation

Step 2: *In-situ* measurements

- Double-ring infiltrometers/ disc infiltrometers to measure infiltration rate in at least 3 representative locations per soil series/Land Management Unit (LMU)
- Gravimetric surface soil moisture measurement for validation of soil moisture sensor data
- Leaf area measurement using leaf area meters, Leaf Area Index (LAI) meter, fisheye lenses, canopy analysers, *etc*. at different crop stages
- Soil moisture constants like field capacity, wilting point, available water content at each soil series/LMUs
- Hydraulic conductivity at each soil series/LMUs
- Measurement of crop phonological parameters and chlorophyll content by SPAD meter
- Pumping test of at least two wells in model and monitoring Micro Watersheds (MWS)
    - Groundwater exploratory survey at 500x500 m (hilly areas) or 1000x1000 m (plain areas) grid at model and monitoring MWS

b. Preparation of hydrological atlas

Step 1: Characterize the watershed

- Use high-resolution DEM for watershed boundary delineation and extract drainage lines
- Size, shape, drainage and topographical characteristics
- Generate spatial and temporal rainfall distributions and precipitation indices maps
- Survey and map locations of existing wells, tube wells, canals, tanks, lakes, drainage line *etc*.
- Water balance components, peak rate of runoff, soil erosion estimation and simulation using hydrological models at MWS and Hydrological Response Unit (HRU) level
- Simulation of crop water requirement and irrigation schedule of major crops using models like CROPWAT, *etc*.

Step 2: Map hydrological properties

- Mapping of infiltration rate and hydraulic conductivity data (through geo-statistics)
- Generate spatio-temporal information of soil moisture; and mapping of actual and potential evapotranspiration using remote sensing products and field calibration models.

- Prepare iso-bath maps (groundwater level maps) using data from CGWB/monitoring wells and state agencies
- From the infiltration data, apply "point infiltration methods" to estimate runoff volume with peak runoff and map the runoff potential of each soil phase or HRU
- Map HRU/soil phase-wise runoff and soil erosion
- Mapping groundwater potential and recharge using Multi-Criteria Decision Making (MCDM) technique
- Plot Budyko curve showing interaction between climate aridity (PET/P) and evapotranspiration ratio (AET/P)

Step 3: Compile and standardize thematic layers (prepare hydrology atlas)

- Ensure all maps use uniform projection, scale, and legend standards
- Include metadata, sources, and methodology for each layer
- Organize all thematic maps with interpretation notes
- Include summary tables, charts, and management suggestions

c. *Hydrological data analysis*

Step 1: Quantify water budget

- The water budget at the micro-watershed/sub-watershed level can be expressed as:

$$\mathbf{P + Q_{in} = R + Q_{out} + AET + \Delta S + \Delta G}$$

- The water budget at the farm parcel or field level can be expressed as:

$$\mathbf{P = R + AET + \Delta SM}$$

- Estimate season-wise surface water, groundwater, and soil moisture availability.
- Definitions, measurement methods, and modeling approaches of key water budget components that aid in accurate water resource assessment and decision-making are as follows:

Component	Definition	Modeling method
P	Precipitation/Rainfall	Spatial interpolation, Weather prediction
Q_{in}	Water entering from upstream watersheds (rivers, reservoirs, transfers)	Hydrological routing, Flow modeling
R	Runoff/stream flow	Empirical equations, rational method, SCS curve number method, point infiltration methods
Q_{out}	Water leaving the downstream watersheds	River discharge modeling, Flow balance
ΔS	Change in surface water storage/soil moisture	Soil-water budgeting, hydrological simulation, remote sensing
ΔG	Change in ground water	Water table fluctuation method, water balance approach
AET	Actual evapotranspiration	Energy balance, physical/empirical equations
ΔSM	Change in soil moisture	Soil-water balance, soil moisture deficit approach, remote sensing

Step 2: Supply and demand assessment

- Quantify water supply components from the water budget
- Estimate irrigation demand (ID) as:

$$I_D = \text{Crop Water Requirement (CWR)} - \text{Available soil moisture}$$

- Calculate CWR from the crop-specific field data of ΔSM or using Reference ET (ET0) and Crop Coefficient (Kc)

$$CWR = ET_o \times K_c$$

- Estimate domestic water demand (WDD) using population data and per capita water consumption
- Calculate livestock water demand (WDL) based on livestock heads and species-specific daily water requirements
- Derive industrial water demand (WDI) from industry type, production scale, and sector-specific water use coefficients or surveys
- Calculate the season-wise water demand-supply:

$$\text{Water surplus/deficit} = (P + Q_{in} + \Delta S + \Delta G - R - Q_{in} - AET) - (I_D + WD_D + WD_L + WD_I)$$

4.3.2 Variations in the hydrological models in the REWARD states

Karnataka and Odisha follow distinct hydrological approaches tailored to their local contexts and capacities:

- For evapotranspiration, Karnataka used advanced methods like Bowen flux towers and remote sensing, whereas Odisha applied the Pan Evaporimeter
- Runoff modeling in Karnataka is based on the Philip Infiltration Model, in contrast to Odisha's use of the SWAT model for broader watershed simulations
- Karnataka applied the Ambhas-1D model for groundwater simulations, while Odisha used Analytic Hierarchy Process (AHP) approach to identify groundwater potential and recharge zones

4.3.3 Integration of LRI and hydrology approach and guidelines for watershed planning

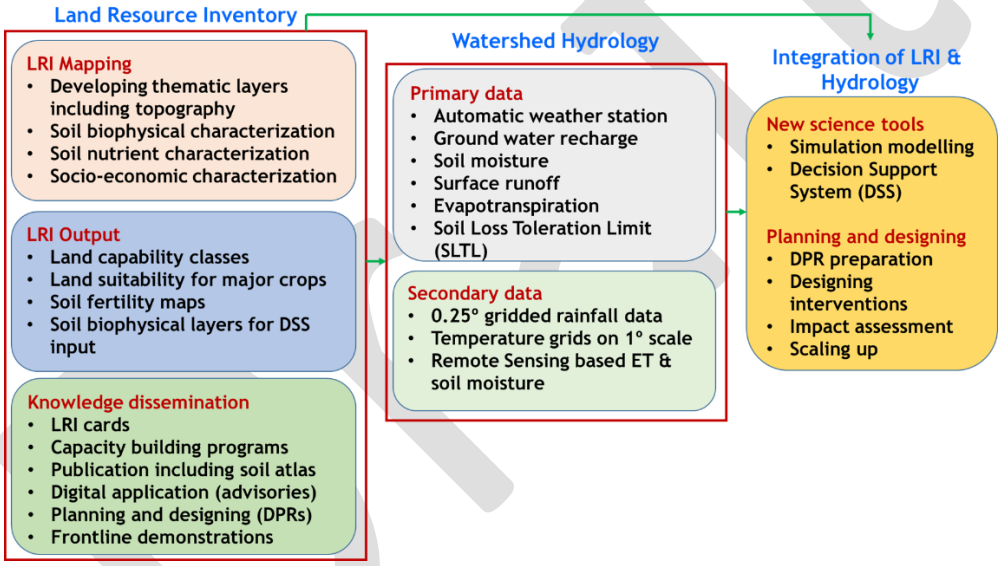
- As per the REWARD States Karnataka and Odisha, the slope classes for designing the soil and water conservation as well as water harvesting structures are categorized as 0–1%, 1–3%, 3–5%, 5–10%, 10–15%, and >15%.
- It is recommended to arrive vertical accuracy up to 0.3 meters to capture micro-topographical variations using suitable high-resolution remote sensing imagery along with topographical survey using Differential Global Positioning System (DGPS), total station, drones, or other accurate survey tools, for designing ex-situ rainwater harvesting structures particularly in 1st and 2nd order drainage network.
- Soil and water conservation measures should be planned to maintain soil loss within the permissible limit of 11.2 tonnes per hectare per year.

- Integration of LRI atlas by ICAR-NBSSLUP and Soil Loss Tolerance Limit (SLTL) atlas by ICAR-Indian Institute of Soil and Water Conservation (ICAR-IISWC) for resource conservation plan.
- Ex-situ rainwater harvesting structures planned for 1 to 5 ha catchments require a refined streamflow network, as human-induced interventions like roads and bunds often alter natural flow directions; therefore, planning should account for these altered field conditions and align with the specific water requirements of the targeted area.
- The environmental flows during the monsoon, lean, non-monsoon and non-lean seasons may be considered as 30%, 20%, and 25%, respectively in watershed development to ensure sufficient downstream flow to sustain people and nature.
- Cropping system-wise water demands, including orchards and agro-forestry system may be assessed.
- Integrate LRI data and its linkage with field scale hydrology to estimate how much fraction of runoff would be available for harvesting which will meet the irrigation requirements and design the suitable cropping system.
- Springshed management should be considered as per availability and the need.
- While assessing the demand–supply gap, consider the following:
    - Prioritize domestic and livestock water requirements, particularly during summers;
    - Estimate demand–supply gaps under dry, normal, and wet year scenarios;
    - Assess the water demand-supply gap under treated watershed conditions;
    - Design and promote cropping systems that align with available water resources (surface water, replenishable groundwater and available soil moisture in root zone) and create awareness among stakeholders
- Establish hydrological gauging stations at multiple scales in model/pilot/monitoring/plus watersheds: 5 ha (field/HRU/LMU), 50 ha (topo-sequence), and 500 ha (micro-watershed). Appropriate gauging stations to be constructed (*e.g.*, V-notch up to 5 ha catchment and broad crested weir for catchment greater than 5 ha) at each scale to capture both storm flow and base flow.
- Develop empirical rainfall–runoff relationships across different soil types, land uses, topo-sequences, and management practices using primary runoff data to support replication and scalability.
- Watershed management following LRI and hydrology approach need interactive DSS to integrate various field data to take informed decision and incorporation while developing a detailed watershed project report for efficient utilization of various resources.
- Necessary protection measures of meteorological and hydrological instruments against theft and mutilation should be ensured.
- In the watershed area, agroforestry, crop diversification, and IFS may be given importance on agricultural land. The green cover should be maintained at 66% in hilly areas, 20% in

plain areas, with an overall average of 33% for the entire watershed. Forest areas should be maintained at 100%, while agricultural areas should cover 30%.

- Existing structures and traditional knowledge should be utilized and strengthened in preference to constructing new ones within the watershed.
- There should be effective coordination between the upper, middle, and lower ridges of the watershed to ensure equitable distribution of resources.
- The site suitability of appropriate soil and water conservation measures may be identified using MCDM tools and techniques.
- Good quality instruments should be selected as per the standards of IMD, CWC, CGWB, ISI, and ISO.
- The LRI card should include crop water requirement, average irrigation requirement and irrigation schedules for major crops.

The overall flow of the LRI, hydrology, and their integration is depicted in the figure below.



4.3.4 Cost of LRI and hydrology approach for watershed planning

The cost estimates provided in this section are based on the following assumptions and may be further refined through stakeholder consultations. Both recurring and non-recurring expenditures have been taken into account. We propose the establishment of state-level referral laboratories to support large-scale implementation and quality assurance of the LRI and hydrology components. These include:

- RS&GIS laboratory
- Soil nutrient testing laboratory
- Soil biophysical analysis laboratory
- Landscape survey and mapping facility

These state level facilities will serve the entire state and help build the necessary infrastructure to scale up the LRI and hydrology approach over time. In addition, we recognize the need to

establish pilot/model watersheds for stakeholder sensitization and capacity-building initiatives. One pilot watershed is proposed for every 25,000 hectares of landscape treatment (i.e., one pilot per 100 micro-watersheds of 50 hectares each). These pilots will be equipped with state-of-the-art instruments for monitoring hydrological processes and capturing local-scale variability in soil types, topography, and cropping systems. Hydrological monitoring should start one year before the LRI activities. At least 2 years hydro-meteorological data is required before watershed treatment for watershed modelling. We also propose setting up robust field-scale monitoring systems to regularly collect data on key LRI and hydrology parameters. These systems will ensure primary data collection for planning, validation, and refinement of watershed interventions.

4.3.5 Summary of cost estimates

To carry out the LRI process, we propose the cost with three scenarios for both hilly and plain regions (Table 2).

Table 2. LRI cost estimates

Scenario	Hilly (Rs/ ha)	Plains (Rs/ ha)
No facility except WDT	784	684
With RS&GIS facilities	714	574
With RS&GIS, soil testing labs, and domain experts	474	454

For hydrology monitoring, an amount of Rs 35/ha is proposed, considering the total rainfed area (10 benchmark sites in each agro-climatic zone of India). The detailed cost estimates are shown in **Annexure-II**

4.4 Web-portal and Decision Support System (DSS)

4.4.1 Web-portal for LRI and hydrology-based interventions

REWARD programme has developed web-based platforms to provide recorded data on hydrology, and to offer location-specific recommendations through the DSS on soil and water conservation, crop selection, land capability classification, nutrient management, runoff estimation, farm ponds/check dams, crop water requirements, soil moisture balance, and water budgeting. Under the REWARD programme, Karnataka has developed a web portal called the LRI Portal, while Odisha has developed the ADAPT Portal. Based on these portals and other experiences, the NTG recommend the following key specifications that may be utilized in the development of web portals for watershed development programmes.

Table 3. Key specifications for a web-portal framework

Component	Specification	Purpose
User Interface (UI)	Responsive, intuitive, accessible (WCAG 2.1 compliant), multilingual support	Ensures usability for a wide range of stakeholders, including field staff
Authentication	Secure login with role-based access control (RBAC), integration with national IDs if needed	Manages data privacy and user permissions
Data layers	Integration of geospatial layers (satellite imagery, LRI maps, hydrology, land use, *etc*.)	Enables visual analysis and decision-making
Backend architecture	Scalable server-side platform (*e.g.*, Node.js, Django) with API-driven architecture	Supports modular expansion and third-party integration
Database	Spatial database (*e.g.,* PostgreSQL with PostGIS)	Efficient storage and retrieval of geospatial and tabular data
GIS integration	OpenLayers or Leaflet for 2D maps, CesiumJS for 3D if required	Interactive visualization of geospatial data
Data upload/download	Bulk data import/export (CSV, shapefile, GeoJSON, *etc.)* with validation tools	Facilitates data sharing and reporting
Analytics tools	Built-in dashboards, charting tools, and thematic analysis	Provides insights for planning and monitoring
Hosting environment	Cloud-based (*e.g.,* AWS, NIC Cloud, Azure) with SSL encryption and regular backups	Ensures availability, security, and disaster recovery
Maintenance & support	Routine updates, user helpdesk, training modules	Sustains long-term usability and capacity-building
Compliance	Adherence to Government of India data security and e-governance standards	Ensures legal and technical compliance
Dashboard	Total Layers Uploaded (raster/vector) - Active users - Recent Uploads/downloads - Update & Modifications - Analysis Requests -Layer usage statistics	To visualize and download

	- Raster analysis summary - Time series chart	
Search & filtering	- Search by location, attribute, or layer name - SQL-style attribute filters - Spatial search (point, bounding box, polygon)	To monitor/visualize data efficiently
Live data feed widgets	Integrate satellite feeds into dashboard for real-time updates	For quick analysis during natural calamities
Export dashboard report	Export dashboard summary as PDF or shareable web link	For planning and scientific research purpose

4.4.2 Decision Support System (DSS) tools for LRI and hydrology-based interventions

Under the recommended web portal, an integrated platform should be developed to support both LRI and hydrology, incorporating various DSS tools to address the needs of effective watershed management.

