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Socio-Cultural Practices and Improved Cooking Stove Technology Choices among Agro-Pastoral Communities in Arumeru District, Tanzania

Luka Njau[1*]
George Matto[2]

AFFILIATIONS

[1]Department of Community Development and Gender, Moshi Co-operative University, Moshi, Tanzania.
[2]ICT Department, Moshi Co-operative University, Moshi, Tanzania.

CORRESPONDENCE

Email: luka.njau@mocu.ac.tz*

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Abstract: This study assessed the socio-cultural factors influencing the choice of improved cooking stove technology among agro-pastoral communities in Arumeru District, Arusha region. The study used a cross-sectional research design and was conducted in four villages. Two categories of respondents were involved in the study. The first category consisted of 37 participants interviewed as Key Informants (KIs) and through focus group discussions (FGDs). The second category who responded to the questionnaire involved 92 respondents who had benefited from the alternative cooking energy technologies programme. Both qualitative and quantitative data were collected, with a greater emphasis on qualitative data. Content analysis was used to analyse the qualitative data, while the quantitative data were analysed using Statistical Package for Social Sciences (SPSS) computer software. The study found the persistence of certain socio-cultural practices that encourage the use of traditional three-stone stoves over improved stoves. These practices include preferences for food cooked using traditional three-stone stoves and the tradition of formally handing over the traditional cooking stoves to a newly married woman in the household, among others. It is concluded that while some community members consider these practices positive and valuable, they largely contribute to high biomass consumption and, therefore, the likelihood of environmental degradation. It is recommended that serious sensitisation and training programmes, among other recommendations detailed in this study, be conducted.

Keywords: Improved cooking stoves, socio-cultural practices, agro-pastoral communities, Tanzania.

1. Introduction

The population in third-world countries continues to grow exponentially, as does the demand for cooking energy. This is partly because some countries have a rapidly growing population but limited transition initiatives from conventional cooking energy technologies to improved ones. According to Massawe et al. (2015), although the cooking energy used may be renewable, it is becoming scarce in many parts of the world due to its increasing demand. Globally, approximately four billion people, mostly in poor countries, still lack access to clean, efficient, convenient, safe, reliable, and affordable cooking energy (World Bank, 2020). Traditionally, the majority of people in third-world countries have depended on firewood, charcoal, and other conventional energies as their main sources of cooking energy for a long time. It is estimated that one-third of the global population in third-world countries relies on biomass as the main source of cooking energy (Makonese et al., 2019; UNEP, 2019; IEA, 2017). The World Bank (2020) indicated that approximately 2.8 billion people globally still cook with traditional polluting fuels and technologies, costing the world over USD 2.4 trillion each year due to adverse impacts on health (USD 1.4 trillion), climate (USD 0.2 trillion), and women (USD 0.8

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trillion) from lost productivity. There is a significant urban-rural divide in access to clean cooking energy globally, with 86 per cent of people in urban areas and only 48 per cent of the rural population having access to clean fuels and technologies in 2020 (WHO, 2022).

In Sub-Saharan Africa (SSA), more than 50% of households in urban centres rely on charcoal, fuel wood, or wood waste to meet their cooking needs (Onyekuru et al., 2020; Mperejekumana, 2021). While the number of people with access to clean energy has continued to grow globally, the situation is quite the opposite in Sub-Saharan Africa (SSA). This is because the number of people without access to clean cooking energy in SSA is currently increasing by about 20 million people per year (Pelizan et al., 2019). Unfortunately, the region has the largest share of countries with the lowest access rate. It is estimated that approximately 1 billion people in this region are already experiencing the negative health and socio-economic impacts of polluting cooking energy sources, with the majority of them being in rural areas.

In Sub-Saharan Africa (SSA), access to clean cooking fuels and technologies is lacking for more than 93 per cent of the rural population, compared to 71 per cent in urban areas (WHO, 2022; WHO, 2014). A study conducted in Ethiopia by Adams et al. (2023) found that approximately 90.7% of rural households rely on fuel wood, while only 3.14% use clean fuels as their primary source of cooking energy. This heavy dependence on traditional cooking energy sources, such as charcoal and firewood, contributes to forest loss, land degradation, and negative impacts on the economy, environment, and health of users (Crentsil & Nantwi, 2022; Jung & Huxham, 2018; Stanturf, 2017; Liu et al., 2008).

