

IDH RPLC Midline Assessment - Chhindwara Compact

Final Report

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Executive summary

The midline assessment of the Regenerative Production Landscape Collaborative (RPLC) within the Chhindwara Compact reveals significant progress toward its objectives of regenerating agricultural landscapes through soil health improvement, biodiversity enhancement, greenhouse gas (GHG) emission reduction, and livelihood resilience, while highlighting key areas that require further attention.

RPLC targets transforming 100,000 hectares by 2026 across ten districts of Madhya Pradesh, with Chhindwara and Pandhurna as initial focus areas. The program employs a jurisdictional Production, Protection, and Inclusion (PPI) approach engaging multi-stakeholder partnerships. The midline evaluation compares 2025 data with 2021–22 baseline findings, utilizing a mixed-methods design including surveys of 1,220 households across 61 villages (48 treatment, 13 comparison), 163 soil samples, FAO's EX-ACT greenhouse gas modelling, NDVI satellite analysis, and 22 qualitative engagements with key stakeholders to comprehensively assess ecological, economic, gender, and institutional dimensions.

Key findings include strong adoption of regenerative agriculture (RA) practices in treatment villages. Compost and farmyard manure (FYM) use increased to approximately 82% from baseline levels of about 60%, with more farms preparing pit-based compost and integrating livestock manure. Intercropping expanded significantly in kharif season—36.8% treatment households vs. 16.8% in comparison, and agroforestry or on-farm tree cover rose to about 30% of treatment households compared to 12% of comparison groups, with demonstration farmers leading adoption at 43%. Advanced soil management and biodiversity features also show gradual uptake. Water use efficiency improved as irrigation access nearly doubled for treatment households, moving from 42% to 82%, and micro-irrigation adoption increased from 19% to 34%, especially on demonstration plots where drip irrigation delivered higher yield per water unit compared to flood irrigation.

Despite these gains, soils remain fragile. Nearly 48% of sampled farms have low soil organic carbon (SOC) below 0.5%, and 34% fall in medium SOC range (0.5-0.75%). Nutrient imbalances persist; nitrogen is universally low, phosphorus and potassium highly variable with 18% of soils mildly alkaline, impairing phosphorus uptake. Fertilizer use remains widespread (72%), but organic input use rose significantly in treated areas (61% vs. 39% in comparison). Groundwater dependence escalated as irrigation frequency increased with rabi irrigation events rising by 81% (3.2 to 5.8 per season in treatment). NDVI analysis confirms increased cropping intensity (163% in treatment vs. 147% in control) and greater biomass retention, indicating positive landscape-level effects.

Farm productivity and livelihoods show encouraging trends. Treatment farmers cultivate on average 5.4 crop species (3.2 in comparison), with diversity supported by a Shannon Diversity Index of 0.94 (treatment) vs. 0.64 (comparison) during kharif in Sausar block. Average household income in treatment areas rose to INR 168,035 from INR 146,570 in comparison villages, about 13% higher. Households report diversified income sources and better income-to-debt ratios. Farmers reflected enhanced cost calculation skills and reduced spending on chemical fertilizers attributable to bio-input training and practice adoption, improving financial resilience.

GHG emissions modelled via FAO's EX-ACT tool estimate a total of 1,977 tonnes CO_2-equivalents per year from fertilizer use, dominated by urea emissions (approximately 1,365 tonnes). Emission intensity per hectare significantly declined from baseline levels: cotton emissions fell from 3.6 to 0.45 tCO_2-e/ha, maize from 3.9 to 0.56, wheat and groundnut from approx. 3.8 to 0.56 and 0.33 respectively, reflecting improved nutrient management. These results exclude emissions from irrigation energy, machinery, and pesticides, and hence represent partial estimates, though trends align with program goals.

The gender-focused component reveals meaningful gains in women's empowerment in treatment villages. About 75% of women belong to Self-Help Groups or Farmer Producer Organizations (versus 48% in comparison), and training participation increased with only 40% of women in treatment villages reporting never attending compared to 75% in control areas. Women's confidence and mobility improved with 71% reporting speaking in public meetings (versus 46%) and 27% visiting markets, up from 10%. Decision-making power remains partial, especially in financial and cropping choices, yet

women reported increased roles in input preparation, group leadership, and market engagement, indicating rising agency.

Institutionally, the Training-plus-Demonstration approach effectively catalyzes complex practice adoption and fosters community resource persons. Spillovers to training-only farmers exist but are weaker. Gram Panchayat Development Plans in treatment villages show progressive agenda expansion beyond basic infrastructure toward irrigation, agriculture schemes, and climate resilience, reflecting improving governance integration. Convergence with government schemes such as PM-KSY, SMAM, and NMSA supports program scaling and institutional anchoring.

In conclusion, the midline assessment affirms RPLC's strong relevance and effectiveness in advancing regenerative practices and livelihoods in Chhindwara's agricultural landscape. However, persistent soil degradation, high fertiliser and groundwater reliance, and gendered constraints in mechanisation and decision-making pose risks that require integrated strategies focusing on soil carbon restoration, water governance, nutrient balance, and women-centred inclusive interventions. These insights will guide program refinement to sustain and deepen impact at scale.

Key Recommendations

High-Hanging Fruit (Complex, Longer-Term Efforts)	Low-Hanging Fruit (Feasible, Near-Term Actions)
• Prioritize improving soil organic carbon beyond current low levels by advancing composting, cover cropping, and organic matter management practices tailored to fragile soils. • Develop and implement comprehensive water governance frameworks to address accelerating groundwater depletion linked to expanded irrigation, including conjunctive use and recharge interventions. • Integrate nutrient substitution strategies to reduce chemical fertiliser dependence, balancing inorganic inputs with biofertilisers and tailored fertiliser management plans. • Strengthen gender-transformative interventions focusing on enhancing women's decision-making authority, mechanisation access, and leadership opportunities within farming communities and institutions. • Expand monitoring, reporting, and verification (MRV) systems to include irrigation energy, machinery, and pesticide emissions for holistic GHG accounting and adaptive management.	• Scale up Training-plus-Demonstration models to accelerate adoption of intermediate and complex regenerative practices beyond early adopters. • Enhance farmer awareness and capacity-building programs to sustain and deepen gains in composting, intercropping, agroforestry, and bio-input preparation. • Facilitate institutional convergence by strengthening linkages between community groups, Gram Panchayat Development Plans, and key public schemes such as PM-KSY, SMAM, and NMSA. • Promote market access programs targeting women farmers to build on improved participation and visibility in input procurement and output marketing. • Encourage diffusion of micro-irrigation technologies to wider farmer segments beyond demo plots, supported by better access to affordable equipment and technical assistance.

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List of Acronyms and Abbreviations

CFT	Cool Farm Tool
CLF	Cluster-Level Federation
CO_2e	Carbon Dioxide Equivalent
DAC	Development Assistance Committee (OECD DAC criteria)
DAP	Diammonium Phosphate
DAP	Di-Ammonium Phosphate (fertiliser)
EC	Electrical Conductivity
EX-ACT	Ex-Ante Carbon Balance Tool (FAO)
FAO	Food and Agriculture Organisation
FFS	Farmer Field School
FGD	Focus Group Discussion
FPO	Farmer Producer Organisation
FYM	Farm Yard Manure
GESI	Gender Equality and Social Inclusion
GHG	Greenhouse Gas
GIS	Geographic Information System
GPDP	Gram Panchayat Development Plan
HH	Household
ICAR	Indian Council of Agricultural Research
IDH	The Sustainable Trade Initiative (IDH)
IDI	In-Depth Interview
INR	Indian Rupee
IRRI	International Rice Research Institute
KII	Key Informant Interview
KVK	Krishi Vigyan Kendra
LULC	Land Use / Land Cover
LULC	Land Use and Land Cover
MOSER	Moser Framework (Gender analysis tool)
MP	Madhya Pradesh
MPIDC	Madhya Pradesh Industrial Development Corporation
MRV	Monitoring, Reporting, and Verification
NDVI	Normalized Difference Vegetation Index
NMSA	National Mission on Sustainable Agriculture
NTFP	Non-Timber Forest Products
OC	Organic Carbon
OECD	Organisation for Economic Co-operation and Development
OECD DAC	OECD Development Assistance Committee
PM-KISAN	Pradhan Mantri Kisan Samman Nidhi
PM-KSY	Pradhan Mantri Krishi Sinchayee Yojana
PPI	Progress out of Poverty Index

RA	Regenerative Agriculture
RPLC	Regenerative Production Landscape Collaborative
RPLC	Resilient and Productive Landscapes in Chhindwara
SHG	Self-Help Group
SMAM	Sub-Mission on Agricultural Mechanisation
SOC	Soil Organic Carbon
SSP	Single Super Phosphate
ToC	Theory of Change
WADI	Orchard-based “Wadi” model (agroforestry/tribal horticulture)
WEAI	Women’s Empowerment in Agriculture Index
WHC	Water Holding Capacity
WUE	Water Use Efficiency

1.Introduction

Chhindwara and Pandhurna, located in Madhya Pradesh, continue to exhibit significant agricultural activity while facing persistent ecological and socio-economic challenges. As of August 2025, Chhindwara district alone accounts for 27,533 hectares under cultivation, with cereals occupying 17,193 hectares and yielding over 213,000 metric tons annually. The district also cultivates pulses (611 hectares, around 10,625 metric tons), oilseeds (603 hectares, approximately 14,092 metric tons), and horticultural crops (261 hectares, 4048 metric tons)[1] highlighting ongoing diversification in crop patterns. Cotton is also a significant crop in the Compact[2], especially in Sausar and Pandhurna.

At the state level, Madhya Pradesh remains one of the leading cotton producers. MPIDC notes that the state accounts for **43% of India's and 24% of the world's organic cotton production**, with total cotton production of **~31,700 metric tons**[3]. This prominence in cotton also shapes seasonal labour demand and input costs. However, ecological challenges remain. Between 2001 and 2024, the district lost approximately 129 hectares of tree cover (a 0.27% decline), resulting in around 66.3 kilotons of CO_2 equivalent emissions, data emphasizing the urgency for regenerative land management.[4] Renewed efforts in water resource management, such as constructing check dams, ponds, and recharge zones, support irrigation and groundwater replenishment, especially vital in a state where over 75% of net sown area relies on wells and tube wells.[5]

Given the changing scenario in the region, Regenerative Production Landscape Collaborative (RPLC) was launched to transform agricultural landscapes in Madhya Pradesh using a jurisdictional approach grounded in Production, Protection, and Inclusion (PPI). With the dual goals of regenerating soil health, boosting biodiversity, reducing greenhouse gas emissions, and improving farmer livelihoods, RPLC emphasizes multi-stakeholder partnerships that span government, private sector, and community actors. The baseline study, conducted in 2021–22, provided the starting benchmarks for the program. The baseline established key ecological and agronomic benchmarks essential for tracking long-term landscape outcomes. Soil organic carbon (SOC) levels were low, averaging 0.70% across sampled plots. Baseline agricultural greenhouse gas emissions from major cropping systems were in the range approximately *0.5- 22 tCO_2e per year* depending on location and season, largely driven by fertilizer application and residue practices. Cropping intensity at the time was moderate at around 139%, reflecting limited diversification and seasonal underutilization of land. These metrics now anchor the program's monitoring framework. Covering 51 villages across Mohkhed and Sausar blocks in Chhindwara district, it combined household surveys with over 1,000 farmers, stratified soil sampling, and high-resolution satellite imagery to assess ecological and socio-economic conditions. Findings revealed degraded soils with low soil organic carbon, heavy dependence on chemical inputs, and yield gaps across major crops. Socially, the study highlighted gender inequities, with women's roles in agriculture underrecognized despite their central contribution to farm labour and household food systems. Since then, the program has expanded considerably. By 2026, RPLC aims to transform 100,000 hectares of cropland across Chhindwara, Pandhurna, and eight additional districts in western Madhya Pradesh. It has broadened its scope to include watershed restoration and gender-responsive strategies, reflecting the dual priorities of ecological resilience and social inclusion.

1.1 Purpose and Scope of the Midline Assessment

The mid-term assessment served as a checkpoint to measure progress against the 2021–22 baseline and guide RPLC's expansion trajectory. While the baseline established key ecological, economic, and social benchmarks, the midline seeks to evaluate change, recognize successes, and identify areas requiring further attention. However, with the program expansion to ten districts and new thematic focuses, such as watershed and gender-responsive interventions, the evaluation assessed both efforts

[1] Source- www.wdcpmksy.dolr.gov.in/distblscrpwiseareaoutdtlrpt?stcode=23

[2] A Compact under the RPLC program refers to a jurisdictional landscape unit comprising of various blocks across districts in Madhya Pradesh, where partners jointly promote regenerative and sustainable farming practices.

[3] Source- https://invest.mp.gov.in/textile-and-garments/

[4] Source- https://www.globalforestwatch.org/dashboards/country/IND/19/12/?map=eyJjYW5Cb3VuZCI6dHJ1ZX0%3D

[5] Source- www.wdcpmksy.dolr.gov.in/distblscrpwiseareaoutdtlrpt?stcode=23

adopted at the onset of RPLC (such as soil regeneration and livelihood improvements) and newly introduced components pursued in the program's scaling phase.

The midline assessment was guided by three mutually reinforcing objectives:

Assess Progress Since the Baseline	Identify Persistent Gaps and Constraints	Inform Scale-Up and Strategic Adaptations
• Comparing indicators, such as soil organic carbon, water use efficiency, biodiversity, yields, and incomes, against 2021–22 metrics to quantify the uptake and impact of regenerative practices	• Investigating lingering ecological issues (e.g., soil degradation, water stress), barriers to adoption, and sociocultural challenges, particularly in women's participation and equitable access to resources.	• Leveraging evidence to refine the program's Theory of Change, strengthen watershed and gender strategies, and align RPLC's expansion with government policies and private sec-tor opportunities, ensuring that future growth is both ecologically sound and socially in-clusive.

1.2 Evaluation Framework

The framework encompasses summative and formative assessment guided by a theory-based approach to ascertain RPLC's progress against the key performance indicators for specific impact domains. The midline evaluation adopts a realist lens to understand underlying causal mechanisms and explore what works, for whom, and under what conditions and comparing the situation in different areas, gender, and social groups.

Evaluation Design Considerations

Dual Assessment Strategy

- *Summative*: Cross-sectional design to measure program outcomes since baseline, using quantitative insights
- *Formative*: Analyze program implementation, role of stakeholder and their engagement, assessment of perceived benefits, best practices and challenges.
- *Synthesis of Summative and Formative insights* to answer the evaluation questions and contextualize the findings

Enquiry Approaches

- *Theory based approach: Assess outcomes along the ToC causal pathways and validate/align the evidence against program strategies at the midline*
- *Outcome harvesting: Enquiry into key impact domain with key stakeholders to capture both anticipated and unanticipated impacts (direct and indirect) and explore potential of integrating newer focus areas of gender and watershed management*

Guiding Analytical Framework: OECD DAC Criteria (relevance, effectiveness, efficiency, impact, sustainability, coherence).

Component-Specific Assessment Framework

- *Ecological: GIS/remote sensing, FAO CropWat for water use efficiency, soil health testing.*
- *Gender: Moser Framework (practical/strategic needs) or optional GESI Framework (Gender Equality & Social Inclusion).*
- *International benchmarking standards, document best practices within the ecosystem*

The assessment was also designed to assess the validity of the key assumptions and causal pathways under ToC of RPLC (*detailed ToC in Annex)*. It examined the assumption that smallholder farmers, when provided with appropriate training, technical support, institutional linkages, and enabling market and policy environments, would adopt regenerative and climate-smart agricultural practices that improve productivity while protecting natural resources. The mid-term assessment attempted to test these pathways by tracking indicators across farm, household, and landscape levels, such as crop performance, farm incomes, cost of cultivation, livelihood resilience, organic carbon soil efficiency, water use efficiency, land-use change, agro-biodiversity, and gender inclusion. These indicators, established during the baseline and refined in light of post-baseline interventions, were used to assess progress, verify the underlying change logic, and identify gaps or enablers that could inform adaptive programming and scaling.



2. Methodology

Our methodology followed a staged, mixed-methods design. We began with a desk review of program documents and literature to refine evaluation objectives and indicators. We then collected primary and secondary data: household surveys, IDIs, KIIs and FGDs for socio-economic components; soil-sample testing and water-use assessments for overlapping ecological–livelihood components; and GIS mapping (including NDVI) with government datasets for the ecological layer. The inquiry focused on watershed development; soil health and water use; incomes and livelihood enhancement; women's empowerment in agriculture; market linkages; and the adoption, intensity, and quality of regenerative agriculture practices across seasons and farmer segments. Finally, we triangulated quantitative, qualitative, and geospatial evidence to test causal pathways and report on the agreed indicators.

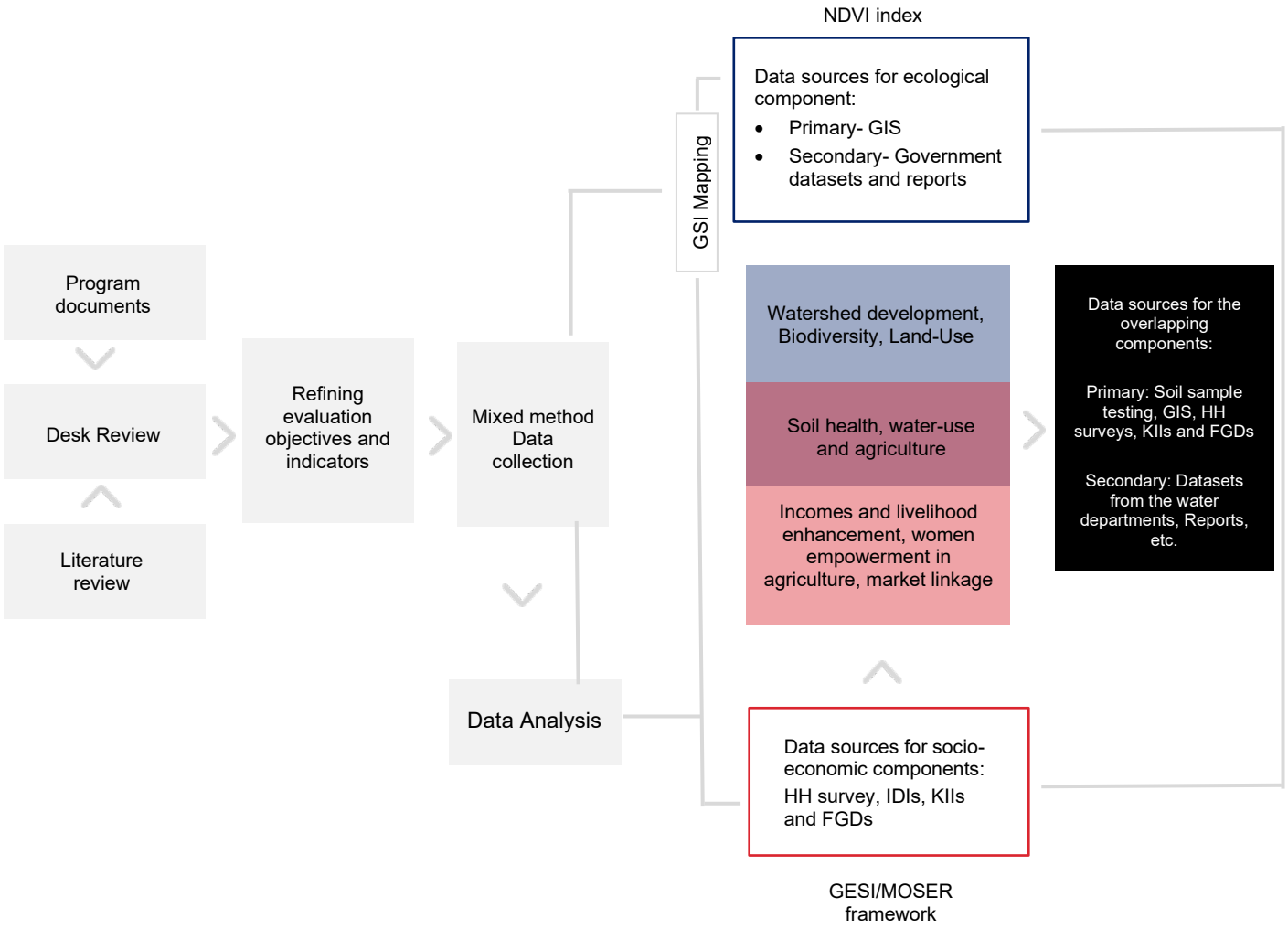


Figure 1: Methodological Components

3. Sampling Strategy

The sampling strategy for midline assessment ensures statistical strength, program comparability, and relevance to both the socio-economic and ecological evaluation components.

a. Sampling Objectives and Approach

The primary objective of the assessment is to enable comparative analysis between treatment and comparison areas and to capture variations by intervention intensity, gender, and irrigation levels. The design retains key baseline stratifications and includes adjustments to reflect program expansion and ecological requirements.

A **two-stage sampling approach** was adopted:

1. **Stage 1 – Village Selection**: Villages were stratified into treatment and comparison groups and selected from the lists provided by implementation partners. Treatment villages were further divided into **Training-only (T1)** and **Training + Demonstration (T2)** categories. Control villages were identified through matching socio-economic indicators from Census 2011 datasets in the respective blocks to ensure comparability.
2. **Stage 2 – Household Selection**: Within each selected village, households were chosen through random sampling. Efforts were made to ensure balanced representation across gender, farm sizes, and intervention categories. An intentional emphasis was placed on **including at least 50% women farmers** to support gender-differentiated analysis.

b. Household Sampling Strategy

A total of 20 households from each village were selected, yielding a sample size of 1,220 households[6]. Treatment villages contribute 10 households each from T1 and T2 groups, with a target of 50% male and 50% female farmers within each category. Comparison villages follow a similar structure.

The final sample includes a total of 61 villages, comprising 48 treatment villages and 13 comparison villages. These were distributed proportionately across the four blocks, with comparison villages selected based on agro-ecological matching criteria such as soil type, irrigation access, and socio-economic characteristics. Table 1 summarizes the block-wise allocation.

Table 1: Sample Distribution

SN	Block	Treatment Villages	Comparison Villages	Total Villages	Total HH (20 HH/Village)
1	Chhindwara	12	3	15	300
2	Mohkhed	12	3	15	300
3	Sausar	12	3	15	300
4	Pandhurna	12	4	16	320
	Total	48	13	61	1220*

[6] * Calculation

- Baseline Reference: 1020 households (51 villages x 20 households).
- 20% buffer: Added to account for variability: 1020 + (0.2 x1020) =1224
- Power calculation: Assumed 80% power, 5% significance level, and moderate effect size (0.25 SD). A sample of 1200 households is sufficient for detecting differences across treatment/control and gender. *The number 1224 was rounded-off to 1220 to align with the calculated numbers for distribution across all blocks*

c. Sampling for Qualitative Components

The qualitative sampling framework was aligned with the household survey sample to deep dive into emerging trends and enable synthesis of findings. A total of **22 qualitative interactions** (across FGDs, IDIs, and KIIs) were conducted with farmers, women collectives, village institutions, input suppliers, and KVKs. These are split across **program** and **non-program** geographies to facilitate comparison.

Integration with Ecological and GHG Components

The sampling approach supports a coherent integration of ecological parameters and GHG assessments across the Compact. A total of **163 soil samples** (109 treatment and 54 comparison) were collected across **61 villages** and proportionally distributed across all **four blocks**. These samples provide updated soil organic carbon (SOC) values and soil health indicators and complement the household survey and remote-sensing datasets.

For the GHG assessment, the **midline analysis uses FAO's Ex-Ante Carbon-balance Tool (Ex-ACT)**. Although the household survey was initially structured to capture variables typically required for the Cool Farm Tool (CFT), **CFT could not be operationalised at midline** due to data limitations and methodological constraints detailed in **Section 9.4**. In contrast, **Ex-ACT's data requirements align with the information consistently available across both baseline and midline**, including fertiliser-use categories, irrigation practices, cropping systems (kharif and rabi), land-use classes, and SOC values.

Baseline GHG estimates are available block-wise for Sausar and Mokhed (across both kharif and rabi seasons), as shown in the baseline GHG graphs (). While these estimates were **not aggregated into a single Compact-level baseline number**, they were derived using **activity data categories compatible with Ex-ACT**. Because **Ex-ACT comparisons rely on consistency of activity data, not identical spatial aggregation, baseline block-level values remain fully comparable to the midline Ex-ACT estimates**. The absence of an aggregated Compact-level baseline estimate therefore does not affect methodological comparability.

In addition to the GHG modelling, **soil sample results**, **Sentinel-2 NDVI data**, and **remote-sensing–derived land-use indicators** are integrated to assess vegetation condition, land-use changes, and ecological performance across blocks and seasons. **Water Use Efficiency (WUE)** indicators are derived from household-level irrigation and crop-water data gathered across the full sample. The combined use of survey, soil, and satellite datasets enables triangulation of findings, improves accuracy of ecological indicators, and strengthens cross-block comparability.



