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Community-Based Sustainable Forest Management of the Amazon Rainforest: A Focus on Pará State, Brazil

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Abstract

The study aimed at analysing communities based sustainable forest management of Amazon Rainforest. Forest cover of the world is coming under threat as a result of the fast growth of human population and its needs especially those depend on forest products and related issues. Areas under agriculture and pasture are alarmingly expanding often at the expense of forest covers or lands. This study used a mixed-methods approach that combines quantitative and qualitative analysis to examine the efficacy of community-based sustainable forest management in Amazon Rainforest. The sustainability of the forest is threatened by deforestation, illegal logging, and agricultural encroachment, as evidenced by quantitative results from 200 respondents, household surveys, and forest inventory assessments. The significance of a participatory approach is highlighted by the fact that 74.5% (149 respondents) reported participating in community-based forest management that forest-based activities have improved their socioeconomic status, and most highlighted the lack of alternative livelihood options and their financial reliance on forest resources. On the other hand, 25.5% (51 respondents) chose not to participate, presumably as a result of the community's lack of motivation to engage in forest management is a result of unclear rewards, low awareness, and lax enforcement of conservation regulations. The study concludes that while CBSFM has the ability to strike a balance between livelihoods and conservation, community alienation, pressures from deforestation, and inadequate institutional frameworks make it less successful. To guarantee the long-term viability of Amazon Rainforest, it suggests boosting community awareness initiatives, fortifying regional institutions, encouraging alternative livelihoods like agroforestry, and encouraging stakeholder cooperation.

Keywords: *Community-Based Forest Management (CBFM), Amazon Rainforest, Sustainable Livelihoods, Deforestation and Conservation, Pará State, Brazil*

1.1 Introduction

According to Kamula (2006), forest provides a wide range of ecosystem services such as non-domestic food, building materials, fuel, medicines and related products and has been the traditional mainstay of local communities for thousands of years. Badege (2009) discloses that, human beings are changing the natural ecologies, resiliencies and biological diversities. Forest ecosystem contains the majority, approximately 60% of the carbon in terrestrial ecosystem and the potential to absorb about 10% of global carbon emissions projected for the first half of this century (Stretch C., 2008). Hence, non-industrialized nations can create opportunities to get remittances for their citizens due to expanding extent of forests, increasing the varieties of plant species and maintaining existing forests. Tropical forest plants also can be used to modern agriculture in three ways; such as sources of new crops that can be brought into cultivation; as sources of material for breeding improved plant varieties; and as sources of biodegradable pesticides (M.J. Plotkin, 1988).

Participatory Forest Management is sufficiently wide spread and effective in Africa today to be recognized as a significant route towards securing and sustaining forests. Although almost all the states are arriving at more participatory approaches especially to natural forest management, broad communities among a process and paradigms are notable (Alden, L. W., 2002). Yet the role of people at the local level is crucial. National governments rarely possess enough personnel to enforce their laws adequately, prompting many officials to consider decentralizing authority over forest resources. It is becoming increasingly clear that local communities filter and ignore the central government's rules. They also add their own rules, generating local institutions, rules in use and pattern of activity that can diverge widely from legislators and bureaucrats‟ expectations (Gibson et. al., 2000). In some parts Brazil, the availability of protected forest is considered as the pride of their cultures. For example, in south western and southern part of Brazil, communities prepare food, especially at holly day celebration to get joy full festival with their families and they cut trees for this purposes.

According to Dessalegn (2002), Biodiversity in Brazil is characterized by the composition of various species from mountainous to lowland climatic conditions. Moreover, distribution of indigenous forest depends on altitudinal variation Unfortunately over utilization of forest resources inevitably reduced its size and quality due to long history of forest and community interactions to meet their basic needs. These human induced serious problems are resulting in decline of productivities of the forests. However, clearing closed tropical forests quickly impoverished the exposed soils, because most of them are tied up in living materials of the forest and its floor. That means the components of soil materials are made up of plant organs and trapped by plants deep roots to protect from wearing a way of materials (FARM Africa, 2007).

As experience of researchers, the forest cover of Bule Hora and Dugda Dawa specifically the Amazon Rainforest declined at rapid/faster rates due to the deforestation, population pressure, expansion of agricultural lands, timber production, home consumption, selling firewood to Bule Hora and Fincawa town.

1.2 Statement of the Problem

Forest cover of the world is coming under threat as a result of the fast growth of human population and its needs especially those depend on forest products and related issues. Areas under agriculture and pasture are alarmingly expanding often at the expense of forest covers or lands. The impact of agricultural expansion has been particularly severe in tropical forest regions, where pasture and crop lands are continuously increasing (MEA, 2005).

Brazil is one of the African countries where the environment is severely degraded (J. Campbell, 1991). Deforestation has reduced its tree cover to 2.5 million hectares from 42 million hectares at the beginning of the twentieth century's according to Ayele Kuris 2003 cited in Temesgen, 2007. Due to this large scale of deforestation the water table has dried up, soil materials are removed, biodiversity's have declined and moreover, various ecosystem services and functions are disturbed. Such rates of biodiversity loss will be irreversible, unless the preventions are introduced. Deforestation reduces the retention capacity of water sheds which may produce siltation and flooding of downstream, far from the actual size of land cover change. Reduction in species diversity may result in the loss of important ecosystem services although the nature and the value of these are highly location specific and are beginning to be understood (Ibid).

The extents of biodiversity loss are highlighted by different studies. According to FAO projection, the demand for fuel wood at a national level could be taken as an example. By the year 2014, the demand for industrial and construction wood will reach over 1.6 million m^3 and 4.3 million m^3 respectively. The demand for fuel wood is estimated to increase by 14.4 million m3 (FAO, 1992 cited in Temesgen, 2007).

Some studies have been conducted on the cases of Forest Management like Temesgen (2007), Under demographic categories the marital status of women, sex, age, and education, occupation, knowledge, social institutions and technologies are variables that affect the Community Forest Management with regards to active involvements of community based forest management, Henok (2007) the poor people, who earn their livelihood from natural forests, are actively involved on Community Forest Management practices for family and self-survival and Henok citing the statement of Dessalegn Rahmto (2001) argues that, the worst events on ineffective forest management are not activities of peasants, or human population pressures, rather the government policy itself. The government policy gives priorities to the investment provide rather than maintaining the existing forest land. Although, Getaneh Haile, (2007) the peasants' indigenous knowledge of forest resources conservation and maintenances at the local level is the main source of scientific knowledge which is the knowledge of the community about community based forest managements can be affected through income, occupation, and marital status and residence sites.

However, this study differs from the above and other related studies in that it fill the research gap which is to analyze the community based sustainable forest management of Amazon Rainforest in which the area is under a wide expansion of human population, extensive forest areas are cleared for the expansion of farm lands, logging or wood harvest for domestic fuel or charcoal, and infrastructure expansion for urbanization and livestock grazing land. These forest areas have not been sustainably well maintained by active involvement of the communities and recognizing some of the efforts that has been employed by the local communities to save these forest resources, in the study area which did not studied deeply in comprehensive manner, previously.

1.3 Research Objective

i. Identify the causes of forest depletion in Amazon Rainforest.
ii. Explain the level of the communities' perception on the forest services to the study area.
iii. Evaluate the challenges of the community based sustainable forest managements in the study area.
iv. Examine the role of Indigenous Knowledge for the community based sustainable forest management at the study area.

1.4 Research Questions

i. What are the causes for forest depletion in Amazon Rainforest?
ii. To what extent the communities' have perception about the forest services at the study area?
iii. What are the factors that affect community based sustainable forest management in the study area?
iv. How the Indigenous Knowledge helps to manage forest in sustainable ways at the study area?

3.1 Research Methodology

The research design for this study was employed as a sequential explanatory research design by surveying the current cases of the community based sustainable forest management description. Based on the nature of the inquiry, the research was employing a mixed research approach. By applying quantitative principles, the researchers was attempt to answer; a research question that seeks to describe the existing situations of analyzing the community based sustainable natural forest management of Amazon Rainforest and its implication on the surrounding environment. Through a qualitative research approach, the researchers were collecting the opinion of respondents about the role of the community based sustainable forest management at both weredas and on the Surrounding Environment.

Sampling Techniques and Sample Size Determining

Multi-stage sampling procedures will be used to select sample size for this study. Firstly, the researchers were select purposively Amazon Rainforest and again, purposive sampling method was used to select three kebeles out of seven kebeles of two woredas which is from Bule Hora and Dugda Dawa woreda of Pará States, because of the natural forests is found at this two woredas.

Secondly, the questionnaires were distributed to the respondents who were selected by simple random sampling with in all these three kebeles. Thus, the sample size will be determined using the formula given by Yamane (1967) in drawing an adequate sample size from a given population at a confidence level is 93% Level of precision which is an error (0.07).

$$SS = \frac{N}{1+N(e)^2} \quad \text{.....1}$$

$$= \frac{8,420}{1+8,420(0.07)^2} = \frac{8,420}{1+8,420(0.0049)} = \frac{8,420}{42.1992}$$

n = 200

Where n= sample size e= level of precision N= total population

The selected kebeles has a total of 8,420 household populations. Hence, the sample size was 200 (Table 1).

Finally, In order to determine the weight of sample size in each Kebele, the total sample populations were distributed proportionally in to the respective kebeles by using proportionality scientific formula (Cochran, 1977) given below.

$$ni = \frac{Nis}{N} \quad \text{.....2}$$

Where, ni=the number of sample population on each sample Kebele,

Ni=the number of population in each kebele,

S= total number of sample population,

N= ∑Ni i.e. number of population in kebele

Table 1: Sample Size Determination

No.	Name of Sample Kebeles	Distribution of population(Ni)	Distribution of sample size(ni)	Sample percentage
1	Dekisa Chebeti	2960	70.3	35.15
2	Fancha Wazero	2825	67.1	33.55
3	Burkitu Magada	2635	62.6	31.3
	Total	8, 420	200	100

Source: West Guji Communication Administrative office, 2021, Bule Hora.

