Registered Report Stage 1: Proposal

Does Devolving Decision-Making Power To Women Improve Forest Restoration? Experimental Evidence From the Himalayas

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Abstract

While decentralization can improve the performance of public programs, the effectiveness of devolving full decision-making authority over implementation to community groups remains unclear. We conduct a cluster randomized controlled trial in Himachal Pradesh, India, with 271 women's groups participating in a government-led forest restoration program, to test whether devolving decision-making authority to women improves forest governance and ecological outcomes. In treated villages, women's groups receive autonomy over plantation design and management, while control groups operate under centralized forest department authority. We will assess the impact of decentralization on women's group functioning, the actualization of women's preferences in plantation design, and tree sapling survival using a combination of institutional surveys, ecological field surveys, and remote sensing. By experimentally isolating governance within an active public program, we provide experimental evidence on whether women-led forest restoration strengthens collective action in resource management, informing the design of grassroots environmental policies in developing countries.

Keywords: Forest governance, decentralization, women's empowerment, community institutions, field experiment, randomized control trial

JEL codes: Q23, Q28, O13, D72

Study pre-registration: AEARCTR-0016090

Proposed timeline

The survey instrument was piloted in March 2025, followed by randomization in May 2025, and baseline data collection in June 2025; tree planting under the Rajiv Gandhi Van Samvardhan Yojana (RGVSY) intervention began in August 2025. A midline survey will be conducted on May 25th, 2026, with the first endline survey scheduled for August 2028. We have not collected any post-intervention data.

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1. Introduction

The loss of forests globally presents a major challenge to multiple societal goals. Forests are among the planet's most biodiverse ecosystems, store substantial amounts of carbon dioxide, and provide vital ecosystem services to billions of people who live in or near forested ecosystems. They also hold deep cultural importance for many forest-dependent communities, shaping identity, traditions, and knowledge systems across generations. Yet forests continue to be lost or degraded at alarming rates in many parts of the world. Achieving the full value of forests globally will therefore require not only conserving existing forests, but also restoring degraded forests and expanding forested areas where forest loss has already occurred (Cook-Patton, 2021).

While a large literature examines policies and institutions for forest conservation (Busch and Ferretti-Gallon, 2017, 2023), far less is known about how to design effective forest restoration programs. Forest restoration differs fundamentally from forest conservation: restoration seeks to rebuild forest cover on degraded or previously cleared land, whereas conservation aims to prevent the loss or degradation of existing forests. As a result, restoration requires active planting, sustained post-planting care, and alignment with community livelihoods to ensure trees survive and ecosystems recover. A growing body of observational evidence suggests that restoration initiatives perform better when local communities have meaningful roles in planning, monitoring, and enforcement (Fischer et al., 2025; Rana and Miller, 2021). However, because most existing studies rely on non-experimental data, it remains unclear whether and what types of decentralized forest management causally improve restoration and other socio-ecological outcomes (Coleman and Fleischman, 2012).

Within this broader push for community-based management, many scholars and practitioners have emphasized expanding women's participation in natural resource institutions (James et al., 2021). Prior research shows that community institutions with women in positions of authority often achieve better conservation outcomes (Agarwal, 2009), potentially due to differences in resource use priorities, monitoring behavior, and investment in collective goods. Yet we know little about whether and how women's leadership shapes outcomes in the context of forest restoration, where sustained collective action and longer-term stewardship are especially critical.

This study aims to fill this gap by experimentally evaluating the role of local institutional autonomy – specifically along a gender dimension – in forest restoration. We conduct a randomized controlled trial embedded within a large, government-run forest restoration program implemented through local women's groups in the Indian state of Himachal Pradesh. The experiment tests whether devolving decision-making authority to local women's groups improves restoration success, institutional functioning, and women's participation, relative to the status quo model of centralized forest department control.

Himachal Pradesh provides an ideal and policy-relevant setting to evaluate community-led forest restoration for three main reasons. First, the state has a long history of community engagement in forest management. Himachal Pradesh had a variety of pre-colonial and colonial era community forest management institutions which have continuing legacies to this day. It was also an early adopter of Joint Forest Management (JFM) in the 1980s, a hybrid system where village committees and the Forest Department share responsibility for forest protection and use of forest benefits. The state enacted additional participatory forest management rules in the 1990s (Vasan, 2001). Today, hundreds of grassroots institutions, including women's groups, temple committees managing sacred groves, and local cultural groups, play an important role in forest stewardship (Kandari et al., 2014). These institutional arrangements provide an existing foundation of collective action, social norms, and administrative experience that makes it feasible to test improvements in community-based restoration rather than introducing entirely new governance structures.

Second, Himachal Pradesh has achieved substantial increases in forest cover over the past three to four decades (Forest Survey of India, 2019) through a combination of externally aided projects and national and state-level afforestation and restoration programs. This extensive experience with plantation-based restoration and community institutional development creates a rich empirical context in which to rigorously evaluate alternative institutional arrangements for restoration. Importantly, the scale and maturity of these programs mean that experimental evidence can directly inform ongoing policy choices.

Third, forest restoration in Himachal Pradesh has direct implications for local welfare. A large share of the state's population—particularly agriculturalists, horticulturalists, and pastoralists—continues to depend on forests for livelihoods, fodder, fuelwood, and ecosystem services. As a result, the success or failure of restoration efforts affects not only ecological outcomes, but also household well-being, gendered labor burdens, and long-run welfare (Coleman et al, 2021; Fleischman et al, 2020).

Despite the above factors, substantial scope for improvement remains in existing JFM regimes. Recent evidence shows that plantation sites are often selected in areas with poor biophysical suitability for tree growth or in already dense forest patches, leading to low survival rates and inefficient use of public funds (Fleischman et al., 2020; Coleman et al., 2021; Rana et al., 2022; Fischer et al., 2025). In addition, many top-down, state-led restoration efforts continue to experience low-seedling survival, which has been attributed to limited incorporation of local knowledge and weak community engagement in restoration design, implementation, and monitoring (Lofqvist et al., 2023). Local communities frequently have little influence over key decisions, including site selection, species choice, and how restoration success is defined and evaluated. As a result, restoration programs become driven by targets for how many trees to plant, rather than being site-specific, need-based, and livelihood-oriented (Fleischman et al., 2025).

Our study experimentally allocates full decision-making authority over forest restoration to local women's groups, called Mahila Mandals (MMs), in an effort to isolate the role of local institutional autonomy in shaping forest restoration outcomes. We implement a cluster-randomized controlled trial embedded within the Rajiv Gandhi Van Samvardhan Yojana (RGVSY), Himachal Pradesh's flagship forest restoration program. The experiment is conducted in collaboration with the Himachal Pradesh Forest Department and involves 271 Mahila Mandals across multiple forest divisions (the key administrative planning unit for delivering forestry programs). Mahila Mandals play a central role in RGVSY implementation and are responsible for planting and maintaining small forest plantations allocated to their villages.

Our intervention will experimentally vary whether Mahila Mandals are granted complete autonomy or continue under the status quo within RGVSY. Under the status quo regime, Mahila Mandals participate in plantation activities, but key decisions—such as species selection and planting design—remain under Forest Department control. In treatment villages, Mahila Mandals will instead be granted complete formal decision-making authority to plan, implement and monitor restoration activities. This design thus isolates the causal effect of decentralization of governance to women's groups.

Our main outcomes are (i) sapling survival and sapling health, which measures ecological restoration success, (ii) collective action around monitoring and enforcement, which measures institutional strength, and (iii) women's participation in planting and decision-making. First, we hypothesize that decentralized governance improves restoration success, measured by higher sapling survival and health. This is because, when restoration initiatives are designed to meet local needs besides creating income opportunities near villages, women have stronger incentives to ensure that the seedlings reach maturity. Second, we hypothesize that granting autonomy strengthens local institutions, leading to greater collective engagement in forest management activities such as planning, monitoring, and enforcement. Third, we hypothesize that decentralization of authority to women's groups increases women's participation in restoration by shifting women from nominal involvement toward direct decision-making and implementation roles.

To test these hypotheses, we combine multiple data sources collected before and after program implementation. Baseline institutional and ecological surveys were conducted prior to planting, and will be followed by midline data collection in May-June 2026. Detailed Mahila Mandal–level surveys capture governance practices, participation, and resource control; ecological field surveys measure sapling survival and health, species details, and site protection measures; administrative records on planting costs are from the Forest Department; and high-resolution satellite imagery will be used to track medium-run changes in vegetation cover.

Beyond average treatment effects, the RCT will incorporate a detailed analysis of mechanisms linking local autonomy to ecological and institutional outcomes. Our surveys include a variety of questions on planning autonomy, labor and effort allocation, monitoring practices, benefit sharing, and alignment between community and Forest Department preferences. For example, we ask whether communities that receive autonomy are more likely to select plantation sites better suited to local ecological conditions, whether women directly participate in planting and fencing rather than outsourcing labor, and whether increased collective monitoring reduces grazing and encroachment. We therefore move beyond asking whether decentralizing authority to women's groups works, and examine how and under what conditions it shapes outcomes.

Literature Contributions

This study will advance several literatures in environmental economics, political economy, and restoration ecology. First, we contribute to the literature in environmental economics by providing novel experimental evidence on devolution of forest governance. Existing work has shown this relationship using quasi-experimental evidence and structural models at the village level (Sims 2010), district level (Burgess et al, 2012; Assuncao et al, 2023; Souza-Rodrigues, 2019), country-level (Abman, 2018; Araujo et al, 2025), and globally (Farrokhi et al, 2025)[1]. We advance this work in three ways: first, we show how decentralized forest policy—specifically, devolution of decision making power to women—affects socio-ecological outcomes at the level of individual forest plantation sites. Second, we are among the first to use an RCT to generate causal evidence in this context. And third, whereas the existing literature primarily focuses on conservation outcomes, it provides limited guidance on restoration, which requires post-planting effort, protection, and community involvement. By experimentally varying local autonomy, we are able to identify whether decentralization causes improvements in forest restoration.

[1] Two exceptions are Arriagada et al. (2012) and Alix-Garcia et al. (2015), which study PES and forest cover at the farm-level.

Second, we contribute to the political economy literature by experimentally testing a core claim: that devolving authority to local institutions strengthens collective action and monitoring. Seminal work by Ostrom (1990) emphasizes the importance of local institutions for managing common-pool resources, while more recent work has emphasized joint management with local governments. However, much of this work relies on case studies (Rana and Chhatre, 2017) and pure theory (Alix-Garcia, 2007) and cannot disentangle whether observed effects of decentralization are driven by institutional design or community-level confounding characteristics. By randomizing local autonomy and comparing it with a hybrid management status quo, we are able to credibly study the impact of local capacity versus state capacity, and quantify the exact mechanisms through which local autonomy leads to program success.

Third, we contribute to the literature on gender-responsive conservation and development interventions by examining a typical case where women are recruited to help implement a conservation intervention. We go beyond this common model by testing whether devolving decision-making authority over design, implementation, and monitoring of the intervention to women's groups improves outcomes for both forests and the women. This evidence is particularly important because global restoration goals, by necessity, involve millions of smallholders (Shyamsundar et al. 2022), yet policymakers face fundamental choices about how to involve women and how much autonomy to grant local institutions.

Fourth, we contribute to the restoration ecology literature by integrating variation in local governance with ecological field methods to provide causal evidence on how institutional design affects restoration outcomes. Restoration ecology has generated extensive guidance on species selection, planting techniques, and site characteristics, yet governance and community behavior are often treated as background conditions rather than causal determinants, with few studies in the field incorporating actual measurements of governance or social outcomes (Botero, 2024, Chapter 4; Mansourian et al., 2025).

2. Background and Study Context

2.1 State of Forests in Himachal Pradesh

Himachal Pradesh is one of India's most forested states, with forests covering nearly two-thirds of its geographical area. These forests play a critical role in carbon storage, biodiversity conservation, watershed protection, and climate regulation in the Western Himalayas. Despite relatively high forest cover compared to many Indian states, a large share of Himachal Pradesh's forests are classified as degraded or open forests, reflecting long-standing pressures from human use, grazing, fire, and extraction (Forest Survey of India, 2023; Madhsudhan and Vanak, 2025).