In Tanzania, solid biomass (charcoal and firewood) accounts for 85% of total consumption, making it a major source of cooking and heating energy in the country (Pelizan et al., 2019; Massawe et al., 2015). This high reliance on charcoal and firewood is driven by their inefficient use as residential cooking fuels. In contrast, electricity only contributes 2% to the country's total energy consumption (Pelizan et al., 2019). Apart from the negative environmental effects, the use of traditional fuels for cooking poses health risks due to indoor air pollution, leading to premature deaths and other health problems (Edwards et al., 2015; De et al., 2014). However, transitioning to alternative fuels is influenced by various factors, including the availability of alternative fuel options, financial and technical capabilities for adopting improved cooking technologies, community awareness of the need for clean energy, and cultural attachment to specific fuel sources (Adams et al., 2023).

Efforts have been made by the Tanzanian government, private sector, non-governmental organisations, and other stakeholders to address the challenge of using unclean cooking fuels in both rural and urban areas. The government has implemented tax subsidies to ensure improved cooking stove technologies (ICST) are more affordable and accessible. Furthermore, initiatives have been undertaken to make these technologies widely available, especially in rural areas of Tanzania. Various prototypes of improved cooking stoves have been designed and introduced to different community members, including agro-pastoral communities in the Arumeru district. Empirical literature indicates that improved cooking energy technologies have addressed most of the challenges posed by traditional methods. They are more efficient than conventional methods (Adams et al., 2023; Arora et al., 2020; Bailis et al., 2007). Improved cooking energy technologies not only reduce carbon monoxide (CO) and carbon dioxide (CO2) emissions by 28% and 22%, respectively, but also decrease cooking time (Mamuye et al., 2018). Additionally, they reduce household expenditure on fuel and improve savings (Valenti et al., 2021). Improved cooking energy technologies increase thermal efficiency, reduce smoke, and lead to better health outcomes (Valenti et al., 2021). However, limited studies have assessed how socio-cultural factors, particularly among indigenous agro-pastoral communities, may influence the choice of improved cooking energy technologies over traditional three-stone cooking practices.

Muwanga et al. (2023) defined socio-cultural practices as habitual activities and rituals that include various behaviours, from simple routines to complex ones such as cooking preferences. In the context of this study, socio-cultural practices refer to habitual and ritual activities that somehow impact community members' choice of their preferred cooking stoves. These practices include attitudes toward food taste, traditions and customs related to traditional cooking stoves, and procedures governing community social gatherings during cooking as a means of warmth and knowledge transfer.

While assessing socio-cultural aspects and their influence on the choice of improved cooking energy technologies is crucial among indigenous communities, studies have indicated that non-income factors have little effect on fuel selection (Safari et al., 2022). Most studies have focused on how economic factors such as cost, accessibility, affordability, and technical performance influence choices of cooking energy technologies (Adams et al., 2023; Arora et al., 2020; Sovacool & Griffiths, 2020; Bailis et al., 2007). The majority of empirical literature has emphasised economic and technical factors (Safari et al., 2022), neglecting the socio-cultural aspects.

Nonetheless, empirical literature indicates that socio-cultural aspects are equally important when it comes to communities' choice of cooking energy technologies. As a result, efforts and strategies that disregard socio-cultural factors and concentrate only on economic and technical viability are likely to have little success (Muwanga et al., 2023). Therefore, this paper contributes to the limited body of knowledge on how socio-cultural setbacks, especially among indigenous agro-pastoral communities, are likely to influence their choice of the Improved Cookstove Technology (ICST) over traditional three-stone cooking practices. Specifically, the study intends to:

- Establish whether households which benefited from ICST training have transitioned from the use of traditional three-stone cooking stoves to improved stoves in the study areas, and
- Establish how socio-cultural factors influence ICST choices among indigenous agro-pastoral communities in the study area.

