

From voluntarism to incentivised forest fire management in Nepal: Evidence on labour costs and risk perceptions from four CFUGS

Manish Shrestha^{1,*}, Dipesh K.C.², Rahul Karki¹, Madan Bashyal¹

¹*ForestAction Nepal, Ashram Road, Bagdol, Lalitpur, Bagmati, Nepal*

²*Ministry of Industry, Tourism, Forest and Environment, Birendranagar, Surkhet, Karnali, Nepal*

*Corresponding author: manish.shrestha1979@gmail.com

Abstract

Nepal's community forestry model, recognised for decentralised governance, has long relied on voluntary collective action. Rural out-migration and rising labour opportunity costs are weakening this model as climate-driven forest fire risks intensify. This study examines a shift toward incentive-based management through a pilot program that introduced wages, personal protective equipment (PPE), and technical training across four Community Forest User Groups (CFUGs). Using a convergent mixed-methods design, the study analysed quantitative data from 87 participants, along with 24 key informant interviews and 8 focus group discussions. McNemar's chi-squared and Wilcoxon signed-rank tests show that although daily wages were only 6.1 per cent above market rates, the effective hourly wage premium reached 32.01 per cent. This higher valuation encouraged participation among households previously excluded due to the opportunity cost of unpaid labour. Technical knowledge scores improved significantly ($p < 0.001$). However, a clear "risk gap" emerged. Participants preferred institutional insurance over PPE, reflecting concern about income loss from injury. Willingness to participate was assessed through stated preference scenarios with and without wage incentives, not observed behaviour over time. Governance challenges remain. Risks of elite capture persist, and gender barriers limit participation. Women formed 55 per cent of trainees but remained underrepresented in fire response leadership. Overall, the findings from this pilot study suggest that the long-term viability of community forestry in transitioning economies depends on a gradual shift from "free labour" assumptions toward more incentive-compatible models. These results provide indicative evidence to inform future research and policy design in similar contexts.

Keywords: Community forestry, Forest fires, Labour opportunity cost, Incentive-based management, Collective action sustainability

INTRODUCTION

For over four decades, Nepal's community forestry program has set the global standard for decentralised natural resource management, often praised as the "gold standard" for balancing ecological restoration with local livelihoods (Ostrom, 1990; Agrawal and Ostrom, 2001). This shift from state-led to community-driven governance was achieved by devolving a bundle of

rights to local Forest User Groups (FUGs), effectively reversing the "tragedy of the commons" through localised collective action. Historically, this success depended on a subsistence-oriented peasantry with low labour opportunity costs and strong voluntarism. Under these conditions, households assumed the demanding tasks of monitoring, patrolling, and silvicultural management as part of their routine collective duties (Adhikari and Lovett, 2006). The

institutional design aligned labour availability, resource dependence, and collective incentives within a relatively closed, subsistence-based socio-economic system (Ghimire and Lamichhane, 2020; Libois *et al.*, 2022).

However, a critical structural shift has emerged. This study focuses on two core analytical constructs: (i) a “wage incentive gap,” referring to the divergence between rising labour opportunity costs and existing institutional compensation mechanisms, and (ii) a “risk-gap,” referring to the divergence between risk exposure and available risk mitigation or transfer mechanisms. Distributional fairness is treated throughout the study as a cross-cutting interpretive concern linked to participation, inclusion, and governance, rather than as a standalone analytical construct defined *ex ante* and guiding the empirical analysis. Ecological improvements, including increased forest biomass, have raised both the value of forest resources and their exposure to fire risk, while institutional arrangements have not adapted to changing socio-economic conditions such as labour scarcity and market integration (Shrestha *et al.*, 2025). At the same time, outmigration and livelihood diversification have reduced the availability of local labour, weakening the voluntaristic base of collective action (Poudyal *et al.*, 2023; Laudari *et al.*, 2024). As a result, participation in fire management is increasingly shaped by wage expectations and risk considerations rather than norm-based obligations. This study examines how these two constructs shape participation in community-based fire management within selected cases.

A fundamental driver of this transition is the reordering of rural labour economies. In the past, the implicit wage for forest management was derived from subsistence benefits such as fuelwood and fodder (Ghimire and

Lamichhane, 2020; Libois *et al.*, 2022). As rural households diversify income sources, with remittances contributing over 25 per cent of national GDP (Sunam, 2020), labour allocation has shifted toward higher-return wage opportunities. This has reduced the residual labour available for collective forest management. Households now evaluate participation in fire management against prevailing wage rates, making unpaid labour economically unattractive. The erosion of subsistence-based incentives has therefore created a clear mismatch between institutional expectations and household decision-making.

This mismatch is best understood as a wage incentive gap, where existing institutional arrangements fail to compensate for rising opportunity costs of labour. Non-participation reflects rational labour allocation rather than declining social cohesion. Evidence from community forests shows that users increasingly prefer to pay fines instead of contributing labour, indicating a shift toward monetised decision-making. Within this study, the wage incentive gap is operationalised through comparisons between prevailing wage rates, project-based incentives, and stated willingness to participate under different incentive conditions. At the same time, participation is shaped not only by wages but also by risk exposure. Fire management involves significant physical danger, yet existing interventions have largely focused on providing equipment such as fire-swatters and basic protective gear. This study conceptualises a “risk-gap” as the divergence between risk mitigation measures, such as Personal Protective Equipment (PPE), and risk transfer mechanisms, such as insurance, which participants increasingly prioritise. In the absence of insurance or formal safety nets, households face the possibility of severe economic loss from injury or death during firefighting. This implicit risk cost raises the



effective price of labour beyond what daily wages alone can offset, directly influencing participation decisions. In the empirical analysis, this construct is examined through participant perceptions and stated preferences regarding PPE and insurance mechanisms.