Rural livelihoods in Himachal Pradesh remain closely tied to forest ecosystems. Households depend on forests for firewood, leaf and grass fodder, small timber, non-timber forest products, and grazing land, particularly in mid- and high-elevation regions where agricultural options are limited. Existing research from the study area shows that women, in particular, bear a disproportionate share of forest-related labor, including fuelwood and fodder collection, making forests central not only to household welfare but also to gendered divisions of labor and time use (Fischer and Chhatre 2013). Existing evidence shows that forest institutions, and very often women's groups, shape management practices and access to benefits (Vasan, 2006; Sanyal and Dasgupta, 2025; Asher and Bhandari, 2021).

Forest degradation in Himachal Pradesh is driven less by large-scale deforestation and more by cumulative local pressures. Key drivers include developmental works including roads, buildings and hydropower projects, chronic livestock grazing, fuelwood extraction, recurrent low-intensity forest fires, invasive species, and weak enforcement of forest use rules. Importantly, degradation is often linked to institutional failures rather than purely ecological constraints. When local forest users lack meaningful decision-making authority, incentives to invest labor in protection and maintenance are attenuated, increasing the likelihood of plantation failure and continued degradation. (Coleman et al, 2021; Fleischman et al, 2020).

Forest restoration rather than protection alone is a central policy priority in Himachal Pradesh. Restoring degraded forest lands offers the potential to enhance ecosystem services, improve rural livelihoods, and strengthen climate resilience. However, restoration success depends critically on post-planting maintenance, protection from grazing and fire, and sustained local engagement. Observational evidence suggests that restoration initiatives perform better when communities, and women in particular, have meaningful roles in planning, monitoring, and enforcement, yet causal evidence on the institutional conditions that foster effective restoration remains limited (Rana and Miller, 2021; Fischer et al., 2025).

2.2 Rajiv Gandhi Van Samvardhan Yojana

The Rajiv Gandhi Van Samvardhan Yojana (RGVSY), launched in June 2025, is a flagship forest restoration program of the Government of Himachal Pradesh that aims to shift forest restoration from a forest-department-led model toward a community-based approach. The program seeks to restore degraded forests by engaging local community institutions in plantation and maintenance.

RGVSY involves Mahila Mandals (women's groups), Yuvak Mandals (youth groups), and conservation-oriented Self-Help Groups, collectively referred to as Community-Based Organizations (CBOs). Our study only concerns Mahila Mandals. The objectives of RGVSY are threefold: (i) to increase community participation in afforestation and forest conservation, (ii) to ensure long-term survival of plantations through performance-based incentives, and (iii) to promote biodiversity by prioritizing native and high-value plant species.

The program has a total budget of approximately ₹100 crore over five years, equivalent to roughly ₹1.2 lakh per hectare. In the current phase, around 1,320 hectares have been allocated to 550 CBOs for planting activities. Each participating CBO manages between one and five hectares and is responsible for planting, maintaining, and protecting the plantation site for five years. Roughly 20 percent of funds is designated for purchasing material inputs (e.g. wooden fencing) and 80 percent for wage labor (e.g. pit digging, planting, fencing). Funds disbursed within a financial year must be spent within that same year. The Himachal Pradesh Forest Department supplies saplings through government nurseries and provides technical guidance on site preparation, soil and moisture conservation, and protection measures.

Each site requires a detailed plantation restoration and management plan prepared by the CBO with technical input from the HPFD. Performance-based incentives are built into the scheme: plantations that achieve more than 50 percent seedling survival after the first year are eligible for additional payments following physical inspections by forest officials.

2.3 Mahila Mandals and Women's Empowerment

Mahila Mandals (MM) are community-based women's collectives voluntarily formed and formally registered under government in Himachal Pradesh. These groups operate across a wide range of domains, including social welfare, health, credit, civic engagement, and environmental management. A central objective of MMs is to enhance women's participation in local governance while improving economic welfare and collective agency.

The Government of Himachal Pradesh, alongside NGOs and cooperative bodies, actively supports the formation and functioning of MMs through rural development programs. Prior research emphasizes that women's groups in Himachal Pradesh often possess strong local knowledge of forest use and face distinct incentives related to forest access and restoration outcomes, making them particularly relevant actors for decentralized forest governance (Agarwal, 2010).

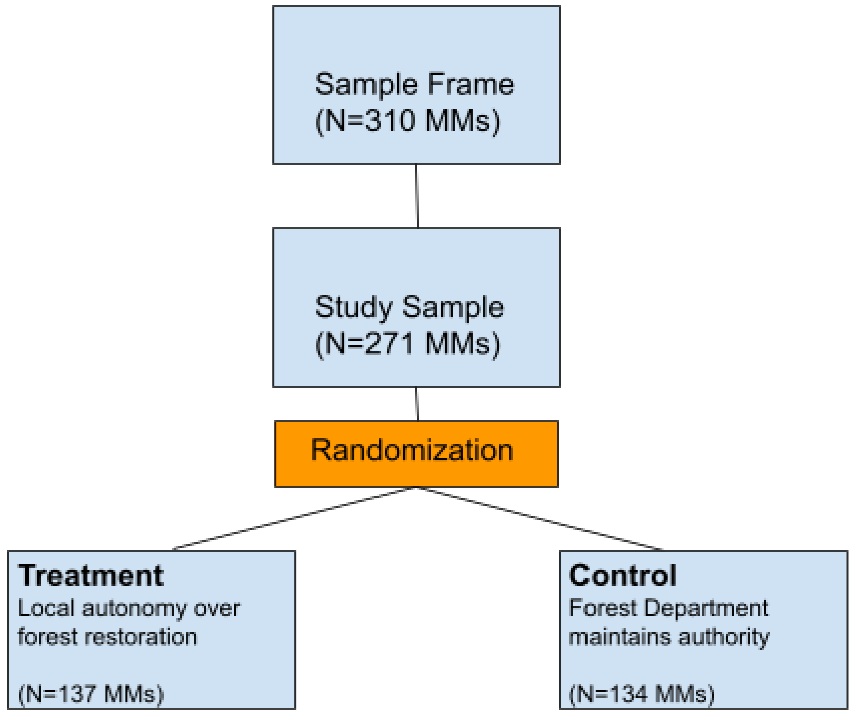
Against this background, our study is implemented in partnership with the HPFD, the government body responsible for RGVSY execution. This partnership enables a randomized evaluation embedded within an active government program, ensuring policy relevance and administrative feasibility. By experimentally varying whether or not Mahila Mandals within RGVSY are granted complete autonomy in decision making, the study directly tests whether increased local autonomy improves socio-ecological outcomes.

3. Research Design

3.1 Overview

We have designed a Randomized Control Trial (RCT) to estimate the benefits of women-led decentralized community forest management. The RCT will be rolled out as a cluster randomized trial at the Mahila Mandal (MM) level. Figure 1 visualizes the randomization design. Our sample frame is the listing of all MMs in Himachal Pradesh that are part of the RGVSY program (N=310). From this sample frame, our baseline sample includes 271 MMs, as some were lost to non-participation. There are approximately 20-40 households in each MM, making the total target population about 11,000 households. We randomize half of the MM's into a "decentralized" treatment group, where MM's are granted autonomous decision-making power over forest restoration. The other half are randomized into a control group that continues with the status quo regime where the Forest Department retains decision-making authority. To improve statistical power and ensure balance, we stratify our randomization by Forest Division, which are key administrative units for forest policy implementation.

Figure 1: Experimental Design



Note: figure shows design for our cluster-randomized experiment, which includes one treatment and one control arm. Treatment MMs will have local autonomy over forest restoration practices, whereas control MMs will follow the status quo where the Forest Department maintains authority over forest restoration.

Approximately 1 month after designating treatment and control groups, we conducted a baseline survey of MM leadership and an ecological baseline survey (see Section 3.3.2 for details). We will not conduct a full baseline survey of all MM members due to lack of funding. The midline is expected to be conducted in late May 2026. Below, we provide more details about treatment implementation and outcomes.

It is important to clarify that the experiment does not randomize the gender composition of local governance institutions. Both treatment and control villages operate through MMs, which are women-led community groups already integrated into the RGVSY program. The intervention instead randomizes the degree of operational authority delegated to these existing institutions. The experiment therefore identifies the effect of granting greater decision-making autonomy to existing women-led institutions, rather than comparing women-led governance to male-led governance, mixed gender governance or to alternative local institutions such as village councils.

3.2 Implementing Partner

We will implement the RCT in partnership with the Himachal Pradesh Forest Department (HPFD), the primary government agency responsible for protecting, improving and managing the forestry landscapes of the state. The hierarchy of the department includes 8 territorial circles and 3 wildlife circles, with 44 forest divisions. Forest divisions are key administrative units for forest policy implementation, further divided into Ranges (headed by Forest Range Officers). Ranges have multiple forest blocks (headed by Deputy Rangers) and each block has multiple forest beats (headed by a Forest Guard). In practie, each plantation site in our sample falls under the jurisdiction of a particular forest guard responsible for that beat area. Thus, for purposes of treatment implementation, the operational relationship was effectively organized at the MM–plantation–forest guard level.

There are a total of 2047 forest beats in the state. Each forest division is headed by a Divisional Forest Officer (DFO) who reports to the Conservator of Forests at the circle level. Conservators report to the Principal Chief Conservator of Forests (Head of Forest Force). RGVSY is implemented by DFOs in their respective forest divisions, with funding provided by the Compensatory Afforestation Fund Management and Planning Authority. HPFD officials are well-trained and capable to roll out and implement this scheme in the state due to their past experience working with different forest communities under Joint Forest Management (JFM) and other participatory schemes and projects. Local forest guards and other staff have direct working and cordial relations to local communities including their elected representatives and other departments.

Partnering with HPFD is crucial for the success of the experiment. First, the Department's authority over forest land ensures that treatment variation in decision-making authority is administratively valid. Second, HPFD's involvement lends credibility to the intervention, increasing compliance among forest staff and acceptance among MMs. Finally, embedding the experiment within an ongoing government program ensures that the results speak directly to real-world policy choices regarding the decentralization of forest restoration in Himachal Pradesh.

3.3 Intervention Details

Our experiment is embedded within the RGVSY, a state-run forest restoration program under which MMs receive small plantation sites for afforestation. In **both** treatment and control arms, MMs act as labor for planting and maintaining trees. The forest department provides funding, government-run seed nurseries, and technical guidance.

Our experimental intervention varies **governance**. Control MMs operate under the status quo institutional arrangement, in which the Forest Department retains final authority over species choice, planting methods, and site management, with MMs primarily contributing labor. In contrast, treatment MMs are granted complete decision-making authority over forest restoration. While they face the same available planting stock at the nursery as control MMs, treatment MMs can choose which species to plant, how to allocate them across the planting site, and how to organize protection, maintenance, and monitoring. Treatment MMs may still consult forest officers or nursery staff for technical advice if needed.

3.3.1 Delivery of Treatment

The experiment features a simple 1x1 design with a single treatment and control group:

Table 1: Treatment and Control Group Descriptions

Treatment Group	**Control Group**
<u>Decentralized Forest Governance</u> • MMs given funding, access to planting stock from government nurseries • MMs given complete decision-making authority over species choice and planting design. • MMs autonomously organize monitoring, protection, and maintenance • MMs may consult forest guards as needed for technical guidance	<u>Status Quo</u> • MMs given funding, access to planting stock from government nurseries • Forest department has final decision-making authority over species choice and planting design • Forest Department handles monitoring, protection, and maintenance • MMs may be consulted but do not hold final authority over restoration decisions

The intervention was delivered through the existing operational structure of the Himachal Pradesh Forest Department (HPFD). Forest guards are the frontline officials who directly coordinate plantation activities with MMs through routine meetings, plantation visits, implementation supervision, and day-to-day field coordination. The treatment therefore operated by changing the operational authority of MMs within this existing implementation chain.

To preserve the independence of the experiment, treatment delivery was managed centrally by a team of outsourced staff from the GIS Lab at HPFD headquarters in Shimla, rather than by local forest divisions. Divisional Forest Officers and other local administrative actors were intentionally excluded from treatment assignment in order to minimize contamination across experimental arms.