2. Theoretical Background

This paper draws insights from the Energy Culture (EC) Framework (Stephenson, 2018). The EC framework highlights the importance of practices and habits in influencing energy usage behaviour and achievement (Muwanga et al., 2023). The core intent of the EC framework is to capture the likely drivers of household energy choices and usage behaviour to ensure sustainable energy use. It is argued that energy choice behaviour is a product of the interaction between societal norms, materials, and social practices. The EC framework emphasises that people would choose to use a form of energy that matches their ways of life (Stephenson, 2018). In this study, the EC framework was used to analyse how socio-cultural aspects, such as attitude towards food taste and cooking stove-related traditions, influence community members' choice of cooking energy stoves. The framework was also used to analyse how community social practices, specifically gathering around traditional cooking stove fires for warming benefits, are likely to influence community members' choice of cooking energy stove types. The framework also guides the analysis of whether their choices of traditional cooking stoves and/or improved stoves match study participants' ways of life.

3. Study Methodology

3.1 Choice of the study area and its rationale

The study was conducted in four villages within the Arumeru district in the Arusha region, Tanzania. The villages were Lengijave, Ngyeku, Sakila Juu, and Losinoni Kati. The choice of the study area was based on the fact that all of the selected villages are rural-based and inhabited by agro-pastoral communities. The choice of the four villages was also because, in the past years (from 2019 to 2022), they benefited from a programme that focused on addressing climate change effects through

technical training and community sensitisation on the use of alternative/improved energy technologies. These technologies aimed to promote the use of improved cooking stoves that require less firewood, thus discouraging the use of traditional three-stone stoves. The implementation of such a programme was facilitated by the women's membership organisation named Women Development for Science and Technology Association (WODSTA) in collaboration with the local government.

3.2 Research design, sampling, data sources and study participants

A cross-sectional research design, which involves collecting data at a single point in time (Dawadi et al., 2021), was employed. The study population involved all residents in the study area. Two categories of respondents were involved. The first category involved participants with first-hand information, direct experience, or relevant knowledge regarding socio-cultural practices on improved cooking stove technology amongst agro-pastoralists in the villages. This category involved 37 participants who were interviewed; 9 of them were Key Informants (KIs), and 28 were interviewed through focus group discussions (FGDs). Purposive sampling was used to obtain study participants in this category.

The second category of respondents involved those who benefited from the alternative cooking energy technologies programme implemented in four villages. The programme involved a total of 120 beneficiaries, 30 from each village. Stratified sampling and simple random sampling techniques were employed to obtain representative samples from a pool of programme beneficiaries. A stratified sampling technique was employed to form four strata, one for each village's programme beneficiaries. Then, the simple random sampling technique was used to obtain 23 respondents from each stratum, making a total of 92 respondents, which is 76.7% of the total population of 120 initial programme beneficiaries. Thus, 23 respondents were selected randomly from among the 30 community members initially selected to participate in the programme.

The Spiegel and Stephens (2017) formula, as shown in equation (i), guides in deriving the study sample size from a population of 120 programme beneficiaries.

$$n = \frac{Z^2 Q^2 N}{e^2(N-1)+Z^2Q^2} \qquad \text{(i)}$$

Where:

n = size of sample;
N = size of the total study population, which was 120 programme beneficiaries;
Q = standard deviation of the population, which is a constant value of 0.5;
Z = confidence level, preferred 95% that is 1.96; and
e = the acceptable limit of sampling error, with 0.05 as the standard value used in research

Thus, inserting values to variables in equation (i) gives a sample size of 91 as shown in equation (ii).

$$n = \frac{1.96^2 \times 0.5^2 \times 120}{0.05^2 \times (120-1)+1.96^2 \times 0.5^2} = 91.6 \approx 91 \qquad \text{(ii)}$$

Since the sample size from the formula was 91, which cannot be evenly divided by four, and the programme beneficiaries were equally distributed across the four surveyed villages, the sample size was increased to a final sample size of 92 (23 from each of the four villages) to ensure a uniform distribution across the villages. Increasing the sample size is permitted for better outcomes, as stated by Dolnicar et al. (2016).

3.3 Data collection and analysis

Data collection was done through key informant interviews (KIs), focus group discussions (FGDs), and questionnaires, where the consent of study participants was sought before involving them. Notebooks and an audio recorder were used to help capture responses from study participants.