Together, the wage incentive gap and the risk-gap define the emerging constraints on collective action in community forest fire management. Addressing these gaps requires moving beyond voluntarism toward structured incentive systems that combine wage payments with risk coverage. In this context, this study addresses three questions: (1) the extent to which wage-based incentives offset rising opportunity costs of labour, (2) how participants perceive and prioritise risk management mechanisms, particularly PPE relative to insurance, and (3) how financial incentives are associated with patterns of participation and perceived equity within Community Forest User Groups (CFUGs).

METHODOLOGY

This study used a convergent mixed methods design to examine incentive-based forest fire management in Nepal’s community forestry. The qualitative component focused

on community perceptions, motivations for participation, and institutional challenges related to fire management, while the quantitative component assessed participation rates, wage incentives, and changes in knowledge levels associated with fire management activities. The convergent design enabled triangulation of findings and strengthened internal validity by comparing results across data sources (Creswell and Plano Clark, 2017). This approach addressed research questions beyond the scope of single-method studies and aligned with established guidance for socio-ecological and policy-oriented research in forestry and natural resource management (Hong *et al.*, 2017). To strengthen data integration, each research question was addressed using both quantitative and qualitative evidence, as shown in Table 1, and integration occurred at the interpretation stage, where findings were compared and used to explain convergences and divergences across data sources.

Study sites

The study was conducted in four purposively selected CFUGs in the Sindhupalchowk and Dolakha districts of Nepal. These sites were selected as critical cases because they

Table 1: Integration of research questions, data sources, and analytical approach

Research Question	Analytical Focus	Quantitative Evidence	Qualitative Evidence
RQ1. Wage incentives and participation	Effect of incentives on labour participation	Willingness to participate with and without incentives; wage comparisons	FGDs and KIIs on motivation, labour allocation, and incentive preferences
RQ2. PPE versus insurance (risk gap)	Risk mitigation and participation behaviour	Survey responses on safety perception and participation motivation	FGDs and KIIs on risk perception, safety concerns, and stated preferences
RQ3. Equity and participation	Inclusion across gender and caste groups	Gender and caste disaggregated participation data	FGDs and KIIs on fairness, inclusion, and access to incentives

represent the intersection of high ecological fire risk and high socio-economic transition. Site selection was based on three criteria: (i) documented exposure to recurrent seasonal forest fires based on local forest office records and community reports, (ii) evidence of high out-migration and reduced local labour availability, and (iii) proximity to local labour markets influencing wage expectations. This purposive sampling allows for an intensive examination of the pilot intervention “*Fostering community-led forest fire management in Himalayan regions of Nepal*”. These criteria provide indicative justification but do not establish that the sites are fully representative of all fire-prone or transitioning regions in Nepal. Figure 1 shows the study sites.

Study participants

The study involved two groups of participants. (1) Community stakeholders: Members of CFUGs involved in the pilot intervention. These participants engaged in fire prevention, forest management operations such as thinning, pruning, and fire line construction, and training on forest fire prevention and response. (2) Institutional stakeholders: Representatives from provincial, district, and local governance bodies responsible for forest fire coordination, monitoring, and policy implementation. These included officials from the provincial Ministry of Forest and Environment, divisional forest offices, district administration, local governments, Federation of Community Forestry Users Nepal (FECOFUN), and CFUG leadership structures.