GIS Lab staff contacted forest guards responsible for sampled MMs via mobile phone and WhatsApp. All communications were delivered in Hindi and repeated three times during July–August 2025 at approximately two-week intervals during the planting season. After each communication round, forest guards were required to confirm delivery to the GIS Lab team.

Treatment Group

The treatment intervention explicitly reassigned operational authority over plantation decisions from the Forest Department to the MM. Forest guards assigned to treatment villages were instructed to communicate verbatim to MMs that the women's group itself would hold responsibility for plantation implementation and decision-making under RGVSY. The official Hindi letter of instruction is provided in Appendix Figure A1.

Specifically, treatment MMs were informed that they possessed authority to decide:

1. Where plantation activities would occur;
2. Which tree species would be planted;
3. How plantation and fencing activities would be conducted;
4. How saplings would be cared for;
5. How plantations would be maintained and protected after planting; and
6. How plantation monitoring and related implementation decisions would be organized.

Forest guards were instructed to communicate these instructions word-for-word and not alter the content of the message.

Control Group

Forest guards were instructed to communicate that plantation activities would proceed according to existing Forest Department procedures. Under this arrangement, the Forest Department retained final authority over species choice, plantation design, fencing standards, implementation methods, monitoring, and maintenance decisions. MMs participated in plantation activities and could provide input, but did not possess final operational authority over restoration decisions.

The full Hindi-language communications delivered to forest guards in both treatment and control groups, along with English translations, are provided in Appendix Figures A1–A2.

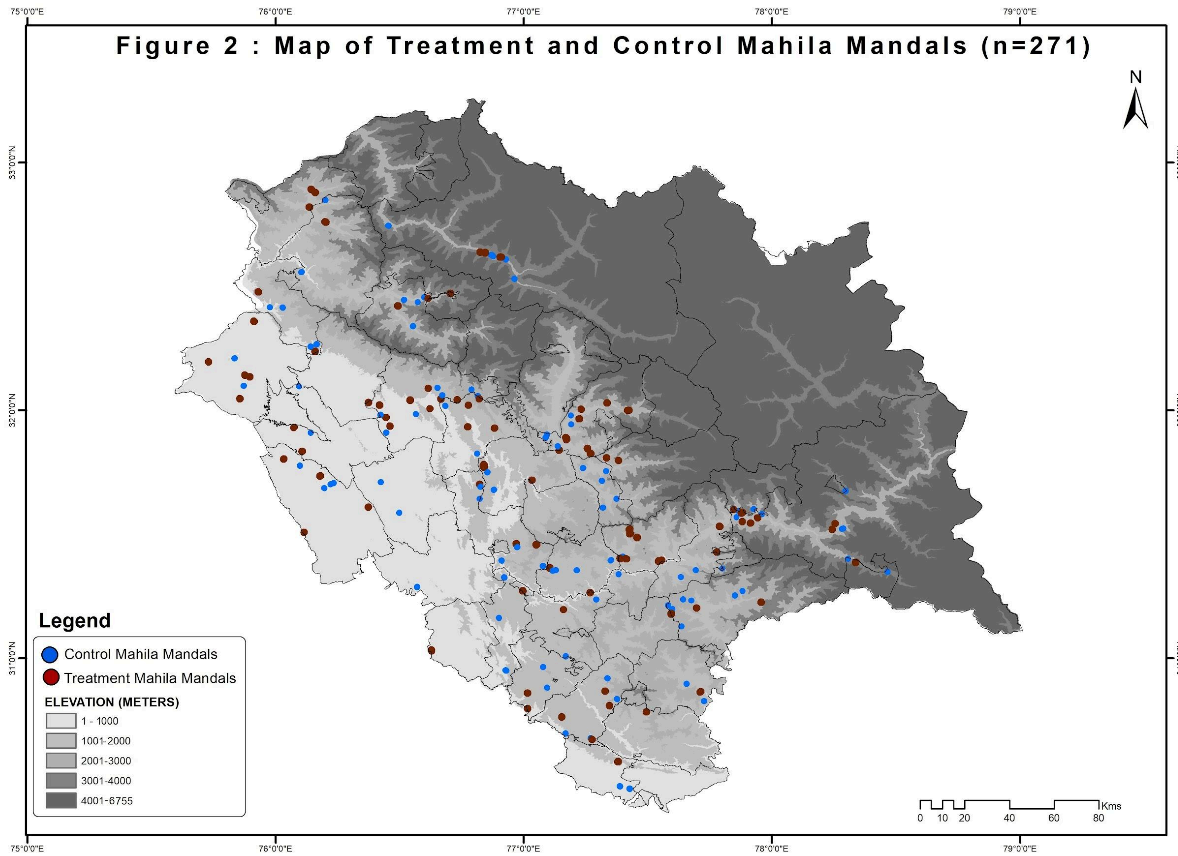
The research team additionally conducted repeated implementation follow-up and independent field verification visits to confirm that treatment MMs understood the authority structure communicated through the intervention.

3.3.2 Sampling Frame and Survey Implementation

The sampling frame consists of all 310 MMs identified for participation in the RGVSY program. Forest divisions submitted lists of eligible MMs through a google sheet coordinated by the Office of the Principal Chief Conservator of Forests (HoFF). The sheets were cleaned for duplications and other errors.

The baseline survey instrument was designed by the research team, drawing on prior literature, field experience, and the study's conceptual framework. The instrument was piloted by the research team in selected locations in Himachal Pradesh in March 2025, after which it was refined and finalized for full-scale implementation in June 2025.

The baseline survey was administered by Prevalence, a survey firm contracted by the research team. Enumerators traveled across Himachal Pradesh by motorbike to conduct the baseline survey in June 2025. Survey implementation was jointly monitored by the Prevalence team and the research team to minimize errors and ensure protocol compliance. Data were collected using the ODK Collect application on Android devices, with built-in checks to flag inconsistencies and missing values, which were reviewed and corrected in near real time by the Prevalence team. Survey instruments were programmed in XML, uploaded to the ODK Central server, and downloaded onto enumerators' devices. Data were collected offline in the field and synchronized to the server when connectivity was available, after which they were exported in Excel formats for analysis. Additional details on the baseline are in Section 4.3.



Note: Map shows locations of treatment (red) and control (blue) Mahila Mandals. Borders represent strata.

3.4 Randomization

The experiment is a cluster randomized RCT with treatment randomized at the MM level and stratified by forest division. This generates exogenous variation across treatment and control groups within forest management units. Treatment assignment was done in Stata using a random number generator.

Of the initial pool of 310 Mahila Mandals, baseline surveys were completed in **271 MMs**, with attrition primarily due to administrative setbacks and subsequent withdrawal from the RGVSY program in several locations due to budgetary constraints. The final sample includes 137 treatment MMs and 134 control MMs. Within each MM, four respondents were interviewed: (i) two members of the Executive Committee (president, secretary, vice president, or cashier), (ii) one member from a Below Poverty Line or lower-caste household, and (iii) one member directly dependent on forest resources for livelihoods. This yields a total of 1,084 individual surveys (536 control, 548 treatment).

Figure 2 presents the location of treatment and control MMs throughout Himachal Pradesh, with borders describing our forest division strata. It can be seen that we have spatially representative coverage across the state. Note that the North Eastern part of Himachal Pradesh is not surveyed as it constitutes a predominantly non-forest ecosystem, and is rough and inaccessible terrain in the high-altitude Himalayas.

4. Data

4.1 Primary Outcomes

We will use a combination of remote sensing data, institutional surveys, and ecological surveys to glean a comprehensive understanding of the impacts of decentralized women-led forest management. Below, we define the key outcomes of interest.

(i) Ecological Performance

Our primary ecological outcome is sapling survival, measured as the percentage of planted saplings that survive one year after planting. Sapling survival is a direct and policy-relevant indicator of restoration success. Additionally, we assess sapling diversity, measured using sapling richness and the Shannon diversity index, to understand whether autonomy over planting creates more diverse forests.

(ii) Remote Sensing Outcomes

Remote sensing data will enable us to measure tree cover gain and loss at the plot level. This outcome captures medium-run ecological impacts beyond initial survival and provides an externally validated measure of restoration success. Section 4.3 describes the satellite data sources.

(iii) Institutional Functioning

Our three primary institutional outcomes are:

- **Participation in Planting:** Measured by the % of members who directly participated in tree planting. We hypothesize that greater autonomy leads to increased local engagement in restoration planning.
- **Preference matching:** measures the degree to which actual planting reflects women's preferences expressed at baseline. It is measured as follows:

$$Preference\ Match\ = \frac{\#\ preferred\ sapling\ species\ planted}{total\ saplings\ species\ planted} \quad (1)$$

where "preferred species" refers to the top 5 most frequently mentioned species in baseline Q28 ("List all species which the mahila mandal plans to plant"; Appendix C), and total saplings planted will be measured in the ecological midline survey. Values closer to 1 indicate that a larger share of planted saplings came from the MMs preferred list, indicating greater actualization of women's preferences

- **Species preference bias:** measures whether MMs invest more in tree species that the women care about. We measure preference bias as follows:

$$Preference\ Bias\ = \frac{\#\ preferred\ species\ survived}{\#\ preferred\ species\ planted} - \frac{\#\ non-preferred\ species\ survived}{\#\ non-preferred\ species\ planted} \quad (2)$$

where "preferred" refers to species in the "most preferred" list (Q28 in the baseline survey). The measure can range from -1 to 1, and positive values indicate that preferred species survived at higher rates than non-preferred ones, consistent with effort being allocated to favored species.

4.2 Data on Mechanisms

To understand **how** devolution of authority to women's groups affects the primary outcomes, we will collect a rich set of mechanism variables through surveys and ecological monitoring. These measures also signify the extent to which forest governance practices actually changed on the ground, as a result of the treatment details provided by forest guards (Section 3.3.1). Measures of mechanisms are not treated as primary outcomes but are used to test specific channels linking decentralized governance to restoration performance. We distinguish four such channels—collective action, decision autonomy, labor effort, and resource control—and describe specific measures of each mechanism in Table 2 below:

Table 2: Variable List to Document Mechanisms

Mechanism	Measure	Data	Interpretation
Collective Action	Presence of group patrol	MM survey	Tests whether decentralization increases monitoring capacity
	Share of members participating in post-planting monitoring	MM survey	Indicates sustained engagement beyond planting

Decision Autonomy & Preference Alignment	Species preferred by women/community actually planted	MM + FD records	Measures alignment between local and government preferences
	Women involved in nursery selection	MM survey	Tests control over technical decisions
	Women involved in planting design (rows vs clusters)	MM survey	Captures autonomy in restoration strategy
	Women accept guidance from technology[2]	MM survey	Tests how women interact with technology in forest restoration decisions
Effort Allocation & Labor Control	Share of women directly planting	MM survey	Distinguishes participation from outsourcing to men
	Fencing installed by MM vs external labor	MM survey	Tests ownership over protection effort
	Condition of fencing	MM survey	Tests protection effort
Resource Control & Benefit Distribution	Share of plantation budget allocated to MM groups	MM survey	Measures control over financial resources
	Presence of conflict over work or benefits[3]	MM survey	Tests whether decentralization generates coordination costs
Local Forest Pressure	Grazing inside plantation (intrusion into site)	Ecological survey	Tests whether governance affects enforcement
	Human trails and cattle dung density	Ecological survey	Proxy for resource use pressure and compliance

4.3 Data Sources

We combine three complementary data sources—Mahila Mandal surveys, ecological field surveys, and remote sensing data—to measure the outcome and mechanisms variables described above.

Mahila Mandal Baseline Survey: A baseline institutional survey of Mahila Mandals was conducted in June 2025 across 271 MMs (see Section 3.3.2 for details). In each MM, four respondents were

[2] Treatment and control MMs have access to a Forest Department mobile app that provide guidance on forest restoration practices

[3] Conflict may arise both within MMs (e.g., disagreements over species choice, labor allocation, monitoring responsibilities, or benefit distribution) and between MMs and non-MM actors. External conflicts may involve livestock owners, pastoral groups such as Gaddis and Gujjars, or other resource users whose access to grazing areas or common forest resources may be affected by plantation activities.

interviewed: at least two members of the Executive Committee (e.g., president, secretary, vice president, or cashier), one member from a Below Poverty Line or lower-caste household, and one member directly dependent on forest resources for livelihoods. This survey is intended to capture MM institutional structure, governance practices, prior engagement in forest management, and decision-making autonomy. In particular, we ask whether decision-making authority was genuinely devolved to MMs by examining who controlled site selection, maintenance, and species choice; MMs themselves, with forest guards jointly, or forest guards alone (see Q20a-h in Appendix C). The baseline survey also provides pre-treatment measures used for balance checks (see Section 4.6) and covariates. The full baseline questionnaire is provided in Appendix C.