Data Sources and Methods of Collection

The study was applying both primary and secondary sources of data to address the objectives of the study. The research mainly was depend on primary data obtained by quantitative and supported by a qualitative method of data collection through questionnaires, interviews, and personal observation. The secondary data were obtain from various sources such as books, journals, recorded materials, and published materials.

The primary data was gathered through Questionnaires, Field Observation, Focus Group discussion, and Key informant interview to analysis the Communities Based Sustainable Forest Management of Amazon Rainforest.

Data Analysis Methods

Both descriptive and inferential statistics methods were used to analyze the data with regard to the objectives of the study. The collected data from different sources organized into meaningful facts and was made detail explanation using questionnaires and correlation test were used to analyze data according to objective # 1, 2, and 3. T-tests were used to test the significant of the difference categories between variables. Pearson correlation (measures the strength between variables and relationships) and From the theoretical framework, the decision to predict those people who are either willing or not willing to participate in forest management make the choice of a logistic regression a more appropriate tool for this analysis. Therefore, Logistic Regression model was used to assess the effect of socio-economic and demographic factors of the households' willingness to participate in forest management. Binary Logistic regression is a widely applied statistical tool to study farmers' perception about using technologies. Logistic regression allows predicting a discrete outcome from a set of variables that may be continuous, discrete, and dichotomous or a combination of them. The dependent variable, (i.e., perception of PFM practice) is dichotomous discrete variable that is generated from the questionnaire survey and the independent variables are a mixture of discrete and continuous (Nelson F, 2010). Following the methods of used by Abera and Mekuria, the logistic regression model characterizing perception of the sample households is specified as:

The model is represented as:

$P=e^{-}/1+ e^{-}$

p=probability of an individual saying 'no' (0=unwilling) or 'yes' (1=willing) to participatory forest management. In using the model, it is assumed that the probability that an individual supports participatory forest management is independent of their demographic and socioeconomic characteristics, i.e., $\ln(Pi /1- Pi)= \beta0 + \beta1X1 +\ldots+ \beta kXki$.

Where:

i denotes the i-th observation in the sample.

P is the probability of willingness to participate in forest management.

β0 is the intercept term.

β1… βk are the coefficients associated with each explanatory variable *X1…Xk.*

On the other hand, the data obtained from the document analysis, and interview was analyzed qualitatively. The qualitative analysis was done as follows. First, organizing and noting down of the different categories was made to assess what types of themes may come through the instruments to collect data with reference to the research questions. Then, transcribed and coded the data to make the analysis easy. Also, the result was triangulated with the quantitative findings.

4.1 Results and Discussions

According to the results from Table 2, there is a notable gender difference in participatory forest management (PFM), out of 200 participants, 87% (174) were male, and 13% (26) were female-headed households. Traditional gender roles, scarce resources, and sociocultural norms that frequently limit women's participation may be the cause of this discrepancy. Notwithstanding these obstacles, women provide important information and encourage sustainable practices, making gender-inclusive participation essential for efficient forest management. PFM results can be improved by closing this gap through initiatives for women's empowerment and capacity-building programs.

Regarding family size, out of 200 respondents, 24.5% (49) had between 1 to 3 family members, 37.5% (75) had between 4 to 6 family members, 33% (66) had between 7 to 10 family members, and 5% (10) had more than 10 family members (Table 2). PFM outcomes are greatly impacted by family size. As per Mekuriaw & Harris-Coble (2021), larger households can provide more labour for conservation efforts, but they also tend to have higher resource needs (fuel wood, grazing). Although they have less labour capability for group activities, smaller households have fewer resource needs (Yirga et al., 2024). With customized awareness and livelihood programs, effective PFM should ensure equitable participation, encourage sustainable resource use, and leverage bigger households for conservation efforts (FAO, 2019).

Educational status among the respondents revealed that out of 200 individuals, 46.5% (93) had completed grade 1 to 8 educations, 27.5% (55) had completed grade 9 to 12, 13.5% (27) had diploma education, and 11.5% (23) had tertiary education (Table 2). Education level affects PFM

participation. Higher educated households are more likely to engage in decision-making and embrace sustainable practices (Alemu et al., 2023). Individuals with lesser levels of education could be more likely to use traditional resources, necessitating focused awareness campaigns (FAO, 2019). According to Yirga et al. (2024) in order to improve informed involvement and sustainable resource management, effective PFM should incorporate educational outreach and capacity-building. Conversely, as reported in the FGD, lower educational levels may restrict access to advanced knowledge and technologies, potentially hindering participator forest management. Socioeconomic factors such as gender, family size, and educational status play a crucial role in shaping forest management in the Amazon Rainforest, influencing households' ability to engage in and sustain forest conservation efforts.

Table 2: The Sex, Family Size and Educational Status of the Household

Sex of Respondents	**Frequency**	**Percent**	**Cumulative Percent**
Male	174	87.0	87.0
Female	26	13.0	100.0
Total	200	100.0	
Age of Respondents	**Frequency**	**Percent**	**Cumulative Percent**
20-30 years old	49	24.5	24.5
31-40 years old	61	30.5	55.0
41- 50 years old	76	38.0	93.0
above 51	14	7.0	100.0
Total	200	100.0	
Family Size	**Frequency**	**Percent**	**Cumulative Percent**
1-3 family	49	24.5	24.5
4-6 family	75	37.5	62.0
7-10 family	66	33.0	95.0
above 10 family	10	5.0	100.0
Total	200	100.0	
Education Status	**Frequency**	**Percent**	**Cumulative Percent**
1-8 grade	93	46.5	46.5
9-12 grade	55	27.5	74.0
Diploma or Level	27	13.5	87.5
First Degree	23	11.5	99.0
second Degree or above	2	1.0	100.0
Total	200	100.0	

The Livelihoods Sources, Farm lands, and Types of Farming Characteristics

In the research area, 89% of households (178 respondents) relied largely on agricultural activities, such as crop cultivation, livestock rearing, and other farm-based activities, indicating a close relationship between forest resources and household livelihoods. As a result of their frequent reliance on forest resources, these households' involvement in participatory forest management (PFM) is essential to guaranteeing the resources' sustainable use. Along with agriculture, 7.5% (15 respondents) work off-farm in jobs like petty trade and daily labour, while 3.5% (7 respondents) work in non-farm occupations like small companies. These non-farm and off-farm pursuits can be crucial in conserving forests, providing other revenue streams, and lessening the strain on forest resources.

In terms of farmland ownership, the majority of respondents own tiny amounts of land; 40% (80 respondents) possess between 1 and 2 hectares, and 34% (68 respondents) own less than 1 hectare. Due to the limited land area, these people usually rely on forest resources to supplement their income because farming alone may not generate enough money. Six percent (12 respondents)

possess between one and four hectares, while almost 20% (40 respondents) own between one and three hectares. Agroforestry techniques are more likely to be used by larger landowners, which can lessen their reliance on forest resources and support sustainable forest management.

Regarding farming types, 23% of families (46 respondents) concentrate on raising cattle, whereas 51% of households (102 respondents) only produce crops. 52 respondents, or 26% of the total, use mixed farming, which combines raising cattle and crops. Opportunities to incorporate forest management into farming methods, such agroforestry, are presented by mixed farming, which can help with both livelihoods and forest conservation initiatives. In order to improve sustainability and community involvement in forest conservation efforts, these findings highlight the necessity of inclusive forest management strategies that take into account a variety of livelihoods and land use patterns.

According to the FGD and KI reports, these socioeconomic characteristics highlight the vital role of forest management in the livelihoods of households in the study area. The studies show the impact of many factors on households' ability to engage in and maintain forest management, including income levels, livestock ownership, and alternative sources of income. These elements not only affect households' financial security but also their capacity to invest in a variety of sources of income, which emphasizes how crucial it is to incorporate economic considerations into forest management plans.

Table 3: The Livelihoods Sources, Farm lands, and Types of Farming Characteristics

Livelihoods Sources	**Frequency**	**Percent**	**Cumulative Percent**
Agricultural activities	178	89.0	89.0
Off-farm activities	15	7.5	96.5
Non-farm activities	7	3.5	100.0
Total	200	100.0	
Farm Lands Owned	**Frequency**	**Percent**	**Cumulative Percent**
<1hectars	68	34.0	34.0
1-2 hectars	80	40.0	74.0
1-3 hectars	40	20.0	94.0
1-4 hectars	12	6.0	100.0
Total	200	100.0	
Types of Farming	**Frequency**	**Percent**	**Cumulative Percent**
Only crop production	102	51.0	51.0
Livestock raring	46	23.0	74.0
Mixed farming(Crop production and livestock raring)	52	26.0	100.0
Total	200	100.0	

The Community Based Forest Management

The findings of the study area's community-based forest management (CBFM) survey (Table 4) show a high level of participation in forest conservation efforts. Participation in community-based forest management programs was indicated by 149 respondents, or 74.5% of the sample, highlighting the importance of a participatory approach to forest sustainability. But 25.5% (51 respondents) do not participate, which could indicate problems such restricted access, low

awareness, or other obstacles that keep people from taking part in forest management activities (Yirga et al., 2024).

