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RESEARCH ARTICLE

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Planting and replanting: Continuity and change over four decades of forest restoration in Himachal Pradesh, India

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Societal Impact Statement

India has a long history of planting trees to restore ecosystem services providing an opportunity to evaluate long-term ecosystem restoration processes. We show that these programs have shifted over time in response to public demands as well as through changes in the government's vision for forests. These shifts point towards opportunities and limits for political responsiveness in the design and implementation of restoration programs. Independent evaluations have shown that the tree planting programs we study often fail to achieve their goals, raising questions about their benefits, and risks from positioning tree planting as a panacea for social and environmental problems.

Summary

- **Aims:** Interest in forest restoration has increased in recent years with the goal of increasing carbon storage, protecting biodiversity, and improving the delivery of ecosystem services to aid rural livelihoods. However, there is little systematic analysis of how this trend relates to broader histories of landscape interventions.
- **Methods:** We analyze a dataset comprising 36 years of government plantation records from the forest department of the Indian Himalayan state of Himachal Pradesh.
- **Findings:** Restoration-oriented tree planting peaked in the 1980s and 1990s with heavy domestic funding. Counter to dominant policy narratives, most plantation programs did not formally involve the participation of local people and were not funded by donors or carbon markets. Over time, planting shifted away from commercial timber species towards a more diverse set of native broadleaf species, reflecting local preferences for the production of firewood, fodder, and other non-timber forest products and ecosystem services as well as changing conceptions by government agencies about *what* and *who* a forest is meant to serve. Over time, the number of programs sponsoring tree planting has proliferated, reflecting the ways that tree planting has been framed as the solution to a growing number of problems, ranging from poverty alleviation to climate adaptation.

- **Conclusion:** The current global focus on forest restoration and nature-based climate solutions represents a reframing of long-existing policies and programs in this region. As with past policy changes, restoration practices are likely to be influenced by long-term histories, entrenched practices, and local political influences.

KEYWORDS
Forest restoration, Himachal Pradesh, landscape history, nature-based climate solutions, restoration social science, tree planting

1 | INTRODUCTION

The last decade has seen a rapid growth in policies aiming to increase global forest cover, including Reducing Emissions from Deforestation and Forest Degradation (REDD+), the Bonn Challenge, New Generation Plantations, Forest Landscape Restoration, the Kew Declaration, and the UN decade on Ecosystem Restoration (Agrawal et al., 2011; Bastin et al., 2019; Duchelle et al., 2018; Erbaugh & Oldekop, 2018; Hawes, 2018; Laestadius et al., 2015; Silva et al., 2019; The Bonn Challenge, 2016; The Declaration Drafting Committee, 2021). Ecological restoration has the potential to make a substantial contribution to protecting biodiversity, storing carbon in the biosphere, and improving human well-being (Bastin et al., 2019; Cook-Patton et al., 2021; Erbaugh et al., 2020; Löfqvist et al., 2023; Mo et al., 2023; Strassburg et al., 2020; Walker et al., 2022), yet these programs have been accompanied by significant controversy over potential biophysical and social impacts (Chomba et al., 2016; Ece et al., 2017; Fleischman et al., 2022; Fleischman, Basant, et al., 2020; Löfqvist et al., 2023; Osborne et al., 2021; Ribot & Larson M, 2012; Sacco et al., 2021; Schultz et al., 2022; Veldman et al., 2015, 2017). While some view restoration as a revolutionary new paradigm for environmental management (Mansourian et al., 2021), others see restoration as the repackaging of old programs in new framing (Djenontin et al., 2020) much as earlier initiatives such as REDD+ also consisted of repackaging old programs to fit new development paradigms (Lund et al., 2017). In light of this expansion of activity and controversy, it is becoming increasingly important to understand what activities are undertaken in the name of restoration and how they have changed over time, as well as to study historical examples of restoration.

In this paper, we draw on detailed records of government-implemented forest restoration programs in the Indian state of Himachal Pradesh between 1979 and 2015 to understand what forest restoration programs look like in practice and how they have changed over time. These programs mostly focus on planting trees with goals that include restoring perceived historical forest cover and improving the delivery of ecosystem goods and services to local people and thus are similar to many contemporary restoration programs, particularly those in India which continue to rely on similar planting techniques. Himachal Pradesh represents an excellent opportunity to study restoration processes because it has a reputation for being a relatively well-governed state (Dreze & Sen, 2002, 1997) and has a long history of large-scale forest restoration, primarily in the form of tree planting on government-owned forest land, leading it to be a "most likely case" (George & Bennett, 2005) for finding long-term success. However several recent evaluations have reported disappointing ecological and social outcomes from restoration programs in the state (Aggarwal, 2020, 2021; Asher & Bhandari, 2021; Coleman et al., 2021; Ramprasad et al., 2020; Rana et al., 2022; Rana & Miller, 2019a, 2019b).

In this paper, we document how tree planting practices have persisted and changed as trees have come to stand for different values and purposes over time. We show that changes to tree planting practices do not connect smoothly with global or national dialogues about forests and restoration. We focus on four main findings:

1. Forest restoration through tree planting is an ongoing practice.
   In contrast to narratives that suggest that contemporary initiatives for forest restoration are a new or emerging phenomenon, we find that tree planting-based restoration has been an ongoing practice in Himachal Pradesh for our entire study period. However, tree planting has declined in extent since the 1980s and 1990s.
2. The Indian government, rather than donors or markets, is the main funder of restoration.
   While much of the current focus is on the role of international donors, NGOs, and markets in forest restoration, we find that the vast majority of forest restoration was funded by state and national governments through programs that aim to achieve important regional and national goals, such as watershed protection.
3. While local participation is emphasized in restoration discourse, it is not reflected in practice.
   While Indian forestry agencies claim that participatory decision-making is central to their work, participatory programs represent only a small percent of overall restoration funding, and independent evaluations often find that the so-called participatory programs fail to foster actual participation.
4. Restoration practice is diverse and has changed over time.
   In contrast to critics who assert that Indian restoration programs are dominated by a small number of tree species valued for their commercial potential, our data show a shift towards a more diverse set of native species valued at the local level, as well as towards more diverse justifications for forest restoration. These diverse justifications reflect that forest restoration through tree planting is frequently seen as a solution to many unrelated problems, and also

may reflect increasing state responsiveness to local demands. It also demonstrates that simple dichotomies between production forestry and restoration-oriented forestry, participatory and non-participatory forestry, and normative prescriptions from restoration ecologists about what activities or species are appropriate in a particular site, may be quite distinct from the practices government agencies adopt when tasked with restoring what they perceive to be degraded landscapes. Furthermore, we show that some practices which may have been originally developed for the purpose of production forestry, such as high-density plantings of small numbers of easily propagated species without local consultation, remain widespread and are central to what India now considers its restoration practices.