The data collected from key informants included district forestry officials, village extension officers, village community development officers, community elders, and retired government officials at the village level, as detailed in Table 1.

Table 1: *Key Informants involved in the study*

Key Informants Position	Lengijave Village		Ngyeku Village		Sakila Juu Village		Losinoni Village	
	Number of participant	Gender	Number of participant	Gender	Number of participant	Gender	Number of participant	Gender
District Forestry Official	1 (Male)							
Village extension officers	1	Male	1	Female	0	Female	1	Male
Village community development officers	0	N/A	1	Male	0	Female	0	N/A
Community elders	1	Female	0	N/A	0	N/A	0	N/A
Retired government officials	1	Male	0	N/A	1	Male	1	Male

Four FGD sessions, one in each village, were conducted. Each FGD session had six to eight participants. There is no definitive number of focus group participants, but according to Stewart and Shamdasani (2015), six to twelve participants are ideal as too many participants may be difficult to manage. Likewise, fewer than six participants tend to reveal less information and the discussion may be dull. Specifically, the study involved 8 FGD participants in Lengijave, 6 in Ngyeku, 7 in Sakila Juu, and 7 in Losinoni Kati. The FGD participants included normal residents (women, men, and youth), school teachers, environmental conservationists, herders, extension workers, religious leaders, and community leaders.

Quantitative data for this study was collected using a structured questionnaire that was developed and pre-tested before being administered in face-to-face interviews with respondents. The quantitative findings were used to complement some aspects of the study, whereas qualitative data sources were used.

The collected data was analysed using both qualitative and quantitative techniques. Qualitative data was analysed using content analysis, while quantitative data was analysed with the help of SPSS. Data gathered through field notes and recordings were transcribed before analysis. Content analysis was used to analyse the textual data, and Atlas.ti computer software enabled the analysis of data generated from FGDs and KIs. The data analysis involved searching for meanings, patterns, surprises, contradictions, and silences in the textual data, guided by research questions and theory. The analysis involved three stages, including computer-assisted data reduction such as screening, coding, condensing, and transforming empirical data. The purpose of data reduction was to ensure that the data can speak authentically. Secondly, the data was displayed using reduced texts and tables, and finally, research conclusions were drawn (Taylor et al., 2011). Likewise, descriptive analysis was performed on the data collected through questionnaires, generating descriptive findings in the form of frequencies and percentages.

3.4 Ethical consideration

Since this study involved human beings, ethical issues, as suggested by Fleming and Zegwaard (2018), were observed during all stages of the study. Among others, the researchers obtained a research permit from the respective authorities to undertake data collection. In addition, during the

data collection exercise, researchers reported to village executive officers in the villages where data was collected, who introduced the researchers to respondents. Researchers obtained informed consent from participants before data collection. Participation in the study was voluntary, and participants were free to choose to participate or not. Furthermore, data collection ensured the privacy, confidentiality, and anonymity of research participants, as there was no disclosure of the names of the respondents.

4. Findings and Discussion

4.1 Socio-demographic characteristics of respondents

The sex of respondents was determined to understand the participation of different categories of women and men in improved cooking stove technology (ICST) activities. The study findings reveal that the majority of respondents were women, accounting for 73.9%, while men made up 26.1%. The significant difference in the number of respondents can be explained by the fact that the programme initially aimed to reach more women than men. This is because women are the primary cooking energy change agents in the study area, as they are solely responsible for meal preparation in their households. Therefore, women were considered to be the key agents of change when it came to transitioning from traditional three-stone cooking stoves to ICST.

Furthermore, the age of the respondents was also established to ascertain the involvement of different age groups in ICST activities. The study findings reveal that respondents between 18 and 35 years constituted 20.6%, those between 36 and 60 years constituted 52.2%, and those aged 60 years and above were 27.2%. The findings reveal that the majority of the respondents (52.2%) were in their thirties, forties, and early fifties. This implies that since most of them were in their active middle-age group, they are likely to support the transition from traditional three-stone cooking stoves to ICST. This age group can actively influence substantial change (Matto & Njau, 2023) in the areas of cooking energy transformation and ICST choice. Most of the respondents in this group are energetically active in farming activities (Matto, 2018), and therefore, they are also likely to be energetically active in influencing the use of ICST. This means they were in a position to offer their physical resources as well as actively engage in the technical aspects of appropriate ICST prototype design and usage.

