Landscape Evaluation and Assessment Framework (LEAF): A GIS-enabled Decision Support System for Evidence-Based Agroecological Planning

What is LEAF and why does it matter?

Agriculture in India remains highly weather-sensitive, with most rainfall concentrated in the monsoon months and nearly half of the cultivated area still rainfed. Climate change is intensifying temperature rise and rainfall variability, increasing the frequency of extreme events and heightening vulnerability. At the same time, input-intensive and unsustainable practices have degraded natural resources including groundwater depletion, soil degradation, pollution, and biodiversity loss, resulting in low productivity, food and nutrition risks, and farmer distress.

Developing sustainable and climate-resilient agricultural landscapes - clusters of interacting ecosystems managed to meet both human and environmental needs - is now a policy priority. Such landscapes can strengthen food and nutrition security, improve water reliability, reduce erosion, and enhance ecosystem services while remaining resilient to shocks. However, landscapes differ widely in climate, land use, topography, culture, and resource availability. A one-size-fits-all model is not feasible. Interventions must be tailored to local biophysical and socio-economic context, recognizing that costs, effectiveness, and impacts vary by landscape.

This underscores the need for a robust Decision Support System (DSS) that applies scientific decision rules to characterize stability, prioritize investments, and assess the likely impacts of proposed interventions - reducing ad-hoc decision making and improving transparency in planning. This brief outlines the development and key features of LEAF DSS – a Landscape Evaluation and Assessment Framework that integrates, visualises, and analyses multi-source data on agricultural systems (crops and livestock), water, climate, socio-economic conditions, and infrastructure to support informed decision-making and investment prioritisation.

128
Variables

7
Data Dimensions

4
Admin Levels

4
Agroecology interventions

What is LEAF?

LEAF (Landscape Evaluation and Assessment Framework) is a GIS-enabled Decision Support System that supports evidence-based planning for agroecology (AE) initiatives including livestock, organic, natural farming and integrated farming systems. LEAF collates a multi-dimensional dataset at state, district, block, and cluster (group of villages) level, drawing on over 120 indicators organised into seven data categories. Together, these categories allow LEAF to represent not only biophysical suitability, but also the enabling conditions required for successful adoption and scaling of AE pathways. To ensure replicability and scalability, LEAF relies on freely available and open data sources wherever possible, so that any state or implementing agency can adopt the tool without dependence on proprietary datasets.

