CGIAR INITIATIVE ON Agroecology

Agroecological Homestead Model (AHM): Technical and Implementation Report, Madhya Pradesh, India

December 2024

Copyright © 2024 International Water Management Institute. Some rights reserved.

Suggested Citation: Malaiappan, S.; Gadewar, P.; Goverdhanam, S.; Konwar, D.; Kumar, G.; Krishnan, S.; Sikka, A. 2024. *Agroecological Homestead Model (AHM): technical and implementation report, Madhya Pradesh, India*. Colombo, Sri Lanka: International Water Management Institute (IWMI). CGIAR Initiative on Agroecology. 24p.

Disclaimer: This publication has been prepared as an output of the CGIAR Initiative on Agroecology. Responsibility for editing, proofreading, and layout, opinions expressed, and any possible errors lies with the authors and not the institutions involved.

This work is licensed under Creative Commons License CC BY-NC-ND 4.0

[https://creativecommons.org/licenses/by-nc-nd/4.0/]

Cover Image: Sudharsan Malaiappan/IWMI

Authors:

Sudharsan Malaiappan, International Water Management Institute (IWMI)
Pragya Gadewar, Professional Assistance for Development Action (PRADAN)
Sahith Goverdhanam, Professional Assistance for Development Action (PRADAN)
Dikhyani Konwar, Professional Assistance for Development Action (PRADAN)
Gopal Kumar, International Water Management Institute (IWMI)
Smitha Krishnan, Alliance – Bioversity and CIAT
Alok Sikka, International Water Management Institute (IWMI)

Design & Layout: Tanmoy Bhaduri/IWMI

Acknowledgment: Preparation of this report was supported through CGIAR's Agroecology Initiative. The authors are grateful to all the field staff from PRADAN for facilitating field visits, interactions with farmers, implementation of AHM pilots and data collection.

The contributions of the PRADAN team (Savni Kulasthe, Nilesh Singroure, Munni Vishwakarma, Achelal Vishwakarma, Gomthi Warkade and Saurabh Singh), members of Self-Help Groups, Sh. Shreyas Kumar, IAS, CEO of Zila Panchayat Mandla, Sh. B. D. Bhaisare, District Planning Officer Mandla, SRLM officials from Mandla, Smt. Ritu Tiwari, District Programme Officer, Smt. Madhu Ali, Deputy Director of Agriculture Mandla, Sh. K. S. Netam, Joint Director of Agriculture, Madhya Pradesh, Md. Akip Khand, IAS, Mandla, the District Forest Officer, and other officials from the Forest Department Mandla, as well as Sh. R. G. Ahirwar and other scientists from KVK Mandla, are sincerely acknowledged for their roles in planning, mobilization, visioning, and the co-design workshop. We also extend our heartfelt gratitude to all the CGIAR partners for their invaluable support and for fostering a spirit of collaboration and cohesion throughout the process.

The CGIAR Initiative on Transformational Agroecology across Food, Land, and Water Systems develops and scales agroecological innovations with small-scale farmers and other food system actors in seven low- and middle-income countries. CGIAR is a global research partnership for a food-secure future. CGIAR science is dedicated to transforming food, land, and water systems in a climate crisis. Its research is carried out by 13 CGIAR Centers/Alliances in close collaboration with hundreds of partners, including national and regional research institutes, civil society organizations, academia, development organizations and the private sector. www.cgiar.org We would like to thank all funders who support this research through their contributions to the CGIAR Trust Fund: www.cgiar.org/funders.

To learn more about this Initiative, please visit this webpage.

To learn more about this and other Initiatives in the CGIAR Research Portfolio, please visit www.cgiar.org/cgiar-portfolio

Contents

1. Executive summary

The Agroecological Homestead Model (AHM), conceptualized under the CGIAR Agroecology Initiative in collaboration with PRADAN, provides an innovative framework to address critical challenges faced by tribal communities in Mandla district, Madhya Pradesh, India. These challenges include dietary monotony, malnutrition, irregular income, and resource degradation. Rooted in agroecological principles, AHM offers a sustainable and holistic approach to managing homestead resources.

The AHM integrates diverse elements such as multilayer farming systems, natural composting techniques, water harvesting through Jal Kund, backyard poultry farming, livestock rearing, and beekeeping. Its participatory codesign process involved local farmers, women's self-help groups, and other stakeholders, ensuring the model's adaptability and relevance to the local context. The implementation process included baseline assessments, visioning exercises, stakeholder consultations, exposure visits, and tailored training programs to equip participants with the knowledge and tools for sustainable homestead management.

AHM has significantly enhanced production diversity (over 350%), dietary diversity (100%), and the consumption of nutrient-rich foods such as leafy greens (70% increase). Additionally, it has improved protein intake and created opportunities for regularized income, empowering marginalized communities, particularly women. The model has also demonstrated the potential to optimize resource use efficiency, strengthen resilience to climatic and economic shocks, and contribute to environmental sustainability.

Despite its successes, the implementation of AHM encountered challenges, including resource limitations, knowledge gaps, pest infestations, and extreme weather events. These lessons highlight the need for enhanced training, improved market linkages, and site-specific adjustments to the model.

Future directions for AHM include developing typologies based on resource availability, incorporating mid-course corrections from field learnings, and integrating AHM into regional and national agricultural extension frameworks. Emphasis will also be placed on scaling the model through partnerships, impact assessments, and policy advocacy to promote sustainable livelihoods and food security across diverse agroecological contexts.

This document serves as a comprehensive guide for implementing the AHM, offering practical insights into its design, components, and transformative potential for rural communities. It underscores the importance of agroecological innovations in creating resilient, sustainable, and inclusive food systems.

2. Background and challenges

Tribal communities in Madhya Pradesh, India are largely dependents on monoculture agriculture and Non-Timber Forest Products (NTFP) for their livelihoods, resulting in imbalanced nutrition and irregular income (Kumar, et al. 2024). Dwindling forest-based resources and incentivized shift towards chemical based farming and degraded land conditions have aggravated this imbalance and food sovereignty. They also lack access to resources and knowledge, especially development initiatives for improving their livelihood. This often leads to migration in search of better livelihood.

Role of homesteads in rural communities: Homesteads are an integral part of most rural households, serving as hubs for production and consumption of diverse foods required by the household. Although integration of animals into these homesteads is common in farming communities, rapid urbanization, rising land costs, distress migration, and the increasing reliance on chemical-intensive farming practices have led to abandonment of some of these traditional homestead activities. This shift has contributed to reduced dietary diversity, imbalanced nutrition, malnourishment, and compromised human health.

Women's participation in agriculture: In rural and tribal areas, agriculture remains primary source of livelihood, especially for women. According to Niti Aayog report (Patel and Sethi, 2021), among 80% economically active women, 33% work as agricultural labourers and 48% are self-employed farmers, with women being engaged at every step of agricultural value chain, contributing significantly to the Gross Domestic Product (GDP) per capita.

