

Assessing the Attitudes of Urban Residents towards Improved Stove and its Contribution to the Conservation of Forest Resources in Central Ethiopia: The Case of Debre Berhan Town

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Abstract

Due to deforestation and land degradation, domestic energy crisis resulting from the unsustainable use of biomass energy is becoming one of serious environmental problems in Ethiopia. This study was conducted with the objectives to: (1) examine the attitudes of the urban residents towards the use of improved stoves over traditional stoves in Debre Berhan town; (2) evaluate the efforts made by the concerned bodies to introduce and distribute improved stoves; and (3) quantify the effect of the use of improved stoves over traditional stoves in reducing the problem of fuelwood shortage and ultimately its contribution to the conservation of forest resources in the surrounding area of Debre Berhan town. Closed- and open-ended structured questionnaire was developed by considering socioeconomic variables. The questionnaire was administered to a total of $n = 150$ households. Descriptive statistics and multiple linear regression were used to analyze and interpret the data. The results revealed that there is high demand for fuelwood in Debre Berhan town because most of the households use traditional stoves for baking “injera” and bread. Unfortunately, resulting from low income and high purchasing costs, introduction and dissemination of improved stoves is not widely practiced in the town. However, majority of the respondents strongly agreed (about 55%) that they had positive attitudes towards the use of improved stove over traditional stove. The multiple linear regression model revealed that several socioeconomic variables significantly affected the attitudes of the urban residents towards ‘the use of improved stove over traditional stove’. Overall, the multiple linear regression model revealed that socioeconomic variables had significant effects on the attitudes of the urban residents towards ‘the use of improved stove over traditional stove’ (34% variance explained). Raising the awareness level of the urban residents about the significance of the use of improved stoves over traditional stoves is essential. Introducing and distributing improved stoves by various stakeholders in the town is a key to the success of the use of improved stoves over traditional stoves. The government is also required to subsidize the costs of improved stoves so that dissemination of energy efficient modern technology can be pragmatic in Ethiopia.

Keywords: Deforestation; Energy efficient; Fuelwood; Forest resources; Multiple linear regression

Abbreviations:

EFAP: Ethiopian Forest Action Program; FAO: Food and Agriculture Organization of the United Nations; GTZ: German Technical Cooperation Agency; NGs: Non-Governmental Organizations

Introduction

Over half of the world people use solid biomass or coal fuels for basic cooking and heating [1]. Increasing attention is being paid to the consumption of such fuels because of their role in producing damages at three distinct scales [2,3]. For example, at the household and village level, combustion of solid fuels produces pollution that is damaging to health and a larger contributor to the global burden of disease [2-4] and imposes a high time burden on those collecting fuelwood, typically for women and girls. At the community and national level, when fuelwood is harvested in unsustainable manner, its consumption contributes to the loss of forest and associated ecosystem services. Finally, at the regional and global scale, the burning of biomass and

coal using inefficient stoves, which represents roughly 15% of the global energy use, releases large amounts of black carbon and carbon-based greenhouse gases [5,6]. This is because many of these gases fall into the category of products of incomplete combustion, which are more damaging in terms of global warming potential than the carbon dioxide released from more fossil fuel-burning stoves [1]. These emissions can also contribute to global warming, particularly where such fuels are harvested non-renewably [3,4].

The total coverage of the forest resources in Ethiopia is being reduced at an alarming rate over time resulting from different factors. One of the main reasons for such decline is the unwise utilization of the forests for fuelwood consumption which covers close to twenty times greater than the combined demand for other forest products [7-9]. For example, deforestation and degradation of forests constitute the most important sources of greenhouse gas emissions in many developing countries, particularly in Sub-Saharan Africa [10]. At the same time, energy from fuelwood is essential to sustain the livelihoods of the urban residents in this region [11,12]. So, fuelwood collection for cooking is the main driving force for forest degradation in those countries [13], though this phenomenon is difficult to quantify, even with sophisticated methods, such as remote sensing [14]. Moreover, indoor air pollution caused by traditional cooking constitutes a major health risk [15]. Therefore, strategies to reduce fuelwood consumption

have the potential to simultaneously mitigate the impacts of climate change, conserve forests, and also improve the livelihoods of humans.