In terms of following local administrators' advice, 69% of respondents (138) completely adhere to the guidelines, demonstrating a high degree of involvement and dedication to forest conservation. While 13% (26 respondents) do not follow the instructions at all, 18% (36 respondents) only partially follow them. According to Bekele Mulatu et al. (2023), this variation implies that although the majority of community members support forest management measures, a sizeable section of the populace either finds it difficult to completely adopt these policies or is ignorant of their advantages.

These results highlight how crucial it is to remove obstacles to full participation and make sure local administrators' proposals are broadly embraced and carried out in order to increase the efficacy of community-based forest management. Improving engagement and adherence to sustainable forest management methods may be facilitated by raising awareness, offering incentives, and delivering training (Hagos et al., 2022).

Table 4: The Community Based Forest Management Characteristics at kebeles

Community Based Forest Management	**Frequency**	**Percent**	**Cumulative Percent**
Yes	149	74.5	74.5
No	51	25.5	100.0
Total	200	100.0	
Practicing the advice of the administrator	**Frequency**	**Percent**	**Cumulative Percent**
Fully	138	69.0	69.0
Partially	36	18.0	87.0
Never	26	13.0	100.0
Total	200	100.0	

The Causes of Forest Depletion

The results of the poll provide insight into the root causes of forest loss and the disparities in community awareness of deforestation, thereby illuminating the area's environmental problems.

According to results of table 5, 29% (58) of respondents state that, the extensive use of forests for building materials and fuel wood is the main cause of forest loss. The need for firewood for cooking and lumber for construction is a major cause of deforestation in rural areas, especially in developing countries like Brazil. Forests are still being exploited at unsustainable rates because to restricted availability to alternate energy sources, which exacerbates environmental deterioration (Alemu et al., 2023). The community's daily needs are prioritized over long-term ecological health, which leads to a vicious cycle of depletion. This issue is exacerbated in Brazil, where there are few energy alternatives and forests are viewed as the primary resource for economic activity and survival (Derebe et al., 2025). The growing strain on forests highlights the need for sustainable solutions that will meet community needs without endangering the environment.

According to result of table 5, 21.5% (43 respondents), the growth of agricultural land is another significant factor contributing to deforestation. A major factor contributing to forest decline is the conversion of verdant woods into agricultural land, which is fuelled by both commercial and

subsistence farming. The spread of agriculture pushes farther into forested areas due to fast growing populations and rising food demands, depriving the land of its priceless ecological functions. The loss of forests for farming accelerates climate change and disturbs ecosystems, despite the fact that forests are essential for carbon sequestration, water control, and biodiversity protection (Bekele et al., 2023).

Similarly, according to 24% (48 respondents), settlement growth is another significant factor contributing to deforestation (table 5). There is a concerning encroachment on forests as a result of the growing demand for land to build homes in both urban and rural areas. In addition to depleting trees for housing, this trend of urbanization and population increase makes environmental problems worse by progressively replacing forested areas with concrete (Hoffmann et al., 2022). The intricate balance between development and conservation is emphasized by both agricultural and settlement growth, underscoring the necessity of sustainable land use practices to save our forests.

According to table 5 results, 9.5% (19 respondents), livestock overgrazing is another important factor contributing to deforestation. The land experiences soil deterioration, vegetation cover loss, and increased erosion when animals graze excessively, all of which contribute to the loss of forests. Maintaining the health of the soil requires controlling grazing patterns in areas where animals are crucial to subsistence. Overgrazing poses a hazard to the sustainability of forest ecosystems and can hasten environmental degradation if it is not properly managed (Zeleke et al., 2023). Insecurity over land tenure was another important concern mentioned by 9.5% (19) of respondents. There is less motivation to make investments in sustainable resource management or long-term conservation when people do not have solid land rights. Because they might not benefit from protecting woods, people are less inclined to do so in places where property ownership is ambiguous or not officially recognized. Deforestation is exacerbated by this insecurity, endangering economic and environmental stability (Zeleke et al., 2023).

Furthermore, 6.5% (13) of respondents cited illegal forest fires as contributing factors to forest depletion. Despite the fact that these activities are frequently ignored and unchecked, they increase deforestation and pose a severe danger to attempts to save forests. These elements' combined effect shows the intricate network of issues causing forest loss in the area, underscoring the pressing need for all-encompassing conservation measures.

According to the results of table 5, 65% (130) of the respondents acknowledge the extent of deforestation in the areas, demonstrating a general awareness of the negative environmental effects of forest loss. In order to mobilize collective action for forest conservation and sustainable management, it is imperative that there be widespread awareness (Yirga et al., 2024). Divergent opinions do exist, though, with 11.5% (23 respondents) maintaining that there is no deforestation at all and 16.5% (33 respondents) believing that only a small amount of deforestation is taking place. Local differences in forest health, the accessibility of forest products, or a lack of current data regarding the degree of forest loss could be the cause of these disparities (Mengistu et al., 2023).

Additionally, 7% (14) respondents acknowledged that they were ignorant of the problems associated with deforestation, highlighting the necessity of focused environmental education. Educational initiatives that emphasize the causes and effects of deforestation as well as sustainable forest management techniques are crucial for closing this knowledge gap and encouraging more community participation in conservation initiatives. The results highlight how critical it is to

address the underlying causes of deforestation as well as raising public awareness. Sustainable fuel wood substitutes, better farming methods, secure land tenure, and more community involvement via education and participatory forest management are all components of successful conservation plans.

Table 5: The Causes of Forest Depletions or Deforestations and Community Knowhow about Deforestation

Causes of Forest Depletions	**Frequency**	**Percent**	**Cumulative Percent**
For use of forests for fuel wood and construction materials	58	29.0	29.0
For agricultural land	43	21.5	50.5
For Settlements	48	24.0	74.5
For overgrazing by livestock	19	9.5	84.0
For land tenure security	19	9.5	93.5
Others	13	6.5	100.0
Total	200	100.0	
Community Knowhow about Deforestation	**Frequency**	**Percent**	**Cumulative Percent**
there is sever deforestation going on	130	65.0	65.0
there is some deforestation going on	33	16.5	81.5
there is no deforestation going on	23	11.5	93.0
I don't know any about deforestation	14	7.0	100.0
Total	200	100.0	

The Level of the Communities' Perception and Participation on the Forest Services

Participatory Forest Management's (PFM) success depends on how the community outlooks it. According to survey results table 6, PFM is strongly supported overall, which shows that 49% (98) of respondents accepts it "very important" and 34% (68) think it is "somewhat important." Nonetheless, 17% (34 respondents) believe PFM is "not important," underscoring the necessity of focused awareness efforts and engagement tactics to dispel myths and showcase the advantages of sustainable forest management. Zeleke et al., (2023), found that community involvement promotes improved forest conservation results and resource management, which is consistent with this favorable perception. Long-term forest protection depends on fostering a sense of accountability and ownership, which is what such involvement does. The findings show that although PFM is valued by the majority of the community, efforts should concentrate on removing obstacles and educating those who are less certain of its significance. According to Solomon et al. (2024) closing this gap through community discussions, capacity-building initiatives, and participatory decision-making procedures can improve teamwork, fortify local government, and support sustainable forest management techniques.

The community supports PFM because it offers several important advantages that meet their needs for livelihood and conservation (table 6). The most often stated explanation, given by 45.5% (91) of the respondents is that PFM gives the community more authority, highlighting the significance of local government in attaining improved conservation results (Teshome et al., 2023). Communities are more likely to adopt sustainable practices and save resources for future

generations when they manage their forests. Furthermore, according to Zeleke et al., (2023), community-managed forests frequently have lower rates of deforestation than those subject to stringent government supervision. This is supported by the fact that 16% (32 respondents) think PFM minimizes deforestation. Participation of the community cultivates a sense of shared accountability to stop illicit logging and forest destruction. Furthermore, 13.5% (27 respondents) said that PFM fosters accountability, which is essential for successful conservation over the long run. According to FAO (2019), shared accountability promotes more successful forest monitoring and preservation initiatives.

Active community involvement is crucial for successful forest regeneration and biodiversity recovery, as seen by the additional 12% (24 respondents) who mentioned that PFM boosts forest inventory (table 6). In order to restore damaged landscapes, communities that are actively involved in resource management, tree planting, and protection are essential. Finally, 17.5% (17) of respondents expressed appreciation for PFM's protection of their rights to use forest products, indicating that participatory techniques strike a balance between conservation objectives and local livelihoods, guaranteeing that communities get the benefits of sustainably managed resources (Lamedjo, 2019). These results highlight how PFM fosters social and economic empowerment in communities while also promoting environmental sustainability, resulting in a solution that benefits both people and the environment.

The majority of respondents 57% (114 respondents) are engaged in nursery establishment, a crucial component of afforestation and reforestation projects, when it comes to their involvement in forest management activities. Forest regeneration is ensured by the participation of 20.5% (41 respondents) in plantation operations. Furthermore, a smaller fraction 2.5% (5 respondents) is involved in saving harvestable trees, but 14.5% (29 respondents) support the protection of regenerating trees. Three respondents, or 1.5%, said they did not participate, highlighting the need for more inclusive strategies to promote wider involvement (table 6). Additionally, 4% (8) respondents, participate in additional unidentified forest management activities, indicating a range of contributions to conservation initiatives.

The results demonstrate how well community-based forest management (CBFM) promotes sustainable forestry by strengthening conservation outcomes, encouraging responsibility, and empowering local populations. CBFM shows that communities actively participate in preserving and reviving important ecosystems when they are trusted to manage their forests. However, initiatives that address obstacles to participation in Participatory Forest Management (PFM) must be strengthened in order to further increase participation and impact. By offering training on resource management, climate resilience, and sustainable forestry practices, capacity-building initiatives play a critical role in empowering local populations with the information and abilities required for efficient forest management (Kabiso et al., 2022).

