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MRV SUPPORT TO CIFF'S INVESTMENT TOWARDS

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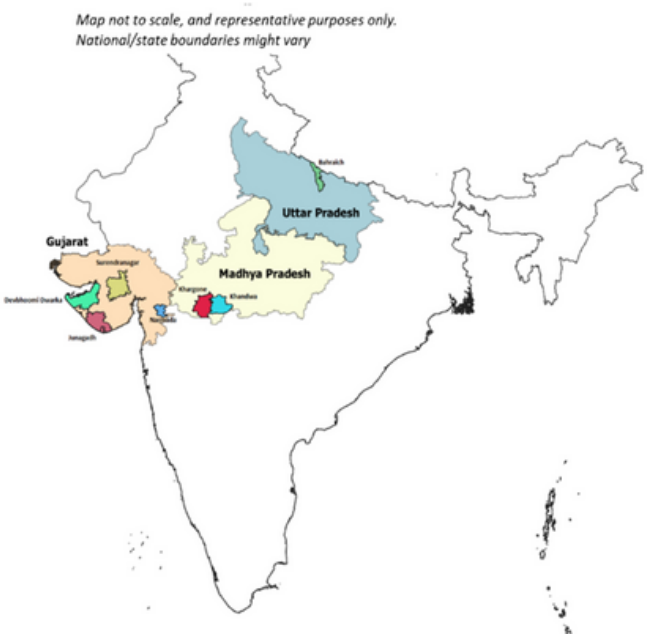
LOW CARBON AGRICULTURE PROJECT

1. PROJECT BACKGROUND

INTRODUCTION TO LOW CARBON AGRICULTURE

The Low Carbon Agriculture (LCA) project was aimed to pilot and scale up LCA practices among 18,000 farmers across three agro-ecological zones in India: Gujarat, Madhya Pradesh, and Uttar Pradesh. The impact of the project was assessed through key performance indicators (KPIs) such as the adoption rate of LCA practices, dis-adoption of high carbon agriculture (HCA) practices, changes in soil health, and socio-economic well-being. Data collection for this assessment was conducted in pilot intervention villages using the Land Degradation Surveillance Framework (LDSF) and farm family and village level surveys.



LDSF

- Collection of 1288 soil samples and recording various observations as per the LDSF methodology from 627 plots across 56 villages/clusters spread over three states
- Soil samples were analyzed for pH, texture, nitrogen content, soil organic carbon and soil infiltration

Family and village surveys

- 1100 families in 55 villages, with 1046 families followed up at the endline
- Gathered detailed information on household demographics, land characteristics, livestock, asset ownership, field activities, household coping strategies, and food insecurity experiences

Data collection was done at three junctures – the baseline to establish the baseline situation; follow-up for progress monitoring; and endline to evaluate changes resulting from LCA interventions.

2. LDSF FINDINGS

The results of analysis of soil parameters and LDSF observations are described below. The status and changes in soil parameters of Topsoil over Subsoil and LCA plots over non-LCA plots were observed with help of density plots and statistical analysis ('t' test).

SOIL *pH*:

It has a significant influence on the availability of nutrients to plants. The optimal pH range for nutrient availability is between 6.0 and 7.0 and is called neutral. Below this range the soil is acidic while pH above this range refers to alkaline soil and leads to unavailability of various nutrients.

The pH trends from the project locations are summarized below.

Gujarat	Madhya Pradesh	Uttar Pradesh
'Moderately alkaline'	'Nearly neutral to alkaline'	'Slightly acidic to nearly neutral'
No depth-wise variation in LCA plots	Slight depth-wise variation in LCA plots	Depth-wise variation in LCA plots
Depth-wise variation in non-LCA plots	Depth wise variation in non-LCA plots	Depth-wise variation in non-LCA plots
Higher in Topsoil of LCA plot than non-LCA	Lower in Topsoil of LCA plot than non-LCA	Higher in Topsoil of LCA plot than non-LCA
Lower in Subsoil of LCA plot than non-LCA	Higher in Subsoil of LCA plot than non-LCA	Higher in Subsoil of LCA plot than non-LCA

The statistically analyzed data showed significant and slightly higher *pH* in Topsoil of LCA plots over non-LCA and non-significant but higher *pH* in Subsoil of LCA plots over non-LCA plots at Sayla. Overall, not much variation in soil *pH* was observed here. At Jhirnya, slight depth-wise variation and plot-wise variation was noted but the change was not significant. Significant increase in *pH* of Topsoil and Subsoil of LCA plots over non-LCA plots at Bahraich was reported.