4. Key Evaluation Questions

The next section details the findings from the midline structured against the following impact domain and indicators.

Impact Domain	Research Questions	Assessment Areas/Indicators
Ecological	• What has been the change in the ecological parameters relevant to the RPCL? • What specific practices have had the most impact on enhancing biodiversity indicators?	• Changes in soil health • Adoption of regen-ag tech and practices • Changes in agriculture inputs and outputs- productivity of crops, cost of cultivation, • Change in the Agro-biodiversity • WUE across major crops, change in cropping patterns, crop diversity • Change in biodiversity indicators- land-use, vegetation, water resources, presence of natural pest control • GHG reduction from agri activities
Economic	• If and how did transitioning to bio-inputs affect yields, income, and input costs? • How have regenerative practices influenced crop diversification and market access? • What impact have gender dynamics had on the adoption of regenerative practices? • What are potential areas for gender-specific interventions?	• Yield per crop • Income (gross and net) • Input cost reductions (seed cost, fertilisers, pesticides, change in mechanisation for labour cost, etc.) • Diversity of crops produced • Access to new markets and price stability • Income from alternative activities (e.g., bio-input centres) • Gender-disaggregated roles and labour inputs • Barriers and opportunities for women's participation • Women's participation in decision-making and income control
Program Implementation	• What are the main challenges and successes in implementing program interventions? • What effectiveness does strategies and tools have in supporting farmers' adoption of regenerative practices? • What lessons have been learned about the approach to regenerative agriculture? • What program adjustments are recommended to enhance effectiveness?	• Activities successfully implemented as planned. • Frequency and extent of tool usage by farmers. • Innovative practices developed.

5. Midline Findings

5.1 Who are the respondents?

The respondents are farmers participating in the program with the current sample constituting 50.2% women. They are dominated by small and marginal farmers with average landholdings below 1.5 acres. The respondent pool reflects broadly similar household sizes, education levels, and demographic structures across treatment and comparison areas.

The household survey covered 1,240 households across four blocks with 975 respondents from the treatment group and 265 in the comparison group. Women accounted for half of all respondents (50.2 %); within the treatment group women were slightly in the majority (52.6 %), while in the comparison group they formed 41.1 %.

Table 2: Sample Distribution

SN	Group	Male	Female	Total	% Female
1	Treatment (T)	462	513	975	52.60%
2	Comparison (C)	156	109	265	41.10%
Overall		**618**	**622**	**1240**	**50.20%**

Household size averaged **4.03 persons in treatment** and **3.91 in comparison households**, with each typically comprising two adults and 1–2 children. The demographic structure is therefore broadly comparable across groups, with no systematic differences in household composition. Education levels showed a diverse spread. In treatment villages, **29.2% studied up to middle school**, **24.7% up to secondary**, **17.9% up to primary**, and **15.7% reported no schooling**. The comparison group followed a similar pattern, suggesting that educational levels are independent of the treatment exposure as this is shaped more by broader structural conditions than by treatment exposure. Around 73% of treatment respondents joined the program prior to 2023, which provides an adequate exposure window to observe adoption and behavioral changes.

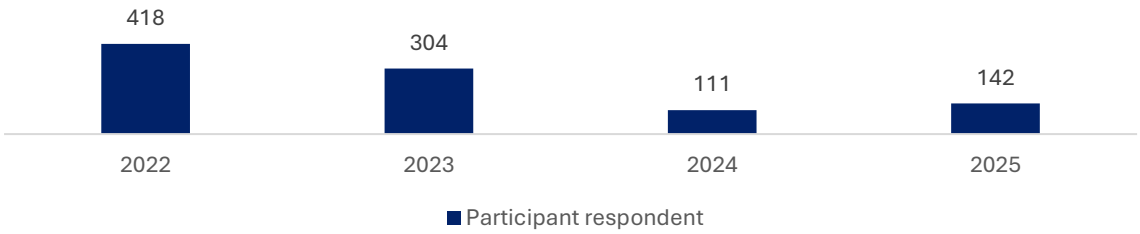


Figure 2: Joining year of the participants

Average household size was comparable across both groups (4 persons in each group), indicating broadly similar demographic structures. The sample is predominantly composed of small and marginal farmers. Landholding sizes at the time of the midline survey were in the marginal range, with an overall mean land area of 3.9 acres. The table below describes the block-wise land owned as reported:

	Baseline	Midline			
		Treatment		Comparison	
Block	Area (acre)	n	Area (acre)	n	Area (acre)
Chhindwara	-	81	4.4	38	4.4
Sausar	4.6	419	4.0	89	3.8
Mohkhed	4.4	258	3.7	66	2.8
Pandhurna	-	203	4.2	60	4.1

This difference in mean landholding size between baseline and midline does not necessarily indicate a real decline in farm sizes. Instead, it reflects differences in sample composition: the baseline had proportionally more medium and semi-medium farmers, while the midline deliberately included more

marginal and small farmers in line with program expansion. Consequently, caution is required when comparing baseline and midline averages. The observed reduction in landholding size should be interpreted as a shift in farmer profile rather than an agrarian structural change, and this context is important when analyzing outcomes such as productivity, input use, and income.

Placed against the regional statistics, the primary profile of respondents is more marginal than the broader agrarian structure. India's latest published Agriculture Census shows a national average operational holding size of 1.08 ha in 2015-16. The average operational holding size in Madhya Pradesh is 1.57 ha, substantially larger than the all-India average of 1.08 ha. Placed against this state benchmark, our survey mean of 0.60 ha indicates a markedly more marginal profile than the typical MP farm.[7]. This gap is analytically important: the technologies and risk-management options available to respondents are those suitable for small plots with tight liquidity and labour constraints, making the programme focus on low-cost regenerative practices particularly congruent with the production context. Gender representation in the sample is also important. In Madhya Pradesh, women constitute roughly 1 in 9 operational holders (about 1.19 million females versus 8.81 million male holders in 2015–16), and women's share among beneficiaries of farm schemes tends to be lower than their labour contribution.[8] By contrast, women form 50.2% of respondents under the assessment. This difference suggests that the primary data deliberately captured women's roles in decision-making and practice adoption more fully than administrative records would, while also highlighting the structural gap in land rights and formal recognition that can inhibit women's direct access to inputs, credit, and insurance.

Land in the region is predominantly owner-operated (91–94%), with only a small share under tenancy or sharecropping. The average operational holding at midline is 1.49 acres (1.51 in treatment vs. 1.45 in comparison), consistent with smallholder conditions observed at baseline. Irrigation access shows a clear seasonal asymmetry (*Shown in Table 3*): while 98–100% of Rabi plots (wheat and gram) are irrigated, only 18–58% of Kharif plots (maize, arhar, cotton) receive irrigation. This disparity directly shapes productivity patterns. Kharif crops, particularly maize, remain highly sensitive to rainfall variability- 82% of maize plots are rainfed- whereas Rabi crops benefit from assured irrigation and therefore record more stable yields. In 2025, rainfall was 11% above the long-period normal, yet maize yields still fluctuated, while Rabi wheat and gram showed consistent productivity gains.

This pattern is consistent with the state's agronomy and with the intensification documented in official land-use statistics. Cropping intensity in Madhya Pradesh has risen to about 190 % in 2022–23 (Gross Cropped Area 30.1 million ha versus Net Sown Area 15.8 million ha)[9], indicating widespread double-cropping anchored in an irrigated Rabi. The respondents' Rabi emphasis on wheat and gram aligns with the state's production profile: Madhya Pradesh is routinely among India's top producers of chickpea/gram and is one of the country's major maize states.[10] These similarities support the external validity of the sample's seasonal choices and suggest that water control, rather than land expansion, is the principal lever for intensification among smallholders.

At baseline (2021–22), average cropping intensity in the Chhindwara compact was recorded at 139%. Midline results show that treatment households have increased this to 163%, while comparison households report 147%. This upward shift, though modest, indicates that regenerative households are sustaining more multi-season cultivation compared to their baseline peers, primarily through improved irrigation and mechanisation.

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[7] Government of India, Agriculture Census Division. All India Report on Number and Area of Operational Holdings 2015-16. Ministry of Agriculture & Farmers Welfare. https://www.thehinducentre.com/the-arena/current-issues/article28682480.ece/binary/T1_ac_2015_16.pdf

[8] Government of India, Agriculture Census Division. (n.d.). All India Report on Number and Area of Operational Holdings 2015-16. Ministry of Agriculture & Farmers Welfare. https://www.thehinducentre.com/the-arena/current-issues/article28682480.ece/binary/T1_ac_2015_16.pdf

[9] Department of Agriculture & Farmers Welfare. (2024). Land Use Statistics at a Glance: 2022–23. Government of India. https://desagri.gov.in/wp-content/uploads/2024/09/Final-file-of-LUS-2022-23-for-uploading.pdf

[10] Government of India, Ministry of Finance. (2025). *Economic Survey 2024–25: Statistical Appendix* (Table 1.18, *Production of important crops in three largest producing states in 2023–24*). https://www.indiabudget.gov.in/economicsurvey/doc/stat/tab1.18.pdf

Table 3: Irrigation Status of Major Kharif Crops

Crop	% Irrigated (T)	% Irrigated (C)	% Rainfed (T)	% Rainfed (C)
Maize	18	15	82	85
Arhar	52	48	48	52
Cotton	58	54	42	46

Kharif crops are largely rainfed; maize is especially rainfall-dependent with **82-85% rainfed plots**.

Table 4: Irrigation Status of Major Rabi Crops

Crop	% Irrigated (T)	% Irrigated (C)	% Rainfed (T)	% Rainfed (C)
Wheat	98	100	2	0
Chickpea	88	88	12	13
Groundnut	98	92	2	8

Rabi crops are almost **universally irrigated (98- 100%)**, ensuring stable yields.

Table 5: Irrigation Status of Major Zaid Crops

Crop	% Irrigated (T)	% Irrigated (C)	% Rainfed (T)	% Rainfed (C)
Groundnut	94	100	6	0
Moong	100	75	0	25
Brinjal	100	0	0	0

Zaid crops are cultivated only where irrigation is assured, explaining high irrigation percentages but low coverage.

Irrigation source and reliability contextualize the observed practice mix. National land-use statistics show a secular shift toward groundwater-based irrigation: by 2022-23, tube-wells accounted for about 49% of irrigated area nationally, while canal shares have declined to around 23 %.[11] Minor Irrigation Census data indicate that, in number terms, groundwater structures constitute the overwhelming majority of schemes (about 94.8 % nationwide), and adoption of micro-irrigation in Madhya Pradesh (about 3.56 lakh hectares) cumulatively under the Per Drop More Crop program since 2015-16,[12] remains modest relative to the state's cultivated area.

When it comes to the rainfall conditions during the current monsoon, it further explains respondents' Kharif choices. Up to August 2025, Chhindwara district had received 842.2 mm against a long-period normal of 757.9 mm for the same window (June-July 25), an 11 % surplus but still classified as "Normal" by the India Meteorological Department.[13] A Kharif that is slightly wetter-than-normal but within the

[11] Directorate of Pulses Development. (2024, February 20). Pulses in India: Annual Report 2022–23. Department of Agriculture & Farmers Welfare, Government of India. https://dpd.gov.in/Final%20%20Annual%20Report%20%282022-23%29%20with%20Preface%20%28As%20on%2020.02.2024%29.pdf

[12] Press Information Bureau. (2024, February 6). Micro Irrigation (Per Drop More Crop): State-wise area covered, 2015–16 to 2023–24 (till date) [Press release]. Government of India. https://www.pib.gov.in/PressReleasePage.aspx?PRID=2003188

[13] India Meteorological Department. (2025, August 25). District wise Rainfall Distribution (01 June 2025–25 August 2025). https://mausam.imd.gov.in/Rainfall/DISTRICT_RAINFALL_DISTRIBUTION_COUNTRY_INDIA_cd.pdf

expected band supports maize and other rainfed cereals without fundamentally altering risk perceptions formed by prior drought years. This reinforces the rationale for soil-moisture conservation, mulching, and timely showing-regenerative practices. The primary data show to be widely adopted by trained households.

The respondent profile reflects densely cultivated, irrigation-dependent smallholder systems in a high-intensity state, with women heavily involved in production but under-represented in land ownership.

5.2 Adoption of Regenerative Agriculture Practices

Key Finding: *Adoption of regenerative agriculture practices is significantly higher in treatment areas, particularly where farmers have access to demonstration plots. While compost/FYM use is nearly universal, adoption of bio-fertilizers, crop rotation, and agroforestry is much stronger among demo-plot households. Agro-diversity is emerging through minor crops, indigenous varieties, and intercropping, especially in Kharif. However, chemical fertilizer use remains near-universal with more than 90% of the farmers reporting use of chemical inputs. Farmers cite land constraints, delayed returns, and lack of consistent support as key barriers. Importantly, over 71% of households and a higher share of women than men express willingness to adopt if provided with support*

The RPLC program was designed to promote a suite of regenerative agriculture (RA) practices aimed at enhancing soil health, improving water efficiency, increasing biodiversity, and diversifying farm incomes. Activities focused on six practice sets: **(i) soil cover and crop diversity, (ii) input shift toward bio-inputs, (iii) water-smart practices such as micro-irrigation, bunding and mulching, (iv) agroforestry and on-farm tree planting, (v) advanced soil management including minimum tillage, green manuring and microbial inoculants, and (vi) biodiversity features such as trap crops, hedgerows and pollinator strips.** Program interventions combined training, exposure visits, distribution of planting materials and inputs, and establishment of demonstration plots to showcase outcomes and reduce adoption risk. Overall adoption patterns illustrate significantly higher uptake of RA practices among demo-plot households compared to non-demo and comparison farmers.

In the discussion below, adoption is reviewed across the six practice sets promoted under RPLC. For each set, baseline conditions are presented alongside midline outcomes, followed by key inferences on progress, barriers, and areas requiring continued support.

Soil Cover and Crop Diversity

At baseline (2021–22), cropping intensity in Chhindwara was **139%**, with soybean in Kharif and wheat in Rabi dominating the system. Intercropping was reported by **<10%** of households, and adoption of indigenous varieties was very limited (**3.4% in treatment vs. 2.1% in comparison**).

By midline (2025), cropping intensity had risen to **163% in treatment households** compared to **147% in comparison households** (Table 3). Intercropping in Kharif expanded sharply, reaching **36.8% of treatment households** compared to **16.8% in comparison areas** (Table 5). Indigenous varieties were cultivated by **5.99% of treatment households** versus **3.8% in comparison households**. Biodiversity features also improved, with border/trap crops (mustard, marigold, castor) being reported by **22% of treatment households** against **11% in comparison** (Table 10).

Table 6: Baseline and Midline comparison on Soil cover and crop diversity

Indicator	Baseline (T)	Baseline (C)	Midline (T)	Midline (C)	Comparability
Cropping intensity	139%	138%	163%	147%	Comparable
Intercropping – Kharif	<10	<10	36.8	16.8	Comparable
Indigenous varieties – Kharif	3.4	2.1	5.99	3.8	Comparable
Border/trap crops	4.3	3.8	22.0	11.0	Comparable

Indicator	Baseline (T)	Baseline (C)	Midline (T)	Midline (C)	Comparability
Shannon Diversity Index	–	–	0.94 (Sausar), 0.79 (Pandhurna)	0.64, 0.56	Midline only
NDVI greenness	–	–	Higher	Lower	Midline only

The data shows clear movement toward diversification in treatment areas. Higher cropping intensity (+24 percentage points over baseline), more intercropping (+26 percentage points compared to

> *Earlier we only grew maize and wheat, but now turmeric, pigeon pea, vegetables, and local varieties are included. It took nearly five years for the soil to recover after moving to organic methods."*
>
> *(IDI with farmer, Nandanwadi village, Pandhurna block)*

> *"Initially, yields declined, but the soil quality improved. We started using farmyard manure, and the soil became softer compared to before."*
>
> *(IDI with farmer, Vikrampur village, Ardhanaresh block)*

> *"Earlier we spent heavily on pesticides for pest control, but now by planting marigold and mustard, the crops are protected naturally."*
>
> *(IDI with farmer, Mohkhed)*

comparison), and greater retention of indigenous varieties and border crops point to stronger functional and temporal diversity. These changes improve soil cover, microclimate buffering, pest regulation, and organic matter inputs through crop residues.

However, the absence of baseline biodiversity indices (e.g., Shannon Index, NDVI) limits robust round-to-round comparison. Still, directionally, the evidence indicates that treatment systems are becoming more resilient and ecologically balanced. Qualitative testimonies confirm and explain these shifts:

The amalgamation of quantitative adoption gains and farmer testimonies points to a **systemic shift from narrow monocultures toward diversified, more ecologically stable farming systems** in treatment areas. Crop diversification is both an economic strategy (risk management, reduced costs) and an ecological adaptation (soil health recovery, pest control).

Input Shift Toward Bio-Inputs

At baseline (2021–22), farming systems were heavily dependent on chemical inputs: over **95% of households** applied urea and DAP, while adoption of FYM/compost was more modest (**60.2% in treatment vs. 57.4% in comparison**). Vermicompost use was negligible (**2.8% treatment, 1.5% comparison**). Soil Organic Carbon (SOC) levels were uniformly low, ranging between **0.51–1.07% in treatment blocks** and **0.49–1.05% in comparison blocks**[14] (Refer to Baseline Soil Annexure for details). By midline (2025), adoption of compost/FYM increased to **82.1% of treatment households** (77% comparison), supported by SHG-based bio-input production and demonstration effects (Table 7, Midline). Vermicompost adoption rose to **24% of demo households, compared to 4% in FFS farmer households** (6% in treatment overall, against 0.3% in comparison). However, chemical fertiliser use

[14] Soil Organic Carbon (SOC) of 1.0–1.5% is generally considered healthy for central Indian rainfed soils. Values below 0.75% indicate low organic matter, reduced microbial activity, and limited moisture retention.

remained near-universal (**99.1% treatment vs. 98.7% comparison**). SOC levels showed marginal improvement (**0.61–0.65% in treatment vs. 0.61–0.64% in comparison**, Figure 10, Midline)

Table 7: Input Use and Soil Health

Indicator	Baseline (T)	Baseline (C)	Midline (T)	Midline (C)	Comparability
FYM/compost use	60.2	57.4	82.1	77.0	Comparable
Vermicompost use	2.8	1.5	5.59	0.38	Comparable
Chemical fertiliser use	95.5	93.2	99.1	98.7	Comparable
SOC (%)	0.51–1.07	0.49–1.05	0.61–0.65	0.61–0.64	Caution: different lab/site methods

The data suggests a **layering strategy**: farmers are adding bio-inputs on top of their existing chemical fertiliser regimes rather than replacing them. This is a rational adaptation under conditions of yield risk, uncertain markets, and entrenched extension messages promoting urea and DAP.

Farmers with >24 months program exposure (joined before 2023) show consistently higher uptake of bio-inputs (vermi/ compost/ FYM - (82% in 2022 vs 77% in 2025), agroforestry (32% in 2022 vs 25% in 2025) and mixed-cropping or intercropping (38% in 2022 vs 18% in 2025, than those with

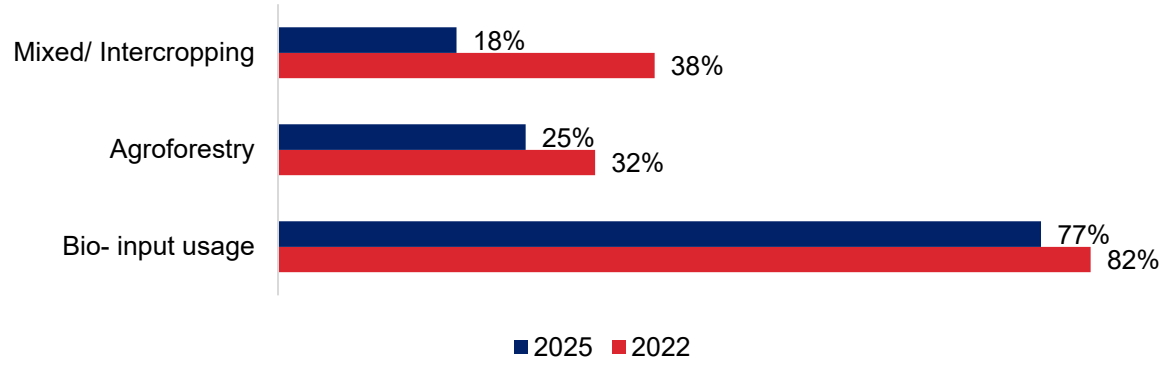


Figure 3: RA practice adoption (Year 1 vs Year 4)

less than 12 months exposure (joined 2024–25).

Ecologically, increased use of FYM and vermicompost contributes to improved soil structure, enhanced microbial activity, and better water retention. Yet the dominance of chemical inputs maintains an imbalance in nutrient cycling and limits the pace of long-term soil health recovery. SOC gains, while measurable, remain incremental and are complicated by differences in lab and site methods.



Mr Dobhare's Shift to Regenerative Farming in Satbhaidhana, Pandhurna

For most of his farming life, **Imrat Dobhare** from Satbhai Dhana in Pandhurna believed, like many others in the village, that without urea and DAP nothing could grow. "*The land had lost its strength,*" he said, recalling how the soil seemed to demand chemical boosters season after season. Information on organic methods had always existed, on mobile phones, TV (DD Kisan), even through neighbours, but never with enough conviction to change practice. That shift happened only three years ago, when the Regenerative Production Landscape Collaborative (RPLC) introduced trainings and a demonstration plot in the area. For Imrat, these sessions were a turning point: "*If Punjab's land can get damaged from chemicals, why won't ours? What will we leave for the next generation?*"

Over the next seasons, he made a decisive move: **completely abandoning chemical fertilisers** and shifting to bio-inputs. His seed-treatment ritual became almost meditative: mixing soil, cow urine, dung slurry and ash, coating each seed before sowing. He learned to space mango trees at 25 feet for Amrapali varieties and up to 50 feet for local ones, gradually expanding from twenty to forty trees across his field. The transformation was not immediate. In the first year, organic yield dropped to **5 quintals**, validating every fear farmers usually carry during transition. However, in the second year, the output rose to 10 quintals, and by the third year, it had reached 15 quintals, surpassing the yield he had once achieved with chemicals. "*The soil regained power. Earlier, 10 quintals was normal; now 15 is normal,*" he smiled, pointing to the visibly softer, richer earth on his farm.

The ecological change extended beyond yield. Soil retained moisture longer, crops showed better resilience, and vegetable patches grew so clean that schoolteachers and neighbours began taking produce directly from his field. Water was managed more efficiently using bund irrigation, while crop rows were sown carefully in lines, a practice reinforced through RPLC demonstrations. Visitors now come regularly to learn from him: "*They ask how I do it. I show them: take soil, ash, and cow urine, mix them, and coat the seed. When results are in front of them, people believe.*"

What makes Imrat's story remarkable is not only his adoption but his conviction. Even without premium rates for organic produce, he remains rooted in regeneration: "*Even if the yield is a little less, it is fine. The land must stay alive.*" His journey embodies the essence of RPLC's landscape approach, characterised by visible improvements **in soil health, steady yield recovery, reduced chemical dependence, and a farmer who becomes a catalyst for community learning**. In Satbhai Dhana, Imrat's field is no longer just a plot of land; it is a living classroom showing what regenerative agriculture can look like in practice.

Adoption of bio-inputs has clearly advanced since baseline, with FYM/compost and vermicompost becoming more widespread. Nonetheless, the persistence of near-universal chemical fertiliser use indicates that regenerative nutrient management is proceeding through **incremental layering rather than wholesale transition**. Comparability of adoption indicators across rounds is strong, but SOC comparisons remain tentative due to methodological differences.

Qualitative evidence illustrates this layered adoption:

> *"We are planning to expand vermicompost beds this season. There is farmer demand for organic manure, and producing it ourselves saves costs compared to buying chemical fertilisers."*

> *"Earlier the expenses were higher with chemical fertilisers. Now we prepare bio-pesticides and compost ourselves, so costs are reduced."*

> *"The best way to maintain soil health in the long run is organic farming."*

These voices confirm that farmers perceive bio-inputs as both a **cost-saving measure** and an **ecological practice**. However, most continue to rely on chemical fertilisers to safeguard yields, reflecting pragmatic risk management rather than ideological conversion to organic systems.

Midline Evidence on Water Use Efficiency (WUE)

At baseline (2021–22), irrigation access was uneven. 58% of households were rainfed-only, and less than 20% reported using micro-irrigation systems (Baseline report Section 3.1.3). Mulching was noted but not quantified in surveys.

By midline (2025), irrigation access had expanded significantly. 82% of treatment households had irrigation access compared to 63% in comparison households (Table 12). On average, treatment farmers reported 2.3 irrigations in Kharif (vs. 1.6 in comparison areas) and 5.8 irrigations in Rabi (vs. 3.9 in comparison areas). Importantly, 74% of treatment farmers irrigated at critical flowering/fruiting stages, compared to 49% in comparison areas (Figure 12). Mulching was increasingly reported in FGDs, but adoption remained limited due to crop residue constraints.