Despite their increasing participation and contributions, women in agriculture continue to face challenges such as lack of land ownership, limited role in decision making within households or in community, limited financial accessibility, and economic constraints. These factors often leave their efforts unrecognized in agriculture and allied sectors. Women in typical Indian rural societies often receive the least priority when it comes to accessing purchased consumption items, placing them at significant risk of malnutrition and poor health.

To address these challenges, CGIAR's Agroecology Initiative established Agroecological Living Landscapes (ALLs) in the Mandla district. These ALLs are multi-stakeholder, territorial spaces where agroecological innovations are co-designed, tested, and implemented by a diverse range of actors, including small-scale farmers, local communities, researchers, NGOs, and government bodies.

The context assessment (Malaiappan et al., 2024b), baseline assessment (Krishnan et al., 2024) identified resource-based challenges and opportunities. visioning exercise (Singh et al., 2024) was conducted to understand the aspirations of the community and multiple food system actors. Subsequently, co-design workshop (Kumar et al., 2024b), and multiple interactions with farmers and women self-help groups (W-SHGs) led to the identification of the Agroecological Homestead Model (AHM) as a potential technology for co-experimentation. This model aims to enhance livelihoods, improve economic diversity, regularize income, diversify diets, and promote sustainable agricultural practices in tribal and rural areas, thereby ensuring long-term resilience for communities, particularly women. Initial results have demonstrated the model's cost-effectiveness (Kumar et al., 2024b) and its ability to deliver multiple benefits. This report aims to serve as a practical guide for implementing the AHM, developed through a participatory decision-making process, including mechanisms for scaling up the model. This also highlight the challenges faced during implementation and lessons learnt that need to be addressed to actualize full potential of the AHM. - A

3. Co-design process of AHM

Co-design of innovations with various food system actors is a crucial step in achieving effective agroecological transformation, especially for a country like India with various socio-economic and environmental factors influence agricultural practices. Co-design process include several activities, including context and baseline assessment, visioning/vision to action exercise, multi stakeholder's consultation, field visits, farmers interaction in the field, farmers feedback, co-design workshops, partners meetings, visit to the learning sites and group discussions, with special focus on women collectives (Malaiappan et al., 2024b; Krishnan et al., 2024; Singh et al., 2024; Kumar et al., 2024b; Monserrate et al., 2024).

Identifying key challenges: During the visioning or vision-to-action exercise (Figure 1), farmers envisioned their aspirations for the future, imagining what they hope to achieve in farming and beyond over the next 10 years. They also identified several key challenges related to livelihoods and farming that must be addressed to realize their dream goals. This community approach was possible riding on reputation built by the PRADAN, the ground implementation partner through several years of active engagement. Women's groups specifically emphasized the lack of reliable sources of income and sustainable livelihood opportunities, as well as limited knowledge about practicing sustainable agriculture. The discussion with various stakeholders group including members W-SHG, representative from government departments, civil society organizations, women groups, researchers and Krishi Vigyan Kendras, and extension agencies highlighted several challenges. These included inadequate dietary diversity, poor land productivity, rampant land degradation, water scarcity, climate extremes and unpredictability, and other challenges echoed in mixed-group discussions. The workshop discussion also emphasized urgent need to optimize the use of available land resources, particularly homestead land in which women can have a greater involvement. Civil society organizations and women's groups specifically raised concerns about the increasing use of chemicals in farming and the need for effective alternatives. The farmers and stakeholders collectively envisioned improving homestead land to address these challenges.

Figure 1 Visioning / Vision to action exercise (Photo: IWMI, PRADAN)

Subsequently, a co-design workshop was conducted (Figure 2) to bring all the stakeholders onto a common platform to discuss the challenges and innovations. One of the outcomes of co-design workshop is the women led management of homestead for improving food, nutritional and income security.

Building on the workshop outcomes, Agroecological Homestead Model (AHM) was developed. AHM is an integrated and holistic model of land management focused on optimal utilization of homestead land, which aims to improve and stabilize income while enhancing dietary diversity, ensuring balanced self-consumption, and promoting environmental sustainability.

Figure 2: Co-design workshop (Photo: IWMI, PRADAN)

The co-design workshop and multiple consultations with the community and other stakeholders were instrumental in identifying and optimizing the components of the AHM. However, when it came to selecting crops for the multilayer model, farmers were given the freedom to choose from a basket of options provided to them.

4. Components of AHM

Components of Agroecological Homestead Model (AHM) includes, **multi-layer vegetable cultivation** (including roots (tuber), leafy greens, shrubs such as brinjal, climbers such as gourds), **crop rotation**, use of **natural amendments, composting, backyard poultry, water harvesting and storage systems** for irrigation, while also exploring the potential of **livestock rearing** and **beekeeping**. Table 1 list the components of AHM.

Table 1: Components of AHM

Parameters/components	**Description**
Area required	350 to 450 square meters.
Site preparation (Mult layer plots)	8 to 15 beds per plot (Width: 1.2 meter. Length: Depending on land availability), bamboo trellis, green net cover
Water storage tanks (Jal Kund)	Above ground portable tank (10 m^3) / below ground storage pits (about 20 m^3)
Compost Pits	Single pit composting/ NADEP compost pit/ Vermicompost pits
Seed treatment	Trichoderma, Phosphorus Solubilizing Bacteria (PSB)
Nutrient Management	Farmyard Manure (FYM), Vermicompost, *Kanda khaad* (Cow dung slurry), *Jeevamirth* (Cow urine and cow dung based preparation).
Pest Management	*Brahmastra, Neemastra, Agniastra* (Plant based organic pesticides), *Mathastra (fermented milk based preparation).*
Tuber crops:	Ginger, Taro roots (Colocasia), Turmeric
Leafy vegetables:	Red Amaranthus, Spinach, Fenugreek

Herbs and Shrubs:	Brinjal (Eggplant), Tomato, Chilli, Okra (Lady's Finger)
Climbers:	Cow pea, Bitter gourd, Sponge gourd, Cucumber, Runner beans, Cluster beans
Livestock	Low-cost poultry shed and poultry management, Indigenous cow.
Pollinators and Honey	Bee boxes, training on beehive management and honey rearing

Figure 3 shows the components of Agroecological Homestead Model (AHM). Section to 6 to 11 provides details for implementing various components of AHM. The flexibility inherent in the AHM currently being co-experimented allows farmers to select crops and components among the options available based on specific needs and resource availability. This adaptability enhances its scalability beyond the ALL.

