ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jun664

Evaluating the Effectiveness of Afforestation Policies and Alternative Energy Programs in Reducing Deforestation and Charcoal Dependency in Rural Part of Sinazongwe District: A Case of Chiyube and Kasanse Villages

Rodwell Gwelengwe[1]; Dr. Kelvin Chibomba[2]; Dr. Chisala[3]

[1]School of Humanities, MA Development Studies Student, Information and Communication University, Lusaka, Zambia.
[2]Lecturer, School of Humanities, Information and Communication University, Zambia
[3]Lecturer, School of Humanities, Information and Communication University, Lusak

Publication Date: 2026/08/03

Abstract: Understanding afforestation programs and alternative energy programs is key and important in addressing deforestation and charcoal dependence among residents. The aim of the study was to evaluate the effectiveness of afforestation policies and alternative energy programs in reducing deforestation and charcoal dependency in rural Sinazongwe, Zambia: A case study of Kasanse and Chiyube villages. The study objectives focused on assessing the benefits of afforestation policy in minimizing deforestation, evaluate the effect of alternative energy programs on household charcoal dependency and energy transition in rural communities, examine challenges to the effective implementation of afforestation and alternative energy policies at the local level and recommend strategies for enhancing afforestation efforts and alternative energy sources adoption. The study used qualitative and descriptive research design. In this study, the target population was 100 participant of which 70 was the sample size sampled using purposive followed by snowball sampling technique. The study collected both primary and secondary data therefore, primary data was collected using interviews, focus group discussion and key informants interviews while secondary was based on the previous studies done by different authors in line with the study objectives. Data analysis was done systematically with content analysis with the help of SPSS and Nvivo wth triangulation method. The study found that afforestation policy in Kasanse and Chiyube villages increased awareness of tree planting, improved vegetation cover, restored biodiversity, and created income-generating opportunities such as beekeeping, seedling sales, and sustainable timber harvesting. Alternative energy programs reduced household reliance on charcoal by promoting solar home systems and improved stoves, resulting in cost savings, improved health, and time efficiency. However, challenges including high upfront costs, low seedling survival, unreliable electricity, weak policy enforcement, and land tenure insecurity limited the full effectiveness of both interventions. Overall, the findings indicate that while these policies have positively impacted environmental conservation and energy transition, addressing economic, technical, and institutional barriers is critical for sustained benefits. In line with the fourth and last objective, the study found that, the recommended strategies which included economic incentives to residents, local supply chain strengthening, enforcing the policies, extensive capacity building for people, enforce and promote climate resilient tree planting and educating the community on afforestation and alternative energy programme. The study concluded and recommended the need for consented effort among government, private sector and local people and enhance enforcement to improve preservation and conservation.

Keywords: *Afforestation, Alternative Energy, Policy, Effectiveness, Deforestation, Charcoal Dependence*.

How to Cite: Rodwell Gwelengwe; Dr. Kelvin Chibomba; Dr. Chisala (2026) Evaluating the Effectiveness of Afforestation Policies and Alternative Energy Programs in Reducing Deforestation and Charcoal Dependency in Rural Part of Sinazongwe District: A Case of Chiyube and Kasanse Villages. *International Journal of Innovative Science and Research Technology*, 11(6), 3984-4005. https://doi.org/10.38124/ijisrt/26jun664

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jun664

I. INTRODUCTION

➢ *Background*

Zambia faces significant deforestation challenges, with an estimated annual loss of 250,000 to 300,000 hectares of forest. Key drivers include agricultural expansion, infrastructure development, and a heavy reliance on wood fuel-charcoal and firewood-for energy. Charcoal production is a major contributor to forest degradation in Zambia. A study by Syampungani et al. (2022) indicates that forest degradation resulting from charcoal production has surpassed deforestation due to agricultural expansion as the main tree cover loss process in Zambia. The study highlights that charcoal production is responsible for the removal of about 79.3% of the aboveground biomass and reductions of 74.2% of trees cover in affected areas.

The Zambian government has recognized the severity of deforestation and has implemented various policies and programs to address the issue. The National Investment Plan to Reduce Deforestation and Forest Degradation (2018-2022) outlines strategies to combat deforestation, including afforestation and reforestation initiatives, promotion of alternative livelihoods, and strengthening of forest governance. Furthermore, the government has been scaling up afforestation and reforestation programs and enforcing forest protection laws to mitigate deforestation (Ministry of Land and Natural Resources, 2022).

In addition to afforestation efforts, Zambia has been exploring alternative energy solutions to reduce charcoal dependency. The promotion of sustainable energy solutions, such as solar and biogas technologies, aims to provide cleaner and more sustainable energy sources for households. However, the adoption of these alternatives faces challenges, including high initial costs, limited awareness, and cultural preferences for traditional cooking methods.

➢ *Statement of the Problem*

Zambia has been promoting afforestation measures to reduce deforestation and exploring alternative energy solutions to reduce charcoal dependency. The promotion of sustainable energy solutions, such as solar and biogas technologies, aims to provide cleaner and more sustainable energy sources for households. Despite the implementation of afforestation policies and alternative energy programs in Zambia, deforestation rates remain alarmingly high, particularly in rural areas like Sinazongwe District. The adoption of these alternatives faces challenges, including high initial costs, limited awareness, and cultural preferences for traditional cooking methods. Communities in Kasanse and Chiyube villages continue to rely heavily on charcoal for their energy needs, contributing to ongoing forest degradation. The persistent dependence on charcoal suggests potential shortcomings in current policies and programs, including issues related to implementation, community engagement, and the availability and adoption of alternative energy sources. A critical evaluation of these interventions is necessary to identify gaps and develop more effective strategies to reduce deforestation and charcoal dependency in these communities.

➢ *Objectives*

This study was guided by the following objectives.

- To explore the benefits of afforestation policy in minimizing deforestation.
- To evaluate the effect of alternative energy programs on household charcoal dependency and energy transition in rural communities.
- To examine challenges to the effective implementation of afforestation and alternative energy policies at the local level.
- To recommend strategies for enhancing afforestation efforts and alternative energy sources adoption.

➢ *Research Questions*

The study was seeking answers to the following questions.

- What are the benefits of afforestation in minimizing deforestation?
- What are the effects of alternative energy programs on household charcoal dependency and energy transition in rural communities?
- What challenges are there for effective implementation of afforestation and alternative energy policies/programs at the local level?
- What recommended strategies are effective for enhancing afforestation efforts and alternative energy sources adoption?

➢ *Conceptual Framework*

Afforestation policies and alternative energy programs influence deforestation and charcoal dependency by providing sustainable alternatives. However, the effectiveness of these interventions depends on moderating factors such as government enforcement, community acceptance/willingness, and affordability. Strong policy implementation and community engagement enhance adoption rates, while weak enforcement and high costs may hinder success. The balance between these variables determines whether the interventions lead to long-term/short-term sustainability in rural communities.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jun664

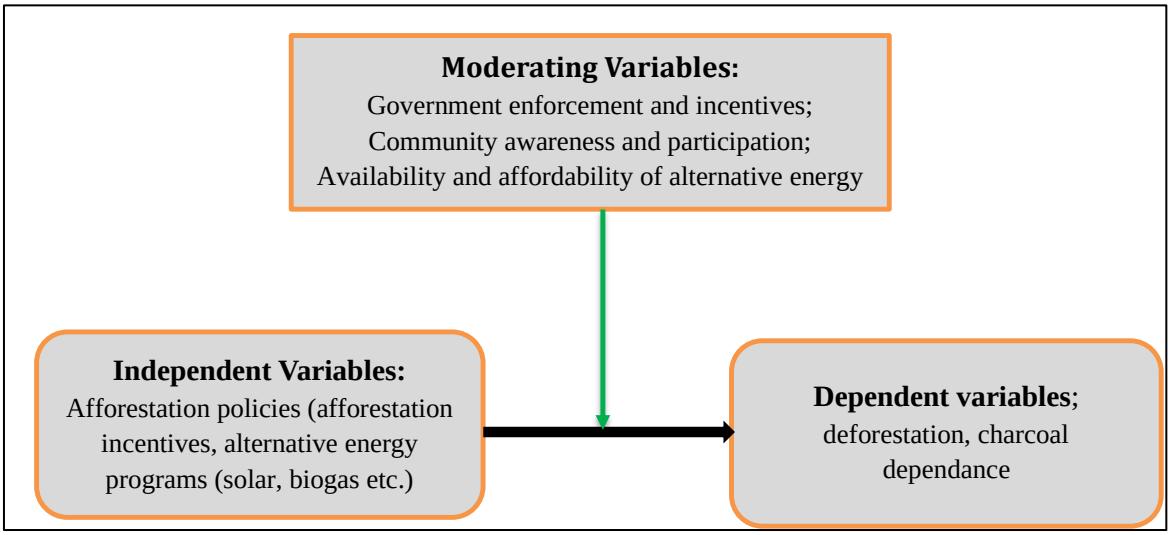

Fig 1 Conceptual Framework

II. LITERATURE REVIEW

Afforestation policies, which promote the establishment of forests on previously non-forested land, are vital for mitigating deforestation and addressing climate change. Globally, such initiatives enhance carbon sequestration, restore ecosystems, and provide cost-effective solutions for reducing greenhouse gas emissions. Studies show that well-designed afforestation programs strengthen biodiversity, improve soil and water quality, and support economic development through job creation and sustainable livelihoods (Freeman et al., 2021; MIT News, 2023).

In Africa, afforestation contributes to poverty reduction and environmental restoration by improving local incomes and regulating climate systems. Tree plantations and forest regrowth have been linked to enhanced living standards, while improved forest governance remains key to sustaining these benefits (Cheng et al., 2024; Tegegne et al., 2020). Afforestation also supports ecosystem resilience by curbing land degradation and promoting the green economy.

In Zambia, forests contribute significantly to national GDP and rural livelihoods, providing employment and income for over a million people. Despite this, deforestation driven by agriculture, charcoal production, and unsustainable logging persists. Effective afforestation policies supported by adequate funding, institutional coordination, and community engagement-can restore degraded lands, strengthen climate resilience, and promote sustainable forest management (Phiri et al., 2016; UNEP, 2015; Mulenga et al., 2011).

Globally, promoting alternative energy sources reduces dependence on charcoal and other biomass fuels, improving environmental quality, public health, and energy security (Hassen et al., 2022). Community-based renewable energy initiatives have enhanced energy access, created jobs, and supported transitions to cleaner fuels in rural areas (Sari et al., 2024).

In Africa, where up to 90% of urban households rely on charcoal, promoting affordable and culturally acceptable alternatives is crucial for reducing deforestation and improving livelihoods (Zulu & Richardson, 2013). Renewable energy communities and local green enterprises have proven effective in driving energy transitions and reducing pressure on forest resources.

In Zambia, charcoal use remains a major cause of forest loss, with approximately 250,000 hectares cleared annually. Programs such as USAID's *Alternatives to Charcoal (A2C)* project aim to promote clean cooking solutions and private-sector participation in low-emission technologies (World Bank, 2023). However, even with increased electricity access, charcoal remains prevalent due to affordability issues, unreliable supply, and cultural preferences (Guta et al., 2017). Policies must therefore integrate affordability, awareness, and infrastructure development to enable a genuine transition to alternative energy sources.

Implementation of afforestation and renewable energy policies faces global, regional, and national challenges related to institutional capacity, finance, technology, and socio-cultural barriers. Globally, inconsistent policies, financial constraints, and local opposition limit project scalability (Rand & Hoen, 2017; FAO, 2005). High initial costs and inadequate funding mechanisms further hinder progress (E-International Relations, 2016).

Across Africa, limited infrastructure, weak technological capacity, and community resistance often slow adoption of renewable energy and afforestation initiatives (Adebayo et al., 2020). Land tenure conflicts and governance weaknesses also complicate implementation (FAO, 2005).

In Zambia, weak institutional capacity, poor coordination, insufficient funding, and insecure land tenure remain major obstacles (Phiri et al., 2016; Kalaba, 2016). The absence of strong intersectoral collaboration and inadequate technical expertise further constrain progress.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jun664

Addressing these challenges requires governance reforms, investment in local capacity, and multi-stakeholder engagement to ensure policy sustainability.

Globally, afforestation and renewable energy adoption are central to climate change mitigation, ecosystem restoration, and sustainable livelihoods (World Economic Forum, 2021). International frameworks emphasize policy coherence, clean energy investment, and integration of environmental, social, and economic goals (United Nations, n.d.). Combining afforestation with renewable energy projects can deliver synergistic benefits for climate and community resilience.