Our results have important implications for the design of forest restoration programs in India, and in many other countries in the world. First, they suggest that the long history of forest restoration programs in India may provide lessons for effective restoration strategies. Unfortunately, as noted earlier, evaluations of these programs indicate that they have often been unsuccessful, suggesting that historical practices may need to be reformed to be effective (Coleman et al., 2021; Rana et al., 2022; Aggarwal, 2020, 2021; Asher & Bhandari, 2021; Ramprasad et al., 2020; Rana & Miller, 2021; Rana & Miller, 2019a; Banin et al., 2023). The longstanding nature of these programs, and their continuity with new Indian policies (Sethi, 2024), combined with their apparent ineffectiveness, raises questions about the reasons for their persistence, as well as the ways that forest restoration might be made more effective in India and other countries using similar practices.

Second, our analysis echoes recent studies from other parts of the world (Djenontin et al., 2020; Fagan et al., 2020; Lund et al., 2017; Martin et al., 2021; Schubert et al., 2024) that demonstrate how forest restoration commitments are transformed in complex ways based on the knowledge, experience, and incentives of state and local actors. We demonstrate that programs with very diverse goals adopt tree planting as a major technology because of the knowledge and incentives of those tasked with carrying out restoration (Fleischman, 2014). In particular, while some restoration ecologists seek to exclude production-oriented forest practices from restoration commitments (Lewis et al., 2019), we found that many government programs used language that identified ecological restoration as a goal, but used practices drawn from production forestry to achieve this goal, and/or claimed that practices aimed at enhancing production for commercial or livelihood supporting goals simultaneously would lead to restoration. This suggests that international commitments may not accurately reflect or explain restoration practices, and therefore, that greater empirical study is needed of what restoration means to people, how restoration is practiced on the ground, and how this relates to international commitments and ideas generated by the research community.

Third, our results show that while participatory programs in our study area have not been implemented to the extent that they are discussed, important natural resource management changes that favor rural livelihoods have nonetheless occurred, as planting has shifted towards a more locally desired mix of species. This suggests that Indian forest departments are less monolithic and more adaptable than assumed in much discussion of Indian forests (Fleischman, 2016), and that factors other than local participation may play important roles in developing pro-poor forest reforms. Although our data do not give us much insight into the reasons for this transformation, some evidence suggests that grassroots political movements that pushed for state-level reforms, pressure from donors, or changing visions by foresters may have contributed to this change (Personal communications, Dr. G.S. Goraya, retired Principal Chief Conservator of Forests, Himachal Pradesh Forest Department).

1.1 | Forest restoration in India

India's long engagement with forest restoration (Davis & Robbins, 2018; Roy & Fleischman, 2022) provides an ideal environment in which to examine how forest restoration programs have been framed and implemented. Ashokan edicts dating to the third century BC mention planting trees along roadsides to provide shade for travelers, but the earliest well-documented large-scale tree planting programs in India were undertaken by the British in the 1840s (Stebbing, 1922; Tewari, 1992). Davis and Robbins (2018) argue that by the late 19th century, discourses of ecological degradation that could be solved by planting trees were firmly established in British India (see also Grove, 1995). In this period, planting trees was justified simultaneously as a technique for increasing production, as well as a way to restore what were understood as degraded forests. Yet records show that the extent of colonial and early post-colonial restoration activities were small: for example, during the first 5-year plan (1951–1956), only 30,350 Ha of forest plantations were planted across India (Forest Research Institute Dehra Dun, 1961), and data compiled by Ravindranath et al. (2007) from varied government sources show relatively little planting activity prior to approximately 1980. Ravindranath et al.'s data indicate that between 1980 and 2005, tree planting occurred over an area equivalent to 10% of India's land area, although this may include some areas that were planted multiple times in that 25-year period. Remote sensing studies indicate that India's forests are increasingly of planted rather than natural origin (Puyravaud et al., 2010a, 2010b).

In recent decades, India experienced waves of forest policy reforms that echo those on the global stage. Each of these waves has been accompanied by a framing of forest restoration as a solution to a different problem, and these different emphases have sometimes been accompanied by shifts in species preferences (see Figure 1). Unifying these waves has been a preoccupation with reaching a national goal of 33% forest cover, a goal enshrined in an early post-independence policy statement (Government of India, 1952) based on the average forest cover of European countries at that time (Davis & Robbins, 2018; Joshi et al., 2010) and not representative of the actual availability of land for forest restoration (Rana & Varshney, 2023).

Although forest restoration programs existed prior to the 1970s, we found little documentation. An apparent increase in the

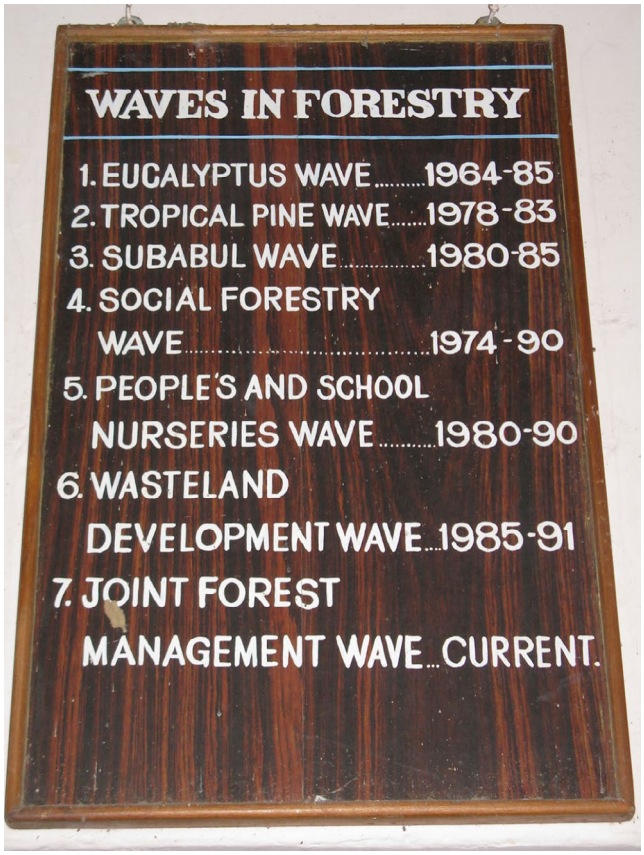

FIGURE 1 "Waves in Forestry." Photo taken in forest rest house, Chandrapur, Maharashtra, October 2010 by Forrest Fleischman.