Figure 3: Components of AHM (Photo: IWMI, PRADAN)

5. Implementation process

Co-experimentation begins after the finalization of the AHM conceptual model during the co-design workshop, followed by farmers feedback, multiple consultations and exposure visits for the farmers. The overall concept focuses on optimizing resource use efficiency while addressing various identified challenges. Figure 4 shows the steps involved in the implementation of AHM. Implementation team followed a **4A** approach to understand a farmer's **A**ttitude, **A**bility to practice regenerative agriculture, **A**ccess to resources, and **A**ssurance for better returns and low production costs.

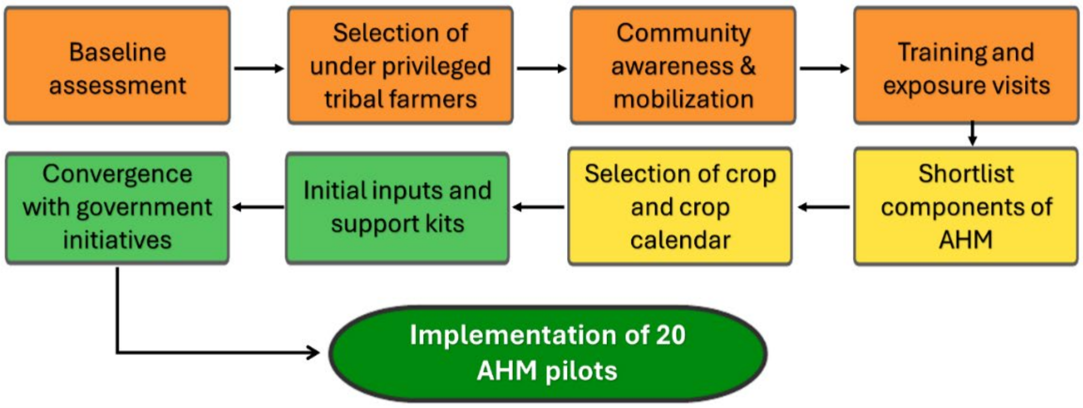

Figure 4 Implementation process of AHM (Source: Authors)

Site and farmer selection was crucial for successful implementation of AHM. Therefore, while selecting the villages within ALL, multiple factors were considered to make sure that resources are directed toward the most vulnerable areas. In Narayanganj block, PRADAN[1] in collaboration with cluster coordinators, shortlisted villages based on the need assessment, prioritization of resources, geographic, demographic, socio-economic and cultural factors, and accessibility to basic services and infrastructures. In a broader context, the team has also considered the potential to sustain the model for a longer period. A field exposure visit was organized in Kumhara village in the Mandla district, where 48 farmers from the ALL were introduced to agroecological practices that were planned to be integrated into AHM. This was followed by a practical session on the implementation and management techniques of AHM (Figure 5).

Figure 5 Exposure visits and Training of farmers at district level (Photo: PRADAN)

[1] PRADAN - NGO working in Narayanganj block.

After the exposure visits and trainings, cluster coordinators conducted meetings with the women of Self-Help groups at the Village organization level to identify the women interested in implementing the AHM prototype. The available resources such as access to irrigation, the ability to adapt to new prototypes and a market to sell the produce were also mapped. Later, after multiple discussions, components of AHM were shortlisted based on the discussion with farmers and stakeholders. 20 female framers from four villages (*Kunda, Jujhari, Kondra mal, Dargargh*) in Narayanganj block were selected for implementing the AHM pilots (Figure 6).

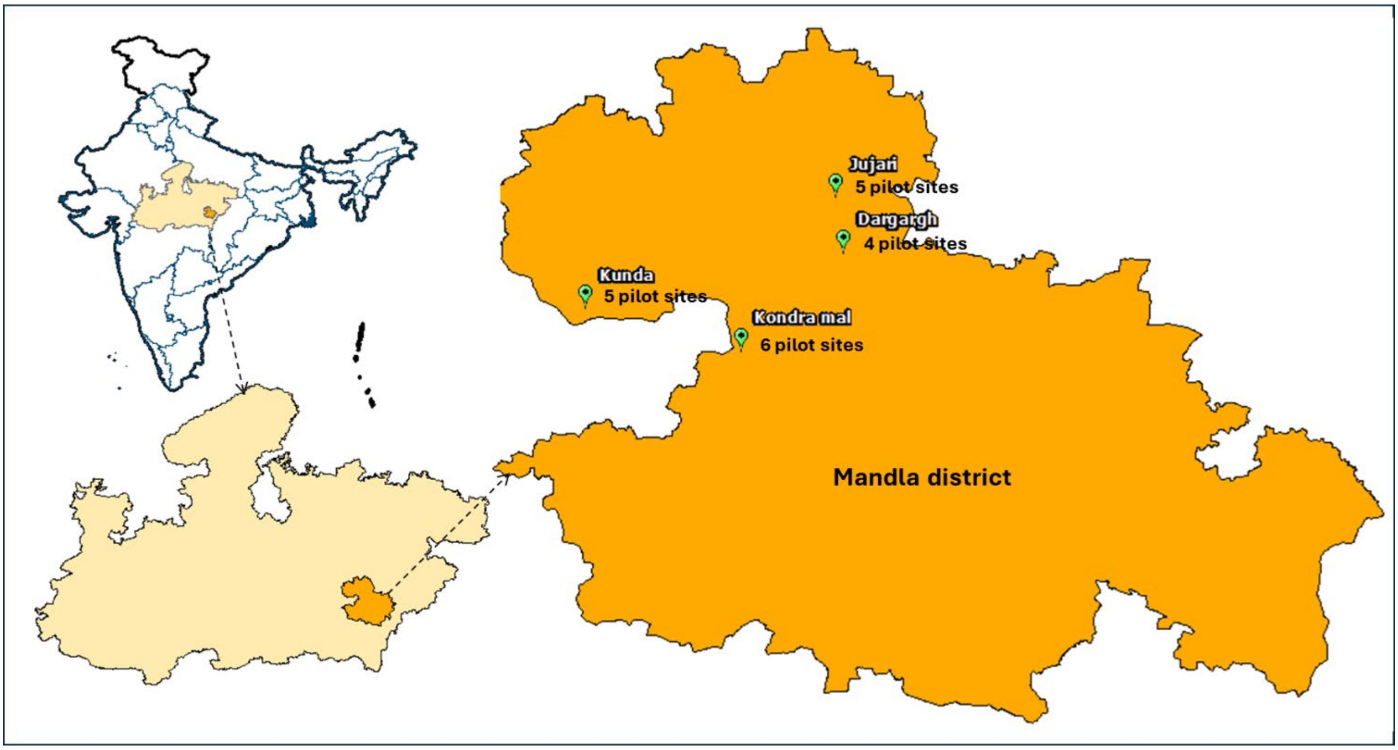

Figure 6 AHM pilot locations. (Source: Authors using Survey of India boundary)

The team also conducted trainings (Malaiappan et al., 2024a) at different stages during implementation at village level to help the farmers in Multilayer structure preparation, organic input preparation and pest management, poultry shed construction, and farmers' field school was organized in the village.