It was found that approximately 66% of respondents were married, 15.1% were single, 11.0% were widowed, and the remaining 8.7% were separated or divorced (Table 2). It is widely recognised that marriage brings a sense of responsibility among individuals (Njau, 2023). Since the majority of the respondents were married and had family obligations, they were also expected to be committed change agents in the realm of ICST.

In terms of education level, the study revealed a moderate level of literacy among respondents. Approximately 65.2% of the respondents had completed primary education, 20.6% had completed secondary education, 3.3% had received college or university education, 2.2% had attended vocational training, and the remaining 8.1% had not received formal education (Table 2). This moderate level of education is expected to enable respondents to recognise the benefits of choosing ICST over traditional three-stone stoves and allocate available resources towards its success. Likewise, this level of education is expected to significantly enable respondents to learn the technical aspects of ICST design and usage and share this knowledge with other community members. Regnar et al. (2002) emphasised that the ultimate objective of education is to increase labour productivity, making it a crucial factor for one's ability to efficiently utilise various resources available in certain communities.

Table 2: *Socio-demographic Characteristics of Respondents benefited from the alternative cooking energy technologies programme*

Variable	Category	Frequency	Percentage
Age (years)	18-35	19	20.6
	36-60	48	52.2
	Above 60	25	27.2
	Total	**92**	**100**
Sex	Female	68	73.9
	Male	24	26.1
	Total	**92**	**100**
Marital status	Single	12	13.0
	Married	61	66.3
	Divorced/separated	8	8.7
	Widow	11	12.0
	Total	**92**	**100**
Education level	No formal education	8	8.7
	Primary (Standard VII)	60	65.2
	Secondary education	19	20.6
	Vocational education	2	2.2
	College/University	3	3.3
	Total	**92**	**100**
Sex of household head	Female	15	16.3
	Male	77	83.7
	Total	**92**	**100**

4.2 Household heads socio-demographic status and its influence on ICST choice

The socio-demographic characteristics of household heads were established from respondents. This was done in tandem with establishing how such characteristics could influence respondents' transition from traditional three-stone stoves to ICST. The study findings revealed that about 83.7% of the households were headed by males, while the remaining 16.3% were female-headed households (Table 2). The findings imply that most of the households in the study areas were headed by men, and thus, household decisions were mainly skewed towards the male side since the respondents belong to a patriarchal society. Under such a society, positions of dominance and privilege are primarily held by men.

Despite men holding key household decisions and privilege in the study areas, it was established that not all men were responsibly providing for their households. This was evidenced by one of the female KI who said, "*nowadays the issue of providing for the family is no longer the sole duty of a man. Many households are nowadays sustained by women since men spend their incomes on nonessential expenditures, including alcohol and others*" (KI1, May 2023). Similar findings were established among FGD participants expressing the shifting dynamic among women, where despite men traditionally being household decision-makers, responsibility for providing for the household is increasingly falling on women.

Regarding the household head's influence on ICST choice, the respondents indicated that despite declining household financial sustenance capability among some men and their limited kitchen roles, men must decide whether to allow their wives to choose the technology or not. This implies that the choice of whether the household should switch from traditional three-stone stoves to ICST, especially in male-headed households, was made by men.

Moreover, it was found that more than half of the household heads (56.5%) were between 36 and 60 years old. Regarding the education level of the household heads, the study established that about 65.2% had attained primary education, 20.7% had attained secondary education, 3.3% had college and/or university education, while the remaining 8.7% had no formal education. This implies that since most of the household heads were in their active middle age group and had attained some basic education level, they are likely to support the ICST programme activities.

4.3 Households transition from traditional three-stone cooking stoves to ICST

Respondents were asked to indicate whether the education and training they received has enabled them to transition from using traditional TSCS to ICST. Findings revealed that none of the respondents, regardless of their education level, had completely switched from TSCS to ICST. It was found that approximately 56.5% of the study participants frequently used TSCS, 43.5% regularly used ICST, and none had fully transitioned to improved cooking stove technology (Table 3). Furthermore, it was revealed that all respondents intentionally maintained both traditional TSCS and improved cooking stoves. One of the key informants expressed concern, stating, "*despite our understanding of the benefits of improved cooking stove technologies, we have not fully switched to improved cooking stoves because traditional three-stone stoves are familiar and readily available to us compared to improved stoves*" (KI 2, May 2023). This suggests that the decision-making process regarding the transition to improved cooking stoves may not be solely based on a rational assessment of the benefits but may also be influenced by other factors such as availability and familiarity.