Key components

- Rule-based decision tables and scientific models (simulation models, rule-based look-up tables, criteria tables and location-specific recommendations)
- Land evaluation modules (criteria tables for assessing land capability, crop suitability, and erosion risk).
- Runoff assessment tools/models (potential runoff and peak runoff)
- Crop suitability (suitability matrix based on crop water requirement and irrigation scheduling)
- Nutrient and soil health advisory (fertilizer recommendations based on soil fertility parameters, pH, and crop-specific nutrient demands)
- Water budgeting framework (available water resources and planning for optimal allocation among agriculture, livestock, domestic, and industrial uses).
- Positioning, design and cost norms of natural resource management structures (technical specifications and unit cost norms for NRM interventions)

Karnataka has developed 9 DSS modules. These modules along with their components and decisions are depicted in Table 4.

Table 4. DSS modules developed by Karnataka

S. No.	DSS module	Component	Decision
1	Soil and water conservation plan	Land use	Select conservation measures both for arable or non-arable
		Land slope	Selection of bunding, terracing, trenching, ponds and check dams
		Soil texture	Conservation structures suitable for land forms hill slope, foot hill, upland, medium land and low land
		Rainfall/runoff	Choice between contour bunding, graded bund, terracing, check dams, loose boulder check dams, masonry check dams
		Gravel content	Selection of continuous or staggered contour trenching
2	Crop selection	Land capability class	Crop matrix suitability assessment
		Physical suitability	Crop selection based on soil and climate
		Benefit-Cost (B) ratio	Selection of economically viable crops
3	Land capability classification	Slope	Classification as arable/non-arable land
		Soil depth	Determination of prime farmland
		Erosion status	Selection of appropriate land use and conservation practices
4	Nutrient management and soil health	Soil fertility (NPK levels)	Adjustments in recommended fertilizer doses
		Soil pH and micronutrients	Application of specific nutrients
		Crop type	Tailored nutrient management advisories
5	Surface runoff estimation	Land cover/use	Estimation of runoff potential
		Soil hydrologic group	Use of specific curve numbers in models
		Rainfall intensity	Estimation of runoff volume, peak flow and frequency
6	Farm ponds and check dam design	Runoff volume	Determination of size and storage capacity for structures
		Topography land slope and soil texture	Site selection for pond/check dam
		Soil infiltration rate	Choice of water retention structure type
7	Crop water requirement	Crop type	Calculation of water needs
		Growth stage (Kc value)	Adjusted water application rates
		Rainfall and evapotranspiration	Determination of irrigation requirements
8	Soil water balance	Soil moisture content	Calculation of water balance for soil moisture maintenance
		Rainfall and irrigation input	Adjustment for maintaining soil moisture levels
		Evaporation and runoff	Adjustment of irrigation schedules

9	Water budgeting	Water sources (rainfall, groundwater)	Assessment of overall water availability
		Crop and livestock water needs	Allocation of water resources
		Human and community water use	Comprehensive water distribution plan

For the development of the DSS, the following cost is proposed (Table 5).

Table 5. DSS cost estimation

Sl. No.	Item	Units	Unit rate	Total Cost
1	To launch a pilot level dashboard in State level			
1.1	Cloud Server & DSS dashboard	1	1500000	1500000
1.2	DSS Platform Development	1	80000000	80000000
1.3	Data manager-LRI (3 years)	1	1200000	3600000
1.4	Data manager-Hydrology (3 years)	1	1200000	3600000
Total				88700000
2	Annual recurring cost per year (Year 2 onwards)			5000000

4.5 Community engagement, social mobilization and livelihoods

Community engagement and social mobilization are essential for sustainable watershed development and improving local livelihoods. Active community participation ensure lasting economic and ecological benefits with equitable benefits distribution. Social mobilization involves forming local institutions such as user groups/area groups, farmers groups, self-help groups, farmer producer organizations, and others. Improving awareness, mobilize resources, and forging collaborative between these people institutions and *Gram Panchayats* are key community engagement processes that ensure long-term benefits from watershed projects. The practices and methods used under each aspect in the REWARD states has been presented in Table 6.

Table 6. Practices and methods used in REWARD states for community engagement

S. No	Aspect/Parameter	Orissa	Karnataka
1	Social Mobilization	• Focuses on SHGs, WCs, FPOs; • Formation of new or use of existing CBOs; • Field NGOs engaged in mobilization and expand their skills and assets, and convert them to meaningful livelihoods through a dedicated support structure.	• Focuses on PRA-based tools (*e.g.,* transact walks, resource mapping); • Focuses on forming new AGs and WCs aligned to LRI planning.
2	Capacity Building	• Capacity building is led by Capacity Building state agency at the state level to conduct TNA formulating training modules and materials and monitoring all CB events by the RO and also train PD, APD, PIA line departments, OUAT, ICAR institutions, NGOs; • Trainings are linked to DPR, hydrology, value chains at district, block and village levels	• Karnataka trainings are driven by District Agricultural Training Centres (DATCs) for the community level organisations like AG/UG, SHG's and WC • CoE (UAS Bengaluru) trains only SLNA RO, WDD, • It is a detailed module-based training.
3	Livelihood Promotions	• FPO formation, IGA via MGNREGS and VRGs • Focus on landless and SHG women	• FPO strengthening with value chain linkage; • Site-specific livelihoods using LRI cards, agronomic packages
4	Community Consultation Tools	• Awareness campaigns, street meetings, leaflets, EPA's, LRI card dissemination, training sessions of the community members on vision building, team building and leadership, gender, equity and inclusiveness, institution	• Demystification of LRI via visual aids, video clippings, posters, Jatharas, street plays, community planning walks, use of LRI portals at GP level

		building data driven watershed planning.	

4.5.1 Recommendations from field experiences of REWARD:

- While traditional community mobilization processes (eg: Participatory Rural Appraisals, Jathara and other folk art forms, meetings, home visits, exposure visits, and other events) are still relevant, these methods/ events should be able to integrate science into the message. The conversations/ discussions with the community should include the insights from LRI/ Hydrology, crop and water-related issues in each watershed area, and these observations should be communicated to the local communities in an organized and simplified manner.
- Apart from the traditional methods (such as awareness programs, Jatharas and other such events), modern digital tools/ social media platforms (WhatsApp, YouTube, Facebook, others) could be utilized to improve awareness, sensitivity and acceptance among community members on the basic principles of watershed management.
- Farmers could be organized around land management units of each watershed, as these units have similar characteristics and problems/ opportunities. Farmers in these land management units could be motivated to develop similar action plans and interventions. Efforts should be made to motivate the farmers in each land management unit to become members of the Farmers Producers Organization. The FPO should emerge from the local farmers' groups (user groups/ area groups/ land management units).

4.5.2 Guidelines for community engagement, social mobilization and livelihoods

a. Pre-Planning stage: *Understanding the village and building trust*

This is the foundation stage where the project team learns about the village and starts engaging with the people.

i. Forming the teams

- State Level Nodal Agency (SLNA) selects a Project Implementing Agency (PIA) with relevant experience in watershed, forestry, agriculture, and community mobilization.
- PIA forms a Watershed Development Team (WDT) consisting of professionals in agriculture, water, soil, and community work. One team member must be a woman. All are trained in communication, gender sensitivity, and technical concepts.

ii. Developing LRI

- Experts (resource organizations appointed by SLNA) study land and soil and develop LRI cards and status report on soils/land use. PIA/WDT will make serious efforts to understand these reports/cards. Villagers participate in ground truthing processes along with the resource organization.
- WDT/PIA and resource organizations will explain to the area groups/ villagers about the details/ implications of LRI cards and land management units (potential interventions such as suitable crops, soil amendments) using simple language and pictures.

- Leaders and groups are involved, field visits are done, and youth are trained to assist.

iii. Water resource planning

- SLNA appoints resource organization to study hydrology/water resources of each watershed, using remotely sensed special databases and LRI cards/reports. The resource organization will make efforts to understand and integrate local knowledge/ practices and integrate them in water resource analysis and planning.

iv. Baseline survey

- WDT/PIA develops a baseline report, which consists of details of land, water and socio-economic features of the villages in watershed areas. Participatory tools are used for collecting data from communities. Reports from resource organisations on LRI and hydrology are integrated into this baseline report.

v. Entry Point Activities (EPA)

- PIA/WDT will execute EPA in the villages to develop rapport and trust between the villages and PIA. These works could include small works such as repairing wells, cleaning ponds, potable water, water troughs, and others.
- Various types of consultation meetings are organized with community members to finalize these EPA activities. Women and local groups help identify the activities under EPA.
- Villagers are encouraged to contribute to these activities in the form of voluntary labor and suggestions.

Key outputs/outcomes

- Community and team build trust, establishing a strong rapport between PIA/WDT and villagers.
- Baseline report including LRI, Hydrology, Natural Resources, and Socio-Economic Profile of the villages
- People understand and support the project

b. Planning stage: *Preparing the plan with the community*

At this stage, the Detailed Project Report (DPR) is prepared, with full community participation.

i. Detailed Project Report (DPR) preparation

- Resource Organizations will develop draft Detailed Project Reports, based on various surveys (LRI and Hydrology). These plans will consist of natural resource management and crop/ farming systems-related interventions. Similarly, PIA/WDT will develop action plans for livelihoods, capacity building, enterprise, and other themes. These two streams of action plans are integrated into Watershed Development Plans (DPRs). PIA/ WDT will organize various consultation meetings and participatory assessments along with local communities.

- DPR includes the needs and aspirations of different categories of families in the watershed villages, especially poor and vulnerable.
- DPR includes various sections – natural resource development and management (water resource development; soil and land improvement); production systems (Agriculture and Livestock), livelihoods & enterprises, and capacity building.
- WDT and experts discuss land, water, and farming with villagers. Scientific reasoning behind every proposed activity/intervention is presented to local communities. WDT/ PIA will share the details of the implications of LRI and hydrological assessments in developing solutions to the problems of the watershed area.
- Interventions on crops/ farming/ production systems will promote regenerative and resilient farming practices.

ii. Role of women SHGs

- WDT/PIA involve SHGs in planning after creating awareness on various opportunities within watershed development projects for SHG members.
- SHG members are motivated to develop plans for collective farming, kitchen gardens, livestock management, and support to production systems (seeds, local fertilizers units, processing facilities and others), engage in social audits, and manage village resource centers.

iii. User group and area group planning

- WDT/PIA facilitates mapping exercises with farmers and groups to connect LRI/ Hydrology with their fields/ plots. Each land management unit will develop an action plan in the light of recommendations from LRI/Hydrology teams.
- The plan will focus on water and soil conservation in each plot, appropriate crops in each plot, and related interventions for promoting resilient farming practices.
- Demonstration plots will be established to encourage new methods of cultivation that are climate and eco-friendly. Youth and women are included in all the watershed development activities.

iv. Forming the watershed committee

- WDT establishes the Watershed Committee (WC) in the *Gram Sabha*. WDT trains all the members of WC. These members are trained and guided by WDT.
- Plans and implements project activities in three focus areas:
    - Ecology (*e.g.*, trees, organic farming, water conservation)
    - Economy (*e.g.*, farming, livestock, eco-business)
    - Equity (*e.g.*, fair wages, inclusion, support for the poor)

v. Creating/ Strengthening of Farmer Producer Organizations (FPOs)

- The PIA should prioritize forming an FPO as a starting activity. If an FPO already exists, efforts should be made to strengthen it.

- The FPO will be a member-owned (members/farmers of the watershed villages) and managed body. Any household relying on watershed resources can become a member by paying the required share capital set by the FPO.
- Watershed Development Teams (WDTs) will lead community mobilization, raise awareness, and educate people on the benefits of forming an FPO. They can also involve GP members and other local influencers to build support.
- Once the FPO has 300–500 paid members, it can be registered as a cooperative, society, or company under the applicable law, with clear bylaws and governance. SHGs may be encouraged to join to widen membership. These FPOs will take up initiatives to promote resilient farming practices that rejuvenate watershed resources within 2-3 years.
- The existing FPOs should be screened based on the Pitch competition method and may preferably be within 10 km from the watershed villages for operational effectiveness.
- Conducting regular orientation sessions for the FPO/FPC staff, Board of Directors, Community Resource Persons for effective implementation.
- FPO/FPC is proposed to develop an effective business plan by integrating the LRI outputs, crop suitability & nutrient recommendations, potential value addition, and market linkages, etc.
- NTG guidelines envisage partnering with agri-tech start-ups and support agencies to develop digital platforms for marketing by capacity building of youth and FPO/FPC staff. The social media marketing can play a catalytic role in achieving the overall objectives.
- The guidelines also suggest enabling eco-systems for tie-ups with institutional buyers, trade exposure (expos and buyer seller meet, etc.) for harnessing the benefits of stable markets.

vi. Selection of FPO under REWARD Programme

The selection of FPOs under the REWARD Programme was carried out through a structured, multi-stage process to ensure transparency, competitiveness, and alignment with programme objectives.

1. Landscaping: FPOs were identified across REWARD districts, including those promoted by various line departments such as Agriculture, Horticulture, NABARD, and others under schemes like RKVY and the 10,000 FPO programme.

2. Committee formation: As per the guidance of World Bank two committees are formed for screening and Evaluation of FPOs

- **Screening committee** – The committee is responsible for initial shortlisting and is chaired by the Commissioner, WDD, and approved by the Secretary, Agriculture Department.
- **Pitch evaluation committee** – It is responsible for evaluating business pitches from shortlisted FPOs and is also chaired by the Commissioner, WDD, and approved by the Secretary, Agriculture Department.

3. Shortlisting: FPOs in REWARD districts were mapped and assessed using a rating tool developed by the CoE FPO. District-level departments provided initial evaluations. The Screening Committee shortlisted FPOs based on criteria such as organisational age, location, legal compliance, and beneficiary composition (including SC/ST/Women farmers).

4. Pitch competition: Following World Bank recommendations, a business pitch competition was organised in which an orientation programme was conducted to help shortlisted FPOs prepare their business plans. The FPOs presented their plans to an expert panel and were evaluated on a 100-point scale (80 for documentation, 20 for presentation). The evaluation criteria included vision, business performance, staffing, assets, marketing strategy, and growth plans (details in Annexure III).

5. Finalisation: Based on pitch competition scores, selected FPOs were chosen to receive targeted support under REWARD. This innovative, business-oriented approach ensures that only viable, scalable FPOs are supported, positioning them as key drivers of rural transformation and agricultural resilience.

Key outputs

- DPR is approved by the *Gram Sabha*
- Committees and groups are trained and active
- FPOs are formed and existing ones are linked with the project

c. Execution stage: Doing the work on the ground

This is the action phase where the planned work gets done.

Main activities

i. Execution of proposed interventions of DPR

- All proposed interventions of DPR will be executed by the WC with WDT/PIA support including, natural resource management , productivity enhancement (demonstrations, seeds/soil fertility improvement, bio-resource centres, health care *etc*.), livelihoods and micro enterprises, and capacity building events.
- Watershed Development Fund (WDF) is created through small contributions from villagers and used for asset maintenance.
- Payments to workers, wage seekers, material suppliers, *etc.* will be made based on work progress. The WDT will follow the Central Financial Management System (CFMS) for this process.

ii. Training & monitoring

- Community and committee members are trained on quality control/maintenance of assets created during the project period.
- Local people help monitor the work quality.

iii. Employment Opportunities for Local Laborers

- Priority is given to local labor (manual work preferred over machines).
- Villagers are trained in new methods of farming, water management, livestock, and more.

Village events & livelihood promotion

Crop water planning

Crop water budgeting/planning events are organized twice a year. These events combine the hydrology data with project experiences and people's aspirations. Based on the water balance, seasonal crop selection is made which will be useful for irrigation planning and water management decisions.

Creation of WDF for maintenance

WDT encourages the local community to contribute in these activities by providing voluntary labour. This contribution is deposited in a separateWDF, which will be utilized for maintaining assets created during the watershed development project.