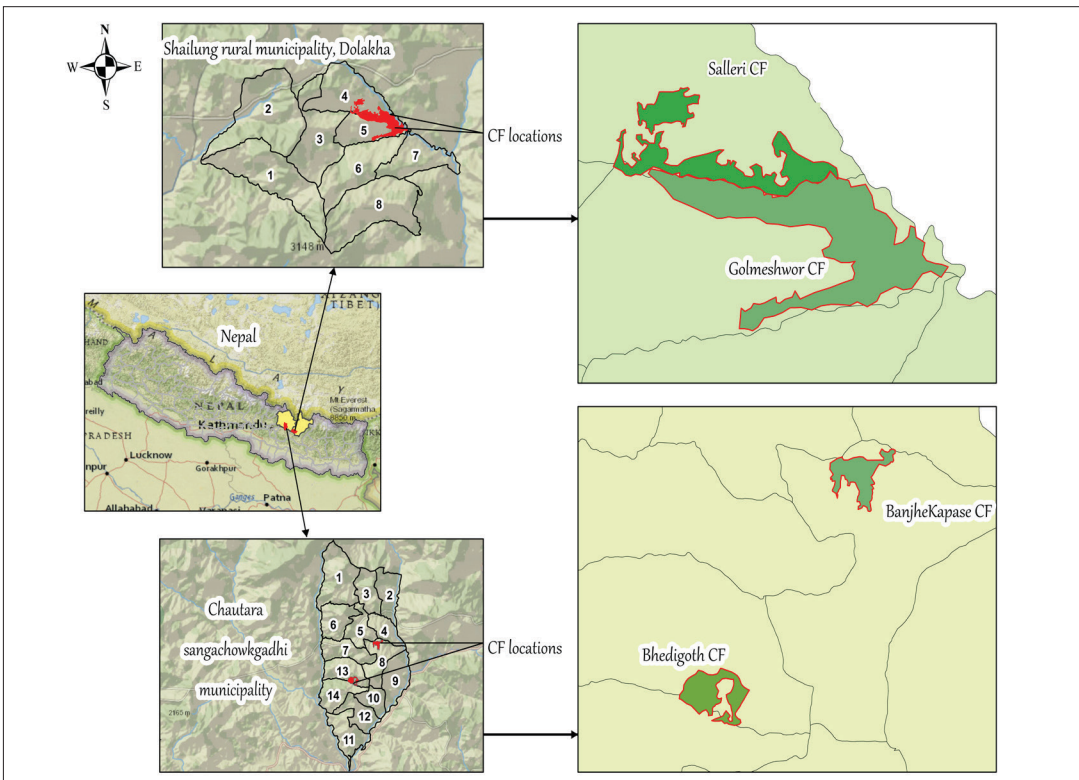


Figure 1: Study sites

CFUGs were selected based on their involvement in the pilot project and exposure to incentive-based fire management measures. Participant selection followed purposive criteria linked to direct participation in fire management activities and decision-making roles. The absence of a counterfactual group and the purposive selection of four CFUG limit causal inference and generalisability. Findings should be interpreted as context-specific insights applicable to similar high out-migration and fire-prone settings. This sampling approach prioritises information-rich cases but may over represent individuals already engaged in intervention, thereby limiting the inclusion of non-participants or dissenting perspectives.

Data collection

Data collection combined focus group discussions (FGDs), Key Informant interviews (KIIs), and semi-structured questionnaire surveys. The study conducted eight FGDs, with two FGDs in each selected CFUG comprising 8-10 participants, to capture site-specific fire risks, local practices,

and experiences with incentives across all intervention areas, while allowing comparison among user subgroups and supporting thematic saturation at the community level. In addition, 24 KIIs were carried out as shown in Table 2, selected based on formal roles, technical responsibilities, and oversight functions, ensuring representation across governance levels and saturation on issues related to institutional capacity, coordination, sustainability, and policy gaps. The quantitative component included 87 semi-structured questionnaire surveys administered to CFUG members engaged in fire prevention activities and training, targeting active participants exposed to wage incentives, equipment provision, and capacity building measures, and enabling assessment of participation levels, perceived opportunity costs, and changes in knowledge associated with incentive-based engagement. The same respondents contributed to both pre- and post-training knowledge assessments. The post-training assessments were administered immediately after completion of the training sessions, capturing short-term knowledge gains rather than long-term retention.

Table 2: Details of key informants

Type of informant	Number
Provincial Ministry of Forest and Environment, Bagmati Province	2
District Administrative Officers	2
Divisional Forest Officers	2
Local Government Staffs	4
FECOFUN members	4
CFUG Chairpersons	4
Forest Fire Response and Prevention Sub-Committee Members	4
Cluster-level Committee Members for Fire Prevention and Response	2
Total	24

Interview procedures and ethics

A semi-structured questionnaire was developed to examine participants' perceptions on wage-based incentives from project implementation sites. The questionnaire was designed based on a review of the literature on different incentive-based mechanisms in community-based fire management and refined through consultation with forestry and economics experts to ensure contextual relevance. The questionnaire included both closed-ended and open-ended questions to capture both qualitative and quantitative insights. In order to make sure the respondents could effectively explain their viewpoints, the interview was conducted in Nepali.

FGDs and KIIs were conducted primarily in the latter half of 2025 A.D. KIIs were selected purposively based on institutional roles and experience in forest fire management. All participants provided informed consent prior to data collection. The study followed standard ethical procedures, including informed consent, voluntary participation and anonymisation of responses. Anonymity was ensured through participant coding, for example, KII 1 to KII 24. Quotes in the results section identify the respondent type (e.g., "CFUG Chairperson, Dolakha" or "DFO Officer, Sindhupalchowk"). Quotations in the results section identify respondent categories without revealing personal identities. Formal institutional ethics approval was not obtained, which is a limitation. However, all participants were informed about the purpose of the study. All KIIs and FGDs were audio-recorded, transcribed verbatim in Nepali, and subsequently translated into English for analysis. During FGD, semi-structured discussion guides were employed to allow the participants to articulate detailed and context-specific insights while maintaining consistency and comparability across sites (Krueger, 2014).

Data analysis

Quantitative data management and analysis

Data were entered in Microsoft Excel 2019 and analysed in R version 4.4.2 (R Core Team, 2025). Survey data were analysed using descriptive statistics, including frequencies and percentages, to summarise participation patterns, perceived opportunity costs, and preferences regarding incentives. The wage premium of 6.1 per cent was calculated by comparing the project wage rate (NPR 800 per day) with the official minimum wage benchmark (NPR 754 per day) issued by MoLESS (2025), using the formula: $[(800 - 754) / 754 \times 100]$. The hourly benchmark was calculated using the official minimum daily wage of NPR 754 divided by the standard 7.5-hour workday commonly applied in national labour guidance and practice ($754/7.5 = 100.53$, rounded to NPR 101). Though this benchmark may not fully reflect local labour market conditions or actual opportunity costs in the study sites. Therefore, the estimated premium should be interpreted as indicative rather than a precise measure of local wage advantage.