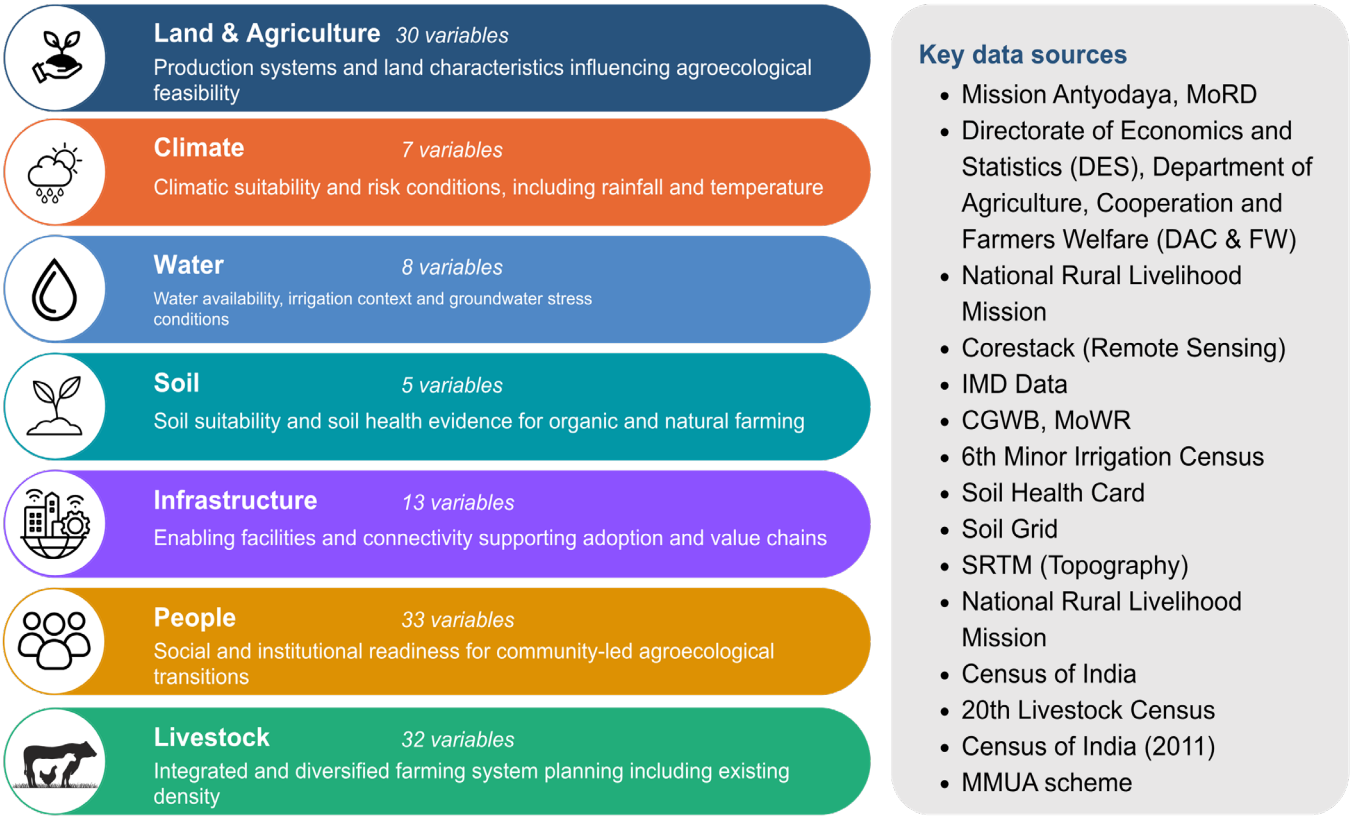


Figure 1. Seven data dimensions that form the building blocks of LEAF. (Source: IWMI)

At the heart of LEAF DSS is a unified interface that brings all datasets together in one place, allowing users and planners to analyze and visualize multiple dimensions of a landscape simultaneously, rather than working across fragmented tools and sources.