FPO support activities

WDT ensures that FPO is capacitated to perform various functions to strengthen the local farming practices and production systems. As part of this, FPO will,

- Improve access to markets by linking farmers to buyers, markets.
- Improve access to finance in the form of loans, insurance, and savings.
- Bring better technology by introducing improved farming methods and agri-tech tools.
- Provide tools and equipment via Custom Hiring Centers (CHCs), and ensuring access to seeds, fertilizers, and technical advice.
- Capacity building for improving leadership, governance, and record-keeping.
- Up-scale sustainable farming practices by promoting farming practices that are ecologically sensitive, economically viable and institutionally feasible.

Final outcomes

- Watershed Committee, local institutions and villagers implement and monitor the works.
- Natural farming and eco-friendly methods are adopted.
- Village assets are well maintained.
- FPOs and local groups support farmers and improve their livelihoods.
- Community engagement leads to stronger, greener, and self-reliant villages.

d. Consolidation/withdrawal stage

This phase ensures sustainable use of natural resources and maintenance of assets. Local institutions like *Gram Panchayat*, WC, SHGs, and FPOs manage norms, eco-friendly practices, and resources. FPOs and SHGs connect with financial institutions and markets. With systems

in place, PIA/WDT withdraws, enabling villages to sustain ecological and livelihood gains independently.

Main activities

i. Market integration for FPOs

- Map markets: identify crops, demand, buyers, and gaps
- Build FPO capacity: training on market trends, quality, handling, pricing, packaging, branding
- Facilitate linkages with govt. schemes (MSP, e-NAM)
- Support infrastructure: aggregation centers, warehouses, cold storage
- Promote value addition and agri-tech partnerships
- Enable trade exposure: expos and buyer-seller meets
- Train on digital market platforms and networking tools
- Link with banks/NABARD for working capital and funds
- Monitor market performance, buyer satisfaction, and income

ii. Community-based monitoring system

- Create simple checklists for assets and resources
- Train local bodies and volunteers on monitoring
- Regular field data collection on water, soil, and infrastructure
- Maintain transparent records and hold review meetings
- Share findings with the community for transparency
- Institutionalize monitoring roles within local bodies
- Optionally use digital tools for data management

iii. Formal project exit and handover

- Plan and schedule a handover event with all community groups
- Mobilize community participation via awareness campaigns
- Officially transfer assets, funds, and management responsibilities
- Clarify roles and get formal acceptance through agreements
- Recognize community efforts and stress sustainable management
- Document and share the process for transparency

iv. Post-project maintenance

- Each asset to be officially handed over to the GP, UG or FPO with an MoU for maintenance

- Maintenance Committee to be formed. It may be a part of the watershed committee or separate group responsible for O&M
- Define a 12-month post project handholding phase relevant contacts required and technical support from WDT/PIA/FPO.
- About 1% of total watershed budget may be deposited in WDF for post project maintenance. Also encourage creation of local operation and maintenance funds via users fee, GP contribution, MGNREGS maintenance grants, *etc*.
- Annual Asset inspection to be done by the community and report submitted to GP and district PIA

Ensuring continuity of benefit flows from watershed development projects even after withdrawal of PIA/ WDT:

- As the aspirations of farmers change with technology, markets/ prices, and the situation of natural resources (particularly water), there is a tendency to over-exploit the natural resources and adopt destructive farming practices. There are serious implications of climate change-related incidents and urbanization, too, on the continuity of benefits from watershed projects (high/low rains, floods, changes in temperatures and pest attacks and so on). Given this complex combination of issues and influencing factors, the benefits of watershed projects are likely to reduce, after some years. There has been a tendency to overlook the physical structures and assets developed under the watershed project, as well as to move away from the norms and practices adopted during its implementation. Additionally, the community institutions, which are meant to take responsibility for ongoing maintenance, often face challenges in sustaining themselves.
- Therefore, it is important that the assets created during the watershed project period are regularly maintained, repaired and renewed, to ensure that these structures provide the benefits that are expected from them. For this to happen, *Gram Panchayat* and other government departments, particularly Department of Rural Development and PRI (MGNREGS) work together to allocate necessary funds for repair and maintenance of the structures.
- State Rural Livelihoods Mission/ NABARD/ local financial institutions/ Department of Agriculture may take special interest in nurturing and supporting local women SHGs (mainly livelihoods activities of SHGs) and production-related interventions of FPOs from watershed area.
- *Gram Panchayats* may be motivated to ensure that natural resources are used by farmers in a regulated way, without leading to overexploitation of water, common lands, soils/ land.
- Providing incentives to crops that require less water, produced without harmful chemicals, could also ensure that natural resources are not exploited. Farmers have an interest in continuing good and eco-friendly production practices that do not undermine the quality/quantity of natural resources.

- It requires regular hand-holding support to the *Gram Panchayat*/FPOs/Watershed Committees, by any local NGO/ CSO/ Government Department/ Agency. Without such support, it is difficult to expect that local institutions will maintain the assets after withdrawal of project.
- State Level Nodal Agency could work towards creating an enabling policy and administrative environment, where various development/ welfare schemes are channelled to *Gram Panchayat*, where watershed development projects are already completed. This policy framework could include – allocation of funds to repair/ maintenance of watershed works; incentives for less water-consuming crops, incentives for products from regenerative crops; punishments for misuse of natural resources and so on.

4.5.3 Community consultation

Community consultation is a cornerstone of effective and sustainable watershed planning. While data-driven tools like LRI and hydrological analysis provide a scientific foundation, meaningful community engagement ensures that these scientific insights are aligned with the needs, understanding, and realities of local stakeholders. It bridges the gap between digital planning and on-ground implementation, fostering a sense of ownership, enhancing accountability, and promoting long-term sustainability. The REWARD program seeks to develop science-based DPRs using advanced tools and data. However, for these plans to be effective, the scientific concepts behind them must be demystified for the local communities to ensure clarity, understanding, and practical relevance. Moreover, integrating local knowledge is essential for validating scientific recommendations, ensuring they align with on-ground realities, land ownership patterns, usage practices, and socio-environmental contexts.

Community consultation process

The community consultation is a well-structured, multi-step process integrated into the DPR preparation, ensuring both scientific accuracy and local relevance. The key steps include:

a. *Preparatory steps*

- Download table-top DPRs from the DSS.
- Organize Area Groups (AGs) based on mini or micro-catchments.
- Convert AG-wise maps to Excel format for easy reference.
- Schedule transect walks with fixed dates and times for each AG.
- Identify suitable locations for community gatherings.

b. *Transect walk and ground verification*

- Conduct field walks with AG members, comparing LRI-based intervention plans with actual field conditions.
- Verify the local conditions specific to the lands like extent of land holdings, location & site characteristics with LRI output and mark if any corrections required.

- Compare map showing existing structures, land use, drainage lines *etc*., with actual observations and do necessary corrections.
- Discuss intervention proposals with farmers and collect their feedback, modifications, or deletions (recorded carefully to avoid compromising overall plan integrity).

Demystifying science to communities:

- Explain scientific rationale (LRI and hydrology-based) to the community.
- Educate them on how proposed treatments address site-specific issues.

Table 7: Practices on demystification of sciences to communities in REWARD States

State	Best Practices
Odisha	• Dissemination of LRI cards in local language • Farmer training sessions on DSS • CRPs facilitating farmer meetings • Women-inclusive awareness drives
Karnataka	• Community transacts walks using LRI overlays • Use of flip charts and pictorial tools • Training watershed executive committees and area groups to interpret LRI cards • Digital LRI library accessible at GP level

c. *Post-transect walk discussions*

- Discuss with the community on pros & cons and impact of the proposed activities on social and environment aspects.
- For common land treatment, opinion of the WEC and neighbour farmers should be recorded.
- Prioritize the interventions, each farmer should be aware of the investment to be made on his/her land and contribution to be paid, explain the cost sharing mechanism to beneficiary and take his/her consent.

d. *Participatory Rural Appraisal (PRA):* *After transect walk and discussions*

- Cross-verification of information gathered during transect walk
- Seeking clarification on any issue that might have arisen during transect walk
- Finalizing the activities to be taken in the watershed on individual and common lands
- Discussing implementation strategies, cost sharing aspects, *etc*.
- Integrate community inputs into the revised Micro Watershed (MWS) plan.

e. *Validation and consolidation*

- Consolidate all AG feedback and updated interventions into revised MWS plans.

- Generate detailed plans, including budget, contributions, and implementation methods.

f. *Gram Sabha presentation and approval*

- Present the finalized MWS plan in the *Gram Sabha*.
- Include key details: budgets, investment contributions, implementation strategy, and environmental/social impacts.
- Record approval proceedings with photographs or videos.

DPR approval protocols: After community validation and *Gram Sabha* approval:

- Taluk PIA finalizes draft DPR and verifies components.
- District Level Technical Committee (DLTC) examines feasibility and prepares a convergence plan.
- Watershed Committee for District Coordination (WCDC) reviews and recommends to the State Project Empowered Committee (PEC).
- State Level Review by PEC leads to final approval.
- Implementation begins after approved DPRs are shared with field staff, NGOs, and WECs, with funds transferred accordingly.

Recommendations from the field experiences of REWARD

- SLNA/PIA teams have to develop greater insights/ understanding of the contents of DPR in science-based watershed projects. Based on this deeper understanding, the PIA/ WDT must engage in conversations with the local communities on the situation of local resources and proposed options in the Table Top DPR (0 draft by expert/resource organizations).
- PIA/ WDT should develop relevant participatory tools/ methods to understand the local issues/ challenges/ opportunities and good practices on water/ soil management, crops/ livestock/ bio diversity issues. This understanding should be integrated into table top DPR and improve the contents of the same.
- PIA/ WDT should be able to spend a reasonable amount of time and effort in communicating the contents of the DPR (prepared by experts/ resource organizations). This process should not be rushed to cross the milestones of the project. WDT/ PIA should be open to make any changes/ modifications based on the genuine feedback from the communities.
- Scientific methods/ tools should be deployed to identify the most vulnerable communities and vulnerable pockets of land/resources. The priority of the Watershed Development Project should be these pockets/ communities.

4.5.4 Capacity building programs for states and local bodies

Community participation is a specialized subject that requires necessary attitudes (sensitivity, empathy), skills, and knowledge on the subject. The training and capacity-building inputs are very critical in watershed development projects. This section deals with the agenda of building capacities of various actors in the watershed development projects, which are mentioned in Table 8.

Table 8. Agenda of capacity building

Target group	**Main content**	**Institutional arrangements**
Facilitators- Staff of SLNA, Resource Organizations, PIA/ WDT, FNGO and Staff of line departments, Banks	Attitude and Behaviour Change-related agenda. Several participatory methods/ skills for engaging community participation. Science-based monitoring tools, understanding data/ measurements and decision-making skills on water use, regulation, and crop choices.	ICAR-NBSS &LUP/CoE/ MANAGE/ EEI/ WDD
People's Institutions- Members of *Gram Panchayats*; Watershed Execution Committee, SHGs, Area Groups, FPO members and other local community resource persons	Basics of science-based approach (LRI cards, Hydrology, *etc*.), different themes (land and soil management, water use, natural/ eco-friendly farming practices, crop planning, livestock, and institutions like FPOs)	FNGO/ KVK/ /PIA/ CoE-FPO *SLNA could identify and deploy suitable Civil Society Organization as resource organization

The structure of capacity building modules has been presented in **Annexure-IV.**

To ensure the effective delivery of the capacity-building agenda, a coordinated institutional framework is essential. Various entities, ranging from national and state-level technical organizations to grassroots institutions, play distinct but complementary roles in this effort. The next section, presented in Table 9, details the specific institutional responsibilities and partnerships across REWARD states, highlighting how these stakeholders support and operationalize the capacity-building process on the ground.

Table 9. Institutional role in capacity building in REWARD states

S.no	Aspect	Odisha	Karnataka
1	**COE**	OUAT, IIT Bhubaneswar, ICAR-IIWM, IISWC: developing DSS, training modules, hydrology models	UAS Bangalore as lead CoE for LRI, agro-advisory, climate-smart practices and conducting training programs for SLNA, WDD and RO and developing training modules.
2	**Technical Partners**	OUAT, IIT, ICAR, IIWM and the Resource organisations develops protocols for hydrology, groundwater models, DSS; train CRPs and PIA staff, the local RO /NGO also capacitate the FPO.	ICAR-NBSS&LUP, KSNDMC, KSRSAC support LRI training, climate data, digital mapping
3	**DATC**	Not specifically mentioned but Capacity Building State Agency formulates the training modules and material and monitors the CB events by the RO at state level, the PD at the district level implements the CB for the PIA, WMT, Line Dept and PRI members with the help of KVK. The local NGO implement the CB activities at the village and block level for the CBO's.	Lead orientation and ToT programs for WDTs and local bodies like AG/UG, SHG's and WC at the district level and development of training materials and modules.
4	**NGO/ FNGO's**	Mobilize SHGs, organize community consultations, and assist in DPR	Conduct PRA tools, support validation of scientific DPRs with community input
5	**PIA**	Coordinate training, community consultation and field implementation of the activities	Anchor planning and implementation at sub-watershed level with trained staff.

Recommendations from field experiences of REWARD

- Each State Level Nodal Agency should establish appropriate institutional systems/ arrangements for providing capacity-building services to various partners/ participants/ stakeholders in watershed development projects. This institutional arrangement include state-level resource organizations, district/project-level resource organizations, and other resource organizations.

- These agencies should have relevant experience and expertise on various dimensions of the capacity building agenda-developing modules on various themes (Refer **Annexure IV** for a structure of the module) and conducting various learning events.
- The available budgets for capacity building could be appropriately channelled for effective delivery of capacity building inputs to various partners of the Watershed Development Projects.
- As community engagement and participation is a critical requirement of Watershed Development Projects, it is important that PIA/WDT should have the necessary expertise, and human resources deployed for this purpose. It is highly desirable to engage Field Level Facilitating Agency from NGOs/Civil Society Organizations to function as a field level support organization to PIA to strengthen community mobilization, engagement and participation in Watershed Development Projects.
- SLNA may develop a communications strategy to utilize the best opportunities from the social media sector to spread the message, good practices on watershed management and promote positive support systems for the same. DoLR/ SLNA could partner with appropriate media groups/ agencies that can support DoLR/ SLNA in this process of creating positive picture of Watershed Development Projects in the society and also improve the levels of participation of local communities in the program.

4.5.5 Enhancing Livelihood

Enhancing livelihoods of the community is one of the pivotal goals of watershed. It links better land and water management practices with a platform to generate income for the watershed communities with interventions like LRI and Hydrology, while also strengthening local institutions of the watershed villages.

a) Linking livelihoods with Watershed Planning: These activities will be planned together with land and water interventions. Community based organizations like SHG's, UG's and FPO's help choose the right activity based on:

- Land and Water Status.
- Skills and the interest of the community.
- Market Opportunities

b) Support System for the CBO's and Locals:

- *Small and Marginal Farmers*: Organic and Natural Farming, mixed cropping, kitchen garden, livestock-related activities.
- *Landless people and women*: Poultry, Goatery, food processing, and small enterprises form the SHGs.
- *Youth*: Capacitating local youth in farm services, equipment repair, nursery work, bio-inputs shop or bio-resource center at the village level.
- *Common land users*: Activities like cultivating fodder for the village cattle, vermi-compost, and collecting forest products.

c) Local Institutions:

- FPO's can help get seeds, tools and market access to the locals.
- SHG's can run small enterprise and get support from govt. schemes.
- UG/AG's: They can plan livelihood activities for every household in the watershed village.

d) Capacitating the Stakeholders:

- Encouraging small enterprises, budgeting, marketing and packaging.
- Climate resilient farming practices, making and application of bio-inputs, nursery development, operating and repairing farm equipment.
- Exposure visits, field visits, discussions, and demo plots to learn by seeing and doing.

e) Training and Capacity Building: Watershed community receive training on-

- Running small businesses, budgeting, marketing, packaging
- Farming skills, nursery development, and operating farm equipment
- Exposure visits and demo plots to learn by doing.

f) Sustaining Livelihood: After the project end, SHG's and FPO's continue to-

- Support farmers buy inputs and sell their produce.
- Grow small enterprise.
- Access market and fetch govt. support through schemes.