Table 3: *Households cooking energy stoves transition status (N=92)*

Cooking energy stoves transition status	Lengijave	Ngyeku	Sakila Juu	Losinoni Kati	Total	Per cent
Frequently use TSCS	13	15	14	10	52	56.5
Regularly use ICST	10	8	9	13	40	43.5
Maintained both TSCS & ICST	23	23	23	23	92	100
Transitioned to ICST	**0**	**0**	**0**	**0**	**0**	**0**

Moreover, it was established that in some households, TSCS were used more than improved cooking stoves. This finding was supported by a female key informant's response who stated, "*we prefer using traditional three-stone stoves because they are easier to design and repair by our household heads compared to improved ones, which may require a trained technician*" (KI 3, May 2023). It was revealed that despite women being aware of the setting of three-stone stoves, men usually design and set such stoves. The findings imply that the reliance on elders for stove design and repair reflects a social structure where traditional wisdom and skills are valued over-reliance on unsustainable external expertise, shaping cooking practices among agro-pastoralists. This mirrors the sentiments expressed during FGDs, where the study participants expressed the high value placed on traditional wisdom and knowledge within these communities.

4.3.1 Households cooking energy use patterns

Participants were asked about their preferred cooking energy source. The findings revealed that approximately 56.5% of the study participants frequently use traditional three-stone cooking stoves, while 43.5% regularly use improved cooking stoves. Surprisingly, none of the participants had completely transitioned to improved cooking stove technology (Table 4). The findings suggest a continued reliance on traditional three-stone cooking stoves among the study participants despite the training opportunities provided to facilitate their transition to improved cooking stove technology. A study conducted by Safari et al. (2022) on patterns and predictors of household fuel choices in Maswa district, Tanzania, found that fuel stacking was more common than fuel switching among the surveyed households. Similarly, this study observed a prevailing tendency for the

surveyed households to use multiple cooking energy sources (i.e., traditional three-stone cooking stoves and improved cooking stove technology) rather than fully transitioning to improved cooking stove technology.

Table 4: *Households cooking energy use patterns (N=92)*

Preferred cooking energy source	Frequency	Percent	Type of cooking activities
Frequently use TSCS	52	56.5	- Traditional meals preparations - Breakfast preparation - Heating water for bathing - Traditional feast preparation
Regularly use ICST	40	43.5	- Fast foods preparation - Breakfast preparation - Heating water for bathing
Using both TSCS & ICST	93	100	- TSCS used in preparation of meals taking longer cooking time and ICST for fast foods - Breakfast preparation - Heating water for bathing & washing utensils
Total transition to ICST use	**0**	**0**	- Not applicable

4.4 Socio-cultural factors and its influence on ICST choices among respondents

This study established how some socio-cultural factors, particularly attitudes on food taste, cooking stove-related traditions, and habitual practices, specifically social gathering and warming around cooking stoves, influence ICST choice. Regarding attitudes on food taste, it was revealed that some study participants believed that a meal prepared using traditional cooking stoves is more appetising than one prepared using improved stoves. One of the KIs expressed concerns that "*the meal prepared using modern or improved cooking stoves is less tasty than the one cooked using traditional TSCS. This is because improved cooking stoves are kind of fast-food cooking equipment and hence less preferred in my household*" (KI 4, May 2023). Another KI emphasised that "*there has been a persistent cultural attachment among some agro-pastoralists that improved cooking stoves do not offer the same taste as dishes prepared on traditional three-stone stoves*" (KI 5, May 2023).