Using midline yield data and FAO-standard seasonal water requirement ranges, estimated WUE was highest for maize (3.81 kg/ha-mm), followed by soybean (1.68 kg/ha-mm) and cotton (1.41 kg/ha-mm). Wheat could not be assessed due to missing yield inputs.

Table 8: Crop wise WUE

SN	Crop	Midline Yield (q/acre)	Yield (kg/ha)	WUE (kg/ha-mm)
1	Maize	8.1	2,002	3.81
2	Soybean	3.9	964	1.68
3	Cotton	5.7	1,409	1.41

These values reinforce a key finding: the program has succeeded in expanding irrigation access and improving timing, but water productivity varies widely across crops. Maize emerges as the most water-efficient crop under midline conditions, whereas cotton and soybean, though supported with more frequent and better-timed irrigation, still demonstrate moderate to low WUE, suggesting potential over-application or sub-optimal scheduling relative to crop evapotranspiration needs.

With the recent rise in sprinkler adoption (micro-irrigation increasing from 19% to 34% among treatment households), future gains in cotton and soybean WUE are feasible if irrigation decision-making becomes more precise, for example, through deficit irrigation, soil-moisture-guided scheduling, or irrigation only at physiological critical stages.

Table 8: Irrigation and Water-Smart Practices

S.No	Indicator	Baseline (T)	Baseline (C)	Midline (T)	Midline (C)	Comparability
1	Irrigation access	42.0	39.5	82.0	63.0	Comparable
2	Avg irrigations – Kharif	–	–	2.3	1.6	Midline only
3	Avg irrigations – Rabi	3.2	2.8	5.8	3.9	Comparable
4	Micro-irrigation (drip/sprinkler)	19.0	17.5	34.0	22.0	Comparable
5	**Irrigation timing (flowering/fruiting)**	**–**	**–**	**74%**	**49%**	**Midline only**

These changes reflect a water-smart intensification of agriculture. Expanded irrigation access, more frequent watering during Rabi, and significantly improved stage-specific irrigation indicate increasing control over water resources, a hallmark of climate-smart farming. The WUE estimates suggest that maize is currently the most resource-efficient crop, while cotton and soybean still have scope to optimise irrigation volumes.
Mulching, though limited in spread, demonstrates ecological value where used, reducing evaporative losses, maintaining soil temperature, and helping sustain moisture during dry spells. Constraints around residue availability and competing fodder demand continue to limit adoption. Improvements in irrigation access, frequency, and timing have been decisive in sustaining higher cropping intensity and stabilising yields; however, the next gains will come from improving water productivity, not just availability.

Mulching, though not widely adopted, is ecologically significant where practiced: it reduces evaporation, moderates soil temperature, and protects against erosion. However, residue scarcity and competing uses (fodder, fuel) continue to constrain uptake. The gains remain asymmetric: water control improvements are strongest in Rabi, aided by irrigation infrastructure, while Kharif systems are still more vulnerable to rainfall shocks. Farmer narratives substantiate these findings:

> *"Earlier we needed to irrigate wheat six times, but now with improved practices it is sufficient with four irrigations."*
>
> *(Farmer FGD, Ambamali, Sausar)*

> *"Now we give water at the right stage — when the crop is flowering or fruiting — so even with fewer irrigations, the yield is good."*

> *"Residues are not always available for mulching because they are used as fodder, so applying mulch every season is difficult."*

Improvements in irrigation access, frequency, and especially timing have been central to sustaining higher cropping intensity and stabilizing yields. These gains demonstrate a clear program effect in water-smart agriculture. Yet, mulching and bunding remain under-adopted, largely due to resource constraints, and the full ecological potential of water-smart practices will only be realized with stronger support for residue management and integration with crop-livestock systems.

Agroforestry and On-Farm Trees

At baseline (2021–22), adoption of on-farm trees was negligible; about **8–10% of households** reported scattered fruit trees near homesteads, with no systematic agroforestry practices. By midline (2025), adoption had increased substantially. **30% of treatment households** reported agroforestry practices,

compared to **12% in comparison villages** (Table 8, Midline). Demo-plot households showed the highest uptake at **43%**. Farmers planted an average of **68 trees per farm** (vs. 42 in comparison) since they joined the project, with survival rates of about **60%**. On-farm species diversity was limited, averaging 3-4 species, mostly fruit (mango, guava) and multipurpose (sesbania, subabul) species (Figure 11, Midline).

Table 9: Agroforestry Adoption

Indicator	Baseline (T)	Baseline (C)	Midline (T)	Midline (C)	Comparability
Agroforestry adoption	8.6	7.9	30.0	12.0	Comparable
Demo-plot adoption	–	–	43.0	–	Not comparable (midline-only)
Avg trees per farm	–	–	68	42	Not comparable
Survival rate (%)	–	–	60	55	Not comparable

> *"The benefit from trees comes only after five–seven years; it does not help with current needs."*

Agroforestry represents one of the most **visible ecological transitions** within the RPLC program. Trees deliver multiple ecosystem services: carbon sequestration, shade, fodder and fuelwood supply, and soil/bund stabilisation. However, adoption is tempered by farmers' concerns over delayed returns. As one farmer explained:

This highlights the dual nature of adoption: ecological benefits are long-term, but short-term economic imperatives slow expansion. Moreover, limited species diversity and survival rates point to gaps in extension support and aftercare services. Agroforestry adoption has expanded significantly, particularly among demo-plot farmers, but structural and behavioral constraints remain. Without stronger support for species diversification, aftercare, and livelihood co-benefits, the ecological potential of agroforestry may remain underutilized.

Advanced Soil Management

At baseline, soil management practices were conventional, with evidence of structured adoption of advanced techniques such as minimum tillage, microbial inoculants, or green manures. SOC levels were already low (0.51–1.07%). By midline, adoption of advanced practices remained minimal. **Minimum tillage was <2%**, **green manuring around 4%**, and **microbial inoculants ~3%** (Table 9,). SOC levels stagnated at around **0.61–0.65%**, with limited improvement compared to baseline.

Table 10: Advanced Soil Practices

S.No	Indicator	Baseline (T)	Baseline (C)	Midline (T)	Midline (C)	Comparability
1	Minimum tillage	–	–	<2%	<1%	Not comparable (midline-only)
2	Green manuring	Rare	Rare	4%	2%	Limited comparability
3	Microbial inoculants	–	–	3%	1%	Not comparable (midline-only)

S.No	Indicator	Baseline (T)	Baseline (C)	Midline (T)	Midline (C)	Comparability
4	SOC (%)	0.51–1.07	0.49–1.05	0.61–0.65	0.61–0.64	Partially comparable; lab variation

This practice set remains the **least adopted** among the regenerative interventions. Despite awareness campaigns, farmers perceive advanced soil practices as risky, labour-intensive, and delivering uncertain benefits. A farmer expressed skepticism:

Ecologically, the missed opportunity is significant. Minimum tillage conserves soil structure and moisture, while green manures could improve nutrient cycling. Yet adoption has stalled, largely because short-term yield assurance outweighs longer-term ecological payoffs.

Advanced soil management is still nascent, with negligible adoption beyond demonstration contexts. Without stronger technical guidance, incentives, and risk-sharing mechanisms, it is unlikely that these practices will scale. SOC levels remain stagnant, underscoring the slow pace of soil health recovery under current adoption dynamics.

Biodiversity Features

At baseline (2021–22), biodiversity-enhancing practices were almost absent. Fewer than **5% of farmers** reported using border crops, and no systematic measures of on-farm species diversity or ecological indicators were collected.

By midline (2025), adoption of biodiversity features showed measurable improvement. **22% of treatment households** reported using trap/border crops (vs. **11% in comparison villages**, Table 10, Midline). Farms in treatment areas averaged **5.4 crop species per farm annually**, compared to **3.2 in comparison areas** (Annex Table A7). Remote-sensing (NDVI) imagery confirmed higher and more resilient seasonal greenness in treatment villages (Figure 7).

Table 11: Emerging biodiversity practices

Indicator	Baseline (T)	Baseline (C)	Midline (T)	Midline (C)	Comparability
Border/trap crops adoption[15]	4.3	3.8	22.0	11.0	Comparable
Avg crop species per farm	–	–	5.4	3.2	Not comparable (midline only)
NDVI greenness	–	–	Higher	Lower	Not comparable (midline only)

These shifts, though modest, are ecologically critical. Trap crops such as marigold, mustard, and castor break pest cycles and reduce reliance on chemical pesticides. Greater crop species diversity improves ecological resilience by lowering vulnerability to pests, diseases, and rainfall variability. NDVI results provide a visual confirmation of these ecological dividends, showing stronger biomass retention in treatment villages.

However, biodiversity indicators (species counts, NDVI) were introduced only at midline, limiting direct round-to-round comparison. Farmers recognize the ecological benefits of biodiversity-enhancing practices:

[15] Minor or border crops include marigold, castor, fodder grasses, vegetables, and legumes, typically planted on field margins for pest management, soil cover, or household use. Indigenous/local varieties refer to traditional landraces of maize, pulses, and oilseeds that are maintained by farmers for resilience and seed sovereignty.

These voices illustrate that adoption is not only program-driven but also reinforced by farmers' experiential learning. Biodiversity features have begun to take hold in treatment villages, moving farmers away from monocultures toward more diversified systems. While still early, the adoption of trap crops and greater species richness suggests that farmers are beginning to internalise ecological strategies for pest management and resilience. The NDVI evidence strengthens this inference by demonstrating visible gains in vegetative cover. Scaling these practices will require sustained support in seed availability, extension, and market alignment to reward diversified production.



Growing Forests Faster Miyawaki Plantations in the Chhindwara Compact

Across the Chhindwara compact, the landscape is beginning to show a new kind of green. Guided by SRIJAN and the Green Foundation, communities have been establishing dense, fast-growing **Miyawaki plantation clusters** in village commons and unused community land. These micro-forests are designed to regenerate native ecology by planting multiple indigenous species at high density, creating layers of quick-growing shrubs, mid-canopy trees and tall species.

In several villages, the transformation is already visible. Photographs from the field show neatly fenced plots, closely spaced saplings, moisture-retaining mulched beds and volunteer groups tending to young growth. Community members describe how the plantations have begun attracting birds and insects within a year. Local temperatures around the clusters feel cooler, and moisture retention in the surrounding soil has improved.

The Miyawaki model has quickly become a symbol of collective action in the compact. It demonstrates how villages, with technical support, can revive degraded spaces into living forest patches. As these pockets mature, they are expected to contribute to improved biodiversity, carbon sequestration and stronger ecological resilience across the landscape.

The midline evidence confirms that RPLC has initiated a meaningful shift toward ecological intensification, with treatment farmers adopting more diverse cropping systems, layering bio-inputs, improving irrigation timing, expanding agroforestry, and integrating biodiversity features. These practices are generating visible ecological dividends- stronger soil cover, improved water productivity, reduced pesticide use, and higher NDVI greenness - while also reflecting pragmatic farmer strategies to safeguard yields and reduce costs. However, adoption remains partial and layered, with chemical inputs still dominant, advanced soil practices underdeveloped, and structural barriers such as delayed returns, labour constraints, and market disincentives slowing deeper transformation. Overall, the program is steering farming systems onto a regenerative trajectory, but sustaining and scaling these gains will require stronger institutional support, risk-sharing mechanisms, and market linkages that align short-term livelihood needs with long-term ecological outcomes.

> *"Where we grow more crop varieties together, we see fewer pest attacks and better soil fertility compared to single-crop fields."*

> *"We have heard of soil improvement techniques, but the benefits are not visible or certain."*

> *"Earlier we spent heavily on pesticides for pest control, but now by planting marigold and mustard, the crops are protected naturally."*

Additional Dimensions of Adoption

Awareness as foundation: At midline, **70% of farmers in treatment villages** reported familiarity with regenerative agriculture, compared to **33% in comparison villages**. Conversely, **67% of comparison households** reported lack of awareness (vs. 30% in treatment). Awareness is thus a necessary precursor to adoption, but not sufficient on its own for practice uptake.

Catalytic role of demonstration plots: Demo-plot ownership strongly influenced adoption. **89% of demo-plot farmers** reported using compost/FYM (vs. 83% of non-owners and 77% in comparison). Similarly, **43% of demo-plot owners integrated trees**, compared to 28% of non-owners and only 12% of comparison farmers.

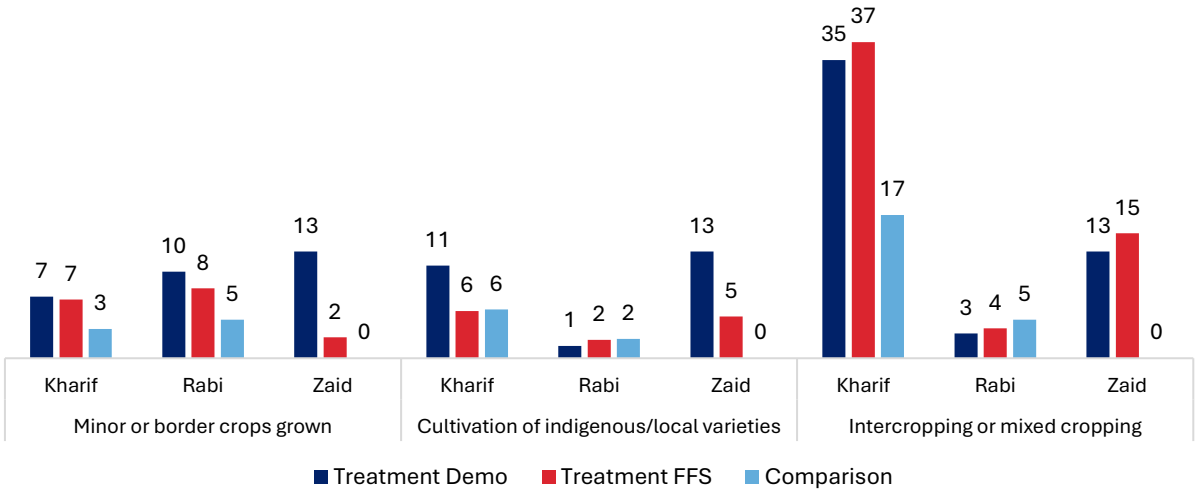


Figure 4: Percentage farmers adopting the cropping practice each season

> *"We saw on the demo plot that the crop was doing well with organic inputs, so we tried it ourselves."*
>
> *(Treatment farmer, IDI)*

Farmers repeatedly emphasized the role of demo plots in reducing uncertainty:

> *"We apply manure, but farming cannot continue without urea."*
>
> *(Farmer IDI, Treatment village)*

Seasonal variation in diversification: Intercropping was highest in Kharif (**36.8% treatment vs. 16.8% comparison**), but adoption dropped to **3.4% in Rabi** and **14.3% in Zaid**. Treatment households also cultivated a higher number of crops simultaneously: 2 in Kharif, 1 in Rabi, and partial land in Zaid (vs. 2, 1, and negligible in comparison). Farmers listed **cowpea, pigeon pea, mustard, marigold, castor, fodder grasses, brinjal, and chilli**, mostly for risk management and pest control.

Gendered willingness to adopt: Overall willingness to adopt regenerative practices is high (**71.2% of farmers**), with **women (75.9%) reporting greater willingness than men (67.3%)**. This suggests women could be critical drivers of scaling adoption.

Support ecosystems: For agroforestry, farmers accessed seedlings from **NGOs (33%)**, **private nurseries (33%)**, and **government nurseries (23%)**. Women's groups were instrumental in producing and diffusing bio-inputs. Despite these supports, farmers emphasized irregularity:

> *"We will put in the effort, but if the price is not assured, we cannot continue."*
>
> *(FGD, Treatment village, Sausar)*

Sustained adoption was seen as contingent on reliable returns in terms of market linkage and price assurance:

Record-keeping and decision-making: A promising behavioural change was more frequent farm

> *"We wrote down how much the organic plot cost versus the other four acres, kept it in a notebook for reference, and how much inputs I put in last season."*
>
> *(Treatment farmer, IDI)*

record-keeping in treatment households (**41% vs. 32% comparison**). Farmers described deliberately tracking costs and outcomes:

5.3 Farm Productivity, Crop Yields and Incomes

Rabi crops such as wheat and chickpea show modest but consistent productivity gains in treatment areas, supported by near-universal irrigation and regenerative practices like FYM use and soil management. By contrast, Kharif cereals remain vulnerable to rainfall variability, with maize yields lower in treatment than comparison villages, highlighting that yield stability rather than yield growth is the most tangible midline benefit of regenerative adoption. On the income side, treatment households report moderately higher average earnings (INR 168,035 vs. INR 146,570), but landholding size continues to be the strongest determinant of income, and high levels of indebtedness persist across both groups, consuming nearly one-third of annual income.

Midline findings confirm that **farm productivity in the RPLC landscape** reflects both the structural realities of Madhya Pradesh's agriculture and the gradual influence of regenerative practices. A strong distinction persists between the irrigated Rabi season, where wheat and chickpea dominate, and the rainfed Kharif season, where cereals such as maize remain highly sensitive to rainfall shocks.

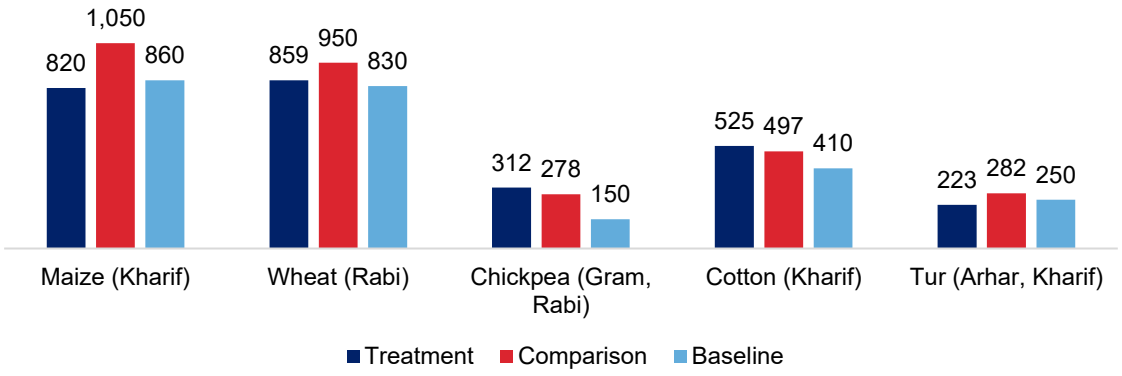


Figure 5: Crop yield comparison (in kg/acre)

During kharif, maize yields were measured at 820.2 kg/acre in treatment villages, compared to 1,049.8 kg/acre in comparison areas. Field accounts suggest that late sowing and episodes of waterlogging in some treatment villages offset otherwise favorable rainfall (+11% above normal in 2025). This difference

> *"The benefit from trees comes only after five–seven years; it does not help with current needs."*
>
> *(Farmer IDI, Treatment village)*

is also consistent with wider evidence that organic or regenerative systems may initially deliver lower yields than conventional chemical farming, particularly for cereals like maize, before soil health benefits

accumulate over time.[16] [17] **Yield effects remain crop-specific and partial. For example, chickpea/gram yields are higher in treatment (1,102 kg/acre) vs. comparison (1,064 kg/acre), but maize yields are lower in treatment (820 kg/acre vs. 1,050 in comparison). The program hasn't yet shifted overall yields across the whole landscape, but in Rabi season, crops like wheat and gram are showing some stability and small improvements.** Cotton yields showed parity across groups, with treatment farmers holding a 2–3% edge. Farmers explained that pest incidence was lower in treatment plots due to bio-pesticide use and border crops such as marigold and castor. Pigeon pea (tur/arhar) remained weak across both groups, with yields stunted by untimely rains.

> *"With marigold and castor lines, pests don't enter the main crop. If the rain doesn't arrive on time, pigeon pea just withers while standing".*
>
> *-Treatment FGD*

Wheat in Rabi, the primary staple, benefitted from almost universal irrigation coverage (98–100% of plots). Farmers consistently reported steady productivity, but treatment farmers linked slightly better outcomes to soil health gains and reduced fertiliser dependence due to continuous FYM application. Chickpea yields showed clearer treatment advantages as yields counted at 1,102 kg/acre in treatment vs. 1,064 kg/acre in comparison. Farmers attributed these gains to mulching and crop rotations that retained soil moisture and improved fertility.

As mentioned earlier, cultivation during zaid was reported marginal, with only 4-6% of households reporting crops such as ground nuts, moong, and brinjal. These were concentrated in pockets with assured irrigation. Hence, it has not been considered for the analysis.

Importantly**, treatment households are more commercially oriented**. Soybean was cultivated by 63.6% of treatment households vs. 56.2% of comparison, cotton by 35.4% vs. 26.2%, and maize by 22.5% vs. 14.7%, while comparison households maintained higher coverage of chickpea (33.9% vs. 28.3%) and wheat (78.1% vs. 75.3%). This suggests that treatment households are diversifying into higher-value crops. As a treatment farmer in Mohkhed put it-

> *"Earlier we used to grow only one crop, now we also grow maize, soybean, and vegetables so that our income is not dependent on a single source".*
>
> *-Treatment FGD*

Table 12: Cropping pattern by treatment and comparison households (% of households reporting)

SN	Crop	Treatment (%)	Comparison (%)	Difference (T–C)
1	Soybean	63.6	56.2	+7.4
2	Cotton	35.4	26.2	+9.2
3	Maize	22.5	14.7	+7.8
4	Wheat	75.3	78.1	–2.8
5	Chickpea	28.3	33.9	–5.6
6	Groundnut	8.2	9.6	–1.4
7	Moong	4.3	6.0	–1.7

[16] Seufert, V., Ramankutty, N., & Foley, J. A. (2012). Comparing the yields of organic and conventional agriculture. Nature, 485(7397), 229–232.

[17] Reganold, J. P., & Wachter, J. M. (2016). Organic agriculture in the twenty-first century. Nature Plants, 2(2), 15221.

Productivity was supported by **mechanisation of farms** as most farmers in both groups reported using machinery, with 86% of treatment and 88% of comparison households using at least one machine in the past year. This aligns with national patterns showing high mechanisation in land preparation and seeding for cereals, with India's overall farm mechanisation level estimated at 47% in 2021–22 and

> *"We can wet one acre in about two to two-and-a-half hours now… earlier we gave six irrigations to wheat; now four are enough. Once the line is set, we press the button and it runs; if there's excess water, we shut the nozzle".*
>
> *- IDI Farmer*

higher in wheat and rice operations relative to pulses and oilseeds.[18]

> *"Earlier wheat required six irrigations, now four are sufficient".*
>
> *-Treatment IDI*

Farmers in the treatment villages also described practical irrigation technologies such as mini-nozzles, sprinklers, and drip have been routine labor-savers.

Consistent with FAO's guidance on gender-responsive mechanisation, these tools reduce time and physical strain and can lower costs when appropriately matched to farm size and task.[19] Such findings indicate that mechanisation is embedded across core operations in the farms, especially land preparation, spraying, and irrigation, delivering time savings consistent with national evidence.

In treatment and comparison villages, Land preparation (94% vs. 97%), sowing/planting (40% vs. 43%), irrigation (58% vs. 59%), harvesting (23% vs. 30%), and spraying (66% vs. 72%) were the main mechanized operations. Access to equipment is somewhat higher among treatment farmers (85% vs. 81%). Farmers highlighted that sprinklers and small implements have reduced input intensity-

Together, these points to incremental, crop-specific yield gains. Kharif cereals remain fragile, with maize showing no advantage in the treatment villages, while cotton and pigeon pea showed resilience benefits rather than yield growth. By contrast, Rabi crops, especially chickpea, show modest but reliable productivity improvements. Farmers perceive the main benefits of regenerative agriculture in cost savings, input efficiency, and stability of output. Mechanisation, especially small tools and efficient irrigation, has reinforced these gains by reducing labor and water use. Overall, the evidence suggests that while absolute productivity gains are limited at this stage, regenerative practices are strengthening the resilience and efficiency of farming systems, laying the groundwork for longer-term ecological and yield benefits.

[18] Mehta, C. R., Bangale, R., Chandel, N. S., & Kumar, M. (2024). *Farm mechanisation in India: Status and way forward.* Agricultural Mechanisation in Asia, Africa and Latin America, 54(2), 75–88.

[19] Food and Agriculture Organisation of the United Nations (FAO). (2016). *Agricultural mechanisation: A key input for sub-Saharan African smallholders.* Rome: FAO. https://www.fao.org

5.4 Fertiliser Use and Soil Health

Farming systems in the RPLC landscape are heavily dependent on chemical fertilisers, with urea and Diammonium Phosphate (DAP) serving as the primary tools for nutrient management. While this reliance is nearly universal, treatment households show a marginal advantage in adopting more balanced fertilisation and are beginning to explore regenerative alternatives.