Knowledge assessment

A composite knowledge index (0–3) was created by summing binary scores (yes=1; no=0) across three domains: evacuation, tool use, and safety awareness. This approach aligns with established practices for quantifying knowledge outcomes (Cameron and Trivedi, 2010; Deaton, 2019). Changes in knowledge were assessed using a paired non-parametric Wilcoxon signed-rank test, consistent with guidance for repeated-measured data (Siegel and Castellan, 1988; Wilcoxon, 1992). Five pre-training and one post-training observations contained missing values. The paired Wilcoxon signed rank test

was conducted using only complete cases, resulting in a final paired sample size of $N=81$. Indices were defined as:

Pre Knowledge Index = Pre Knowledge Evacuation + Pre Tool Knowledge + Pre Safety Awareness

Post Knowledge Index = Post Knowledge Evacuation + Post Tool Knowledge + Post Safety Awareness

Willingness to participate analysis

The project participants' survey data included two questions measuring respondents' willingness to participate in forest management and fire prevention activities under two conditions: (i) without monetary incentives, assuming access to training and safety materials, and (ii) with wage incentives. Variables were renamed as "willingness without incentives" and "willingness with incentives" for clarity. Responses were recoded into binary values (yes = 1; no = 0), enabling paired comparison across conditions.

The 2*2 contingency table (provided in Appendix 1) was constructed to summarise changes in willingness, capturing four response patterns: willing to willing, willing to unwilling, unwilling to willing, and unwilling to unwilling. McNemar's chi-squared test was applied to evaluate whether wage incentives significantly influenced willingness, with an exact version without continuity correction used to strengthen inference given the sample size and distribution of discordant responses (McNemar, 1947; Agresti, 2019). The McNemar test compares stated willingness under two hypothetical conditions, not observed behaviour before and after an intervention. The second condition includes a bundle of incentives (wages, training, and PPE). Therefore, results should be interpreted as reflecting the combined effect of these elements rather than wages alone.

Qualitative data analysis

Qualitative data from FGDs and KIIs were coded and managed using Taguette (Rampin and Rampin, 2021). The analysis followed a six-stage thematic procedure outlined by Naeem *et al.* (2023) covering data familiarisation, initial coding, theme identification, theme review, theme definition, and reporting.

A hybrid coding strategy was employed. A deductive approach guided by a predefined coding framework (Appendix 2) was first applied followed by iterative refinement through inductive identification of emergent themes. To improve transparency, two researchers independently coded approximately 25 per cent of the transcripts. Coding outputs were subsequently compared, and discrepancies were resolved through iterative discussion until consensus was reached. Although formal inter-coder reliability statistics were not calculated, this reconciliation process strengthened consistency in code application. Final themes were generated through repeated comparison across codes, transcripts, and data sources, with continuous refinement to ensure internal coherence between codes and higher-order themes. Illustrative excerpts from FGDs and KIIs were used to validate theme construction by explicitly linking empirical statements to corresponding codes and thematic categories.

Stakeholder engagement was further differentiated into direct and indirect forms to capture variation in levels of participation and involvement across actors. Consistency checks were conducted throughout the analytical process to maintain alignment between raw data, codes, and emergent themes. Given the qualitative-dominant design, findings are interpreted as explanatory and perception-based, without inference

of causal relationships. While dominant patterns indicated broad support for incentive-based approaches to forest fire management, divergent perspectives were also identified. A subset of respondents raised concerns regarding potential dependency on wage-based incentives, possible erosion of voluntary participation, and unequal distribution of benefits. These contrasting views were retained to ensure a balanced and comprehensive interpretation of stakeholder perceptions.

RESULTS

Wage incentives and community participation in forest fire management

Participation in forest fire management increased following the introduction of wages, relative to earlier seasons when activities relied primarily on voluntary labour by a small group of regular participants. During the intervention period, approximately 20 individuals per CFUG engaged daily during the pre-fire season, based on the reports from FGDs and KIIs rather than systematic baseline records. As no consistent pre-intervention participation counts were available, this comparison should be interpreted as perception-based rather than a direct before-and-after measurement. The daily wage provided for forest fire management across the four CFUGs is uniform at NPR 800 per day. When compared to the prevailing labour daily wage rate (NPR 754), the incentive for forest fire management work was 6.1 per cent higher. However, the incentive structure changes when adjusted for actual labour time. Field observations show that fire management work requires approximately 6 hours per day on average. Based on this, the effective hourly wage under the project is NPR 133, compared

to the statutory hourly benchmark of NPR 101 derived from national labour standards. This results in an effective hourly wage premium of 32.01 per cent. This difference highlights that the incentive strength is more accurately reflected at the hourly level rather than the daily rate. The total number of paid workdays also varies across CFUGs, with Golmeshwor recording 28 days, Salleri 26 days, Bhedigoth 23 days, and BanjheKapase 32 days.