In Africa, initiatives such as the *Great Green Wall* and regional afforestation programs promote reforestation, renewable energy use, and poverty reduction. Scaling up solar, wind, and biogas technologies, alongside technical training and financial incentives, is key to sustainable energy transitions (EY, 2024; Green, 2023).

In Zambia, the *National Forestry Policy (2015)* and *National Energy Policy (2019)* provide frameworks for sustainable forest management and diversification of the energy mix. Programs such as the *Renewable Energy Strategy and Action Plan (RESAP, 2022)* aim to expand renewable capacity by 500 MW by 2030, focusing on solar and small hydro. The government also promotes rural mini-grids and alternative livelihoods to reduce charcoal dependency and enhance energy access (Ministry of Energy, 2022; UN Climate Change, 2018). These integrated strategies position Zambia toward a greener, more sustainable energy and environmental future.

III. METHODOLOGY

➢ *Research Design*

In this study a descriptive research design was used in order to get detailed descriptions based on open-ended questions, context and meaning to explore and understand the afforestation and alternative programmes in Sinazongwe District. This research design helped to get deep insight and views from participants. Based on the design and study focus, the study used qualitative research approach.

➢ *Target Population*

The target population for this study were villagers or residents of the two villages, traditional leaders, government and private officers in charge of afforestation and alternative charcoal programmes in the district. This population was targeted because they have first-hand information on the study subject. The study balanced gender and the target population was 100 (50 per village) of which 40 were female and 60 males.

➢ *Sampling Design*

The study used purposive sampling followed by snowball sampling. Purposive was used to identify participant relevant to the study while snowball sampling was used to find and recruit participants through referrals from existing participants selected purposively. This sampling technique was used because the target population of the study is hidden and difficult to identify/find and access due to nature of the study.

A non-probability purposive followed by snowball sampling technique was used to recruit 70 participants out of a total target population of 100 in rural Sinazongwe. The initial sample consisted of 10 individuals identified through community leaders and local organizations/government officers. Each participant were asked to refer 2-5 others who met the study criteria. Recruitment continued in waves until the desired sample size of 70 were achieved.

➢ *Sample Size Determination*

The sample size was 70. Out of this sample size, 60 were residents from Chiyube and Kasanse representing 30 per village; 2 traditional leaders (1 from each village). The other remaining 6 were from private and government officers.

➢ *Data Collection Methods*

The study collected primary and secondary data. The data collection in this research was based on both secondary and primary data. Primary data was collected using structured interview and focus group discussions/key informants. Therefore, secondary data was obtained by checking various documents in line with the study.

➢ *Interview Guide*

The kind of interview used were structured, open and simple to allow participants (residents) express and answer freely on afforestation policies and alternative energy programmes. The interviews were conducted in both open and closed places one on one to allow participants express freely.

➢ *Focus group Discussion*

In this study, conducted four (4) focus group discussion two per village consisting approximately 7 or 8 participants with mixed gender. The focus group were conducted in a professional manner and very ethical.

➢ *Key Informants interviews*

Key Informant Interviews (KIIs) were conducted with local leaders, forestry officers, NGO representatives, and energy programme staff in rural Sinazongwe. These individuals were selected based on their roles and expertise in the implementation and monitoring of afforestation policies and alternative energy interventions.

➢ *Data Analysis*

Content analysis will be used to analyze data qualitatively. Content analysis is a qualitative research tool or technique that is used widely to analyze the content of data and its features. The purpose of content analysis in this study is to organize and elicit meaning from the data collected and to draw realistic conclusions about benefits of afforestation in minimizing deforestation; impacts of alternative energy programs on household charcoal dependency and energy transition in rural communities, challenges are there for effective implementation of

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jun664

afforestation and alternative energy policies/programs at the local level and strategies are effective for enhancing afforestation efforts and alternative energy sources adoption.

➢ *Triangulation*

The researcher used analytical triangulation in order to get different perceptions and views of local residents, traditional leaders and other stakeholders in the selected villages through direct discussions and interviews with the participants using multiple dimensions to understand the study and, ensure that data collected is valid and very reliable for decision making.

➢ *Limitations of the study*

Limitations of the study include limited data access, geographical constraints and response bias due to lack of awareness on the study.

➢ *Ethical Considerations*

Under ethical considerations, the researcher abided by all ethics surrounding or ground rules of Chiyube and Kasanse villages. Lastly, as a researcher, a Consent Letter was gotten to conduct the research from the Information and Communication University (ICU).

IV. PRESENTATION OF RESEARCH FINDINGS AND DISCUSSION OF RESULTS

➢ *Presentation of Results on Background Characteristics of the Respondents*

Based on the study findings, the study targeted 70 respondents/participants of which 39 were male and 31 were females representing 56% and 44% respectively from the two sample villages.

- *Gender Distribution*

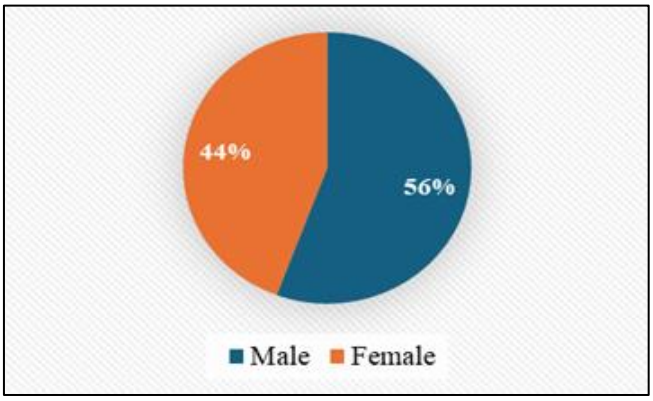

Fig 2 Pie-Chart Showing Gender of the Respondents
Source: Field Data, 2025

- *Age Categories of the Respondents*

The respondent years ranged from 21 to 68 years old. The age distribution of respondents shows a balanced representation across different age groups, with a slight concentration in the middle-aged category of both villages.

✓ The 41–50 years age group constitutes the largest proportion of respondents at 30%, indicating that middle-aged individuals were the most represented in the study. This could suggest that this group is more knowledge about afforestation and alternative energy programmes.
✓ The 31- 40 years group follows closely with 27%, showing strong participation from younger middle-aged adults in the study.
✓ The 51 year and above category accounts for 23%, reflecting a significant presence of older participants, which may contribute valuable experience or long-term perspectives to afforestation and alternative energy programs available in the district.
✓ The youngest group (21-30 years) makes up 20%, the smallest segment, possibly indicating lower involvement or relevance because they are few engaged in the practices and most of them are engaged in by their parents.

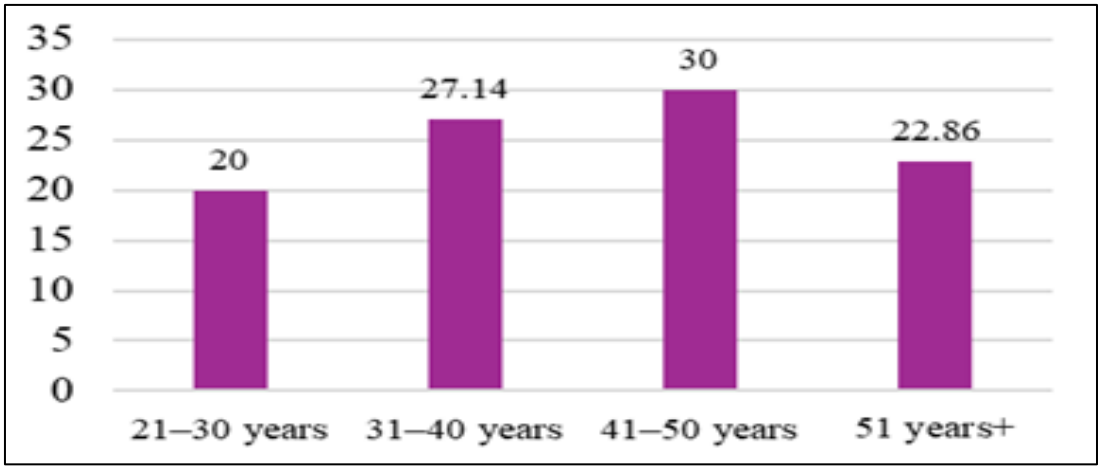

Fig 3 Bar Chart Showing Age Distribution of the Respondents
Source: Field Data, 2025

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jun664

- *Education Level of the Respondents*

The study was done in Chiyube and Kasanse villages therefore, the education distribution is rural biased. The results indicate that most respondents had attained primary education (25 respondents representing 36%), followed closely by those with secondary education (22 respondents representing 31%). A notable portion of the sample, 15 respondents (21%), reported having no formal education or have not gone to school or reached primary school. Only 8 (12%) respondents had attained tertiary education, representing the smallest group in the sample and this included the government extension workers and some key private workers that were part of the study.

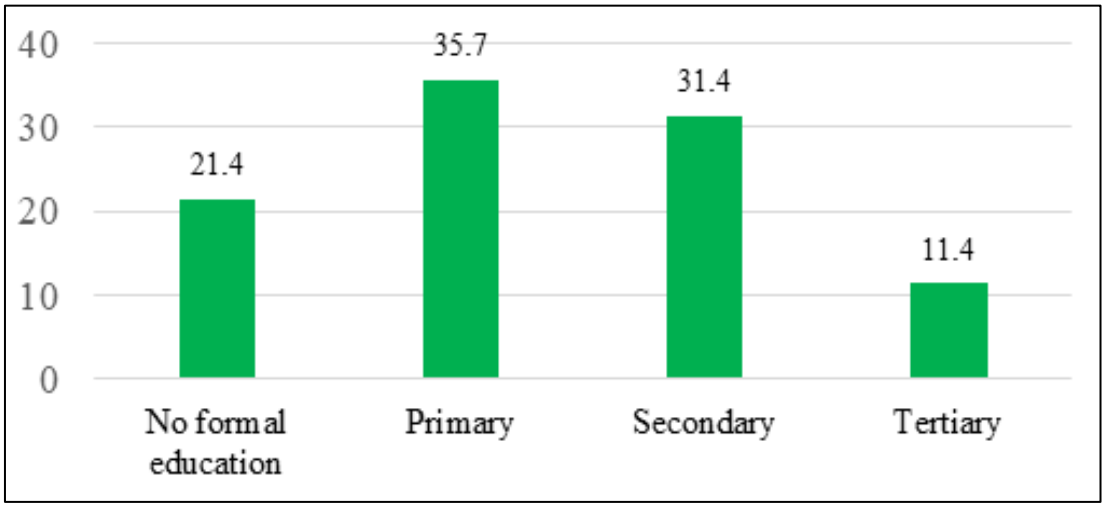

Fig 4 Education Levels of the Respondents
Source: Field Data, 2025.

- *Occupation of the Respondents*

The study established the occupation of the respondents, and it was established that, 44 were subsistence farmers representing 63%; 13 were involved in small business/trading representing 19%; 5 were Artisan/crafts representing 7 % however, 8 respondents were in formal employment representing 12%. These findings suggest that most of the respondents were involved in subsistence farming as a way of their livelihood in the two villages.