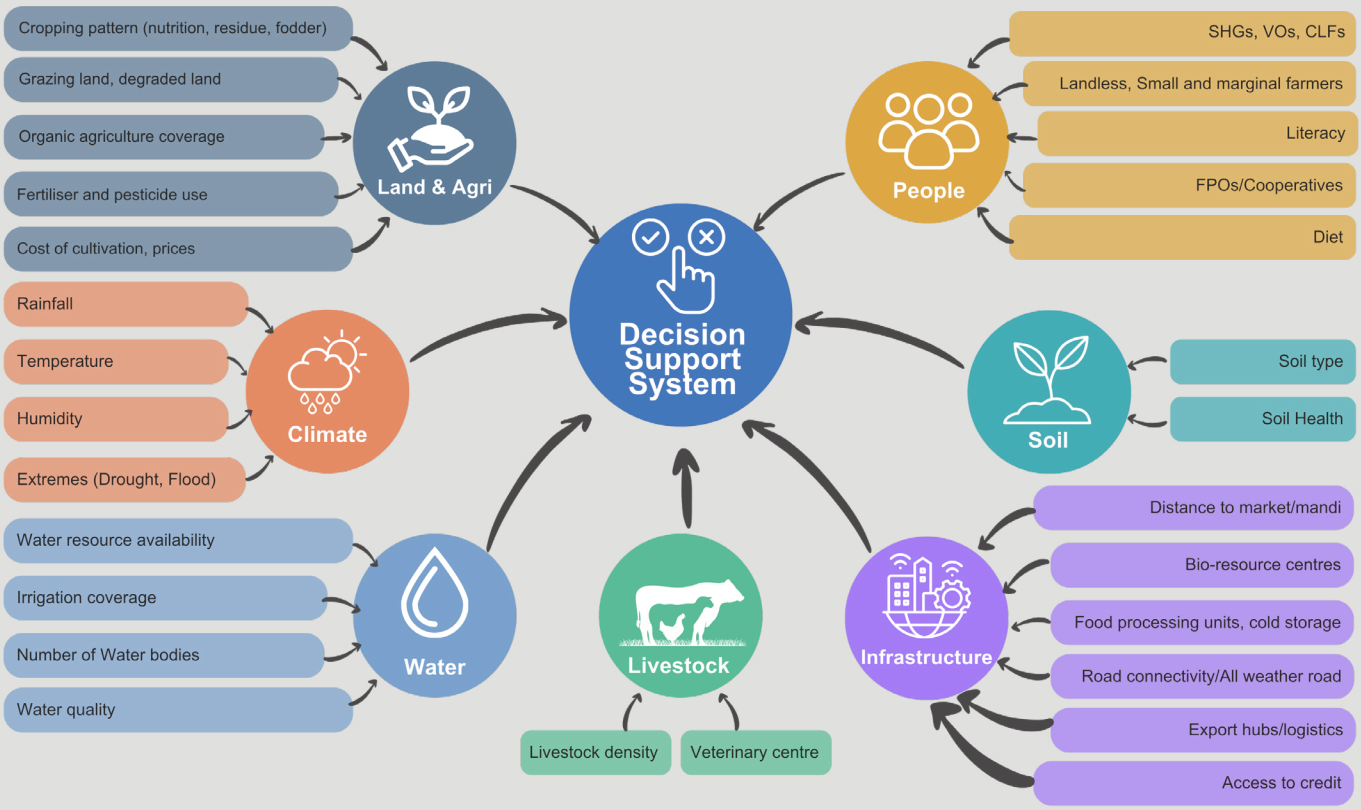


Figure 2. Key data categories that underpin the LEAF tool.(Source: IWMI)

What LEAF IS

- A transparent decision-support layer for planners
- A spatial tool showing where and why an intervention fits
- A scalable, state-replicable platform built on open data
- An export-ready reporting engine for approvals

What LEAF is NOT

- A replacement for field judgment or local knowledge
- A black-box - all criteria are user-defined and transparent
- Prescriptive - it highlights conditions, not mandates
- Dependent on proprietary data sources

Decision Making in LEAF

LEAF enables users to identify suitable areas landscapes including districts, blocks, or village clusters by generating feasibility and suitability assessments for agroecology-aligned interventions, including Organic, Natural, and livestock-based approaches. It is designed to support government schemes and programmes such as PKVY (Paramparagat Krishi Vikas Yojana) and DAY–NRLM (Deendayal Antyodaya Yojana – National Rural Livelihoods Mission), the National Mission on Natural Farming and Assam's Mukhya Mantri Mahila Udyamita Abhiyan (MMUA) and UDAYINI, which envisage cluster-based strategies to promote livestock, organic and natural farming in a structured, scalable, and market-linked manner.

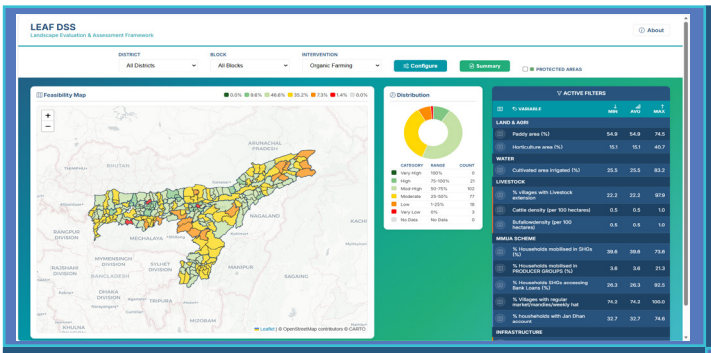
LEAF Decision Making Workflow

At the core of LEAF's decision-making layer is a curated set of 120+ variables drawn from open, government-published datasets - Mission Antyodaya, Livestock Census, IMD, MMUA scheme, SRLM programme data, remote sensing, and soil health sources. These variables are organised into seven thematic dimensions and are pre-assigned as critical variables with recommended range based on literature review and consultations for each supported intervention type. However, the system is configurable: planners can adjust which variables are included, set preferred ranges (e.g. minimum cattle density, maximum groundwater exploitation), and modify weights to reflect local programme priorities or evolving policy guidance. For any selected area - a district, a block, or a cluster of villages - LEAF compares actual values against these configured thresholds and generates a composite suitability profile. Each variable contributes a scored signal: whether it is in the preferred range (strength), close to it (marginal), or significantly below it (gap requiring attention). This produces a transparent, indicator-by-indicator picture of where an area stands - not a black-box score, but a structured diagnostic that practitioners can read, interrogate, and act on.