Fuel demand dominates the forest product to obtain energy for household consumption. For example, the total demand for household energy in 1992 in Ethiopia was estimated to be about 68 million m³ of wood equivalent with fuelwood share being 45 million m³. This suggests that fuelwood is the single most dominant sources of household energy in the whole country. In 1994, the estimated annual fuelwood demand in Ethiopia was about 45m³, whereas the estimated annual incremental yield available for fuelwood is 12.4m³ [8]. In this situation, fuelwood deficit was 32.5 million m³ [16,17]. This suggests that the exploitation of the forest resources has been making above its regeneration capacity which results in the decline of the growing stock over time period. This, in turn, has brought a serious and severe problem of deforestation, soil erosion, moisture stress, resource use conflicts, shortage of water supply for different purposes, poverty, and less conducive for health [18].

Ethiopia has acute shortage of fuelwood resulting from the use inefficient traditional cooking method [18,19]. For example, most of the people use biomass energy for cooking and heating, and the equipment they use for such purposes is mainly the simplest stove type which is three stone fires where by arranging the three stones in a triangular position around the fire. The major drawbacks of the use of the three stones (i.e. traditional mud stoves) is its inconvenience, exposure to fire hazards, poor quality, and high smoke resulting from the incomplete combustion of the fuelwood, low efficiencies as there is excess loss of heat to the surroundings because of wind and poor control over the fire [16-19].

“Injera” is the staple flat bread for the majority of Ethiopians and also in most households in Debre Berhan town because it is used in daily meals. For example, baking “Injera” accounts for over half of all the household energy consumption in Ethiopia [19]. As it requires quick and fast heat evenly distributed over energy under the traditional ceramic plate, but there is high dissipation of heat energy to the surrounding environment [18]. This suggests that there is high fuelwood consumption at household level in Debre Berhan town. To meet their household energy demands, the urban residents spend most of their working time to collect fuelwood. Moreover, the usage of cow dung, leaves, and crop residues as sources of fuelwood which otherwise could be used as organic fertilizer to boost agricultural productivity. In addition, to fulfill their fuelwood needs, the local people also cut trees from the surrounding forests which ultimately leads to the deterioration of the forest resources [18,19].

Improved stoves have several contributions over traditional stoves including savings of the women’s labor to households’ work, woods, and power use [19,20]. Recently, people understand to strive towards technology-based activities so as to sustainably utilize their forest resources [18-20]. Moreover, in areas where there is high shortage of fuelwood, the households are forced to use cow dung and crop residues as sources of fuelwood or cooking with less fuel. However, the demand for fuelwood is increasing from time to time due to the inefficient utilization of improved technologies (e.g. energy saving stoves) in Ethiopia[19,20]. Rather many people use traditional stoves which do not increase the efficiency of fuelwood usage which in turn aggravates the loss of the existing forest resources.

There is less effort made towards the introduction and dissemination of improved stoves to Debre Berhan town. As a result, majority of the urban residents in the town are facing acute shortage of

fuelwood. Therefore, to resolve such kind of problems, examining the attitudes of the urban residents towards the use of improved stoves over traditional stoves is a critical issue. In doing so, it is also important to evaluate the efforts made by the concerned bodies (e.g. North Shewa Administrative Zone’s Water, Mines and Energy department, NGOs) to introduce and distribute improved stoves in the town. Quantifying the effect of the use of improved stoves over traditional stoves in reducing the problem of fuelwood shortage and ultimately scrutinizing its contribution to the conservation of the forest resources around the study site are of high priority to be addressed in the proposed study.