This fact is more apparent when we take into consideration the utensils and time taken to prepare meals through traditional practices. The traditional utensils used in cooking are normally clay-made pots. These take time to heat up compared to modern tin-made pots. For example, when preparing the main dish, the pot must be heated for a considerably longer time. This time adds value to the taste. After the meal is properly cooked, it remains in the pots to acquire more taste momentum. The modern ways of food preparation have no time for this practice. In addition, some foods are locally cooked in clay pots in order to achieve the required tastes. For instance, Maize flour can be mixed with pumpkins, and Maize meals can be mixed with beans or pumpkins, etc. The issue of time among rural communities might not be as vital as the time taken to prepare a tasty household meal. This may be part of the equation that differentiates the acceptance between TSCS and ICST among agro-pastoralists in Tanzania or even globally. To them, it seems ICST is compromising their preferred and long-established food taste requirements.

This implies that some community members have a strong belief that traditional TSCS are better than improved cooking stoves. The findings are in line with Sovacool and Griffiths' (2020) study, which established food taste requirements as one of the social and cultural aspects influencing community members' choice to stick with traditional cooking energy stoves.

In clarifying the study participants' concerns, one of the KIs from the district forestry department said that "*some households favour choosing traditional stoves over improved ones because the latter take a shorter cooking duration. Thus, if the cook is not keen enough, there is a likelihood that the meal may be quickly overcooked, spoiling its taste and quality*" (KI 6, May 2023). This risk, therefore, has partly contributed to some community members clinging to traditional three-stone cooking stoves over improved ones. This implies that the food taste issue is not a matter of which cooking approach was used but rather the practices and technicalities involved in the cooking process.

This study revealed that study participants continued to largely use traditional three-stone stoves despite realising that the latter has been proven to consume less biomass and, hence, likely to save the environment (Crentsil & Nantwi, 2022; Valenti et al., 2021; Jung & Huxham, 2018). This was the case even though some subsidies in the form of a waiver on technical training and materials for designing the improved cooking stoves were available to study participants. A retired government official, serving as one of the key informants, claimed that "*usually habits and tradition among our community members have always outweighed the awareness of environmental conservation in our daily cooking practices*" (KI 7, May 2023). This insight is in line with the EC framework, which emphasises that people would choose to use a form of energy that matches their way of life (Stephenson, 2018).

This study was conducted in localities inhabited by agro-pastoral communities, mainly the Waarusha and Maasai tribes. These tribes are among the communities in Tanzania which have strict traditions and customs that include adherence to strict three-stone cooking stove protocols. It was revealed that it has been a long-standing tradition among the residents that once a newlywed woman is introduced into the family, a special ritual is conducted for her to assume kitchen duties. In such rituals, women are given, among other kitchen tools, the traditional three-stone cooking stoves as a welcoming and kitchen duty mandate. This practice was found to be a valued ritual and, therefore, one of the reasons for respondents' reluctance to fully transition to improved cooking stoves. Muwanga et al. (2023) established contextual differences in the way activities are executed, meaning some energy technologies may face resistance, especially when people are unwilling to abandon practices that they consider life-sustaining.

The bone of contention between TSCS and ICST seems to emanate from the process of change rather than anything else. The transition from traditional to modern has always faced difficulties. Rather than enhancing a total revolution in traditional matters, especially among agro-pastoral communities, it seems imperative to allow an evolutionary approach rather than a total revolution (although time is the main enemy). Agro-pastoral communities' socio-cultural factors are among the most delicate parts of the change equation. This can be supported by study findings that the level of literacy among agro-pastoral communities is a subject of debate, where for example, about 75.9% of respondents have either no formal education and/or have only received primary school education. This seems to be a grey area.

One of the KIs originating from the studied agro-pastoral communities said, "*As for now, given our persistent traditions and customs, a total transition from traditional TSCS to improved cooking stoves is close to unattainable. Maybe the focus, at least for now, should be on both while offering the community an opportunity to undertake their own cost-benefit analysis*" (KI 8, May 2023). The EC framework emphasises that people would choose to use a form of energy that matches their ways of life (Stephenson, 2018). This implies that respondents in the study areas have chosen to be more inclined towards traditional cooking stoves as an approach that matches their current ways of life. This inclination is likely to delay and/or hamper the transition from traditional three-stone cooking stoves to improved stoves. Bach et al. (2020) established that, usually, widespread choices of energy technologies require a deeper understanding of the underlying cultural specifics, needs, and expectations depicted in the routines and other energy usage habits of the community.