The local GP and FPO's can help manage resources and maintain the assets like water structure and common land interventions.

g) Expected Outcomes:

- Better income opportunities for farmers and landless families.
- Lack of Migration and more rural jobs or opportunities.
- Eco-friendly framing practices become part and parcel of life.
- Strong community groups supporting livelihoods.

The implementing agency must identify and promote social, human, financial, physical and natural capital elements that increase the watershed area's income and employment generation opportunities.

4.6 Technology-enhanced monitoring and evaluation

Monitoring and evaluation (M&E) is a scientific process that helps in assessing the effectiveness of the watershed program and are critical part of good governance, as it promotes transparency, accountability and trust among stakeholders.

To strengthen M&E, the program integrates advanced technologies such as RS, GIS, mobile-based applications, and Management Information Systems (MIS) in the REWARD implementing states. These tools support high-resolution, real time monitoring of interventions through field-deployed gauges and satellite data. Key processes like Land Resource Inventory (LRI), Hydrology, Detailed and Project Report (DPR) preparation including community mobilization play a critical role during the planning phase. Therefore, systematic process monitoring must be ensured to deliver high-quality outputs within designated timelines, drawing on successful practices from the REWARD program implemented in Karnataka and Odisha.

4.6.1 Monitoring and evaluation

The M&E plays a vital role in watershed programs by tracking progress, assessing impact, and informing decision-making. It helps in identifying successful strategies, areas for improvement, and lessons learned, ensuring effective resource allocation and maximizing benefits for local communities and the environment. By measuring outcomes and impacts, M&E enables implementing agencies to adapt and refine interventions, ultimately enhance the sustainability and effectiveness of watershed initiatives following are the steps followed for M&E.

a. Preparatory steps in planning for M&E

- *Review Program Goals and Objectives*: The first step in developing a monitoring and evaluation framework is to review the program's goals and objectives.
- *Determine Key Indicators*: Once the program goals and objectives are clear, the next step is to identify key performance indicators (KPIs) for each objective.
- *Identify Stakeholders*: Identifying key stakeholders involved in the program is crucial for effective monitoring and evaluation.
- *Establish Criteria for Sample Selection*: To ensure that the sample is representative of the watershed community, criteria for sample selection need to be established.
- *Draw Representative Sample*: A representative sample of the watershed community should be drawn based on the established criteria.
- *Develop data collection tools and instruments*: Data collection tools and instruments should be developed to collect relevant data.
- *Conduct baseline survey*: A baseline survey should be conducted to establish a reference point for future monitoring and evaluation.

- *Engage stakeholders in the monitoring and evaluation process*: Stakeholders should be engaged in the monitoring and evaluation process to ensure that their needs are met and that they are informed about program progress.
- *Plan for data management and analysis*: A plan should be developed for data management and analysis.
- *Plan for reporting and dissemination*: A plan should be developed for reporting and dissemination of results.

b. Sample selection

The selection criteria for a sample directly impact the reliability and quality of the data collected, while the sample size determines the time and resources required for effective monitoring and evaluation. Considering all these aspects, the sample selection criteria and sample size for evaluation surveys proposed as follows:

- For sample selection at the watershed level, households should be listed based on parameters such as social profile, land holding size, occupational profile, gender of the household head, location within the watershed (Upper, Middle, Lower).
- Sample for baseline survey: Data collected during the baseline survey forms as bench mark for evaluating the results, impacts of watersheds investment, and extrapolating the sample data to the entire population may not give accurate learnings. Therefore, listing the households and collecting data from 100% of households in the watershed for baseline surveys.
- Sample size for mid-line and end-line surveys: The sample (25%) for mid-line and end-line surveys to be selected covering the beneficiaries of all watershed interventions like soil, water conservation, productivity enhancement, livelihoods, capacity building *etc*.
- Sample selection criteria and sample size for control category: For Baseline, Mid-line and End-line surveys data should be selected from 10% of the farmers from neighbouring villages within the radius of 10-15 km from untreated the watershed. Rationale: Analysing mid-line and end-line survey data helps assess the outcomes and impacts achieved compared to baseline data. However, attributing these results solely to watershed interventions can be challenging. To accurately determine the net impact of watershed initiatives, we propose including farmers from non-intervention villages as a control group for comparison.
- The probabilistic sampling methods such as random sampling stratified random sampling and cluster sampling procedures can be considered in the watershed areas for evaluation of household impacts.

c. Data collection and analysis

- Monitoring data to be collected on quarterly basis during planning and execution stage of the watershed, this will help in understanding the status of the project interventions.
- Evaluation data to address the impacts/ results of watershed program to be collected in all stages of the watershed program (pre-planning to the execution level). For example,

the village, cluster, block/taluk and district level data under watershed to be collected that helps in understanding the hydrological, biophysical, socio-economic, ecological, and institutional aspects of the watersheds in the preplanning phase.

- Data on watershed interventions related to the agronomical, engineering, community, capacity building and livelihood aspects will assess the impact of the program.
- The institutional arrangements made in watershed for regular operation and maintenance of the assets created in the common land need to be ensured. Establishment of watershed development fund (WDF) and guidelines for utilizing the WDF has to be ensured for the exit protocol.
- The data collected to be used for analyzing the baseline, mid-line and end-line impacts in comparison with the control area.

4.6.2 Process monitoring

The M&E are two essential components of project management that are often interconnected but serve distinct purposes. Understanding their relationship and differences is crucial for effective project implementation and assessment. Monitoring and Evaluation are interrelated in terms of shared goal, data-driven approach and continuous cycle. However, they are distinct in terms of purpose, scope, timing and methodology. Therefore, the monitoring and evaluation is explained in separate sections in the guideline.

Monitoring is a continuous process that identifies potential bottle necks and facilitates learning and tracks progress towards goals and documents results, processes, and experiences. Monitoring data is used to inform decision-making and learning.

a. *Types and indicators for Monitoring*

- There three types of monitoring, i.e., Progress Monitoring, Performance monitoring and Institutional monitoring.
- Progress Monitoring: Progress monitoring refers to the physical and financial accomplishment. The activities executed under this process are entry point activity, natural resource management, productivity systems and micro enterprise, livelihoods, institution and capacity building to be monitored (100%) on quarterly basis in comparison with DPR and Estimates.
- Performance Monitoring: Performance monitoring refers to quality and utility/usability of the interventions. It can be done to assess the quality, effectiveness, outcome of the interventions executed in 20% of the completed works during the quarter in the above mentioned intervention under progress monitoring.
    - In case of high density interventions such as trench cum bunding, staggered trenches, resilient agriculture practices and climate adjusted soil moisture interventions, *etc.* 10% of the total benefitted farmers in the quarter need to be monitored for progress and performance assessment.
- Institutional monitoring: Institutions involved and existed in the watershed such as Self Help Groups, Watershed Committees, Farmers' Producers Companies, *etc.* to be monitored

every quarter. The parameters to be considered for monitoring are, trainings, role in watershed program, documentation, financial aspects and bank linkages, *etc*.

Component-wise monitoring indicators are developed for data collection across key areas such as Soil and Water Conservation (SWC), including feedback from SWC beneficiaries; Land Resource Inventory (LRI) and Agro-Advisory Services; Capacity Building initiatives; as well as Horticulture and Forestry interventions, with specific inputs from respective beneficiaries are given in **Annexure V.**

b. Monitoring methods

Monitoring team to employ the following methods and tools to collect relevant data and measure project progress-

- Primary data collection: Data to be collected through household surveys, focus group discussions, interviews with key informants through questionnaires and direct observations.
- Secondary data collection: Secondary data to be collected from reliable/ trusted sources to substantiate the observations drawn from primary data and/ or where primary data is not possible.
- Indicators: Key performance indicators (KPIs) to be developed to measure progress and assess project performance. An indicative list of 120 indicators developed are annexed in the report.
- Data analysis: Analysing collected data to identify trends, patterns and deviations.
- Reporting: Presenting monitoring findings through reports, dashboards or visual representations for effective communication.

Table 10. Sample coverage for monitoring

Aspect/Theme	Sample Size
No. of Sub Watersheds	20 SWDs out of 20 SWDs (100%)
Entry Point Activity	• Progress Monitoring - 100% • Performance Monitoring – 20%
Natural Resource Management	• Progress Monitoring - 100% • Performance Monitoring – 20%
Livelihood Interventions	• Progress Monitoring - 100% • Performance Monitoring – 20%
Land Area Treatment	• 1000 beneficiaries during the project period
Resilient Agriculture Practices	• 1000 beneficiaries during the project period
Climate Adjusted Soil Moisture Interventions (Demonstrations, special SMC interventions)	• 1000 beneficiaries during the project period
Institutional Monitoring (Trainings, Participation in Execution, Documentation, Financial Aspects and Bank Linkages)	• Performance of Watershed Executive Committee – 20 WECs / Year • Performance of SHGs – 20 SHGs / Year • Performance of FPOs – 20 FPOs / Year

c. Tools for monitoring

- Tested questionnaires on different components to be used, Mobile Applications/ software, Remote Sensing, real time data platforms (Google cloud, *etc*.), open source tools.

4.6.3 Impact evaluation

Evaluation is a periodic review of watershed project's results on communities and environment, typically at mid-term or completion in comparison with pre project/ baseline. It helps to improve programs and projects in the future and identify best practices and provides evidences for scaling up. Key evaluation approaches are include

With and without project: This method evaluates the impact of watershed interventions by comparing project areas with non-intervention (control) areas. It helps isolate the effects directly attributable to the project, offering a clearer picture of changes in soil health, water availability, vegetation, and socio-economic conditions.
Before and after the project: In this approach, the project area is evaluated by comparing conditions before implementation (baseline) and after project completion. This method provides a more accurate assessment of changes over time, but requires robust baseline data and longer timelines for meaningful results.

a. Indicators for evaluation

The selection of indicators is a crucial and skilled intensive process in the evaluation of the watershed projects. It must start with a careful analysis of the project plan and objectives, ensuring that the chosen indicators align with expected outcomes. The selected indicators should be simple and easy to measure, reliable and replicable, sensitive to changes, simple to compute, and easy to understand and interpret. To ensure comprehensive evaluation, indicators are grouped into following seven key categories, each reflecting a different dimension of watershed development. (Detailed format is annexed as **Annexure VI**).

- Biophysical and hydrological (Cropping pattern, ground water, irrigation potential, agronomic practices, runoff, soil loss, biodiversity, vegetation, *etc*.)
- Ecological (Climate resilient practices, improvement in agro-ecology, biodiversity)
- Economical (cost & benefits, land holding, crop yield, regular employment, migration, ecosystem services, circular economy)
- Institutional (SHGs, WECs, FPOs, equity)
- Social (Access to education, health, asset building, public services)
- Sustainability (Post project asset maintenance, WDF)

b. ***Evaluation methods***

An evaluation team to employ the following methods and tools for evaluating the watershed project intervention effectiveness and impact.

- *Surveys and Interviews*: Collecting data from project primary and secondary beneficiaries of the watershed
- *Focus Group Discussion*: Group discussions with stakeholders (*e.g.*, farmers, women, SHGs, youth) to gather qualitative inputs
- *Self-assessment through scoring technique*: Community members rate key project indicators using a simple scoring system
- *SWOT Analysis*: Structured identification of Strengths, Weaknesses, Opportunities, and Threats
- *Case Studies*: Case studies provide detailed insights about a particular intervention or a component of the watershed. In-depth analysis (Inputs from watersheds, process of of specific project components, outcomes and impacts.
- *Data Analysis*: Analysing quantitative and qualitative data to identify trends, patterns, and correlations.
- *Comparative Analysis*: Comparing the project's achievements against established benchmarks or similar projects.
- *Cost-Benefit Analysis*: Evaluating the economic viability and cost-effectiveness of the project.

c. *Tools for evaluation*

- *Field data collection tools:* (GPS devices, Mobile applications, handheld sensors, drones, portable weather stations)
- *Remote sensing tools:* Satellite imagery, Aerial photography
- *Water quality and quantity monitoring:* Water quality probes, automatic water samples, hydrological measuring devices
- *Soil moisture and ground water monitoring:* soil moisture sensors, ground water monitoring wells/ bore wells)
- *Weather and climate monitoring:* weather stations, rain gauges, soil temperature probes
- *Data management and analysis tools:* GIS software, Data visualization tools, Statistical analysis tools, machine learning tools, MIS
- *Economic Analysis tools:* Cost Benefit Analysis (at farm Level, at project level), Double Difference Method (Before and after, with and without interventions).
- Other tools for evaluations under LRI and hydrology are mentioned in respective sections.

Table 11. Important steps to be taken up during evaluation surveys

Baseline survey	Midline survey	End line survey
• Listing of households • Sample household selection for survey • Identification of indicators on which data to be collected • Baseline survey format preparation • Identification of enumerators • Orientation of enumerators • Pre-testing of baseline survey format • Revision of baseline survey format • Administering the baseline survey • Monitoring the baseline survey format – gap filling • Assessing the quality of baseline data – make necessary changes in the format • Baseline data processing, analysis – identify problem statement of watershed area	• Midline survey format preparation • Identification/ orientation of enumerators • Pre-testing of midline survey format • Revision of midline survey format • Administering the midline survey • Monitoring the midline survey format – gap filling • Assessing the quality of baseline data – make necessary changes in the format • Midline data processing, analysis • Comparing the midline data with the baseline • Identifying, quantifying the areas where improvement is achieved	• End line survey format preparation • Identification/ orientation of enumerators • Pre-testing of end-line survey format • Revision of end-line survey format • Administering the end-line survey • Monitoring the end-line survey format – gap filling • Assessing the quality of baseline data – make necessary changes in the format • End-line data processing, analysis • Comparing the end-line data with the baseline • Identifying, quantifying the areas where improvement is achieved

d. ***Data requirements from remote sensing and field***

Using geospatial technology, the monitoring of biophysical variables can be effectively carried out through:

- Remote sensing based indices which can be used for monitoring watershed management outcomes such as Normalized Difference Vegetation Index (NDVI), Normalized Difference Water Index (NDWI), Modified Normalized Difference Water Index (MNDWI), Soil Adjusted Vegetation Index (SAVI), Enhanced Vegetation Index (EVI), Water Ratio Index (WRI), Automated Water Extraction Index (AWEI), Normalized Difference Moisture Index (NDMI), Normalized Difference Pond Index (NDPI), Soil Adjusted Vegetation Index (SAVI), and Normalized Difference Built-up Index (NDBI).

- Change detection of water availability in the watershed
- Change detection through Land Use/Land Cover (LULC) analysis to assess land dynamics over time.
- To access the impact of the interventions using evapotranspiration, information is required at 15-day or monthly intervals. Sensors like MODIS provide evapotranspiration products at a spatial resolution of 1 km. The upcoming TRISHNA mission will offer ET products at a 60 m resolution every third day for each 1 km2 area. Such high-resolution data products can be used to estimate evapotranspiration with improved precision and accuracy.
- For monitoring the soil moisture throughout the project period, satellite sensors like, Sentinel, MODIS, SMAP, RISAT and NISAR may be used.

e. ***Data elements in household level survey format***

It covers general and respondent details, agriculture, livestock, farming practices, income, assets, memberships, land treatments, and contributions to assess watershed impact at household level. Though primary data collection is prominent and cost effective, it has demerits. Since, primary data is memory based information, there is a possibility of biasness and accuracy may not be highest level in the data. In order to substantiate or increase the accuracy of the data, it is vital to collect data from secondary sources and remote sensing as well **(**detailed format is annexed as **Annexure VII).**

4.6.4 Economic analysis

a. Data collection on costs and benefits

Conducting an economic analysis of watersheds requires the collection of comprehensive data on both costs and benefits. This analysis is crucial for assessing the economic viability of watershed investments. The standard procedure and protocols should be used for economics analysis.

b. Cost components

The total costs of watershed investments include:

- Initial investment costs: The upfront expenditures associated with watershed development and implementation.
- Annual maintenance costs: The recurring expenses required to sustain the watershed's functionality and benefits.

c. Benefit assessment

To evaluate the benefits of watershed investments, data should be collected from beneficiaries of various components on a sample basis. This may include:

- Direct benefits: Increased agricultural productivity, improved water availability, and enhanced livelihoods.
- Indirect benefits: Ecological services, reduced erosion, *etc*.