SOIL ORGANIC CARBON:

It is a basic indicator of soil health. Organic carbon is basis of soil fertility and serves like a nutrient store house. Therefore, it is crucial to increase its content in soil.

The plot-wise and location-wise variation and content of soil organic carbon are mentioned in table below.

Gujarat	Madhya Pradesh	Uttar Pradesh
'Low to medium'	'Medium'	'Medium'
Higher in Topsoil than Subsoil in LCA plots	Higher in Topsoil than Subsoil in LCA plots	Higher in Topsoil than Subsoil in LCA plots
Higher in Topsoil than Subsoil in non-LCA plots	Higher in Topsoil than Subsoil in non-LCA plots	Higher in Topsoil than Subsoil in non-LCA plots
Higher in Topsoil of LCA plot than non-LCA	Higher in Topsoil of LCA plot than non-LCA	Higher in Topsoil of LCA plot than non-LCA
Higher in Subsoil of LCA plot than non-LCA	Higher in Subsoil of LCA plot than non-LCA	Higher in Subsoil of LCA plot than non-LCA

The results showed an overall improvement in soil organic carbon content in LCA intervention plots compared to non-intervention plots. Further, higher content of soil organic carbon was observed in Topsoil over Subsoil.

NITROGEN CONTENT:

The scenario of soil nitrogen content can be seen from the table below.

Gujarat	Madhya Pradesh	Uttar Pradesh
Higher content in Subsoil than Topsoil in LCA Plots	Higher content in Subsoil than Topsoil in LCA Plots	Higher content in Subsoil than Topsoil in LCA Plots
Higher content in Topsoil than Subsoil in non-LCA plots	Higher content in Topsoil than Subsoil in non-LCA plots	Higher content in Topsoil than Subsoil in non-LCA plots
Higher content in Topsoil of LCA plot than non-LCA plot	Higher content in Topsoil of LCA plot than non-LCA plot	Higher content in Topsoil of non-LCA plot than LCA plot
Higher content in Subsoil of LCA plot than non-LCA plot	Higher content in Subsoil of LCA plot than non-LCA plot	Higher content in Subsoil of LCA plot than non-LCA plot

Significant improvement in nitrogen content was recorded at Jhirnya and Bahriach in LCA plots over non-LCA plots. However, at Sayla non-significant increase was reported.

TEXTURE (SAND, SILT AND CLAY CONTENTS IN %):

Soil texture refers to the proportion of sand, silt and clay. An appropriate proportion improves aeration in soil, water movement and storage and nutrient holding capacity of soil.

Below is the table which shows plot-wise trends of soil texture at all three locations.

Gujarat
Dominance of sand content
Overall textural class 'Sandy loam'
Improvement in clay percentage in Topsoil of LCA plot over non-LCA plot
Improvement in silt percentage in Topsoil of LCA plot over non-LCA plot
Decline in sand content in LCA plot than non-LCA plot

Madhya Pradesh
Overall textural class 'Sandy clay loam'

Uttar Pradesh
Overall textural class 'Sandy loam'
Slight plot-wise change in sand, silt and clay content

Statistical analysis showed improvement in clay and silt percentage in Topsoil of LCA plots over non-LCA plots with decline in sand content at Sayla. However, at Jhirnya and Bahraich non-significant plot-wise variation was reported.

SOIL INFILTRATION:

The single-ring infiltration test, which is a robust method, was used for calculating infiltration rates. The analysed data of soil infiltration measurements showed no significant plot-wise and location-wise variation.

LAND COVER/USE CLASSIFICATION:

Land degradation surveillance framework (LDSF) covers recording of observations related to land cover system, which speak undoubtfully about soil health. In all three project locations, agroforestry systems were less common, with annual crops prevailing over trees. This highlights the need to increase tree cover as well as pasture, which could ultimately lead to improvements in soil and ecosystem health.