prominence of forest restoration in the late 1970s may have been spurred by reports of "Himalayan degradation" (Eckholm, 1975; Ives, 1987), a "wood fuel crisis" affecting the rural poor (Agarwal, 1986), as well as demands from agronomists to increase the industrial productivity of India's forests through plantations (National Commission on Agriculture, 1976), reflecting a mix of ecological and economic concerns. Policy-makers and donors responded with a massive increase in tree planting with funding from a variety of domestic and donor sources (Saigal, 2011a; Fleischman, 2014), as well as sustaining and increasing restrictions on rural land uses such as pastoralism and small-scale firewood harvesting on forest land (Fernandes & Kulkarni, 1983; Saberwal, 1999). During the period of Rajiv Gandhi's prime ministership, forest restoration through tree planting campaigns coordinated by the National Wastelands Development Board aimed to "green" 5 million hectares per year in India (India Today, 1991; Saigal, 2011a, 2011b). In Himachal Pradesh, an increasing number of plantations were supported under the aegis of "social forestry" during the 1980s, with an emphasis on planting wood fuel crops near people's homes to lessen pressure on natural forests (The World Bank, South Asia Projects Office Department, General Agricultural Division, 1985). Importantly, while these programs often adopted techniques that we might associate with production forestry, such as large-scale planting of a small number of species in blocks, these were justified not only as valuable for timber production but also as a way to restore degraded land.

Early evaluations of social forestry programs were largely negative: Discourses around the wood fuel crisis ignored the many ways that wood fuel collection was influenced by the adaptive behavior of individual households, as well as supplied from outside of forests, and forest departments tended to plant species they were experienced with, such as conifers in the Himalayas, instead of species that were locally valued for fuel (Agarwal, 1986; DeFries & Pandey, 2010; Dewees, 1989; Misra & Bhatty, 1990; Pandey, 2002; Pathak, 1995; Saxena, 1994; Saxena & Ballabh, 1995); the Himalayan degradation theory was thoroughly discredited (Blaikie & Muldavin, 2004; Ives, 1987; Ives & Messerli, 2003; Saberwal, 1999), and as discussed earlier, the forest cover targets in the 1952 forest policy were arbitrary (Davis & Robbins, 2018; Joshi et al., 2010; Rana & Varshney, 2023). Although wealthy farmers would invest in profitable tree crops, poor people were often reluctant to invest in social forestry activities, participatory aspects of the program failed to meaningfully engage with local decision-making, anticipated forest products markets did not materialize, many selected species failed to thrive or became harmful invasives, and survivorship on government plantations was disappointing (Saxena, 1994; Saxena & Ballabh, 1995; Pathak, 1995; Saxena, 1992; Dove, 1995; Anderson & Huber, 1988; Robinson, 1998; Misra & Bhatty, 1990; Euroconsult, Deccan Consultants, and Om Consultants, 1992; Saigal, 2011b; Polk, 1992).However, longer run evaluations have shown that since the 1980s an increasing share of India's wood products have come from intensively managed farm-based forestry operations of the kind first widely promoted under the aegis of social forestry (Saigal, 2011a; Saxena & Shrivastava, 2017).

In the late 1980s, a new paradigm emerged: Joint Forest Management (JFM) promised to share decision-making authority and revenues from forests, thereby overcoming the power and participation imbalances that plagued earlier forestry programs (Joshi, 1999, 2000; Poffenberger & McGean, 1996). Forest officials would work together with elected user committees to plan for protecting and improving forests near villages, and eventual benefits from forestry (e.g., revenue from commercial harvests) would be shared with villagers using formulas that varied from state to state and over time. These new ideas coincided with an increased concern for ecological degradation, resulting in a ban on commercial timber harvest in many hilly states in India, including Himachal Pradesh, which begun in 1986 and extended several times before being made permanent, and a revised National Forest Policy in 1988 which emphasized ecological integrity and provision of ecosystem goods and services over production of industrial materials (Ministry of Environment and Forests, 1988). The Himachal Pradesh government issued the first JFM Notification in 1993, and the program was gradually expanded. In JFM, forest restoration would occur because villagers would invest in protecting forests now that they had shared responsibility for them, and some evaluations indicated successes along these lines (Baland et al., 2010; Somanathan et al., 2009). JFM projects often heavily emphasized tree planting—Fleischman (2014) reports that some World Bank funded JFM projects devoted 60% or more of their budgets to tree planting. Many other studies on JFM concluded that in

practice JFM was neither participatory nor effective (Lele & Menon, 2014; Springate-Baginski & Blaikie, 2007; Sundar et al., 2001). At the same time, while initially controversial within the forest department (Vira, 1997), forest departments increasingly advertise JFM as a core component of their everyday practice.

Since 2000 a new funder of tree planting activity has been Compensatory Afforestation (or CAMPA). Under the provisions of the Forest Conservation Act of 1980, any diversion of government-owned forest land (for example, to build a road, mine, or hydroelectric project) must be compensated. A series of court decisions and new laws led to the creation of a system whereby compensation monies are reinvested in forest restoration through tree planting (Afreen et al., 2011; Das, 2010; Saxena, 2019). The concept is that the loss of forests should be compensated by the restoration and/or creation of new forests which in theory provide equivalent benefits to society. Although the term "afforestation" is used in the name of the program, it does not appear that the term is used in the same way as in international forestry discourse, where afforestation specifically refers to the creation of forests where none existed previously—the few published accounts of CAMPA plantations often refer to plantations in areas of degraded and recently cleared forests (Ghosh, 2017; Parikh, 2018; Tambe et al., 2022; Valencia, 2022). The amount of money available for forest restoration through CAMPA is now quite large (Bhasme & Rai, 2018; Choudhury, 2019; Shrivastava, 2016, 2018).

India has also received donor and international funding to restore forests in the name of both climate mitigation and adaptation, and has made large-scale pledges to restore forests as part of a variety of global agreements; however, there are relatively few evaluations of these programs (Aggarwal, 2020). The Indian central government funds large-scale forest restoration through tree planting programs directly through the National Mission for Green India, launched in 2014, which aims to increase forest and tree cover in the country by 5 million hectares, and improve quality on another 5 million hectares by spending 460 billion rupees, approximately 6 billion US dollars (Jha, 2012; Davis & Robbins, 2018; Datta, 2016), as well as through domestic transfer payments to states (Busch et al., 2020; Busch & Mukherjee, 2017; Chaturvedi, 2016). There is substantial debate about the ecological and social appropriateness of these forest restoration activities that relate to the appropriateness of increasing tree cover in what may be naturally open ecosystems, the selection of appropriate species and restoration techniques, the social impacts of restoration, and tradeoffs between multiple restoration goals (Choksi et al., 2023; Gopalakrishna et al., 2022, 2024; Lahiri et al., 2023; Madhusudan & Vanak, 2023; Ratnam et al., 2011, 2016; Valencia, 2022). Unfortunately, baseline data about the pre-modern distribution of forests and open ecosystems in Himachal Pradesh are not available, so it is not possible to evaluate the appropriateness of restoration activities in the state from this standpoint.