A **summary dashboard view** gives planners a 5–6 line snapshot with all of the data of the area's key strengths, critical gaps, and headline recommendations - suitable for presentations, review meetings, and quick prioritisation. A detailed **report supported by AI recommendation engine**, working with this data and those background references, provides full indicator values, dimension-wise scores, gap analysis, and specific recommendations - grounded in both the quantitative data and the policy background documents that define what "suitable" means for that intervention type.

Multi-Scale Planning: From State to Cluster

LEAF operates across four spatial scales, allowing planners to move seamlessly from state-wide prioritisation down to individual village cluster formation. Each level of the platform presents the same underlying data at a different resolution, with outputs calibrated to the decisions made at each scale.



1. State-Wide Overview

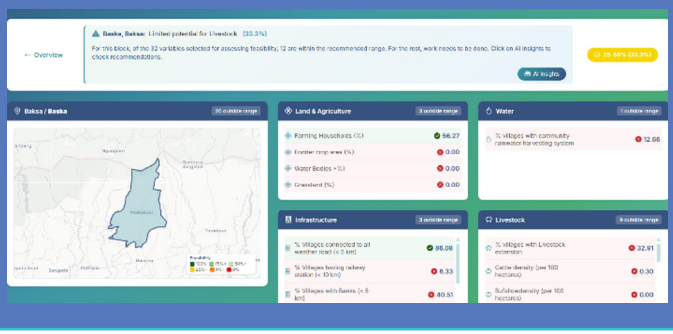
Compare all districts and blocks at a glance

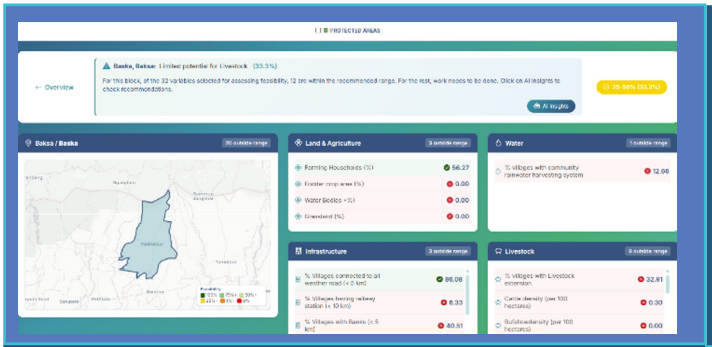
- Suitability scores mapped across all 34 districts of Assam
- Identify high-potential districts for organic, NF, or livestock
- Show state wise average data in map and table for all indicators selected
- Export summary report

2. District View

Block-by-block performance within a district

- All blocks within the selected district scored and ranked
- District aggregate dimension-wise breakdown and data
- Recommendation overview with AI supported detailed insights and report
- Supports ASRLM distrct planning, approvals, and monitoring reviews



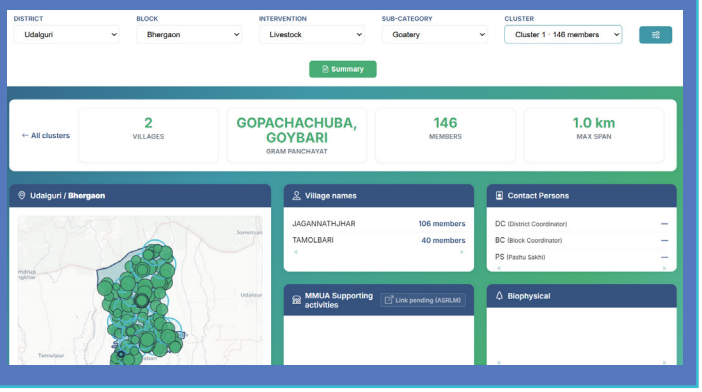


3. Block Profile & Assessment
Full indicator scorecard with AI recommendations

- Selected indicator values displayed against configured thresholds
- Strengths and critical gaps identified at variable level
- AI engine generates a summary and detailed recommendation report
- Supports ASRLM block planning, approvals, and monitoring reviews

4. Cluster view and information
Commodity-specific cluster formation and profiling

- Commodity cluster wise information: nodes, village names, block coordinators and Pasu Sakhis
- Cluster associated MMUA supporting activities information (transport, shops etc)
- Convergence infrastructure information (e.g, Vet center, fertilizer shop) and key biophysical attributes