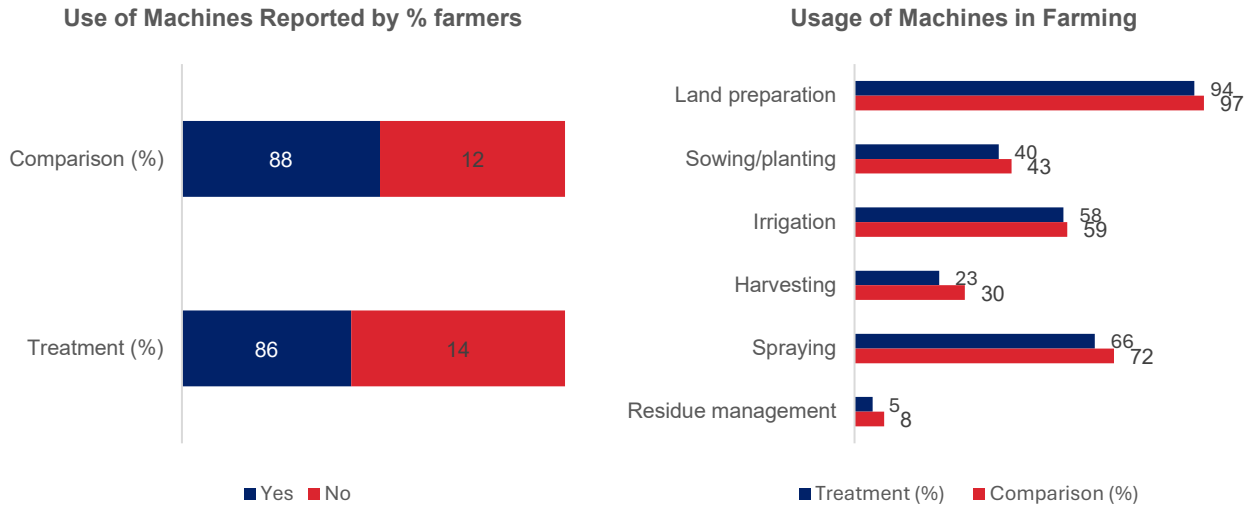


Figure 6: Use of Farm Machinery

Data shows high application rates of chemical fertilisers across all farmer groups and major crops like wheat, soybean, maize, and cotton. For instance, in wheat cultivation, 95.6% of treatment farmers applied urea compared to 93.4% of the comparison group. A similar pattern exists for DAP use. In stark contrast, organic inputs such as compost or farmyard manure are almost entirely absent, with only 1-3% of farmers reporting their use. This indicates a system deeply reliant on chemical inputs.

Table 13: Fertiliser use by crops and group (% of farmers applying)

S. No	Crop	Input	Treatment (%)	Comparison (%)	Difference (T–C)
1	Wheat	Urea	95.6	93.4	+2.2
		DAP	93.7	91.5	+2.2
2	Soybean	SSP	59.9	58.1	+1.8
3	Maize	Urea	92.3	90.2	+2.1
4	Cotton	DAP	79.2	77.4	+1.8
5	Organic	All	1–3	<2	marginal

Block-level variation mirrors cropping patterns: Sausar and Mohkhed, both treatment-intensive blocks, show the highest intensity of chemical use, with over 95% adoption of urea and DAP, whereas Chhindwara, with more comparison households, reports slightly lower coverage (91% urea and 87% DAP).

Despite continued high dependence on chemical fertilisers across crop systems, soil quality indicators show the first signs of stabilisation. **Soil Organic Carbon (SOC)**, which ranged widely at baseline (**0.51–1.07%**), shows a more concentrated band at midline (**0.61–0.65%**). Although the absolute increase is modest, the narrowed range reflects reduced variability across plots, indicating that soil carbon levels are beginning to stabilise rather than decline further. This shift aligns with emerging

regenerative practices such as residue retention, mulching in pockets, and crop diversification as reported in FGDs, even though bio-inputs remain limited (1, 3% full adoption).

Parallel to SOC trends, **GHG emissions continue to reflect current fertiliser behaviour rather than ecological recovery**. With near-universal application of urea and DAP in wheat, maize, soybean and cotton, emission loads remain strongly linked to synthetic nutrient use. Without substantive reduction in nitrogen-based fertilisers or scale-up of biological inputs, large shifts in emission intensity are unlikely in the short term. However, improving SOC levels provide early evidence of carbon-accumulation potential, an outcome that can accelerate if bio-input adoption and soil cover practices increase.

The rising cost of fertilisers and labour is a recurrent theme in both groups. A comparison farmer in Sausar explained:

> *"Costs are rising the most for fertilisers and labour… in cotton alone, it takes fifteen to twenty thousand rupees per acre."*
>
> *- Comparison IDI, Sausar*

Treatment farmers, however, described gradual experimentation with bio-inputs:

> *"We have slowly reduced chemical use, now we prssepare our own inputs, and this saves costs."*
>
> *-Treatment IDI, Pandhurna*

Soil tests results (for detailed results, please refer to Annexure 1) show why this heavy chemical reliance is inefficient. Across the region, soils are neutral to slightly alkaline (pH 7.45–7.66), which can hinder nutrient uptake. Despite intensive fertiliser application, available nitrogen remains only moderate (340–359 kg/ha), and phosphorus levels are persistently low (9.7–10.1 kg/ha), partly because alkaline conditions promote phosphorus fixation, making it unavailable to plants. The most critical challenge is the low soil organic carbon (SOC)[20], which is limited to 0.61–0.65%. At baseline, Soil Organic Carbon (SOC) averaged **0.70%**. By midline, SOC levels declined slightly: **0.63% in demo plots**, **0.61% among FFS farmers**, and **0.63% in comparison plots**. While overall values remain low, demo plots show relatively stronger retention compared to other groups, highlighting their role in sustaining soil health. This deficiency restricts microbial activity, nutrient cycling, and long-term soil resilience. Consequently, the blanket application of urea and DAP fails to resolve underlying nutrient imbalances and degrades the soil's carbon foundation.

Table 14: Soil health parameters (compact averages)

Values	Demo	FFS	Comparison
pH (1:2.5)	7.50	7.53	7.57
EC (dS/m)	0.34	0.34	0.31
N (kg/ha)	349.65	350.07	344.17
P (kg/ha)	10.00	10.04	9.85
K (kg/ha)	365.17	365.53	365.66
SOC (%)	0.63	0.61	0.63
WHC (%)	66.37	65.97	66.06

[20] Soil Organic Carbon (SOC) indicates soil's ability to hold nutrients and water. <0.5% = low, 0.5–0.75% = medium, >0.75% = high.

While chemical use remains dominant and organic alternatives are scarcely adopted, the data suggests practice-level dependence rather than full transition readiness. Given small landholdings and perceived yield risk, adoption of bio-inputs is gradual and cautious among farmers.

5.5 Household Incomes, Debt, and Livelihoods

Farm households in the RPLC landscape remain predominantly agrarian, though modest diversification is emerging. At midline, most households continued to depend on a mix of crop sales, livestock, and, to a lesser extent, wage labour or small businesses. Non-farm income was reported by 22% of treatment households and 25% of comparison households (shown in the figure below) and was most common among marginal and small landholders.

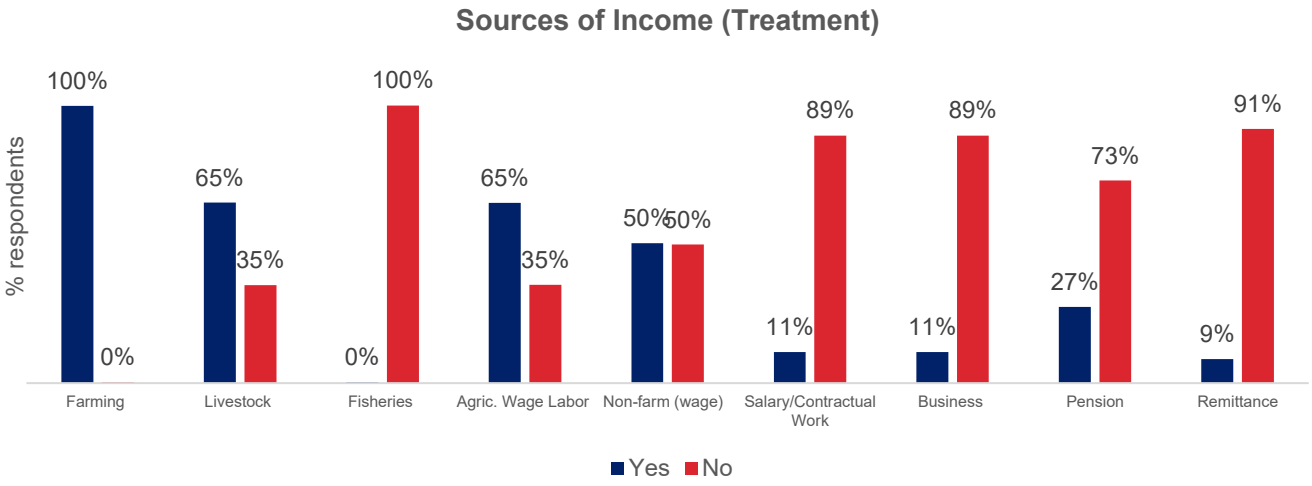


Figure 7: Source of Income- Treatment

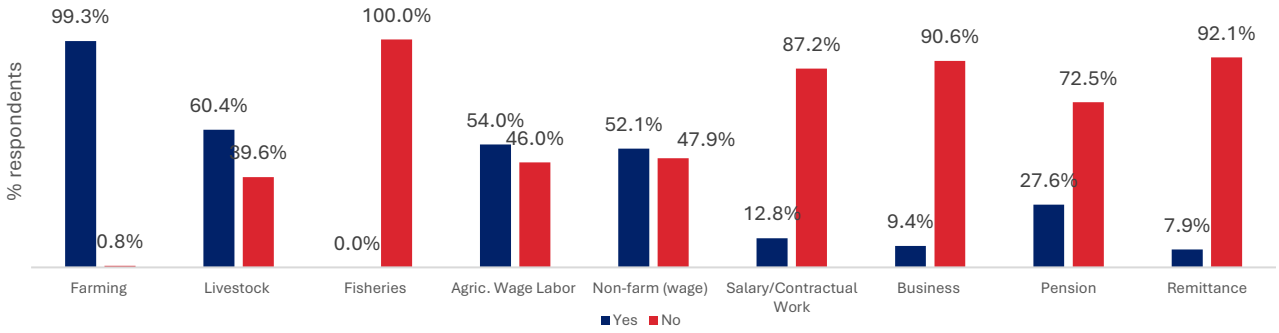


Figure 8: Source of Income- Comparison

Average household incomes in treatment villages reached INR 168,035, compared to INR 146,570 in comparison with variations in income by land size. Findings suggest that between baseline[21] and midline, the farmers' household income jumped 32.5%. Similarly, farmers in the treatment earned 13% more than comparison at the time of the midline. Key drivers for this improved income include lower input costs from bio-inputs, better market linkages through the FPCs for the produce, and convergence with irrigation schemes reducing crop failure risk.

[21] RPLC Chhindwara Compact - Baseline Report - https://rplcollaborative.org/files/Chhindwara_Baseline_Report_IRRI.pdf

Table 15: Average Household Income by Land Size

SN	Land Size Category	Baseline (2021–22) INR	Midline Treatment INR	% increase from baseline to midline	Midline Comparison INR	% difference between midline treatment and comparison
1	Marginal (<1 acre)	88,710	96,530	8%	89,240	8%
2	Small (1–2 acres)	122,520	114,250	-7%	110,980	3%
3	Semi-med (2–4 acres)	158,650	156,170	-2%	152,300	3%
4	Medium (4+ acres)	241,800	225,920	-7%	214,410	5%
Overall avg.		126,830	168,035	32.5%	146,570	13%

Landholding size, however, remained the most important determinant. Marginal farmers (<1 acre) earned about **INR 96,530 in treatment villages** versus **INR 89,20 in comparison villages**, while medium farmers (>4 acres) earned **INR 225,920 in treatment villages** and **INR 214,410 in**

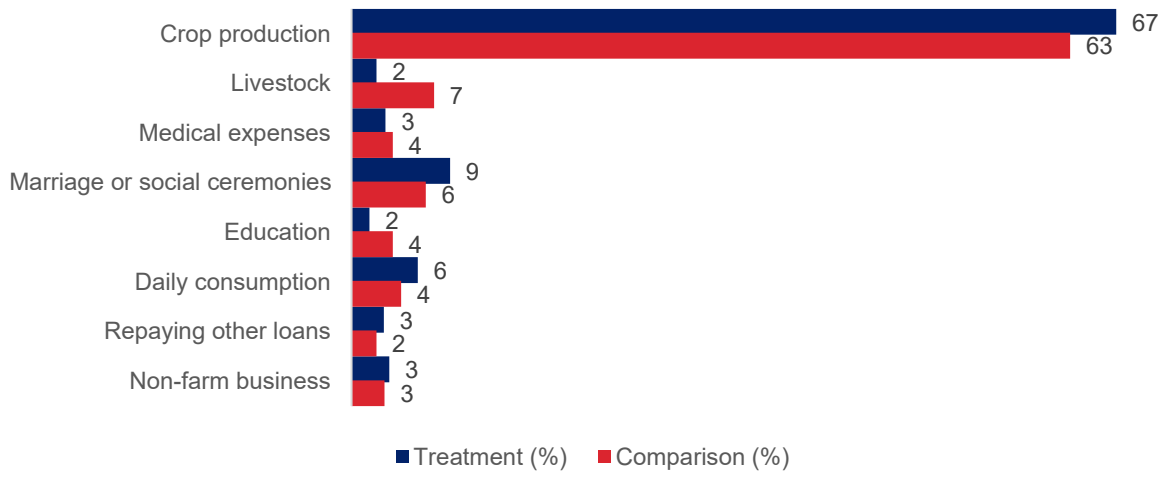


Figure 9: Purpose of securing a loan

comparison villages. The baseline had recorded much larger average holdings in Mohkhed and Sausar (4.4–4.6 acres), but the midline sample's lower average (1.5 acres) reflects both program expansion into new blocks and a deliberate focus on smaller, more marginal farmers.

Table 16: Income-debt ratio

SN	Indicator	Treatment	Comparison
1	Avg. income (all HH, INR)	168,035	146,570
2	% households with non-farm inc.	22	25
3	% indebted	66	68
4	Avg. debt (INR)	46,890	43,570
Income–debt ratio*		3.6	3.4

Debt remains a widespread stressor. At midline, **66% of treatment households** and **68% of comparison households** reported indebtedness. The average loan burden stood at **INR 46,890 in treatment villages** and **INR 43,570 in comparison villages**, typically contracted for input purchases, health care, or social obligations. Relative to income, this implies that debt consumes nearly **28% of annual earnings in treatment households and 29% in comparison households**.

Access to Finance and Scheme Convergence – Benefits for Farmers

1. **Improved financial access:** 70% of treatment households reported access to formal financial resources, compared to ~40% in comparison areas. SHGs and FPOs enabled farmers to save regularly and access small loans, reducing dependence on moneylenders.
2. **Reduced input costs through bio-input centers:** SHG-based production of compost and bio-pesticides lowered costs, while some farmers expanded vermicompost units to meet demand locally.
3. **Government schemes leveraged:** Convergence facilitated farmer uptake of **PM-Kisan, irrigation subsidies under PM-KSY, and soil health testing**. Farmers reported that these benefits would not have reached them without program facilitation.
4. **Practical impact:** 74% of treatment farmers irrigated at critical flowering/fruiting stages (vs. 49% comparison), and FYM/compost use rose to 82% (vs. 77% comparison), with many attributing this to scheme-based support.

"Earlier we spent heavily on pesticides, but now with marigold and mustard provided through the program, crops are protected naturally. The savings help us manage other costs." Farmer FGD, Sausar

⚠️ **Remaining challenge:** Despite improved access, **66% of treatment households remain indebted**, with average loans of INR 46,890- consuming nearly one-third of annual income. Finance and convergence are enabling, but not sufficient to overcome structural livelihood stress.

Farmers described this situation as both enabling and constraining while debt is essential to purchase timely inputs, repayment pressures erode household savings and constrain reinvestment in farming. The persistence of high debt levels, effectively absorbing one-third of household earnings, shows that while regenerative adoption may improve margins, it cannot by itself address the structural vulnerabilities of rural livelihoods. Strengthening institutional credit, enhancing market access, and supporting non-farm diversification are therefore essential complements if the program's economic gains are to become transformative rather than marginal. As one farmer in Nandanwadi explained,

> *"We have to take a loan every year… without credit, farming cannot continue."*

However, households also reported borrowing for **health care and social obligations**, which are *non-productive loans* that add to household strain.

Women's collectives described SHG loans being used both for farming and domestic needs:

> *"We get loans from the group… we use them for farming as well as for household expenses."*

Relative to incomes, debt consumed nearly **28% of annual earnings in treatment households and 29% in comparison households**, meaning that even input-linked credit, while productive, remains a structural burden. Farmers consistently emphasized that credit is both enabling and constraining: it is vital for production, but repayment pressures erode savings, and, as one FGD participant noted,

> *"Loans are every farmer's compulsion, but repayment is the biggest burden."*

Cost of production under regenerative agriculture

The midline did not include a full rupee-based cost of cultivation, therefore a complete per-acre cost comparison between regenerative and conventional production is not statistically estimable at this stage. What the report is confidently reporting here are fertilizer, bio-input usage, Irrigation (diesel/electric/solar), Labour cost, Machine hire and pesticide cost. Data show that chemical fertiliser application remains widespread across both groups, while RA plots introduce compost/FYM and bio-inputs rather than replacing chemicals entirely. Farmers consistently described a perceived reduction in fertiliser requirement after two or more seasons of composting and residue retention; however, the cost savings remain indicative rather than monetised, as most farmers are applying RA only on limited plot areas and are not yet selling produce separately in a regenerative premium market.

> *"Fertiliser spending is reducing slowly after using FYM and jeevamrit."*
>
> *- Farmer in Mohkhed*

Labour emerges as the **primary transition-stage cost driver**, but this is based on qualitative recall rather than expenditure data. Farmers uniformly reported that preparing jeevamrit, compost, mulches and intercrops increase labour/time requirements, especially collection and preparation labour typically handled by women.

Irrigation cost

S.No	Group	HHs with irrigation energy cost (%)	Mean irrigation cost (₹/HH/season)
1	Treatment	55.7%	**₹4,168**
2	Comparison	63.8%	**₹3,743**
3	RA adopters (≥3 practices, small N=20)*	75%	**₹6,905**

Because regenerative practices are being adopted alongside rather than in place of chemical fertilisers, and irrigation expenditure remains largely unchanged, the cost structure has not yet shifted in a way that enables net savings. The transition is currently **additive rather than cost-replacing**, meaning expenditures persist across both chemical and regenerative input streams. No rupee-value labour cost was reported; therefore labour-intensity can be inferred only through narratives, not calculated.

5.6 Ecological and Environmental Outcomes

Satellite and survey evidence show rising land stress, shrinking water bodies[22] (20%) and falling Kharif NDVI[23], yet RPLC villages buffer impacts through higher cropping intensity (163% T vs. 147% C), more irrigation (5.8 T vs. 3.9 C events), and stronger mechanisation. Soil remains fragile (48% low Organic Carbon), but treatment farmers adopt more composting (34% T vs. 21% C) and organic inputs (61% vs. 39%). Biodiversity is higher in treatment areas, especially in Kharif, with moderate agroforestry and livestock integration supporting resilience. Preliminary GHG emissions (1,977 tCO_2-e/yr) are fertiliser-driven, with totals likely underestimated due to missing benchmark numbers for irrigation and machinery data.

a. Land use and land cover

Geo-spatial analysis of land use and land cover (LULC) highlights notable changes in the Chhindwara Compact between February 2021 and February 2024, reflecting the post-Rabi harvest period. The

[22] Refers to shrinking of surface water area (for water bodies like, ponds, lakes, etc.) at midline compared to baseline (as per the reports shared by Farms.io)

[23] Normalized Difference Vegetation Index (NDVI) is a satellite-based measure of crop greenness, ranging from –1 to +1. Values <0.3 indicate stressed vegetation, 0.3–0.5 moderate, >0.5 healthy.

paired maps (*Figure 7*) show a visible reduction in cropland greenness and an expansion of bare-ground and built-up classes, particularly in central and northern Chhindwara. Water bodies have also contracted by roughly 20% over this period, signalling mounting pressure on shared surface water resources. While cropland remains the dominant land class, these shifts underline a gradual but persistent drift toward land degradation.

Household survey results reinforce this picture of intensifying pressure on agricultural land. Average holding sizes remain small (around 3.1 acres), but only 72% of land is cropped in both Kharif and Rabi. Of the total landholdings, around 28% remains fallow or is used as pasture land and non-crop purposes during Kharif. This explains why cropping intensity is below 200% despite multiple seasons of cultivation, and reflects both land scarcity and water availability constraints. Cropping intensity[24] is nonetheless higher in treatment villages (163%) compared to comparison (147%), supported by stronger mechanisation uptake (65% vs. 52% of households). Higher cropping intensity in treatment areas is closely linked to mechanisation: 65% of treatment households reported usage of a type of

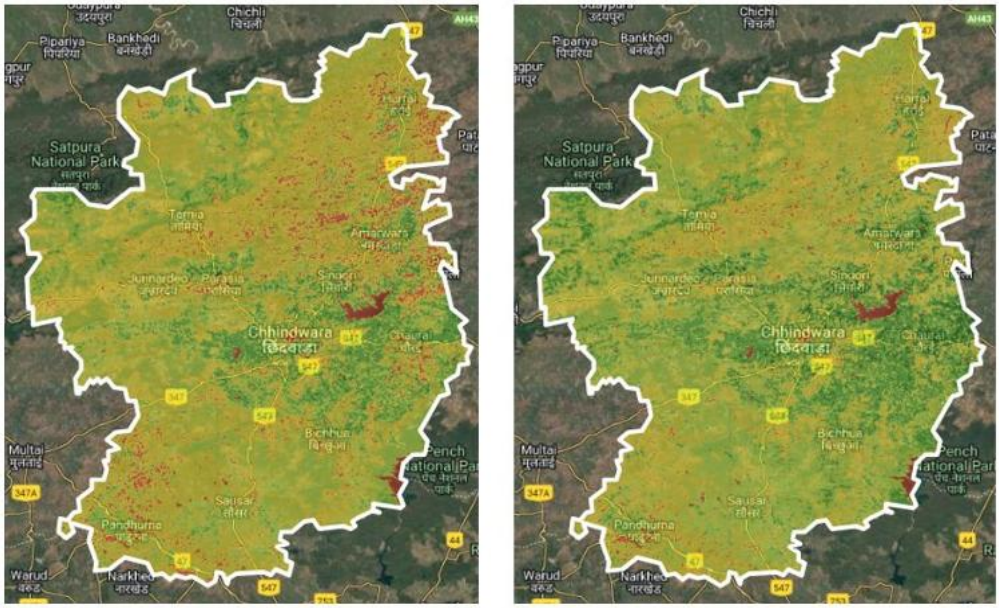


Figure 10: Normalized Difference Vegetation Index (NDVI) - Feb 2021 (left) vs Feb 2024 (right)

machine (;for either irrigation, tillage, etc.) compared to 52% of comparison households. This allows faster turnaround between crops and supports double-cropping even on small plots. These differences indicate that RPLC-supported households are sustaining multi-season cropping through technology and labour efficiency, partially countering the broader land-use stress evident in the satellite record.

Vegetation indices add further nuance. Kharif NDVI values have declined by around 0.13–0.15 points across blocks since 2020, mirroring erratic rainfall. By contrast, Rabi NDVI has increased by 0.10–0.12 points in the same period, even in years of negligible rainfall; thus reflecting stronger resilience due to irrigation and compost use. While the Kharif season remains vulnerable, the Rabi season shows clear ecological gains and this confirms that resilience in the dry season is largely management-driven, irrigation, mechanisation, and compost use, rather than rainfall-dependent. Taken together, the LULC evidence of expanding bare ground is tempered by NDVI and survey findings showing that treatment areas maintain higher cropping intensity and greenness, pointing to an active buffering of climate stress through improved farm management.

b. Biodiversity

Household survey data show that farmers in the Compact cultivate an average of 5.4 crop species annually, including main crops, border crops, and intercrops. Farmers growing more than 3 crops

[24] Cropping intensity measures how many times land is cultivated in a year. It is calculated as Gross Cropped Area ÷ Net Sown Area × 100. A value of 163% means that, on average, farmers are cultivating 1.6 crops per plot annually."

reported 18% lower income variability and 12% higher food security scores compared to mono-croppers, confirming the role of diversity in household resilience

> *"Other than the regular crops, we have now started growing vegetables as well. We sell these vegetables in local markets which helps us with weekly income.*
>
> *– Treatment Farmer FGD – Konda Savari, Sausar*

When these are translated into the Shannon Diversity Index (H′), clear differences emerge across blocks, seasons, and between Treatment and Comparison villages. The **heatmap** table illustrates these contrasts:

Table 17: Seasonal Shannon Diversity Index (H')

Season	Kharif H′		Rabi H′		Zaid H′		Overall H′	
Block	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**
Chhindwara	0.24	0.12	0.16	0.08	0.25	0.32	0.19	0.10
Mohkhed	0.27	0.23	0.20	0.08	0.24	0.17	0.24	0.16
Pandhurna	0.79	0.56	0.24	0.13	0.00	0.00	0.60	0.44
Sausar	0.94	0.64	0.34	0.25	0.33	0.00	0.80	0.52

How to read this heat map

An H′ = 0 indicates monocropping, i.e. only one crop is grown in that season (indicated in pale yellow). Higher values shaded green (closer to 1.0) represent greater resilience through balanced multi-cropping.