According to Emiru et al. (2023), policy support is also necessary to guarantee that legal frameworks acknowledge and defend community land rights while fostering participatory decision-making procedures to stimulate local involvement. Economic incentives that encourage sustained community involvement and sustainable resource use, such as benefit-sharing plans, access to forest products, ecotourism opportunities, or payments for ecosystem services, are equally significant. All things considered, CBFM can become a potent instrument for preserving forests, enhancing livelihoods, and promoting sustainable development by fusing community empowerment with advantageous laws and business prospects.

Table 6: The Perception and Reasons towards PFM of Community

Perception towards PFM	**Frequency**	**Percent**	**Cumulative Percent**
It is very important	98	49.0	49.0
It is somewhat important	68	34.0	83.0
It is not important	34	17.0	100.0
Total	200	100.0	
Reasons towards PFM	**Frequency**	**Percent**	**Cumulative Percent**
It gives Authority to the community	91	45.5	45.5
It create feeling of accountability	27	13.5	59.0
It reduces deforestation	32	16.0	75.0
There is increment of forest inventory	24	12.0	87.0
We have right to use the forest product	17	8.5	95.5
Others	9	4.5	100.0
Total	200	100.0	
Participate in Forest Management	**Frequency**	**Percent**	**Cumulative Percent**
Nursery	114	57.0	57.0
Plantation	41	20.5	77.5
Protection of regenerating trees	29	14.5	92.0
Protection of harvestable trees	5	2.5	94.5
None	3	1.5	96.0
Others	8	4.0	100.0
Total	200	100.0	

The Challenges of the Community Based Sustainable Forest Managements

Community-Based Sustainable Forest Management (CBSFM) key issues are highlighted in Figure 4, which focuses on the responses of the respondents who identified each issue. Policy gaps, inadequate government assistance, employee turnover, budgetary limitations, inadequate facilities, and regional barriers are the six main challenges it identifies. These difficulties highlight the complexity of the CBSFM, with the main obstacles to efficient forest management being structural, monetary, and policy-related limitations. The figure 4 highlights how urgently these problems must be resolved in order to improve the sustainability and success of community-led forest conservation initiatives.

The most significant challenge identified in the data is the gaps in the Participatory Forest Management (PFM) policy and legal framework, which was reported by 55 respondents (27.5%). This emphasizes how urgently more organized, cogent, and helpful policies are needed. Conflicts over land use rights, inefficiency, and uncertainty are frequently caused by the poor design or implementation of current policies. Strong institutional frameworks, ambiguous land tenure rights, and uneven policy enforcement seriously impede sustainable forest management initiatives, according to research by (Worku, 2022). Local communities frequently find it difficult to properly manage and safeguard forest resources in the absence of clear rules and solid legal support. In addition, inefficient policy frameworks restrict community involvement, make it more difficult for stakeholders to coordinate, and may lead to resource mismanagement (Temesgen et al., 2022). The sustainability and efficacy of community-based forest management could be greatly increased by fortifying the legal provisions and combining statutory and customary governance systems (Gebeyehu et al., 2023).

According to results of figure 4, 23% (46) of respondents, Poor government support is another important concern that the study highlights. This includes limited technical support, insufficient financing, and lax enforcement of legislation pertaining to forest conservation. The viability of community forestry programs depends on government participation, yet insufficient state engagement frequently leads to poor resource management and environmental deterioration (Koroso, 2022). Long-term forest conservation efforts are difficult for local populations to maintain without substantial institutional support. Insufficient funding and inadequate institutional backing impede the efficacy of these initiatives, making it challenging for local populations to obtain the tools and knowledge required for efficient forest management. Studies by Tufa (2021)demonstrate how well-funded community forestry projects and access to training and extension services are essential for their effectiveness, providing empirical proof of the value of proactive government engagement. Thus, policy changes that boost funding and develop technical expertise are crucial to enhancing Community-Based Forest Management (CBFM) implementation and sustainability.

According to figure 4 results 16% (32) respondents, staff turnover is a major problem that breaks the continuity of forest management initiatives. The implementation of programs is weakened by high turnover rates because they cause the loss of institutional knowledge, decrease the effectiveness of current projects, and erode community and authority trust. High turnover in community forestry programs is caused by a number of issues, including low pay, little opportunity for professional advancement, and a lack of incentives, according to research by (Regasa et al., 2021). In order to overcome this difficulty, enhancing pay plans, providing chances for professional growth, and planning long-term agreements could improve employee retention while also bolstering the continuity and general efficacy of forest management initiatives. Addressing these fundamental problems could help communities develop a more reliable and informed workforce, which would result in more effective and long-lasting forest conservation programs.

Limitations in infrastructure 13.5% (27 respondents) and a lack of funding 14% (28 responses) are major obstacles that prevent communities from implementing sustainable forest management. Investment in training programs, vital infrastructure, and instruments required for forest management is hampered by financial limitations. Communities find it difficult to obtain the technologies that are essential for contemporary forest protection initiatives, such as drone-based monitoring or satellite images. Enhancing financial resources and obtaining outside financing sources, such international grants, carbon trading programs, and eco-tourism earnings, may offer the much-needed assistance for community forestry projects, according to Molnar et al. (2021). For resource allocation to be optimized, improved financial transparency and participatory budgeting are also essential.

Effective forest management is often hampered by inadequate facilities. Communities' capacity to effectively manage forest resources is hampered by shortages in vital infrastructure, including monitoring tools, communication systems, and transportation. As suggested by Solomon et al., (2024), funding for contemporary forest monitoring technologies could greatly support forest conservation initiatives. Local capacities would be further strengthened by the establishment of community resource centres and knowledge-sharing platforms, allowing for more efficient management of forest resources. Communities would be better prepared to use sustainable forest management techniques if both infrastructural deficiencies and budgetary constraints were addressed.

Other localized obstacles such land tenure issues, social resistance, climate variability, and external pressures like commercial logging are highlighted in the "Other Challenges" category, which was mentioned by 12 respondents (6%). The effectiveness of forest management initiatives may be subtly harmed by these problems. It takes a comprehensive, integrated strategy that includes cooperation between government agencies, NGOs, and local communities to address these complex issues (Sinclair et al., 2019b). Important elements of this strategy include increased community involvement, financial investments, and policy changes. To ensure the long-term viability and sustainability of Community-Based Sustainable Forest Management (CBSFM) efforts, a comprehensive approach that addresses these interrelated issues collectively will be essential.

Finally, the survey results (figure 4) shows that the most urgent problems are gaps in policy and inadequate government assistance, which are followed by problems with facilities, personnel retention, and resources. Comprehensive reforms are required to remove these obstacles, which include bolstering capacity-building initiatives, boosting financial support, and fortifying policies. To further sustainable forest management and guarantee the long-term viability of community-based projects, it will also be essential to promote increased cooperation between local communities and governmental organizations.

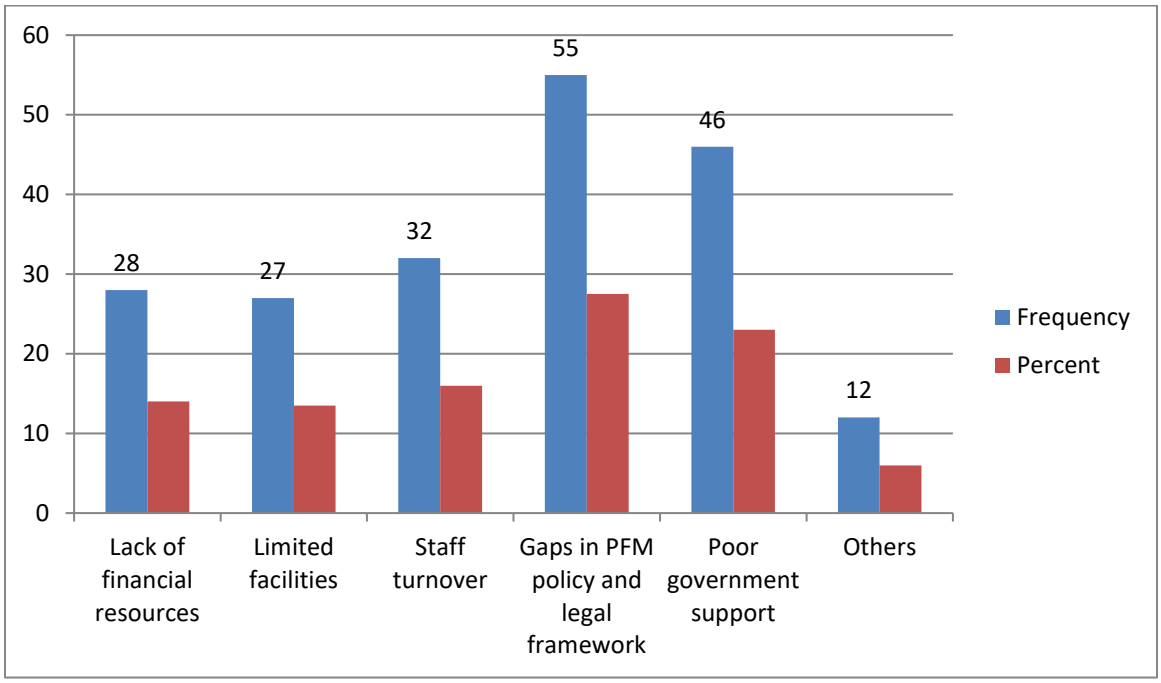

Figure 1: Challenges of the Community Based Sustainable Forest Managements

The Consequences of Deforestation on Livelihood at the Study Area

According to the survey results shown in Figure 5, deforestation has a major impact on local communities and has numerous, complex repercussions for livelihoods. The main effects crop loss, animal mortality, health issues for humans, and water scarcity are intricately linked to one another and compound the socioeconomic difficulties that impacted communities' experience. These repercussions highlight how urgently integrated and sustainable environmental approaches are needed to shield vulnerable people from additional harm.