This study also revealed that it is a cultural practice among the residents in the study areas, specifically women and children, to use traditional three-stone cooking stoves as a means of social gathering and warmth, especially during the coldest season of the year (April to July), rainy seasons, and evenings. Typically, women, girls, and children, and sometimes men, gather around the cooking stove during and after meal preparation. An elderly female key informant strongly emphasised that "*our evening gatherings around traditional three-stones stoves for knowledge and skills sharing are worth hundreds of what is offered in formal classes, and thus it is not easy to entirely abandon it*" (KI 9, May, 2023). This suggests that while the use of traditional three-stone stoves is perceived to be detrimental due to high biomass consumption, it holds invaluable cultural and educational significance, as well as some warming benefits, among agro-pastoral communities. Therefore, it is relatively challenging for these communities to completely transition to improved cooking stove technology, as it often lacks these advantages. Khandelwal et al. (2017) documented a similar scenario where improved cooking stove initiatives failed in certain parts of India because community members preferred open-fire cooking stoves for the warming benefits they provided.

From the findings of this study, it appears that the issue at hand is not only connected to the ingrained practice of using traditional three-stone cooking stoves. During the cold months of the year (May to June) in Tanzania, home heating becomes necessary. In fact, much of the home heating is done away from the three-stone cooking stoves, as men, who are not allowed to enter the kitchen, prepare their own bonfires with large fuel consumption at the house's doorstep. In some communities, men bring back large logs from the bush for the purpose of home heating. This practice may even surpass the amount of wood used in the kitchen for cooking purposes. However, further in-depth research is needed to explore this observation.

5. Conclusions and Recommendations

This study established the persistence of some social and cultural practices that encourage the use of traditional three-stone stoves over improved stoves. These practices include a preference for cooking food using traditional three-stone stoves and the tradition of special rituals that involve formally handing over the traditional cooking stoves to a newly married woman in the household. Another practice is the habit of community social gatherings for warming purposes during cold and rainy seasons. All of these practices limit the transition of community members from traditional cooking stoves to improved ones. It is concluded that while some community members consider these practices positive and valuable, they largely contribute to high biomass consumption and, therefore, increase the likelihood of environmental degradation. It is recommended that serious sensitisation and training programmes be conducted by the government, community development practitioners, the private sector, religious institutions, NGOs, and other stakeholders working in the study areas. This will enable the agro-pastoral communities to understand the negative aspects of practices that are perceived as positive but are actually lacking. This includes training on the fact that meals prepared using certain improved stove technology maintain the same or even higher quality when the cooking process is well maintained.

Regarding the rituals that focus on handing over traditional cooking stoves to newly married women in the household, serious sensitisation should also be provided. This includes helping the community understand that while their rituals are valued, the same rituals can be conducted using improved stoves without harming or distorting their intentions. Likewise, it is recognised that social gatherings around traditional cooking stoves during cold seasons, rainy seasons, and evenings are a valued tradition since they can be used as a means of sharing and transferring knowledge and skills from one generation to another. It is recommended that community members be made aware that improved stove technology often offers this advantage in a more beneficial manner, as it uses less biomass and generates less smoke.

6. Areas for Further Research

This study focused on socio-cultural factors that influence the choice of improved cooking stove technology among agro-pastoral communities. While these factors were found to be crucial in influencing technology choices, a comprehensive study is needed to assess the complex interplay of factors that influence the decision-making process regarding the choice of improved cooking stove technologies among agro-pastoral communities in the study area. These factors may include individual preferences, economic considerations, cultural norms, environmental factors, and technological accessibility. Moreover, future research could focus on understanding the underlying behavioural and psychological factors that influence agro-pastoral communities' choices between traditional three-stone stoves and improved cooking stoves. This is necessary for establishing how such communities weigh the perceived benefits of traditional practices against the possible long-term environmental effects. Furthermore, future research could compare the effectiveness of various intervention strategies that focus on promoting the use of improved cooking stoves among agro-pastoral communities residing elsewhere in Tanzania. This would likely add more value to the study, given the contextual variations in terms of socio-cultural, environmental, and economic factors.

7. Declarations

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