Case 1 - Natural Farming

Natural Farming (NF) is built on the principle of near-zero external input use, with soil biology activated through farm-made bio-stimulants such as Jeevamrit and Beejamrit. This places a specific set of preconditions on the landscape - livestock presence, on-farm biomass, and community capacity - that LEAF translates into an integrated display based on which insights can be drawn. The pre-selected variables are set for NF among the data categories and LEAF is pre-configured with defaults derived from national NF guidelines and SRLM programme experience, but other variables can be added and each variable's threshold can be adjusted by the user:

- **Livestock and biomass base** – Livestock density, fodder crop area (%), grassland and tree or shrub cover (%) - these determine whether sufficient desi cow dung and urine, and enough on-farm biomass, are available to prepare Jeevamrit, Beejamrit, and mulching material without external purchase.

- **Farming system characteristics** - cropping intensity (%), crop diversification index capturing whether farmers already practice multi-cropping and residue cycling, which underpin NF's soil cover and minimal tillage principles.

- **Water and ecology** - rainfed area share, pre- and post-monsoon groundwater levels, stage of groundwater development is included because NF tends to perform better in areas with limited irrigation dependence and moderate groundwater stress.

- **Institutional readiness** - proportion of households mobilised into SHGs, community pond coverage, Krishi Sakhi positions capture presence of institutional and community support.

When LEAF assesses a district/block for NF suitability, it scores each variable against its configured range, aggregates these scores into an overall suitability rating, and identifies the top enabling conditions (strengths) and the most significant gaps. The AI engine then translates this structured output into a plain-language assessment and recommendation set. For instance, a block with strong SHG coverage and adequate livestock density but very low crop diversification would be assessed as "moderately suitable" with a specific recommendation to promote multi-cropping and pulses as intercrops before scaling NF adoption. A block with negligible cattle density would be flagged as requiring livestock development as a precondition, not a concurrent activity.

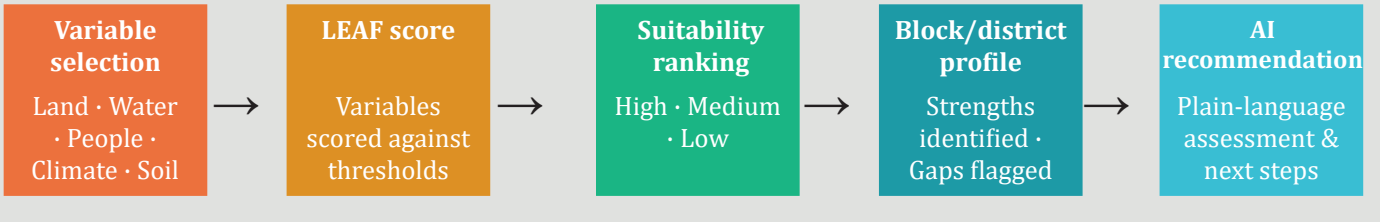


Figure 3. LEAF intervention suitability assessment flow.(Source: IWMI)

AI Recommendation Engine

LEAF integrates an AI-powered recommendation engine, through API integration with a large language model, that analyses a district and block's performance profile against policy documents and programme guidelines to generate targeted, context-specific activity suggestions - moving LEAF after AI-generated recommendations are intended to support, not replace, expert judgement and field validation.

How the Engine Works

Input 1: User Objectives - Selected intervention type (Organic, Natural Farming, Livestock) and priority goals set by the planner.
Input 2: Suitability Indicators - Block-level scores across all 120+ LEAF variables - strengths, gaps, and threshold performance.

Input 3: Policy and Programme Documents - The AI engine references curated policy and programme guidance documents including PKVY guidelines, NMNNF framework, DAY–NRLM IFC guidelines, NLM operational guidelines, ASRLM SOP, and MMUA manual to ground recommendations in scheme-specific language and eligibility norms.

Output: Recommendations - Activity-level suggestions tailored to the specific block profile: what to do, where to focus, and in what priority order are structured as a summary view and a full detailed report.

The engine is designed to be official and technical in tone, grounded in programme language, and constrained by the same suitability logic that governs LEAF's scoring, ensuring recommendations stay feasible, scheme-aligned, and actionable for SRLM field teams.