As seen in figure 5, 43% (86) of respondents cited crop loss as a direct consequence of deforestation's effect on regional environmental conditions. When trees are cut down, the local climate changes, resulting in hotter temperatures and unpredictable rainfall patterns. Due to the increased vulnerability of crops to droughts, floods, and erratic weather patterns, these changes impair agricultural productivity (Sinclair et al., 2019b). Furthermore, deforestation increases soil erosion, which lowers soil fertility and lessens the land's ability to sustain robust crops. When trees are cut down, the soil becomes vulnerable to wind and rain, which removes important topsoil and reduces the land's suitability for farming.

Therefore, deforestation exacerbates poverty and vulnerability in rural communities that rely largely on agriculture for survival, endangering long-term food security in addition to causing immediate crop failures (Emiru et al., 2023).

Animal deaths are another significant effect of deforestation, as reported by 23% (46) of respondents. This is a serious problem for communities who rely on cattle for cultural traditions, food, and revenue. Local biodiversity is at risk due to habitat loss caused by the degradation of forests, which offer vital habitats for species. The loss of forests results in less grazing places and water sources for livestock, which stresses animals and makes them more susceptible to disease, predation, and hunger. The loss of natural pollinators and pest controllers, which are crucial for preserving balanced agricultural ecosystems, is one example of how biodiversity loss indirectly exacerbates the direct consequences on cattle health (Sinclair et al., 2019). In addition to endangering food security, animal losses also jeopardize farming families' financial stability, making it harder for them to handle financial difficulties and escalating poverty (Ayinu et al., 2022).

According to results of figure 5, 26% (52) of respondents, human health issues are another important effect of deforestation. There are several direct and indirect health concerns associated with forest degradation. The burning of plants during forest clearance raises urgent concerns about air pollution because it releases particulate matter into the atmosphere, aggravating respiratory conditions such pneumonia, bronchitis, and asthma (FAO, 2021). Furthermore, because shifting land use patterns frequently result in new breeding grounds for disease-carrying insects like mosquitoes, deforestation is associated with the spread of vector-borne diseases. This raises the danger of illnesses like dengue fever and malaria, especially in areas with already overburdened health systems (Gashure, 2024). The health issues that communities in deforested areas confront are made worse by the loss of forests, which also reduces the availability of medicinal plants that are essential to regional health systems (Jagger et al., 2021). Deforestation thus causes a complex health catastrophe that impacts public health systems as well as the physical environment.

Another major effect of deforestation, according to survey results 8% (16) of respondents, is water scarcity. By preserving soil moisture levels and promoting groundwater recharge, forests are essential for controlling regional hydrological cycles. These vital processes are upset when forests are cut down, which lowers water availability and exacerbates water stress, especially in rural regions where water scarcity is already a problem (Eeswaran et al., 2022). Deforestation increases surface runoff, which speeds up soil erosion and lowers the quality of available water, while tree loss decreases the soil's capacity to hold water. Consequently, the socio-economic vulnerabilities of rural populations are exacerbated as communities that rely on forests for dependable and clean water supplies encounter growing challenges in obtaining water for drinking, irrigation, and livestock (Malczewski, 2006).

Finally, Figure 5's depiction of the effects of deforestation highlights the connection between socioeconomic stability and environmental health. Water scarcity, crop loss, animal deaths, and human health issues highlight the complex ways that deforestation affects lives and highlight how urgent it is to solve environmental degradation. In rural communities, these issues have an impact on public health, food security, economic stability, and general resilience. The results emphasize the necessity of reforestation initiatives, sustainable land-use practices, and legislative changes that put forest conservation first and safeguard the vital services that forests offer. In order to mitigate the effects of deforestation, foster resilience in impacted communities, and ensure long-term environmental and economic sustainability, it is imperative that such solutions be put into practice (OCHA, 2018).

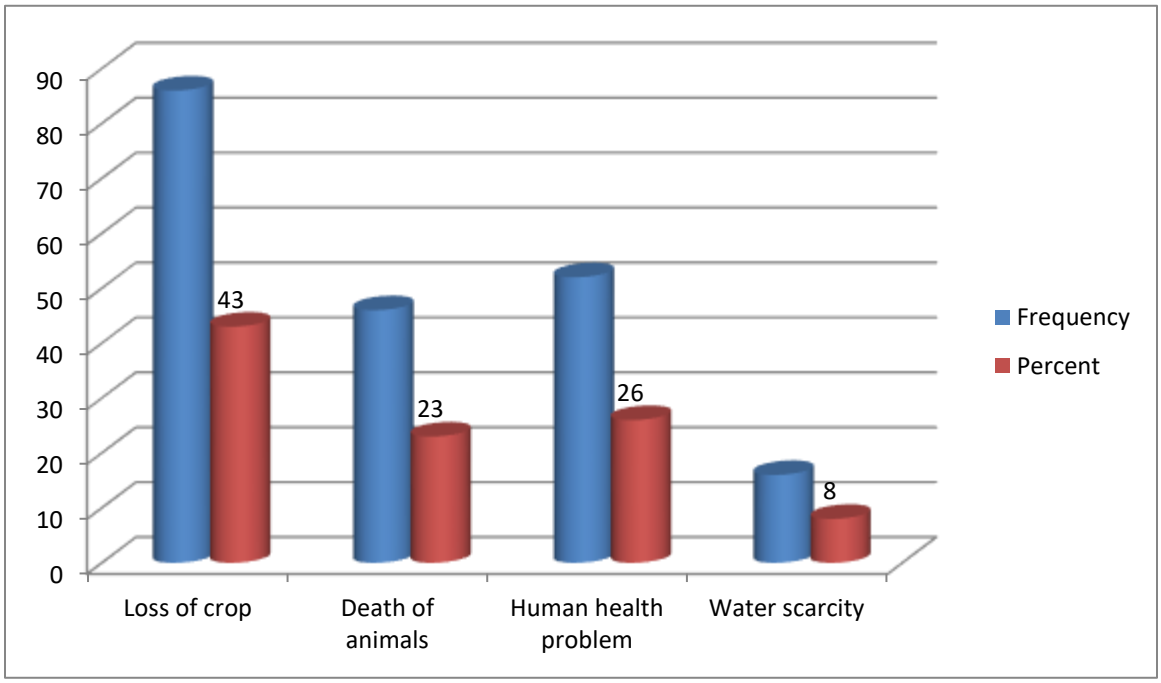

Figure 2: The Consequences of Deforestation on Livelihood

The strategies to Minimize Deforestation in the Study Area

Deforestation continues to be one of the world's most urgent environmental problems, affecting soil health, biodiversity, and climate. For long-term ecological and socioeconomic stability, effective measures to lessen its consequences are essential. According to survey results, respondents have indicated a number of measures, such as planting trees in conjunction with water and soil conservation practices, educating societies, afforestation and reforestation, enhancing household livelihoods, and encouraging participatory forest management (PFM). Different aspects of the deforestation problem are addressed by each of these tactics, and current research confirms their importance and efficacy in advancing sustainable forest management.

Table 7 shows that 49% (98) of respondents selected the combination of planting trees and putting soil and water conservation measures into practice as the most often favored strategy. By restoring ecosystem functioning, this strategy immediately addresses the environmental damage brought on by deforestation. A tried-and-true strategy for increasing biodiversity, restoring forest cover, and

enhancing soil quality is planting trees. It stabilizes water cycles, improves carbon sequestration, and lessens soil erosion (Alene, 2022). The efficiency of planting trees is further strengthened by using soil and water conservation techniques, such as terracing, mulching, and agroforestry systems, which decrease land degradation, improve soil fertility, and increase water retention. In particular, agroforestry is a two-pronged strategy that helps preserve forest ecosystems and boost agricultural productivity by planting trees next to crops (Emerta & Aragie, 2013). Tree planting combined with integrated soil and water conservation methods has been shown in recent research to restore ecosystems and guarantee the long-term viability of farming communities (Ferede et al., 2013). Because of this, it provides a thorough and long-lasting remedy for deforestation.

Table 7 results show that 18% (36) of respondents agreed that educating society about the value of forest conservation is important. In order to change behaviour and promote a greater appreciation of the importance of forests, education is essential. Increasing knowledge of the advantages of forest protection for the environment, the economy, and human health might encourage local communities to embrace sustainable practices. According to Chomba et al. (2019), community-based education initiatives are very successful at boosting involvement in conservation initiatives. Communities are made more aware of the long-term benefits of preserving forest resources by educating them about the ecological functions of forests, such as carbon sequestration, water control, and biodiversity conservation. For instance, these educational campaigns have boosted local participation in forest conservation projects in Brazil (Anteneh, 2022). The foundation for community-driven conservation initiatives is thus strengthened by educating societies, which results in more sustainable forest management.

According to table 7, reforestation and afforestation, which were mentioned by 12.5% (25) of respondents, concentrate on reforesting regions that were previously unfrosted or deforested. Reversing deforestation and its negative environmental effects requires both tactics. Reforestation is the process of growing trees again in regions where forests have disappeared. It improves biodiversity, restores soil fertility, and helps ecosystems recover. Planting trees in previously unfrosted regions, or afforestation, helps increase global forest cover and improve carbon sequestration, both of which are essential for reducing the effects of climate change (Ferede et al., 2013). In addition to helping to restore the environment, these initiatives generate revenue through ecotourism, carbon credits, and sustainable timber production (Molnar et al., 2021). Afforestation and reforestation initiatives that are successful need careful planning, which includes selecting native species that are appropriate for the area. According to recent studies, these kinds of initiatives help communities economically and ecologically, providing long-term answers to the problems caused by deforestation (Lillesand et al., 2004).