- Collecting data on costs and benefits is essential for assessing the economic viability of watershed investments. This analysis will enable decision-makers to:
- Evaluate the effectiveness: Determine whether the benefits of watershed investments outweigh the costs.
- Inform future investments: Use data-driven insights to optimize future watershed development and management strategies.
- For economic analysis, the life of watershed investments may be considered as 10 years and annual discount rate as 8% to derive the economic benefits of the program.

4.6.5 Management Information System (MIS)

A well-designed Management Information System (MIS) plays a vital role in the successful implementation of watershed programs. The MIS is essential in various phases of the program, including:

a. Relevance of MIS in Watershed Programs

- Pre-planning phase: Informing program design and planning.
- Planning phase: Supporting the development of strategies and interventions.
- Implementation phase: Monitoring progress and identifying areas for improvement.
- Post-implementation phase: Evaluating program impact and sustainability.

b. Features of an effective MIS

- Comprehensive monitoring and evaluation: Tracking input-level, output-level, and result/impact-level indicators to assess program performance.
- Multi-stakeholder access: Providing access to various stakeholders, including:
  i. Data contributors: Uploading collected data from the field to the portal
  ii. Data processors: Managing and analyzing the data
  iii. Data users: Utilizing the data to inform decision-making

c. Functionality of MIS

The MIS should process the data entered from the field and provide:

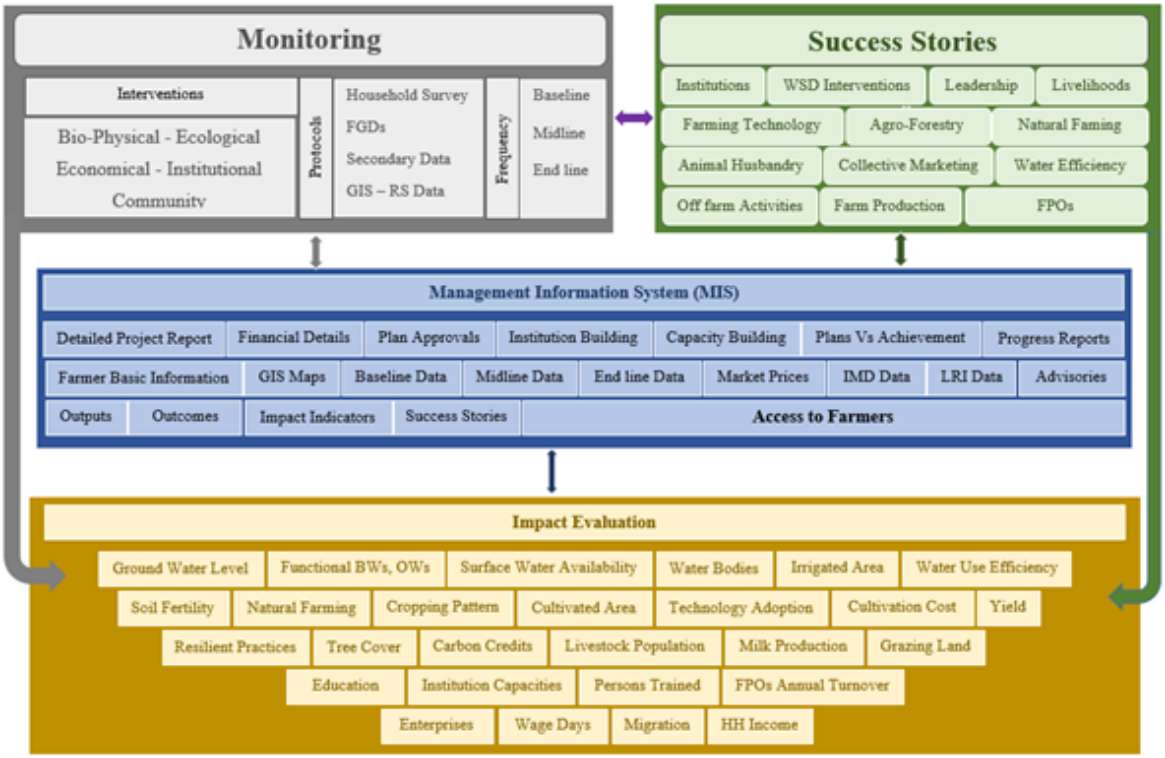
- Reports and dashboards: Highlighting physical and financial progress, best practices, and bottlenecks affecting the program.
- Data-driven insights: Enabling decision-makers to take informed decisions to align the program towards its objectives.

MIS with full of these features and functionalities, watershed programs can ensure effective monitoring, evaluation, and decision-making, ultimately leading to improved program outcomes and sustainability.

4.6.6 Framework of monitoring and evaluation

The M&E framework under the REWARD program represents a significant advancement over traditional approaches and earlier watershed development projects. Previous models, which primarily relied on periodic progress reports and post-facto evaluations, REWARD emphasizes continuous, data-driven, and real-time monitoring. It integrates process and performance monitoring with the use of advanced tools such as GIS, remote sensing, and mobile-based applications to ensure spatial and temporal accuracy. While earlier programs focused on pre-defined reporting templates and limited outcome evaluation. Furthermore, REWARD places greater emphasis on technology-enabled evaluation**,** using high-resolution satellite imagery, NDVI and NDWI indices, drone surveys, and economic and socio-economic analyses to capture both biophysical and human impacts. In contrast to the traditional three-phase evaluation (pre, mid, and post), REWARD follows a baseline, midline, and end-line evaluation framework, which is more rigorous and evidence-based. Overall, REWARD introduces a modern, technology-integrated, participatory, and adaptive M&E system, making it a significant leap from the conventional monitoring models in watershed management.

A robust M&E framework is essential to any successful watershed management initiative. This framework serves as a systematic approach to assess the progress, effectiveness, and impact of watershed interventions over time.



5. Uniqueness of NTG

The following table provides the overall recommendations for these domains in relation to the existing guidelines (WDC-PMKSY 2.0).

Table 12: Comparison of existing WDC-PMKSY 2.0 Guidelines and NTG

Domain	Guidelines/Recommendations	
	Existing Guideline (WDC-PMKSY 2.0)	**National Technical Guidelines (Recommendations)**
RS&GIS (Planning Phase)	• Digital Elevation Model (DEM) should not be coarser than 2.5 m. Preference may be given for use of images of 40 cm or better resolution. • Mapping should be carried out at a scale of 1:5000 or 1:10,000.	• For base map preparation, such as delineating field boundaries and identifying the locations of permanent features, preference should be given to satellite data with **sub-meter spatial resolution**. However, for the preparation of thematic layers or for monitoring and evaluation purposes, a spatial resolution of 1 to 10 meters is recommended. • High-resolution DEMs generated from stereo imagery such as Pleiades, WorldView-II, and WorldView-III with approximately 1 m spatial resolution is recommended. • Mapping scale between 1:4,000 and 1:8,000 may be used at micro-watershed level and a scale between 1:15,000 and 1:25,000 may be used for sub-watershed level.
Land Resource Inventory (LRI)-Technical Framework	At least 10% of projects be covered under the LRI system. Method and scale to be decided by States	Highly structured, science-based stepwise protocols for *pre-field, field, and post-field* stages standardized by ICAR-NBSS&LUP for detailed mapping on cadastral scale is recommended
LRI-Integration and Outputs	Emphasizes integration with baseline surveys and output reporting but does not mandate recommendations based on analysis for farmers use or creating digital atlases.	Recommends operational output for planning and generation of digital LRI cards for farmers, digital libraries, and atlases from a standardized database integrated with DSS

Hydrological Data (Collection and Monitoring)	• Focuses on state capacity for hydrological analysis with the help of available infrastructure • Emphasis on local and participatory monitoring. However, instrumentation is left to the state's discretion.	Recommends protocols for field validation and real-time data collection with a multi-scale instrumentation system both, automated and manual, with particular focus on primary and real-time data collection
Hydrology-Modelling and Water Balance	General guidelines for rainfall-runoff, aquifer mapping, and crop alignment, where hydrological modelling and DSS linkage are optional	Prescribes a hydrological atlas with explicit water balance and crop-water budgeting methods tailored precisely to State's needs.
Hydrology-Integration with Planning	Data-driven interventions are recommended but these are not standardized. Water budgeting, MIS integration, and participatory planning are encouraged, but integration of hydrology with LRI through DSS is not essential.	Mandatory data integration for all field planning (conservation structure design, irrigation scheduling, crop-water budgeting), which requires data-driven, digital DSS tools for all phases of implementation
Institutional & Operational Rigour	Allows institutional support, training, and partnerships, but the State have flexibility to interpret guidelines, which results in less operational uniformity across India.	NTG requires active support of specialized national/state level agencies, involves well defined procedure and protocols with intension to realize best outcomes while supporting scientific and economics approach towards sustainability and climate actions.
Community engagement	Watershed management involved project level people's institutions, entry point activities, capacity building, etc.	In addition to the existing activities, there is demystification of science-based watershed management approach (LRI, Hydrology, crop plans, DPR etc.) for the local communities through capacity building in terms of handling the instruments, data collection, maintenance of records and instrument, etc.
Community consultation	Orientation of people, local PRI members and officials concerned for executing a community led watershed development	• The community consultation process has been explained separately in greater details and in step-wise manner from preparatory steps to validation and consolidation. • NTG envisions community consultations keeping their local needs, understanding on-ground realities for

		validating scientific recommendations based on LRI and hydrology by integrating their local knowledge.
Farmer Producer Organisations (FPO)	Utilize existing FPOs in the project vicinity; where none exist, support the creation of new ones	FPOs to emphasize on atleast 25% increase in business turnover at the end of project period
		• Forming and strengthening the existing FPO as a starting activity has been made mandatory • Existing FPOs are initially shortlisted by a screening committee based on specific criteria such as their age, location, legal compliance, and the profile of their beneficiaries, including SC/ST and women farmers. Once shortlisted, these FPOs participate in a pitch orientation program designed to help them effectively present their business plans. Following this, the shortlisted FPOs present their business plans to an expert panel known as the Pitch Evaluation Committee and are evaluated based on criteria like FPO's vision, business performance, staffing, assets, marketing strategy, and growth plans. • The FPO should preferably be within 10 km from the watershed villages for operational effectiveness. • Conducting regular orientation sessions for the FPO/FPC staff, Board of Directors, Community Resource Persons for effective implementation
	Business development plans and models were not suitably highlighted	• FPO/FPC is proposed to develop an effective business plan by integrating the LRI outputs, crop suitability & nutrient recommendations, potential value addition, and market linkages, etc.
	Digital tools/ strategies are not specifically mentioned for promoting markets and market linkages	• NTG guidelines envisage partnering with agri-tech start-ups and support agencies to develop digital platforms for marketing by capacity building of youth and FPO/FPC staff. The social media marketing can play a catalytic role in achieving the overall objectives. • The guidelines also suggest enabling eco-systems for tie-ups with institutional buyers, trade exposure (expos and buyer seller meet, *etc*.) for

		harnessing the benefits of stable markets
Post-project maintenance	WDC 2.0 post-consolidation and withdrawal phase has provisions for Watershed Development Fund (WDF) which is utilised based on the amount available and assets to be maintained.	• Post-project maintenance is proposed to be handed over to GP/ Watershed Committee/ FPO/FPC under a MoU. • A dedicated Maintenance Committee responsible for Operation and Maintenance (O&M) of the assets is proposed to be formed. NTG also envisages 12 month post-project handholding for the Committee and depositing approximately 1% of total watershed budget in WDF. • Creation of local O&M fund has also been envisaged in NTG by receiving contributions from UGs, GPs, and schemes like MNREGS, RKVY, RAD, etc. • The community is supposed to undertake annual assessment of the assets created and submit the report to the GP and Maintenance Committee for necessary interventions.
Technology enhanced Monitoring and Evaluation (Institutional and frequency)	• Institutional arrangements for M&E through WC, PIA, WCDC, SLNA and NLNA • Monthly review meeting with all PIAs in the district by WCDC • Quarterly reporting/review by SLNA • Half yearly review by NLNA • Evaluation: Pre project, Mid project and Post project phases	• Institutional arrangements for M&E through WC, PIA, WCDC, SLNA and NLNA • In addition to this for science based M&E different relevant technical institution/agencies (TERI, IRMA SAMBODHI, AFC etc.) • Monitoring during the pre-planning, planning, execution/implementation and post project phases by state agencies throughout the project period • Quarterly reporting is recommended and need based review by SLNA and NLNA • Evaluation: Pre-project (Baseline), Midline and End Line
Monitoring (Tools and Methods)	• Exhaustive list of parameters related to soil health, hydrology, forestry, agriculture and horticulture, animal husbandry, dairy and fisheries; economic, financial process assets institutional risks and convergence for M&E in IWMP, 2015 and WDC-2.0 • Process, performance and outcomes based monitoring	In addition to the tools and methodology of IWMP and WDC 2.0 following tools and methodology were adopted in NTG: • Continuous and real time monitoring of the parameters listed in IWMP, 2015 and WDC-2.0 including some more parameters related to High resolution satellite imagery, Soil moisture sensor and other hydrological instruments, LRI parameters, Hydrology, water quality, Hydrological modelling, eco-system service, sustainability,

	• Mobile application to be used for geo-tagging existing structures and proposed new structures at different stages of work for real-time monitoring. • Geo-tagged works should be verified using satellite imagery • Survey through simple questionnaires	institutional/FPO/FPC, people's participation index, watershed eco-index, ground water monitoring, etc. • Proposed categories of parameters (bio-physical, ecological, social, economic, institutional, sustainability, etc.) • Progress monitoring (100% of activities), performance monitoring (20% of completed works) and institutional monitoring (all institutions). For high density interventions such as, Trench cum bunding, earthen bunding, etc (10% of benefitted farmers). • Separate structured questionnaires for process/progress, performance and institutional monitoring including modern digital tools and techniques. • Evapotranspiration data at 15-day or monthly intervals (e.g., MODIS at 1 km) to be used to assess intervention impacts. The upcoming TRISHNA mission will provide higher-resolution ET data (60 m, every third day) for more precise estimates. • For monitoring soil moisture throughout the project period, satellite sensors such as Sentinel, MODIS, SMAP, RISAT, and NISAR may be used.
Evaluation (Tools and methods)	• Remote sensing–based change detection should be used to assess changes in vegetation cover using NDVI and changes in water availability using NDWI. • Use satellite imagery of the same resolution for pre, mid, and post-project phases. • Management Information System (MIS) to be developed • The RS&GIS technologies to depict periodic changes and impacts. • Baseline, mid-line and end-line evaluations	• High resolution remote sensing–based change detection used to assess changes in features such as vegetation and water availability using indices NDVI and NDWI, other indices like MNDWI, SAVI, EVI, WRI, AWEI, NDMI, NDPI, and NDBI. • Change detection using Land Use/Land Cover (LULC), change in water availability analysis • Irrigation water quality index, soil quality index, terrain management indices, water resource utilization indices, agronomic vitality indices, livestock vitality indices, employability indices, human empowerment indices and sustainability indicators • Integration of monitoring parameters through questionnaire and developed MIS by states for evaluation