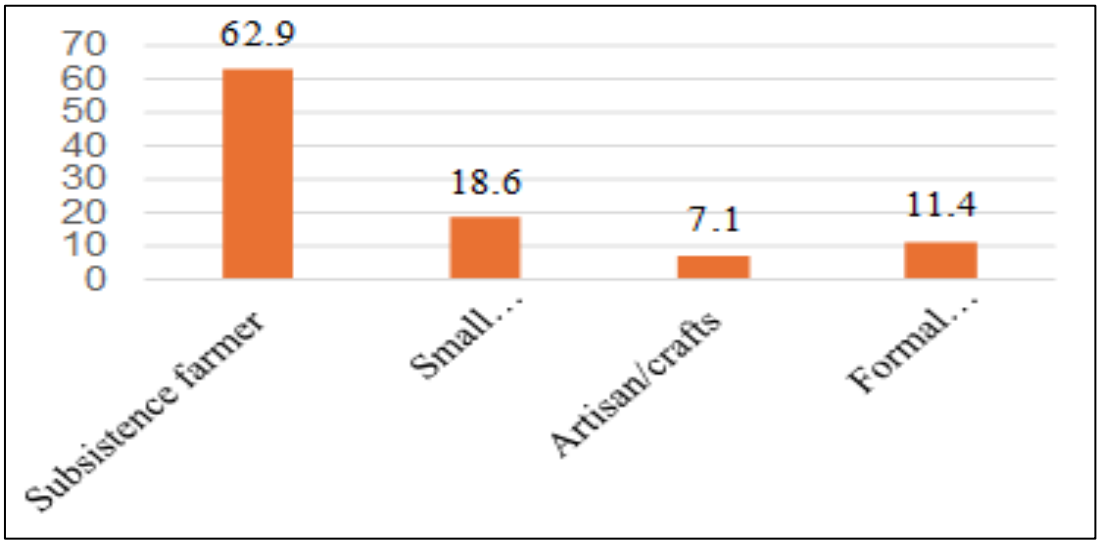

Fig 5 Graph Showing Main Occupation of the Respondents
Source: Field Data, 2025

- *Years of Residence in the Village*

The study also wanted to find out how long people have been living in the area so that it is easy to connect their lived experiences. The study found that most respondents had lived in the two villages for over 10 years, indicating deep local knowledge. It is deduced that 47 representing 67% of the respondents had lived more than 10 years while 16 respondents representing 23% had lived more 5-10 years however, only 7 respondents representing 10% had lived less than 5 years. This presents a deep and good understanding of the study based on their lived experiences.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jun664

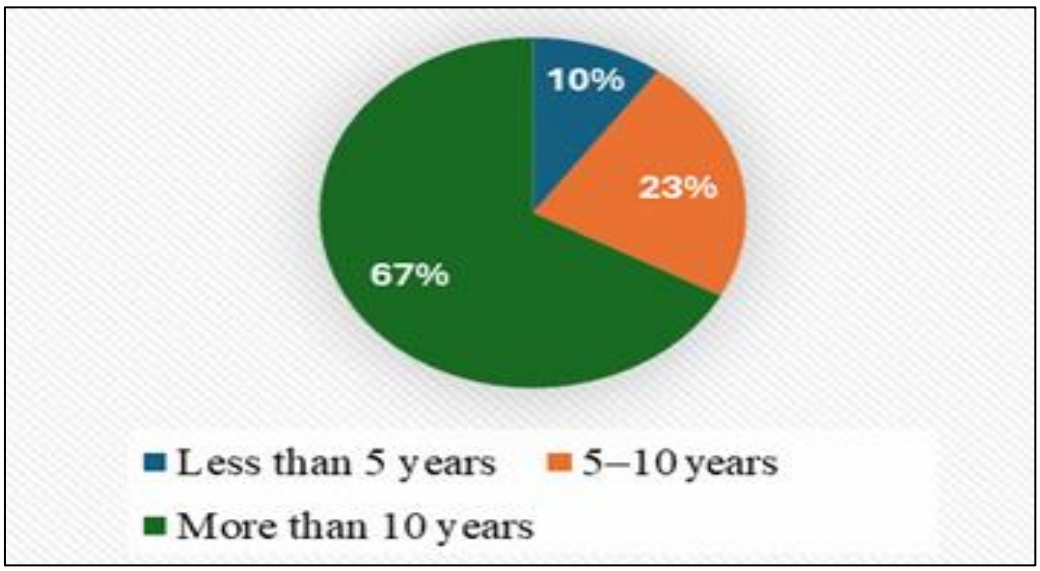

Fig 6 Pie Chart Showing the Years in the Selected Villages
Source: Field Data, 2025

➢ *Presentation of Results on Benefits of Afforestation Policy in Minimizing Deforestation in Kasanse and Chiyube Villages of Sinazongwe District.*

The study sought to determine the perceived and observed benefits of the afforestation policy in the context of rural Sinazongwe, focusing on Kasanse and Chiyube villages. Using a combination of interviews, focus group discussions, and key informant insights, responses were collated from 70 participants (selected via snowball sampling) representing households, community leaders, forestry officers, and other government and private employees.

- *Community Awareness and Knowledge of Afforestation Policy*

The respondents/participants generally indicated that they had heard of the afforestation policy through community sensitization meetings, forestry extension officers, and non-governmental organizations (NGOs) implementing conservation initiatives. Respondents reported that awareness campaigns had increased over the last five years, often coinciding with the distribution of tree seedlings during national tree planting days. It was found that some organizations are in the district distributing trees and promoting tree planting. Organizations such as Conservation for Africa and Keeper Foundation and World Vision are in the district therefore, they complement these efforts.

However, the study found that the level of awareness differed among them therefore, it was found that 38 were fully of the policy, 20 partially aware and 12 were not aware of the afforestation policy in place. Policy implementors from government and private sector have more knowledge than community members and households because they have less information. Levels of awareness are presented in the pie chart below.

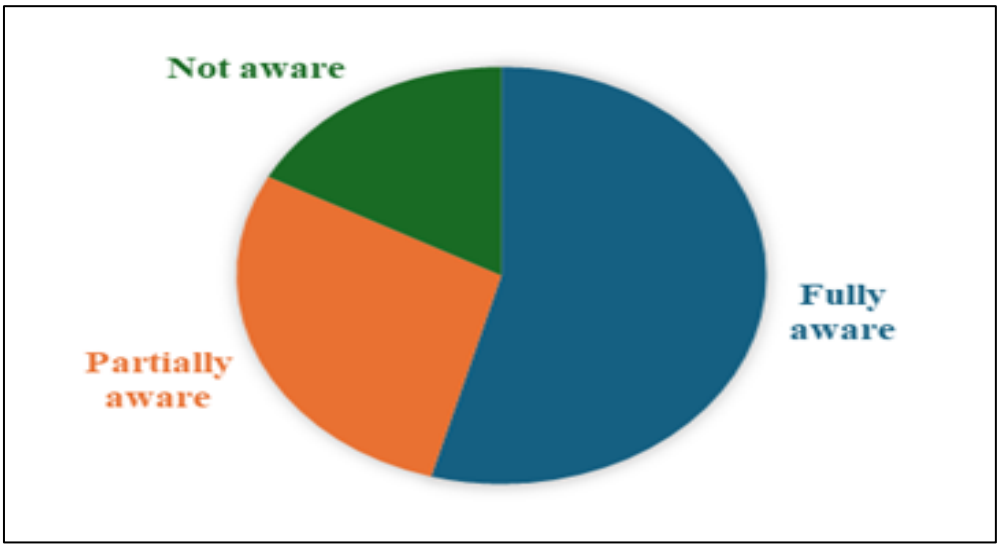

Fig 7 Pie Chart Showing the Awareness Levels for Afforestation Policy
Source: Field Data, 2025

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jun664

Based on the findings, it was noted that 54.3% of participants reported to be fully aware of the policy, while 17.1% admitted to having no knowledge of it. Key informants from the Forestry Department highlighted that the policy's visibility was still constrained by limited budget allocations for outreach.

- *Perceived Environmental Benefits*

The respondents that new the policy expressed that the afforestation policy had contributed to soil conservation, reduced land degradation, and restored biodiversity in specific community-managed forest areas. Focus group participants in Chiyube village explained that areas previously degraded by charcoal burning now showed significant regrowth due to the replanting of indigenous and fast-growing exotic tree species that were once distributed by non-government organizations (NGOs).

The findings on the perceived environmental benefits of the afforestation policy are summarized below.

- ✓ Increased vegetation cover was identified as the most significant benefit, cited by 30% of respondents. This suggests that afforestation is widely recognized for its role in enhancing green cover and landscape restoration.
- ✓ Improved soil fertility followed closely at 25%, indicating that many respondents associate tree planting with better soil health and agricultural productivity.
- ✓ Reduced erosion was noted by 20% of participants, reflecting awareness of afforestation's role in stabilizing soil and preventing land degradation.
- ✓ Restored biodiversity accounted for 18%, showing that respondents appreciate the ecological value of afforestation in supporting wildlife and plant diversity.
- ✓ Climate regulation was the least cited benefit at 7%, which may suggest limited public understanding of afforestation's impact on climate mitigation or that it is viewed as a secondary effect.

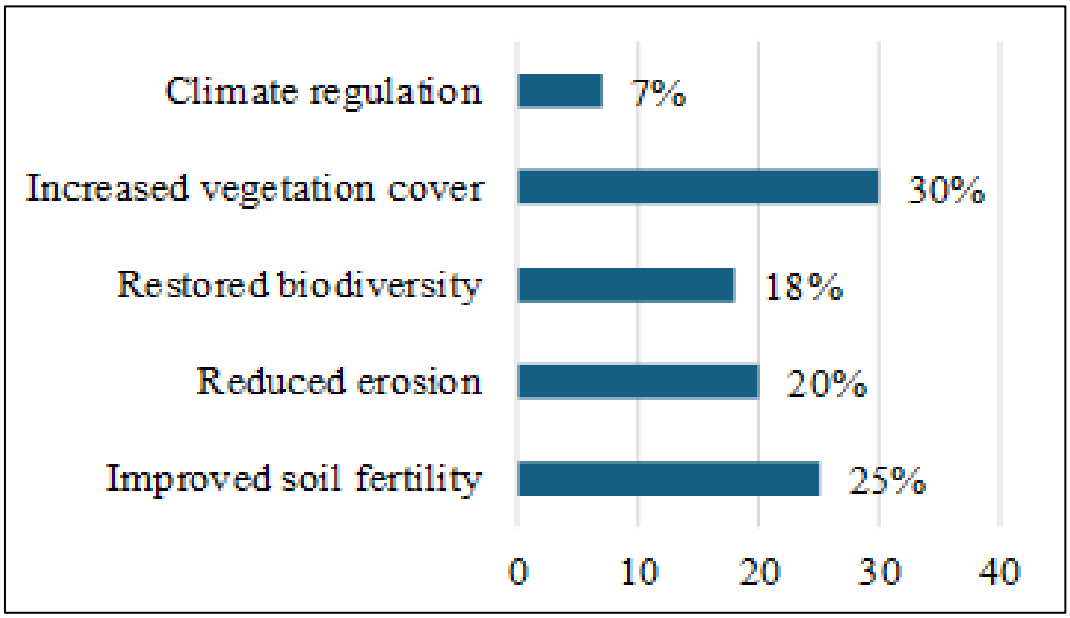

Fig 8 Perceived Environmental Benefits of Afforestation Policy
Source: Field Data, 2025

- *Economic and Livelihood Benefits*

Participants acknowledged that tree planting programs had opened small-scale income-generating opportunities. In Kasanse, youth groups reported earning income from selling seedlings and harvesting fruits from planted orchards. A forestry officer indicated that certain households had benefited from beekeeping activities integrated into reforested zones.

One participant from Kasanse said that beekeeping in the reforested areas had doubled household income during peak honey harvesting periods, which reduced their reliance on charcoal production for cash income.

The pie chart below illustrates the economic benefits derived from afforestation-related activities. Sustainable timber harvesting emerges as the most frequent income-generating activity at 26%, followed by beekeeping at 20% and fruit harvesting at 17%, indicating a strong reliance on forest resources for livelihoods. Sales of seedlings contribute 14%, showing moderate engagement in nursery-based enterprises. Notably, 23% of respondents reported no economic activity, suggesting untapped potential or barriers to participation in forest-based income opportunities.

The economic benefits pie chart is shown below to understand the economic benefits on the next page above.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jun664

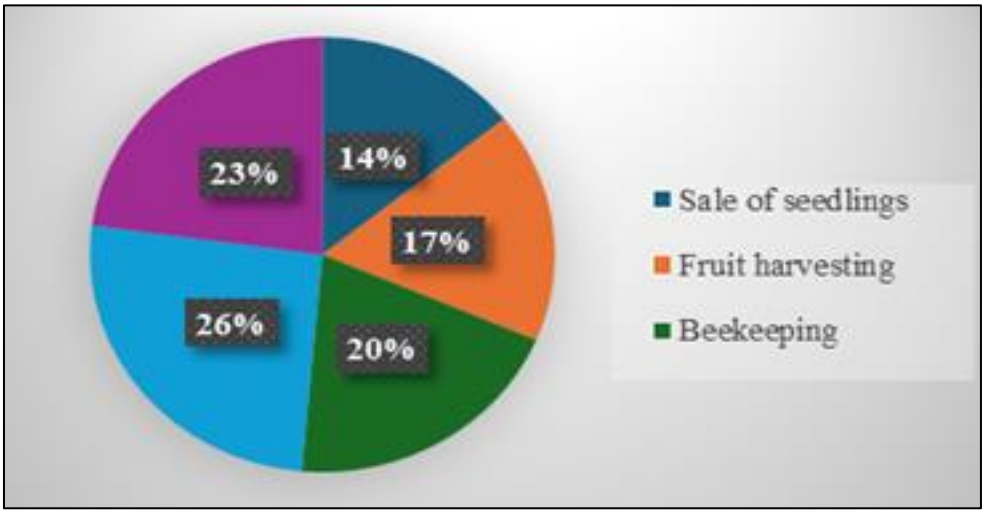

Fig 9 Pie Chart Showing Economic Benefits
Source: Field Data, 2025.