India has ambitious plans to further increase forest restoration (Bhasme & Rai, 2018; Sethi, 2024), yet as this brief review shows, information is limited on past forest restoration programs in part because records have not been widely available. As we will show in this paper, the programs that have received attention from scholars—including social forestry, JFM, and CAMPA—account for only a small percentage of historical planting.

2 | METHODS

The Himachal Pradesh Forest Department collates records of plantation activity annually. Reports are gathered from local (range) offices, collated at the divisional and circle levels, and then reported to the state headquarters, where a consolidated set of figures is created and published as an "Annual Plantation Brochure." These figures reflect plantation activities undertaken by the forest department, which are overwhelmingly targeted towards government-owned designated forest land. They do not include the autonomous activities of farmers planting trees on their land, although they may include forest department projects that assisted farmers on private land.

We obtained these reports for every year from 1979 to 2015, except 1983 when a fire destroyed records, from the Forest Department's library in the state capital of Shimla in 2017. Reports were not available prior to 1979—we do not know if this is because of lost reports or because this kind of report was first created in that year. Aggregated national level data reported elsewhere indicates that the period from 1979 to present should capture the vast majority of historical tree planting (Ravindranath et al., 2007). We entered the data from these reports into spreadsheets manually. Data entered included the area planted statewide in each year for each distinct government program, as well as the number of individual trees and the species each year for each program. In addition to information on the species and number of trees planted, these reports contained information on the names of government programs that funded the planting. We also conducted supplemental searches for information specifically about plantations of eucalyptus, as the plantation brochures did not include this information.

These records were analyzed and interpreted in light of our research teams' extensive knowledge of forestry in the state gained through long-term research and practical experience implementing plantation programs. This allowed us to code whether each program identified in the records was funded by donors, the national government, or the state government, as well as what the goals of the program were, and the extent to which the program required formal participation by local people. Notably, programs that do not formally require participation may still involve participation by local people, but only those programs which were formally centered on local involvement, such as Joint Forest Management, were coded as participatory programs. Similarly, we coded species based on their utility as either commercial timber species or species whose primary utility is for local uses (e.g. as fuelwood, fodder, or for production of various other non-timber forest products). The coding of species primary uses was based on our team's extensive experience in forestry in the study region. A complete copy of the dataset, including our coding, has been archived in a publicly available data repository (Fleischman, Basant, et al., 2020).

Forest restoration potentially involves a wide variety of activities beyond tree planting. We choose to focus on tree planting for two reasons. First, there is substantial evidence that most official forest restoration programs in India have focused on planting trees (Davis & Robbins, 2018; Fleischman, 2014; Roy & Fleischman, 2022). Second, we have substantial data on tree planting, whereas systematic evidence on other forest restoration practices, such as working with local communities to protect and naturally regenerate forests, is not readily available.

Government records represent a powerful source of information about the nature of governmental processes and have been historically underutilized in South Asia (Hull, 2012a, 2012b). In contrast to studies of governmental processes based on interviews with officials, government records provide independent sources of information on governmental processes and thus avoid common source bias (Bruner, 2001; Favero & Bullock, 2015; Meier & O'Toole, 2013). However, as Hull (2012b) illustrates, government records are rhetorical documents that can be manipulated by officials to tell stories that may not reflect on-the-ground realities. Thus, government records need to be viewed not as objectively accurate, but rather as representations of rhetorical claim-making. They speak to the institutional and political context in which tree plantation projects are formulated, and the incentives and imperatives that forestry officials face in their implementation.

This being said, we believe that the plantation records we draw on in this paper are likely to be more accurate than many other Indian government records. Himachal Pradesh performs better than most Indian states in the delivery of public services (Dreze & Sen, 2002) and has an active civil society which provides for increased government accountability and transparency (Chhatre, 2008; Fischer & Ali, 2019). We have observed that the Himachal forest department keeps records more carefully than many other Indian states. Annual reports go through several rounds of internal review before being audited by the head statistician and senior Indian Forest Service officers in the office of Principal Chief Conservator of Forests of Himachal Pradesh. Since 2011, Himachal Pradesh has made efforts to digitize and make annual reports available online. All of these factors increase our confidence in the accuracy of government records.

Nevertheless, given the rhetorical importance of tree planting to forest management in India (Fleischman, 2014), officials throughout the forest bureaucracy may face pressure to falsify records to make their plantation activities appear more extensive. The annual plantation brochures are compiled in the state headquarters from reports that are sent in from local offices, which are in turn compilations from field records. We expect that at least some records are inflated to show more local activity than actually occurred. Because these records have never been georeferenced, independent verification is not feasible. However, we have no reason to think that this pressure has changed over the 40-year period under study. Thus, while we believe that the precise annual totals are likely inflated by an unknown amount, we believe that time trends are likely to be accurate. In the absence of georeferenced data on plantation locations which would allow satellite-based monitoring of vegetation changes after reported planting episodes, these records provide the best available picture of overall trends in tree planting activity.

3 | RESULTS

3.1 | Area planted and major funding sources

In all, government records show 845,188 ha of trees planted with 880,359,796 trees, between 1979 and 2018. For comparison, the Forest Survey of India reported in 2017 that 1,543,400 ha in Himachal Pradesh had forest cover with greater than 10% canopy cover, including orchards and agroforestry, while the land legally owned by the forest department ("recorded forest area") was 3,703,300 ha—this includes natural grasslands and extensive areas above the tree line and high-altitude deserts in the rain shadow of the Himalayas, all of which are owned and managed by the forest department (Forest Survey of India, 2017). These numbers indicate that as much as half of the state's forest cover may be the result of government-run plantations. We believe that the real number is substantially lower, as we have observed that many plantations overlap prior plantations, occur in areas with existing forest cover, and/or fail to thrive (Coleman et al., 2021; Rana et al., 2022). Replanting may occur because earlier plantations failed to establish forest cover or were harvested, or because new plantations aim to introduce diversity to established plantations. Fleischman (2014) suggests that intense pressure to meet planting targets may incentivize planting in inappropriate locations, such as existing dense forests. Throughout the time period under study, the density of recorded plantation remained close to the standard of 1200 trees/ha, an appropriate level for an intensively managed timber plantation but likely less appropriate for gap-filling, enrichment planting, or assisted natural regeneration techniques. Although commercial timber harvest has been banned in Himachal Pradesh since 1986 (HT Correspondent, 2014; Rana & Chhatre, 2016), illegal harvests may still lead to depletion that requires replanting.