FGDs documented changes in participation patterns. FGDs confirmed that the wage incentive reduced the burden of choosing between household subsistence and forest protection. For poorer households dependent on casual labour, respondents described the wage incentive as an important factor shaping their willingness to participate. One participant noted, “If I receive the wages for the forest management works, then I can contribute daily. It’s easier and less labour-intensive in comparison to our prevailing daily labour work in the construction of houses and so on.” (FGD, Golmeshwor CFUG).

Key informant interviews confirmed that wages increased participation during the project year, but raised concerns about continuity:

“We managed to pay wages this year with donor support, but without a regular budget, we cannot guarantee it in the future.” (KII, Bhedigoth CFUG)

Provision and coverage of Personal Protective Equipment (PPE) and its role in voluntary participation

Across four CFUGs, 40 PPE sets were distributed, averaging 10 per group, covering 45 per cent of active fire management participants. This estimate is based on an



approximate total of 20-22 active participants per CFUG reported during the intervention period, yielding an estimated denominator of 80-88 individuals across sites. As participation varied across days and activities, this coverage rate should be interpreted as indicative rather than exact.

FGDs indicate that PPE improved perceived safety and confidence among participants. A participant noted:

“Before we used to go in with only leaf twigs and branches. With jackets and helmets, we feel safer, even if not everyone has them.” (FGD, BanjheKapase CFUG)

Some FGD participants also emphasised the need for insurance for fire responders, noting, “We cannot predict the impact of fires, and fire behaviour is very tricky; only those who are involved in the response activities know how dangerous the fires are in a real-life scenario. So, these PPEs don’t motivate us to engage in forest fire response activities. If there were a provision of insurance mechanisms, if there were any accident in the field, we can feel secure that the insurance can make or sustain our livelihood.”

Key informants noted that while PPEs are important for safety, they alone do not drive participation. One of the key informants stated:

“PPE is essential, but it is not enough to motivate participation on its own. Without wages or other support, the gear alone will not sustain community participation.” (KII, District Forest Office, Sindhupalchowk)

Training participation, and changes in knowledge practices and roles in community fire response

Training significantly increased participant knowledge related to forest fire prevention and response. The pre-training knowledge index ranged from 0 to 3, with a median value of 2 and a mean of 1.93. These scores reflect a partial understanding of evacuation procedures, tool operation, and safety principles. Five observations were excluded due to missing values. After training, the distribution shifted upward. The post-training knowledge index had a median of 3 and a mean of 2.78. 75 per cent of participants attained the maximum possible score. Only one post-training observation contained missing data. The Wilcoxon signed rank test confirmed a statistically significant increase in knowledge scores ($W = 1445.5$, $p = 2.295e-10$). These results indicate short-term improvement in reported knowledge and core competencies across participants immediately following the training sessions.

Qualitative findings from FGDs align with the observed quantitative gains. Participants described a shift from informal and experience-based fire response toward more structured and safety-oriented practices. One participant reported:

“Before, we thought fire was only about beating flames with green branches. Now we learned the importance of PPEs and how to use the forest fire tools.” (FGD, BanjheKapase CFUG)

While post-training scores indicate immediate gains in knowledge and confidence, KIIs

further contextualise the durability of observed knowledge gains. One key informant stated, “One training is not enough. People forget, and new members join every year.” (KII, Forest Fire Response and Prevention Sub-Committee Members). These findings signal the limits of one-time capacity building in maintaining the value of unpaid volunteer labour over time.

Training activities reached 87 participants across four CFUGs. Table 3 presents participation by gender and caste/ethnic

group. Women accounted for 55.17 per cent of trainees. Dalit participation remained low at 19.54 per cent. Dalit participation at 19.54 per cent should be interpreted with caution, as no consistent benchmark on overall CFUG membership composition or ward-level population shares was available for comparison. Participation levels varied across sites, with some CFUGs showing higher representation. There, this figure reflects sample composition rather than a definitive measure of underrepresentation.

Table 3: Training participation by CFUG, gender, and caste group

CFUG Name	Total Participants	Women (%)	Dalit (%)	Janajati (%)	Other Castes (%)
Golmeshwor CFUG	21	7(33.33)	2 (9.52)	1 (4.76)	18 (85.71)
Salleri CFUG	22	15(68.18)	0 (0.00)	14 (63.63)	8(36.36)
Bhedigoth CFUG	21	13 (61.9)	15 (71.42)	0 (0.00)	6(28.57)
BanjheKapase CFUG	23	13(56.5)	0 (0.00)	14(60.8)	9 (39.1)
Total/Average	87	48 (55.17)	17 (19.54)	29 (33.33)	41 (47.12)

Despite overall gains, qualitative data highlight differences in how knowledge is translated into roles during fire response. Women participants reported increased confidence but limited leadership during active fire response:

“The training was useful, but during fire events, men still take the lead. We are expected to watch from behind.” (FGD, Bhedigoth CFUG).

Additional examples from FGDs indicate that women were often assigned supportive roles such as carrying water, managing logistics, or observing from safer locations, while decision-making during active fire suppression, such as directing fire lines or coordinating response teams, was typically led by men.

Impact of incentives on community participation in forest fire management

The project participants’ responses showed limited willingness to engage in forest fire management on a voluntary basis. When the same respondents assessed participation under conditions including formal training, personal protective equipment, and daily wages, willingness increased sharply. McNemar chi-squared analysis of paired responses confirmed a significant shift in perceptions ($\chi^2 = 23$, $df = 1$, $p = 1.62 \times 10^{-6}$). No respondents shifted from willing participation under the non-incentive condition to unwilling participation under the bundled-incentive condition, while 23 respondents shifted from unwilling



to willing participation. Figure 2 showcases the changes in willingness as per Gender, Education level, and types of occupation the stakeholders are engaged in.