Therefore, the following four main questions were addressed in this study: 1. how are the attitudes of the urban residents towards the use of improved stoves over traditional stoves in Debre Berhan town? 2. What are the main efforts made by the concerned bodies to introduce and distribute improved stoves in the town? 3. How much do the improved stoves increase the fuel consumption efficiencies over the usage of traditional stoves? 4. How much is the effect of the use of improved stoves in reducing the problem of fuelwood shortage and its contribution to the conservation of the forest resources around the study site? The objectives of the study were to: 1. examine the attitudes of the urban residents towards the use of improved stoves over traditional stoves in Debre Berhan town; 2. evaluate the efforts made by the concerned bodies to introduce and distribute improved stoves; and 3. quantify the effect of the use of improved stoves over traditional stoves in reducing the problem of fuelwood shortage and ultimately its contribution to the conservation of the forest resources in the surrounding area of Debre Berhan town.

Other than academic purpose, the present study may have positive implication to provide quantitative scientific information for policy- and decision-makers, researchers and other stakeholders who have direct and/or indirect role to conserve the remnant forest resources through the introduction of energy efficient technologies including the dissemination of improved stoves in Debre Berhan town (Figure 1). This, in turn, will ensure efficient energy use that is geared towards socio-economic development and conservation of natural resources, which could be instrumental in achieving the broad goal of reducing fuelwood scarcity and poverty in Ethiopia. Moreover, this study can serve as a springboard for further researches in the study area and elsewhere.

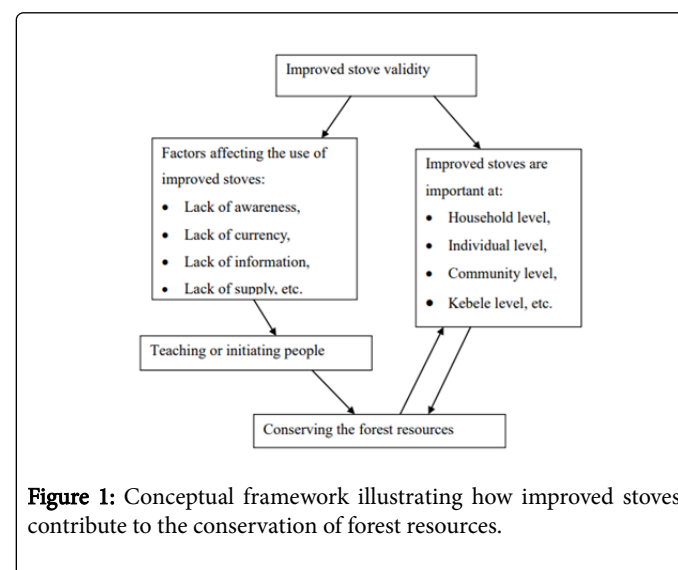


Figure 1: Conceptual framework illustrating how improved stoves contribute to the conservation of forest resources.

Materials and Methods

The study area

The study was conducted in Debre Berhan, one of the fastest growing towns in the central part of Ethiopia. Debre Berhan is found in Amhara National Regional State, Ethiopia. It is situated in North Shewa Administrative Zone about 130 kilometers northeast of Addis Ababa on the highway to Dessie town. The town is located at latitude and longitude of 9°41'N and 39°32'E, respectively. The average altitude of the town is about 2,840 meters. Debre Berhan town is one of the coolest towns which are found at subtropical zone of Ethiopia. For example, the average annual temperatures of the town during day and night times were 20.7°C and 8.2°C, respectively. The mean annual precipitation in the town was about 964 mm. The total population size of the town was estimated to be about 100,000 inhabitants.

Survey procedure

A preliminary survey was carried out to get better information about the study site and the relevant types of data to be collected. Structured questionnaire comprising closed-and-open ended questions were prepared [19,21,22] that likely affect the attitudes of the urban residents towards 'the use of improved stoves over traditional stoves' in Debre Berhan town. Most socio-economic, knowledge, and experience measuring questions were measured in nominal scale and rated using 3 = yes, unsure = 2, and 1 = no. Larger values expressed greater knowledge on improved stove and its contribution to the conservation of the forest resources. Age, family size, length of residence in the study site, annual income, and level of education were measured in continuous quantitative values. For the supplementary open-ended questions, the respondents narrated their experiences and knowledge on improved stove and its contribution to the conservation of the forest resources. To quantify the attitudes of the respondents towards 'the use of improved stoves over traditional stoves', Likert scale was employed and rated using 5 = strongly agree, 4 = agree, 3 = unsure, 2 = disagree and 1 = strongly disagree through the structured questionnaire survey [23,24]. Larger values reflected positive attitudes of the urban residents towards 'the use of improved stoves over traditional stoves'.