- *Reduction in Deforestation Rates*

Respondents indicated that in areas with consistent afforestation interventions, the visible rate of tree loss had slowed. While satellite imagery data was not available for this study, community leaders and extension officers reported that riverbanks previously devoid of shade now had regrown vegetation, reducing incidences of stream drying during the dry season.

A key informant held from the District Forestry Office confirmed that tree cutting permits issued in Kasanse dropped by 18% between 2021 and 2024, suggesting a partial shift away from uncontrolled harvesting. However, both Kasanse and Chiyube still faced illegal logging pressures. And the challenge is that illegal cutting of trees is not properly regulated, and most people do not really understand the importance of afforestation.

- *Social and Cultural Benefits*

In both villages, respondents highlighted renewed communal pride in natural resource management. The planting of trees around schools and churches was seen as symbolic of community unity and future-oriented thinking. Traditional leaders and expansion officers expressed that the policy revived cultural norms around tree protection, such as prohibiting the cutting of certain species deemed sacred.

- *Community Participation in Afforestation*

The corrected data on participation levels in afforestation activities reveals that a majority of respondents (57.1%) are actively involved, indicating strong community engagement in tree planting efforts. Meanwhile, 21.4% are occasionally involved, and an equal proportion (21.4%) are not involved at all, suggesting that while participation is generally high, there remains a segment of the population that do not participate because they have little knowledge and do not understand afforestation. The table on the next page shows these distributions.

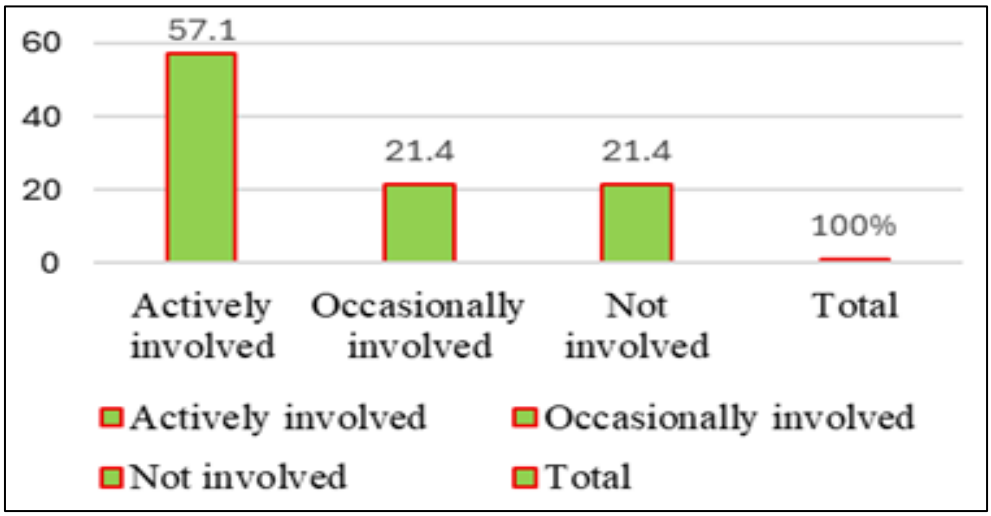

Fig 10 Community Participation in Afforestation
Source: Field Data, 2025

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jun664

- *Perceived Change in Forest Cover Over Last 5 Years*

The data shows that 50.0% of respondents perceived a significant improvement in the forest cover for the last 5 years due to the afforestation policy, indicating strong positive impact. However, 14.3% reported only slight improvement, while 21.4% saw no change, and another 14.3% indicated a decline. This suggests that although the policy is largely effective, there gaps and it has not be in place and not known by most community members and, this had led to decline in forest covers in rural areas.

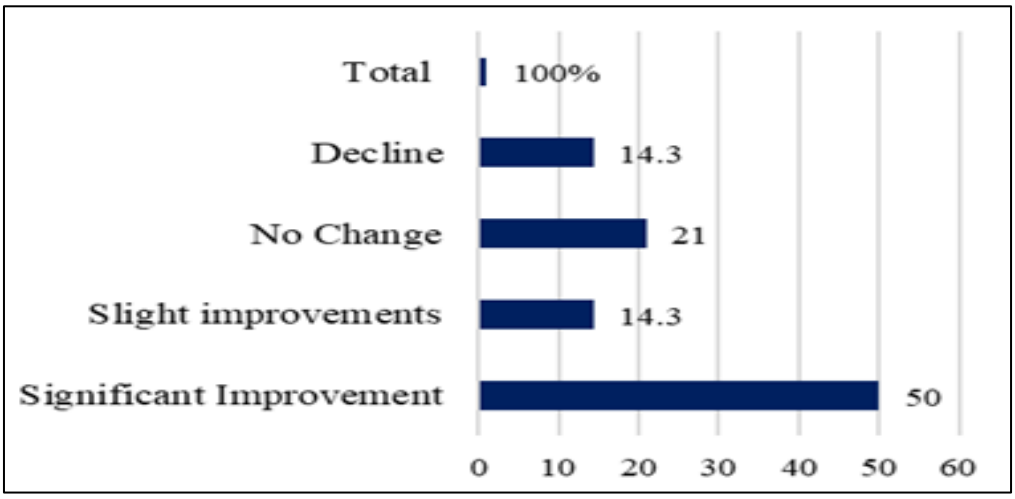

Fig 11 Changes in Forest Cover Over last 5 years
Source: Field Data, 2025

- *Access to Forest Resources*

Respondents noted improved access to non-timber forest products such as wild fruits, mushrooms, and medicinal plants due to increased tree cover. This is because the forests are free to anyone and there is no restriction attached. Members of the community are free to access the access the forest anytime.

➢ *Presentation of Results on the Effects of Alternative Energy Programs on Household Charcoal Dependency and Energy Transition in Kasanse and Chiyube Villages of Sinazongwe District*

This section presents the findings on the second objective of the study, which sought to evaluate the effect of alternative energy programs on household charcoal dependency and the broader energy transition within rural Sinazongwe District, focusing on Kasanse and Chiyube villages. These were the results for the second objectives.

- *Awareness and Participation in Alternative Energy Programs*

The study first explored the level of awareness and participation in alternative energy programs, including solar initiatives, improved cookstove programs, and biogas projects promoted by NGOs and the government.

The study revealed varying levels of awareness and participation. Out of the 70 respondents, 41.4% (29 respondents) were both aware and participated in the program, while 35.7% (25 respondents) were aware but did not participate. On the other hand, 22.9% (16 respondents) indicated that they were not aware of the program at all. This shows that although awareness was generally high, not all respondents translated their awareness into participation or could not participate.

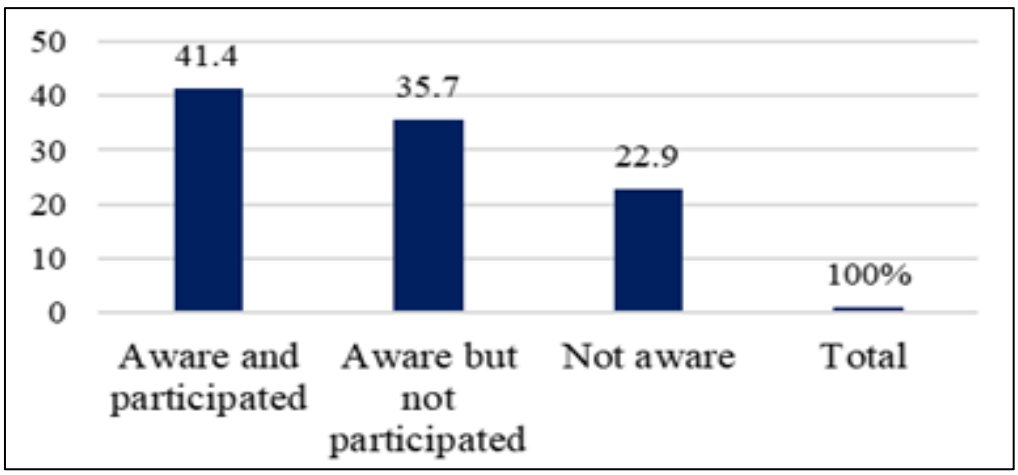

Fig 12 Awareness Levels of Alternative Programs
Source: Field Data, 2025

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jun664

- *Types of Alternative Energy Sources Adopted*

Among households that had participated in alternative energy programs, the most adopted energy sources included solar home systems and improved charcoal/wood stoves. Although these are used very few are being used because villagers mostly use firewood for cooking. The study further found that only these sources were mentioned, and others did not use any source.

The study sought to establish the types of energy sources utilized by households in the study area. Results indicate that there are varying levels of adoption of alternative energy solutions. Out of the total 70 respondents, 25 households (35.7%) reported using solar home systems, while 15 households (21.4%) reported using improved stoves. However, a significant proportion, 30 households (42.9%), indicated that they do not use any form of alternative energy technology.

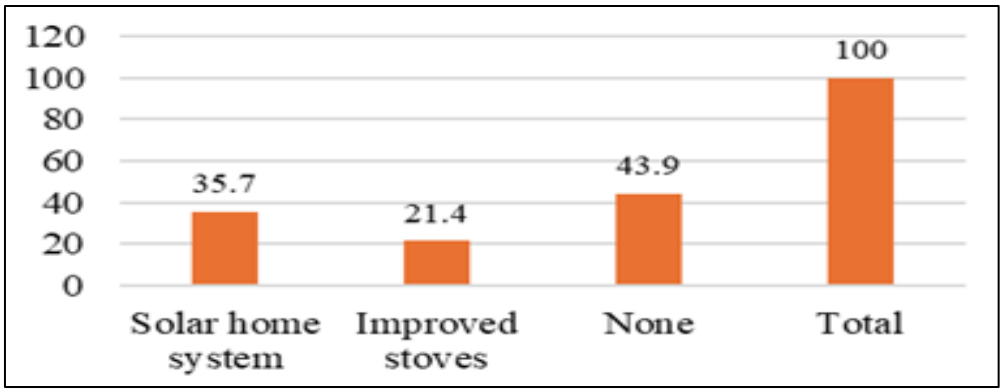

Fig 13 Type of Energy Source Used
Source: Field Data, 2025

Key informants from the District Forestry Department noted that solar solutions had higher adoption rates due to active NGO engagement, while other sources like biomass or biogas are not used due to technical complexity and high maintenance requirements.

- *Impact on Charcoal Dependency*

To assess whether these programs were reducing household reliance on charcoal, respondents were asked about their primary cooking fuel before and after participation in alternative energy programs and their response were summarized as follows in the table below.

Changes in Primary Cooking Fuel Usage before and after the alternative energy programs

The study assessed shifts in the use of primary cooking fuels before and after the implementation of the program. The findings show a notable transition from traditional fuels to alternative energy sources. Prior to the alternative energy program, most households, 68.9%, relied on charcoal as their main cooking fuel, while 27.5% used firewood. Only a small fraction, 3.6%, reported the use of alternative fuels such as solar.

After the alternative program, the proportion of households using charcoal dropped significantly to 45.5%, while firewood uses slightly increased to 31%. The most remarkable change was in the uptake of alternative fuels, which rose sharply to 23.5%.

These findings indicate a 23.4 percent decline in charcoal as the main cooking fuel among participating households. However, charcoal was not eliminated, as some respondents reported using it as a supplementary energy source during rainy seasons, when solar power generation was insufficient.