Ecological Survey: Due to time constraints before the commencement of the planting season, a rapid ecological baseline survey was also conducted in June 2025 to document pre-existing land cover, land use, and vegetation conditions at only 50% of the plantation sites. Vegetation data were collected using 1-meter-wide, 30-meter-long transects. For plots smaller than 2 hectares, two transects were laid from the plot centroid in opposite cardinal directions. For plots between 2 and 5 hectares, four transects were conducted from the centroid in two cardinal directions, with a 30-meter break after the first two transects. When transects reached plot boundaries due to irregular shapes, cardinal directions were randomized to complete sampling.

Baseline ecological data include: (i) pre-plantation land cover and land use (forest, agriculture, grazing land, barren land, grassland); (ii) count of visible human or cattle trails; (iii) dung density (sheep, goat, and cattle); (iv) fire scars on adult trees (>30 cm Diameter at Breast Height (DBH)); (v) sapling abundance and richness (<0.5 m height, DBH ≤10 cm); (vi) understory tree abundance and richness (>1m height, DBH 10–30 cm); (vii) adult tree abundance and richness (>30 cm DBH); (viii) canopy cover measured using a mobile application at four cardinal directions from the transect midpoint; and (ix) presence of non-native shrubs (Lantana, Eupatorium, Ageratum), recorded separately for juvenile (<1m height) and mature plants (>1m height).

We will collect midline data on vegetation growth approximately one year post-planting in Summer 2026. We will lay down 100-meter sq. vegetation plots for every 0.5 hectares. In these plots, we will collect data on plantation maintenance by documenting the presence and condition of fencing (categories include: well-maintained, broken/ damaged in parts, completely broken/ damaged, no fence). We will also record indicators of human and cattle disturbance (trails and dung density), invasive shrub density, grass richness, canopy cover, and evidence of fire scars. Understory and adult tree diameters will be measured using DBH tapes, and tree heights will be visually estimated. In parallel, the HPFD will independently collect administrative data on sapling survival during the growing season (May–June 2026). We will use these administrative records to validate sapling survival measured in our ecological surveys and cross-check them against plantation journals maintained by local forest guards.

Lastly, we will also construct landscape metrics—patch area, total edge, core area, perimeter-area ratio (a comparison of the perimeter of the polygon to its area), shape index (standardized perimeter-area ratio to a square), and elongation index (how linear the patch is). These metrics will be used as controls in our regressions (Section 5.2) since these landscape features have been shown to affect tree cover growth.

Remote Sensing: We will use satellite imagery to measure changes in the canopy cover beginning in the third year following tree plantation. Satellite imagery will not be part of the midline analysis in Summer 2026. We wait three years post-plantation due to difficulties measuring each sapling's growth trajectory, even with available high resolution satellite imagery. Satellite data will be retrieved from Planet Labs every March from 2026 onwards, which will enable us to measure tree cover gain, loss and persistence. Some of the metrics we will calculate to compare the control and treatment plots include the NDVI (Normalized Difference Vegetation Index) and EVI (Enhanced Vegetation Index).

4.4 Data Collection and Processing

The MM baseline survey was administered by Prevalence, a professional survey firm contracted by the research team. Prevalence will also be responsible for administering the midline survey planned for Summer 2026. Survey teams will visit each MM during regular working hours and interview four respondents per MM, following the sampling protocol described above. Prevalence will be responsible for survey implementation, data entry, and quality checks, including flagging and correcting inconsistencies, before delivering the finalized dataset to the research team.

The post-treatment ecological surveys will be conducted by a trained field team from the Nature Conservation Foundation, under the scientific supervision of Dr. Pooja Choksi and Dr. Munib Khanyari.

Deviations from the intended sample size may arise due to non-consent, adverse weather conditions limiting access to plantation sites, or if plantations close down between the baseline and endline survey. To minimize non-response, Prevalence will implement standardized protocols for approaching Mahila Mandal members and clearly communicating the purpose of the study. Enumerators are experienced in conducting community-based surveys and will follow informed consent procedures to ensure respondent comfort. In cases of poor weather, common in Himalayan terrain, survey teams will return when conditions permit. We therefore expect attrition to be limited.

All processed datasets will be owned by the research team and securely stored on the team's institutional Dropbox, with the possibility of reuse for related research projects consistent with ethical approvals.

4.5 Proposed Timeline

Summarizing the timeline, our survey instrument was designed by the research team and piloted in selected locations in **March 2025**. Treatment assignment was conducted in **May 2025**, with Mahila Mandals randomized at the cluster level prior to program implementation. Baseline data collection was carried out in **June 2025**, before any planting activities began. Tree planting under the RGVSY program commenced in **August 2025**, marking the start of the intervention period. A midline survey is scheduled to begin on **May 25th, 2026** to assess early institutional and ecological responses. The first endline survey, capturing longer-run ecological outcomes and institutional functioning, will be conducted in **August 2028**

4.6 Balance Statistics and Descriptives

Table 3 shows overall summary statistics, treatment and control means, and p-values for the difference in means for key continuous variables in our baseline survey. To calculate p-values, we perform randomization inference and report values from the design-based Kruskal-Wallis test.

We find strong balance across all characteristics in Table 3. There are no significant differences between MMs in the treatment and control groups at five-percent levels. Table A1 in the appendix shows the same table for categorical variables. We again find no significant difference in means between treatment and control groups for any of the listed categorical variables. Although our sample is well balanced, we will include a regression specification that includes many of these baseline covariates to ensure robustness.

Table 3: Balance Table (Continuous Variables)

Characteristic	**Overall (N = 271)**	**Control (N = 134)**	**Treatment (N = 137)**	**p-value**
Altitude	1,512.91 (733.07)	1,513.54 (748.14)	1,512.29 (720.78)	>0.9
Year MM Formed	2,008.92 (13.30)	2,008.37 (13.43)	2,009.47 (13.20)	0.5

Number of Forest Management Activities	10.10 (3.43)	9.92 (3.51)	10.27 (3.34)	0.5
Area of Plantation (ha)	2.59 (1.38)	2.63 (1.32)	2.55 (1.43)	0.3
Distance to Plantation (mins)	36.53 (33.81)	38.58 (37.52)	34.51 (29.74)	0.7
Distance of Nursery from Plantation (km)	19.57 (16.45)	19.52 (17.03)	19.62 (15.92)	0.7
No. MM Members	25.81 (14.56)	24.83 (13.68)	26.78 (15.37)	0.3
Last Meeting Attendance	19.47 (10.74)	18.37 (9.93)	20.54 (11.42)	0.13
Total MM Members	25.77 (14.51)	24.75 (13.62)	26.77 (15.32)	0.
Current head years in office	5.84 (5.91)	5.97 (5.74)	5.70 (6.09)	0.3
Anticipated Benefit – Employment Days	622.92 (269.58)	623.29 (290.93)	622.56 (248.00)	0.9
Number of NGOs Engaged	0.08 (0.43)	0.08 (0.55)	0.08 (0.26)	0.3
Number of Local Community Groups Engaged	2.11 (3.89)	1.81 (2.67)	2.41 (4.78)	0.7
Number of Private Companies Engaged	0.05 (0.23)	0.04 (0.24)	0.05 (0.22)	0.8

Note: Table values show means and standard deviations in parentheses. P-values are calculated using randomization inference using the design-based Kruskal-Wallis test.

Our baseline survey also collected detailed information on preferred tree species. Appendix Table A2 reports the ten most frequently preferred species and the number of respondents identifying each. The results reveal substantial heterogeneity in species preferences across MMs, suggesting that local groups hold context-specific restoration priorities rather than converging on a single "best" species. The most preferred species, including Deodar, Walnut, Amla, Ban, Blue Pine, Kair, Wild Apricot, Sheesham, Jamun, and Baheda, span timber, fodder, fruit-bearing, fuelwood, and ecologically resilient varieties. This pattern suggests that MMs value plantations along multiple dimensions, including household use, income generation, grazing resistance, survival probability, and compatibility with local agricultural and ecological conditions. The variation in preferences across villages is consistent with the idea that communities possess highly localized information about which species are most useful and sustainable in a given setting. This strengthens the motivation for the intervention: centralized plantation planning may fail to incorporate important local ecological knowledge and livelihood priorities when determining plantation design and species selection.

5. Analysis Plan

5.1 Overview

The analysis plan is designed to achieve our key research objective: to quantify the causal effect of devolving authority to women's groups on forest restoration outcomes. A secondary goal is to establish causal claims on the deeper mechanisms linking decentralized forest governance to changes in institutional and ecological health. The underlying assumption to establish causality is that the the treatment variable ($Decentralized_j$ in Equation (3)) is orthogonal to the error term, ϵ_{ij} . We achieve this through randomly assigning the treatment (see Section 3.4), which ensures that treatment and control groups are statistically similar. As previously described, randomization is at the MM level and stratified by forest division. Balance checks are provided in Section 4.6.

5.2 Hypotheses and Inference

5.2.1 Empirical Strategy

Our core empirical strategy estimates the impact of decentralized women-led forest governance by comparing outcomes in Section 4.1 between a randomly assigned treatment group with autonomous decision making and a control group following status quo governance. We will estimate:

$$Y_{ij} = \alpha + \beta \cdot Decentralized_j + \Omega X_{ij} + \theta_f + \boldsymbol{\gamma}_n + \epsilon_{ij} \qquad (3)$$

Where Y_{ij} is an outcome for individual *i* surveyed in MM j. Individual outcomes (e.g., participation in planting decisions) and MM outcomes (e.g., investment in fencing) will be measured in the MM midline or the ecological midline survey[4]. All outcomes are described in Section 4.1. $Decentralized_j$ is an indicator for whether or not j was randomized into the decentralized treatment. X_{ij} is a vector of

[4] Ecological outcomes pertain to the plantation managed by MM j. Thus, ecological outcomes are at the same unit of analysis as the MM, since each MM manages a single plantation.

pre-treatment covariates, including plantation site altitude (meters), area (hectares), distance from MM to plantation site (minutes), total MM membership, years since MM formation, and number of prior forest management activities. In Robustness Checks, we will also use post-double selection lasso (Belloni et al., 2014) to select covariates. Since randomization is stratified by forest division, *f*, we include strata fixed effects, θ_f, to remove time-invariant unobserved heterogeneity across forest divisions and exploit random treatment variation *within* divisions for identification.

In specifications where Y_{ij} denotes ecological outcomes, we include nursery fixed effects, $\boldsymbol{\gamma}_n$, where *n* indexes the specific government nursery from which MM j obtained planting materials. Including $\boldsymbol{\gamma}_n$ accounts for differences in seed quality, planting material characteristics, and quality of technical advice from nursery staff. Standard errors will be clustered at the MM level, which is the unit of randomization.

β is our coefficient of interest; we interpret it as the causal impact of decentralized forest restoration on women's outcomes, MM outcomes, or local ecology (Section 4.1). Outcomes at the respondent (woman) level are denoted by Y_{ij} for respondent *i* whereas MM outcomes and ecological outcomes are denoted by Y_j for MM *j*. As such, β is interpreted as the average treatment effect across respondents in treated MMs in the former case, or the average treatment effect on treated MMs in the latter.

5.2.2 Expected Effects on Coefficients

For each primary outcome defined in Section 4.1, we test three hypotheses:

Hypothesis 1 (Null): β=0: The null hypothesis is that decentralized forest governance has no impact on socio-ecological outcomes. This implies that status quo forest governance–where the Forest Department maintains authority over forest restoration decisions–and decentralized forest governance–where MMs have autonomous decision-making power over forest restoration–have statistically equal impacts such that no difference between these governance regimes can be detected.

Hypothesis 2 (Positive): β>0. A positive coefficient has the following implications for each outcome:

- Survival rates: higher sapling survival rates in treatment MMs, irrespective of whether they are preferred species or not, indicating greater stewardship of local ecosystem
- Participation rate: more women involved in planting, suggesting more engagement in forest restoration and less outsourcing of labor when women have control over resource management.