6. Multilayer farming plots

An integral part of the Agroecology Homestead Model (AHM) is the multilayered farming system within the homestead. This system promotes a low-cost approach to farming, that integrates root vegetables, green leafy vegetables, shrubs, climbers, and fruit-bearing perennials like papaya and moringa within the same plot. It ensures efficient land use by incorporating layers of crops, enhancing biodiversity, conserving soil moisture, and improving nutrient cycles. This approach aligns with the regenerative agricultural principles by maintaining continuous cropping coverage, crop rotation, utilizing organic inputs and microbial formulations, minimizing soil disturbance, use botanical extracts or formulations, and effective utilization of land. It provides a diverse range of produce and contributes to food security and income generation for families (Monserrate et al., 2024).

Material required for setting up multi layered farming plots:

- Bamboo poles - 8 to 10 feet in length
- Centering wire (To tie knots between the poles)
- Wire (To place above the structure for climbers' plants to grow)
- Stubbles and thin sticks
- Green net cover (cover the boundary)
- Oil / castor oil (To dip the poles in the oil and place)

Step 1: Field selection and preparation

- Select a rectangular or square plot with an area ranging from 350 to 450 m^2 for site preparation.
- Begin with cleaning the sites and levelling of soil.

Step 2: Bed preparation

- Prepare 8 to 15 raised beds per plot, depending on land availability.
- Ensure each raised bed has a width of 1.2 meters, while the length of the raised bed varies depending on the land availability.
- Maintain a spacing of approximately 0.3 meters between the two beds.
- Apply compost such as Farm Yard Manure (ideally @ 20 t/ha), PROM (Phosphate Rich Organic Manure, ideally @ 10 t/ha), vermicompost, crop residue compost, based on the availability of resources. The high dose applied initially is likely to have lasting effect and help build natural ecology.

Step 3: Construction bamboo trellis

- Dig pits along the marked layout, positioned at the center of the raised bed.
- Apply Castor/ burnt vehicle oil at the base of bamboo poles to protect them from termites and place the bamboo poles vertically.
- Place bamboo sticks horizontally between vertical poles at the top to form a stable structure. Use small wires to join vertical and horizontal poles.
- Tie wire over the bamboo structure (3 lines of wire along the length and two lines of wire across the width).
- Place stubbles of bamboo or crop stems/stubble over the structure for the climbers to spread.
- Bamboo trellis covering 50% of the AHM area in alternate strips of 1.2-meter width is considered ideal. However, farmers prefer to cover the entire area to ensure better production of climbing vegetables, even though this increases the risk of diseases and insect infestations during the rainy season. Figure 7 shows the layout of the multilayer plot with raised beds and bamboo trellis covering the whole area.

Figure 7 Constructed raised beds and bamboo trellis (Photo: PRADAN)

Step 4: Selection of cropping pattern and Seed treatment

- Plan the cropping pattern to maximize the efficient land use and achieve high productivity through multi layered system.
- Divide the crops into four major categories: Tuber crops, leafy greens, climbers and herbs & shrubs. For crop selection, farmers were offered a basket of options within each category. The final selection was made by the farmers, aligning with the principles of maximizing land use, resource efficiency, complementarity, and integration. Table 2 list the village wise cropping pattern of multi-layer farming plots.

- High-quality and viable seeds are selected and treated with Trichoderma and PSB (Phosphate Solubilizing Bacteria) to protect against seeds from soil-borne diseases, root dampening, and to promote root growth and nutrient uptake. PSB is used to increase the solubility and availability of phosphorus.
- To improve agrobiodiversity, economic diversity and income enhancement, Papaya and Moringa (Drumstick) were also planned along the plot boundaries. Figure 8 shows the fully developed multilayer farming plot.

Table 2: Village wise cropping pattern

Village	Tubers	Leafy greens	Shrubs	Climbers
Kunda	Ginger, Colocasia	Red Amaranthus, Spinach, Fenugreek	Brinjal, Tomato, Chilly	Cow Pea, Bitter Gourd, Sponge Gourd, Cluster Beans, Cucumber, Runner Beans
Kondra	Ginger, Colocasia	Red Amaranthus, Spinach, Fenugreek, Coriander	Brinjal, Tomato	Cow Pea, Bitter Gourd, Sponge Gourd,
Dargarh	Ginger, Colocasia	Red Amaranthus		Cow Pea, Bitter Gourd
Jujhari	Ginger, Colocasia	Red Amaranthus, Spinach	Brinjal, Tomato, Chilly	Cow Pea, Bitter Gourd, Cucumber,

Figure 8: Fully developed Multilayer farming plot (Photo: Green Hub)

7. Nutrient and pest / disease management

For nutrient and pest / disease management, natural inputs and amendments were used instead of chemical fertilizer and pesticides. All 20 farmers were educated and trained in preparation of bio-fertilizers/microbial concoction such as *Jeevamrit*, organic input *like Shivansh Khad, Kanda Khad,* vermicompost and bio-pesticides such as *Neemastra, Jivamrit, Brahmastra, Agniastra,* and *Mathastra* (Figure 9) (Malaiappan et al., 2024a).

Figure 9 Training on bio-inoculant preparation (Photo: PRADAN)

Table 3 provides list of the bio-inoculants for AHM management, including their type and application method (foliar or soil). Pests such as fruit borers, pod borers, aphids, and leaf-roller are observed in crops of multi-layer. To mitigate the adverse effects of these pests, bioinoculants are used by the farmers. Pheromone traps and sticky traps were installed to attract harmful pests and insects. Figure 10 shows the setup of insect traps and application of bio-inoculants in the AHM plots.

Table 3: List of bio-inoculants for AHM management

S.No.	Name	Type	Application (Foliar or soil)
1	*Farm Yard Manure*	Organic input/ Amendments	Soil
2	*Shivash khad*	Organic input/ Amendments	Soil
3	*Vermicompost*	Organic input	Soil
4	*Kanda khaad*	Organic input	Soil and Foliar
5	*Jivamrit*	Bio-fertilizer	Soil and Foliar
6	*Neemastra*	Bio-pesticide	Foliar
7	*Brahmastra*	Bio-pesticide	Foliar
8	*Agniastra*	Bio-pesticide	Foliar
9	*Mathastra*	Bio-pesticide	Foliar

Figure 10: Insect traps and application of bio-inoculants (Photo: PRADAN)

8. Shivansh khad - composting

Composting is a process that decomposes organic materials into smaller, nutrient-rich components. As a bulk form of organic matter, it serves two key purposes: acting as a source of nutrients and functioning as a soil amendment. Compost gradually releases nutrients into the soil, ensuring a steady supply for plant uptake. Additionally, it enhances soil physical properties, including aggregation, which influences critical attributes such as moisture retention, resistance to erosion, water infiltration, and thermal buffering. Moreover, compost creates an ideal environment for microbial populations to thrive, further enriching soil health. One notable compost used by some of the AHM farmers are berkeley compost, localized and called *Shivansh Khaad*. Berkeley compost preparation involves an aerobic process and hot composting method that decomposes organic materials in short time.