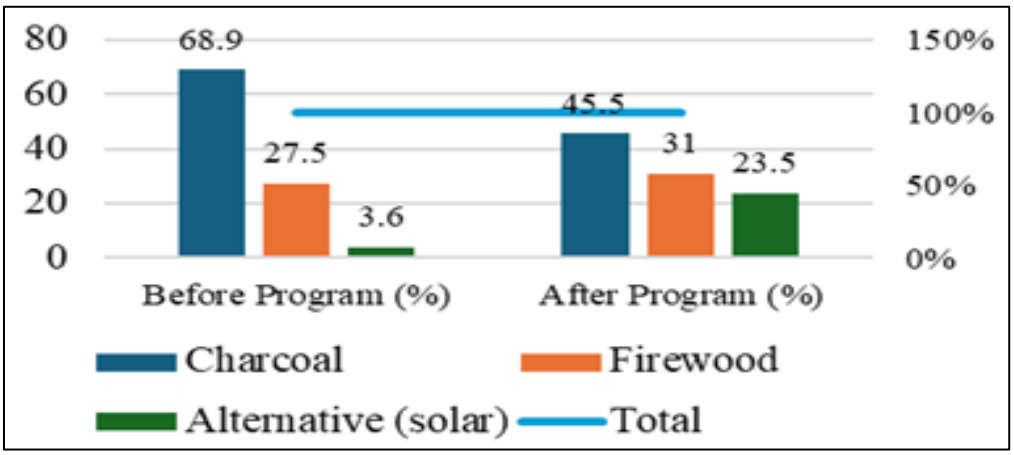

Fig 14 Changes in Primary Cooking Fuel Usage
Source: Field Data, 2025

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jun664

Four respondents from Kasanse shared that:

"We now use the solar cooker most days, but when there is no sun, our spouses still use charcoal for faster cooking."

- *Household Expenditure on Energy*

The study also examined how alternative energy adoption influenced household spending on fuel. On average, households reported a 35–50% reduction in monthly charcoal expenditure after adopting solar or improved cookstoves. They were no longer spending more resources than before unless during rainy season when sunlight is dim.

The cost savings were most significant among households using solar lighting and cooking devices, as these eliminated the need for daily charcoal purchases.

- *Perceived Benefits of Alternative Energy Programs*

When asked about perceived benefits, respondents highlighted the following key outcomes:

- ✓ Reduced household expenditure on charcoal and firewood
- ✓ Improved health due to less exposure to smoke from charcoal stoves
- ✓ Time savings in collection and cooking
- ✓ Environmental benefits, particularly in reduced tree cutting

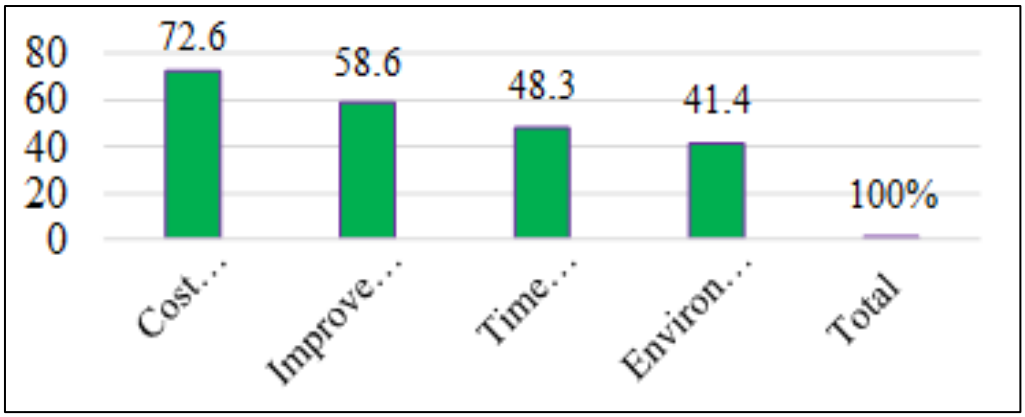

Fig 15 Perceived Benefits of Alternative Program
Source: Field Data, 2025

➢ *Challenges to the Effective Implementation of Afforestation and Alternative Energy Policies in Kasanse and Chiyube Villages*

The study revealed multiple, interrelated barriers to successful policy implementation, cutting across economic, technical, institutional, and socio-cultural dimensions. Participants repeatedly emphasised that these challenges were not isolated but reinforced one another, creating a cycle that hindered policy impact.

- *Economic Barriers*

A substantial proportion of respondents (67%) indicated that high upfront costs for alternative energy technologies such as LPG cookers or solar systems limited adoption. Even when subsidies were introduced, beneficiaries reported that maintenance and refill costs remained prohibitive for low-income rural households. Key informants from the Ministry of Green Economy also reported that budget constraints affected the ability to sustain afforestation programs through adequate seedling supply and aftercare.

Respondents indicated that purchasing LPG cylinders, improved stoves, or solar kits required lump-sum payments beyond their means. As one participant explained, "We understand gas is better, but finding 800 Kwacha at once is not possible when school fees and farming costs are waiting."

- *Seasonal Income Patterns*

The respondent said that most of them are farmers as indicated earlier therefore, reported that their income is highly seasonal, making it difficult to commit to new technologies outside the harvest period.

- *Technical and Infrastructure Barriers*

Unreliable electricity supply was cited by 47% of participants as a major constraint to adoption of electric cooking. Respondents explained that power outages often forced households back to charcoal, undermining energy transition efforts. In addition, last-mile distribution challenges meant that spare parts, fuel refills, and replacement components for improved stoves or solar kits were unavailable in the village, discouraging long-term use.

- *Institutional and Policy Barriers*

Weak local policy awareness emerged as a persistent barrier. About 37% of respondents stated that they had never heard about specific government afforestation or energy transition policies, despite being direct targets of these programs. District-level Forestry Department officials noted that limited extension officer capacity meant that one officer often covered vast areas, making regular follow-up impossible. Moreover, weak enforcement of illegal charcoal production was flagged by 52% of respondents, with some noting that even when seizures occurred, offenders often returned to production due to lack of alternative livelihoods.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jun664

- *Environmental and Land Tenure Barriers*

Respondents in Kasanse and Chiyube reported that low seedling survival rates due to drought, poor soil conditions, fire, and free-grazing livestock significantly undermined tree planting efforts. Furthermore, land tenure insecurity discouraged some households from investing in long-term tree planting, particularly in areas with contested customary land boundaries.

Furthermore, the study analyzed and summarized the challenges based on respondent feedback. The analysis of NVivo-coded data on implementation challenges of afforestation and alternative energy policies in Kasanse and Chiyube villages reveals a range of economic, technical, institutional, and socio-cultural barriers. Among the challenges, the high upfront cost of solar kits and improved stoves was the most frequently reported, accounting for 11.81% of the total responses, highlighting financial constraints as a major impediment to household adoption of alternative energy technologies. Closely following were low seedling survival due to drought, grazing, and fire (11.06%), and weak last-mile supply and after-sales support (10.30%), indicating that both environmental factors and logistical limitations significantly undermine the success of afforestation and energy interventions.

Other notable challenges included fuel/stove stacking, reported by 9.55% of respondents, and weak enforcement of illegal charcoal production, at 9.07%, suggesting that household behaviors and regulatory gaps continue to hinder full policy impact. Technical constraints, such as unreliable electricity for cooking (8.29%), and institutional limitations, including limited extension capacity (7.54%) and low local policy awareness (6.53%), further reduced the effectiveness of program implementation. Socio-cultural influences, such as cultural taste and cooking preferences (7.29%), as well as governance and coordination issues, including coordination gaps across agencies (6.78%), land tenure insecurity (6.03%), and weak monitoring and evaluation systems (5.78%), also emerged as significant barriers.

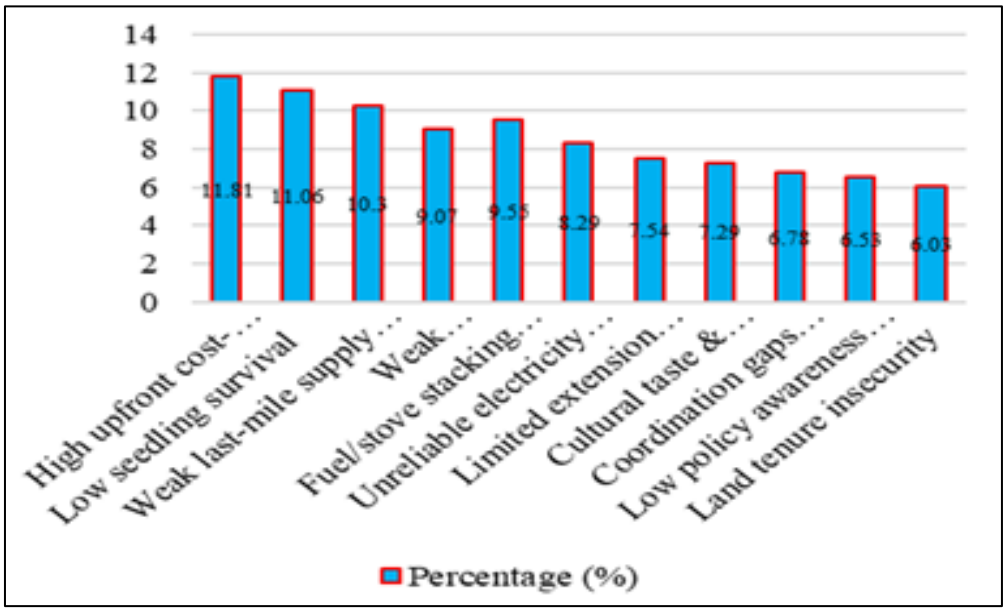

Fig 16 Implementation Challenge
Source: Field Data, 2025

➢ *Strategies for Enhancing Afforestation and Alternative Energy Adoption in Kasanse and Chiyube Villages of Sinazongwe District*

The fourth objective sought to identify practical strategies for improving policy implementation and adoption rates. The findings showed that respondents proposed a blend of economic incentives, technical solutions, policy reforms, and community engagement approaches.

- *Economic Support Mechanisms*

Participants strongly recommended targeted subsidies and microcredit schemes to lower the entry cost for clean energy technologies. Some proposed a "pay-as-you-go" financing model for solar kits and improved stoves, citing its success in neighbouring districts. Additionally, respondents suggested market incentives for tree growers, such as linking them with timber buyers or carbon credit markets.

- *Strengthening Local Supply Chains*

The majority of respondents (61%) emphasised the importance of strengthening last-mile supply and after-sales services. This included training local entrepreneurs as technicians for stove repair and solar servicing and establishing rural energy depots within a reasonable walking distance.

- *Policy and Institutional Reforms*

Respondents called for more visible and consistent policy enforcement against illegal charcoal production, accompanied by viable alternative livelihoods for affected producers. Increasing the number of extension officers, particularly those trained in both forestry and energy technologies, was considered essential.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jun664

Key informants suggested integrating afforestation targets into local development plans and creating village-level "green committees" to coordinate activities between government, NGOs, and community members.

- *Environmental and Social Strategies*

On the environmental front, respondents proposed introducing drought-resistant tree species, establishing community woodlots with shared maintenance responsibilities, and fencing vulnerable seedlings to protect them from grazing. Socially, they recommended community education campaigns linking tree planting and clean cooking adoption to tangible household benefits such as reduced health risks and fuel costs.

➢ *Discussion of the Findings/Results*

- *Benefits of Afforestation Policy in Minimizing Deforestation in Kasanse and Chiyube Villages of Sinazongwe District.*

The study established that community awareness of the afforestation policy in Kasanse and Chiyube villages was moderate, though uneven across different groups. Over half of the respondents (54.3%) reported being fully aware of the policy, largely due to sensitization activities spearheaded by the Forestry Department and non-governmental organizations such as Conservation for Africa, Keeper Foundation, and World Vision. Awareness campaigns were often linked to tree planting days where seedlings were distributed, which provided communities with both knowledge and practical opportunities to participate in afforestation. However, the study also revealed that 17.1% of respondents had no awareness of the policy at all, suggesting that dissemination strategies have not adequately reached all segments of the population. This disparity is explained in part by limited budget allocations for outreach, which has restricted the visibility of the policy. Similar findings were reported by Kalaba, Chirwa, Syampungani, and Ajayi (2010), who observed that forestry policies in Zambia are often poorly disseminated to rural communities, leading to gaps in participation and ownership.

The findings further demonstrate that afforestation has contributed significantly to environmental benefits in the two villages. Respondents identified increased vegetation cover, soil fertility improvement, erosion control, biodiversity restoration, and climate regulation as some of the key gains. Of these, vegetation cover was the most frequently cited (30%), followed by improvements in soil fertility (25%). Focus group participants in Chiyube confirmed that areas once degraded by charcoal production had begun to show signs of regrowth, thanks to the planting of both indigenous and exotic tree species distributed by NGOs. The perception that afforestation contributes to soil fertility and erosion control resonates with global evidence, as Mansourian (2017) observed that afforestation initiatives enhance agricultural productivity by improving soil quality. Similarly, Syampungani, Chirwa, and Akinnifesi (2009) reported that afforestation strengthens biodiversity recovery in southern Africa, which supports the findings from this study. Nonetheless, climate regulation was the least cited benefit at only 7%, which may reflect a limited public understanding of the broader global role forests play in mitigating climate change.