As we can see in Figure 2, the annual area planted has varied significantly over the years. Planting levels were highest in the 1980s and 1990s, and appear to be declining in recent years. Except for 2006, every year since 2000 saw fewer trees planted than any year between 1979 and 2000, and there has been a declining trend since 2006. This decline is striking when compared to India's rhetoric about large-scale forest restoration programs at the center of its compensatory afforestation and climate programs which date back to the beginning of the Green India Mission in 2010 (Ministry of Environment and Forests, 2010).

One possible explanation for the decline in acreage planted is that international donor funding for forest restoration activities declined. We can reject this explanation because our data show that donor funding for tree planting activity never accounted for more than 30% percent of the total tree planting activity (see Figure 3). The first major donor aided forestry project in the state that we were able to locate solid records of was the "National Social Forestry Project," funded by

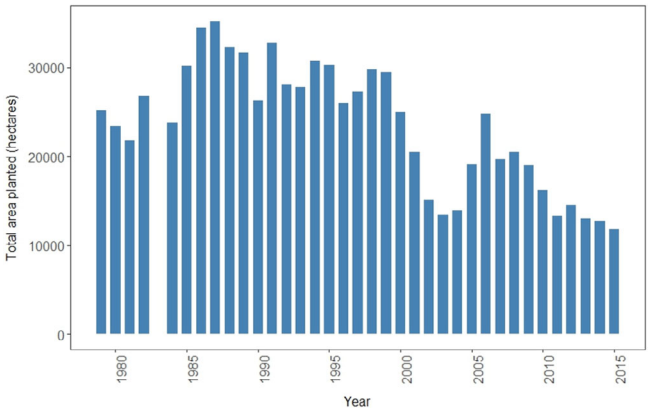

FIGURE 2 Number of hectares planted by the Himachal Pradesh Forest Department per year.

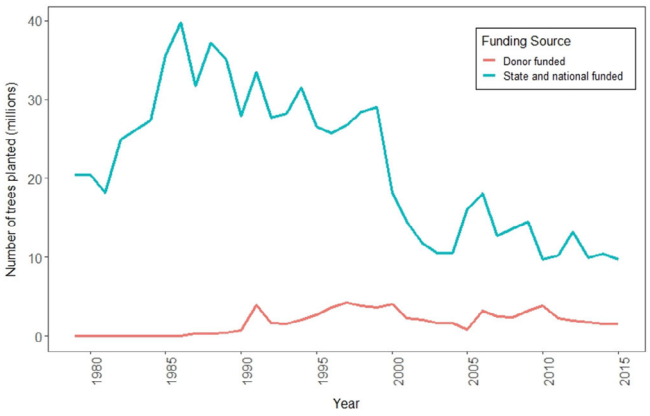

FIGURE 3 Proportion of trees planted through state and donor funding in Himachal Pradesh.

the World Bank in 1985 in four states including Himachal (The World Bank, 1985). As visible in Figure 4, funding increased in the 1990s, in conjunction with donor funding for Himachal Pradesh's JFM program, and has fluctuated since then. It is possible that some donor-funded projects have influenced other afforestation activities, as donor-funded projects sometimes contain support for technical development or trialing new techniques.

Other changes in the sources of funding for plantation programs have occurred. Although large-scale workfare programs (e.g., the National Rural Employment Guarantee program) have been used to fund plantation programs in some parts of India, workfare programs did not show up in our data as a significant source of funding. Some forest restoration through tree planting programs in the 1980s were developed with the idea of using plantations to generate employment, but this has not continued. However, compensatory afforestation has risen in importance since 2005, when funds for compensatory afforestation first became widely available (Ministry of Environment and Forests, Government of India, 2009a, 2009b). Since 2005, compensatory afforestation has accounted for between 1 and 6 million trees planted per year, fluctuating between 6% and 27% of total planting activity

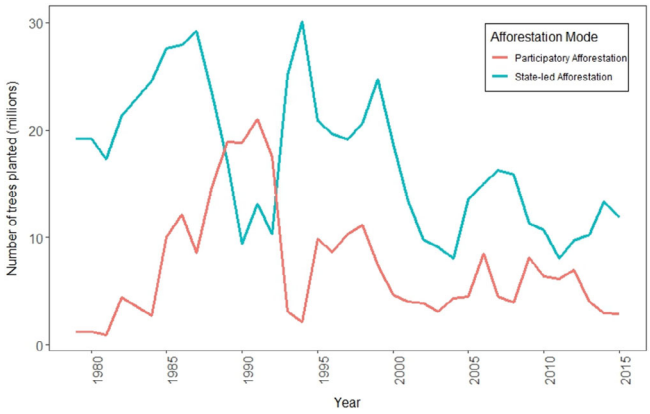

FIGURE 4 Number of trees planted by participatory and state-led forest restoration programs, 1979–2015.

during these years. Compensatory afforestation has been portrayed as a singular threat to forest-dependent people in India (Choudhury, 2019), but at least in Himachal Pradesh, it remains only one of many sources of funding for a tree planting program that is smaller than it has been historically and is primarily funded from other sources.

3.2 | Public participation in tree planting and shifts in species composition

While Joint Forest Management in India has received enormous amounts of attention in the scholarly literature, and although government officials often claim that most or all forestry activities are now carried out with the involvement of the community, Joint Forest Management does not dominate tree planting activity of the Himachal Forest Department. Except for a brief period from 1989 to 1993, more trees have been planted under state-led, non-participatory government programs than under participatory programs, and for most of the study period, state-led programs planted more than twice as many trees as participatory programs (see Figure 4). It is notable that the peak years of participatory forest restoration occurred prior to the official start of JFM in Himachal, perhaps reflecting Himachal's long history of community-engaged forestry that exists apart from high-profile government programs (Vasan, 2001, 2006). In addition, we note that the absence of a formal participatory program does not mean that local people did not influence program outcomes, as it is well documented that in Himachal Pradesh local people have a variety of formal and informal mechanisms for influencing government actions (Vasan, 2002; Pushpendra Rana & Chhatre, 2016; Fischer, 2016; Fischer & Ali, 2019; Chhatre, 2008).

However, examining the species planted reveals a shift towards locally preferred species. Of the 880,359,796 trees for which we found plantation records, only 69% included species information. Of those for which species information was provided, 85.7% belonged to five species: chir pine (*Pinus roxburghii*, 31.5%), khair (*Acacia*

catechu, 21.7%), deodar (*Cedrus deodara*, 20.5), robinia (*Robinia pseudoacacia*, known as black locust in its native range in North America and the only commonly planted non-native tree, 8.4%), and shisham (*Dalbergia sissoo*, 3.5%). The remaining 14.3% consisted of 18 other species all found in lower abundance, for a total of 23 commonly planted species, which are listed in Table 1. Anecdotally, we have heard of nearly 100 other species being planted by the forest department in the state; however, the forest department has not systematically recorded data on these species—perhaps, they are included in the 31% of all trees planted for which data were not available in the statewide plantation brochures. In addition to trees, the forest department also planted over 4.5 million grass tufts of improved fodder grasses.