As results of table 7, enhancing household incomes or livelihoods is a technique that 14.5% (29) of respondents favor. Particularly in rural areas where residents mostly depend on forest resources for subsistence, economic development is a major contributor to deforestation. Communities can lessen their reliance on damaging land-use practices like slash-and-burn agriculture by offering alternative livelihoods like eco-friendly agriculture, sustainable forestry methods, or the gathering of non-timber forest products (NTFPs). Encouraging agroforestry, in which farmers plant trees next to crops, provides a practical substitute for deforestation. While maintaining forest cover, these systems boost revenue (Purba et al., 2019). Communities are also empowered to embrace sustainable practices through training, financial resources, and market accessibility. Studies have indicated that enhancing livelihoods via these substitutes can lessen forest pressure and support both environmental sustainability and economic stability (Abera et al., 2021). This approach

guarantees the welfare of both people and the environment by combining revenue-generating endeavors with environmental preservation.

Finally, 6% (12) of respondents favored participatory forest management (PFM), a tactic that promotes active community involvement in forest management and conservation (table 7). PFM encourages a sense of accountability and ownership, which results in more sustainable forest conservation and use. This method guarantees that forest management is in line with the interests and goals of people who depend on forests for their livelihoods by including local communities in decision-making processes. Recent research has shown that PFM promotes better forest regeneration, better forest governance, and more biodiversity protection. Additionally, it fosters social justice because sustainable forest management benefits nearby communities (Deribe, 2019). Brazil has demonstrated the promise of this community-based approach for reducing deforestation through successful PFM efforts that have led to better forest resource management and more effective forest conservation (Tesfaye, 2004).

Finally, the methods that survey participants highlighted offer a thorough strategy for dealing with deforestation, each of which contributes to a different facet of the issue. These techniques provide workable ways to reduce deforestation, from planting trees and conserving soil and water to developing participatory forest management, educating people, encouraging afforestation and reforestation, and enhancing livelihoods. By combining these tactics into a coherent framework and supporting them with good policy, community education, and active engagement, it is possible to create resilient communities and protect important ecosystems. The ecology and local livelihoods are still at risk due to the effects of deforestation, therefore these diverse approaches offer a comprehensive and long-term solution to forest protection (Giliba et al., 2011).

Table 7: The Best Strategies to Minimize Deforestation

Strategies to Minimize Deforestation	Frequency	Percent	Cumulative Percent
Planting Trees and Soil & water conservation practices	98	49.0	49.0
Teaching societies	36	18.0	67.0
Afforest and Reforest	25	12.5	79.5
improve livelihoods of the households	29	14.5	94.0
Practice the PFM	12	6.0	100.0
Total	200	100.0	

The Role of Indigenous Knowledge for the Community Based Sustainable Forest Management

In Brazil, indigenous knowledge has long been the cornerstone of community-based programs and sustainable forest management. These customs have been carried down through the years and are ingrained in the local communities' culture and traditions. Based on survey data and the several responsibilities indicated in the table, the analysis that follows examines how IK promotes sustainable forest management. Traditional forest management, biodiversity preservation, agroforestry, climate change adaptation, community empowerment and conflict resolution, sustainable resource use, and fair access are some of these functions.

According to table 8 results, Traditional Forest Management (TFM) practices, as indicated by 12% (24) of respondents, have long been essential to study area's sustainable forest use. Community-

based governance and traditional laws, like the Kebele forest management system, which aids in local resource use regulation, serve as the foundation for these practices. By using collaborative decision-making to regulate timber and non-timber forest products and restrict seasonal harvesting, IK makes sure that forest resources are used responsibly. In addition to maintaining forest regeneration and preventing overexploitation, these methods provide long-term ecological sustainability (IPCC, 2014). Research shows that community resilience and forest health are enhanced by locally led forest management methods (Berrang-Ford et al., 2011). Indigenous practices are a great addition to contemporary conservation techniques since they are flexible and able to react to changes in the local environment.

The preservation of biodiversity is another crucial area where IK is essential, as highlighted by 11.5% (23) of respondents (table 8). Indigenous people in Brazil preserve biodiversity through cultural taboos and sacred woods. Often off-limits to human activity outside of religious rites, sacred forests function as natural havens that protect biodiversity and provide sanctuary to endangered species. In order to preserve species diversity and environmental balance, indigenous practices also involve sustainable resource harvesting techniques. According to Batdelger et al. (2025), these conservation techniques provide important insights on how to incorporate traditional knowledge with modern conservation frameworks, as they frequently correspond with present biodiversity protection measures. These techniques' profound reverence for the natural world encourages a conservation ethic that permeates every facet of forest management, safeguarding the ecosystem and local livelihoods.

Table 8 results show that 15% (30) of respondents acknowledged agroforestry as a crucial component of sustainable land use and forest management. Agroforestry systems, in which trees are incorporated into agricultural landscapes, have long been a part of indigenous knowledge. Numerous advantages result from this method, including increased agricultural productivity, water conservation, and improved soil fertility. Alongside crops, trees provide shade, prevent soil erosion, and enhance microclimates, all of which increase a crop's resistance to climate change. According to studies, Braziln agroforestry systems improve food security, encourage forest conservation, and lessen the negative effects of deforestation (Moloise et al., 2024). Forest ecosystems and agricultural lives can coexist successfully thanks to this integrated approach, which benefits the environment and nearby populations.

Indigenous knowledge is crucial for adapting to climate change, according to 21% (42) of respondents (table 8). For communities who depend on forests in Brazil, where climate variability and extreme weather events are becoming more prevalent, traditional knowledge offers vital insights into regional climate trends. Communities can forecast seasonal shifts and modify agricultural methods to prepare for unfavorable weather by using natural indications like plant blossoming or animal behaviors. Climate-smart forest management techniques are promoted by these adaptive strategies, which have been demonstrated to increase resilience to climate impacts including temperature and rainfall fluctuations. Local adaptability is increased and climate change vulnerability is decreased when traditional knowledge and contemporary climate research are combined (Ayinu et al., 2022). This integration of scientific and Indigenous knowledge provides a comprehensive strategy for enhancing community resilience to climate-related issues.

Table 8 shows that 21% (42) of respondents said that indigenous knowledge is important for conflict resolution and community empowerment. By resolving conflicts over forest resources, traditional conflict resolution techniques like elder mediation ensure fair access and preserve social

peace. By empowering local people with IK, more sustainable forest management results from a sense of ownership and accountability for local resources. In Brazil, participatory forest management (PFM) systems that integrate local knowledge and decision-making have shown effectiveness, proving that community-based approaches boost social justice and improve conservation outcomes (Motuma, 2017). By offering a forum for discussion and dispute settlement, IK fortifies governance frameworks and guarantees that resources are distributed fairly, which benefits every community member.

Indigenous Knowledge systems are based on the core principles of equal access and sustainable resource usage, as reported by 5.5% (11) of respondents (table 8). Overexploitation of forests is prevented by methods including controlled burning, selective cutting, and the sustainable harvesting of non-timber forest products (NTFPs). These techniques contribute to the long-term availability of resources and the preservation of forest health. Furthermore, traditional knowledge makes sure that everyone in the society has fair access to forest resources, avoiding the concentration of resources in the hands of a small number of people. This strategy ensures that everyone, particularly underserved communities, benefits from forest resources while preventing resource depletion and promoting social fairness (Erena & Worku, 2018).

According to Table 8 shows 14% (28) of the responses, represents other functions of Indigenous Knowledge in forest management that do not cleanly fit into the aforementioned categories. These could include methods for conserving water, managing fires, or using therapeutic herbs. Even though these methods vary, they all support the general sustainability of forest ecosystems. Traditional approaches to managing water supplies and preventing forest fires, for instance, are essential to preserving the health of forests. Similarly, the utilization of therapeutic herbs, which are frequently found in woods, offers both financial and health advantages. Local communities' well-being and sustainable forest management benefit greatly from these knowledge systems, which have been handed down through the generations (Malczewski, 2006).

Finally, the survey's results show the diverse contribution that Braziln Indigenous Knowledge makes to Community-Based Sustainable Forest Management (CBFM). IK provides a comprehensive approach to forest conservation that includes everything from climate change adaptation and community empowerment to biodiversity protection and traditional forest management practices. Brazil can improve its forests' sustainability and resilience by combining Indigenous customs with contemporary conservation techniques, guaranteeing that nearby populations will continue to profit from these essential resources. Forest governance systems will become more inclusive, sustainable, and efficient if IK is incorporated into official policies and management frameworks like Participatory Forest Management (PFM). Brazil serves as an example of how to combine traditional knowledge with modern environmental management techniques to protect people and the environment, as the world community comes to understand the value of community-based approaches (Wanjiru, 2021).

Table 8: Role of Indigenous Knowledge for the Community Based Sustainable Forest Management

Role of Indigenous Knowledge	Frequency	Percent	Cumulative Percent
Traditional Forest Management	24	12.0	12.0
Biodiversity Conservation	23	11.5	23.5
Agroforestry	30	15.0	38.5
Climate Change Adaptation	42	21.0	59.5
Community Empowerment and Conflict Resolutions	42	21.0	80.5
Sustainable Resource Use and Equitable Access	11	5.5	86.0
Others	28	14.0	100.0
Total	200	100.0	

Community's Cultural Value or Belief towards the Forest

The community's cultural values and beliefs about the forest show a strong bond with the natural world and an understanding of how important forests are to their way of life (figure 5). Figure 5 of the study indicates that most participants had strong cultural beliefs about protecting forests, using resources sustainably, and reducing environmental damage.