Materials required for Berkeley compost preparation

1. Dry materials such as dried leaves, straw, dried rice and wheat stalks and other dry biomass that are high in carbon content.
2. Green materials like green grasses, weeds, kitchen waste and any plant materials that are rich in nitrogen content. The leaves of neem and eucalyptus should be avoided for anti-microbial property.
3. Cow dung.
4. Contamination free water.

Method of Preparation

Step 1 – Site selection and marking: Farmers select shaded area, preferably under trees with good drainage to avoid water stagnation. The site is marked in a circular shape ideally with a diameter of 1.5 meters.

Step 2 – Collect the ingredients: Dry and green materials, along with cow dung, are gathered at the selected site. Green materials are finely chopped to accelerate decomposition.

Step 3 – Layering of materials:

First layer: Approximately 6-inch (15 centimeter) layer of dry materials (approximately 15 to 20 kg) are evenly spread, and water is sprinkled on top of the first layer to keep moisture level 50-60% (about 5 liters of water).

Second layer: Approximately 4-inch (10 centimeter) of green materials mixed with cow dung (35-50 kg depending on the proportion of cow dung, ideally 50:50) is evenly spread over the first layer, and water is sprinkled at the top to maintain 50 to 60% of moisture. The amount of water applied depends on the moisture in cow dung leaves mixture (about 2 to 4 liters of water).

These layers are repeated alternately until the heap reaches shoulder height (about 3.5–4.5 feet). Preferably, the **top layer should end with the green materials and cow dung mixture.** The heap is then covered with a polythene sheet to facilitate decomposition.

Step 4 – Mixing of compost: On the 4th day, the compost temperature is checked by inserting a hand into the heap. The compost is squeezed by hand to assess moisture, If few water droplets are coming out, it indicates optimum moisture and readiness for turning. The first turning/mixing occurs on the 4th day (or 5th day if decomposition is slow) to ensuring aeration and even decomposition.

The pile is turned/mixed every other day to ensure thorough mixing of materials, which maintained aeration and promoted efficient decomposition. By the 18th day, the compost is normally ready for use, as indicated by its colour turning brownish. Farmers store the compost in cool and dry place, and can be stored up to 3 months. Farmers utilized compost in multi-layer crops by top dressing method, ensuring the crops receive optimal nutrients.

9. Jal kund – a water reservoir

Water is a key component of the AHM. For cost effective and efficient method of water storage, polythene lined below ground water reservoir (locally called as *Jal Kund*), was introduced for rain harvesting and storage. Depending on the feasibility of water lifting/transportation from other sites, *jal kund* were periodically filled and utilized to support AHM. By constructing these reservoirs manually, farmers reduced the cost of implementation and reduced their dependency on external water sources, ensuring continuous farming even during dry periods. Standard dimensions of *Jal kund* are 10 x 10 x 7 feet, providing a water storage capacity of about 20,000 liters (Figure 11). While the concept of harvesting runoff with proper filtration is possible, its current application has been limited to rainfall harvesting and storage.

Steps involved in the construction of Jal Kund are

- **Site selection:** Choose an area near the multilayer plot, preferably lower portion where runoff is accumulating or passing through.
- **Excavation:** Excavate a pit with dimensions of 10 feet in length, 10 feet in width, and 7 feet in depth before the onset of the monsoon. This method is ideal for areas where gravel and stones provide natural stability to the sides under unlined conditions, allowing the pit to store approximately 19 m^3 of water. In cases where side stability is a concern, a side slope of 0.5:1 (H:V) can be provided, resulting in a pit with a length of 12 feet and a width adjusted accordingly to store about 16 m^3 of water. Alternatively, in areas with clean soil, a hemispherical pit with a diameter of approximately 2.2 meters is preferred for better stability and functionality (Figure 11).
- **Preparation:** The sides and bed of the pit are levelled by removing stones and other debris.
- **Plastering:** The inner walls and bed are plastered with a mixture of cow dung and clay
- **Lining**: After 2-3 days, polythene sheet is placed on inside to prevent water seepage. UV resistant polyline of at least 250GSM (grams per square meter) is used for long lasting.

Figure 11 A Jal Kund constructed near multilayer plots (Photo: Green Hub)

Portable Jal kund: An Alternative for Water Storage

While the traditional below-ground *Jal kund* has served its purpose, maintaining its structure and manually using the stored water has proven challenging in some cases. Additionally, there are instances where water can be sourced from nearby wells, solar pumps, or rooftop rainwater harvesting systems, which calls for a more versatile solution.

Figure 12 Above ground portable Jal Kund constructed near multilayer plots (Photo: PRADAN)

To address these challenges, an above-ground portable and foldable water tank, known as the above-ground *Jal kund*, is being tested as an alternative (Figure 12). This portable *Jal kund* is typically installed on upper side of the plot or on slightly elevated (6-8 inch) earthen platform in the homestead land, ensuring convenient access to water for regular irrigation needs.

The above-ground portable *Jal kund* is designed as a circular reservoir made from durable materials such as steel sheets and iron rods, with a polythene lining of 650 GSM (grams per square meter) for water storage. This innovative design not only simplifies installation and maintenance but also provides flexibility in areas where traditional below-ground structures are less feasible. It has an estimated lifespan of 10 years for the lining material, which can be extended to 20 years with periodic replacement of the lining. It can store up to 12,000 liters of water. These above ground reservoirs bring ease in the application of water through gravity and address irrigation challenges.

10. Livestock and poultry

Livestock and poultry farming is an essential component of AHM. Integration of low-cost livestock farming serves dual purpose of producing organic manure for multilayer farming and utilizing crop residues or non-marketed surplus as animal feed. The introduction of poultry is to utilize the homestead land effectively to generate additional income. Backyard poultry has been integrated with all 20 AHM, its success has motivated the farmers to incorporate goats/pigs into AHM.

Objectives of including backyard poultry in AHM are

1. To provide income stability and resilience.
2. To improve household nutrition by providing access to meat and egg consumption.
3. To optimize resource utilization, increasing efficiency, and reducing input costs.
4. To promote women's entrepreneurship and empower them economically and socially.