Among the most widely planted species, both chir pine and khair have seen consistent sharp drops in their use over time, whereas the number of deodar have fluctuated, and Robinia planting rose rapidly in the late 1980s but has been low since approximately 2000 (see Figure 5).

Most less abundant species show fluctuations more resembling those of deodar than those of chir pine and khair, while few species have seen an increase. The diversity of trees planted across the state has increased over time, although this is driven by the decline in the planting of a small number of common species, rather than by an increasing number of overall species being planted. We calculated Simpson's Index of Diversity, Simpson's Reciprocal Index, Shannon

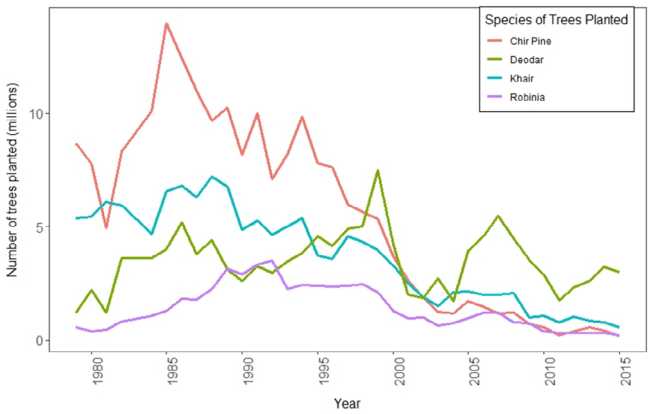

FIGURE 5 Change in importance of the four most commonly planted tree species in Himachal Pradesh.

TABLE 1 List of commonly planted species, with totals for the study period.

Local species name	Scientific name	Number planted	Percent of total
Not identified	Not applicable	272,126,626	30.8
Chir pine	*Pinus roxburghii*	191,881,693	21.7
Khair	*Acacia catechu*	132,038,409	14.9
Deodar	*Cedrus deodara*	124,857,231	14.1
Robinia	*Robinia pseudoacacia*[a]	51,218,122	5.8
Shisham	*Dalbergia sissoo*	21,115,084	2.4
Poplar	*Populus deltoides*[a]	13,443,877	1.5
Fir or spruce	*Abies pindrow; Picea smithiana*	11,875,933	1.3
Bamboo	*Dendrocalamus strictus; Dendrocalamus hamiltonii; Bambusa arundinacea*	10,436,031	1.2
Kail	*Pinus wallichiana*	10,029,460	1.1
Willow	*Salix* sp.	9,681,345	1.1
Kachnar	*Bauhinia variegata*	6,409,640	0.7
Lucinia	*Leucaena leucocephala*[a]	6,163,674	0.7
Banoak	*Quercus incana*	5,408,772	0.6
Grass tufts	Not applicable	4,582,461	0.5
Amla	*Emblica officinalis*	4,372,780	0.5
Daroo	*Punica granatum*	3,800,071	0.4
Ritha	*Sapindus mukorossi*	1,854,792	0.2
Drake	*Melia azedarach*	1,506,781	0.2
Walnut	*Juglans regia*	1,407,982	0.2
Jatropha	*Jatropha curcas*[a]	349,835	0.0
Teak	*Tectona grandis*[a]	157,497	0.0
Mulberry	*Morus alba*	74,797	0.0
Black cherry	*Prunus* sp.	39,246	0.0

[a]Species that are not native to areas in which they are widely planted in Himachal Pradesh (Sekar et al., 2015).

Diversity Index, and Shannon's Equitability, and all show an increasing trend. One interesting pattern was the sharp rise in the planting of jatropha (*Jatropha curcas*) beginning in 2008, returning to zero by 2012. Jatropha was heavily promoted as a biofuel feedstock during this time, with disappointing results (Baka, 2013, 2014, 2017; Biswas et al., 2010; Jain & Sharma, 2010).

The species for which we have records can be divided into two categories: those whose primary human use involves industrial scale extraction, which is managed by the forest department ("state interest species"), and those whose primary use involves extraction by local people for meeting livelihood needs ("community interest species"). In Figure 6, we present the change over time in the number of trees planted of these two categories. For example, chir pine, the most commonly planted species, is a state interest species: it is valued for commercial timber and resin production and has been widely propagated for this purpose (Kala, 2004; Tewari, 1994). However, it is less preferred for local domestic use because the wood makes smoky and sparky cooking fires, the needles are not palatable to domestic animals, and domestic timber consumption is limited. Pine plantations are associated with increased fire risk (Brown et al., 2011; Kumar et al., 2015; Naudiyal & Schmerbeck, 2017). The heavy duff and frequent fires created by pine plantations tends to crowd out the growth of grass and other trees, and is reportedly associated with the growth of unpalatable invasive species (*Lantana camara* and *Eupatorium adenophorum*). By contrast, species such as kachnar (*Bauhinia variegata*), jamun (*Syzygium cumini*), buel (*Grewia optiva*), and khirak (*Celtis australis*) are preferred by local communities because they provide good quality firewood and leaves that can be used as fodder for domestic animals, including sheep, cattle, and goats. Firewood and fodder are the most important uses of forest products by local people in Himachal Pradesh (Chakraborty et al., 2018; Gouri et al., 2004).

Figure 6 shows that planting of state interest species declined rapidly after approximately 2000, whereas planting of community interest species declined less, so that in the last decade, planting of state and community interest species is more or less equal, whereas before 2000 state interest species were planted almost twice as much as community interest species. This is not surprising given the downward trends in planting of the most common state interest species (chir pine) documented in Figure 5. However, this shift cannot be traced to any clear policy change. The most obvious policy change that should have affected the planting of state interest species was the green felling ban of 1986. If green trees cannot be felled, there is less incentive to plant timber species. Nonetheless, planting of state interest species remained high for another 13 years, until approximately the year 2000. One possible explanation for this lag is that it simply took time to reorient the plantation program. Trees that are planted are raised in nurseries for 2–3 years prior to planting, and thus some lag is to be expected. Foresters and their funders may have initially seen the green-felling ban as a temporary policy, and only shifted away from planting timber species after a decade had made clear that the ban would not be lifted. Alternatively, the shift may reflect more subtle political shifts, as increasingly empowered local governments and elected officials pressured the department to shift species composition.