		• Detailed Economic Analysis (cost benefits) taking into account additional evaluation parameters • Sample size during baseline (100% of households in the watershed), midline and end line evaluation (25% each to be selected covering the beneficiaries of all watershed interventions) • For control group 10% of the farmers from neighbouring villages/ untreated villages within the radius of 10-15 km from the watershed. • Evaluation using "with and without"/ "before and after" projects

6. Framework for implementation and scaling of NTG

The successful implementation and scaling of the guideline across the other parts of the country require well-structured institutional arrangements at various levels to ensure the effective and scientific management of watershed development projects. The following institutional arrangements are recommended.

a) At the national level: National Level Nodal Department (NLND), National Level Steering Committee (NLSC), National Level Technical Committee (NLTC), National Level Nodal Agency (NLNA), National Level Data Centre, and a National Portal

b) At the state level: State Level Sanctioning Committee (SLSC), State Level Nodal Department (SLND), and State Level Nodal Agency (SLNA) and Technical Institutions. Agricultural Engineers/SWCE in watershed/Soil Conservation Department for scince-led development should be included.

c) At district level: Watershed Cell cum Data Centre (WCDC), Project Implementing Agency (PIA), Watershed Development Team (WDT), *Gram Sabha* (GS), Watershed Committee (WC), Farmer Producers Organization (FPO), Self Help Groups (SHGs), and User Groups (UGs)

d) Support from knowledge partner

The National Rainfed Area Authority (NRAA), under the Ministry of Agriculture and Farmers Welfare is an organization mandated to advise changes to agricultural policies and programs that will enable sustainable development of agriculture in rainfed areas of the country. The role of NRAA is as follows:

- NRAA can assist NLNA on design/policy formulation, evolution of participatory methodologies for planning & implementation of the program, and also development of monitoring and evaluation tools.
- NRAA can help the SLNAs in developing location-specific strategic plans for project development programs of States/UTs, consistent with their agro-climatic and socio-economic conditions.
- It can facilitate action research relevant to watershed development program in different agro-climatic regions. It can also undertake studies, evaluation and impact assessment assignments, so that appropriate & timely learnings are generated for incorporation into both ongoing projects, and new ones to be taken up.
- NRAA can facilitate DoLR in organizing annual Watershed Conclave to share best practices & learnings. This annual event will facilitate SLNAs and various other stakeholders to deliberate on issues relates to implementation and the mid-course corrections required. The learnings emerging there on can feed into refining the new generation Guidelines.
- NRAA can facilitate DoLR in bringing out an 'Annual Status Report on the Program' for wider dissemination. NRAA can establish a 'Practitioners' Platform' by pooling expertise and experiences from civil society organizations, research organisation and enterprises to make such pool easily accessible to the SLNAs. It can also identify and

accredit reputed national level agencies for capacity building, monitoring and evaluation of the program to be deployed in different parts of the country.

The detailed institutional mechanism at each level are described in the WDC-PMKSY 2.0 guideline.

7. Criteria of the selection of watersheds based on NTG

The successful implementation of watershed also depends on the right selection of the watersheds. The selection criteria for watersheds given in WDC-PMKSY 2.0 guidelines need to be revised as per the NTG. The detailed selection criteria of watersheds is given in Table 13.

Table 13. Watershed selection criteria based on NTG

S. No.	Parameters	Criteria
1	**Economic**	• Absolute poverty and economic backwardness of the population/ stakeholder, including SC/ST population (>20%), literacy rate, malnutrition, etc. • Watersheds with >60% of farmers under small and marginal category
2	**Infrastructure**	• Nearness to the developed watershed
3	**Meteorological**	• Frequency of drought/ flood occurrence • Low composite drought index
4	**Hydrological**	• Acute scarcity of drinking water • Degree of over-exploitation of groundwater resources • Preponderance of degraded/ wastelands • Area not covered under assured irrigation (<30%) • More number of defunct water bodies
5	**Soil, Land cover and Production**	• Low productivity of major crops compared to the district/ state average • Low soil fertility and organic carbon • Decline in Normalized Difference Vegetation Index (NDVI).
6	**Social**	Willingness of the village community to: • Make a voluntary contribution • Adopt regulatory norms for the maintenance of common property resources

8. Priority actions for finalizing NTG

To finalize the NTG, a robust review mechanism has been set up. This includes technical advisories to the implementing agencies, field visits, monitoring and impact evaluation of the LRI-hydrology based treatment measures on watershed basis along with community mobilization and capacity building, conducting national-level consultation meetings with domain experts from prestigious institutions and universities across India. The mechanism for monitor of the flow at watershed or sub-watershd scale should be developed by state watershed department.

9. Challenges for developing NTG for watershed management in India

- India's vast agro-climatic and geographic diversity, makes it difficult to formulate uniform guidelines that can effectively address variations in soil types, rainfall patterns, cropping systems, and water availability.
- The presence of multiple agencies and sector-specific policies across agriculture, forestry, water, and rural development leads to fragmented go vernance, conflicting mandates, and challenges in integrating NTG into a unified national strategy.
- Achieving cost optimization for LRI and hydrological assessments is difficult due to the diverse topographical conditions and institutional infrastructure across various states.
- Recommending appropriate slope classes from a natural resource management perspective is challenging, as such classifications must account for variations in location-specific topography.
- Limited technical skills, institutional capacity, and training at the local level hinder the effective implementation of NTG and demand significant investment in capacity building and human resources.
- LRI is time intensive process which consumes 2/3rd of the total project duration leaving limited time frame for implementation and impact evaluation. This led to delayed generation of field data for development of NTG.
- Delayed implementation has slowed down the M&E process, making it hard to capture good practices.
- Codal formalities for procurement of hydrological instruments and their installation takes long time, that results in unintended delay in the data generation for modelling.
- Administrative delay in fund flow hampered the activities particularly field visits.

10. Next steps for adoption of NTG by stakeholders

- Organize training sessions for the stakeholders and field teams on the methodology outlined in the NTG.
- To percolate down the scientific thoughts to field, the field functionaries of multidisciplinary may be involved including agricultural graduates and Agricultural Engineering graduates including post graduates with soil and water conservation engineering specialization.
- Develop specialized training modules on each domains such as LRI, hydrology, RS&GIS, M&E, and community engagement and capacity building.
- Organize brain storming sessions, knowledge exchange workshops and seminars for experience sharing between NRAA, DoLR, World Bank, technical institutions, REWARD states and other non-REWARD adopting states.
- Incentives may be provided to watershed Yodhas to enhance awareness and encourage people participation in watershed management.

Annexure

Annexure-I

Parameter	Category	Sub-category	Criteria
Slope	Hills/uplands	Highly slopping upland/hill	>25%
	Low and medium lands		
		Rolling upland	15-25%
		Rolling medium land	10-15%
		Moderately sloping medium land	6-10%
		Moderately sloping low land	2-6%
		Gently sloping low land	0-2%
Soil Depth	Shallow		25-50 cm
	Moderately Shallow		50-75 cm
	Moderately deep		75-100 cm
	Deep		100-150 cm
	Very Deep		>150 cm
Soil texture	Loamy sand		Based on % sand, silt, and clay
	Sandy loam		
	Loam		
	Silt loam		
	Silt		
	Sandy clay loam		
	Clay loam		
	Silty clay loam		
	Sandy clay		
	Silty clay		
	Clay		
Gravelliness	Non-gravelly		<15%
	Gravelly		15-35%
	Very gravelly		35-60%
	Extremely gravelly		60-80%
	Considered as part of topsoil		>80%
Available water capacity	Very low		<50 mm/m
	Low		51-100 mm/m
	Medium		101-150 mm/m
	High		151-200 mm/m
	Very high		>200 mm/m
Erosion	Class1/Slight		0-25%
	Class2/Moderate		25-75%
	Class3/Severe		75-100%
	Class4/Very Severy		Total removal of surface/subsoil
Drainage	Excessively drained		

	Somewhat excessively drained		Normal water table depth and morphological changes in soil profile due to prolonged wetness and poor drainage
	Well drained		
	Moderately well drained		
	Somewhat poorly drained		
	Poorly drained		
	Very poorly drained		
Soil	Soil series code	Soil phase symbol	Texture class, slope, drainage, and erosion
Runoff	Ponded		Observed soil profile, soil slope, climate, and vegetation cover
	Very slow		
	Slow		
	Medium		
	Rapid		
	Very Rapid		
Soil reaction (pH)	Very strongly acid		4.5-5
	Moderately acid		5-6
	Slightly acid		6-6.5
	Neutral		6.5-7.3
	Slightly alkaline		7.3-7.8
	Moderately alkaline		7.8-8.4
	Strongly alkaline		8.4-9
	Very strongly alkaline		>9
Soil fertility	Salinity	Low/Medium/High	Standard ranges
	Available Nitrogen		
	Organic Carbon		
	Available Phosphorus		
	Available Potassium		
	Available Boron		
	Available Sulphur		
	Available Iron		
	Available Manganese		
	Available Copper		
	Available Zinc		
Land Capability map	Suitable for Agriculture	Class 1	Climate, Slope, Erosion, Drainage, Soil depth, Texture, Gravels, Rockout crops, Salinity, pH, Permeability
		Class 2	
		Class 3	
		Class 4	
	Suitable for forestry, silvopasture, wildlife *etc.*	Class 5	
		Class 6	
		Class 7	
		Class 8	
Land suitability map of a given crop	Highly Suitable		Slope, Cropping period, Drainage, pH, Texture, Soil depth, Gravel,
	Moderately Suitable		
	Marginally Suitable		
	Not Suitable		

			Salinity Sodicity, and CaCO3 in the root zone

Annexure II: Cost matrix table for LRI and Hydrology

Scenario-1:					
No facility except WDT					
Plain landscape					
A	**Items**	**Unit**	**Unit rate**	**Area**	**Total Cost**
1	**Thematic layer generation**				
1.1	Base maps and pre-field layers/shapefiles	16	200	5000	1000000
1.2	DGPS/Drone survey in 10% area		600	500	300000
2	**Soil sample and analysis**				
2.1	Local staff for field opeartions (@ 1 months)	2	35000		70000
2.2	Labour for field operations (@ 1 months)	2	25000		50000
2.3	Profile sampling	20	10000		200000
2.4	Nutrient analysis	500	1000		500000
2.5	Physical analysis	100	1000		100000
3	**HH survey**				
3.1	Demographic, socio-economic	250	2000		500000
4	**Data analysis of LRI**				
4.1	HR/Experts cost @ 6 months	6	100000		600000
4.2	Misc. (Software/logistic/other operation cost)	1	100000		100000
	Total				**3420000**
	LRI cost (Rs/ha)				**684**

Scenario-2:					
No facility except WDT					
Hilly landscape					
B	**Items**	**Unit**	**Unit rate**	**Area**	**Total Cost**
1	**Thematic layer generation**				
1.1	Base maps and pre-field layers/shapefiles	16	200	5000	1000000

1.2	DGPS/Drone survey in 10% area		600	1000	600000
2	**Soil sample and analysis**				
2.1	Local staff for field opeartions (@ 1 months)	2	35000		70000
2.2	Labour for field operations (@ 1 months)	2	25000		50000
2.3	Profile sampling	30	10000		300000
2.4	Nutrient analysis	500	1000		500000
2.5	Physical analysis	200	1000		200000
3	**HH survey**				
3.1	Demographic, socio-economic	250	2000		500000
4	**Data analysis of LRI**				
4.1	HR/Experts cost @ 6 months	6	100000		600000
4.2	Misc. (Software/logistic/other operation cost)	1	100000		100000
	Total				**3920000**
	LRI cost (Rs/ha)				**784**

Scenario-3:					
With RS&GIS facilities					
Plain landscape					
C	**Items**	**Unit**	**Unit rate**	**Area**	**Total Cost**
1	**Thematic layer generation**				
1.1	Base maps and pre-field layers/shapefiles	16	100	5000	500000
1.2	DGPS/Drone survey in 10% area		250	1000	250000
2	**Soil sample and analysis**				
2.1	Local staff for field opeartions (@ 1 months)	2	35000		70000
2.2	Labour for field operations (@ 1 months)	2	25000		50000
2.3	Profile sampling	20	10000		200000
2.4	Nutrient analysis	500	1000		500000
2.5	Physical analysis	100	1000		100000
3	**HH survey**				
3.1	Demographic, socio-economic	250	2000		500000

4	**Data analysis of LRI**				
4.1	HR/Experts cost @ 6 months	6	100000		600000
4.2	Misc. (Software/logistic/other operation cost)	1	100000		100000
	Total				**2870000**
	LRI cost (Rs/ha)				**574**

Scenario-4:					
With RS&GIS facilities					
Hilly landscape					
D	**Items**	**Unit**	**Unit rate**	**Area**	**Total Cost**
1	**Thematic layer generation**				
1.1	Base maps and pre-field layers/shapefiles	16	100	5000	500000
1.2	DGPS/Drone survey in 10% area		250	1000	250000
2	**Soil sample and analysis**				
2.1	Local staff for field opeartions (@ 1 months)	2	35000		70000
2.2	Labour for field operations (@ 1 months)	2	25000		50000
2.3	Profile sampling	30	10000		300000
2.4	Nutrient analysis	500	1000		500000
2.5	Physical analysis	200	1000		200000
3	**HH survey**				
3.1	Demographic, socio-economic	250	2000		500000
4	**Data analysis of LRI**				
4.1	HR/Experts cost @ 6 months	6	100000		600000
4.2	Misc. (Software/logistic/other operation cost)	6	100000		600000
	Total				**3570000**
	LRI cost (Rs/ha)				**714**

Scenario-5:					
With facilities (RS&GIS, Soil testing labs, and domain experts)					
Plain landscape					

E	Items	Unit	Unit rate	Area	Total Cost
1	**Thematic layer generation**				
1.1	Base maps and pre-field layers/shapefiles	16	100	5000	500000
1.2	DGPS/Drone survey in 10% area		250	1000	250000
2	**Soil sample and analysis**				
2.1	Local staff for field opeartions (@ 1 months)	2	35000		70000
2.2	Labour for field operations (@ 1 months)	2	25000		50000
2.3	Profile sampling	20	10000		200000
2.4	Nutrient analysis	500	1000		500000
2.5	Physical analysis	100	1000		100000
3	**HH survey**				
3.1	Demographic, socio-economic	250	2000		500000
4	**Data analysis of LRI**				
4.1	HR/Experts cost @ 6 months	6	0		0
4.2	Misc. (Software/logistic/other operation cost)	1	100000		100000
	Total				**2270000**
	LRI cost (Rs/ha)				**454**

Scenario-6:					
With facilities (RS&GIS, Soil testing labs, and domain experts)					
Hilly landscape					
F	**Items**	**Unit**	**Unit rate**	**Area**	**Total Cost**
1	**Thematic layer generation**				
1.1	Base maps and pre-field layers/shapefiles	16	100	5000	500000
1.2	DGPS/Drone survey in 10% area		250	1000	250000
2	**Soil sample and analysis**				
2.1	Local staff for field opeartions (@ 1 months)	2	35000		70000
2.2	Labour for field operations (@ 1 months)	2	25000		50000
2.3	Profile sampling	30	10000		300000

2.4	Nutrient analysis	500	1000		500000
2.5	Physical analysis	200	1000		200000
3	**HH survey**				
3.1	Demographic, socio-economic	250	2000		500000
4	**Data analysis of LRI**				
4.1	HR/Experts cost @ 6 months	6	0		0
4.2	Misc. (Software/logistic/other operation cost)	1	100000		100000
	Total				**2370000**
	LRI cost (Rs/ha)				**474**