The economic and livelihood benefits of afforestation were also widely recognized by respondents. Many households in Kasanse and Chiyube reported deriving income from activities such as sustainable timber harvesting, beekeeping, fruit harvesting, and seedling sales. Timber harvesting emerged as the most frequently reported source of income (26%), followed by beekeeping (20%) and fruit harvesting (17%). In Kasanse, youth groups noted that the sale of seedlings and orchard produce had provided steady sources of income, while some households benefitted from integrating beekeeping into reforested areas. One participant specifically reported that honey production had doubled household income during peak harvesting seasons, thereby reducing dependence on charcoal production for income generation. These findings align with studies in Malawi where Jumbe and Angelsen (2011) found that afforestation projects contributed significantly to income diversification, particularly through non-timber forest products. In Zambia, Gumbo, Syampungani, and Chirwa (2018) also noted that beekeeping in reforested areas provided households with sustainable livelihood opportunities. However, it was also found that 23% of respondents reported no economic benefit from afforestation, suggesting untapped opportunities or barriers to participation, possibly related to limited market access or lack of resources.

The results also suggest that afforestation has contributed to reducing deforestation rates in targeted areas, though the impact remains partial. Community leaders and extension officers reported that areas along riverbanks which were once bare now exhibited regrown vegetation, contributing to stream flow retention during dry seasons. Administrative records further supported these perceptions, with the District Forestry Office confirming that tree-cutting permits in Kasanse declined by 18% between 2021 and 2024. Despite this positive trend, respondents acknowledged that illegal logging remained a persistent challenge, exacerbated by weak regulation and poor enforcement. These findings are consistent with Kalaba et al. (2010), who noted that while afforestation initiatives can help slow deforestation, their effectiveness is often undermined by continued illegal exploitation of forest resources.

Beyond economic and environmental aspects, afforestation was also reported to yield social and cultural benefits within the study communities. Respondents indicated that tree planting around schools, churches, and communal areas fostered a sense of unity and pride, reinforcing collective responsibility for environmental stewardship. Traditional leaders emphasized that the afforestation policy revived cultural practices related to natural resource protection, such as respecting taboos against cutting certain sacred tree species. These findings are in line with studies from Tanzania which show that afforestation efforts often revive traditional ecological

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jun664

norms and community identity, thereby strengthening local ownership of conservation initiatives (Mbwambo, Eid, & Malimbwi, 2012).

Community participation emerged as a critical factor in shaping the outcomes of afforestation. More than half of the respondents (57.1%) reported active involvement in afforestation activities, while 21.4% were occasionally involved and another 21.4% not involved at all. The findings suggest that while many community members engage actively, some households remain excluded due to limited knowledge and understanding of afforestation. These results point to the need for improved awareness campaigns and capacity building. Kiyingi and Mogaka (2019) argue that long-term success of afforestation initiatives in Africa depends on inclusive and sustained community involvement, underscoring the importance of broadening participation in Kasanse and Chiyube.

In assessing perceived changes in forest cover over the past five years, half of the respondents reported significant improvements attributed to the afforestation policy. Others, however, observed only slight improvements (14.3%), no change (21.4%), or even a decline (14.3%). This variation highlights that while the policy has been effective in some areas, its impact is not universal across the district. These mixed perceptions mirror observations by FAO (2020), which noted that while afforestation often achieves localized success, wider impact depends on consistent funding, monitoring, and enforcement across all affected landscapes.

Finally, the study revealed that access to forest resources such as wild fruits, mushrooms, and medicinal plants had improved due to increased forest cover. Respondents emphasized that these resources were freely accessible to all community members, contributing to household food security and serving as a fallback during periods of agricultural stress. This finding is supported by Shackleton and Gumbo (2010), who documented that non-timber forest products remain an essential safety net for rural households in southern Africa, particularly during times of economic hardship.

- *Discussion of Findings on the effects of Alternative Energy Programs on Household Charcoal Dependency and Energy Transition*

This section presents the discussion of findings on the second objective of the study, which sought to evaluate the effects of alternative energy programs on household charcoal dependency and the broader energy transition within rural Sinazongwe District, with a focus on Kasanse and Chiyube villages.

The findings first established levels of awareness and participation in alternative energy initiatives. Results showed that 41.4% of households were both aware of and actively participated in the programs, while 35.7% had knowledge of these programs but did not take part, and 22.9% were not aware at all. This indicates that while general awareness was relatively high, there remained gaps in effective participation. Limited participation despite awareness may be attributed to economic barriers, limited access to program infrastructure, or cultural preferences for traditional fuels. This aligns with the observations of Malabo and Matinga (2016), who argue that rural adoption of clean energy technologies often stalls not because of lack of knowledge, but due to affordability and accessibility constraints. The implication is that awareness campaigns alone are insufficient to achieve full household transitions unless paired with mechanisms to address affordability and availability of the technologies.

The types of energy sources adopted also reveal critical insights into the ongoing energy transition. The study found that solar home systems were the most adopted, with 35.7% of respondents reporting usage, followed by improved stoves at 21.4%, while 42.9% of households did not use any alternative energy technology. These findings underscore that despite the introduction of alternative solutions, traditional reliance on firewood and charcoal remains strong. Key informants noted that solar had higher uptake due to NGO involvement and relative ease of use compared to biogas or biomass technologies, which face higher technical and maintenance barriers. Similar findings have been reported in other Sub-Saharan African contexts, where solar has emerged as the most accessible form of renewable energy for rural households (Peters & Sievert, 2016). This suggests that while multiple technologies exist, the viability of adoption in rural Zambia largely depends on simplicity, cost-effectiveness, and ongoing institutional support.

The results further assessed the impact of these programs on household dependency on charcoal. Before program interventions, 68.9% of households relied on charcoal as their main cooking fuel, 27.5% used firewood, and only 3.6% used alternative fuels. Following participation in alternative energy programs, the proportion of households relying on charcoal dropped significantly to 45.5%, while firewood use increased slightly to 31%. Most notably, alternative fuel use increased to 23.5%. This represents a 23.4% decline in charcoal dependency, highlighting the potential of alternative energy programs to facilitate a meaningful, though partial, transition away from unsustainable biomass fuels. However, complete elimination of charcoal reliance was not achieved, as many households continued to use it as a supplementary source, especially during rainy seasons when solar power generation was less reliable. This resonates with the concept of “fuel stacking” discussed by Masera et al. (2000), which shows that households in low-income contexts rarely abandon traditional fuels entirely but rather combine them with modern alternatives depending on seasonality, availability, and convenience.

Household expenditure patterns further reinforce the potential economic benefits of these programs. Respondents reported a 35–50% reduction in monthly charcoal expenditure after adopting solar systems or improved cookstoves. These savings were particularly significant among households that adopted solar, as they reduced the need for daily fuel purchases. Such financial relief is critical

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jun664

in rural contexts where disposable incomes are low, and it demonstrates the capacity of renewable energy to contribute to poverty alleviation. This aligns with findings by Barnes and Floor (1996), who note that access to affordable modern energy sources directly reduces household energy poverty by lowering expenditure burdens and freeing resources for other necessities such as education and food security.

The study also revealed multiple perceived benefits from alternative energy adoption. Respondents emphasized cost savings (72.6%), improved health outcomes due to reduced smoke exposure (58.6%), time savings in fuel collection and cooking (48.3%), and environmental conservation benefits such as reduced tree cutting (41.4%). These perceptions highlight that households are aware of the multi-dimensional advantages of energy transition beyond economic savings. Reduced smoke exposure, in particular, is crucial, as indoor air pollution from charcoal and firewood combustion is a leading cause of respiratory illnesses in rural Sub-Saharan Africa (World Health Organization, 2018). The environmental benefits are equally significant, as unsustainable charcoal production is a key driver of deforestation in Zambia (Chidumayo & Gumbo, 2013). Thus, the adoption of alternative energy not only improves household welfare but also contributes to broader environmental sustainability and public health outcomes.

Despite these positive outcomes, the findings suggest that challenges remain in fully transitioning households from traditional to modern energy sources. The persistence of charcoal use, particularly as a backup during periods of low solar reliability, underscores the need for diversified and resilient energy solutions that can meet household needs consistently throughout the year. Furthermore, high upfront costs of technologies like solar systems remain prohibitive for many households, limiting broader participation. As observed by Kammen and Kirubi (2008), rural electrification and renewable energy programs must be accompanied by financing mechanisms, subsidies, or revolving funds to enable affordability and equitable access.

In summary as indicated by the study, the findings demonstrate that alternative energy programs in Kasanse and Chiyube villages have had a measurable impact on reducing charcoal dependency and facilitating partial energy transitions. While the uptake of solar and improved stoves shows promising results in lowering expenditures, improving health, and conserving the environment, complete reliance on clean alternatives is yet to be achieved due to structural, financial, and technical barriers. The evidence aligns with broader regional literature that emphasizes the importance of sustained institutional support, affordability measures, and context-specific technological choices in ensuring successful rural energy transitions.

- *Challenges to Effective Local Implementation of Afforestation and Alternative Energy Programs in Chiyube and Kasanse villages of Sinazongwe District*

The findings of this study revealed that the implementation of afforestation and alternative energy policies in Kasanse and Chiyube villages is constrained by multiple, interrelated challenges. These barriers span across economic, technical, institutional, environmental, and socio-cultural dimensions, and they are mutually reinforcing. The persistence of these constraints explains why the impact of existing programs has been modest despite considerable investment from government and non-governmental actors.

One of the most significant barriers identified relates to economic constraints. The study showed that 67% of respondents pointed to the high upfront costs of technologies such as solar kits, LPG cookers, or improved stoves as a major barrier to adoption. This was also reflected in the NVivo-coded ranking, where “high upfront cost of solar/stoves” emerged as the top challenge with 11.81% of the total frequencies recorded (Table 7). Respondents explained that lump-sum payments of several hundred kwacha for these technologies were beyond the reach of most farming households, particularly during the lean season when income was scarce. Even where subsidies were provided, the recurring costs of maintenance, gas refills, or component replacement were prohibitive. This finding is consistent with Barnes and Floor (1996), who argue that affordability is the central determinant of household energy choice in low-income rural contexts. It also echoes Peters and Sievert (2016), who observed that although solar solutions are spreading across rural Africa, high initial investment remains a structural barrier that disproportionately excludes poorer households.

Closely linked to the economic issue is the seasonal income pattern of rural households. Because most respondents in Kasanse and Chiyube are smallholder farmers, their incomes peak after harvest but remain constrained during planting and lean seasons. This irregularity makes it difficult for households to invest in durable energy technologies, even when they are aware of their benefits. As one respondent remarked, finding money for technologies like LPG cookers is difficult when competing demands such as school fees and farm inputs take priority. This is in line with Zulu and Richardson (2013), who emphasized that seasonality in rural livelihoods must be considered in designing energy programs to ensure affordability throughout the year.

Technical and infrastructure barriers also emerged strongly. Nearly half of respondents (47%) cited unreliable electricity supply as a key limitation to adopting electric cooking, with households often reverting to charcoal during power outages. Furthermore, 10.3% of NVivo-coded frequencies highlighted “weak last-mile supply and after-sales support” as a persistent challenge. Households reported that spare parts, fuel refills, or repair services for improved stoves and solar kits were rarely available in local markets, which discouraged long-term use. These findings resonate with the work of Eberhard et al. (2014), who stress that without strong distribution chains and technical backstopping, renewable energy adoption in rural Africa often falters after initial enthusiasm.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jun664

The study also revealed institutional and policy-related challenges. About 37% of respondents indicated that they were unaware of any formal government policies on afforestation or alternative energy, despite being the intended beneficiaries. This aligns with Table 7, where "low policy awareness locally" accounted for 6.53% of reported challenges. Weak extension capacity compounded the problem, as one officer often had to cover large areas, limiting consistent follow-up with communities. Weak enforcement of regulations against illegal charcoal production was also flagged by 52% of respondents and ranked as the fourth-highest challenge (9.07%). Although some enforcement actions such as confiscations were occasionally reported, offenders often resumed production due to lack of viable alternative livelihoods. These results mirror findings by Chidumayo and Gumbo (2013), who argue that weak enforcement capacity and limited livelihood alternatives perpetuate unsustainable charcoal production in Zambia and across Sub-Saharan Africa.