The strongest result here for Treatment Households in the survey in Sausar block (Kharif crops) (H′ = 0.94, deep green), signals a cropping system with multiple species sharing land relatively evenly.

Baseline estimates of crop diversity were reported in terms of the **number of crop species per household** (typically 3–4 in treatment vs. 2–3 in comparison), whereas the midline employs the **Shannon Diversity Index (H')**. The two metrics are not directly comparable, but both point in the same direction: treatment areas consistently exhibit higher diversity, especially in Kharif, while Rabi remains dominated by wheat and Zaid records negligible diversification. While simple crop counts provide a snapshot of how many species are grown, they cannot capture the **relative balance between crops**.

For example, a household growing four crops but allocating 90% of land to wheat and 10% to others would appear "diverse" in a count-based measure, but its Shannon Index would reveal low evenness. H′ therefore provides a more **robust indicator of biodiversity**, sensitive both to the number of species and the distribution of area among them. This richer metric is better suited to tracking regenerative agriculture outcomes and offers a stronger basis for comparing treatment and comparison groups going forward.

- **Kharif (Jun–Sep):** Diversity is visibly higher in treatment areas of Sausar (H′ = 0.94, dark green) and Pandhurna (H′ = 0.79, green) compared to their comparison counterparts (0.64 and 0.56). This reflects a stronger presence of intercropping (soybean–maize–pulses) and more balanced land distribution across crops. In contrast, Chhindwara and Mohkhed remain in the yellow zone (<0.30), where monocropping dominates.
- **Rabi (Nov–Feb):** Values are lower across the board (mostly <0.35), as wheat dominates seasonal planting. Still, treatment villages in Sausar (H′ = 0.34) and Mohkhed (0.20) show modestly higher diversity than comparison villages, where values dip closer to 0.10.
- **Zaid (Mar–May):** Diversity is negligible in most blocks, with values approaching zero (yellow), reflecting the limited adoption of summer crops. Only Chhindwara treatment households (H′ = 0.25) and Sausar (0.33) record moderate diversification in this season.

Higher crop diversity in **Sausar and Pandhurna** is shaped by both ecological advantages and program support. Remote sensing shows stronger Kharif greenness (NDVI 0.40–0.45), reflecting better rainfall and soil moisture compared to Chhindwara and Mohkhed, where NDVI has declined since 2020. Baseline assessments also found soils in these blocks to be more fertile and moisture-retentive, encouraging multiple cropping. Demonstrations further reinforced adoption: agroforestry uptake is 43% among demo-plot farmers, compared to 28% among FFS-only farmers.

By contrast, **Chhindwara and Mohkhed** show limited diversity despite outreach. Monocropping remains dominant, and gains in Rabi are largely explained by wheat's prevalence. Without ecological advantages and demonstrations, diversification has been slower to take hold. Farmers in these blocks highlighted **water scarcity** as the most binding constraint, particularly for Zaid crops. They also noted **lack of quality seeds, weak market demand for summer crops, and limited land availability** as barriers.

> *"Trees do not survive without irrigation; we only keep them on bunds"*
>
> *- FGD, Sausar*

> *"There is no space for extra crops, we stick to the main season crop"*
>
> *- FGD, Mohkhed*

These testimonies underline that while demonstrations and rainfall help, the **barriers of water, seed, demand, and land remain decisive in limiting crop diversity**, and must guide future interventions.

At midline, about **30% of surveyed treatment households** reported maintaining agroforestry plots (orchards, WADIs, or boundary plantations), compared to **12% in comparison households**. On average, farmers planted **68 trees per farm**, with a survival rate of roughly **60%**. Uptake is higher among **demo-plot farmers (43%)** than among **FFS participants (28%)**, indicating the influence of demonstration activities on practice adoption.

> *"We planted fruit trees and bund trees on the field border; in 3–5 years they will give shade and fuelwood, and our soil will improve."*
>
> *- Treatment farmer, FGD (Sausar/Pandhurna)*

In terms of diversity, farms reported an average of **3-4 species**, predominantly **fruit trees** such as mango and guava, alongside **fodder species** like subabul and sesbania. While agroforestry adoption has expanded significantly in program areas since the baseline (25%), species richness remains modest, highlighting the need for continued technical and extension support.

> *"With trees and intercrops, even if one crop fails, another gives some income."*
>
> *- Treatment farmer, FGD (Sausar)*

Farmers cite soil conservation and supplementary fodder as key benefits, aligning with regenerative objectives.

c. Soil health

Soil test results from June 2025 indicate a landscape marked by fragility. Nearly 48% of sampled farms fall in the low organic carbon (<0.5%) category (please refer to Annexure 2 for detailed categorisation), reducing water-holding capacity and biological activity, while a further 34% sit in the medium band (0.5–0.75%). pH values are predominantly neutral (6.5–7.5), but around 18% of soils are mildly alkaline (>7.5), constraining phosphorus uptake. Across all blocks, available nitrogen is low, and phosphorus and potassium show highly variable patterns, underscoring uneven fertiliser management and the cumulative effects of soil mining.

As discussed earlier, farmer data shows differences in management practice between treatment and comparison areas. Chemical fertiliser use is nearly universal (72%), but adoption of organic inputs is significantly higher in treatment villages (61% vs. 39%), with more households preparing pit-based

compost on-farm (34% vs. 21%). This signals a gradual shift toward regenerative inputs, though starting from a low baseline of soil carbon and nutrient reserves. Program households are also more likely to integrate manure from livestock into composting cycles, linking nutrient management with wider agroecological practices. Please refer to Annexure 1 for a detailed soil test result.

Taken together, the data suggest that while Chhindwara Compact's soils are inherently vulnerable, treatment households are beginning to rebuild resilience through organic matter management. Raising organic carbon levels remains the most powerful lever for buffering erratic rainfall, improving fertiliser efficiency, and reversing nutrient imbalances. Continued program emphasis on composting, cover crops, and balanced fertiliser use will be critical if soils are to move out of the "low organic carbon (OC) trap" that still affects nearly half of all farms.

d. Water management

At baseline (2021–22), irrigation access was limited: only **42% of treatment households** and **39.5% of comparison households** reported access. By midline (2025), access nearly doubled to **82% in treatment villages** compared to **63% in comparison**. Frequency also increased: **Rabi irrigations rose from 3.2 to 5.8 in treatment vs. 2.8 to 3.9 in comparison**. Kharif irrigations were not tracked at baseline, but midline data show **2.3 in treatment vs. 1.6 in comparison**.

A major programmatic distinction lies between **demo-plot and non-demo farmers in treatment villages. Non-demo plots** expanded irrigation largely through **electric and diesel pumps**, raising total water applied. These farmers achieved higher yields (e.g., wheat at 16.4 q/acre vs. 14.7 in comparison), but with **lower water-use efficiency per unit of water** when using irrigation counts as a proxy. **Demo plots**, by contrast, often received **drip irrigation kits**. Here, each "irrigation" applies far less water than conventional flood irrigation, so yield per cubic metre is significantly higher. This indicates that treatment gains are not only volume-driven but also **efficiency-driven where micro-irrigation is adopted**. **Micro-irrigation adoption rose from 19% at baseline to 34% at midline in treatment areas** (vs. 22% in comparison), concentrated among demo-plot farmers. This demonstrates that efficiency-enhancing technologies are taking root but remain unevenly spread.

Therefore, Treatment farmers improved resilience in two distinct ways: by **broadening access and frequency of irrigation** (especially among non-demo farmers) and by **enhancing water-use efficiency through drip irrigation on demo plots**. Yield gains across the program are thus a combination of **volume-driven expansion** and **efficiency-driven innovation**. However, without volumetric waterlogs, aggregate WUE estimates remain approximate, and scaling efficiency gains beyond demo plots is essential for long-term sustainability.

e. Avoided GHG emissions

Using the FAO EX-ACT tool, GHG emissions were estimated from agricultural inputs in the project area. Based on the available data, the total emissions currently amount to about 1,977 tonnes of CO_2-equivalent per year. Almost all of this comes from the use of synthetic fertilisers, particularly urea, which alone contributes around 1,365 tonnes of CO_2-equivalent. Other nitrogen fertilisers add roughly 308 tonnes, while phosphorus- and potassium-based fertilisers contribute another 274 tonnes in total. A small additional share comes from nitrogen applied to irrigated rice.

Table 18: Emission Sources

Sl. No.	Source (Inputs)	Quantity entered	tCO2-e (field + supply chain)
1	Urea	86.15 t urea/yr	1,365
2	Other synthetic N (as N)	11.14 t N/yr	308
3	P_2O_5 (as product)	76.88 t/yr	226
4	K_2O (as product)	21.95 t/yr	48
5	N in continuously irrigated rice (as N)	1.24 t N/yr	30
	Total – Inputs		1,977 tCO_2-e/yr

At this stage, the calculation only includes fertilizer use. Other important emission sources such as irrigation pumping, tractor and machinery fuel, and pesticide use are not yet reflected in the results because the necessary data is not available for baseline estimates. Therefore, the analysis remains incomplete until irrigation energy, machinery use, pesticides, and baseline ("without project") values are incorporated. While the first set of results presented above reflects total emissions from inputs at the landscape scale (1,977 tCO_2e/yr), disaggregated crop-level estimates per hectare are accessible under Indicator 7 of the results framework (Table below). The EX-ACT results show a **substantial reduction in emission intensity per hectare** compared to baseline benchmarks, even though the current estimates reflect fertiliser-related emissions only. Cotton emissions declined from 3.6 to 0.45 tCO_2e/ha, maize from 3.9 to 0.56 tCO_2e/ha, wheat from 3.8 to 0.56 tCO_2e/ha, and soybean and groundnut dropped to 0.33 tCO_2e/ha. This sharp decrease indicates improved nutrient efficiency and lower fertiliser-driven emissions across the landscape, aligning with the program's objective of reducing GHG intensity from agriculture. **These values should be interpreted with caution**, as the baseline GHG figures are not directly traceable or clearly evidenced in the original baseline documentation. The baseline table reports substantially higher values (3.2-3.9 tCO_2e/ha for major crops), whereas the methodological notes in the baseline report suggest emission levels closer to **below 1 tCO_2e/ha**, resulting in a discrepancy that cannot be validated with the available source material.

Table 19: Crop-wise GHG emissions

SN	Crop	Baseline (MT CO_2e/ha)	Midline (MT CO_2e/ha)
1	Cotton	3.6 MT CO2 eq/ha	0.45
2	Maize	3.9 MT CO2 eq/ha	0.56
3	Wheat	3.2 MT CO2 eq/ha	0.56
4	Groundnut	3.8 MT CO2 eq/ha	0.33
5	Soyabean	1.2MT CO2 eq/ha	0.33

5.7 Potential of integrating women-centric intervention

Women in treatment villages demonstrate greater participation in regenerative practices, stronger engagement with trainings and markets, and higher collective membership, translating into improved confidence and voice. Yet, decision-making over cropping and income remains only partially shared, and drudgery-heavy tasks such as harvesting and residue management are under-mechanized, highlighting both progress toward agency and persistent structural constraints.

The baseline did not include a stand-alone gender module; therefore, rigorous pre-post comparisons for women's outcomes are limited. Midline adds explicit gender indicators. All quantitative results below are Midline Treatment vs. Comparison; qualitative patterns are triangulated from women's collectives FGDs, farmer IDIs, and village-level FGDs. These are interpreted through MOSER [Practical Gender Needs (PGN) vs. Strategic Gender Interests SGI)] and a GESI lens (access, participation, agency, power/relations, and systems).

Women's participation in regenerative practices

The qualitative information in the baseline report showed that women execute most routine field operations (such as bar ploughing); practices embedded in those routines diffuse earliest. Interpretation of these through MOSER framework lens suggests that these are practical gender needs known as PGNs where knowledge and low-cash practices that reduce input dependence and fit women's time constraints are considered useful.

A woman from the treatment area linked the new practices to lower input costs:

> *"With all this, our spending, especially on fertiliser, has gone down."*
>
> *- FGD with women's collective in a treatment village*

Another farmer explained that mulching is now routine field care:

> *"In regenerative farming now, we keep mulch on the field as a regular practice."*
>
> *- FGD with women's collective in a treatment village*

Access to training, input, and decision-making

Access to training, inputs, and decision-making shows clear treatment advantages alongside areas requiring structural change.

The data shows high levels of financial inclusion among women in both groups: bank or digital account ownership is around 95% in treatment and comparison groups, and independent use of the account is similarly high (approximately 95% in both). Group membership is stronger in treatment villages, with

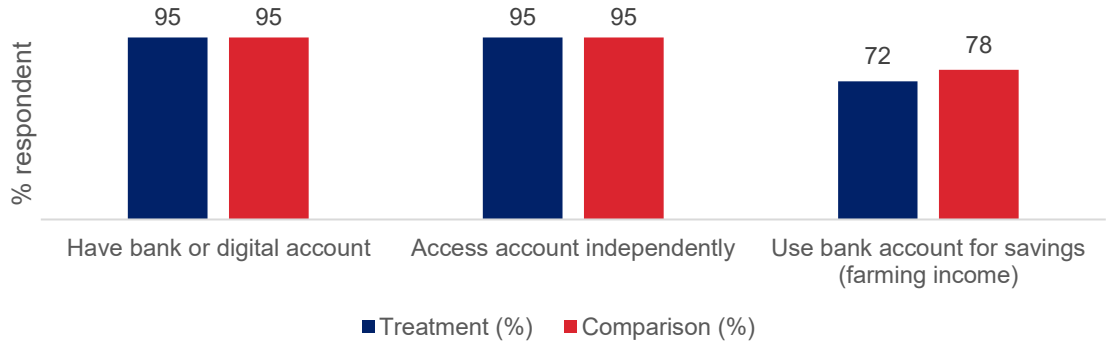


Figure 11: Access to financial resources

around 75% of women being members of Self-Help Groups or Farmer Producer Organisations, compared with only 48% in comparison villages. Taken together, this suggests that while financial access is near universal, program effects are most visible in expanding women's collective participation.

As one woman in a treatment village noted,

> *"Earlier we did not know about these trainings. Now they call us, and we also go to see how to prepare organic fertilisers and medicines."*
>
> *- Treatment Farmer IDI, Badgona, Mohkhed*

Women in the treatment villages demonstrate stronger engagement with trainings: 18% of women who did not attend earlier now attend, compared with 8% in comparison villages, and only 40% of women in treatment villages reported never attending, against 75% in comparison villages. Although higher participation in trainings among treatment farmers is a natural outcome of program targeting, qualitative evidence suggests that the substantive impact lies in the way these trainings have enhanced women farmers' decision-making capacities, confidence, mobility, and recognition within households and communities.

Improved Decision-Making

Farmers consistently reported that training helped them better calculate costs and returns, moving beyond traditional habits. One farmer reflected:

> *"Earlier, we did not know that using chemicals would increase our costs so much… now we keep accounts, noting how much is spent and how much income comes back."*

Exposure visits and demonstrations strengthened their confidence to try new crop combinations and bio-inputs:

> *"When we went to see other farmers doing organic cultivation, we understood that this type of farming is better."*

Confidence and Mobility

Women's collectives highlighted a marked shift in confidence. Where earlier they relied on male family members for transactions, they now engage directly:

> *"Now we go to the market ourselves and make purchases; earlier only husbands or sons used to go."*

Ambamali participants shared that repeated training enabled them to independently prepare inputs such as *jeevamrit* and *dashparni*:

> *"We learned how to make the microbial solutions, and then we applied them in our own fields. Earlier we depended on outside supply, now we can make it ourselves."*

Agency within Households and Community Recognition

Women in treatment villages also described a shift in intra-household relations, moving from passive participation to active decision-making:

> *"Earlier we only attended meetings, but now we take decisions about which inputs to use and how much to save in the SHG. Even men acknowledge this contribution."*

In some villages, trained farmers have become local resource persons:

> *"People now call us to guide them. What we learned in the training, we are passing on to others."*

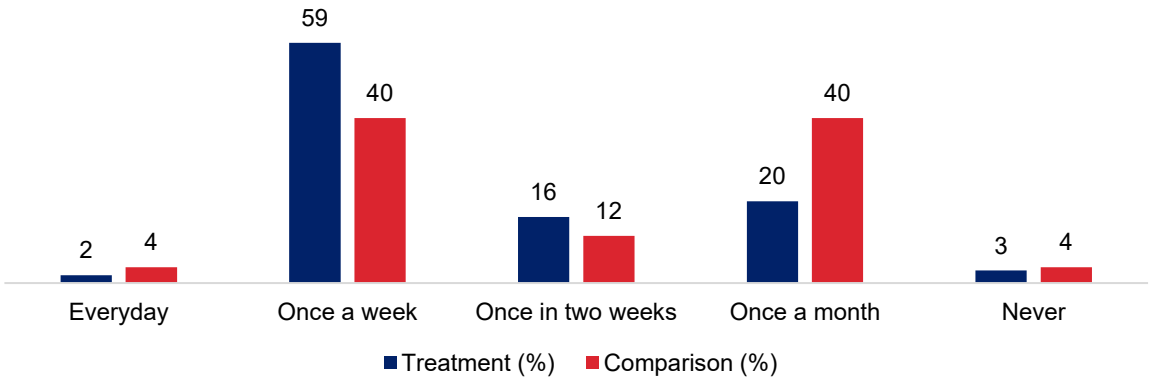


Figure 12: Women reporting frequency of market visits

Market interface has also shifted: 25% of women in treatment villages reported going to the market more frequently after program participation, compared with 17% of women in comparison villages, and 27% of women in treatment villages reported that they did not go earlier but do now, compared with 10% in comparison villages. This indicates that exposure to training and markets is no longer marginal but progressively mainstreaming women's visibility in economic spaces.

Women in treatment villages also articulated that training itself enabled greater mobility. Earlier they rarely left home, but now they routinely travel together for trainings and exposure visits. As one participant explained,

> *"Earlier we did not leave home, but now when there is training, we go out together."*

Others emphasized that without training they would not have abandoned chemical use or adopted new practices-

> *"On our own we would not have suddenly stopped using chemicals… it was only after being taught in training that we started."*

This indicates that training not only enhanced knowledge but also created socially acceptable opportunities for women to step into public and economic spaces, reinforcing the observed increase in their market participation.

> *"Before, I never went to the market. Now after joining the group, I also go with other women to sell vegetables."*
>
> *- Treatment Women's Collectives FGD, Ghoghari, Sausar*

Confidence indicators move in tandem: 75% of women in treatment villages reported that they feel confident solving farm-related problems compared with 71% in comparison villages, and 71% of women in treatment villages have reportedly spoken in public or community meetings, compared with 46% in comparison villages.

> *"Earlier, I would remain quiet in meetings. Now, after being in the women's group, I also speak when there is discussion on farming or loans"*
>
> *- Treatment Women's Collectives FGD, Rangin Khapa, Chhindwara)*

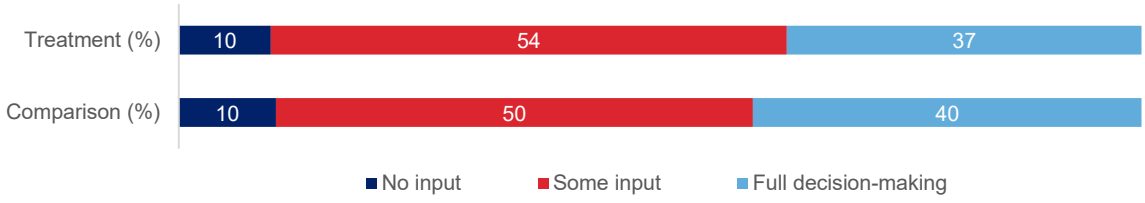


Figure 13: Inputs (by women respondents) during crop-planning

On crop-planning decisions specifically, 37% of women in treatment villages compared with 40% in comparison villages report full decision-making power, while over half report only "some input." In a related self-assessment, 40% of women in treatment villages say they have a "complete say," while 21% report "no say." This points to rising self-confidence and public articulation, even as entrenched patterns of partial influence over cropping decisions continue to constrain full agency.

Interpreted through the MOSER framework, training schedules, group platforms, and liquidity are Practical Gender Needs; the shifts in market presence, public speaking, and perceived say over cropping mark movement toward Strategic Gender Interests; who decides, who transacts, and whose

voice is recognized[25]. In terms of Gender Equality and Social Inclusion, women are moving from access to agency, and into power and relations intra households and local fora. For instance, 71% of women in treatment villages reported speaking in public or community meetings compared to 46% in comparison areas, and 75% were members of SHGs/FPOs versus 48% in comparison. These shifts reflect early gender-transformative change, with women negotiating not just access to resources but also recognition and authority in broader institutional spaces. This reflects early gender-transformative change, with women beginning to negotiate not just access but recognition and authority within broader institutional spaces.

Household decision-making over farm income tilts toward jointness in both groups and is stronger in treatment villages: joint decision-making stands at approximately 77.6% in treatment villages versus 72.5% in comparison villages, with "self" decision-making by women at 19.1% in treatment villages and 24.8% in comparison villages. These patterns suggest that the program is nudging households toward



Figure 14: Decision-maker on farm income usage

greater jointness, consolidating relational equality in financial decisions while women's independent financial authority still remains limited.

> *"We, husband and wife both, work in the field, so decisions on crops and income are taken jointly."*
>
> *- Comparison Farmer IDI, Sawangi, Sausar*

Division of labor and the impact of mechanisation

Mechanisation is widespread: any agricultural machinery used in the last 12 months is 86% in treatment and 88% in comparison. By operation, land preparation (94% treatment; 97% comparison), spraying (66% treatment; 72% comparison), and irrigation (58% treatment; 59% comparison) are the most mechanized.

Two gaps matter for women's workloads. First, harvesting is less mechanized in treatment (23%) than in comparison (30%). Another gap-and most consequential for women's drudgery- is that the residue management remains very low among both groups (5% treatment; 8% comparison). Farmers' descriptions point to labor-intensive post-harvest tasks:

> *"For creepers we set up the machaan (trellis), dig pits, fix bamboo, lift vines, otherwise the crop spoils on the soil". Others contrasted mulching with "old" manual methods "Green mulching gives better output… our old way gives less."*
>
> *- FGD, Women Collectives*

[25] Gender outcomes were assessed using the MOSER framework, which examines practical needs (such as training, credit, and tools) and strategic interests (such as agency, participation, and leadership). In simple words, we looked not only at whether women received support, but also whether they gained greater influence in farming and household decisions.

but mechanized residue solutions (e.g., in-situ chopping, drill-cum-seeding) were not commonly cited in either group. National and regional literature highlights this gap: adoption of mechanized residue management (Happy Seeder, Super Seeder, Straw Management Systems) is still concentrated in pockets, despite documented benefits for soil health, yield, and pollution reduction.[26] [27] [28] Programmatically, India's Sub-Mission on Agricultural Mechanisation now promotes Custom Hiring Centres to broaden access, an avenue to target women-intensive operations such as residue handling.[29]Hence, the drudgery-heavy edge of women's work such as harvesting support and residue handling, remains under-mechanized, signaling a clear target for tool portfolios and service models.

About 41% of treatment households report labour-cost savings due to machinery (53% comparison), with average reported savings of roughly INR 5,300 per season (INR 5,164 comparison). Farmers linked irrigation equipment to time and labour compression:

> *"With mini-nozzles we finish faster; two to three hours wets an acre" and contrasted this with rising daily wages and input prices, which sharpen the payoff from mechanisation: "Wages have gone up… ₹300–₹400 a day now; chemicals too are costlier."*
>
> *- IDI Farmers*

FAO and ICAR emphasize these same pathways, timely operations, reduced drudgery, and lower per-unit costs, when machines are suited to smallholders and reliable services exist.[30] [31] Overall, where machines substitute peak-time labour or speed-up critical operations, households translate time savings into measurable cost savings, even under rising wage and input costs.