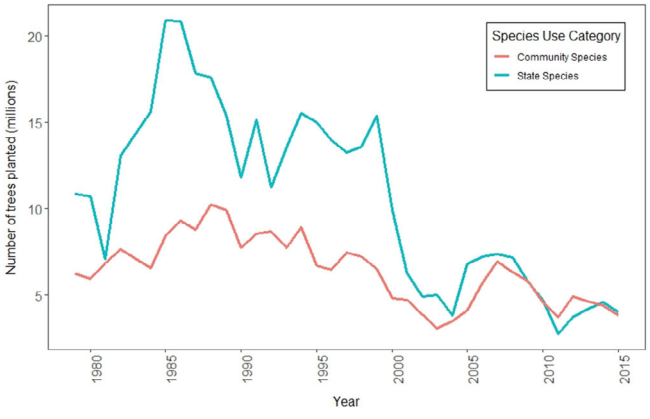

FIGURE 6 Number of trees planted: state versus community interest species. State species are those valued by the state for commercial production of timber or resin, whereas community interest species are those valued by local communities for locally important uses, including firewood, fodder, and medicinal plants.

A similar shift is the decline in planting Eucalyptus. Eucalyptus was widely planted throughout India as part of the social forestry programs of the 1980s, but its use was broadly criticized as it has high water demands but was not very useful to local people because of its poor quality for firewood and unpalatability for livestock (Saxena, 1994). It is still widely planted in some parts of India, most commonly on private lands as a commercial crop to supply pulp mills. Eucalyptus was not included as a species in any of the plantation brochures we reviewed; however, it was widely planted by the Himachal Pradesh Forest Department in the 1980s, and to this day one commonly observes mature Eucalyptus trees in the state. We conducted a supplemental search of forest department archives for information on historical Eucalyptus planting. We found that during the decade of the 1960s 17,102 ha were planted with Eucalyptus, with a total of 13,681,600 individual trees, or an average of 1,520,178 plants per year. We were unable to locate data from the 1970s, 1980s, or 1990s; however, limited records from Bilaspur circle, one of 13 forest circles in Himachal, indicated that 171,110 Eucalyptus trees were planted in 1989–90. Projecting from this very limited data point, we can speculate that Eucalyptus may have formed a very significant portion of the unreported species planted in this era—and thus may have been an important planted species in the era of maximal planting in our dataset. Considerable protest against Eucalyptus planting may explain why the forest department chose not to highlight Eucalyptus plantings in their annual brochures. However, these protests appear to have been successful: Relatively more complete data from the 2000s included records of only 30,493 Eucalyptus trees planted in the entire decade, and only 2735 trees for 2010–2018. Unfortunately, although mature Eucalyptus is not valued locally for firewood or fodder production, these exotic trees cannot be harvested because of the green felling ban in the state, and thus remain as an exotic disturbance on the landscape.

TABLE 2 Most productive tree planting programs in terms of acreage covered.

Program name	Number of years active	Area (ha)	Trees planted	Plantation density (trees/ha)	Last year active
River valley project scheme	24	60787.45	44,271,383	728	2010
Farm and social forestry	9	57282.43	66,269,071	1157	1989
Fuelwood and fodder program	20	49809.63	57,370,369	1152	2001
Plantations of quick growing species	19	47059.91	60,723,092	1290	2000
National social forestry (umbrella project)	3	38138.84	41,659,627	1092	1991
Introductory plantation of deodar, fir, spruce, and bamboos	10	28325.4	33,050,602	1167	1995
Integrated soil and water conservation in Himalayan region	10	27523.58	25,162,443	914	1989
Plantation under kandi project	10	26,423	15,873,700	601	2004
Enrichment plantation scheme	16	23791.07	19,173,332	806	2015
Afforestation in blank area	11	21647.42	23,600,291	1090	2015
Social forestry program	6	20,697	30,178,100	1458	2000
Compensatory plantation scheme	27	19914.1	23,974,752	1204	2015
Integrated watershed management in catchment flood-prone rivers in Indo-Gangetic basin	11	19837.75	16,635,662	839	1992
Economic plantation scheme	9	19490.71	27,586,219	1415	2000
Development of pasture and grazing land	34	19152.06	14,690,957	767	2015
Backward area sub-plan	20	19127.62	24,164,821	1263	2015
FDA samridhi yojna	7	18,186	14,113,100	776	2009
Protective afforestation, soil conservation and demonstration	17	16740.7	16,182,596	967	2015
Mid-Himalayan watershed development project	10	15948.77	16,556,210	1038	2015
Plantation under national social forestry program	1	15,451	15,871,900	1027	1992
Plantation under cat plan	9	14539.38	20,996,623	1444	2015
Sanjhi van yojna	16	13929.37	16,079,252	1154	2013

3.3 | The programs responsible for tree planting

We found 240 distinctly named programs or schemes in the government records of tree planting in Himachal Pradesh, responsible for planting between 0.5 and 60,787 ha, and running for between 1 and 27 years. Many of these distinct names may be the result of minor name changes in what are essentially identical programs—our review indicated at least 50 program names that were very similar to other programs and may simply represent slight changes to program names or content in different years. Furthermore, many programs may have substantially similar operations—for example, there were 14 distinct "catchment area treatment plans," which are plans prepared to improve the function of watersheds where hydropower infrastructure is built; however, while these plans operate in different locations, they may otherwise be quite similar. Unfortunately, we could not locate records with detailed information on these programs. Table 1 presents a listing of the names, areas, and numbers of trees planted under the 20 programs that planted the largest areas.

As we can see from Table 2, the most productive tree planting programs are quite varied. Fitting with the historical narrative in the introduction, several of the largest programs were most active in the 1980s and 1990s, and are explicitly social forestry programs, and/or have names that imply a close relationship to social forestry concepts (e.g., "farm and social forestry," "fuelwood and fodder program," "national social forestry," and "social forestry program"). Some more recent programs, such as the FDA samridhi yojna, were JFM programs. The longest running program, active during all the years for which we have data, is "development of pasture and grazing land." This is particularly perplexing because pasture and grazing land implies land with limited tree cover which is to be managed for the grazing needs of Himachal's many livestock herders (Rana et al., 2022; Saberwal, 1999). Yet while in 34 years this program was responsible for planting 678,579 grass tufts, presumably of improved fodder grasses, it also planted 1,063,808 unpalatable chir pine trees! It is striking that many of the programs do not have obvious relationships to social forestry, JFM, CAMPA, or climate mitigation and adaptation, suggesting that existing literature on Indian forestry programs may offer an incomplete picture of the nature of Indian forestry funding and programming.