Hydrology cost estimation

	Items	**units**	**Unit rate**	**Area**	**Total Cost**
1	**Instrumentation setup**			5000	
1.1	Automatic Weather Stations (AWS)	1	700000		700000
1.2	Soil Moisture Sensors for profile soil moisture monitoring (one for each HRU/cropping system)	3	500000		1500000
1.3	Hot air oven for soil mositure measurments	1	50000		50000
1.4	No of plots to monitor soil moisture using gravematic methods	20	50000		1000000
1.5	Establishment of Piezometers	5	350000		1750000
1.6	Water level recorder for monitoring GW levels	5	75000		375000
1.7	GW table data using water level indicator (15/30 days interval)	50	1200		60000
1.8	Construction of runoff gauging station (with Weirs and Flumes)	3	650000		1950000
1.9	Establishment of PAN Evaporimeter	1	20000		20000
1.10	ET flux tower	1	4000000		4000000
1.11	Double Ring Infiltrometers (manual type)	2	20000		40000
2	**Operations**				
2.2	Local staff for field operations/activities (@5 years)	2	25000		3000000

2.4	Hydrology Technicians (@5 years)	1	100000		3000000
2.5	Transportation & other data collection cost	5	50000		250000
3	**Maintenance cost**	5	320810		1604050
4	**Hydrological data analysis/Modeling (@5 years)**	5	1200000		6000000
	Total Cost for BM watershed				**25299050**
	Hydrology Cost/Benchmark (Rs/ha)				**5059.81**
	Total Cost for BM watersheds@100000 ha coverage in hilly region				**252.99**
	Total Cost for BM watersheds@150000 ha coverage in plain region				**168.66**
	Total Benchmark watersheds for hilly region				**383**
	Total Benchmark watersheds for plain region				**354**
	Total Cost for BM watersheds for hilly region (INR Lakhs)				**4844.77**
	Total Cost for BM watersheds for plain region (INR Lakhs)				**2985.29**

Benchmarking of watersheds at national

ACZ No.	Agro-Climatic Zone	Area (Million ha)	Irrigated Area (Million ha)	Rainfed Area(Million ha)			Benchmark Sites		
				Total Area (Mha)	Hilly Area (M ha)	Plain Area(M ha)	Hilly Sites	Plain Sites	Total Sites
1	Western Himalayan	3.1	1.33	1.77	1.59	0.18	16	1	17
2	Eastern Himalayan	4.3	0.21	4.09	3.68	0.41	37	3	40
3	Lower Gangetic Plain	7.5	3.62	3.88	0.19	3.69	2	25	27
4	Middle Gangetic Plain	13.7	5.34	8.36	0.42	7.94	4	53	57
5	Upper Gangetic Plain	10	7	3	0.3	2.7	3	18	21

6	Trans-Gangetic Plain	5.1	4.5	0.6	0.03	0.57	0	4	4
7	Eastern Plateau & Hills	10.9	2	8.9	5.34	3.56	53	24	77
8	Central Plateau & Hills	9.9	2.48	7.43	4.46	2.97	45	20	65
9	Western Plateau & Hills	16.5	2.05	14.45	7.23	7.23	72	48	121
10	Southern Plateau & Hills	19.3	3.67	15.63	9.38	6.25	94	42	136
11	East Coast Plains & Hills	8.8	2.64	6.16	1.85	4.31	19	29	47
12	West Coast Plains & Ghats	5.9	2.36	3.54	1.42	2.12	14	14	28
13	Gujarat Plains & Hills	6.2	2.77	3.43	1.37	2.06	14	14	27
14	Western Dry Region	13.8	3.64	10.16	1.02	9.14	10	61	71
15	The Islands Region	0.1	0.02	0.08	0.04	0.04	0	0	1
	Total	135.1	43.63	91.48	38.32	53.17	**383**	**354**	**738**

Annexure-III

FPO Pitch Evaluation Scoring Tool - REWARD PROGRAM, Karnataka				
Name of the FPO				
Block				
District				
Slide	**Questions**	**Max Score**	**Obtained Score**	**Remarks**
1	**FPO Introduction**	**5**	**0**	
1.1	FPO profile	1		
1.2	Shareholders Details (Village Wise)	2		
1.3	Vision: **WHERE** you want to reach in 5 to 7 years?	1		
1.4	Mission: **WHY** you want to reach there (what problem you will solve for your customers)?	1		
2	**Customer Segments**	**5**	**0**	
2.1	Who are your customers (Farmers)? How will you GROUP your CUSTOMERS(Farmers) based on their NEED or/and CHANNEL (marketing or sales)?	2.5		
2.2	Who are your customers (Buyers)? How will you GROUP your CUSTOMERS(Buyers) based on their NEED or/and CHANNEL (marketing or sales)?	2.5		
3	**Customer Value Proposition**	**5**	**0**	
3.1	How your products and services are unique or different in the marketplace? And what will motivate customers (Farmers) to switch from their existing service providers or channels?	2.5		
3.2	How your products and services are unique or different in the marketplace? And what will motivate customers (Buyers) to switch from their existing service providers or channels?	2.5		
4	**Channels**	**5**	**0**	
4.1	How to reach customers (Farmers) for marketing (Awareness creation, lead generation)?	2		
4.2	How to reach customers (Farmers) for purchases(purchase process engagement, Purchase order creation, order fulfilment)?	2		
4.3	How to reach customers (Farmers) for after purchase support (customer success)?	1		
5	**Key Resources**	**10**	**0**	
5.1	What Physical resources you have to run your business successfully?	2.5		

5.2	What Human resources (Staff/team) you have to run your business successfully?	2.5		
5.3	What intellectual resources you have to run your business successfully?	2.5		
5.4	What Financial resources you have to run your business successfully?	2.5		

Slide	Questions	Max Score	Obtained Score	Remarks
6	**Key Partnerships**	**6**	**0**	
6.1	MoU with Exporters, Processors, Multinationals where house owners	2		
6.2	e-marketing platforms, Credit linkage with Banks,	2		
6.3	Partnership in particular business with others, Bulk buyers, Transportation, Millers/ginners, groups etc.. Retail chain out lets	2		
7	**Business Performance**	**13**	**0**	
7.1	Active Farmers (who has done input purchase or/and output sales or/and advisory purchase via the FPC) (%) and transaciton with them	5		
7.2	Indicators-Customer(Top 5 Buyers -in a table format):	3		
7.3	Business investment and profit for last 3 years	5		
8	**Growth Plan**	**10**	**0**	
8.1	How will you increase your customer base (farmer)?	2		
8.2	How will you increase your customer base (buyers)?	2		
8.3	How will you increase your margins on the existing products?	2		
8.4	What new products/services will be introduced for additional revenue source?	2		
8.5	What pilots (have considered/will be undertaken) for product testing?	2		
9	**Risks and ways to manage them**	**4**	**0**	
9.1	What are the risks associated with your business?	2		
9.2	How will you manage the risks?	2		
10	**Requirements from REWARD (if selected)**	**7**	**0**	

10.1	Equipment	1		
10.2	Staff	1		
10.3	Working Capital	1		
10.4	Approaching Banks and Preparing Plans	2		
10.5	Business plan of FPO for next 3 years	2		
11	**Governance and Management**	**10**		
11.1	Board composition and BoD details	2		
11.2	Frequency of BoD and AGM and minutes of the meetings/attendance/Meeting notice	2		
11.3	CEO qualification/experience/ business knowledge	2		
11.4	Management teams and their roles	2		
11.5	Details of Board of Directors	2		
12	**Presentation**	**20**		
12.1	Vision and mission	2.5		
12.2	Customer segment /Market segmentation	5		
12.3	Key resources and partnerships	5		
12.4	Business performance	5		
12.5	Management and governance	2.5		
	Total Score	100		

Annexure IV

Structure of capacity building module

A well-structured training module or capacity-building program typically includes several key elements to ensure clarity, engagement, and effectiveness. Here's a comprehensive design to be followed:

1. Training module/program title:

- A clear and concise title reflecting the content and purpose of the training.
- Need Analysis of the stakeholders.
- What, Why and how the training is going to address the issues of the community?

2. Objective(s) of the Program:

- **Purpose:** Clearly state the aim of the training. What should participants know or be able to do after completing the program?
- **Learning outcomes:** Define measurable outcomes that participants are expected to achieve by the end of the program.

3. Target audience:

- **Who:**
- Specify the target participants (*e.g.*, WDT members, women participants, AG/UG/SHG's/FPG's community leaders, members *etc.*).
- **Prerequisites:** Mention any background knowledge or skills required.

4. Duration of the program:

- **Total hours:** Define the length of the program (*e.g.*, one day, two to three days, one weeks, *etc.*).
- **Session breakdown:** Specify the duration of each session or module within the program (*e.g.*, 90 minutes per sessions, hours per module, 5 days total, *etc*.).
- **Session completion:** No of sessions required to complete a particular topic/idea/practice *etc*.,

5. Training methodology:

- **Delivery modes:** Describe the approach for delivery (*e.g.*, face-to-face, online, blended learning).
- **Methods used:** Outline teaching methods (*e.g.*, lectures, discussions, role-playing, case studies, and hands-on activities).
- **Engagement techniques:** Include interactive methods like group work, quizzes, simulations, *etc.*

6. Content/Modules:

The program should be divided into logical, sequential modules. Each module can have the following structure:

- **Module Title:** Name of the module or section.
- **Objectives:** What will participants learn in this module?
- **Key Topics:**
    - List the key concepts, skills, or techniques that will be covered.
- **Methodology:** How will this module be taught (*e.g.*, lecture, activity, role-play)?
- **Materials/Resources:** What materials will be needed (*e.g.*, presentations, handouts, equipment)?

- **Assessments:** How will participants be evaluated (*e.g.*, quizzes, group work, presentations)?

Example Modules:

1. **Module 1: Introduction to Leadership**
    - Objective: Understand leadership styles and traits.
    - Topics: Types of leadership, leadership vs. management, emotional intelligence.
    - Activities: Group discussion, leadership style assessment.
2. **Module 2: Communication Skills for Leaders**
    - Objective: Learn to communicate effectively with teams.
    - Topics: Active listening, assertive communication, non-verbal communication.
    - Activities: Role-playing, group feedback.
3. **Module 3: Conflict Resolution and Problem-Solving**
    - Objective: Learn strategies for resolving conflicts and making decisions.
    - Topics: Conflict management styles, negotiation skills, decision-making processes.
    - Activities: Case study, group exercises.

7. Learning Materials:

- **Handouts and Guides:** Provide relevant materials like slides, handouts, or workbooks.
- **Online Resources:** If applicable, list any websites, videos, or other resources for further learning.
- **Tools and Equipment:** Any special equipment required (*e.g.*, projectors, flipcharts, software).

8. Facilitation/Trainers:

- **Trainer Qualifications:** Briefly outline the qualifications and experience of trainers or facilitators.
- **Trainer Responsibilities:** Ensure facilitators are aware of their roles in guiding participants, encouraging participation, and addressing questions.

9. Participant Engagement and Activities:

- **Interactive Sessions:** Include activities that require active participation such as group discussions, exercises, and case studies.
- **Reflection:** Allocate time for individual reflection on the topics covered, possibly through journaling or group sharing.
- **Debriefing:** After each activity or session, facilitate a debrief to discuss insights gained and lessons learned.

10. Evaluation and Feedback:

- **Pre-Assessment:** Conduct an initial assessment to gauge participants' knowledge or skills before the program.
- **Ongoing Feedback:** Provide feedback throughout the program to ensure learning is on track.
- **Post-Assessment:** Administer a post-program evaluation to assess the effectiveness and identify areas for improvement.
- **Surveys/Feedback Forms:** Use participant feedback to improve future training.

11. Certification or Recognition:

- **Completion Certificate:** Offer a certificate or acknowledgment of completion if applicable.
- **Skills or Competency Badge:** Optionally, award skills or competency badges that reflect what participants have mastered.

12. Follow-up and Support:

- **Post-Training Resources:** Provide follow-up resources, articles, or videos for continued learning.
- **Mentorship or Coaching:** Optionally, offer mentorship or follow-up sessions to reinforce learning.
- **Community of Practice:** Set up an online forum or community where participants can interact and support each other.

13. Budget and Logistics:

- **Cost:** Define the budget for the program, covering training materials, venue (if physical), facilitator fees, and other resources.
- **Logistics:** Details of venue (if applicable), online platform (for virtual training), and any other logistical arrangements.

14. Conclusion and Closing:

- **Summary:** Recap the key learning outcomes and highlight any next steps.
- **Q&A Session:** Provide a space for any final questions.
- **Thank You:** Appreciate the participants' time and effort.

This structure can be adapted to various training needs and formats. By ensuring comprehensive content and a mix of delivery methods, participants will be better equipped to apply what they've learned.

Annexure V: Component wise monitoring indicators for data collection at regular intervals

Soil and Water Conservation

General Details (This section is common for all components)	**Occupation/ Livelihood**	**SWC Intervention**	**Benefit/ Impact**
• Name of the District • Name of the Taluk • Name of the Micro watershed • Name of WEC • Name of the beneficiary • Father /Mother/ Husband name • Name of the Village • Contact Number • Gender • Category (SF/MF/BF) • Institutional Coverage • Educational qualification • Educational qualification • Main occupation • Reach (Upper, Middle and Lower)	• Major occupation • Reach (Upper/ Middle/ Lower) • Size of landholding (ha) • Irrigation Sources • Area under irrigation (ha)	• Land treatment done before watershed program? • If yes, type of structure • Unit /quantity • Dimensions /section • Survey number with Hissa • Intervention under watershed program? • Participation in implementation of intervention? • Quality of work as per your opinion • Found any deviation in work execution compared to DPR? • If yes, what are the deviation • Have you given beneficiary contribution? • If yes how much (Rs)	• Benefits observed from the SWC intervention? • Any changes in the cropping pattern after the intervention? • Adoption of improved agronomic practices? ▪ New crops ▪ Crop rotation ▪ Any other • Changes in yield • If yes, How much per hectare • Opinions/ Suggestion about the programme

LRI and Agro Advisory Services (from SWC Beneficiary)

Land details	**Intervention**
• Size of landholding (ha) • Area under irrigation (ha) • Source of irrigation	• Have you received agro-advisory information • Are you adopted agro-advisory information • If yes, what things have you adopted • Are you using varuna mitra services? • Have you received LRI cards and training • Are you adopting LRI based information for your land treatment • Have you adopted crops as per LRI recommendation?

	• If yes, which crops were adopted and what is the area covered? • Opinions/ Suggestion for the programme

Capacity Building

Training Details	Quality of the Training	Benefit/ Impact
• Type of the training programme attended • Have you attended the training programme? • Have you received the training intimation? • If yes, how many days in advance • Place of training? • Duration of the training programme (hour) • Total number of people participated along with you in the training • Topic covered in the training • Whether any exposure / field visit conducted along with the training?	• Quality of the training as per your opinion • Is the training useful and relevant? • If no, how to improve? • Major Learnings from the training • Teaching Aids used • Resource persons names	• Quality of the training as per your opinion • Is the training useful and relevant? • If no, how to improve? • Major Learnings from the training • Teaching Aids used • Resource persons names • Are you willing to adopt learning's of training? • Problem/issue faced during the training(if any) • If yes, what kind of problem? • Whether refreshment provided during the training? If yes, furnish details • Sitting arrangements or any there training arrangement • Will you recommend same training program to others? • Any additional training will require in future • If yes, which subject would you require

Horticulture

Land Details	Intervention	Impact of intervention
• Size of the landholding (ha) • Area under irrigation (ha) • Source of irrigation	• Have you received horticulture seedling • If, yes how many seedling (species wise) • Have you given beneficiary contribution for the seedling, if yes how much per seedling • Planting type/location • Have you done mulching? • Have you done fencing? • Number of saplings planted • Amount spent for planting (Rs/ha) • Area covered by horticulture plants	• When do you expect yield? • Opinion of the programme

	• Survival number of plants • Quality of sapling • Frequency of watering in a week • Types of manure being used?	