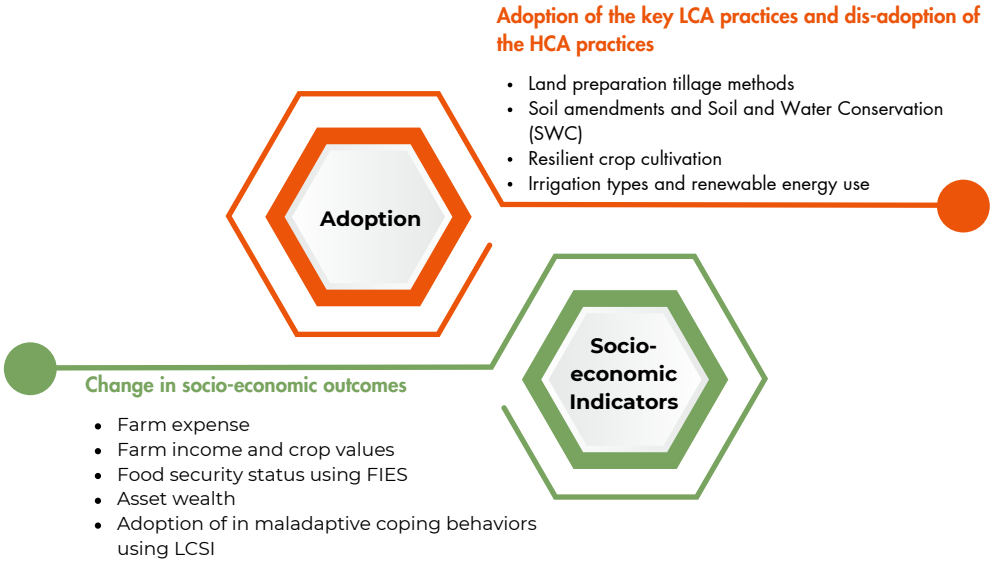
3. FARM FAMILY SURVEY FINDINGS

ADOPTION OF LOW CARBON AGRICULTURAL PRACTICES

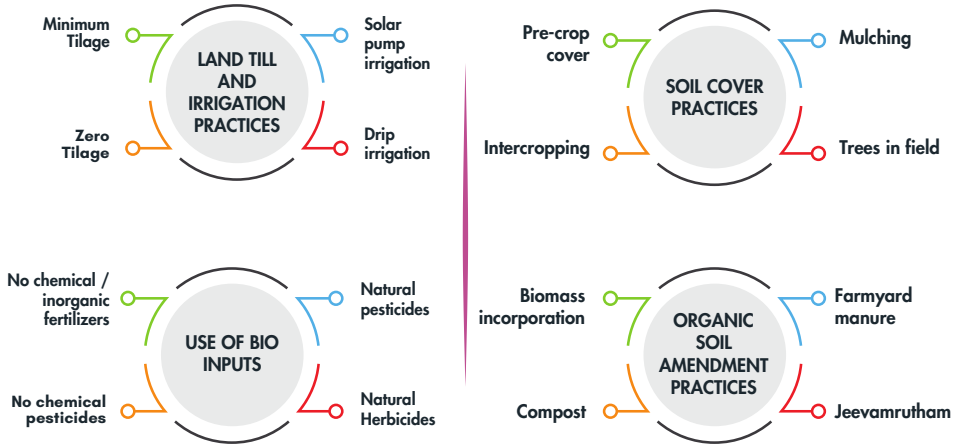
The adoption of Low Carbon Agriculture (LCA) practices among surveyed households showed significant changes between 2021 and 2024. At the baseline in 2021, 13% of households did not adopt any LCA practices, with most households adopting between one to three practices. By the endline (Kharif 2023), this percentage of non-adopters of LCA practices reduced to 2.9%, while a notable increase was observed in households adopting two to four practices, highlighting increased intensification of LCA and dis-adoption of HCA practices. Specifically, the percentage of households adopting two practices increased from 27% to 34%, three practices from 18% to 24%, and four practices from 11% to 13%. In conclusion, while there are some shifts towards biofertilizers and organic soil amendments, specifically in Gujarat, the overall reliance on chemical fertilizers and the lack of adoption of natural farming practices persist across the three states. Furthermore, the rates of natural farming, such as the use of Jeevamrutham, showed no changes across the seasons in the three states.

There is a big variation across the three states. Gujarat showed the most comprehensive adoption of multiple LCA practices, with the highest percentage of households adopting three or more practices, while Uttar Pradesh saw significant growth in households adopting two or more practices. In contrast, Madhya Pradesh had more households adopting one or two practices, but fewer adopting more than three, indicating varying levels of engagement and intensity in LCA adoption across the states, suggesting a need for tailored strategies to enhance further adoption.