Another set of barriers related to environmental and land tenure constraints. Respondents noted that seedling survival rates in afforestation programs were very low due to recurrent drought, soil degradation, fire outbreaks, and free grazing by livestock. In the coded analysis, "low seedling survival" ranked second (11.06%). In addition, insecure land tenure discouraged investment in long-term tree planting, especially in areas with contested customary land boundaries. Similar challenges were documented by Mwase et al. (2015), who found that in Malawi, community afforestation projects suffered high failure rates where land rights were uncertain and environmental stresses were severe. These findings suggest that without secure land tenure and climate-adaptive forestry practices, afforestation programs are unlikely to succeed in the long term.

The socio-cultural dimension also featured prominently, with "cultural taste and cooking needs" accounting for 7.29% of coded frequencies. Some respondents expressed a preference for the taste of food prepared using charcoal or firewood, while others noted that improved stoves did not easily accommodate traditional dishes requiring longer cooking times. This phenomenon is consistent with Masera et al.'s (2000) "fuel stacking" theory, which posits that households often maintain multiple cooking fuels to satisfy diverse needs rather than fully transitioning to modern alternatives.

Finally, the study identified weak coordination and monitoring as cross-cutting institutional challenges. About 6.78% of coded references pointed to poor coordination across government agencies and NGOs, leading to duplication of efforts and gaps in service delivery. Similarly, weak monitoring and evaluation systems (5.78%) meant that progress was rarely tracked systematically, undermining program accountability and learning. As Kammen and Kirubi (2008) note, fragmented institutional arrangements are a common barrier to energy transitions in rural Africa, where overlapping mandates and inadequate resourcing weaken program effectiveness.

Taken together, these findings demonstrate that afforestation and alternative energy policies in Kasanse and Chiyube villages face a web of interlinked challenges. Economic barriers prevent initial adoption, seasonal incomes limit sustainability, technical weaknesses discourage continued use, and institutional gaps undermine both enforcement and policy awareness. Environmental stresses and cultural preferences further compound these difficulties. The NVivo-coded rankings in Table 7 illustrate how these challenges distribute across households, with cost, seedling survival, and supply-chain limitations emerging most frequently. Addressing these barriers requires a multi-dimensional approach: strengthening affordability mechanisms such as microfinance, investing in resilient supply chains, enhancing extension services, securing land rights, and improving inter-agency coordination. Without such comprehensive strategies, both afforestation and energy transition efforts will continue to fall short of their potential.

- *Strategies to Enhance Afforestation and Adoption of Alternative Energy in Kasanse and Chiyube villages of Sinazongwe district*

Participants explained that one of the key barriers to sustained adoption of alternative energy solutions was the perceived incompatibility between these technologies and local culinary practices. They proposed setting up demonstration kitchens, preferably managed by women's groups, where residents could test liquefied petroleum gas (LPG) or electric cooking devices with staple dishes such as nshima, beans, and traditional stews. The aim would be to showcase that these foods can be prepared with similar taste and texture while often reducing preparation time. Respondents further suggested a hybrid-use model such as using LPG for quick boiling and retaining charcoal for certain culturally important dishes followed by a phased reduction of charcoal usage over successive seasons. Additionally, they recommended that appliances be designed to accommodate local cooking needs, such as larger, stable trivets and double-burner options to handle big pots.

This approach directly addresses the cultural embeddedness of cooking practices, which was found to be a significant determinant of energy choice in the field. The staged transition approach also aligns with household risk management strategies observed in many rural contexts, where fuel stacking is used as a hedge against supply disruptions and perceived reliability issues. As van der Kroon et al. (2013) have noted, fuel stacking is often a rational response to uncertainty rather than mere reluctance to change, meaning that embracing rather than resisting it can lead to a smoother long-term transition.

Respondents highlighted that the unreliability of fuel supply and the lack of repair services frequently forced households back to charcoal use, even when they preferred cleaner alternatives. To address this, participants proposed establishing village-based energy agents who would be equipped to manage refill logistics, perform minor repairs, and handle warranty claims. They also suggested

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jun664

introducing performance-based contracts for distributors, where incentives would be tied to timely deliveries and the operational readiness of service centers. A simple after-sales monitoring system, such as a hotline or SMS service to report stock-outs or faulty equipment, was also seen as essential.

These proposals respond to the fragile supply chain that emerged as a recurring implementation challenge. When supply interruptions occur, households tend to revert to the more readily available charcoal, undermining program objectives. By ensuring that distribution and after-sales services are reliable, households are more likely to maintain consistent use of alternative fuels. This finding reinforces earlier studies on rural energy adoption, which emphasize that sustained use depends as much on logistical reliability as on the technology itself.

Participants were concerned that many past afforestation projects had suffered from low seedling survival rates due to drought, grazing by livestock, and bushfires. They recommended matching tree species to site conditions using local knowledge and soil moisture assessments. This would involve combining fast-growing exotic species for fuelwood supply with indigenous trees for biodiversity and resilience. Establishment support measures such as scheduled watering, mulching, fencing, and early firebreak construction were also prioritized. Planting would ideally be timed with the onset of the rainy season to improve survival odds. They further stressed the need for strict nursery quality control to avoid distributing root-bound seedlings and advocated for community woodlots alongside farmer-managed natural regeneration (FMNR) on individual farms.

This strategy responds directly to the seedling survival gap identified in the findings. Literature on Miombo woodland restoration underscores the importance of species-site matching, fire protection, and protection from grazing as critical determinants of success (Chidumayo & Gumbo, 2013). By shifting the focus from planting numbers to actual survival rates, the community aims to ensure that afforestation efforts result in tangible, long-term forest cover recovery.

Unclear land and tree tenure was found to be a major disincentive for households to invest in tree planting and maintenance. In response, participants suggested developing by-laws under customary authority that would formally recognize the planter's rights to use or sell trees, with explicit provisions to ensure that women also had recognized rights to trees they planted. They also recommended that community woodlots adopt transparent harvest protocols, including defined rotation periods, designated uses, and clear sales processes.

This strategy addresses the weak incentive structures that emerged from tenure ambiguity. Without assurance of long-term benefit, households are unlikely to commit labor and resources to tree care. By providing tenure clarity and equitable benefit-sharing, the strategy strengthens household motivation for tree planting and protection, aligning with broader literature on the role of secure tenure in natural resource stewardship.

Participants warned that punitive enforcement of anti-deforestation laws, when applied without viable livelihood alternatives, often displaced charcoal producers into deeper informality and increased community resistance. They proposed pairing enforcement with alternative income opportunities, such as employment in seedling nurseries, paid woodlot guarding, or participation in briquette production enterprises. Additionally, they suggested formalizing the charcoal market through licensed kilns sourcing wood from sustainably managed woodlots, with monitoring by both community committees and forestry officers.

This approach mitigates the social backlash risk identified in the findings. By coupling sanctions with economic alternatives, the strategy fosters compliance without worsening poverty. As Ostrom (1990) observed, local rules are more effective when supported by locally recognized institutions and when compliance generates tangible benefits for participants.

Respondents noted that existing monitoring systems were often focused on counting inputs such as seedlings planted rather than measuring actual outcomes, like survival rates or sustained adoption of alternative fuels. They recommended setting ward-level extension targets based on survival and adoption rates, such as "≥70% survival after the second dry season" or "≥50% of households refilling LPG monthly." Lean monitoring approaches, including quarterly transect walks, photographic logs, and simple household fuel-use cards, were suggested to collect relevant data. After-action reviews at the end of each planting or cooking season could then be used to adjust species mixes, planting schedules, or supply logistics.

By shifting the focus to outcome-based monitoring, this strategy supports real-time learning and course correction. It reflects best practices in adaptive management, where feedback loops are embedded into program implementation to refine approaches and improve impact over time.

Participants emphasized that women are the primary users of household cooking energy and often bear the brunt of fuel collection time and safety risks. They proposed women-led energy savings groups to manage pay-as-you-go (PAYGO) accounts and act as group guarantors for clean energy loans. Training sessions should be scheduled to avoid conflicts with caregiving and market days, and safe transport arrangements for LPG cylinders should be made to reduce physical burden and risk.

This strategy addresses the exclusion of primary stakeholder women from key decision-making processes in past interventions. Empowering women in both financial and operational aspects of program delivery is likely to enhance adoption and sustained use of clean energy

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jun664

solutions, consistent with gender-focused findings in rural energy transitions.

V. CONCLUSION AND RECOMMENDATIONS

➢ *Conclusion*

For the first objective, participants viewed the afforestation policy as beneficial both environmentally and socio-economically. Tree planting initiatives were said to have slowed deforestation, improved microclimate, enhanced soil fertility, and restored degraded lands. Some respondents noted that fruit and timber trees provided new income sources. However, benefits were unevenly distributed, depending on community participation and available resources.

Under the second objective, findings showed that alternative energy programs promoting LPG, solar cookers, and energy-efficient stoves had reduced charcoal dependency among some households. Those with access to these technologies spent less on charcoal, and some shifted entirely to cleaner fuels. Yet, fuel and stove stacking persisted due to affordability challenges and unreliable alternatives, showing that the energy transition remained partial.

Regarding the third objective, several challenges limited the success of both initiatives. High costs of clean energy technologies, unreliable electricity, cultural cooking preferences, weak law enforcement, insecure land tenure, and low seedling survival from drought and grazing were major obstacles. Respondents also cited limited extension services, poor monitoring, and weak coordination among institutions as barriers to effective implementation.

For the fourth objective, participants proposed several strategies to enhance policy effectiveness. These included raising community awareness, providing subsidies or microloans for clean energy, improving support for nurseries, planting drought-tolerant tree species, strengthening law enforcement, and linking conservation with income-generating activities. Collaboration among government, NGOs, and local communities was also recommended to ensure continuity and local ownership through community-based resource management

➢ *Recommendations*

The study's findings reveal several areas where the effectiveness of afforestation and alternative energy programs can be enhanced. Based on the findings, the following recommendations are proposed.

- *Afforestation Recommendations*

✓ Strengthen Afforestation Policy Enforcement the government should improve enforcement of forestry regulations to curb illegal charcoal production. This could involve training and deploying more community-based forest guards and enhancing penalties for illegal logging.

✓ Incentivize Community Participation provide incentives such as fruit trees, beekeeping support, or small grants to encourage active community involvement in afforestation projects. Linking environmental restoration with direct household benefits can improve participation rates.

✓ Promote Drought-Resistant and Fast-Growing Tree Species tree species that are resilient to drought and capable of growing quickly should be prioritized in nurseries, reducing seedling mortality and increasing forest cover recovery rates.

✓ Enhance Coordination Among Stakeholders establish a joint district-level coordination platform involving the Forestry Department, Ministry of Energy, NGOs, and community-based organizations to streamline program delivery and avoid duplication.

- *Alternative Energy Program Recommendations*

✓ Introduce Targeted Subsidies or Credit Schemes provide targeted subsidies, payment plans, or micro-loans for LPG kits, solar cookers, and efficient stoves to make them affordable for low-income households.

✓ Strengthen Supply Chains for Clean Energy Technologies ensure last-mile distribution networks are reliable and establish local maintenance services to increase adoption and sustained use.

✓ Integrate Energy Programs with Livelihood Support link alternative energy programs with income-generating activities such as training in briquette production to make clean energy adoption economically viable.

✓ Promote Energy Literacy and Cultural Adaptation conduct community cooking demonstrations and awareness campaigns to address cultural preferences for certain cooking methods, helping households adapt clean energy solutions to traditional recipes.

ACKNOWLEDGEMENT

I am very grateful to God Almighty for the strength he gave me, also indebted to ICU and Zambia Research and Development Center (ZRDC) for providing the resources and sponsorship which have made this thesis a success.