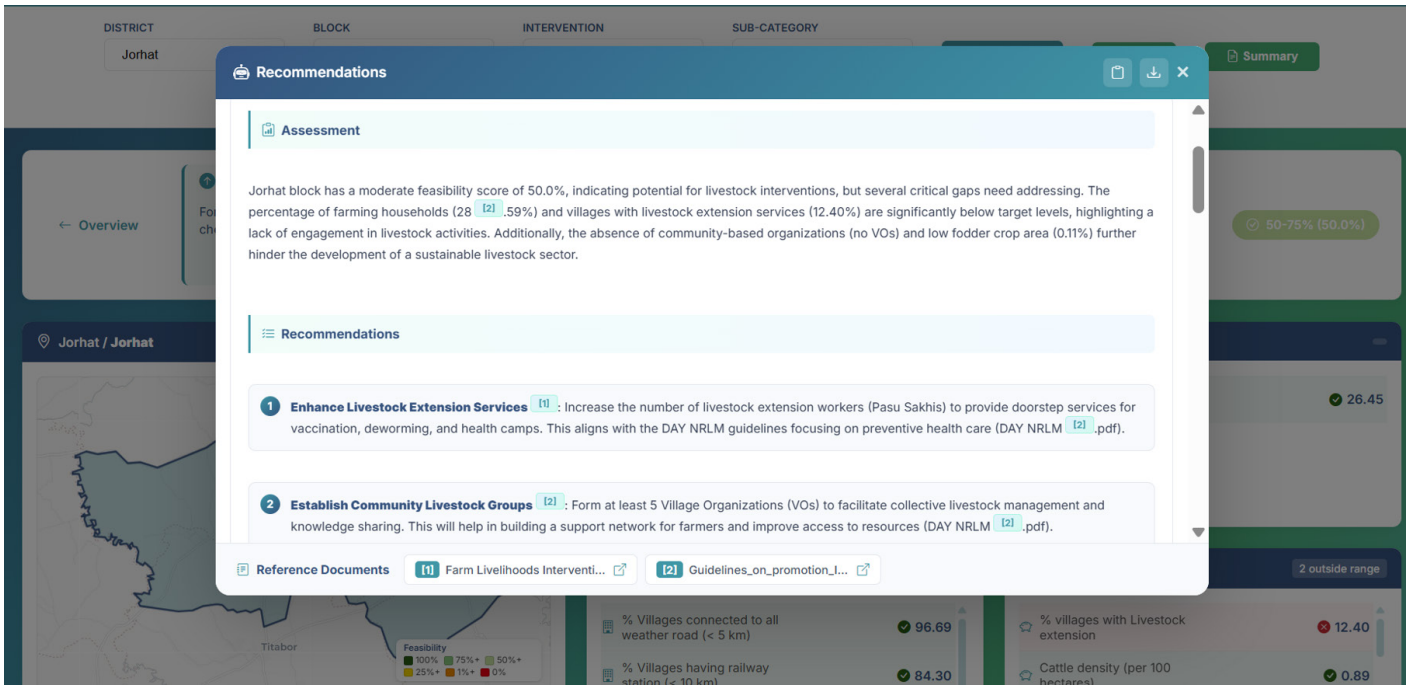


Figure 4. Example interface showing AI powered recommendations for a block.

Case 2 - Livestock Interventions

Livestock-based livelihoods - dairy, goatery, piggery, backyard poultry, duckery, and fishery - each have distinct preconditions related to animal population, feed resource base, service infrastructure, market access, and community mobilisation. LEAF captures these through a pre-configured but adjustable variable set grounded in DAY–NRLM livestock advisories and National Livestock Mission (NLM) guidelines. For a common-livestock assessment applicable across all sub-sectors, the pre-selected indicators span five groups:

• **Livestock density:** cattle, buffalo, goat, and poultry densities establishes the existing animal resource base and signal which sub-sectors are already present at a meaningful scale.

• **Feed and fodder base:** fodder crop area (%) and grassland or tree-shrub coverage (%) is critical for assessing whether the landscape can sustain existing herds and support expansion without feed insecurity.

• **Extension and veterinary access:** share of villages with livestock extension services, veterinary clinic within 5 km, and number of Pasu Sakhis positioned measuring whether the last-mile service infrastructure for animal health and advisory exists or must be built.