Forestry Beneficiary

Land Details	Intervention
• Size of the landholding (ha) • Area under irrigation (ha) • Source of irrigation	• Have you planted forestry saplings? • If, yes, name of the species • Planting type (New area brought under plantation or existing area rejuvenated) • Number of saplings received • Number of saplings planted • Amount spent for planting (Rs/ha) • Area covered by forestry plants • Survival (No.) • Quality of sapling • How many times watering is done in a week? • What is your opinion of the programme?

Annexure VI: Indicators for monitoring watershed outcomes

a. List of indicators for monitoring watershed outcomes

Sl. No	Category of Indicator	Indicator
1.	**Biophysical**	Extent of area (Ha) under Flood irrigation
2.		Extent of area (Ha) under mono/ single crop (Diversity)
3.		Extent of area (Ha) under High water intensive crops
4.		Extent of area (Ha) under Medium water intensive crops
5.		Extent of area (Ha) under Low water intensive crops
6.		Extent of area (Ha) under Cash Crops
7.		Extent of area (Ha) under Food Crops
8.		Extent of area (Ha) under Kharif crop
9.		Extent of area (Ha) under Rabi crop
10.		Extent of area (Ha) under mixed/ multiple cropping (Diversity)
11.		Extent of area (Ha) under Fodder crops
12.		Extent of area (Ha) under Horticulture crops
13.		Fallow land (Ha) brought into cultivation
14.		No. of Bore wells existed in watershed area
15.		Ground Water Level in open wells
16.		Ground Water Level in bore wells
17.		Annually no. of months surface water available in water bodies
18.		Annually no. of months water available in Open wells
19.		Annually no. of months water available in Bore wells
20.		Extent of irrigated area (Ha) under open wells
21.		Extent of irrigated area (Ha) under bore wells
22.		Extent of irrigated area (Ha) under Canal
23.		Extent of irrigated area(Ha) under Springs
24.		Extent of irrigated area (Ha) under Other sources
25.		Extent of area (Ha) under Drip irrigation
26.		Extent of area (Ha) under Sprinklers irrigation
27.		No. of farmers having drip irrigation

Sl. No	Category of Indicator	Indicator
28.		No. of farmers having sprinkler irrigation
29.		Large ruminant population
30.		Milk production in litres / day
31.		No. of families involved in dairy activity
32.		Extent (Ha) of current fallow land
33.		Extent (Ha) of permanent fallow land
34.		% of area levelled (Land Levelling Index)
35.		Soil Erosion Risk Score (based on slope, cover, rainfall)
36.		% of area identified as critical (Critical Area Severity Index)
37.		Deep Percolation Volume (mm/year)
38.		pH level of surface and groundwater
39.		Runoff Conservation Index (volume conserved vs. baseline)
40.		Storage Capacity Utilization (%)
41.		NDVI / % Tree/Canopy Cover
42.		Species Count + Soil Organic Carbon (%)
43.	**Ecological**	Extent (Ha) area under Organic/ Natural Farming to the total cropped area
44.		No. of farmers adapted at least one NF/ OF practice
45.		No. of farmers adapted more than one NF/ OF practices
46.		Rare/ endemic/ endangered species of Flora and Fauna
47.		Slope - Extent of area (Ha) which is gently sloping low land
48.		Slope - Extent of area (Ha) which is moderately sloping low land
49.		Slope - Extent of area (Ha) which is moderately sloping medium land
50.		Slope - Extent of area (Ha) which is rolling medium land
51.		Slope - Extent of area (Ha) which is rolling upland
52.	**Ecological**	Slope - Extent of area (Ha) which is highly slopping upland/hill
53.		Average Soil Salinity - pH %
54.		Average Soil Alkalinity - EC %
55.		Average Soil fertility - OC %
56.		Average Soil fertility - N %
57.		Average Soil fertility - P %
58.		Average Soil fertility - K %
59.		Average Soil fertility - S %
60.		Average Soil fertility - Fe %
61.		Average Soil fertility - Mn %
62.		Average Soil fertility - Zn %
63.		Average Soil fertility - Cu %
64.		Average Soil fertility - B %
65.		Water holding capacity (No. of days)
66.		Soil Erosion – Extent of area (Ha) affected under water erosion
67.		Soil Erosion – Extent of area (Ha) affected under wind erosion
68.		Soil Erosion – Extent of area (Ha) affected under sheet erosion
69.		Soil Erosion Extent of area (Ha) affected under rill erosion
70.		Soil Erosion – Extent of area (Ha) affected under gully erosion
71.		Soil texture - Extent of area (Ha) with Sand
72.		Soil texture - Extent of area (Ha) with Silt
73.		Soil texture – Extent of area (Ha) with Clay
74.		Soil texture - Extent of area (Ha) with Clayey soils
75.		Soil texture - Extent of area (Ha) with Silty soils
76.		Soil texture - Extent of area (Ha) with Sandy loamy
77.		% increases in wild animals/birds
78.	**Economical**	Average no.of wage days in agriculture in a year for a family
79.		Volume/ Value of fertilizer purchases with local dealers
80.		Volume/ Value of fertilizer purchases with FPOs
81.		Volume/ Value of fertilizer purchases from other sources
82.		% of farmers procuring inputs from FPOs
83.		Expenditure in Rs on chemical fertilizers/ acre
84.		Expenditure in Rs on chemical pesticides/ acre
85.		No of HHs with backyard nursery

Sl. No	Category of Indicator	Indicator
86.		No. of famers developing own seeds
87.		No. of HH with agriculture being primary source of income
88.		No. of HH with dairy being primary source of income
89.		No. of HH with small ruminant rearing being primary source of income
90.		No. of HH with labour work being primary source of income
91.		No. of HH with Job being primary source of income
92.		No. of HH with Business being primary source of income
93.		No. of Landless families
94.		No. of HHs getting 25 % of household income from agriculture
95.		No. of HHs getting 50 % of household income from agriculture
96.		No. of HHs getting 75 % of household income from agriculture
97.		No. of HHs getting 100 % of household income from agriculture
98.		No. of months fodder available in a year
99.		Months of Fodder Availability / Livestock Value Index
100.		Crop Yield Change %
101.		Crop Productivity Index (area-weighted)
102.		Crop Diversification Ratio (no. of crops / area)
103.	**Economical**	Soil Fertility Score / Fertilizer Use Efficiency
104.		Poverty Incidence (%) / HH Income Change
105.		% of HH with Regular Employment
106.		Human Development Index (composite education, health, income)
107.		Benefit-Cost Ratio from interventions
108.		% Households reporting seasonal migration
109.		Groundwater level change (Water table depth (m), Pre- and Post-monsoon measurement (June & January))
110.		Functional water harvesting structures (Number and type of structures (check dams, farm ponds, percolation tanks))
111.		Duration of well water availability (Days/months wells provide water for irrigation/domestic use)
112.		Crop yield improvement (Yield per ha (kg/ha) by crop, compared to baseline)
113.		Cropping intensity (% increase in cropping intensity (Net sown area vs. Gross cropped area))
114.		Crop diversification (Number of different crops grown per season/year)
115.		Fodder availability (Quantity of fodder available/collected (kg/household/month))
116.		Reduction in sediment load (Sediment yield (ton/ha/year), silt accumulation in structures)
117.		Increase in vegetative cover (% Vegetation cover (from NDVI or field transects))
118.		Area under SWC measures (Treated area with bunds, trenches, gully plugs, *etc*. (ha))
119.		Increase in biomass (Biomass density (ton/ha) via plot sampling or remote sensing)
120.		Carbon stock in plantations (Estimated carbon sequestration (tC/ha/year) using standard coefficients)
121.		Area under tree/vegetation cover (Area in ha from satellite imagery (change over time))
122.		Base flow improvement (Days with stream flow in lean season)
123.		Recharge structure count (Number, type and functionality of recharge structures)
124.		Soil moisture retention (Soil moisture % using gravimetric or sensor method (at 0–15 cm depth))
125.		Improvement in soil organic carbon content (%)

Sl. No	Category of Indicator	Indicator
126.		Organic carbon improvement (Soil organic carbon % (top 15 cm), pre- and post-intervention)
127.		Composting/manure use (No. of households using compost/vermicompost; amount produced)
128.		Biological activity (Earthworm count per m² (local participatory method))
129.		Native species plantation (Number and % of native species planted)
130.		Area under natural/native vegetation (Area in ha (remote sensing/GIS-based or ground survey))
131.		Species richness (No. of bird, insect, plant species observed (community biodiversity register))
132.		Community perception of landscape improvement (PRA tools, community scoring, ranking on visual/aesthetic changes)
133.		Eco-tourism or cultural site development (Number of functional sites developed/utilized)
134.	**Economical**	Social/cultural use of water bodies (Number of events/rituals conducted; seasonal usage frequency)
135.		Awareness programmes (No. of trainings, awareness sessions, participants (disaggregated by gender))
136.		Educational involvement (No. of school/college activities conducted on environment or conservation)
137.		Traditional ecological knowledge documentation (No. of TEK practices documented or preserved)
138.	**Institutional**	No. of HHs accessing institutional loans (SHGs and its federations, Banks, *etc.*)
139.		No. of HHs having SHG Membership
140.		No. of HHs having UG Membership
141.		No. of HHs having FPO Membership
142.		No of livestock farmers in the watershed committee
143.		Whether women is chairman of WDC?
144.		Nos of women members in Watershed committee
145.		% of women participation in watershed committee meetings
146.		People's Participation Index (attendance, contribution rate)
147.		CBO Functionality Score (meetings, decisions, records)
148.		% of interventions reaching women, SC/ST, landless
149.	**Social**	No. of school dropouts (boys)/ year
150.		No. of school dropouts (girls)/ year
151.		Girl's enrolment in schools
152.		Men wage rate grounding watershed works
153.		Women wage rate in grounding watershed works
154.		No. of HHs with pucca houses
155.		No. of families with electricity
156.		No. of families with drinking tap connection
157.		No. of HHs with toilet with water connection
158.		No. of Hours/ month spent on fetching water by a family
159.		No. of months spent in migration in a year (Average)
160.		No. of Households having access to nutritional food through Anganwadi centres
161.		No. of Households having access to nutritional food through Mid-day meal
162.		Any member of the family suffering with Anaemia
163.		Time spent/ day to fetch drinking water
164.		Time to nearest market (in minutes)
165.		% Households with solar panels / mobile phones
166.		% HH with access to safe drinking water, toilets, electricity
167.		Average Household Size / Labour Availability Index
168.		% Literate Adults / School Enrollment Rate
172		% of HH in community groups (self-help, producer groups, *etc.*)
173	**Sustainability**	No. of HHs benefitted with at least one intervention under the project
174		No. of HHs benefitted with more than one intervention under the project

Sl. No	Category of Indicator	Indicator
175		No. of HHs not at all benefitted under the project
176		% of works executed by User Group members to the total works grounded

b. List of the important indices are listed below;

Sl.	Topic	Indices
1	Terrain Management Indices	Land Levelling Index (LLI)
		Critical Area Index (CAI)
		Gully Stabilization Index (GSI)
2	Water Resources Utilization Indices	Water storage capacity utilization index
		Irrigability index
		Conserved water productivity index
3	Agronomic Vitality Indices	Cultivated land utilization index
		Crop productivity index
		Crop diversification index
		Crop fertilization index
		Soil nutrient index
		Normalized difference vegetation index
4	Livestock Vitality Indices	Livestock composition index
		Livestock production value index
		Carrying capacity index
5	Employability Indices	Women productive time utilization ratio
		Regular employment generation index
		Seasonal outmigration ratio
6	Human Empowerment Indices	Poverty index
		Social equity index
		Enterprise cost effectiveness index
		Human Development Index
7	Sustainability Indicators	Runoff conservation index
		Soil erosion risk index
		Drought resilience ratio
		Induced watershed eco-index
		Participatory Watershed Development Index
		Benefit cost ratio

Annexure VII: Detailed Questionnaire for Household Level Survey

Enumerator Details	
Enumerator Name	
Enumerator Contact Details	
Date and Time of the Survey	

Geographical Information	
Name of the Watershed	
Name of the Watershed Code	
Name of the Tola	
Name of the *Gram Panchayat*	

Name of the Mandal	
Name of the District	
Name of the State	

General Information of the Household Head	
Name of the HH Head	
Age	
Gender	Man/ Woman
Contact Number	
Social Category	(SC/ ST/ BC/ OC/ Min)
Occupation	

Adult Family Members Information	
Name of the Family Member 1	
Gender	Man/ Woman
Relationship with HH Head	
Age	
Education	
Occupation	
Monthly Average Income (Rs)	
Membership in CBOs	SHGs/ UGs/ WEC/ RMGs/ FPOs/ *Gram Panchayat*/ Any other
Repeat the above section for all adult members in the family	

Children Information (Below <=18)	
Name of the member	
Age	
Gender	Boy/ Girl
Education	
School Name	
School Ownership	Private/ Government
Annual School fee	Rs. _____
Repeat the above section for all children in the family	

Agriculture						
Total extent of land holding (Acres)						
Cultivated Area and Crops Grown	Open Irrigation		Drip/ Sprinklers		Rainfed	
	Area (Acres)	Crops	Area (Acres)	Crops	Area (Acres)	Crops
Kharif (current year)						
Kharif (previous year)						
Rabi (current year)						
Rabi (previous year)						
Summer (current year)						
Summer (previous year)						
Cost and Yield	Open Irrigation		Drip/ Sprinklers		Rainfed	
	Yield (Qntl/ Acre)	Cost (Rs)/ Ha	Yield (Qntl/ Acre)	Cost (Rs)/ Ha	Yield (Qntl/ Acre)	Cost (Rs)/ Ha
Crop 1						
Crop 2						
Crop 3						
Crop 4						

Marketing and Income	Quality Sold (Qnlt)	Rate (Rs/ Qntl)
Crop 1		
Crop 2		
Crop 3		
Crop 4		

Agriculture Practices Adopted	Yes/ No
Land Treatment	
Crop Rotation	
Integrated Farming System	
Agro Forestry	
Natural Farming	
Organic Farming	
Soil Test	
Any other	

Animal Husbandry	
Dairy	Details
Cows Population	
Buffalo Population	
Expenditure on Livestock (Rs/ Month)	
Milk Yield (Liters/ Day)	
Milk Sold (Liters/ Day)	
Milk Cost (Rs/ Liter)	
Small Ruminants and Others	
Goat Population	
Sheep Population	
Piggery Population	
Expenditure on Small Ruminants (Rs/ Month)	
Annual Income from Small Ruminants (Rs/ Year)	
Poultry	
Poultry Population	
Expenditure on poultry (Rs/ Month)	
Gross Income from poultry (Rs/ Month)	
Net Income from poultry (Rs/ Month)	

Source wise % of annual household income	
Total Annual Household Income (Rs)	
Source of Income	% of Income to the total HH annual income
Agriculture	
Business	
Dairy	
Small Ruminants	
Poultry	
Job	
Business	
Others	
Total % must be equal to 100	

Asset Profile of the Household	
Assets	Yes/ No
Television	
Fridge	

Cooler	
Bike/ Car	
Tractor	
Tractor mounted implements	
Any Other (Specify)	

Benefits availed from watershed			
Intervention Details	Quantity (Units/ Nos/ RMTs)	Project Investment	Immediate Benefit Perceived
Soil Moisture Conservation Work			
Water Harvesting Structure			
Plantation (Border/ Bund/ Block)			
Soil Sample Test			
Soil Health Card			
Crop Advisory			
Weather Advisory			
Contribution Made by the Household	Cash/ Material/ Labor	Value (Rs)	