FGDs and KII reinforced these patterns. Participants identified wages and material support as primary motivators. Discussions indicated that earlier reliance on unpaid labour limited participation to a small group of committed individuals, whereas the introduction of wages expanded engagement across age and gender groups. One participant noted, “When we worked for free, only a few elders came. With wages, more youth and women are also willing to join.” (FGD Participant, Salleri CFUG).

Another participant emphasised the symbolic value of incentives, stating, “Volunteering felt like an obligation, but with payment, we feel respected.”(FGD Participant, Golmeshwor CFUG).

At the same time, concerns related to fairness and equity emerged across multiple sites. Participants reported that access to wage-based work and distribution of protective equipment were not always perceived as transparent and inclusive. As one respondent observed, “The same families get chosen for wage work each time. Others are ignored.” These perceptions indicate that while incentives increased willingness to participate overall, their distribution shaped how such

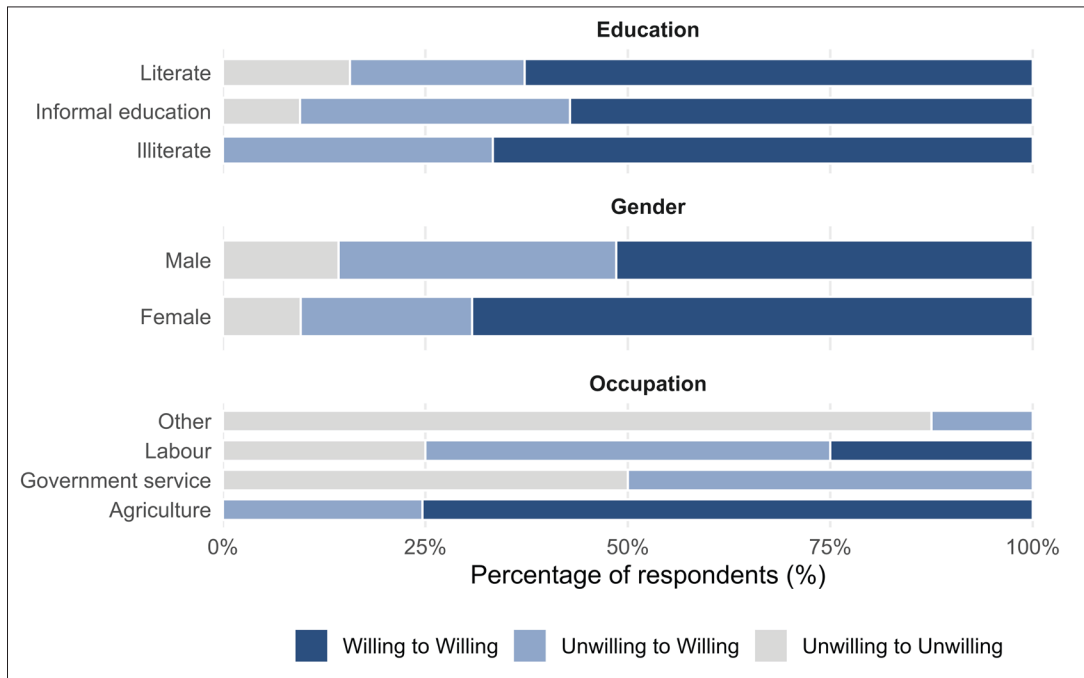


Figure 2: Proportion of respondents indicating willingness to participate under two stated conditions (without incentives and with bundled incentives). Subgroup breakdowns are shown by gender (Male n = 35; Female n = 52), education level, and occupation categories. The figure displays proportions based on the total number of respondents within each subgroup and illustrates changes in stated willingness rather than actual participation behaviour or longitudinal transitions. Sample sizes for each subgroup category are presented directly within the figure panels.

programs were evaluated at the community level. Questions regarding the sustainability of incentive-based fire management were also prominent. Participants expressed uncertainty about the continuation of wages and external support, and several linked future participations to the reliability of funding mechanisms. One focus group participant stated, “This year we had support, but what about next year. If wages stop, people will stop coming.” (FGD, Banjhekapase CFUG). Others pointed to internal CFUG financing as a possible pathway for continuity, noting, “We cannot always depend on donors. If our CFUG fund pays, then maybe it will last.” (FGD, Golmeshwor CFUG).

Institutional and policy dimensions of incentive-based forest fire management

KIIs provided additional insights into the institutional and policy dimensions, highlighting the three main dimensions: institutional sustainability, governance and equity, and policy gaps.

Institutional sustainability

Leaders emphasised the difficulty of maintaining wage payments without external resources. While acknowledging their effectiveness, they highlighted the limits of CFUG funds.

- “Wages attract people, but our community fund is too small to cover this every year.” (KII, CFUG Chairperson, Bhedigoth CFUG)
- “Unless government allocates a budget for fire control, we cannot sustain wage payments.” (KII, CFUG Secretary, Salleri CFUG)

- “Our forests do not have the provision for timber harvesting and trade as the timber value of pine species is not good in the current market, and we cannot adopt any other agroforestry practices as division forest officers prevent us from doing so. As another option to gain quick incentives, the conversion of pine forests into other mixed forests and the adoption of agroforestry practices could be considered.” (KII, Forest fire Cluster member)

Governance and equity

Local government officials and DFO representatives raised concerns about transparency in distributing wages and PPE. They stressed the need for clear criteria to avoid elite capture.