- Preference match (Equation 1): higher share of species preferred by women are planted in treatment MMs, reflecting greater actualization of women's preferences
- Preference bias (Equation 2): higher survival rates for preferred species in treated MMs, consistent with women allocating effort toward higher-valued species.

Hypothesis 3 (Negative): β<0. A negative coefficient implies that decentralized forest governance makes households, MM self help groups, and local ecology *worse off* along each outcome described above and in Section 4.1.

Beyond testing treatment effects on primary outcomes, we use the same regression framework (Equation 3) to analyze the mechanism variables defined in Table 2 (Section 4.2). This helps us understand *why* we observe the treatment effects (or lack thereof) on primary outcomes. Specifically, we estimate:

$$Mechanism_{ij} = \alpha + \beta \cdot Decentralized_j + \Omega X_{ij} + \theta_f + \boldsymbol{\gamma}_n + \epsilon_{ij} \qquad (4)$$

where $Mechanism_{ij}$ represents each of the variables listed in Table 2, including collective action measures (presence of group patrols, share participating in monitoring), decision autonomy measures (species preferred by women actually planted, women involved in nursery selection, women involved in planting design), effort allocation measures (share of women directly planting, fencing installed by MM vs. external labor), and resource control measures (share of plantation budget allocated to MM wages, presence of intra-group conflict).

If we find that decentralization increases sapling survival (primary outcome), the mechanism analysis allows us to test whether this effect operates through, for example, increased collective monitoring (e.g. patrol frequency as the outcome in Equation 4), or greater direct effort (e.g., share of members involved in plant as an outcome). Conversely, if we find null effects on survival, Equation 4 can reveal whether this reflects a failure of treatment to shift decision-making authority (e.g., no effect on autonomy measures).

5.2.3 Treatment Heterogeneity

We will investigate treatment heterogeneity by extending the main empirical model (Equation 3) to include an interaction term. The goal is to identify respondent characteristics or subgroups of MMs where the treatment is most effective. For a given covariate, H_{ij}, we will quantify heterogeneous treatment effects with the following equation:

$$Y_{ij} = \alpha + \beta_1 \cdot Decentralized_j + \beta_2 \cdot (Decentralized_j \times H_{ij}) + \Omega X_{ij} + \theta_f + \epsilon_{ij} \quad (5)$$

Where Y_{ij} is a respondent, MM, or ecological outcome. X_{ij} is a set of covariates, including H_{ij}. θ_f are strata (forest division) fixed effects, and ϵ_{ij} is the error term. Under this specification, the effect of the treatment, $Decentralized_j$, on the treated is $\beta_1 + \beta_2 H_{ij}$, where β_2 is the marginal impact of the treatment for MMs with one unit higher value of H_{ij}. Assuming H_{ij} is demeaned, then the average treatment effect on the treated is simply β_1. Standard errors will be clustered at the MM level, which is the unit of randomization.

We pre-specify four groups of moderator variables for H_{ij} in Equation 5:

Proximity to plantation site

Measure: walking time from MM bhawan (headquarters) to plantation (baseline Q15).

Monitoring and collective action may be more costly when planting sites are distant. We therefore expect treatment effects to be larger when MMs are closer to plantation sites because proximity reduces the travel cost of patrolling, regular maintenance, and direct oversight over planting. If treatment effects concentrate among nearby plantations, this suggests that reducing travel costs is critical for autonomy to improve outcomes.

Local Capacity

Measure 1: count of forest management activities in the past five years (baseline Q6).

Measure 2: Support from other community organizations/NGOs (baseline Q13)

Groups with prior experience in forest management or exposure to external institutions may have stronger governance structures, better technical knowledge, and more established norms of collective action. In contrast, MMs that primarily focus on non-forest activities and have limited experience managing forest-related programs may face coordination and implementation constraints, potentially reducing the effectiveness of decentralized governance. We thus expect treatment effects to be larger in high forest-capacity MMs because they are better positioned to translate decision-making autonomy into action. If effects concentrate among high-capacity groups, this suggests capacity-building should precede or accompany decentralization.

Group Size

Measure: total MM membership (baseline Q7).

This dimension captures coordination costs and the ease of collective action. As group size increases, free-riding and monitoring challenges typically rise, making it harder to translate autonomy into sustained collective effort. We therefore expect treatment effects to be weaker in larger MMs if coordination costs offset the benefits of decentralized decision-making. This moderator is relevant across institutional outcomes (difficulty mobilizing members), participation (higher scope for free-riding), and ecological outcomes (insufficient monitoring and maintenance).

Livelihood Dependence on Forest and Land Resources

Measure: distance to nearest major road, distance to town, satellite measure of remoteness

Where households depend more heavily on land, livestock, and forest resources, incentives to protect and manage plantations may be stronger. We therefore expect treatment effects to be larger in MMs with greater reliance on farm-based livelihoods, particularly for monitoring and ecological outcomes.

5.3 Statistical Methods

For continuous outcomes, we will estimate Equations (3)-(5) using ordinary least squares (OLS). All specifications include nursery and forest-division fixed effects, reflecting the stratified randomization, and standard errors will be clustered at the Mahila Mandal level, the unit of treatment assignment. Coefficients on the treatment indicator and its interactions are interpreted as average causal effects of decentralized governance.

For outcomes that are naturally ordered but not cardinal, such as ranked preferences over tree species, we will employ rank-ordered logit models, which appropriately account for the ordinal structure of the data while allowing treatment effects to be estimated on relative rankings.

For count outcomes, such as the number of Mahila Mandal meetings, the number of unique tree species planted, or the number of invasive species observed within a plantation, we will use Poisson regression models. These models are well-suited to non-negative integer outcomes and allow treatment effects to be interpreted as proportional changes in expected counts.

Importantly, evaluating the ecological impacts of decentralized forest management requires integrating tools from economics with established methods from ecology. Accordingly, we will carry out non-metric dimension scaling (NMDS) analysis to determine the similarity in vegetation in control and treatment sites and a rarefaction analysis to determine the species richness for comparable sampling effort. We will use the Wilcoxon test and the t-test to determine the differences in the large tree abundance and richness, and tree sapling abundance and richness. At the plot level, we will compare the following metrics for the control and treatment sites using a Wilcoxon and t-test of significance: adult tree, understory trees and sapling abundance, diversity and richness, non-native shrub density, grass richness, and canopy cover. We will compare the number of tree species actually planted (species richness) to the top five tree species listed by Mahila Mandals in the baseline survey. This will allow us to determine what proportion of the Mahila Mandal's desired tree species was actually planted in July 2025.

5.4 Missing Values, Outliers, and Enumerator Effects

Missing values may arise if respondents decline to answer specific survey questions. We expect nonresponse to be limited, as the survey does not cover sensitive topics such as income, politics, or violence. Nevertheless, missing data may threaten internal validity if nonresponse is systematically correlated with treatment assignment. We will therefore assess the balance of missing values by constructing indicator variables for missing outcomes and testing for differential nonresponse between treatment and control groups. As a robustness check, we will compare estimates from specifications that (i) exclude observations with missing outcomes and (ii) retain all observations by imputing missing values and including fixed effects for imputation indicators.

We also expect some outliers in our outcome variables and covariates, which is common in field surveys. For continuous variables, we will define outliers as values above the 95th percentile of the outcome distribution in each strata. We will then manually verify whether these observations were data entry errors by consulting with our data collection team at Prevalence. Data entry outliers will be winsorized to the 95th percentile to preserve sample size and statistical power. For genuine extreme values, we will conduct robustness checks using log-transformed outcomes in Equation (3) to ensure results are not driven by the upper tail of the outcome distribution.

In addition to missing data and outliers, we will also guard against non-classical measurement error introduced by which enumerator administers each survey. If certain enumerators interviewed mostly treatment MMs, for example, and enumerators differ in how they record responses, then estimates from Equation 4 could partly reflect enumerator behavior. To address this, we will first examine enumerator balance across treatment and control groups to see if certain enumerators disproportionately surveyed treatment or control units. We will also run robustness checks that include enumerator fixed effects to account for potential enumerator-driven differences in survey responses.

5.5 Multiple outcome and multiple hypothesis testing

Our analysis evaluates the impact of decentralized forest governance on multiple related outcomes, including sapling survival, institutional functioning within Mahila Mandals, and women's participation in forest management. Testing several hypotheses increases the risk of false positives due to multiple comparisons. To ensure valid inference, we adopt two procedures that control the family-wise error rate (FWER)—the probability of rejecting at least one true null hypothesis—while preserving power in a randomized experimental setting.

First, we will use the Westfall–Young procedure with 1,000 bootstrap resamples (Westfall and Young, 1993). This method accounts for the joint dependence structure of test statistics across outcomes and provides strong FWER control under arbitrary correlation. Second, we will compute randomization-based inference (RI) p-values by repeatedly permuting treatment assignment at the Mahila Mandal level—the unit of randomization—and re-estimating treatment effects over 1,000 replications, following Young (2019). We will report unadjusted p-values alongside adjusted p-values. When RI p-values and unadjusted p-values are nearly identical, indicating minimal multiple-testing distortion, we will present Westfall–Young FWER-adjusted p-values as our primary corrected inference in main tables, with full results reported in the appendix. This approach balances transparency and statistical rigor, ensuring that our conclusions are robust to multiple hypothesis testing.

5.6 Power Analysis

We conducted power calculations to assess whether our design is sufficiently powered to detect reasonably-sized treatment effects. We report minimum detectable effects (MDEs) at a 5% two-sided significance level and 80% power for three primary institutional outcomes: (i) whether the women's group reports supportive interaction with the forest department, (ii) whether the group was **consulted on species selection,** and (iii) whether the group participates in patrolling. We also report MDEs under the same specifications for two ecological outcomes: sapling diversity and tree diversity, measured as the number of species observed in each plantation during the baseline ecological survey.

Because treatment is assigned at the Mahila Mandal (MM) level, statistical power for institutional outcomes depends on the degree of within-MM correlation in respondent-level outcomes. We therefore estimate intra-cluster correlation coefficients (ICCs) for each outcome. The estimated ICCs are 0.4395 for supportive interaction with the forest department, 0.8005 for consultation on species selection, and 0.2592 for monitoring/patrolling participation. The study includes 134 control MMs and 137 treatment MMs, with an average of 4 respondents per MM at baseline. Under these parameters, the resulting MDEs are 9.2 percentage points for supportive interaction with the forest department, 6.4 percentage points for consultation on species selection, and 8.2 percentage points for participation in monitoring or patrolling.

Existing evidence from Himachal Pradesh suggests that these are reasonable effect sizes. Guleria et al. (2016) study participation in Joint Forest Management (JFM) and find that 49% of respondents are involved in restoration planning, and 45% report giving suggestions on preferred tree species. In another JFM study, Bingeman (2001) report that 34% of surveyed households in Prini village, and 60% in Solang, participate in local Forest Development Committee meetings. Lastly, a recent World Bank white paper reports that 15% of respondents across four districts are involved in planting operations (Government of Himachal Pradesh Forest Department, 2018). These studies indicate that participation-related outcomes commonly exceed 10% in our setting, reinforcing that our MDEs are well within a realistic range.

Ecological outcomes are measured at the plantation level, with one observation per MM. Because there is no within-MM sampling for these measures, power depends only on the number of clusters per treatment arm rather than on within-cluster correlation. We therefore compute MDEs using a cluster-level difference-in-means framework. Under this design, the MDE at 80% power corresponds to 1.47 sapling species and 1.35 tree species. These values represent 0.34 standard deviations in baseline species richness. We are unable to provide power calculations for our preference match and bias outcome variables since, by definition, these are measured one year after planting (Section 4.1).

5.7 Cost-Effectiveness Analysis

We will use our findings to conduct a cost-effectiveness analysis in order to assess the costs of achieving forest restoration by women's groups through traditional vs. decentralized forest governance. This analysis will focus on the financial costs required to generate improvements in restoration outcomes and does not attempt to put an economic value on the broader benefits of those outcomes. We will also examine the cost of achieving improved institutional functioning.