• **Market and value chain connectivity:** milk collection facility within 5 km, share of villages with regular markets, road connectivity determining whether produce can reach buyers, which is particularly important for perishable livestock outputs such as milk, eggs, and live animals.

• **Institutional capacity and community demand:** SHG mobilisation rate, share of Mahila Kisans supported under livestock interventions, and MMUA voting data (showing community preference for goatery, piggery, poultry, duckery, or fishery) ensuring that recommendations are grounded in expressed community interest and existing organisational infrastructure, not just biophysical signals.

The MMUA activity data, which records what proportion of SHG members showed interest for each livestock sub-sector, is a particularly distinctive input. It means the assessment reflects not just ecological potential but actual community readiness, making the AI recommendation more actionable: a block with strong goatery density and high MMUA interest in goatery receives a targeted recommendation to form goatery producer groups, prioritise Pasu Sakhi deployment, and link with NLM entrepreneurship support; a block with good pond infrastructure but low aquaculture extension coverage is flagged as infrastructure-ready but service-gap constrained, with extension positioning as the recommended first step.

Village Clustering for Livestock Interventions

Beyond feasibility assessment, LEAF powers a dedicated Village Clustering module that supports Assam SRLM in forming geographically contiguous, commodity-specific livestock clusters aligned with the MMUA programme. The workflow moves from field data collection to finalised cluster plans, all within the same platform.

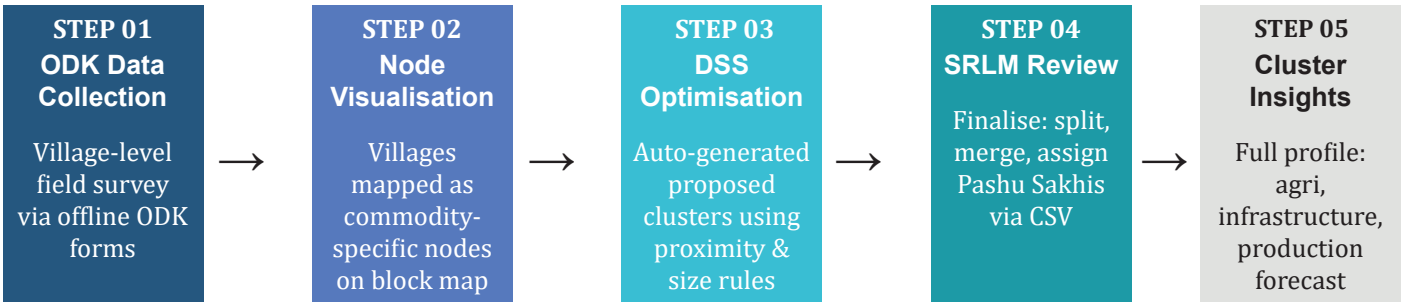


Figure 5. Cluster planning workflow.

Cluster Formation Criteria

- **Minimum Members:** ≥ 45 interested households per village per commodity to qualify
- **Cluster Size Cap:** ≤ 150 total members per commodity cluster
- **Proximity Radius:** ≤ 5 km between connected villages in a cluster
- **Road Connectivity:** All-weather road access preferred

Six Supported Commodities

- **Dairy:** Fodder area, cattle density, vet centre, market access
- **Goatery:** Grazing land, perennial water, local diet preference
- **Piggery:** Water availability, crop residue, input supply proximity
- **Duckery:** Water bodies, humidity, crop residue, SHG support
- **Backyard Poultry:** Climate suitability, feed access, local market
- **Fishery:** Perennial water, flood-zone suitability, market access

Key Concept

One Village, Multiple Commodity Clusters: Clusters are commodity-specific, not village-specific. A single village can simultaneously belong to a Dairy cluster, a Duck cluster, and a Poultry cluster. For example, 20 members interested in Dairy and 15 in Duckery means the village joins both clusters independently.