Aligned to GESI, mechanisation clearly addresses access to tools and eases time and physical strain; yet the strategic payoff depends on who controls the machines and who captures the time savings, and whether tool type explicitly target women-intensive operations (e.g., residue handling, post-harvest lifting). Global evidence cautions that mechanisation can reallocate women's time toward non-farm work only when control barriers are addressed and services are inclusive; otherwise, benefits accrue disproportionately to men.[32] [33] In this light Practical Gender Needs in terms of drudgery reduction are being met, but conversion to Strategic Gender Interests will require institutional design, ownership and service pathways (e.g., Custom Hiring Centres run by Self-Help Groups or Water User Groups) under

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[26] Kaur, M., Malik, D. P., Malhi, G. S., Sardana, V., Bolan, N. S., Lal, R., & Siddique, K. H. M. (2022). Rice residue management in the Indo-Gangetic Plains for climate and food security: A review. Agronomy for Sustainable Development, 42, Article 92. https://doi.org/10.1007/s13593-022-00817-0

[27] Singh, R., Pratibha, M., Chaudhari, S. K., & Singh, A. K. (2021). Last-mile delivery of conservation agriculture in India: Business models, capacity needs and government programmes. Journal of Agricultural Physics, 21(1), 295–308. http://www.agrophysics.in

[28] The Nature Conservancy India (TNC India), Borlaug Institute for South Asia (BISA), International Maize and Wheat Improvement Center (CIMMYT), Precision Agriculture for Development (PAD), & Tata Trusts. (2022). *Happy Seeder and Super Straw Management System (HARIT Project fact sheet)*. HARIT Initiative. https://www.tncindia.in/content/dam/tnc/nature/en/documents/india/HARIT-FactSheet.pdf

[29] Government of India, Ministry of Agriculture & Farmers Welfare. (2024). *Revised operational guidelines: Sub-Mission on Agricultural Mechanisation (SMAM)*. Department of Agriculture & Farmers Welfare. https://farmech.dac.gov.in/Content/Homepdf/Revised_Operational_Guidelines_SMAM_%282024%29.pdf

[30] Government of India, Department of Agriculture & Farmers Welfare, Farm Machinery Training and Testing Institute. (2024). *Annual report 2023–2024*. Government of India. https://srfmtti.dacnet.nic.in/assets/pdfs/Annual%20Reports/2023-2024.pdf

31 Indian Council of Agricultural Research. (2024). Annual report 2023–24 [Annual Report]. Indian Council of Agricultural Research. https://icar.org.in/sites/default/files/2025-04/ICAR%20Annual%20Report%202023-24-english.pdf

[32] Takeshima, H., & Diao, X. (2021). *Agricultural mechanisation and gendered labor activities across sectors: Micro-evidence from multi-country farm household data* (Discussion Paper No. 02066). International Food Policy Research Institute.https://cgspace.cgiar.org/server/api/core/bitstreams/29383101-b0a4-408b-b188-70596e609419/content

[33] Food and Agriculture Organisation of the United Nations. (2023). *Integrating gender in agricultural mechanisation strategies* [Policy brief]. Food and Agriculture Organisation. https://openknowledge.fao.org/items/148a3924-003b-4ed8-8cf9-00deef447535

SMAM guidelines.[34] This suggests despite improvement in the access, agency hinges on governance of machines and services such as who decides, who rents, and whose workloads are actually reduced.

Empowerment pathways

Taken together, the midline shows a coherent staircase of change. At the base are PGNs: reliable access to finance, groups, training, and RA know-how; adoption of routine, low-cash practices; and selective mechanisation that eases demanding tasks. These combine to expand women's participation and agency, they attend more training, visit markets more frequently, keep records more often, and, crucially, participate in joint financial decisions at high rates. The next riser on this staircase is power and relations- translating participation into voice in decisions about income use, cropping choices, and dealings with external actors. The top riser is systems change formalizing women's control over assets (e.g., naming women on subsidy-supported implements/irrigation assets; women-run custom hiring nodes for residue/intercultural equipment), embedding direct payment flows into women's accounts for produce sales, and institutionalizing women's representation in producer organisations and GPDP fora.

Nationally representative data show women shoulder far more unpaid work than men, which can dampen the realized benefits of training and mechanisation unless time-use constraints are explicitly addressed (e.g., scheduling, childcare at trainings, women-first access windows at CHCs, and equipment that substitutes the tasks they perform). This is exactly where MOSER's bridge from practical support (timing, tools, liquidity) to strategic outcomes (control, voice, leadership) becomes critical, and where GESI prompts the program to keep sight of relations and systems- who decides, who is listed, who speaks.

5.8 Beyond Roads and Water: Integrating Agriculture and Gender in GPDPs

Treatment villages, show early signs of shifting the agenda beyond roads and water toward agriculture, irrigation, and climate-resilient farming, with women increasingly voicing priorities through SHGs and CLFs. While perceptions of effectiveness are more positive in treatment areas, structural barriers such as meeting timing, slow implementation of gender-specific interventions, and limited women's autonomy continue to constrain meaningful engagement.

Participation in the Gram Panchayat Development Plan (GPDP) process continues to provide an important window into the ways households articulate development priorities and negotiate their inclusion in local governance structures. The data shows that awareness of the GPDP remains uneven, but engagement levels are relatively high. Just over half of treatment households (including males and female) (52%) reported having heard of the GPDP compared with 45 % in comparison villages. Despite this gap in awareness, nearly four in five households in both groups (78%) reported having participated in GPDP meetings or related activities.

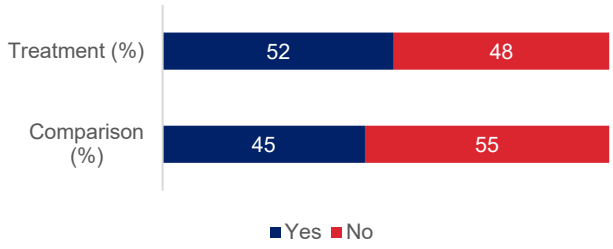


Figure 15: Awareness of GPDP

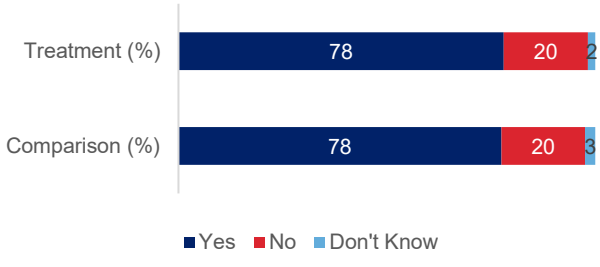


Figure 16: Participation in GPDP Reported

34 Government of India, Ministry of Agriculture & Farmers Welfare. (2024, September 20). Revised operational guidelines: Sub-Mission on Agricultural Mechanisation (SMAM). Department of Agriculture & Farmers Welfare. https://farmech.dac.gov.in/Content/Homepdf/Revised_Operational_Guidelines_SMAM_%282024%29.pdf

Qualitative testimonies, however, suggest that participation (reported during the survey) is often interpreted as physical presence rather than substantive involvement. As one farmer in Sausar said, *"Even if we do not speak, being present is necessary; otherwise, people say we are not part of the village decisions."* This explains a pattern in which attendance may be inflated by social norms of collective obligation, while actual deliberative participation remains more limited.tr

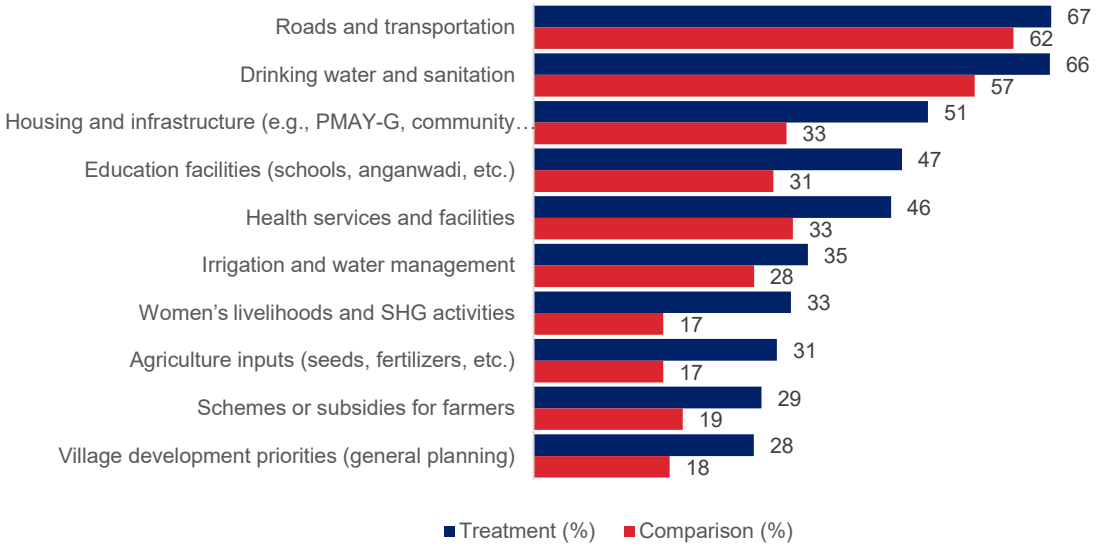


Figure 17: Topics discussed in the GPDP meeting

The agenda of GPDP discussions continues to be dominated by basic infrastructure concerns, with road connectivity, drinking water, and housing emerging as the most cited priorities.

These findings resonate with national-level studies that consistently highlight how Panchayat planning, especially in rural contexts, has historically been oriented towards visible infrastructure rather than sectoral investments in agriculture or livelihoods.[35] What is noteworthy, however, is that in treatment villages there is evidence of a gradual shift towards agriculture-related deliberations. 35% of respondents in treatment areas reported that irrigation and water management were taken up in GPDP meetings compared to 28% in comparison areas.

Similarly, 29% in treatment areas recalled discussions on farmer schemes, compared to only 19% in comparison villages, and a small but visible share (6% vs 4%) mentioned climate-resilient farming. Focus group discussions reinforce this finding: a woman SHG member in Mohkhed said,

> *Earlier we only spoke of roads and houses; now we ask for water-saving schemes and training on new farming methods."*

Such testimonies suggest that exposure to regenerative agriculture and allied interventions is beginning to diffuse into the GPDP process, diversifying its agenda beyond traditional infrastructure priorities.

Perceptions of GPDP effectiveness are relatively positive but marked by differences across groups. 68% of treatment households reported that the GPDP had brought positive changes, compared to 59% in comparison areas. Households most frequently associated these changes with the introduction of new schemes, better water facilities, and the creation of farming infrastructure such as storage units

[35] Ministry of Panchayati Raj, Government of India. (2023). *Annual Report 2022–23*. New Delhi: GoI.

and input supply points. However, qualitative interviews highlight that outcomes are uneven, and time lags often dilute the credibility of the process. A farmer from Chhindwara noted,

> *"We hear promises every year, but only some things get sanctioned. Water was discussed three years ago, but only this year work has started."*

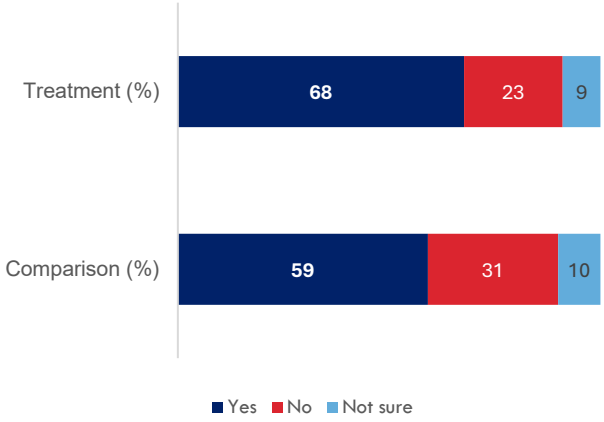


Figure 19: % respondents reported changes in village planning since the onset of GPDP

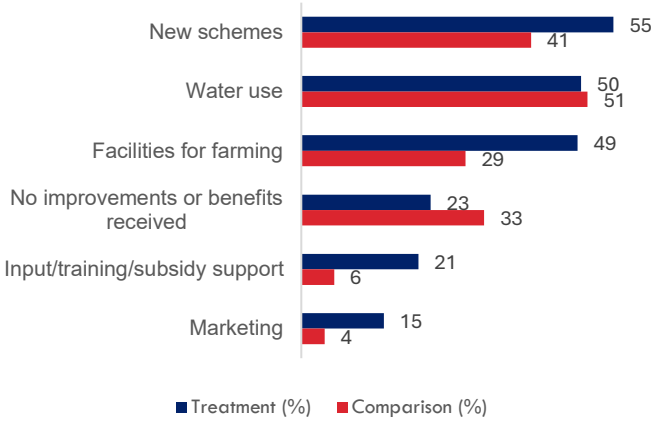


Figure 18: Benefits reached the farmers post GPDP

Such accounts highlight an important structural constraint: while GPDPs provide a space for articulating priorities, the translation of plans into timely implementation remains inconsistent. This is consistent with other evaluations of decentralized planning in India, which find that gaps between planning and execution often weaken trust in participatory institutions.[36]

The gendered dynamics of GPDP participation show both promising advances and persistent barriers; 35% of treatment women reported participation in the trainings. Nearly four in five women in treatment

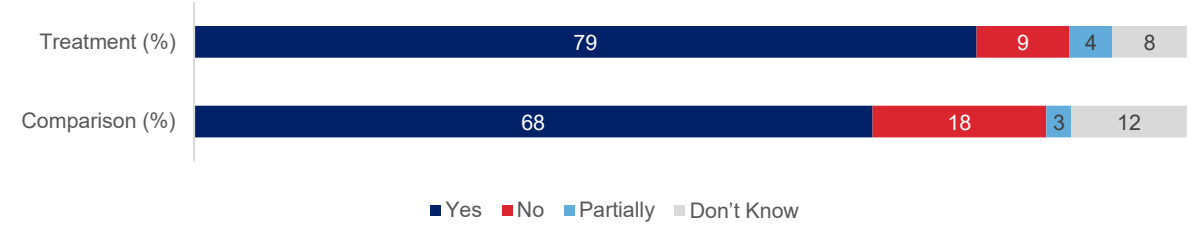


Figure 20: Perceived Inclusion in Village Planning

villages (79-80%) reported that their priorities were reflected in the plan, compared to around 68-73 % in comparison areas. Moreover, 71% of women in treatment areas felt their suggestions had translated into some form of action, compared to 67% in comparison villages.

These quantitative patterns are reinforced by qualitative narratives pointing to a gradual broadening of women's voices. At the same time, structural obstacles continue to constrain meaningful engagement. A large majority of women respondents in treatment villages (70%) expressed the need for women-only meetings where they could articulate priorities without hesitation. Almost half identified inconvenient

[36] UNESCAP. (2022). *SDGs and Gram Panchayat Development Planning in India*. Bangkok: United Nations Economic and Social Commission for Asia and the Pacific.

meeting times as a barrier, and between 30-40% emphasized the need for training to better understand GPDP processes.

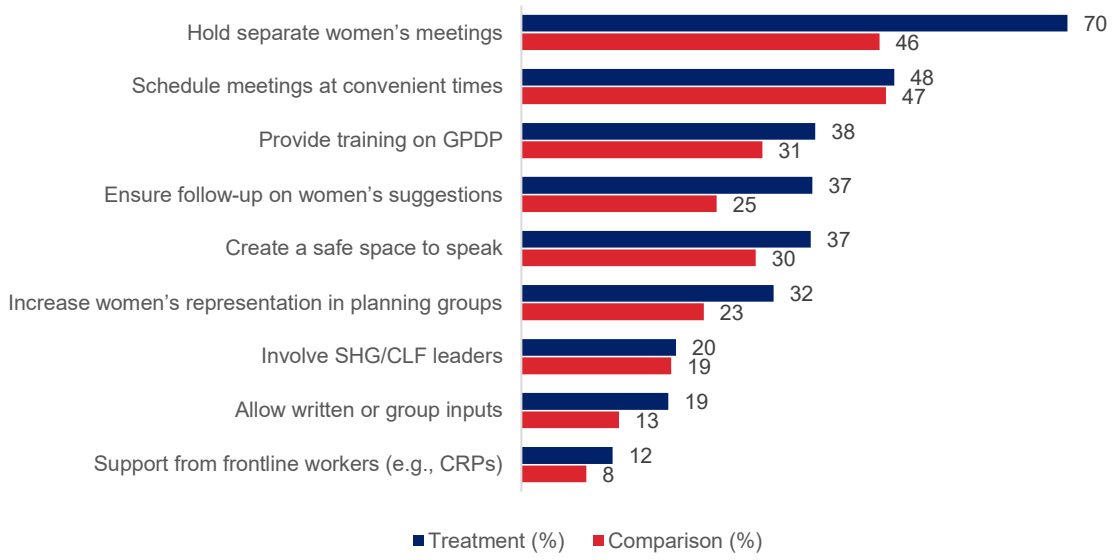


Figure 21: Suggestions for Enhancing Women's Participation in GPDP for Farming and Livelihood Needs

As one SHG leader in Pandhurna explained, "When meetings happen late evening, we cannot go because of household work. If there are separate women's meetings, we can speak freely." This finding resonates with wider research on women's participation in local governance, which shows that while constitutional amendments and quotas have dramatically expanded women's descriptive representation, substantive influence often depends on complementary measures such as training, peer support, and institutional innovations.[37]

Perhaps the most striking gendered finding is women expressed preference for engaging collectively through Self-Help Groups (SHGs) or Cluster-Level Federations (CLFs) rather than individually. This pattern mirrors broader national trends in which SHGs have become a central mechanism for women's empowerment, allowing members to build confidence, pool voice, and exercise influence over local decision-making. Studies from states such as Meghalaya and Bihar have shown that SHG platforms not only improve women's economic outcomes but also increase their capacity to engage with Panchayati Raj Institutions.[38] In this context, the reliance on SHGs and CLFs as vehicles for GPDP engagement in treatment areas signals a promising pathway for embedding women's priorities into local planning processes in a sustained manner.

[37] ResearchGate. (2023). *Impact of quotas for women in village-level local governance bodies in India on women's political participation and agency*. https://www.researchgate.net/publication/377337528

[38] Poverty Action Lab (J-PAL). (2017). Strength in Numbers: The impact of SHGs on women's empowerment in India. Cambridge, MA.

6. Summary of Findings

The midline assessment of the RPLC shows a nuanced and comprehensive picture of a program at a critical juncture. The results on most of the indicators show progress in fostering the adoption of regenerative practices and catalysing social empowerment, particularly for women. However, this progress is set against a backdrop of deeply rooted agricultural settlements and persistent ecological vulnerabilities. The analysis indicates that while the program's foundational strategies are effective, the transition to a fully regenerative and resilient landscape is a long-term endeavour that requires a strategic intensification of efforts. To summarise the findings and provide a strategic way forward for the programmer, findings are mapped against the OECD DAC criteria, and how do they inform the various stakeholders of the initiative are discussed below:

Relevance

The midline confirms that **RPLC interventions are highly relevant to the resilience and livelihood needs of farming households.** Farmers in treatment villages are diversifying their production systems, with cropping intensity increasing from 139 percent at baseline to 163 percent at midline, compared to 147 percent in comparison areas. Intercropping has expanded substantially, from less than 10 percent at baseline to nearly 37 percent of treatment households. NDVI imagery corroborates stronger vegetative cover in treatment villages during poor rainfall years, indicating higher ecological resilience. Farmers also report improved pest control and soil texture through border crops and FYM use.

For **implementation partners**, this demonstrates that the interventions are responsive to farmers' core needs, though greater emphasis on reducing chemical dependence is required. For **IDH**, it validates the strategic relevance of regenerative agriculture, while acknowledging persistent systemic barriers such as fertiliser subsidies. **Funders** can see clear alignment with farmer priorities, and the **private sector** can note that diversification into soybean, cotton, vegetables, and horticulture creates new opportunities for regenerative sourcing.

Coherence

RPLC has begun to align its activities with larger state and national programs. Convergence is visible with PM-KSY on irrigation, SMAM on mechanisation, and NMSA on sustainable agriculture. Government stakeholders interviewed during the midline acknowledged that demo plots complement their objectives but stressed the need for standardized monitoring so that RPLC data can be integrated into official reporting. Implementation partners noted that fragmented departmental mandates limit coordination, but IDH's convening role was recognized as pivotal in bridging across institutions.

For **IPs**, this coherence points to a stronger role in block-level convergence. For **IDH**, it underscores the importance of embedding RPLC into policy frameworks. **Funders** are presented with an opportunity to strengthen durability through co-financing models, while the **private sector** can find space in these partnerships to provide input and service support.

Effectiveness

The program shows encouraging but uneven progress across the six impact areas. Compost/FYM use increased to 82 percent of treatment households compared to 77 percent in comparison. Agroforestry adoption reached 43 percent among demo farmers, far above the 28 percent of non-demo and 12 percent of comparison households. Irrigation access has more than doubled since baseline, with micro-irrigation adoption increasing from 19 to 34 percent. Women's participation is now at parity, with more than three-quarters expressing willingness to adopt regenerative practices.

Table 20: Adoption and Productivity Indicators, Baseline vs Midline

Indicator	Baseline (Treatment)	Midline (Treatment)	Midline (Comparison)
Cropping intensity	139%	163%	147%
Intercropping (Kharif)	<10%	36.8%	16.8%
Compost/FYM adoption	61%	82%	77%
Agroforestry adoption	–	30% (43% demo)	12%
Irrigation access	42%	82%	63%
Micro-irrigation adoption	19%	34%	27%

For **IPs**, the results show demo plots are effective, but spillovers remain weak. For **IDH**, the findings validate the landscape model but highlight risks of uneven diffusion. **Funders** see measurable ecological and economic outcomes, while the **private sector** must recognize that sustained adoption depends on reliable market assurance.

Efficiency

While demo plots deliver strong adoption outcomes, they are resource intensive. Training-only approaches have weaker results, highlighting the need for hybrid models that combine cluster-based demos with low-cost training and digital advisory services. Monitoring gaps — particularly incomplete soil and GHG testing, and absence of farmer-level IDs — limit efficiency in data use.

For **IPs**, efficiency calls for refining delivery models to improve scalability. For **IDH**, standardized monitoring systems are essential. **Funders** can enhance efficiency by investing in robust data infrastructure, while the **private sector** can contribute by leveraging existing networks for digital advisory and input services.

Impact

The program is reshaping household resilience, ecological outcomes, and institutional practices. Average household income in treatment villages is **13% higher** than in comparison areas, and crop diversification has strengthened significantly, with farmers cultivating **5.4 crop species annually vs. 3.2 in comparison**. Ecological indicators show parallel shifts- **Shannon Diversity Index in Kharif (Sausar) is 0.94 compared to 0.64 in comparison villages**, and NDVI imagery indicates healthier biomass retention across Rabi landscapes.

Regenerative agriculture is gaining traction across the landscape. Adoption of compost/FYM has reached **82.1% among treatment farmers**, intercropping in Kharif has expanded to **36.8%**, and agroforestry features are reported by nearly **30% of households**, with diffusion strongest around demo-plot clusters. SHGs and CLFs have begun functioning as institutional anchors, improving last-mile input access and embedding RA in GPDP-linked planning processes.

Water-use dynamics show measurable efficiency gains. With irrigation access rising to **82% of treatment households vs 63% comparison**, and **74% irrigating at critical flowering/fruiting stages**, water productivity has improved across multiple crops. **Water Use Efficiency (WUE)** demonstrates clear increases relative to current benchmarks:

The largest improvement is visible in **Maize**, where farmers are generating substantially higher grain output per millimetre of water applied. Soybean and cotton also show moderate gains, reflecting better irrigation scheduling and improved soil moisture retention.

Cropping intensity has increased from **139% at baseline to 163% in treatment villages**, compared to **147% in comparison**, indicating sustained multi-season cultivation. Meanwhile, **preliminary GHG**

emissions are estimated at 1,977 tCO_2-e/yr, largely fertiliser-driven, highlighting the next pivot required, improving nutrient efficiency to shift from additive to substitution-based regenerative inputs.

Table 21:Outcome Indicators, Baseline vs Midline

S.No	Outcome Indicator	Baseline (T)	Midline (T)	Midline (C)	Notes
1	Average household income (INR)	126,830	**168,035**	146,570	+13% over comparison
2	Crop species per farm	3.1	**5.4**	3.2	Strong diversification
3	Shannon Index (Kharif, Sausar)	–	**0.94**	0.64	Midline only
4	SOC (%)	0.49–1.05	**0.61–0.65**	0.61–0.64	Modest gains
5	Irrigation frequency (Rabi)	3.2	**5.8**	4.6	Higher stage-wise irrigation
6	**Regenerative Adoption (FYM)**	60.2%	**82.1%**	77%	RA momentum sustained
7	**Water Use Efficiency (WUE)**	Improved across crops			See table no.8
8	**Cropping Intensity**	139%	**163%**	147%	Higher multi-season utilisation
9	**GHG Emissions**	–	**1,977 tCO_2-e/yr**	–	Refer to section

The program is reshaping household resilience, ecological outcomes, and institutional practices. Average incomes in treatment villages are 13 percent higher than in comparison areas. Crop diversification is evident, with households in treatment villages cultivating on average 5.4 crop species compared to 3.2 in comparison. Ecological indicators such as the Shannon index are higher in treatment areas, and NDVI imagery demonstrates improved biomass retention. SHGs and cluster-level federations are now playing central roles in farmer adoption and in local GPDP planning processes.

For **IPs**, the priority is to extend impacts beyond demo farmers. For **IDH**, the results provide global proof of concept for landscape-level models. For **funders**, the data validate ecological and social returns on investment. For the **private sector**, diversification and biodiversity highlight new opportunities for procurement and regenerative branding.