The analysis will focus on our primary outcomes: sapling survival and institutional functioning of MMs. Cost data will be compiled from official HPFD plantation journals, which we will collect from each District Forest Officer. Figure A3 shows an example of cost data recorded in a forest officer's plantation journal. These data enable us to calculate per-hectare financial transfers to Mahila Mandals, the allocation of funds between material and wage components, and any additional administrative or monitoring costs (or savings) associated with decentralizing decision-making authority. Because treatment and control groups operate within the same programmatic framework, differences in outcomes can be interpreted relative to clearly defined marginal costs of decentralization.

We will first compute intermediate cost metrics, including the cost per plantation established and cost per hectare under decentralized management. We will then assess outcome-based cost-effectiveness measures, such as the cost per additional surviving sapling one year post-planting, cost per percentage point increase in sapling survival, and cost per standard deviation improvement in indices of institutional functioning and women's participation. These measures allow direct comparison of financial inputs to ecological and institutional returns.

We will then benchmark these estimates against cost-effectiveness figures reported in the literature on other institutional approaches to achieve restoration along with institutional strengthening and women's participation. For example, we can compare the costs of JFM and community-driven conservation programs in India and other low- and middle-income settings. This analysis will provide policymakers with transparent metrics on whether reallocating decision rights to women's groups involved in restoration programs improves the ecological and institutional returns per rupee spent, informing the design and scaling of future forest restoration initiatives.

6. Conclusion and Policy Implications

This study examines whether granting women decision-making authority improves the effectiveness of forest restoration. Focusing on Mahila Mandals (women's groups) in Himachal Pradesh, we evaluate whether women-led decentralized forest governance enhances sapling survival, strengthens community institutional functioning, and increases women's participation relative to status quo, forest-department–led management. To do so, we embed a cluster-randomized controlled trial within Himachal Pradesh's flagship forest restoration program, the Rajiv Gandhi Van Samvardhan Yojana (RGVSY). Mahila Mandals are randomly assigned either to a decentralized governance regime or to the status quo regime, where the Forest Department retains decision-making authority. We will combine administrative data, detailed institutional surveys, ecological field surveys, household surveys, and satellite imagery to track outcomes.

The project will address a central gap in the development, environmental economics, and restoration ecology literature: while community participation is widely promoted in natural resource policy, evidence on how gender and institutional design shapes restoration outcomes remains limited. By experimentally varying the amount of decision-making autonomy granted to women's groups, we isolate the role of governance in shaping ecological and social outcomes.

The findings will inform the design of large-scale restoration programs in India and other developing-country contexts. If decentralized, women-led governance improves forest restoration outcomes at low marginal cost, the results would support policy shifts toward greater community authority within state-led environmental programs, particularly those that leverage women's groups.

7. Administrative information

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Institutional Review Board (ethics approval): We obtained IRB approval from the University of Minnesota on 06/12/2025. The IRB approval number is STUDY00025491.

Declaration of interest: We have no financial interest in the research.

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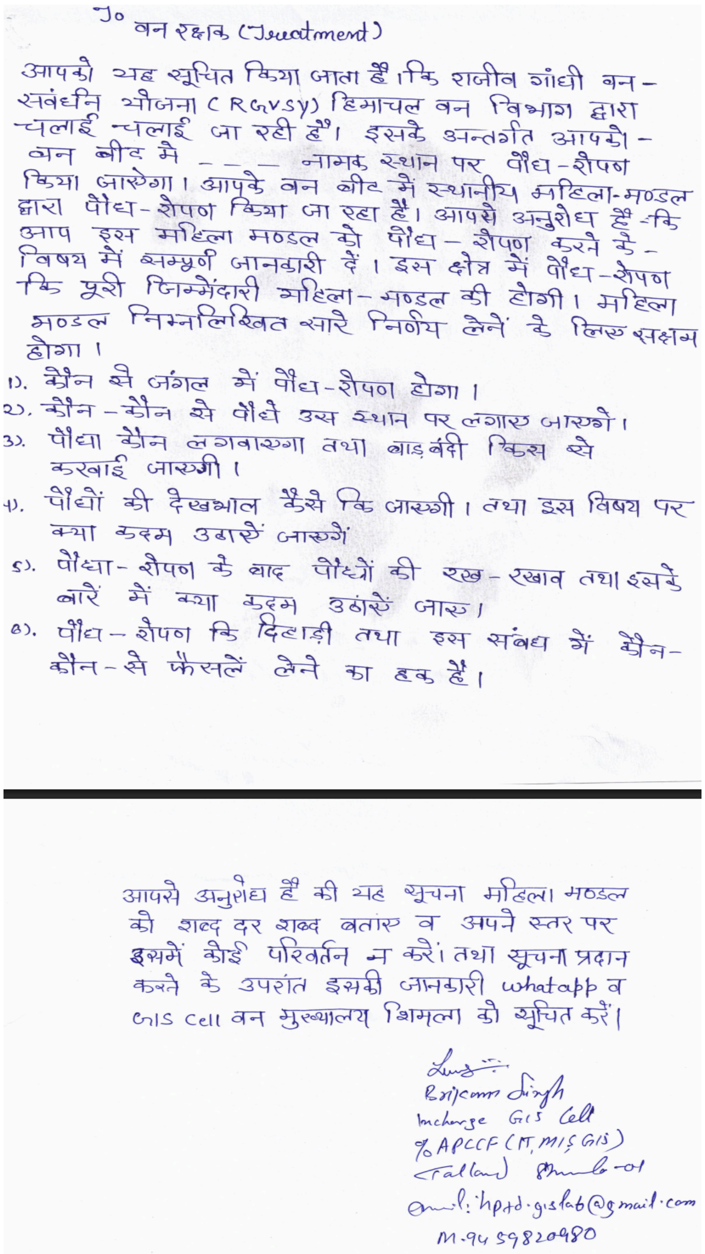
Appendix

Appendix A: Figures

Figure A1: Hindi and English Language Communication to Treatment Group



To
वन रक्षक (Treatment)

आपको यह सूचित किया जाता हैं। कि राजीव गांधी वन-संवंर्धन योजना (RGVSY) हिमाचल वन विभाग द्वारा चलाई चलाई जा रही हैं। इसके अन्तर्गत आपको-वन बीट मे _ _ _ नामक स्थान पर पौध-रोपण किया जाऐगा। आपके वन बीट में स्थानीय महिला-मण्डल द्वारा पौध-रोपण किया जा रहा हैं। आपसे अनुरोध हैं कि आप इस महिला मण्डल को पौध-रोपण करने के-विषय में सम्पूर्ण जानकारी दें। इस क्षेत्र में पौध-रोपण कि पूरी जिम्मेंदारी महिला-मण्डल की होगी। महिला मण्डल निम्नलिखित सारे निर्णय लेनें के लिए सक्षम होगा।

1). कौन से जंगल में पौध-रोपण होगा।
2). कौन-कौन से पौधे उस स्थान पर लगाए जाएगें।
3). पौधा कौन लगवाएगा तथा बाड़बंदी किस से करवाई जाएगी।
4). पौधों की देखभाल कैसे कि जाएगी। तथा इस विषय पर क्या कदम उठाऐं जाएगें
5). पौधा-रोपण के बाद पौधों की रख-रखाव तथा इसके बारें में क्या कदम उठाऐं जाए।
6). पौध-रोपण कि दिहाड़ी तथा इस संबध में कौन-कौन-से फैसलें लेने का हक हैं।

आपसे अनुरोध हैं की यह सूचना महिला मण्डल को शब्द दर शब्द बताए व अपने स्तर पर इसमें कोई परिवर्तन न करें। तथा सूचना प्रदान करने के उपरांत इसकी जानकारी whatapp व GIS Cell वन मुख्यालय शिमला को सूचित करें।

Brijeam Singh
Incharge GIS Cell
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M-9459820980

English Translation

You are hereby informed that the program of the Rajiv Gandhi Forest Conservation Scheme (RGVSY) is currently being implemented by the Himachal Pradesh Forest Department. Under this scheme, tree plantation works will take place in your forest beat at a place named ________. In your forest beat, women's self-help groups will be carrying out the plantation activities. You are requested to provide the following information to this women's self-help group regarding the plantation work, because the responsibility for plantation in this area will belong to the women's self-help group.

The women's group will be free to make all the following decisions:

1. In which part of their surrounding forest the forest plantation will be carried out.
2. Which tree species saplings will be planted at that location.
3. The method of plantation and how the fencing will be carried out.
4. How the saplings will be cared for and what steps will be taken for the care.
5. How the plantation will be maintained and protected after the saplings have been planted.
6. How the plantation will be monitored and who has the right to make decisions related to it.

You are requested to communicate this information to the women's self-help groups word-for-word, and not make any changes at your own level. After providing the information, please inform the GIS Cell at the Forest Headquarters, Shimla through WhatsApp.

Figure A2: Hindi Language Communication to Control Group

To
वन रक्षक (Control)

आपको यह सूचित किया जाता है कि राजीव गांधी वन सम्वर्धन योजना (RGVSY) हिमाचल प्रदेश वन विभाग द्वारा चलाई जा-रही है। इसके अन्तर्गत आपके वन बीट मे . . . . नामक जगह पर पौध-रोपण किया जाएगा। आपके वन बीट मे पौध-रोपण के लिए महिला-मण्डल का सहयोग लिया जा रहा है। इस पौध-रोपण योजना को सफल बनाने हेतू आपसे अनुरोध है कि जिस प्रकार संयुक्त वन प्रबन्धन के तहत पौध-रोपण करते आ रहें हैं। उसी भान्ति महिला-मण्डल को शामिल करें। आप यह निम्नलिखित कार्यकलाप सुनिश्चित करें।

1). आप पहलें की भान्ति पौध-रोपण करें, जिस प्रकार से पुराने-संयुक्त वन प्रबन्धन के माध्यम से पौध-रोपण करते आ रहे हैं। उसी प्रकार इस योजना में पौध-रोपण करें। आप स्वंय महिला-मण्डल को शामिल करें। तथा कौन सा क्षेत्र तथा क्ह पर पौध-रोपण करना है इस बारें में आप स्वंय निर्णय लें।

2). आप यह निर्णय लें कि पौध-रोपण किस विधि द्वारा-कार्यन्वित किया जाएगा तथा उसमे किस प्रजाती के पौधे लगाए जाएगें। साथ ही आप यह सुनिश्चत करें। कि पौध-रोपण के सुरक्षा हेतू उपयुक्त तारबन्दी तथा -पौध-रोपण व अन्य कार्यों में खर्च होने वाली राशि तय मानक के-अनुसार करे।

3) इस योजना के तहत लगाए गए पौधों की देखभाल तथा रख-रखाव कि जिम्मेंवारी आपकी होगी।

आपसे अनुरोध है कि यह सूचना महिला-मण्डल को शब्द-दर शब्द बताएं व इसमें अपने स्तर पर कोई भी परिवर्तन न करें। तथा सूचना प्रदान करने के उपरांत इसकी जानकारी what app व GIS Cell वन-मुख्यालय शिमला को सूचित करें।