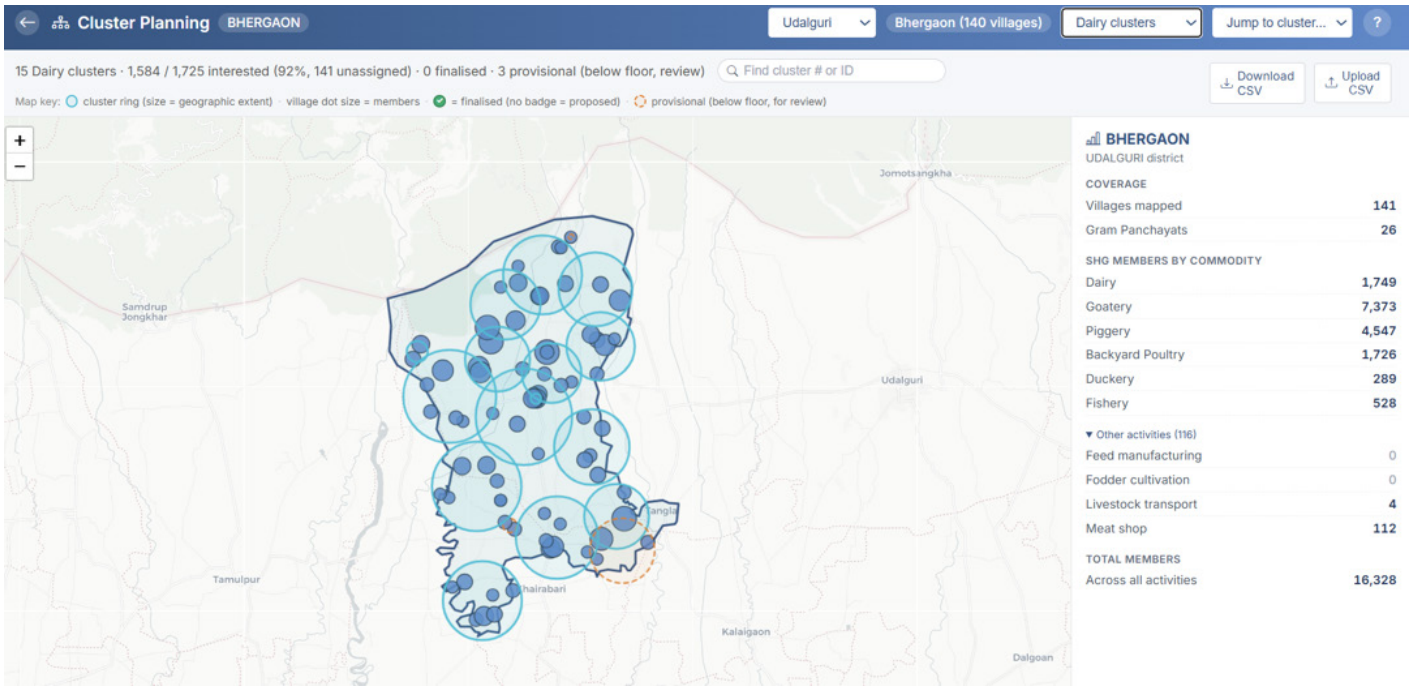


Figure 6. Cluster planning and visualising LEAF window.

How LEAF Supports NRLMs and SRLMs

LEAF is designed to support SRLM and NRLM teams in making clear, evidence-based, and scalable planning decisions for agroecological initiatives. It can be used across the planning cycle from identifying priority geographies to generating communication-ready outputs for approvals and stakeholder coordination. Outputs depend on the quality, timeliness, and spatial resolution of underlying datasets.

Assam's diverse agro-climatic zones from the Brahmaputra floodplains to the Barak valley and hilly districts require highly localised planning. ASRLM works with over 27 lakh SHG households across 34 districts. LEAF enables ASRLM teams to spatially identify where Organic Farming, Natural Farming, or Livestock clusters are most suitable and back those decisions with data-driven evidence for approvals, convergence planning, and reporting.

Targeting & Prioritisation
LEAF helps identify priority blocks/GPS where enabling conditions for AE initiatives are stronger, allowing programs to focus resources where impact potential is highest.

Transparency & Accountability
LEAF makes selection traceable and explainable, summarising the criteria used and showing why a block is included or excluded.

Reporting & Communication
Generates export-ready maps, block lists, and narrative summaries for presentations, review meetings, and approval processes.

Scalability & Replication
Once block-level datasets are loaded, the same workflow replicates across districts and states for standardised planning.

Decision Support
Users can compare multiple approaches and scenarios (e.g., Livestock, Organic, Natural, or Integrated farming pathways) and select the most suitable option based on local context and criteria performance.

Farmer Chandika Saikia feeds her pigs outside home in Karchia village, Sonapur, Assam. (Photo: Stevie Mann/ILRI)

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