According to results of figure 5 show that 59.0% (118) respondents stress the importance of preventing needless harm to the forest. This conviction emphasizes how the community values the forest's ecological and cultural significance. Their protective attitude probably results from long-standing cultural ideals that place a strong emphasis on reverence for the natural world and the understanding that the forest supports local livelihoods, biodiversity, and climate regulation. Communities with such close relationships to forests are more likely to take an active role in conservation efforts because they see the forest as an essential component of their heritage and well-being (Bhatt et al., 2024).

As results of figure 5, 18.5% (37 respondents) that who emphasize limiting resource use to personal necessities in order to minimize needless forest harm. This viewpoint, which advocates for the moderate use of forest products rather than their excessive or commercial usage, represents a sustainable approach to the management of forest resources. According to Stevens et al. (2025), this perspective is consistent with traditional conservation traditions that emphasize the significance of taking only what is necessary to maintain ecological balance and long-term sustainability.

Furthermore, 18.0% (36 respondents) underlined their dedication to the sustainable use of forest resources, supporting methods such as replanting and restricted harvesting. The knowledge that the forest's resources are limited and need to be carefully managed to guarantee their availability for future generations is the foundation of this idea. Communities with such sustainable-use principles are crucial allies in accomplishing long-term conservation objectives and halting deforestation (Legesse et al., 2012).

Nonetheless, 4.5% (9 respondents) of the sample said they had no cultural or relational relevance to the forest. People who have moved away from traditional customs, maybe as a result of urbanization, shifting livelihoods, or a decreased dependence on forest resources, may symbolize

this smaller group. Such changes, according to Anderson (2023), are typical when societies change and adjust to contemporary economic pursuits that are not centered on the forest.

According to the survey's findings of figure 5, most members of the community have strong cultural attitudes about protecting forests, using resources sustainably, and avoiding needless exploitation. These ideals, which highlight the significance of local community participation in forest management, are consistent with more general global conservation concepts (FAO, 2024). The low number of people who are cut off from the forest highlights the necessity of ongoing education and awareness campaigns that promote a sense of shared environmental responsibility and guarantee that future generations maintain their cultural ties to the forest.

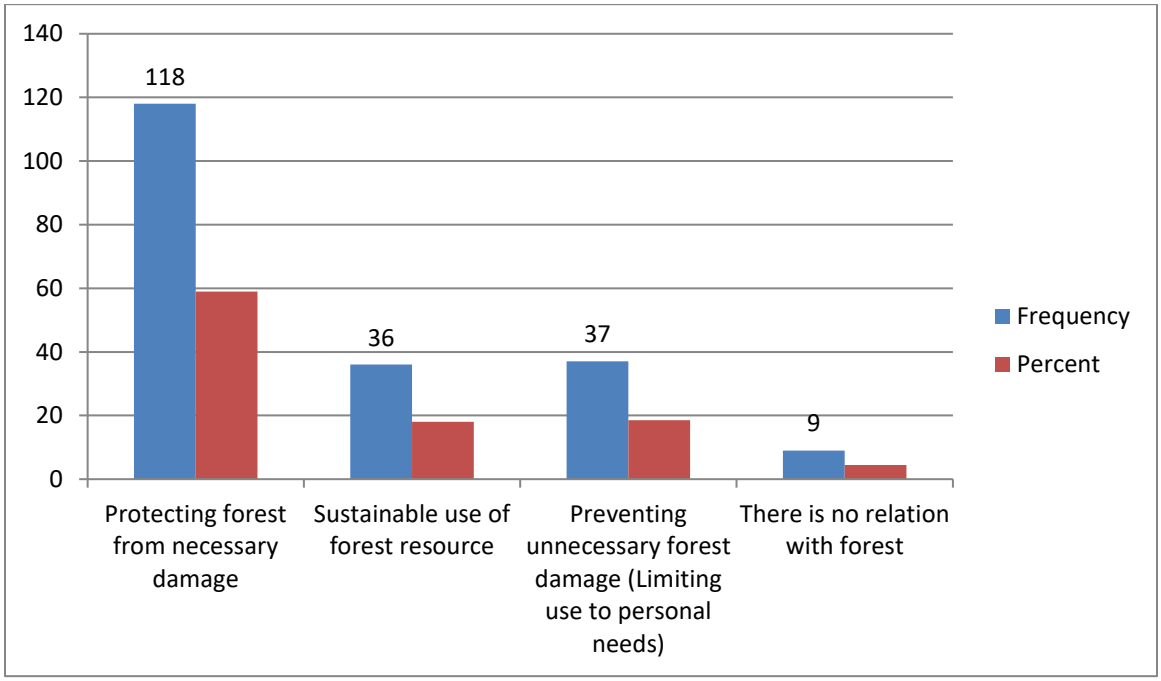

Figure 3: The Cultural Value or Belief of the Community towards the Forest

Analysis of the inferential Statistics

Interpretation of Regression Results for Community-Based Forest Management (CBFM)

According to table 9, the regression analysis's findings shed light on the variables affecting community-based forest management's (CBSFM) existence at the kebele level. According to the model summary, the independent variables can only account for 12.9% of the variance in CBSFM implementation, with an R^2 value of 0.129 (table 9). The low explanatory power of these variables is further highlighted by the adjusted R2 of -0.019, which raises the possibility of other unmeasured factors at work. The total regression model is not statistically significant, as indicated by the F-statistic of 0.871 and p-value of 0.659 (table 9). This suggests that the predictors taken into account in the model are not able to adequately characterize CBSFM practices in the research area.

The two most significant factors among the individual predictors were predicted gains from CBSFM (B = 0.070, p = 0.017) and livelihood activity (B = 0.160, p = 0.083) (table 9). Participation in CBSFM was higher among households with a variety of livelihood activities, including small companies and agriculture, possibly as a result of their increased interest in

sustainable land and resource management. Moreover, the positive correlation for perceived benefits from CBSFM implies that concrete rewards, such enhanced forest resources or financial gains from sustainable practices, boost involvement in forest management.

However, deforestation awareness, attitudes towards PFM (participatory forest management), obstacles to CBSFM, and the effects of deforestation did not significantly correlate with CBSFM participation. This suggests that although the public is aware of the effects of deforestation, forest management practices do not appear to be influenced by these concerns alone. According to these findings, socioeconomic reasons and the anticipation of immediate advantages may have a greater impact on CBSFM's existence than environmental knowledge alone.

The ANOVA findings highlight the complexity of CBSFM implementation and further support the absence of model significance (p = 0.659) (table 9). According to this poor model fit, social norms, local governance, and the execution of policies are some examples of variables that are likely to be crucial in determining the effectiveness of CBSFM.

Lastly, the model's low explanatory power highlights the importance of looking into additional factors, even while traits like livelihood diversification and anticipated benefits showed a positive link with CBSFM participation. Prospective studies could examine how local government structures, policy enforcement, and institutional support affect CBSFM outcomes. By acknowledging these complex relationships and addressing barriers to involvement, more effective strategies for enhancing CBSFM effectiveness can be developed.

Table 9: Analyzing the dependent and independent values (Model Summary[b])

R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
				R Square Change	F Change	df1	df2	Sig. F Change
.360[a]	.129	-.019	.44113	.129	.871	29	170	.659
ANOVA[a]	Sum of Squares	df	Mean Square	F	Sig.			
Regression	4.914	29	.169	.871	.659[b]			
Residual	33.081	170	.195					
.360[a]	.129	-.019	.44113	.129	.871	29	170	.659

a. Predictors: (Constant)

According to table 10 results, the multiple regression analysis investigates the connection between the existence of Community-Based Forest Management (CBFM) in a kebele and sociodemographic, institutional, and economic aspects. By assessing coefficients, significance thresholds, and multicollinearity statistics, the model offers valuable information about the factors that influence CBFM engagement.

The model constant, which indicates a baseline likelihood of CBFM presence, is significant (B = 1.076, p = 0.009) (table 10). However, a large number of socio-demographic characteristics, such as age, marital status, sex, family size, education level, and education level, do not substantially affect CBFM involvement (all p-values > 0.05) (table 10). However, age (VIF = 3.661) indicates

possible multicollinearity problems, indicating that more research is necessary to lessen this redundancy. Furthermore, livelihood activity gets close to significance (B = 0.160, p = 0.083), suggesting that groups with a variety of livelihood strategies may be more likely to engage in CBFM, but the effect is still slight. CBFM is also not significantly impacted by agricultural practices, such as property ownership or agricultural use (B = 0.041, p = 0.771; B = 0.021, p = 0.659). These results imply that differences in CBFM participation cannot be adequately explained by socio-demographic and agricultural factors alone (table 10).

However, the anticipated advantages of Participatory Forest Management (PFM) are the most significant predictor (B = 0.070, p = 0.017, Beta = 0.256) (table 10). Communities are more inclined to participate in CBFM when they expect observable benefits, including better community development or forest protection, according to this positive and statistically significant association (table 10).

Information provision alone may not be enough to promote active involvement in forest management, as institutional characteristics such as perception of PFM and access to forest management information do not substantially effect participation ($p > 0.05$) (table 10). Stronger educational initiatives are required to boost involvement, as evidenced by the insignificance of environmental awareness-related factors including perceptions of forest conservation and awareness of deforestation.

Due to high Variance Inflation Factors (VIFs), multicollinearity is a concern for a number of predictors. The variable "Agriculture major livelihood activity" has a high VIF of 4.569, for instance, indicating a possible link with other factors connected to livelihood. In order to handle multicollinearity, this may skew the regression findings and indicate the necessity for methods like stepwise regression or Principal Component Analysis (PCA).