4 | DISCUSSION AND CONCLUSIONS

Our review of historical records from Himachal Pradesh demonstrate that forest restoration has been a major activity of the state government since at least the late 1970s. In contrast to portrayals of forest

restoration as new or innovative (Chazdon & Laestadius, 2016; Mansourian et al., 2021), we find that forest restoration activities in Himachal peaked in the 1980s and 1990s. This is not unique to India—for example, Spain experienced a peak of forest restoration in the 1940s–1960s which is rarely discussed today in international forest restoration discourse but is readily apparent in the landcover of the country (Vadell et al., 2016). One reason current policy discourses have largely ignored these earlier efforts may be lack of awareness. Although evaluations of these activities were conducted, many of these evaluations were published in venues that the international scientific community does not have easy access to such as donor agency reports or books published by the Indian publishing houses, and these evaluations are framed using different language than contemporary restoration discourse—for example, focusing on supply of fuelwood or evaluation of "social forestry" or "JFM." Furthermore, many of these historical programs utilized techniques drawn from production forestry, which some modern restoration practitioners may view as inappropriate for restoration—yet the goals of these historical programs often emphasized many of the same concepts emphasized in contemporary restoration discourse, such as increasing forest cover, improving watershed function, contributing to rural livelihoods, and enhancing the delivery of ecosystem services, and so they should be understood as significant precursors to the modern restoration agenda. Site-specific knowledge may be needed to tease out the differences between these programs and locate evaluations that may inform design of future restoration.

In the case of Himachal Pradesh, our data show massive investment, yet limited evaluation of that investment or its impacts by either the state government or independent scholars. We are not aware of studies published prior to 2019 that evaluate the impact of restoration in the state. A flurry of studies published since 2019 have uniformly found disappointing impacts. Asher and Bhandari (2021) examined compensatory afforestation programs and found that their examined forest restoration projects had abysmally low survivorship and exacerbated land use conflicts with local communities. Ramprasad et al. (2020) found that forest restoration exacerbated land conflicts between pastoralists and the forest department and helped undermine pastoral livelihoods. Coleman et al. (2021) examined land cover changes over 40 years in a quasi-random selection of forest restoration planting sites and found that plantations did not even increase tree cover, although they did shift forest composition towards conifer species, which is not surprising given the prevalence of conifers in our species data.

The fact that forest restoration is extensive and that there is almost no independent evaluation that suggests positive consequences lead to several interesting research questions. First, have Indian policymakers altered programs in response to past failures? Our evidence suggests that Indian forest policymakers have made significant changes to forest restoration programs over the years. At a nationwide level, "social forestry" programs that emphasized government-run planting of firewood near villages were partially replaced by JFM in part because of trials that showed that JFM-type policies were more effective at conserving forests (A. Joshi, 1999, 2000; Poffenberger & McGean, 1996), although more recent programs such as CAMPA or forest carbon projects seem to be influenced more by legal judgements and donor agendas than by learning from the past. Within Himachal, we showed that planting of species associated with commercial production, such as eucalyptus and chir pine, has declined over time. Multiple factors may have contributed to this shift: the aftermath of the ban on commercial timber harvest, changing national policy discourses and donor priorities, shifts within the forest department itself, and pressure from local communities, who are increasingly empowered through elected local governments to influence the implementation of a wide array of government programs in Himachal (Personal communications, Dr. G.S. Goraya, retired Principal Chief Conservator of Forests, Himachal Pradesh Forest Department). We see these improvements as hopeful signs that Indian policymakers can improve practices, particularly in the context of the broader democratic deepening that occurred in Himachal Pradesh in this same period (Chhatre, 2008; Fischer, 2016; Fischer & Ali, 2019). Furthermore, the fact that this happened outside of the context of participatory forestry points to the potential role that broader democratic political processes, including local democracy and increased professionalization of bureaucracies, occurring outside of the formal realm of forestry programs, play in shaping forest policy.

However, we also see signs of rigidity in forest restoration programs. Examining recent plantation programs we see a continued focus on high-density tree plantings, often dominated by a small suite of easily propagated species, with limited involvement by affected communities. This is disappointing given evidence that forest restoration is often more successful when it uses practices such as applied nucleation and assisted natural regeneration using a diverse set of native species, and involving and responding to local community needs (Brancalion & Holl, 2020). Our informal observations are that Indian forest restoration programs are quite uniform, and little learning is being absorbed from other parts of the world that have achieved restoration successes, nor from the relative success of different programs within India. Fleischman (2014) suggested that tree planting practices in India may be valuable to foresters because they reinforce the discursive power of forest agencies, rather than for any substantive positive impacts on the ground, and our results seem consistent with this theory (see also Mosse, 2004). In light of this, the success of new initiatives such as international carbon markets and the new "Green Credits Scheme," (Sethi, 2024) will depend on whether local practices and incentives produce actual changes or reinforce existing, largely unsuccessful practices.

The large scope of planting in Himachal Pradesh over nearly 40 years supports analyses that find that plantation-origin forests are displacing natural origin forests in India (Puyravaud et al., 2010a). Although evidence from other studies suggest that many plantations fail, we also see evidence that planting practices shifted species composition towards chir pine and other conifers. These native conifers are associated with increased incidence of fire, lower biodiversity, lower human use values, and poorer provision of water services than forest types that they have displaced (Kala, 2004; Shahabuddin, 2018). A wide variety of legal and illegal forest uses,

including harvesting of timber, firewood, and fodder by local communities, as well as recently limited legal commercial timber harvests, are reshaping both planted and natural origin forests. At the same time, agroforestry on private farmland is expanding in many regions of the Himalayas, largely independent of the forest restoration efforts we document on government land. Further study is needed to understand how the interaction of human uses and planting is reshaping the Himalayan landscape.

Forest restoration is being presented to the international community as a new and innovative tool for achieving multiple objectives, yet in Himachal Pradesh we see that a limited set of practices—high density planting of a small number of easily propagated tree species—has dominated a wide variety of forest restoration programs that used distinct justifications and had distinct goals. These practices do not appear to be particularly effective; however, they are already being adapted to meet new goals related to carbon storage and forest restoration (Sethi, 2024). This does not bode well for the success of these new programs. However, we see some positive transformations in restoration practices, such as the incorporation of more diverse species, which suggests that forest restoration programs that are situated within a broader context of democratic societies which provide multiple opportunities for accountability and improvement may be more likely to meet diverse needs.

AUTHOR CONTRIBUTION

Forrest Fleischman: Design, data collection, data analysis, writing. **Pushpendra Rana:** Design, data analysis, writing. **Harry Fischer**: Design, writing. **Vijay Ramprasad:** Design, data collection, writing. **Vijay Guleria:** Data collection. **Rajesh Rana:** Data collection.

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CONFLICT OF INTEREST STATEMENT

Pushpendra Rana is an employee of the Himachal Pradesh Forest Department, which is the primary organization whose activities are described in this paper.

DATA AVAILABILITY STATEMENT

All data used in this paper has been archived and is available for free download at https://conservancy.umn.edu/handle/11299/214088.

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