Infrastructure and poultry breed

A low-cost poultry shed using tin sheets, metal nets, bricks, clay, soil, wooden sticks, and steel clamps were constructed by farmers with support from the initiative (Figure 13). Farmers have installed light bulbs to maintain warmth, that is known to have a physiological effect on poultry productivity. The shed floors are kept dry, and sheds are also enclosed at the base level to safeguard the chicks from predators such as snakes, and cats.

Each AHM famer received up to 40 chicks of vanraj breed, known for its multiple benefits (Figure 13). Vanraj is a kuroiler breed, serve a dual purpose by providing both eggs and meat. Compared to other breeds, vanraj is a climate resilient and high productive, yielding 1.5 to 2 kgs of meat in 2-3 months, and laying 10 to 15 eggs per laying cycle.

Feed management

Though backyard poultry is primarily a free forager, obtaining most of its nutrients from insects, worms, and leftover food, proper nutrition is essential to ensure optimal growth and higher productivity. To support this, farmers were advised to provide the chicks with locally prepared feed, which includes a mixture of maize, rice, pulses, salt, and mineral mixtures.

1. Azolla as a protein supplement.
2. Each chick receives 20 grams of feed per day to meet its dietary requirements.

Only a few farmers are currently growing Azolla, but it is expected to become an integral part of the system in the next phase. The initial phase of implementation underscored the need for proper training for women farmers in poultry management, including feeding, vaccination, azolla cultivation, and egg collection. Poultry manure is rich in nutrients that are planned to be applied in multilayer production systems.

Vaccination

Vaccination is essential to prevent diseases and reduce mortality rates. The farmers were advised to administer following vaccines,

- Lasota vaccine to prevent Ranikhet disease.
- Albendazole for deworming -to be given after 35 days.
- Fowl pox vaccine is administered after 45 days.
- R2B vaccine is given after 55 days as an additional measure against Ranikhet disease.
  However, only a few of the recommended vaccines could be administered due to a lack of skills, timely unavailability, and inadequate storage (cold) facilities. A comprehensive training program, coupled with community sensitization and the involvement of SHG (Self-Help Group) members to promote synchronized vaccination practices, will be crucial and is already being planned.

Figure 13 Poultry shed and vanaraj chickens (Photo: PRADAN)

11. Bee keeping – for pollination and honey rearing

Within the AHM, several crops are pollinator dependent (Table 4). Almost all cucurbits require pollinators for fruit set and thus an intervention to increase pollinator population and activities appears to have potential to substantially enhance crop productivity. Additionally, farmers are trained on beekeeping for enhancing crop yields and benefit from honey production. The main crops grown in AHMs are listed below with the dependency on pollinators.

Table 4: List of crops in AHM and their dependence on pollinators

Crop species	Crop common name	Parts used/ Crop category	Dependence on animal pollination	Min	Max	Mean (D)
Lagenaria vulgaris	Bottle gourd	Fruit/ Vegetables	Essential			1
Luffa aegyptiaca	Gilki/ Sponge gourd	Fruit/ Vegetables	Essential			1
Luffa aegyptiaca	Sponge gourd	Fruit/ Vegetables	Essential			1
Momordica charantia	Bitter gourd/ Karela	Fruit/ Vegetables	Essential			1
Cucumis sativus	Cucumber	Fruit/ Vegetables	Great	0.4	0.9	0.65
Abelmoschus esculentus	Okra	Fruit/ Vegetables	Modest	0.1	0.4	0.25
Solanum melongena	Brinjal	Fruit/ Vegetables	Modest	0.1	0.4	0.25
Capsicum annuum	Chilly	Fruit/ Spices	Little	0	0.1	0.05
Cyamopsis tetragonoloba	Cluster beans/ Guar	Fruit/ Vegetables	Little			
Phaseolus coccineus	Runner beans	Seeds/ Pulse	Little	0	0.1	0.05
Solanum lycopersicum	Tomato	Fruit/ Vegetables	Little	0	0.1	0.05
Vigna unguiculata	Cow pea	Fruit/ Vegetables	Little	0	0.1	0.05
Amaranthus cruentus	Amaranth-red	Leaf and seeds (AHM for leaves)	No increase	0	0	0
Colocasia esculenta	Arbi/ Taro	Root, leaf, leaf stalk/ Roots and Tubers	No increase	0	0	0
Curcuma longa	Turmeric		No increase	0	0	0
Spinacia oleracea	Spinach/ Palak	Leaves/ Vegetables	No increase	0	0	0
Trigonella foenum-graecum	Fenugreek	Leaves (AHM for leaves) and seeds/ Vegetables)	No increase	0	0	0
Zingiber officinale	Ginger	Spices	No increase	0	0	0
Dependence ratio (only crops for which pollinators increase production of parts that we consume) (Klein, et al., 2007)						

12. Initial performance of the AHM

The Agroecological Homestead Model (AHM) was implemented in four villages, by engaging 20 women farmers. Initial investment for trail construction ranged between INR 14000 to 16000 (USD 180–200) per farmer. While the full harvest cycle is yet to be completed, preliminary results from the available harvest show gross and net returns with significant variability (Table 5). All harvest data were systematically recorded, highlighting this variability, which can be attributed to factors such as differences in the scale of adoption, knowledge levels, market access, soil types, management rigor, rainfall extremities, and waterlogging damage.

Despite these challenges, the AHM has demonstrated notable improvements in production diversity, self-consumption, and income (Monserrate et al., 2024). Gross realization increased significantly, ranging from 7.9 to 22.5 times compared to the control group (Kumar et al., 2024b). However, net income results were less pronounced, having negative return due to the relatively high costs associated with AHM infrastructure development, annualized along with input and management expenses. Key factors contributing to higher gross returns included proximity to the Mandla market (10 km), good road connectivity to the villages, timely initiation of action and adoption of the AHM in entirety. Although the initial results are promising, there is substantial potential for improved performance in subsequent cycles. The large variability in gross and net returns is primarily due to differences in farmers' management practices, such as timing of sowing, input application, and level of involvement. As farmers gain experience and confidence, they are expected to utilize AHM components and infrastructure more effectively. For example, the use of bioformulations was initially underutilized, but farmers are now more confident in preparing and applying them, recognizing their benefits.

There is also potential for improvement in water management, canopy management, and composting practices, based on farmer feedback and observations by the CGIAR team. Adjustments in sowing and transplanting schedules could further enhance productivity. Currently, produce aggregation for marketing remains limited, with less than 50% of the marketable surplus being consolidated, which presents an opportunity for improvement in future cycles. The AHM has led to significant benefits, including a 350% increase in production diversity, a 100% improvement in dietary diversity, a 70% rise in leafy green consumption, and a substantial boost in protein intake, alongside regular and enhanced income. Gross returns from land have increased by 1.3 to more than 20 times, while net returns have grown by -4, 8 to 20 times (Kumar et al., 2024b). The lowest returns were observed in cases where fields were left unattended due to changes in family circumstances or damage caused by flooding and soil saturation.