Brijcom Singh
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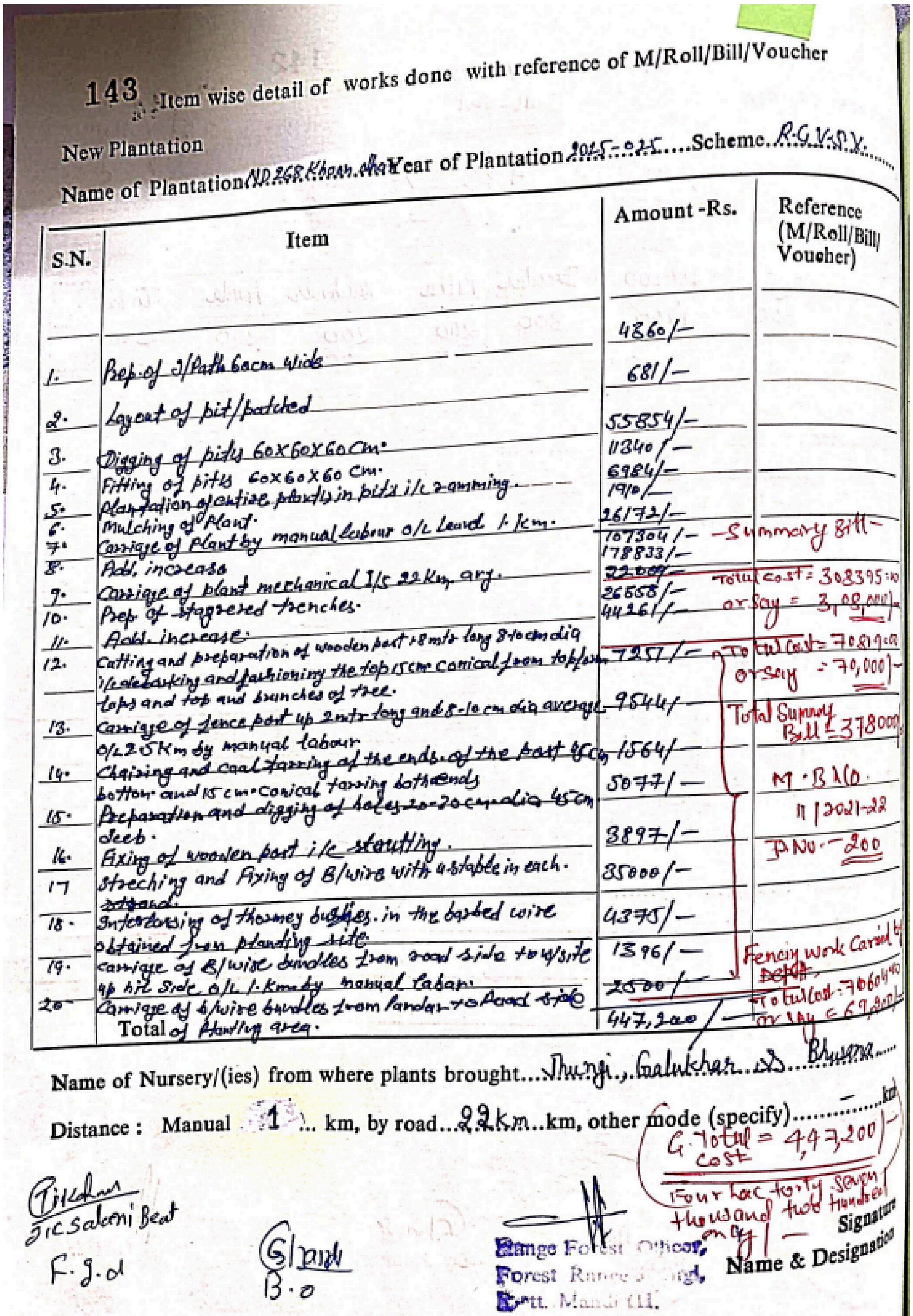
English Translation
You are hereby informed that the program of the Rajiv Gandhi Forest Conservation Scheme (RGVSY) is currently being implemented by the Himachal Pradesh Forest Department. Under this scheme, tree plantation works will take place in your forest beat at a place named ________. In your forest beat, women's self-help groups will be involved in the plantation activities.

To make this plantation scheme successful, please involve the same women's self-help groups that are also involved in the plantation work under Joint Forest Management. You should ensure the following activities:

1. First, carry out plantation in the same manner as has been done earlier under Joint Forest Management. Include the same women's groups in this scheme. The women's group itself may decide the area where plantation is to be carried out.
2. You should decide by which method the plantation work will be implemented and which species of plants will be planted. You should also ensure that the amount spent on barbed wire fencing and other plantation-related works is according to standards.
3. Under this scheme, the responsibility for the care and maintenance of the planted saplings/trees will be yours.

You are requested to communicate this information to the women's self-help groups word-for-word, and not make any changes at your own level. After providing the information, please inform the GIS Cell at the Forest Headquarters, Shimla through WhatsApp.



143 Item wise detail of works done with reference of M/Roll/Bill/Voucher

New Plantation

Name of Plantation ND 268 Khoan dhar Year of Plantation 2015-025 ....Scheme. R.G.V.S.Y.

S.N.	Item	Amount -Rs.	Reference (M/Roll/Bill/ Voucher)
		4860/-	
1.	Prep. of I/Path 60cm wide	681/-	
2.	Layout of pit/patched	55854/-	
3.	Digging of pits 60X60X60 Cm.	11340/-	
4.	Fitting of pits 60x60x60 Cm.	6984/-	
5.	Plantation of entire plants in pits i/c ramming.	1910/-	
6.	Mulching of Plant.	26172/-	
7.	Carriage of Plant by manual labour o/c Lead 1 km.	167304/-	-Summary Bill-
8.	Add. increase	178833/-	
9.	Carriage of plant mechanical I/S 22 Km avg.	~~22009~~ 26558/-	Total cost = 308395.00 or say = 3,08,000/-
10.	Prep. of staggered trenches.	44261/-	
11.	Add. increase:		
12.	Cutting and preparation of wooden post 1.8 mtr long 8-10 cm dia Cutting and preparation the top 15cm conical from top/... i/c debarking and fashioning the top 15cm conical from tops and top and branches of tree.	7257/-	Total Cost = 70819.00 or say = 70,000/-
13.	tops and top and branches of tree. Carriage of fence post up 2 mtr long and 8-10 cm dia average o/c 25 Km by manual labour	9544/-	Total Summary Bill = 378000/-
14.	Chaining and coal tarring of the ends of the post 45 cm bottom and 15 cm conical tarring both ends	1564/- 5077/-	M.B. No.
15.	Preparation and digging of holes 20-20 cm dia 45 cm deep.		11/2021-22
16.	Fixing of wooden post i/c strutting.	3897/-	P. No. - 200
17	Streching and Fixing of B/wire with 4 stable in each strand.	85000/-	
18.	Interlacing of thorney bushes in the barbed wire obtained from planting site	4375/-	
19.	carriage of B/wire bundles from road side to w/site up hill side o/c 1 Km by manual labour	1396/-	Fencing work Carried by Deptt.
20	Carriage of b/wire bundles from landar to Road side	2500/-	Total Cost = 70604.00 or say = 69,000/-
	Total of Planting area.	447,200/-	

Name of Nursery/(ies) from where plants brought...Jhungi, Galukhar & Bhuma...

Distance : Manual 1 ... km, by road...22 Km...km, other mode (specify).................km

G. Total cost = 4,47,200/- (Four lac forty seven thousand two hundred only) –

F.G. JIC Saloni Beat

B.O

Range Forest Officer, Forest Range ..., Distt. Mandi (H.)

Signature Name & Designation

Figure A3: Excerpt of Cost Data from Forest Officer Plantation Journal

Appendix B: Tables

Table A1: Balance Table of Categorical Variables

Characteristic	**Overall** N = 271	**Control** N = 134	**Treatment** N = 137	**p-value**
Meeting Frequency				0.2
Weekly	2 (0.7%)	0 (0%)	2 (1.5%)	
Monthly	240 (89%)	116 (87%)	124 (91%)	
BiMonthly	9 (3.3%)	5 (3.7%)	4 (2.9%)	
Less than BiMonthly	20 (7.4%)	13 (9.7%)	7 (5.1%)	
MM Elects Leaders	211 (78%)	105 (78%)	106 (77%)	0.8
MM Decision Making Process				
Majority Vote	9 (4.4%)	5 (4.8%)	4 (4.0%)	
Consensus	194 (95%)	98 (94%)	96 (96%)	
Key Leaders	0 (0%)	0 (0%)	0 (0%)	
Other	1 (0.5%)	1 (1.0%)	0 (0%)	
MM Benefit Distribution				0.6
Based on Contribution	83 (31%)	39 (29%)	44 (32%)	
Equally to All Members	164 (61%)	85 (63%)	79 (58%)	
Other	24 (8.9%)	10 (7.5%)	14 (10%)	
Manage Forest Invasives	203 (75%)	98 (73%)	105 (77%)	0.5
Guards Forest	191 (70%)	92 (69%)	99 (72%)	0.5
Sanctions Forest Rules	80 (30%)	37 (28%)	43 (31%)	0.5
Weeding, Thinning, &/or Pruning Forest	222 (82%)	109 (81%)	113 (82%)	0.8
Putting Out Forest Fires	226 (83%)	113 (84%)	113 (82%)	0.7
Setting Forest Fires	6 (2.2%)	2 (1.5%)	4 (2.9%)	0.4

Consultation for Participating - Mahila Mandal as a Whole				0.9
Yes, local demand	18 (6.6%)	9 (6.7%)	9 (6.6%)	
Yes, asked to participate	168 (62%)	85 (63%)	83 (61%)	
Yes, agreed after funding info	80 (30%)	37 (28%)	43 (31%)	
No, never agreed	5 (1.8%)	3 (2.2%)	2 (1.5%)	
Consultation for Participating - Mahila Mandal Leadership				>0.9
Yes, local demand	15 (5.5%)	7 (5.2%)	8 (5.8%)	
Yes, asked to participate	170 (63%)	85 (63%)	85 (62%)	
Yes, agreed after funding info	81 (30%)	39 (29%)	42 (31%)	
No, never agreed	5 (1.8%)	3 (2.2%)	2 (1.5%)	
Consultation on Site Selection - Mahila Mandal as a Whole				0.3
Yes, local demand	26 (9.6%)	11 (8.2%)	15 (11%)	
Yes, asked to participate	140 (52%)	75 (56%)	65 (47%)	
Yes, agreed after funding info	96 (35%)	42 (31%)	54 (39%)	
No, never agreed	9 (3.3%)	6 (4.5%)	3 (2.2%)	
Consultation on Site Selection - Mahila Mandal Leadership				0.3
Yes, local demand	26 (9.6%)	11 (8.2%)	15 (11%)	
Yes, asked to participate	141 (52%)	74 (55%)	67 (49%)	
Yes, agreed after funding info	94 (35%)	42 (31%)	52 (38%)	
No, never agreed	10 (3.7%)	7 (5.2%)	3 (2.2%)	
Anticipated Benefit - Employment	266 (98%)	131 (98%)	135 (99%)	0.6
Anticipated Benefit - Firewood	258 (95%)	127 (95%)	131 (96%)	0.7
Anticipated Benefit - Improved Grazing	204 (75%)	97 (72%)	107 (78%)	0.3

Anticipated Benefit - None	7 (2.6%)	3 (2.2%)	4 (2.9%)	0.7
Anticipated Drawback - Loss of Grazing Land	122 (45%)	59 (44%)	63 (46%)	0.7
Anticipated Drawback - Increased Fire Risk	198 (73%)	100 (75%)	98 (72%)	0.6
Anticipated Drawback - None	7 (2.6%)	2 (1.5%)	5 (3.6%)	0.3
Monitoring Strategy - None	19 (7.0%)	9 (6.7%)	10 (7.3%)	0.9
Monitoring Strategy - Community Patrolling	234 (86%)	118 (88%)	116 (85%)	0.4
Monitoring Strategy - Hiring a Guard	101 (37%)	45 (34%)	56 (41%)	0.2
Monitoring Strategy - Fining Those Who Enter/Misuse	220 (81%)	111 (83%)	109 (80%)	0.5
Land Tenure - Community Grazing	249 (92%)	121 (90%)	128 (93%)	0.3
Land Tenure - Community Forest	263 (97%)	131 (98%)	132 (96%)	0.5
Land Tenure - Private Land	5 (1.8%)	1 (0.7%)	4 (2.9%)	0.2
Current Landcover - Sparse Forest	262 (97%)	129 (96%)	133 (97%)	0.7
Current Landcover - Grazing	244 (90%)	118 (88%)	126 (92%)	0.3
Current Landcover - Barren	11 (4.1%)	6 (4.5%)	5 (3.6%)	0.7

Note: cell values report counts, with percentages in parentheses. P-value tests equality of distributions across treatment and control groups using Pearson's chi-squared test with the Rao–Scott adjustment (survey-design corrected).

Table A2: Top 10 Preferred Tree Species Reported by Mahila Mandals at Baseline

Rank	Preferred Species	Number of MMs
1	Deodar	635
2	Walnut	335
3	Amla	326
4	Ban	306
5	Blue Pine	203
6	Kair	202
7	Wild Apricot	182

8	Harar	155
9	Sheesham	153
10	Baheda	146

Note: This table reports the ten most frequently preferred plantation species identified in the baseline survey administered prior to treatment assignment. Column 3 reports the number of MMs identifying each species as preferred for plantation activities.