REFERENCES

[1]. Amir, S., et al. (2021). Energy status in Africa: Challenges, progress, and sustainable development. Energies, 16(23), 7708. Retrieved from https://www.mdpi.com/1996-1073/16/23/7708

[2]. Bosetti, V., & Rose, S. K. (2018). Afforestation and avoided deforestation in a multi-regional climate model: Economic analyses and potential implications. Ecological Economics, 146, 148-159. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0921800918315933

[3]. Busch, J., & Ferretti-Gallon, K. (2023). Public policies and global forest conservation: Empirical evidence from the past two decades. Science of The Total Environment, 856, 158793. Retrieved from https://www.sciencedirect.com/science/article/pii/S09

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jun664

5937802300136X
[4]. Central African Forest Initiative. (2024). Central African Forest Initiative. Retrieved from https://en.wikipedia.org/wiki/Central_African_Forest_Initiative
[5]. Chakrabarti, A., Handa, S., & Malawi and Zambia Cash Transfer Evaluation Teams. (2023). The impacts of cash transfers on household energy choices. American Journal of Agricultural Economics, 105(5), 1426-1457. https://doi.org/10.1111/ajae.12366
[6]. Chambers, R., & Conway, G. (1992). Sustainable rural livelihoods: Practical concepts for the 21st century. IDS Discussion Paper.
[7]. Cheng, S., Davis, K. F., & Ciais, P. (2024). Tree plantations and forest regrowth are linked to poverty reduction across Africa. Communications Earth & Environment, 5, 45. Retrieved from https://www.nature.com/articles/s43247-024-01845-2
[8]. Cheng, S., Davis, K. F., & Ciais, P. (2024). Tree plantations and forest regrowth are linked to poverty reduction across Africa. Communications Earth & Environment, 5, 45. Retrieved from https://www.nature.com/articles/s43247-024-01845-2
[9]. Chidumayo, E. N. (2013). Forest degradation and recovery in a miombo woodland landscape in Zambia: 22 years of observations on permanent sample plots. Forest Ecology and Management, 291, 154-161. https://doi.org/10.1016/j.foreco.2012.11.031.
[10]. E-International Relations. (2016). Renewable energy: Global challenges. Retrieved from https://www.e-ir.info/2016/05/27/renewable-energy-global-challenges/
[11]. FAO. (2005). Challenges in defining, implementing and renewing forest policies. Retrieved from https://www.fao.org/4/a0532e/A0532e03.htm
[12]. Food and Agriculture Organization of the United Nations (FAO). (2020). Global Forest Resources Assessment 2020: Main Report. FAO. https://doi.org/10.4060/ca9825en.
[13]. Food and Agriculture Organization. (2021). Are policies in Africa conducive to sustainability interventions in the charcoal sector?. Retrieved from https://openknowledge.fao.org/server/api/core/bitstreams/b19b71f7-ed39-4dd9-98e6-5cfde0a8918e/content
[14]. Freeman, J., Wagner-Riddle, C., & Lee, E. A. (2021). Commercial afforestation can deliver effective climate change mitigation under multiple decarbonization pathways. Nature Communications, 12, 3831. Retrieved from https://www.nature.com/articles/s41467-021-24084-x
[15]. Government of the Republic of Zambia. (2011). Environmental Management Act, No. 12 of 2011. Lusaka: Government Printer. https://www.parliament.gov.zm/sites/default/files/documents/acts/Environmetal%20Mangement%20Act%2012%20of%202011.pdf
[16]. Government of the Republic of Zambia. (2015). National Forestry Policy. Retrieved from https://www.mgee.gov.zm/wp-content/uploads/2024/08/Draft_National_Forestry_Policy_edited_Final_15082024.docx
[17]. Government of the Republic of Zambia. (2015). The Forests Act No. 4 of 2015. Lusaka: Government Printer. https://www.parliament.gov.zm/node/4535
[18]. Government of the Republic of Zambia. (2019). National Energy Policy. Retrieved from https://faolex.fao.org/docs/pdf/zam219821.pdf
[19]. Grossman, G. M., & Krueger, A. B. (1991). Environmental impacts of a North American Free Trade Agreement. NBER Working Paper.
[20]. Guta, D. D., Jara, J., Adhikari, N. P., Chen, Q., Gaur, V., & Mirzabaev, A. (2017). Electricity access and charcoal consumption among urban households in Zambia. Energy for Sustainable Development, 37, 86-98. Retrieved from https://www.researchgate.net/publication/327404987_Electricity_access_and_charcoal_consumption_among_urban_households_in_Zambia.
[21]. Hassen, S., Mulugeta, G., & Deressa, W. (2022). The impact of alternative energy technology investment on environment, food security, and health. Environmental Research Communications, 4(6), 061005. Retrieved from https://pmc.ncbi.nlm.nih.gov/articles/PMC9213420/
[22]. International Union of Forest Research Organizations (IUFRO). (2021). Forests, Trees and Poverty Alleviation in Africa. Retrieved from https://www.iuf.
[23]. Ministry of Lands and Natural Resources (2017). National Investment Plan to Reduce Deforestation and Forest Degradation (2018-2022). Retrieved from https://www.cif.org/sites/cif_enc/files/meetingdocuments/zambia_final_investment_plan_fip.pdf
[24]. Ministry of Lands and Natural Resources. (2017). Zambia National REDD+ Strategy. Lusaka: Government of the Republic of Zambia. https://www.un-redd.org/sites/default/files/2021-09/9.%20Zambia.pdf
[25]. Mulenga, B. P., Richardson, R. B., & Tembo, G. (2012). Natural resource management and land policy in Zambia. Food Security Research Project Working Paper No. 62, Lusaka: FSRP. https://www.researchgate.net/publication/46471035_Natural_Resource_Management_Food_Security_and_Rural_Development_in_Zambia_Moving_From_Research_Evidence_to_Action_Proceedings_of_the_Public_Forum
[26]. New Partnership for Africa's Development. (n.d.). Addressing Deforestation in Africa Using Environmentally Friendly Energy Technologies. Retrieved from https://www.nepad.org/blog/addressing-deforestation-africa-using-environmentally-friendly-energy-technologies.
[27]. Ng'andwe, P., & Muimba-Kankolongo, A. (2018). Policy and governance issues in the charcoal, timber and forest product industries of Zambia. In A. Muimba-Kankolongo (Ed.), Food Crop Production by Smallholder Farmers in Southern Africa (pp. 353-372). London: Academic Press.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jun664

https://shop.elsevier.com/books/food-crop-production-by-smallholder-farmers-in-southern-africa/muimba-kankolongo/978-0-12-814383-4

[28]. Not Just Carbon: Capturing All the Benefits of Forests for Stabilizing the Climate. (2022). World Resources Institute. Retrieved from https://www.wri.org/research/not-just-carbon-capturing-benefits-forests-climate

[29]. Pelletier, J. M., Hamalambo, B., Trainor, A. M., & Barrett, C. B. (2021). How land tenure and labor relations mediate charcoal's environmental footprint in Zambia: Implications for sustainable energy transitions. World Development, 146, 105600. https://doi.org/10.1016/j.worlddev.2021.105600.

[30]. Phiri, M., Chirwa, P. W., Watts, S., & Syampungani, S. (2016). Barriers to policy implementation and implications for Zambia's forest ecosystems. Forest Policy and Economics, 69, 40-44. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S1389934116300491

[31]. Phiri, M., Chirwa, P. W., Watts, S., & Syampungani, S. (2016). Barriers to policy implementation and implications for Zambia's forest ecosystems. Forest Policy and Economics, 69, 40-44. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S1389934116300491

[32]. Phys organization. (2025). Reforestation-based climate mitigation strategies. Retrieved from https://phys.org/news/2025-01-reforestation-based-climate-mitigation-strategies.html

[33]. Rand, J., & Hoen, B. (2017). Thirty years of North American wind energy acceptance research: What have we learned? Energy Policy, 105, 453-463. Retrieved from https://www.sciencedirect.com/science/article/pii/S0301421517301611

[34]. Sari, R. R., Susanti, L., & Wibowo, A. (2024). Renewable energy communities in rural areas: A review of key drivers and sustainability. Journal of Cleaner Production, 321, 128920. Retrieved from https://www.sciencedirect.com/science/article/pii/S0959652624037855

[35]. Syampungani, S., Chirwa, P. W., Akinnifesi, F. K., & Sileshi, G. W. (2009). The potential of using agroforestry as a win–win solution to climate change mitigation and adaptation and meeting food security challenges in southern Africa. Agricultural Journal, 4(3), 155-161. https://www.researchgate.net/publication/250303843_The_Potential_of_Using_Agroforestry_as_a_Win-Win_Solution_to_Climate_Change_Mitigation_and_Adaptation_and_Meeting_Food_Security_Challenges_in_Southern_Africa

[36]. Syampungani, S., et al. (2022). Influence of Charcoal Production on Forest Degradation in Zambia. Remote Sensing, 14(14), 3352. https://www.mdpi.com/2072-4292/14/14/3352.

[37]. Tanner, E., & Johnston, P. (2021). Forest Conservation and Renewable Energy Consumption. Forests, 12(2), 255. Retrieved from https://www.mdpi.com/1999-4907/12/2/255

[38]. The Forest Act of 2015, Zambia. https://www.parliament.gov.zm/node/4535

[39]. United Nations Climate Change. (2018). Renewable Energy for Sustainable Development in Zambia. Retrieved from https://unfccc.int/climate-action/momentum-for-change/activity-database/momentum-for-change-renewable-energy-for-sustainable-development-in-zambia

[40]. United Nations Environment Programme. (2015). Benefits of forest ecosystems in Zambia and the role of REDD+ in a green economy transformation. Retrieved from https://www.uncclearn.org/wp-content/uploads/library/benefits_of_forest_ecosystem_zambia_full_report_final.pdf

[41]. United Nations Environment Programme. (2015). Zambia's Forest Ecosystems Contribute $1.3 Billion to the National Economy. Retrieved from https://www.unep.org/news-and-stories/press-release/zambias-forest-ecosystems-contribute-13-billion-national-economy

[42]. United Nations. (n.d.). Renewable Energy – Powering a Safer Future. Retrieved from https://www.un.org/en/climatechange/raising-ambition/renewable-energy

[43]. University of Zambia. (2023). Implementation of renewable energy technologies in Zambia: Facilitators and barriers. Retrieved from https://www.researchgate.net/publication/376783563_Implementation_of_Renewable_Energy_Technologies_in_Zambia_Facilitators_and_Barriers

[44]. UN-REDD Programme. (2012). Preliminary analysis of drivers of deforestation and forest degradation in Zambia. Retrieved from https://www.un-redd.org/sites/default/files/2021-10/PRELIMINARY%20ANALYSIS%20OF%20DRIVERS%20OF%20DEFORESTATION_20120808.pdf

[45]. UN-REDD Programme. (2024). REDD and REDD+. Retrieved from https://en.wikipedia.org/wiki/REDD_and_REDD%2B

[46]. Veldman, J. W., Overbeck, G. E., Negreiros, D., Mahy, G., Le Stradic, S., Fernandes, G. W., ... & Bond, W. J. (2023). Conflation of reforestation with restoration is widespread in the context of tree planting. Science, 379(6630), 281-282. Retrieved from https://www.science.org/doi/10.1126/science.adj0899

[47]. Vidadili, N., Suleymanov, E., Bulut, C., & Mahmudlu, C. (2017). Transition to renewable energy and sustainable energy development in Azerbaijan. Renewable and Sustainable Energy Reviews, 80, 1153-1161. https://doi.org/10.1016/j.rser.2017.05.168.

[48]. Wathum, G., & Mwampamba, T. H. (2020). Charcoal production and livelihood options in southern Africa: a review. Forests, 11(12), 1371. https://doi.org/10.3390/f11121371.

[49]. World Bank. (2023). National Energy Compact for Zambia. Retrieved from https://thedocs.worldbank.org/en/doc/54ece4387e7fd

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jun664

4bde8f1b29f55aa579d-0010012025/original/M300-AES-Compact-Zambia.pdf
[50]. Zulu, L. C. (2015). Charcoal, Alternative Energy, and Forest Management in Malawi. MSU Engaged Scholar Magazine. Retrieved from https://engagedscholar.msu.edu/magazine/volume13/zulu.aspx
[51]. Zulu, L. C., & Richardson, R. B. (2013). Charcoal, livelihoods, and poverty reduction: Evidence from sub-Saharan Africa. Energy for Sustainable Development, 17(2), 127-137. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0973082612000506
[52]. Barnes, D. F., & Floor, W. M. (1996). Rural energy in developing countries: A challenge for economic development. Annual Review of Energy and the Environment, 21(1), 497–530.
[53]. Kammen, D. M., & Kirubi, C. (2008). Poverty, energy, and resource use in developing countries: Focus on Africa. Annals of the New York Academy of Sciences, 1136(1), 348–357.
[54]. Malabo, P., & Matinga, M. (2016). Barriers to the adoption of clean energy technologies in rural Africa. Energy Policy, 93, 39–46.