However, these benefits are not uniform across the 20 AHM models due to natural heterogeneity in edaphic, biotic, and abiotic conditions. Additionally, the degree of farmers' active involvement and proximity to markets significantly influenced outcomes. AHM systems established on clayey soils in specific villages faced challenges from extreme rainfall events, resulting in soil saturation and occasional flooding. Despite these challenges, the AHM demonstrates considerable potential for enhancing livelihoods, dietary diversity, and sustainable income with improved management and refinement in practices.

Table 5: Summary of village wise performance of AHM in Mandla ALL, India

Village Name	Meann Gross Return (INR/acre)	SD (INR)	Mean Gross-PEY (Quintal/acre)	SD Gross-PEY	Mean Net Return PEY (Quintal/acre)	SD Net-PEY
Kondra	234548	99216	99.8	42.2	39.8	42.2
Kunda	144240	49232	61.4	20.9	6.7	17.1
Dargarh	61990	26775	26.4	11.4	-20.4	11.4
Juhjari	97893	51813	41.7	22.0	-6.8	23.2

Note: PEY- Paddy Equivalent Yield,

Planned activities:

The future direction of agroecological interventions includes incorporating midterm corrections based on learnings from previous seasons to optimize outcomes.

A detailed site suitability analysis is planned to identify specific interventions to strengthen climate resilience. Proposed measures include the adoption of raised beds, improved drainage systems, and the cultivation of resilient crop varieties in areas prone to water saturation and logging. Efforts will also focus on establishing new AHMs in locations with solar-based irrigation systems and creating hybrid models that integrate microsite improvements and agroforestry practices at degraded sites.

The introduction of honeybee colonies will initially focus on evaluating their effects on pollination and crop productivity besides dynamics of the natural native pollinators. If positive outcomes are observed, beekeeping will be formally integrated as a key component of AHMs. Alongside this, training programs will be designed to introduce best practices in beehive management, including feeding, administering medicines, protecting hives from predators and abiotic stresses, and harvesting honey, wax and queen jelly. Tools and equipment planned to be provided on community sharing basis will not only support these practices but also include small-scale setups for honey straining, processing, and packaging.

Given the proximity to forested areas, many sites are expected to benefit from a strong perennial pollinator base, highlighting the potential for honeybees to evolve into a sustainable enterprise. This integration of beekeeping aligns with agroecological principles, promoting biodiversity, enhancing ecosystem services, and providing additional livelihoods for rural communities.

This holistic approach aims to create resilient, productive, and sustainable farming systems, demonstrating the potential of agroecological practices to address environmental challenges while improving the socio-economic well-being of farmers.

13. Implementation challenges: lessons and learnings

Agricultural Holistic Model (AHM) demonstrated potential to address challenges faced by indigenous communities, especially women. However, its implementation has encountered several critical challenges that require attention.

- Structured activities like stakeholder consultations and co-design workshops are essential, but the absence of a dedicated preparatory phase has hindered successful implementation. Establishing an on-the-ground presence, conducting exposure visits, trainings and implement limited-scale activities could help bridge this gap.
- Despite active participation during all the workshops and interactions, and willingness expressed, adoption of the AHM was limited during the co-design experiment. Crop selection ranged from 3 to 14, reflecting underutilization of the developed infrastructure. With gradual learning on managing the AHM, input preparation, and robust capacity and trust-building measures, this limitation can be addressed.
- A major political agitation because of threat of permanent inundation of villages due to proposed dam construction, significantly impacted implementation in two villages. Proactive planning, foresight, and contingency measures are essential to address such challenges.
- Timely availability of inputs, particularly planting materials, remains a major obstacle in rural areas. Small-scale requirements did not motivate suppliers, and plans for community or SHG nurseries with backward and forward linkages could not be implemented due to the need for additional capacity building. These constraints must be addressed for effective scaling.
- Farmers' learning and adoption rates varied significantly, emphasizing the need for a flexible model that accommodates local conditions and individual experiences. This flexibility is essential for successful integration and scaling.
- Capacity-building gaps are evident, as AHM's multiple components require specialized knowledge. Limited training prior to implementation led to heavy reliance on expert support during execution. Completing training programs and exposure visits well before the cropping season would adequately prepare farmers and enhance their confidence.
- Short time frame between initiation and co-experimentation limited frequent interactions, exposure visits, and trust-building activities, which are critical for fostering mental shifts. A project duration of minimum five years, with the first year dedicated to preparation, is recommended.

- Resource constraints among tribal communities, particularly women, limited their ability to invest in initial capital costs, such as inputs and consumables, making them heavily dependent on external support provided by the initiative. Integrating the model or components with existing Government programme like Mahatma Gandhi National Rural Employment Guarantee programme, or leveraging subsidized loans from self help groups can provide initial support.
- While farmers undertook site preparation tasks like raised bed preparation, seed sowing, and nursery planting without hired labor, reducing costs but prolonged completion. Advanced planning, a preparatory phase and aligning with seasonal calendar can mitigate these delays.
- In some locations, nursery plantations were affected by termite infestations and soil-borne pests, resulting in poor germination and delays in transplantation. High temperatures and insufficient initial irrigation further exacerbated the issue. In chemical-free farming, high pest infestations are common when bioformulations are not effectively applied as control measures. The early application of bioformulations such as *neemastra, brahmastra,* and *agniastra* in the nursery stage can help mitigate these challenges effectively
- Delayed sowing at some sites, due to factors such as political unrest, input unavailability, and knowledge gaps, led to reduced yields. Addressing these challenges with proper planning can improve outcomes.
- Weed management during the monsoon season (July–September) was challenging, with excessive growth affecting nutrient availability to crops. This is common problem with chemical free farming particularly during initial years. Continuous green cover, appropriate weed management practices including turning weeds into compost can address this issue.
- Heavy rainfall during the monsoon season led to pest infestations, such as aphids, thrips, and leaf-cutting caterpillars, primarily affecting leafy vegetables and climbers. Training farmers to prepare and use bioformulations can help mitigate this problem.
- Farmers faced difficulties accessing better marketplaces and fair prices, often selling produce within the village or using it for self-consumption. Aggregating produce, linking it with participatory guarantee schemes (PGS), and increasing consumer awareness of chemical-free products are crucial for improving market access and farmer income.
- Extreme weather, including incessant rain and dam backflow, caused considerable damage to sites, particularly those with clay-heavy soils, resulting in severe damage to the crop. Improved site selection and crop choice, informed by ongoing learning, are essential to mitigate these risks.

By addressing these limitations through targeted interventions and strategic planning, AHM can achieve greater scalability and effectiveness, ensuring its benefits reach vulnerable communities sustainably.