Appendix C: Baseline Survey Instrument

MAHILA MANDAL FORMAT

Information about the mahila mandal module [4 members to be interviewed in one Mahila Mandal group) (at least 2 members from Executive Committee, which can include mahila mandal president, secretary, vice president or cashier + one member from BPL or lower caste category + one mahila mandal member actively dependent on forest)

Executive committee of Mahila mandal

1) Mahila Mandal President
2) Mahila mandal Secretary
3) Vice president
4) Cashier

Other Mahila mandal Member

1) BPL Member
2) Lower caste category member

One mahila mandal member actively dependent on forest.(Forest user)

Name of surveyor(s): Name of supervisor:

Date of interview:

GPS location of interview location:

Name of respondent:

Contact no. Of Respondent:

1. Number of members
2. Year of founding
3. Frequency of meeting

a) weekly,
b) monthly,
c) bimonthly,
d) less than bimonthly)

4. Number of members who attended the last meeting
5. List of activities undertaken by the mahila mandal in the last year
    a. Banking & Credit (y/n)
    b. Skill Development (y/n)

c. Marketing of products (y/n)
d. Health and Welfare (y/n)
e. Rural Development (y/n)
f. Sociocultural activities (y/n)
g. Other (describe)

6. Has the group been involved in any of the following forest management activities in the last five years - (note this refers to the group *as a group* not individual action):
    a. Control of invasives (y/n)
    b. Guarding and patrolling forest area (y/n)
    c. Sanction breaking of rules related to the forest? (y/n)
    d. Weeding, thinning &/or pruning (y/n)
    e. Putting out fires (y/n)
    f. Setting fires (y/n)
    g. Setting rules about use/access to a forest area (y/n)
    h. Monitoring ecological conditions in a forest (e.g. whether planted saplings are growing) (y/n)
    i. Planting trees in a forest area (y/n)
    j. Harvesting timber from a forest area (y/n)
    k. Harvesting firewood from a forest area (y/n)
    l. Harvesting leaf fodder from a forest area (y/n)
    m. Harvesting grass fodder from a forest area (y/n)
    n. Grazing animals in forest area (y/n)
    o. Harvesting other products from a forest area (e.g. medicinal plants, wild foods) (y/n)
    p. Earned money from the sale of any forest products (y/n)
    q. If the group has been involved in past management, has this been a beneficial activity?
7. Number of members of mahila mandal
    a. Total members belonging to ST/SC/OBC/General
    b. Total members holding BPL card
8. Does this institution elect its president or other executive officers (y/n)
    a. How frequently are elections held? (no. of years)
    b. How many years has the current president held their position (no. of years)

9. Leadership profile of top 3 officers:
    a. Position
    b. Age
    c. Gender
    d. Caste (ST/SC/OBC/Gen)
    e. Years in office
    f. Level of education
10. Does the mahila mandal have a functional bank account? Y/N
11. How does the mahila mandal make decisions
    i) by majority vote,
    ii) by consensus,
    iii) key leaders make decisions,
    iv) other)
12. How are benefits of Mahila mandal activities distributed to members?
    a. Based on contribution of time or money to the activity
    b. Equally to all members
    c. Other (describe)
13. Engagement: Have members of this institution worked with other actors?

	Receiving financial support (Y/N)	Receiving information (Y/N)	Receiving other support (Y/N)	Overall level of interaction:1 = little/no interaction; 2 = conflictual; 3 = uncooperative; 4 = supportive; 5 = very supportive
Panchayat Pradhan				
Other panchayat officials (e.g. ward members, panchayat secretary)				
Forest department				
Other agriculture/ Horticulture/other university				
NGO (provide name or multiple names if multiple are				

involved, and other questions should be answered for each NGO)				
Block office				
Other local community group (provide name)				
Political party				
Private company (provide name, provide type of business)				
Other (provide name)				

14. Women's empowerment (this question should be specifically asked to the president of the mahila mandal): Suppose the women in the community wanted to plant certain species and the forest department wanted to plant different species? Which species do you think would be planted? (women's preference or Forest department preference)

    i)

    ii)

    iii)

    iv)

    v)

Information about the mahila mandal plantation module

(questions in this section are about the proposed/planned plantation, *not* about any other plantation that that mahila mandal is involved in, and should focus on this one plantation *only*. Answers to these questions should come from the mahila mandal members, not the forest guard)

15. How far is the Mahila mandal bhawan from the plantation area time (minutes) taken to walk?
16. What is the land tenure of the proposed plantation area? Choose all the options that apply:

a) Community grazing land,

b) community forest land,

c) someone's private land,

d) other

17. What is the area of the plantation in hectares?

18. What is the current land cover in the plantation? Choose all that apply:

a) Sparse forest cover (scattered trees)

b) grazing land,

c) barren land,

d) private land

19. Which of the following invasive species are present in the plantation area

a. Lantana

b. Eupatorium

c. Ageratum

d. Other

20. Consultation? (note that for this question, it will be necessary to collate information both from the mahila mandal leaders and from other members, as we want to know both of the leaders and the general membership).

a. Was the mahila mandal as a whole consulted about whether they wanted to participate in the plantation program?

i) yes, their inclusion was result of local demands to have a plantation;

ii) yes, after being informed about the program they asked to participate;

iii) yes, they agreed to participate after being informed that they would receive funding;

iv) no, they never agreed to participate)

b. Was the mahila mandal leaders consulted about whether they wanted to participate in the plantation program?

i) yes, their inclusion was result of local demands to have a plantation;

ii) yes, after being informed about the program they asked to participate;

iii) yes, they agreed to participate after being informed that they would receive funding;

iv) no, they never agreed to participate)

c. Was the mahila mandal as a whole consulted on the site selection?

i) yes, they chose the site on their own and suggested it to the forest department;

ii) yes, they worked together with the forest dept. To identify the site;

iii) yes, they agreed to the site after it was suggested by the forest department;

iv) no they were not consulted)

d. Was the mahila mandal leadership consulted on the site selection?

i) yes, they chose the site on their own and suggested it to the forest department;

ii) yes, they worked together with the forest dept. To identify the site;

iii) yes, they agreed to the site after it was suggested by the forest department;

iv) no they were not consulted

e. Was the mahila mandal as a whole consulted about the species to be planted?

i) yes, they chose the species on their own;

ii) yes they chose the species with advice from the forest department;

iii) yes, the forest department chose the species and they agreed;

iv) no, they were not consulted

f. Was the mahila mandal leadership consulted about the species to be planted?

i) yes, they chose the species on their own;

ii) yes they chose the species with advice from the forest department;

iii) yes, the forest department chose the species and they agreed;

iv) no, they were not consulted

g. Was the mahila mandal as a whole consulted about the manner of planting (for example planting in rows versus in clusters)

i) Yes, they developed plans for the manner of planting on their own;

ii) yes, they developed plans in consultation with the forest department;

iii) yes, the forest department developed the plans and consulted with them;

iv) no, the forest department developed the plans without consultation)

h. Was the mahila mandal leadership consulted about the manner of planting (for example planting in rows versus in clusters)

i) Yes, they developed plans for the manner of planting on their own;

ii) yes, they developed plans in consultation with the forest department;

iii) yes, the forest department developed the plans and consulted with them;

iv) no, the forest department developed the plans without consultation)

21. What benefits does the mahila mandal anticipate from this plantation activity?

    a. Employment for members (y/n)

        i. # of person-days of employment anticipated

b. Money for mandal as a whole? (y/n)
c. Grass fodder (y/n)
d. Leaf fodder (y/n)
e. Improved grazing (y/n)
f. Firewood (y/n)
g. Wild foods (e.g. fruit, mushrooms, etc.) y/n
h. Medicinal plants (y/n)
i. Political connections (y/n)
j. Other (describe) (y/n)
k. none

22. What drawbacks does the mahila mandal anticipate from this plantation activity?
    a. Loss of access to land for grazing animals (y/n)
    b. Increased fire risk in the plantation area (y/n)
    c. Increased invasive species (y/n)
    d. Increased human wildlife conflict (e.g. crop raiding) (y/n)
    e. Increased control of the mahila mandal by forest department (y/n)
    f. Other (describe) (y/n)
    g. None
23. How does the mahila mandal anticipate distributing the benefits of plantation? Choose from: i) equally amongst the whole MM,

ii) equally only amongst those who participated in tree planting,

iii) in proportion to the number of days people participated in planting and maintenance,

iv) in proportion to the number of days people participated in planting only, other

25. Are there any existing land use related conflicts in the selected planting sites? (y/n, if yes provide a brief description)

26. What plans do the mahila mandal have for planting site preparation?
    a. Weeding y/n
    b. Removal of invasive species y/n
    c. Adding soil y/n
    d. Fencing (yes, provided by forest dept., yes, provided by mahila mandal, no)
    e. Other (describe)

27. Which specific nursery will plants come from for the planting for the site
    i) provide the name of that nursery
    ii) Distance of nursery from plantation area (km).
28. List all species which the mahila mandal plans to plant.(Max. 10 species)
    a)
    b)
    c)
    d)
    e)
    F)
    G)
    H)
    I)
    J)
29. List up to five species the mahila mandal would like to plant but anticipates not planting (e.g. due to lack of availability of seedings)
30. What planting methods are planned to be used?
    a. Planting in rows (y/n)
    b. Planting in clusters (y/n)
    c. Planting with wooden fencing (y/n)
    d. Planting with social fencing (y/n)
    e. Planting with no fencing (y/n)
    f. Planting as per site availability (y/n)
31. Which risks and challenges does the mahila mandal anticipate?
    a) Trampling or browsing by cattle, sheep, goats y/n
    b) Fire y/n
    c) Spread of invasive species y/n
    d) Unequal distribution of benefits y/n
    e) Insufficient support from forest department? y/n
    f) Interference of plans from forest department? y/n
    g) Conflict between members over benefits (y/n)
    h) Other (describe) y/n
32. Which organizations (community groups/government agencies) will you engage with in planning and managing plantation. (List max. 6 organizations)

1.

2.

3.

4.

5.

6.

a. For each organization/community group, ensure they are listed on the organizational inventory of the panchayat. THEN for each organization answer the following question: What type of engagement? (SEPARATE FOR EACH of the 6 community groups/government)

i. Providing financial support to mahila mandal (y/n)

ii. Providing technical support/knowledge to mm (y/n)

iii. Providing labor support to mm (y/n)

iv. Providing equipment support to mm (y/n) (for example tractor or bulldozer)

v. Providing planting materials to mm (y/n)

vi. Providing non planting materials (e.g. fencing) to mm (y/n)

vii. Other (describe)

33. Which of the following monitoring strategies are planned for the plantation area?

a) None (y/n)

b) Community patrolling (e.g. groups fo women share responsibility) (y/n)

c) Hiring a guard to patrol (y/n)

d) Fining those who enter/misuse the plantation area (y/n)

e) Other (describe)

34. Which of the following activities currently occur in the planned plantation area:

a) Grazing of animals belonging to members of the mahila mandal

b) Grazing of animals belonging to other people

c) Collection of grass fodder by members of the mahila mandal

d) Collection of grass fodder by other people

e) Collection of leaf fodder by members of the mahila mandal

f) Collection of leaf fodder by other people

g) Collection of firewood by members of the mahila mandal

h) Collection of firewood by other people

i) Other use by members of the mahila mandal (describe)

j) Other use by other people (describe)

35. Whether Panchayat has earlier provided any of the following support?

. Providing financial support to mahila mandal (y/n)

. Providing technical support/knowledge to mm (y/n)

. Providing labor support to mm (y/n)

. Providing equipment support to mm (y/n) (for example tractor or bulldozer)

. Providing planting materials to mm (y/n)

. Providing non planting materials (e.g. fencing) to mm (y/n)

. Other (describe)

36. What is the plantation site suitability classification for selected sites as per the forest department mobile application?

1) Not suitable
2) Low suitability
3) Medium suitability
4) High suitability

37. If you are not satisfied with the prediction results, please tick the appropriate category of suitability:

1) Not suitable
2) Low suitability
3) Medium suitability
4) High suitability

Comment survey summary
End Time

Plantation centroid location:

Longitude:

Latitude