- “Payments are helpful, but if leaders select only their relatives, the community spirit is damaged.” (KII, District Forest Officer)
- “Incentives must be linked to fair rotation and inclusion of women and marginalised households.” (KII, Shailung rural municipality officer)

Policy gaps

Informants repeatedly noted that while Nepal’s community forestry policy framework recognises voluntary contributions, it does not formally address paid labour for fire management. This gap undermines the institutionalisation of incentive models.

- “Policies talk about volunteer mobilisation, but they do not mention how labour can be valued or paid.” (KII, District Forest Officer)



- “We need clear guidelines so that community funds, donor support, and government programs can work together.” (KII, Provincial Government Officer)

DISCUSSION

Changing volunteerism under rising opportunity costs

Community forestry in Nepal originated within subsistence-based livelihoods, where households relied on fuelwood, fodder, bedding materials, and timber. These dependencies aligned household welfare with forest protection, generating incentives for local rule-making and unpaid collective labour. Low labour opportunity costs, limited market integration, and dense social networks sustained reciprocal norms, enabling voluntary collective management over extended periods (Nuberg *et al.*, 2019; Ghimire and Lamichhane, 2020; Cadman *et al.*, 2023). Volunteer labour was effectively compensated through access to forest products rather than monetary payments.

Findings from the four studied CFUGs indicate a localised adjustment in participation incentives rather than a broader system-wide transition. In the studied CFUGs, willingness to engage in forest fire management without financial compensation has declined as labour opportunity costs rise due to income diversification, seasonal migration, and expanding wage labour markets (Poudyal *et al.*, 2023; Laudari *et al.*, 2024). This interpretation is based on stated preferences and qualitative accounts, not observed behavioural change over time. This reduction in unpaid participation reflects

economic reallocation of labour rather than declining environmental preferences. Moral and cultural attachment to forests persists; however, intrinsic motivations appear insufficient, based on the respondents' perceptions, to offset forgone income during peak fire seasons. This aligns with political economy analyses of common-pool resources, which caution against attributing declining participation solely to weakening social norms (Nightingale, 2017; Ojha *et al.*, 2020).

Participatory governance and local empowerment enhance intrinsic motivation, but labour-intensive forest management increasingly requires extrinsic incentives to sustain engagement under changing economic conditions (Palmer *et al.*, 2020; Charnley, 2023). This study does not empirically test motivational crowding effects; therefore, any reference to such dynamics remains theoretical. Poorly designed financial incentives risk undermining intrinsic motivation, reducing participation once payments end (Oniki *et al.*, 2023; Li *et al.*, 2024). Rising labour scarcity and the physical demands of forestry work increase reliance on hired labour and simplified management practices, with potential implications for long-term sustainability (Jurjonas *et al.*, 2023). Within these study sites, these dynamics suggest a mismatch between institutional expectations of unpaid labour and current livelihood strategies. Remunerating volunteer labour reflects broader economic processes that shape participation and inequality while enabling continued engagement among marginalised groups (Smith *et al.*, 2020). Overall, the findings point to an emerging gap between policy assumptions of voluntary labour and observed participation constraints in high out-migration contexts.

Wage incentives and recognition of labour value

Introducing wage-based incentives was associated with higher stated willingness to participate, indicating that forest fire management competes directly with alternative income-generating activities. The effective hourly wage premium of over 30 per cent suggests that participants perceive compensation as offsetting opportunity costs rather than symbolic payments. Evaluating incentives on an hourly basis improves labour valuation and allows robust comparisons for hazardous, time-intensive tasks (Farina *et al.*, 2021). This inference is drawn from stated willingness and reported labour patterns, not from longitudinal participation data.

Reframing fire management as paid labour aligns participation with household economic strategies, internalising labour costs previously externalised under volunteer-based governance. This addresses chronic under-provision of collective fire protection and aligns with institutional economic theories emphasising incentive compatibility in sustaining public goods (Ostrom, 2010). However, this study does not establish causal effects on sustained participation or long-term institutional outcomes. Evidence from respondents highlights that wages alone are insufficient where risk exposure remains high. Similar patterns were observed in Asia and African community forestry systems when livelihood portfolios expanded, intrinsic motivation alone was insufficient for labour-intensive and risky activities such as fire suppression (Baynes *et al.*, 2015).

Participants consistently emphasised the absence of insurance mechanisms as a constraint on participation despite wage provision. Fire management entails both income and risk dimensions; wages

compensate time but not exposure to physical harm. Evidence from fire suppression and prescribed burning shows that financial incentives increase participation, but risk and liability concerns strongly influence engagement (Watts *et al.*, 2019; Abri, 2022). From a policy perspective, these findings suggest that wage incentives need to be complemented by a risk-sharing mechanism to address both income and safety considerations.