Sustainability

The midline reveals partial sustainability. While farmers appreciate the benefits of compost, diversification, and agroforestry, they continue to rely heavily on chemical fertilisers. SHGs and CLFs provide durable institutional anchors, but debt and weak market assurance constrain long-term uptake. Government officials stressed the importance of integrating RPLC into state schemes, while private sector engagement remains in early stages.

For **IPs**, sustainability requires embedding practices within community-led platforms. For **IDH**, the focus must be on institutionalizing convergence with government schemes. **Funders** should prioritize financial mechanisms such as green credit and procurement pilots that de-risk adoption. For the **private sector**, long-term sustainability hinges on providing stable procurement and premium pricing to incentivize regenerative production.

7. Scenario Building for developing future pathways for regenerative landscapes

Scenario 1: If the RPLC interventions are not scaled or sustained, the trends observed in the comparison villages and the baseline are likely to dominate.

In this scenario, GIS models would project a continued, slow decline in soil organic carbon, leading to lower water-holding capacity and increased soil erosion. GHG emissions would remain high, directly tied to the sustained, blanket application of synthetic fertilisers. Similarly, agro-biodiversity would likely decrease as farmers consolidate around a few "safe" irrigated Rabi crops. Kharif farming would remain highly vulnerable to erratic monsoons, leading to volatile yields and incomes. Farmer predictions would likely focus on rising input costs as the primary threat to profitability. In terms of women's participation in agriculture, it would remain confined to labor, with minimal influence on decision-making or engagement in public forums.

Scenario 2: If the program continues on its current trajectory, with a mix of intense outreach, training and expansion of demonstration plots, the future landscape would be more resilient but still face significant challenges.

Under this scenario, GIS models would forecast a gradual, non-linear increase in soil organic carbon, particularly in clusters with high adoption rates. This would lead to improved water retention. GHG emissions per hectare would slowly decrease as bio-input partially substitute for synthetic fertilisers. The Shannon Diversity Index would continue to be higher in treatment areas, providing a buffer against climate shocks. Farmer predictions, as indicated by the 71% willingness to adopt, suggest a continued demand for regenerative practices, provided support is available. Livelihoods would be characterized by stability and reduced risk rather than rapid income growth. Women's collectives would solidify their role as key economic and political actors in the villages. However, a critical risk in this scenario is unsustainable groundwater use. The very success of the program in stabilizing production could drive further intensification and extraction, leading to a long-term water crisis if not coupled with landscape-level water governance. Therefore, water conservation interventions should also be considered as primary.

7.1 Emerging changes till the mid-term of the project

Substantial gains have been made in social capital, farmer awareness, and adoption of foundational regenerative practices. The program has successfully moved the needle on women's empowerment, creating pathways for the intervention that did not exist at baseline. Agronomically, it has improved the stability and efficiency of the irrigated Rabi season. Persistent gaps remain in achieving a systemic shift away from chemical fertilisers, restoring soil organic carbon at scale, ensuring the resilience of the rainfed Kharif season, and addressing the gender gap in mechanisation and high-level decision-making.

The "Training + Demonstration" model emerges as the most impactful intervention for the adoption of complex regenerative practices. The visual, tangible proof provided by demo plots overcomes farmer uncertainty and accelerates learning far more effectively than training alone. Socially, the most impactful intervention has been the strengthening of women's collectives (SHGs/CLFs), which have become the primary vehicle for both knowledge diffusion and social empowerment.

The program has been highly effective in creating a synergistic link between gender and ecology. It has demonstrated that social empowerment is not just a co-benefit but a core driver of ecological change; women's groups are actively promoting and diffusing regenerative technologies. However, the integration is incomplete. The program has not yet effectively addressed the ecological challenge of groundwater depletion or the gendered challenge of drudgery in under-mechanized tasks as mechanization did not appear to be a focus area.

Therefore, RPLC is well-aligned with the foundational principles of regenerative farming, having successfully introduced soil health practices, biodiversity elements, and reduced chemical dependency across treatment villages. It has laid a strong foundation for awareness and early behaviour change. While farmers are demonstrating clear shifts compared to the comparison group, several ecological

processes, such as soil carbon accumulation, nutrient cycling, and long-term reductions in synthetic fertilizer use, naturally evolve more slowly and require sustained multi-year effort. These transitions involve complex biological dynamics where even small deviations can influence overall ecological outcomes. In this context, the programme's progress on ecological indicators is still at an early stage, not due to lack of effectiveness, but because these components inherently require longer cycles to mature and stabilize toward a fully regenerative, closed-loop system.



8. Recommendations

The results show that the program has made positive headway in raising awareness, strengthening women's participation, and introducing regenerative practices such as composting, intercropping, and efficient irrigation. These interventions have buffered climate stresses and reduced input dependence in treatment villages. However, progress remains uneven. Soil organic carbon is still critically low, fertiliser reliance is near universal, groundwater use is expanding unsustainably, and gender gaps persist in decision-making and mechanisation. The following recommendations highlight what is working well and where further effort is required, offering practical, science-based measures for strengthening ecological resilience, farmer livelihoods, and social inclusion.

1. Soil Health and Nutrient Management

What's working	• Farmers in treatment villages have widely adopted compost/FYM and on-farm bio-inputs, often through women's groups. • This signals a shift toward recycling organic matter, reducing input costs, and aligning with RA principles.
Gap	• Nearly half the soils remain in the "low organic carbon trap" (<0.5%). • Chemical fertiliser dependence persists (>90% urea/DAP use). • Soil phosphorus fixation in alkaline soils reduces efficiency of applied inputs.
Recommendations	• Scale up **Integrated Nutrient Management (INM)** combining compost/bio-inputs with soil test–based fertiliser application. • **Strengthen collaboration with KVK/ICAR to improve phosphorus and nutrient management through a structured ToT model-** Although the programme currently engages with KVK/ICAR, the interaction is largely indirect and has not been translated into consistent, field-level knowledge transfer for farmers. To deepen the impact, a more formalized ToT (Training of Trainers) or master-trainer approach can be adopted. Under this model, a small group of local champions- progressive farmers, CRPs, or women leaders, can receive specialized training from KVK/ICAR on regenerative nutrient management, including phosphorus balancing, integrated nutrient use, and soil testing interpretation. These trained champions can then cascade standardized training across villages, ensuring technical accuracy, local relevance, and continuity. This approach builds on existing but limited engagement and helps ensure that scientific guidance from KVK/ICAR reaches farmers directly and on a scale. • Expand **women-led bio-input centers** for consistent supply and local enterprise. Women-led and group-based centres can significantly strengthen the diffusion of regenerative practices across the Compact. The midline shows that women's collectives are already central to knowledge-sharing and behaviour change, as they convene regularly, exchange experiences, and build trust within the community. When women manage bio-input centres, they not only ensure reliable, low-cost supply of inputs but also create a social learning hub where farmers can observe preparation techniques, discuss nutrient management challenges, and learn directly from early adopters. Such group-based platforms accelerate peer-to-peer learning, reduce hesitation around new practices, and reinforce community-wide adoption more effectively than individual training alone. Expanding these centres therefore supports both soil health improvements and women's economic empowerment while enabling broader, faster diffusion of regenerative practices.
Priority:	INM pilots, soil-test advisories. Bio-input centers, chemical input management packages

To operationalize the strengthened recommendations, IPs should lead field-facing actions such as rolling out Integrated Nutrient Management (INM) pilots, ensuring soil samples translate into farmer-specific advisories, and forming village-level nutrient champions who serve as "master trainers." KVKs/ICAR should be formally engaged through structured ToT contracts rather than informal exposure visits, enabling technical experts to train a small cadre of CRPs, SHG leaders, or progressive farmers on phosphorus balancing, microbial use, and soil-test interpretation. IDH with support of the donor agencies should facilitate MoUs and coordination between IPs and scientific institutions, ensuring consistency and quality control and enable this by supporting additional training cycles, developing standardized training modules, and strengthening M&E protocols. This operationalization will directly support the endline, because consistent INM delivery and structured training pathways will allow clearer attribution of improvements in SOC, input efficiency, and reductions in chemical use.

2. Water and Irrigation Management

What's working	• Treatment farmers irrigate more frequently and at critical crop stages, improving Rabi yields and NDVI. • Sprinklers and mini-nozzles reduced labour and improved efficiency.
Gap	• Groundwater extraction is expanding unsustainably; water bodies shrank by ~20% since 2020. • Small and marginal farmers risk exclusion.
Recommendations	• Shift from farm-level irrigation to **watershed-based recharge** (check dams, ponds, recharge pits). This addresses the root cause of the gap, declining water tables and shrinking water bodies, which micro-irrigation alone cannot reverse. • Promote **community-managed resources** such as Water User Groups (WUGs) for groundwater governance. Improved access to irrigation must be coupled with rules on extraction, equitable allocation, and monitoring to prevent overuse. • Expand **micro-irrigation** to achieve 15-25% higher water productivity. Micro-irrigation improves **efficiency and reliability of water delivery** but does not replace or regulate the aquifer. Its role is complementary: reducing per-acre water demand while recharge and governance systems sustain the source.
Priority:	Watershed recharge and groundwater governance. Expansion of micro-irrigation coverage.

IPs should coordinate village-level action plans that integrate watershed-based recharge (e.g., check-dams, farm ponds, recharge pits) with water budgeting and WUG-led governance. Government departments (Minor Irrigation, PMKSY) must be actively linked for financing structures, while IDH can play a convening role in aligning scheme access (PMKSY, ATMA) for recharge and micro-irrigation coverage. FPOs and WUGs should operationalize groundwater rules, scheduling, and equitable allocation, while donors can support the development of tools such as irrigation water productivity tracking and village water dashboards. The operationalization will strengthen endline outcomes by demonstrating whether water-use efficiency, recharge structures, and governance improvements have resulted in more sustainable water use and improved Rabi performance.

3. Biodiversity and Agroforestry

What's working	• Farmers increasingly integrate border/trap crops (marigold, mustard, castor) that reduce pest incidence. • Agroforestry adoption has expanded (30% treatment vs. 12% comparison; 43% among demo farmers).
Gap	• Species diversity remains limited, averaging 3–4 species per farm. • Farmers cite delayed returns (5–7 years) as a barrier to tree planting. • Survival rates of planted trees are modest (~60%).
Recommendations	• Strengthen **species diversification** in agroforestry (multipurpose, fodder, timber species). • Provide **aftercare support** (extension, watering, protective measures). • Link agroforestry with **short-term livelihood co-benefits** (fodder, NTFPs).
Priority:	Extension and aftercare for trees. Diversification of agroforestry species

IPs should lead diversification campaigns using climate-resilient, multipurpose species tailored to local soils and livelihoods, while establishing village-level "agroforestry stewards" trained in watering, pruning, pest monitoring, and protection measures. To enhance tree density and ecological restoration in degraded or unused village lands, Miyawaki-style native micro-forests may be promoted in consultation with Gram Panchayats, particularly in areas already prioritised in GPDP. Integrating such initiatives into GPDPs enables convergence with funding streams (NREGS, CAMPA, NMSA) and creates local ownership for survival monitoring. Forest Department, KVK, and NMSA can be linked by IDH to ensure appropriate species, technical suitability, and co-financing for saplings, while donors support survival-tracking tools, community incentives, and early-stage maintenance costs. Linking agroforestry with near-term livelihood co-benefits (fodder, NTFPs) can be operationalised through FPOs and women's groups who can aggregate, process, and market products. Strengthening these implementation pathways now allows the endline to assess whether improved species diversity, tree density, and survival translate into measurable ecological gains and livelihood benefits.

4. Advanced Soil Practices

What's working	• Awareness of minimum tillage, microbial inoculants, and green manuring is growing. • Farmers in demo plots show some exposure to these practices.
Gap	• Adoption is negligible (<2% minimum tillage, ~4% green manuring, ~3% inoculants). • Farmers perceive high risk, labour intensity, and uncertain benefits. • SOC levels remain stagnant at 0.61–0.65%.
Recommendations	• Provide **technical guidance and demonstrations** for advanced soil management, but pair these with structured behavioural reinforcement to address farmers' risk-avoidance and layering tendencies. Midline findings show that farmers continue to combine (rather than replace) practices to minimise uncertainty; therefore, demonstrations alone may not translate

into adoption. To close this gap, technical training should be followed by (i) small, low-risk guided trials on a portion of farmers' plots where new practices can be tested without jeopardising yields, (ii) visible performance tracking on demonstration plots so farmers can see season-long outcomes, and (iii) peer-led sharing by early adopters in similar agro-ecologies. These reinforcements reduce perceived risk, help farmers internalise benefits, and create social proof; making the transition from awareness to actual practice change more likely.

- Introduce **risk-sharing mechanisms** (input support, incentives). These may include: (i) small, first-season input support to offset initial costs (e.g., seed for cover crops or microbial formulations), (ii) partial cost-sharing for equipment or implements required for minimum tillage, and (iii) outcome-linked micro-incentives for farmers who demonstrate correct implementation during the transition period. Such mechanisms reduce the **financial exposure** farmers face when experimenting with new soil practices and encourage them to move beyond their current incremental adjustments.
- Promote **integration of cover crops and microbial inoculants** for nutrient cycling.

Priority:	Demonstrations and farmer's training.
	Incentives for adoption in terms of – • *Input-Linked Incentives such as a) subsidised / free green manure seeds (dhaincha, sunhemp, cowpea). This is already being provided under NMSA, ATMA, KVK programmes; very doable. b) Starter packets of microbial inoculants (Azotobacter, PSB, Trichoderma). This is produced by KVKs and agri departments; low-cost and scalable. c) Bio-input starter kits for early adopters- vermicompost pit materials (bed, earthworms) through SHG groups. This has been already seen in NRLM, DAY-NRLM, and state livelihoods missions.* • *Cost-Sharing and Labour Support- This is feasible when structured as time-bound, small grants or group-based support, not as open-ended payments. For example, One-season cost-sharing, subsidised machinery rental for zero-till seeders, happy seeders, mulchers (possible through Custom Hiring Centres (CHCs), FPCs, and Panchayat hiring centres) and support for residue incorporation machinery for small plots. These can work through FPOs/CHCs but must be small-scale and time-bound to avoid administrative burden.* • ***Behavioural / Recognition-Based Incentives-** These are culturally aligned with Indian rural community dynamics, for example- priority access to demo plots or planting material, slotting early adopters for exposure visits, training, or certification, community recognition (awards, certificates, events during Rabi/Kharif campaigns). These leverage social status and peer influence, which are highly effective in farmer groups.*

IPs should strengthen and operationalize structured guided trials (small plot experiments), peer-led demos, and visible progress tracking so farmers see season-long performance. Custom Hiring Centres, FPOs, Panchayat machinery banks should partner to provide short-term, time-bound cost-sharing on tools like zero-till seeders and residue incorporation equipment. IDH should ensure convergence with state-level mechanization schemes (SMAM, CHCs, ATMA). Additionally, support behavioural nudges, recognition systems, and data systems to track adoption trajectories. These strengthened pathways will help the endline assess real movement from awareness-to-cautious trial-to-adoption.

5. Gender and Social Inclusion

What's working	• Women's groups (SHGs/CLFs) are central to bio-input production and diffusion. • Women report higher willingness to adopt regenerative practices (76% vs. 67% men).
Gap	• Women face barriers in mechanisation, decision-making, and land rights. • Gender gaps persist in control over resources and income.
Recommendations	• Strengthen **women-led enterprises** (bio-input centers, seed banks). • Facilitate women's **access to mechanisation** (labour-saving tools). • Enhance women's role in **decision-making** and link them to formal credit/insurance
Priority:	Support for women's enterprises and mechanisation
	Credit and institutional access

6. Program Implementation and Scaling

What's working	• Demo plots are a strong catalyst for adoption. • Farmers show behavioural change in record-keeping and experimenting with new practices.
Gap	• Adoption remains partial and layered (bio-inputs added, but chemical use persists). • Institutional linkages for scaling (markets, policies) are weak. • Irregular support in seedling supply, extension, and market linkage.
Recommendations	• Strengthen **institutional partnerships** (government schemes, KVK, FPOs). • Provide **market linkage and price assurance** for regenerative crops. • Establish **scaling pathways** that connect demo-plot innovations to wider farmer networks
Priority:	Institutional partnerships and market linkages.
	Scaling pathways and replication

IPs should identify women champions and support them in leading enterprises such as bio-input centres or seed banks, while also facilitating women's access to labour-saving tools through CHCs or SHG-managed tool banks. IDH can negotiate partnerships with banks, NRLM, and insurance providers to strengthen women's institutional access and also support gender-disaggregated monitoring, digital literacy, and entrepreneurship training. This operationalization strengthens the endline's ability to measure changes in women's agency, economic participation, and resource control.

Beyond the thematic priorities, there is a need for greater uniformity in reporting and monitoring across the program's key indicators. Assigning unique IDs to all participating farmers will allow consistent tracking of households over time, strengthening the ability to conduct pre-mid-post comparisons and assess adoption trajectories with greater precision. This approach is standard in agricultural impact evaluations and is particularly important for understanding whether adoption trajectories are sustained over multiple years. In parallel, intensive follow-up with non-demo farmers should be prioritized, as the midline findings confirm that diffusion of regenerative practices remains uneven beyond demonstration plots. Without systematic engagement, spillover effects may be overstated, and the endline could fail to capture the true landscape-level adoption patterns. A key expectation emerging from the midline is the establishment of a comprehensive MRV framework. Beyond strengthening M&E, an MRV-verified approach creates standardized indicators for tracking soil health, water use, biodiversity, and farmer outcomes in a credible and comparable way. For farmers, it validates that regenerative practices deliver real benefits; for partners, it enables adaptive program design; and for investors or policy actors, it provides the assurance needed to unlock climate finance and sustainability-linked funding. Embedding MRV into the RPLC framework thus moving the program from monitoring progress to building a verifiable, investment-ready case for regenerative adoption.

At the institutional level, RPLC should strengthen its partnerships with government departments and relevant schemes that already operate on a scale. National programs such as the Pradhan Mantri Krishi Sinchayee Yojana (PM-KSY) on irrigation and watershed development, the Sub-Mission on Agricultural Mechanization (SMAM), and the National Mission on Sustainable Agriculture (NMSA) offer direct opportunities to reinforce RPLC's interventions. Leveraging these platforms will expand both financial and technical resources while embedding regenerative agriculture into mainstream public systems, thereby enhancing sustainability and scalability beyond the project period. Taking together, these measures will ensure that the endline assessment not only evaluates adoption levels but also captures the durability, inclusivity, and institutionalization of regenerative agriculture practices across the landscape.

Based on the above details on the recommendation, we can have a classification informing what IPs are already doing, and what is realistically feasible before endline next year. The disaggregation is done with colour coding- Green for Low-Hanging Fruits (easy, low-cost, short-term) and Orange for High-Hanging Fruits (structural, slower, higher effort).

Low-Hanging Fruits (Short-term, low cost, quick wins)

- **Strengthen soil-test based advisories and INM pilots:** Already part of program routines; only needs better follow-up and farmer-friendly advisories.
- **Activate structured ToT/master-trainer approach with KVK/ICAR:** Engagement exists but is indirect → formalising ToT is easy and low-cost.
- **Expand women-led bio-input centres (incrementally):** Model exists; only requires infrastructure development, improving volume, scheduling, and training.
- **Promote peer-led guided trials for advanced soil practices:** Uses existing demo farmers; minimal cost, high behavioural impact.
- **Provide first-season input starters (green manure seeds, microbial packs):** Already offered under government schemes; IPs only need to facilitate access.
- **Strengthen aftercare for agroforestry saplings (watering, protection, monitoring):** Can be integrated into existing extension visits; limited cost.
- **Promote species diversification using existing nurseries:** KVKs, Forest Dept. and NMSA nurseries already supply species.
- **Establish Water User Groups (WUGs) in villages already mobilized:** Groups exist under other schemes; only requires activation and basic training.
- **Increase follow-up with non-demo farmers:** Primarily an M&E/extension scheduling improvement.
- **Assign unique farmer IDs and streamline MRV data capture:** Mostly procedural; enables strong endline tracking.

High-Hanging Fruits (Structural, long-term, strategic)

- **Shift from farm-level irrigation to watershed-based recharge:** Check dams, farm ponds, recharge pits. Civil works and inter-institutional approvals → long-term.
- **Groundwater governance through WUGs with formal extraction rules:** Requires social acceptance, Panchayat involvement, and sustained facilitation.
- **Building landscape-level MRV system with verification standards**
- **Requires multi-stakeholder buy-in, data system integration, and third-party validation.**
- **Large-scale diversification of agroforestry and Miyawaki plantations:** Tree-based systems require multi-year investment, nursery capacity, and aftercare.
- **Linking regenerative products to assured markets or premium buyers Needs private-sector tie-ups, aggregation, traceability → not immediate.**
- **Scaling regenerative practices through government schemes (PMKSY, NMSA, SMAM)**
- **Requires policy dialogue, proposals, and approvals — beyond short-term operations.**
- **Formalizing Custom Hiring Centers (CHCs) or mechanization hubs for smallholders:** Capital-intensive and requires institutional anchoring.Increase follow-up with non-demo farmers: Primarily an M&E/extension scheduling improvement.
- **Assign unique farmer IDs and streamline MRV data capture:** Mostly procedural; enables strong endline tracking.

9. Annexures

9.1 List of indicators captured

SN	Indicator Category / Domain	Baseline Report Indicator	Midline Report Indicator	Status	Notes / MRV Alignment
1	Cropping Intensity	Reported	Reported	Repeated	Core MRV indicator on land-use intensity
2	Crop Yields (maize, wheat, soybean, gram, tur, etc.)	Baseline crop yields	Midline yields narrative (some crops)	Repeated	MRV-critical but midline limited numeric reporting fsor all crops
3	Household Income	Farm & total income	Income + debt + profitability	Repeated	Strengthened with debt and diversification metrics
4	Soil Organic Carbon (SOC)	SOC% % (0.51–1.07%)	SOC% % (0.61–0.65%)	Repeated	MRV-essential, directly comparable
5	Soil Nutrients (NPK)	N-P-K baseline ranges	N-P-K block-wise midline	Repeated	Required for soil fertility MRV
6	Water Use Efficiency (WUE)	Reported baseline WUE	Reported midline WUE (qual + partial quant)	Repeated	Method consistent, but crop-wise midline numeric limited
7	GHG Emissions (EX-ACT)	Baseline crop-level CFT	Midline total GHG emissions	Repeated (method), but data not comparable	Baseline crop-wise; midline consolidated CO_2e
8	Fallow Land / Land Use	Reported (cropping patterns)	Multi-season cropping evidence	Repeated	Interpreted via cropping intensity at midline
9	Adoption of RA Practices (FYM, mulching, IPM, etc.)	Reported qualitatively	Detailed adoption metrics	Repeated but expanded	Midline adds quantified adoption %
10	Agroforestry Adoption	Tree count + agroforestry presence	% households adopting + survival	Repeated but strengthened	Now MRV-ready because of % adoption

SN	Indicator Category / Domain	Baseline Report Indicator	Midline Report Indicator	Status	Notes / MRV Alignment
11	Soil Cover / Mulching / Intercropping	Limited reporting	Detailed midline (% households)	Repeated but deepened	Now quantifiable
12	Chemical Fertiliser Use (Urea, DAP, etc.)	Baseline consumption patterns	Midline usage patterns	Repeated	MRV-relevant for emission pathways
13	Bio-input Use (FYM, compost, vermicompost)	FYM usage baseline	Detailed midline (% households)	Repeated and expanded	Quantification improved
14	Biodiversity (Crop Diversity Count)	No Shannon Index in baseline	Shannon Diversity Index (H′)	New in Midline	Newly introduced MRV indicator
15	Vegetation Greenness (NDVI)	Not assessed	NDVI trends (Kharif, Rabi, Zaid)	New in Midline	Introduced for ecological MRV
16	Land-Use & Land-Cover (LULC)	Reported in narrative baseline	Remote-sensing validated LULC	New in Midline	RS-based MRV indicator added
17	Water Bodies / Surface Water Extent (NDWI)	Not in baseline	Satellite water extent analysis	New in Midline	New MRV layer for hydrology
18	Women’s Participation in Agriculture	Basic gender roles baseline	Detailed participation & RA adoption	Expanded indicator	Deeper measurement at midline
19	Training Exposure (RA sessions, FFS)	Not tracked baseline	Midline quantified exposure	New in Midline	Required for behavioural MRV
20	Decision-Making Index (Crop planning, input use)	Generic gender roles	% women with full/some say	New in Midline	Enabled by gender-MRV structure
21	Mobility, Confidence, Agency (Women)	Qualitative only	Multi-dimensional empowerment pathways	Expanded indicator	Added as GESI-MRV stream
22	Debt & Indebtedness	Baseline (loans, sources)	Midline (formal vs informal)	Repeated	Comparable
23	Exposure to Climate Risks / Adaptation	Baseline via perception	Midline through RA practice adoption	Repeated but reframed	Linked to RA outcomes

9.2 Soil test results and their interpretation

Category	Block	Demo	FFS	Comparison
Avg pH (1:2.5)	Chhindwara	7.44	7.51	7.53
	Mohkhed	7.59	7.66	7.72
	Pandhurna	7.48	7.42	7.45
	Sausar	7.49	7.49	7.58
Avg EC (dS/m)	Chhindwara	0.33	0.30	0.34
	Mohkhed	0.34	0.34	0.33
	Pandhurna	0.33	0.35	0.26
	Sausar	0.37	0.35	0.31
Avg N (kg/ha)	Chhindwara	332.91	352.60	373.61
	Mohkhed	347.11	346.25	324.70
	Pandhurna	334.75	318.57	372.64
	Sausar	385.18	377.27	327.00
Avg P (kg/ha)	Chhindwara	9.81	9.64	9.87
	Mohkhed	9.49	10.38	9.70
	Pandhurna	10.40	9.92	9.80
	Sausar	10.33	10.17	9.96
Avg K (kg/ha)	Chhindwara	366.79	363.73	364.58
	Mohkhed	364.45	366.64	365.00

Category	Block	Demo	FFS	Comparison
	Pandhurna	363.86	364.34	365.48
	Sausar	365.75	366.99	366.60
Avg WHC (%)	Chhindwara	67.47	64.56	65.46
(Water holding capacity)	Mohkhed	66.54	66.29	65.73
	Pandhurna	65.11	65.37	66.44
	Sausar	66.46	67.38	66.27
Avg SOC (%)	Chhindwara	0.62	0.66	0.65
	Mohkhed	0.68	0.58	0.58
	Pandhurna	0.62	0.57	0.67
	Sausar	0.61	0.62	0.63

Soil pH (Reaction): Soil pH indicates whether the soil is acidic, neutral, or alkaline, measured on a scale from 0 to 14. Most crops perform best when pH is near neutral, as extreme acidity or alkalinity reduces nutrient availability. Values below 6.0 are considered acidic (low), between 6.0 and 7.5 neutral and suitable for most crops (medium), and above 7.5 alkaline (high), where issues like micronutrient deficiency can arise.