14. Outcome and way forward

Through the adoption of the Agroecological Homestead Model (AHM), farmers have transitioned to diversified farming systems, yielding notable outcomes (Monserrate et al., 2024; Kumar et al., 2024b) . AHM has led to increased production diversity by more than 350%, a 100% improvement in dietary diversity, a 70% increase in the consumption of leafy greens, and a substantial rise in protein intake besides regular and enhanced income. Gross returns from land have increased by 1.3 to more than 20 times, The net return ranged from net negative to highly positive (Kumar et al., 2024b). The sites with lowest return were those either left unattended due to changed political circumstances of the farmers and damage by flooding and soil saturation. However, these benefits particularly in terms of harvest, income, dietary diversity, and consumption are not uniform across the 20 AHM models. This variability arises due to natural heterogeneity in edaphic, biotic and abiotic conditions and the degree of farmers' active involvement in management, and proximity to market access significantly influenced outcomes. AHM established on clayey soils in specific villages faced challenges from extreme rainfall events, resulting in soil saturation and, in some cases, flooding.

Way forward:

- *Case to case basis of context-specific AHM typologies***:** Development of AHM typologies based on site-specific analyses, including flood vulnerability, resource availability, market dynamics, and farmers' needs on case-to-case basis. These typologies will ensure adaptability and effectiveness across diverse agroecological and socio-economic contexts.
- *Advance capacity building and sensitization:* Expand training and sensitization programs to include balanced nutrition for children, women (including pregnant women), men, and livestock. Empower farmers with technical skills in bioformulations, pest management, and climate-resilient practices. These activities should be

conducted well in advance of field implementation to allow for effective learning and behavioural shifts, enabling a smooth transition towards agroecology

- *Enhance climate resilience measures*: Integrate resilience-building strategies such as raised beds, improved drainage systems, drought tolerant crop varieties, and hybrid models that combine annual with perennial crops, and microsite improvements to enhance climate resilience.
- *Integrate AHM into government programs*: Integrate AHM into state and national programs, including agricultural extension systems and schemes like MGNREGA, to promote widespread adoption and institutional support. A policy mapping tool or framework to help farmers access and benefit from existing government programs will be essential.
- *Establish robust market linkages for effective scaling*: Facilitate aggregation systems already planned in AHM, participatory guarantee schemes (PGS), and access to better marketplaces to ensure fair prices for farmers while exploring value addition through processing and branding of chemical-free products.
- *Conduct comprehensive impact assessments*: Undertake detailed assessments targeting biophysical and socio-economic indicators to evaluate the model's effectiveness, identify areas for improvement, and guide future interventions.
- *Document success stories and develop scaling strategies*: Emphasize the documentation of case studies and success stories to build advocacy for AHM. Develop financial mechanisms and partnerships to support scaling, ensuring improved livelihoods and sustainable agricultural practices across agroecological contexts.
- *Extend project timeline with preparatory phases:* Introduce a dedicated preparatory phase for on-the-ground presence, capacity building, exposure visits, and infrastructure setup. Extend project timelines to allow for adequate learning, refinement, and scaling of the model.
- *Integration of AHM into multifunctional landscape approach*: Combine AHM with landscape resource conservation, restoration efforts, water harvesting, and multipurpose resource use with the AHM to make it an integral part of multifunctional landscapes.

15. References

Klein, A.-M., Vaissière, B. E., Cane, J. H., Steffan-Dewenter, I., Cunningham, S. A., Kremen, C., & Tscharntke, T. (2007). Importance of pollinators in changing landscapes for world crops. *Proceedings of the Royal Society B, 274*, 303-313. doi:https://doi.org/10.1098/rspb.2006.3721

Krishnan, S., Gupta, S., Malaiappan, S., Singh, S., Kumar, G., Alvi, M., . Sikka, A. (2024). *Performance Assessment of Agroecology in India (Under review).* Alliance - Bioversity and CIAT.

Kumar, G., Malaiappan, S., Sikka, A., Konwar, D., & Singh, S. (2024a). *Agroecology homestead models: Enhancing nutrition, soil health, and income for tribal farmers.* Tropentag 2024: Explore opportunities for managing natural resources and a better life for all, Vienna, Austria. Retrieved from https://www.tropentag.de/2024/abstracts/links/Kumar_a6ysX8Xl.pdf

Kumar, G., Malaiappan, S., Triomphe, B., Shamim, M., Gadewar, P., Acharya, S., Krishnan, S. (2024b). *Consolidated report on Agroecological co-design of innovations in India, (IWMI)*

Malaiappan, S., Gadewar, P., Goverdhanam, S., Konwar, D., Krishnan, S., Kumar, G., & Sikka, A. (2024a). *Agroecology in Action: Empowering Tribal Communities in Mandla, India through Trainings on Bio-Fertilizers and Bio-Pesticides.* International Water Management Institute.

Malaiappan, S., Krishnan, S., Gadewar, P., Sharma, H., Priyadarshini, P., Thakur, A., Sikka, A. (2024b). *Agroecological insights for Mandla, Madhya Pradesh, India: A contextual analysis for sustainable transformation (Under review).* International Water Management Institute.

Monserrate, F., Berre, D., Triomphe, B., & Baudron, F. (2024). *Synthesis of agronomic assessment for co-designed trails and recommendations.* Retrieved from https://hdl.handle.net/10568/169320

Patel, N., & Sethi, T. (2021). *Rural Women: Key to New India's Agrarian Revolution.* Retrieved from Niti Aayog: https://www.niti.gov.in/sites/default/files/2022-03/Rural_Women_Neelam_Tanu_article_03032022.pdf

Singh, S., Gupta, S., Kumar, G., Malaiappan, S., Muzna, A., Krishnan, S., & Sikka, A. (2024). *Vision to action exercise report in Mandla, Madhya Pradesh, India.* Agroecology initiative Brief. CGIAR System Organization. Retrieved from https://hdl.handle.net/10568/169004

Contact

Sudharsan Malaiappan, Research Officer, International Water Management Institute (IWMI), New Delhi, India s.maliappan@cgiar.org

CGIAR is a global research partnership for a food-secure future. CGIAR science is dedicated to transforming food, land, and water systems in a climate crisis. Its research is carried out by 13 CGIAR Centers/Alliances in close collaboration with hundreds of partners, including national and regional research institutes, civil society organizations, academia, development organizations and the private sector. www.cgiar.org

We would like to thank all funders who support this research through their contributions to the CGIAR Trust Fund: www.cgiar.org/funders.

To learn more about this Initiative, please visit this webpage.

To learn more about this and other Initiatives in the CGIAR Research Portfolio, please visit www.cgiar.org/cgiar-portfolio

© 2024 International Water Management Institute. Some rights reserved.

This work is licensed under a Creative Commons Attribution-Noncommercial 4.0 International Licence (CC BYNC 4.0).

INITIATIVE ON
Agroecology