Material and human capital inputs as complementary incentives

PPE improved perceived safety but did not independently drive participation. PPE reduces physical risk but does not offset economic risk from foregone wages or injury. Findings indicate that PPE functions as a supporting input rather than a primary motivator of engagement. Different literature shows that task acceptance increases when PPE is paired with income security, emphasising the need for integrated safety and economic incentives (Wadsworth and Walters, 2019; Abikenova *et al.*, 2024).

Training significantly improved fire management knowledge and preparedness, with post-training gains confirming short-term human capital effectiveness. These gains reflect immediate post-training assessment and do not indicate long-term retention. Qualitative evidence suggests that knowledge depreciates over time, and participant turnover erodes cumulative capacity. One-off training alone does not sustain labour supply for recurrent, high-risk collective action. Sustained human capital development requires repeated training combined with incentive mechanisms. Initial training improves knowledge, skills, and performance but is insufficient to overcome reluctance or perceived risk (Muardi *et al.*, 2022; Ojeda *et*



al., 2025). Social capital and organisational commitment often influence performance more strongly than training alone, highlighting the importance of community relationships and collective engagement (McCaffrey, 2015; Kristanti *et al.*, 2025). The combined evidence from this study suggests that isolated interventions, such as one-time training or PPE provision, are insufficient. Instead, integrated approaches that combine repeated training, financial incentives, and risk coverage are more consistent with observed participation patterns.

Governance, equity, and financial sustainability

Concerns over unequal access to wages and PPE emerged across CFUGs. Perceived inequity undermines trust and threatens institutional legitimacy, even when overall participation rises (Ojha *et al.*, 2009; Turner *et al.*, 2016). Transparent allocation rules, rotation mechanisms, and public disclosure are essential to prevent elite capture. Persistent gender and caste disparities during fire response indicate that human capital gains alone do not translate into equitable role allocation (Agarwal, 2010; Nightingale, 2011). In resource management contexts, inequity and elite capture concentrate benefits, undermining stakeholder support and legitimacy (Turner *et al.*, 2016; Liang and Ma, 2020). Findings from qualitative data highlight that distributional fairness directly shapes community acceptance of incentive-based approaches. Perceived inequity creates governance risks that may limit long-term effectiveness.

Financial sustainability constrains wage-based fire management. CFUGs with limited timber revenue and restricted land-use options often cannot sustain wage payments

without external support. The pilot nature of the intervention further limits inference on long-term financial viability. Dependence on short-term donor funding generates participation volatility and undermines institutional continuity (Ojha *et al.*, 2016). Forests with low commercial value limit long-term financial self-reliance, affecting regular management and adaptation to market-oriented practices (Dhungana *et al.*, 2024). Policy discussions emerging from these findings point towards the need for institutional mechanisms such as co-financing models, integration with municipal budgets, or pooled fire management funds to ensure continuity beyond short-term projects.

Recalibrating volunteerism rather than replacing it

Preferences for wage-based participation reflect rising labour opportunity costs rather than rejection of collective responsibility. Intrinsic motivations persist alongside economic considerations. Incentives appear to modify participation conditions rather than replace existing attachment to forest stewardship. The findings suggest that hybrid models, combining voluntary engagement with targeted incentives for high-risk tasks, are more aligned with current socio-economic conditions in the study sites.

Concerns from forest officials about the erosion of volunteer spirit highlight a governance challenge. The evidence from this study does not demonstrate displacement of intrinsic motivation but indicates changing participation constraints. Fire management remains a high-risk public good; expecting sustained, unpaid provision under changing economic conditions may not align with current labour dynamics.

CONCLUSION: TOWARDS AN INVENTIVE-COMPATIBLE STEWARDSHIP MODEL

The study indicates that Nepal's community forestry program is undergoing a structural transformation driven by rising labour opportunity costs and diversified livelihoods, rendering reliance on unpaid volunteer labour for fire management increasingly unsustainable. Findings from the four studied CFUGs suggest that incentive-based approaches play an important role in sustaining participation in forest fire management under changing socio-economic conditions. While technical training and PPE enhance skills and safety, they do not address economic risks from injury, highlighting the need for bundled interventions that combine skill development, protective equipment, and group insurance to ensure high-risk fire management is accessible, particularly for marginalised households. The evidence indicates that incentives influence stated willingness and perceived participation dynamics, but does not establish causal effects on long-term behavioural change or institutional outcomes. Introducing monetary incentives raises governance concerns, including elite capture and biased allocation, making transparent selection, rotation mechanisms, and targeted inclusion of women and Dalit members essential to maintain legitimacy and equitable participation. Overall, the findings suggest that integrating economic incentives into community forest fire management warrants further investigation across broader, more diverse contexts. The result supports adaptation, rather than substitution of voluntarism through structured and transparent incentive systems, consistent with the empirical evidence from this pilot study.

POLICY RECOMMENDATIONS

The following recommendations are forward-looking and informed by the findings of this pilot study.

- To support CFUG resilience under changing labour markets, policies may consider recognising the economic value of community labour, allowing CFUGs to allocate internal funds toward performance-based incentives for high-risk tasks.
- Technical training and PPE could be complemented by group accident insurance to address perceived risk exposure and improve participation conditions.
- Municipal-level pooled "Fire Resilience Funds" may offer a potential mechanism to support seasonal wage payments and reduce reliance on short-term external funding.
- Transparent incentive protocols, including rotation systems and inclusive participation criteria, are suggested as important considerations to reduce risks of elite capture and improve equity.

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