According to the regression analysis (table 10), perceived gains from PFM are a key factor in explaining CBFM participation, but socio-demographic and institutional factors are little significant. Programs that clearly define and provide communities with measurable benefits should be a top priority for policymakers and forest managers in order to increase community involvement in forest conservation initiatives. More robust and successful community-based forest management initiatives will also be ensured by tackling multicollinearity and increasing educational outreach.

Table 10: Interpretation of Regression Results for Community-Based Forest Management (CBFM)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	1.076	.407		2.647	.009	.274	1.879		
	Sex	.049	.100	.038	.490	.625	-.149	.247	.854	1.172
	Age	.030	.066	.063	.460	.646	-.099	.160	.273	3.661
	Education Level	.012	.034	.028	.336	.737	-.056	.080	.717	1.395
	Marital status	.029	.070	.033	.416	.678	-.109	.168	.809	1.235
	Family size	-.028	.053	-.056	-.533	.595	-.134	.077	.461	2.171
	Livelihood activity	.160	.092	.162	1.745	.083	-.021	.341	.598	1.673
	Farm Lands	.041	.140	.036	.291	.771	-.235	.317	.345	2.903
	Farm Lands you Own	.021	.048	.043	.441	.659	-.074	.117	.531	1.882
	Agriculture livelihood activity	.002	.053	.007	.046	.963	-.103	.108	.219	4.569
	Deforestation	-.038	.051	-.082	-.741	.460	-.138	.063	.421	2.378
	Causes of forest Depletions	-.012	.041	-.043	-.299	.765	-.092	.068	.253	3.957
	Perception towards PFM in conserving forest	-.035	.046	-.061	-.762	.447	-.127	.056	.808	1.237
	Best means of conservation forest	.022	.034	.077	.643	.521	-.045	.088	.361	2.770
	Participate in FM	.024	.036	.070	.671	.503	-.047	.096	.472	2.119
	Benefits you expect from PFM	.070	.029	.256	2.409	.017	.013	.127	.454	2.204
	Interest of group to FM	-.003	.041	-.008	-.084	.933	-.084	.077	.605	1.654
	Cultural value or belief of the community towards the forest	-.007	.045	-.015	-.157	.875	-.096	.082	.564	1.774
	Access to Institutional Factors	.101	.134	.063	.754	.452	-.163	.365	.739	1.352
	Access to FM information?	-.080	.167	-.038	-.476	.635	-.410	.251	.808	1.237
	Source of your information to FM?	.033	.072	.038	.458	.648	-.109	.174	.729	1.372
	Challenges of the CBSFM	-.005	.039	-.018	-.130	.897	-.082	.072	.261	3.830
	Consequences of deforestation	-.003	.059	-.007	-.049	.961	-.119	.114	.276	3.622

What are the best strategies to minimize deforestation?	-.030	.033	-.089	-.901	.369	-.094	.035	.525	1.905

a. Dependent Variable: Is there the community based forest management at your kebele

According to results of figure 6, the normality assumption of the regression model's residuals is evaluated using the Normal P-P plot of Regression Standardized Residuals. Whether community-based forest management (CBFM) is practiced in the respondent's kebele is the dependent variable. The P-P plot contrasts the expected cumulative probabilities from a normal distribution with the observed cumulative probabilities of standardized residuals (figure 6). The diagonal in this plot is closely followed by the majority of the data points, indicating that the residuals are approximately normal (figure 6). Nonetheless, minor variations in the upper tail (above 0.8 on the observed cumulative probability axis) point to potential outliers or positive skewness (figure 6), which could affect the outcomes of the regression. The central limit theorem may prevent assumptions from being violated by minor variations, like the one observed here, which are typical in large samples (Leal et al., 2021).

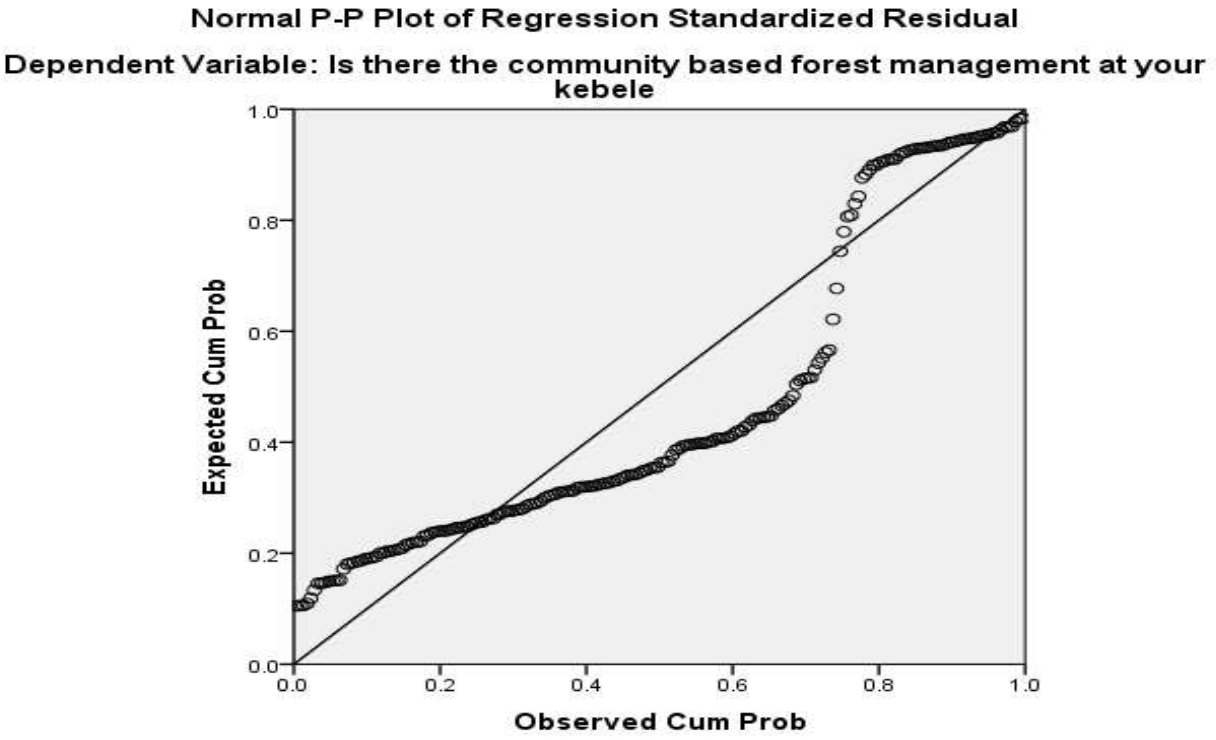

Figure 4: The Normal P-P plot of Regression Standardized Residuals

5.1 Conclusions

In Amazon Rainforest, the use of Community-Based Participatory Forest Management (CBPFM) has become a best-changer for community empowerment and ecological preservation. The following are the study's main findings: Significant gains in biodiversity and forest regeneration have resulted from local communities utilizing both contemporary management techniques and

their traditional knowledge. A strong sense of ownership has been fostered by their active participation, guaranteeing the forest's sustainable management and preservation for coming generations. The Pará State has seen substantial socioeconomic benefits as a result of the CBPFM effort. Communities have lessened their reliance on exploitative behaviors by encouraging varied revenue streams through environmentally friendly businesses and sustainable resource use, creating the foundation for long-term economic sustainability. The community's perception of participatory forest management (PFM) is critical to its effectiveness. Qualitative results showed gaps in community engagement, resource disputes, and a reduction in indigenous conservation practices. The main challenges mentioned by the participants were inadequate stakeholder participation, insufficient institutional support, and inconsistent policy enforcement. For efficient resource management, traditional leaders were adamant about bringing back indigenous customs like community patrols and selective harvesting.

The CBSFM approach relies on strong multi-stakeholder engagement to be successful. Together, local citizens, governmental entities, and non-governmental organizations have developed a dynamic framework that successfully tackles socioeconomic and environmental issues while encouraging a shared responsibility and innovative culture. Notwithstanding the noteworthy accomplishments, there is yet more work to be done to reach complete sustainability. The CBSFM model at Amazon Rainforest must be strengthened, policy frameworks must be improved, and coordination amongst all stakeholders must be improved in order for it to continue serving as a reproducible and long-lasting model for sustainable forest management. In Amazon Rainforest, the CBSFM strategy promotes socioeconomic development and community resilience in addition to protecting a vital environment. This concept is a brilliant illustration of how community-driven, integrated management can produce real advantages for people and the environment, providing important insights for initiatives of a similar sort around the world.

6.1 Recommendations

In order to advance community-based sustainable forest management in Amazon Rainforest, all governmental levels must adopt a cohesive and flexible strategy. First, a strong legal framework that supports community-led conservation should be created and updated on a regular basis by the federal government. This framework should be supported by specific funding sources and strengthened by calculated expenditures in research and capacity building. Second, in order to empower regional efforts, the Regional Government should lead the establishment of a dynamic multi-stakeholder coordination committee that can modify national guidelines to suit local circumstances and offer unwavering technical and logistical assistance.

Thirdly, the Pará State needs authorities to create a comprehensive forest management plan that successfully combines traditional knowledge with contemporary conservation methods, guaranteeing efficient cooperation amongst levels of government. The implementation of participatory management plans that actively involve communities, promote continuous capacity building, and include open monitoring and dispute resolution procedures should be encouraged by both Woreda leaders. Long-term community resilience, sustainable livelihoods, and ecological integrity will all be ensured by consistent communication and cooperation between all tiers of government.

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