Electrical Conductivity (EC): Electrical conductivity (expressed in dS/m) measures the concentration of soluble salts in the soil, reflecting salinity levels. While some salts are natural, excess salinity hampers seed germination and crop growth. EC values below 1.0 dS/m are safe (low), 1.0–2.0 dS/m represent moderate salinity (medium), and values above 2.0 dS/m (high) indicate saline soils unsuitable for most common crops.

Available Nitrogen (Av N): Nitrogen is a critical macronutrient that drives vegetative growth, yield potential, and protein content in crops. Available nitrogen represents the fraction immediately usable by plants. Levels below 280 kg/ha are categorized as low, 280–450 kg/ha as medium, and above 450 kg/ha as high. Nitrogen deficiency restricts growth, while excess may cause lodging and leaching losses.

Available Phosphorus (Av P): Phosphorus supports root development, flowering, and grain formation, making it essential for early crop establishment. Available phosphorus in soils below 10 kg/ha is considered low, 10–25 kg/ha medium, and above 25 kg/ha high. Low values restrict crop vigour, while high values are uncommon but may lead to inefficient fertiliser use.

Available Potassium (Av K): Potassium regulates plant water balance, enhances disease resistance, and improves tolerance to drought. In soil tests, values below 150 kg/ha are low, 150–300 kg/ha medium, and above 300 kg/ha high. Deficiency reduces vigour and crop resilience, whereas adequate to high levels improve yield stability and quality.

Water Holding Capacity (WHC): Water holding capacity expresses the percentage of water a soil can retain and make available to crops. It is influenced by soil texture, structure, and organic matter. WHC below 50% indicates poor retention (low), 50–65% moderate retention (medium), and above 65% high retention, which provides crops with better drought resilience and stability during dry spells.

Soil Organic Carbon (SOC): Soil organic carbon is the amount of carbon stored in soil organic matter and is a key indicator of soil health, fertility, and water retention. SOC values below 0.5% are classified as low, between 0.5% and 0.75% as medium, and above 0.75% as high. Higher SOC enhances nutrient availability, improves soil structure, and supports long-term sustainability of farming systems.

9.3 Geospatial indicators and their interpretation

Normalized Difference Vegetation Index (NDVI): A satellite-derived greenness index (range –1 to +1) used to assess vegetation vigor. Higher values indicate denser, healthier photosynthetic cover; low/negative values indicate bare soil, built-up areas, or water. In the report, NDVI maps are a primary geospatial evidence layer. NDVI is computed on season-specific imagery to compare monsoon (Kharif) and winter (Rabi) vegetation conditions. Seasonal NDVI helps distinguish between rainfall-driven greenness and management-driven greenness, and is presented as a time-separated indicator in the ecology chapter. General NDVI value interpretation:

- **Less than –0.1 (e.g., –1):** Water, clouds, or snow
- **0:** Barren areas, bare soil, or non-vegetated features **to 0.4:** Sparse vegetation, grasslands, or shrubs
- **0.4 to 0.8:** Dense vegetation, like crops or forests
- **More than 0.8 (up to 1):** Very dense, healthy vegetation, such as tropical forests

Land Use / Land Cover (LULC) classification: Multi-date satellite images are classified into categories (e.g., cropland, forest, grass/ bare ground, built-up, water) to describe the spatial composition of the landscape. Comparing classified maps across time windows (e.g., 2021→2024) quantifies area gains/losses among classes, such as expansion of bare ground or built-up relative to cropland/vegetation, and signals land-degradation or surface-water area loss.

Surface water extent (area): Open-water area is delineated from satellite imagery to estimate the spatial footprint of lakes, tanks, and reservoirs (reported in ha or km²). The midline uses mapped water-body extent as a key landscape indicator. Time-series comparison of surface-water masks yields a percentage change (shrink/expand) over the analysis period, indicating pressure on shared water resources and seasonally available storage.

9.4 Methodological Considerations

1. **Use of Cool Farm Tool (CFT):**

   The midline evaluation design originally included the use of the Cool Farm Tool (CFT) for estimating farm-level GHG emissions, as outlined in the Inception Report. However, during implementation, several constraints made CFT application infeasible. First, the baseline dataset contained only percentage-based indicators (e.g.% households using fertiliser or irrigation) rather than the quantitative input values required for CFT (such as fertiliser amounts, diesel volumes, or irrigation hours). Second, IRRI's baseline analysis relied on a modified and proprietary version of CFT that could not be shared, making methodological replication impossible. Third, the CFT credentials provided for the assignment required farmer-wise, plot-level data entry, an intensive process beyond the operational feasibility of this midline round. Applying CFT only at midline, without comparable baseline values, would therefore generate non-comparable absolute emissions. In light of these limitations, the evaluation team used FAO's Ex-ACT tool, which aligned with the available household, soil, and satellite datasets and allowed for consistent baseline–midline

comparison. Going forward, as IDH strengthens farmer-level data capture for CFT within its monitoring system, future evaluations can integrate CFT alongside EX-ACT to provide both granular and program-level emission insights.

2. **Women's Empowerment in Agriculture Index (WEAI):** To capture gendered outcomes, the evaluation also drew on the **Women's Empowerment in Agriculture Index (WEAI)** framework. While not applied in full survey form due to time and cost constraints, key WEAI domains—**access to resources, decision-making, leadership, and time allocation**—were integrated into the household survey and qualitative tools. This allowed the team to track shifts along the **access → agency → power and relations** pathway. Midline results suggest that women farmers are not only accessing training and inputs but increasingly participating in household and community-level decision-making fora, marking early signs of gender-transformative change. Future rounds may deepen this assessment by applying the full WEAI instrument, allowing more granular scoring across domains and benchmarking against global studies.

Impact domain	Key Evaluation Question	Midline answer (synthesis)	Key supporting evidence (from midline)
Ecological	What has been the change in the ecological parameters relevant to the RPLC?	Ecological parameters show a mixed picture of incremental improvements in treatment areas within a generally stressed landscape. Cropping intensity in treatment villages increased from 139% at baseline to 163% at midline (compared to 147% in comparison areas), indicating more intensive use of land over seasons. Soil health has only marginally improved: compact-level SOC now ranges around 0.61–0.65%, with nearly half of soils still below 0.5% organic carbon and continued heavy reliance on urea and DAP, so soils remain in a "low organic carbon trap." Water-related indicators point to higher irrigation access and frequency in treatment areas but also mounting stress: irrigation access rose from 42% at baseline to 82% in treatment versus 63% in comparison, and Rabi irrigation events increased to 5.8 in treatment versus 4.6 in comparison, even as satellite evidence shows cropland greenness declining, bare ground expanding, and water bodies shrinking by about 20%. Biodiversity and vegetative cover are comparatively stronger in treatment villages, with higher NDVI greenness and more diverse cropping systems, but overall land degradation risks remain. GHG assessments using EX-ACT estimate current fertiliser-related emissions at about 1,977 tCO_2-e per year, dominated by synthetic nitrogen application; other emission sources (irrigation energy, machinery) are not yet fully quantified, so the emissions picture is incomplete at midline.	• Cropping intensity: 139% (baseline treatment) → 163% (midline treatment) vs. 147% (midline comparison). • SOC compact averages around 0.61–0.65%; soils characterized as stuck in a low-carbon trap, with >90% urea/DAP use. • Rabi irrigation frequency: 3.2 (baseline treatment) → 5.8 (midline treatment) vs. 4.6 (comparison); irrigation access 42% → 82% in treatment vs. 63% comparison. LULC analysis shows increased bare ground, contraction of water bodies by ~20%, and pressure on land and water resources. • EX-ACT estimates 1,977 tCO_2-e/yr from inputs, largely from urea (1,365 tCO_2-e).

Impact domain	Key Evaluation Question	Midline answer (synthesis)	Key supporting evidence (from midline)
Ecological	What specific practices have had the most impact on enhancing biodiversity indicators?	Biodiversity gains at midline are most closely associated with diversified cropping (including intercropping), border and trap crops, and emerging agroforestry. Intercropping in Kharif expanded from less than 10% of treatment households at baseline to about 36.8% at midline, compared with 16.8% in comparison villages, and treatment households now cultivate on average 5.4 crop species versus 3.2 in comparison areas. Border and trap crop use (marigold, mustard, castor) rose from around 4.3% to 22% in treatment villages, compared with 11% in comparison areas; farmers explicitly link these crops to reduced pest pressure and lower pesticide use. Agroforestry adoption has also expanded: around 30% of treatment households (and 43% of demo farmers) have integrated trees, compared with 12% of comparison households, contributing to structural diversity despite modest species richness and approximately 60% tree survival. These practices together underpin higher NDVI greenness and a higher Shannon Diversity Index (0.94 in treatment vs. 0.64 in comparison in Kharif in Sausar), signalling early but meaningful ecological intensification in program areas.	• Intercropping (Kharif): <10% (baseline treatment) → 36.8% (midline treatment) vs. 16.8% (comparison). • Border/trap crops: 4.3% (baseline treatment) → 22% (midline treatment) vs. 11% (comparison). • Avg. crop species per farm: 5.4 (treatment) vs. 3.2 (comparison). Shannon index (Kharif, Sausar): 0.94 (treatment) vs. 0.64 (comparison). • Agroforestry adoption: ~30% of treatment households (43% demo farmers) vs. 12% in comparison; tree survival about 60%.
Economic	If and how did transitioning to bio-inputs affect yields, income, and input costs?	Transitioning to bio-inputs has reduced input costs and contributed to modest yield gains in some crops and higher overall incomes, but effects are uneven and moderated by structural constraints. Rabi crops such as wheat and chickpea show modest but consistent productivity advantages in treatment areas, while Kharif maize yields remain lower in treatment (820.2 kg/acre) than in comparison (1,049.8 kg/acre), suggesting that yield stability and risk reduction, rather than across-the-board yield increases, are the most tangible benefits at midline. Average household income in treatment villages increased from INR 126,830 at baseline to INR 168,035 at midline (a 32.5% rise) and is about 13% higher than in comparison villages (INR 146,570); analysis attributes these gains partly to lower input costs from bio-inputs and better irrigation and market linkages. SHG-based bio-input centres and farm-made compost and bio-pesticides have reduced fertiliser and pesticide spending, with women farmers	• Chickpea yields higher in treatment (1,102 kg/acre) vs. comparison (1,064 kg/acre); maize lower in treatment (820.2 kg/acre) vs. comparison (1,049.8 kg/acre); wheat and gram show stable or slightly improved Rabi performance in treatment areas. • Avg. household income: 126,830 (baseline treatment) → 168,035 (midline treatment) vs. 146,570 (midline comparison), i.e., 32.5% increase over baseline and 13% higher than comparison. • Drivers of higher income include lower input costs from bio-inputs, better FPC-mediated market linkages, and convergence with irrigation schemes.

Impact domain	Key Evaluation Question	Midline answer (synthesis)	Key supporting evidence (from midline)
		explicitly reporting that “our spending, especially on fertiliser, has gone down.” However, high levels of indebtedness persist: about 66% of treatment households are indebted, with average loans of INR 46,890 absorbing roughly 28–29% of annual income, so economic gains from bio-inputs and regenerative practices are still offset by structural credit and livelihood vulnerabilities.	SHG/farmer testimonies describe reduced spending on fertilisers and pesticides due to compost, bio-pesticides, and trap crops. Indebtedness: 66% of treatment households and 68% of comparison households indebted; average loans of INR 46,890 (treatment) and INR 43,570 (comparison), consuming ~28–29% of income.
Economic	How have regenerative practices influenced crop diversification and market access?	Regenerative practices have clearly driven crop diversification but have only partially translated into stronger and secure market access. Treatment households now cultivate on average 5.4 crop species compared with 3.2 in comparison areas, reflecting diversification through intercropping, minor crops, indigenous varieties, and agroforestry species. Cropping intensity has risen to 163% in treatment areas from a baseline of 139%, against 147% in comparison villages, indicating more multi-season use of land. Border and trap crops (e.g., marigold, mustard, castor) and horticultural additions have expanded, and farmers link these to reduced pest attacks and greater resilience. On the market side, the report notes that better market linkages through Farmer Producer Companies (FPCs) and SHGs contribute to higher incomes, particularly by aggregating and marketing diversified produce; however, institutional market linkages for regenerative crops are still described as weak and irregular, with recommendations emphasizing the need for price assurance and stronger market pathways.	Avg. crop species per farm: 5.4 (treatment) vs. 3.2 (comparison). Cropping intensity: 139% (baseline treatment) → 163% (midline treatment) vs. 147% (comparison). Border/trap crops adoption: 22% (treatment) vs. 11% (comparison). Narrative links diversification and regenerative practices to reduced pest incidence and better soil fertility. Income section attributes higher earnings partly to FPC-enabled market linkages and convergence with schemes, while program-implementation findings flag market linkages and price assurance as current gaps requiring strengthening.

Impact domain	Key Evaluation Question	Midline answer (synthesis)	Key supporting evidence (from midline)
Economic / Gender	What impact have gender dynamics had on the adoption of regenerative practices?	Gender dynamics have shaped both the pace and pattern of regenerative adoption. Women's groups (SHGs and Cluster Level Federations) are central to bio-input production and diffusion, anchoring compost, bio-pesticide preparation, and collective learning around low-cash, time-compatible practices; women are more likely than men to express willingness to adopt regenerative practices (76% of women vs. 67% of men), indicating strong latent demand among women farmers. At the same time, women remain concentrated in labour-intensive tasks (harvesting, residue management) and routine field operations where practices like mulching can be integrated into daily work; baseline and midline narratives underscore that such practices diffuse earliest because they align with women's practical gender needs. Structural gender gaps in land rights, mechanisation access, and control over income, however, constrain women's ability to adopt higher-risk or capital-intensive regenerative practices, such as advanced soil management and agroforestry at scale. Overall, the program's reliance on women's collectives has accelerated adoption of certain regenerative components (bio-inputs, mulching, diversified crops), but gendered asymmetries in assets and decision-making continue to limit the scope and depth of women's adoption trajectories.	• Women's groups (SHGs/CLFs) identified as central to bio-input production and diffusion. • Higher willingness to adopt regenerative practices among women (76%) than men (67%). • Qualitative data show women embedding mulching and cost-reducing practices into routine field care and reporting reduced fertiliser spending. • Persistent barriers for women: mechanisation, decision-making, and land rights; gender gaps in resource and income control remain. • SHGs/CLFs also play a role in linking women to GPDP processes and market interactions, indicating that collective platforms mediate both adoption and voice.
Economic / Gender	What are potential areas for gender-specific interventions?	The midline identifies several priority areas where gender-specific interventions can deepen and sustain regenerative adoption. First, strengthening women-led enterprises such as bio-input centres and seed banks can convert women's existing roles in input preparation into viable income streams and secure local supply of regenerative inputs. Second, facilitating women's access to mechanisation (for tasks like harvesting, residue management, and irrigation) can reduce drudgery and enable women to manage larger or more diverse plots. Third, interventions that enhance women's role in farm and financial decision-making—including linking them to formal credit and insurance, and building capacities in record-keeping and cost-benefit analysis—are highlighted as necessary to move from labour participation to substantive agency. Fourth, gender-	• Recommendations call for: (i) strengthening women-led bio-input centres and seed banks; (ii) enabling women's access to mechanisation; (iii) enhancing women's role in decision-making and linking them with formal credit/insurance. • Women already exhibit high financial inclusion and strong collective membership (≈75% in SHGs/FPOs in treatment vs. 48% in comparison), providing a platform for such interventions.

Impact domain	Key Evaluation Question	Midline answer (synthesis)	Key supporting evidence (from midline)
		responsive local governance measures such as women-only GPDP meetings, convenient timings, and training on planning processes are recommended to enable women to articulate agricultural and livelihood priorities, including regenerative needs, within village plans.	Women request women-only meetings, better meeting times, and training to engage effectively in GPDP processes. Women's higher willingness to adopt RA and central role in bio-input production suggest high returns to targeted support.
Program implementation	What are the main challenges and successes in implementing program interventions?	Implementation has achieved notable successes in practice adoption and institutional engagement, but faces persistent challenges in depth, diffusion, and system integration. Demo plots and associated trainings have proven to be strong catalysts for behaviour change: awareness of regenerative agriculture reaches around 70% of farmers in treatment villages versus 33% in comparison villages, and demo-plot owners exhibit significantly higher adoption of compost/FYM and tree integration than non-owners and comparison farmers. Behavioural shifts, such as more systematic farm record-keeping (41% of treatment vs. 32% of comparison households), indicate growing capacity for informed decision-making. At the same time, adoption remains partial and layered—bio-inputs are added but chemical fertiliser use remains near-universal (>90%), advanced soil practices have negligible uptake, and many farmers perceive regenerative options as risky or labour-intensive. Institutional challenges include weak and irregular market linkages for regenerative produce, gaps in seedling and extension support, and limited convergence in monitoring systems; government stakeholders also highlight the need for standardized data to integrate RPLC insights into official reporting.	Awareness of regenerative agriculture: ≈70% of treatment vs. 33% of comparison households aware; 67% of comparison households report lack of awareness. Demo-plot farmers: 89% using compost/FYM vs. 83% non-owners and 77% comparison; 43% of demo-plot owners integrating trees vs. 28% non-owners and 12% comparison. Record-keeping: 41% of treatment vs. 32% of comparison households report more systematic farm records. Chemical fertiliser use remains near-universal (>90%), and advanced soil practices (minimum tillage, green manuring, microbial inoculants) show <2–4% adoption. Implementation gaps noted in market linkages, seedling supply, extension, and monitoring systems.

Impact domain	Key Evaluation Question	Midline answer (synthesis)	Key supporting evidence (from midline)
Program implementation	What effectiveness do strategies and tools have in supporting farmers' adoption of regenerative practices?	The midline finds that the program's key strategies—demo plots, trainings, bio-input centres, and convergence support—are effective in stimulating adoption, especially where interventions are intensive and bundled. Demo plots significantly amplify uptake of multiple practice sets, including compost/FYM, agroforestry, intercropping, and biodiversity features, and farmers repeatedly describe demo plots as reducing uncertainty and offering visible evidence of results. Training and exposure visits enhance farmers' capacity to calculate costs and returns and have led to more deliberate experimentation with regenerative options; women in particular report increased attendance at trainings and greater confidence to try new input combinations. Bio-input centres run by SHGs facilitate local, low-cost access to compost and bio-pesticides, which farmers credit with lowering input costs and enabling partial substitution away from chemicals. At the landscape scale, however, these tools still yield uneven diffusion: adoption declines from demo to non-demo farmers, and training-only (non-demo) approaches show weaker outcomes, indicating that the current mix of tools is effective but not yet sufficient to drive widespread, standalone adoption without continued technical and institutional support.	□ Demo plots identified as "strong catalysts for adoption," with higher uptake of compost/FYM and agroforestry among demo farmers than non-demo and comparison groups. □ Awareness and adoption of RA practices markedly higher in treatment, especially where demo plots are present. □ Training and exposure visits credited by farmers for better cost accounting and willingness to experiment. □ SHG-led bio-input centres and vermicompost units reduce input costs and expand access to regenerative inputs. □ Summary of findings notes that demo-based strategies deliver strong results but spillovers and training-only approaches remain weaker.
Program implementation	What lessons have been learned about the approach to regenerative agriculture?	Several design and contextual lessons emerge. First, regenerative transitions in smallholder systems are gradual and layered: farmers tend to adopt low-risk, labour-compatible practices first (e.g., compost, mulching, trap crops, intercropping) while retaining chemical fertilisers and postponing more complex or capital-intensive practices such as minimum tillage, advanced soil inoculants, and diversified agroforestry. Second, demonstration-based, cluster models are effective for early adoption but do not automatically generate strong spillovers; intensive support is still needed for non-demo farmers, and diffusion beyond early adopters remains uneven. Third, ecological and economic outcomes are tightly interlinked: modest gains in SOC, NDVI, and biodiversity coincide with higher cropping intensity, income improvements, and enhanced resilience, but these gains are fragile in the face of mounting water	□ Adoption is "partial and layered," with strong uptake of compost/FYM, intercropping, and biodiversity features, but near-universal chemical fertiliser use and negligible adoption of advanced soil practices. □ Demo-plot effects are strong but diffusion beyond demo farmers is weak, requiring targeted engagement with non-demo farmers. □ Treatment areas show higher cropping intensity, greater crop diversity, and better NDVI alongside modest SOC gains and increased irrigation, linking ecological and economic outcomes.

Impact domain	Key Evaluation Question	Midline answer (synthesis)	Key supporting evidence (from midline)
		stress and high debt burdens. Fourth, gender-responsive collective platforms (SHGs/CLFs) are critical vehicles for adoption, suggesting that regenerative approaches must be designed with gender and social inclusion at their core rather than as add-ons. Lastly, robust MRV and standardized farmer tracking are necessary to credibly document change and steer adaptive programming, especially as the program scales beyond the current compact.	SHGs/CLFs central to women's adoption and engagement in GPDP; gender-responsive collective strategies are repeatedly highlighted. MRV and unique farmer IDs are explicitly recommended to improve tracking of adoption trajectories and enable climate-finance-ready evidence.
Program implementation	What program adjustments are recommended to enhance effectiveness?	The report calls for a combination of thematic, institutional, and monitoring-related adjustments to enhance effectiveness. Ecologically, it recommends scaling up integrated nutrient management that combines compost/bio-inputs with soil-test-based fertiliser application; addressing phosphorus management through partnerships with KVK/ICAR; shifting from plot-focused irrigation towards watershed-based recharge; and expanding micro-irrigation to improve water productivity. Biodiversity recommendations include diversifying agroforestry species, improving aftercare to raise tree survival, and linking tree-based systems to short-term livelihood co-benefits (fodder, NTFPs). On gender, the report urges strengthening women-led enterprises, enabling women's mechanisation access, and enhancing their roles in decision-making and financial systems. Programmatically, it stresses strengthening institutional partnerships (with schemes such as PM-KSY, SMAM, NMSA, KVKs, and FPOs), providing market linkages and price assurance for regenerative crops, and formalizing scaling pathways from demo plots to broader farmer networks. Cross-cutting adjustments include establishing a comprehensive MRV framework, assigning unique farmer IDs, and harmonizing indicator tracking to support adaptive management and position RPLC for climate-finance and sustainability-linked investments.	Soil and nutrient management: INM pilots, soil-test advisories, and partnerships for phosphorus management recommended; expansion of women-led bio-input centres. Water and irrigation: shift to watershed-based recharge (check dams, ponds, recharge pits), community groundwater governance, and expansion of micro-irrigation. Biodiversity/agroforestry: diversify tree species, strengthen aftercare, link to short-term co-benefits; address modest (~60%) tree survival. Gender: support women-led enterprises, mechanisation access, and decision-making, alongside gender-responsive GPDP engagement. Implementation & scaling: build institutional partnerships, market linkages and price assurance; establish scaling pathways, MRV framework, and unique farmer IDs to strengthen data and diffusion.