The two important indicator dimensions from the farm family survey highlighted are:



LCA INTENSIFICATION INDEX



IMPACT OF LCA PRACTICES ADOPTION

The project examined whether households that
a) intensified their overall LCA practices (as measured by the LCA index) and b) upscaled LCA practices and accumulated more assets, developed adaptive capacity, experienced less food insecurity and improved farm income at the endline compared to the baseline situation.
The asset gain index was constructed using Principal Component Analysis (PCA) based on data on households' ownership of livestock, nondurable farm assets, other durable assets, and housing characteristics collected at both baseline and endline surveys. To measure the proportion of households reporting the adoption of maladaptive coping behaviours we adapted the World Food Programme's Livelihood Coping Strategies Index (LCSI). For food insecurity exprience, we used Food insecurity experience score (FIES) which is also used to measure SDG Indicator 2.1.2: Prevalence of moderate or severe food insecurity in the population.

Household Asset Wealth

Results observed a significant gain in the overall asset index for the sampled households compared to the baseline. The largest asset gains were experienced by households in Gujarat, followed by Uttar Pradesh, while the change was smaller in Madhya Pradesh.

Livelihood Coping Strategies Index (LCSI)

The results show a decrease in households' use of maladaptive coping strategies compared to the baseline across all states. At the endline, 67 % reported less need to engage in maladaptive coping behaviours compared to the baseline, as measured by the change in LCSI.

Food Insecurity Experience Scale (FIES) – 8 points

Overall FIES score showed a notable improvement, with the median score dropping from 2 to 0 on a scale of 8 points. This indicates a significant reduction in food insecurity. 51% of the families reported improvement in their food security as indicated by the change in FIES.

Net Farm income

The results show that 33% reported at least a 10% increase in crop income after adjusting for inflation. In Gujarat, 35% saw income gains, likely due to adopting biofertilizers and reducing chemical inputs. Uttar Pradesh had the highest improvement, with 50% reporting increased income, likely due to a shift towards natural pesticides and biofertilizers that enhanced soil health and yields. However, only 50 farmers in Madhya Pradesh (14%) experienced income gains, possibly due to lower adoption or effectiveness of these practices, influenced by limited local support and training.

4. CONCLUSIONS

The LDSF survey analysis revealed significant improvements in soil organic carbon and nitrogen content in LCA intervention plots compared to non-intervention plots, indicating the benefits of LCA practices over the short period of the project. However, to achieve sustainable positive change in soil pH, in organic carbon and nitrogen content of soil and in soil infiltration capacity, long-term implementation of ecosystem-specific LCA practices are suggested. The prevalence of annual crops over trees highlights the need to increase tree cover to enhance soil and ecosystem health.

The adoption of LCA practices varied across states, with Gujarat and Uttar Pradesh showing more significant uptake than Madhya Pradesh. The most adopted LCA practices included the use of farmyard manure, incorporation of crop residues, mulching, pre-planting soil cover, and the application of compost.

While 48% of farmers adopted at least one new LCA practice or discontinued one HCA practice, the overall LCA intensification remains limited. Traditional practices like chemical fertilizers and flood irrigation persist, indicating a slow transition to sustainable methods, with agroforestry adoption remaining low. Tailored efforts are needed to promote broader adoption of energy-efficient irrigation, soil and water conservation, agroforestry, and resilient crop varieties across the three states.

Using first difference estimation and accounting for district fixed effects we assess the impact of the intensification of LCA practices on various socio-economic outcomes. The assessment showed that there is a strong and positive association between changes in socio-economic outcomes and the adoption of LCA practices.

The average variable cost significantly decreased in Gujarat and modestly in Uttar Pradesh compared to the baseline. This aligns with the shift from capital-intensive chemical inputs to bio-inputs in both states. The model estimates also indicate that adopting or scaling up LCA practices is associated with a statistically significant reduction in input costs in Gujarat.

To summarise, it shows that households that adopt LCA practices or scale up the use are more likely to see asset wealth growth, engage less in maladaptive coping strategies, and less likely to experience food insecurity.

MATERIALS RELATED TO THE LAND DEGRADATION SURVEILLANCE FRAMEWORK (LDSF):

LDSF Webpage: *https://ldsf.thegrit.earth/*

LDSF Field Manual: *https://www.cifor-icraf.org/knowledge/publication/25533/*

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