Data collection

The household survey was conducted through the administration of closed- and open-ended structured questionnaire by interviewing households living in two randomly selected kebeles (i.e. kebele 06 and 09) that are found in Debre Berhan town. Kebele is the smallest administrative unit in Ethiopia. The two study kebeles were randomly selected through a lottery system based on kebele numbers. The household survey is helpful to collect primary data. The questionnaire was developed by considering socioeconomic variables, such as sex, age, family size, livestock ownership, level of education, length of local residence, occupation type, land ownership, annual income, accessibility to various energy sources and improved stoves [19,21,22,25]. The data were collected via house-to-house interviews. The questionnaire was administered to a total of 150 households, representing 75 households from each kebele. The data were collected in May 2018.

Independent variables

Independent variables were derived from the following 20 questions: (i) sex, (ii) age, (iii) level of education, (iv) family size, (v) annual income, (vi) livestock ownership, (vii) wanted to keep more livestock than had at present, (viii) length of residence in the area (in years), (ix) history of settlement in the area, (x) had the plan to stay in the area in the future, (xi) private land ownership, (xii) had allocated land for woodlot plantations, (xiii) got enough supply of fuelwood throughout the year from their land with the existing trees, (xiv) had a shortage of fuelwood, (xv) the type of stove that the respondents use for baking "injera", bread, etc., (xvi) the type of stove that the respondents use for cooking stew and boiling sauce, (xvii) familiarity with improved stove, (xviii) knowledge to use improved stove, (xix) knew about the contribution of improved stove to reduce the problem of fuelwood shortage and thereby contributing to the conservation of the forest resources, and (xx) the fuelwood and energy consumption efficiencies of improved stove over traditional stove.

Dependent variable

The attitudes of the urban residents towards 'the use of improved stove over traditional stove' were derived from the statement "agree that the respondents had positive attitudes towards the use of improved stove over traditional stove".

Data analyses

Depending on the nature of the data, quantitative analyses method was used to analyze and interpret the data. For example, descriptive statistics, such as mean, standard deviation, and proportion were used to analyze the household characteristics. Multiple linear regression model set at alpha value of 0.05 was used to analyze and predict the value of the dependent variable, i.e. the attitudes of the urban residents towards 'the use of improved stove over traditional stove'. After accounting for multiple comparisons (21 tests per dependent variable) with a Bonferroni correction, $P \leq 0.002$ was considered significant. The Bonferroni correction was computed by dividing 0.05 to 20 which is equal to 0.002. This is because Bonferroni correction is a safeguard against multiple tests of statistical significance on the same data falsely giving the appearance of significance [21,25]. The analyses were undertaken using SPSS version 16.

Results

A total of 150 persons responded to the questionnaire survey. Majority of the respondents (about 55%) were females, and the average age of the respondents was about 38.6 years with a standard deviation of 13.2. The average family size in a household was about 4.32 persons. Regarding the level of education, about quarter (25%) of the respondents went to secondary school. A majority of the respondents (about 83%) engaged in studentship, daily employment, retailing, and government jobs. The average annual income of the respondents was about 10,963.96 ETB. The larger percentage (about 72%) of the respondents had no livestock. This is because most of the respondents (about 81%) complained that they did not have enough grazing land. Thus, majority of the respondents (about 79%) did not need to keep more livestock than had at present. However, the respondents noted that having more livestock serves as insurance during crop failure (Table 1).

On average, the respondents had lived in the area for about 30.35 years. Regarding the history of settlement, more than quarter (28%) of the respondents noted that they had settled by the state. Similarly, about 73% and 53% of the respondents planned to stay in the area in the future and noted that they had their own private lands, respectively. However, 77% of the respondents confirmed that they had allocated none of their landholdings for woodlot plantations (Table 1).

Majority of the respondents (about 77%) confirmed that they had not planted trees on their land for the purpose of fuelwood. So, 75% of the respondents noted that they had a shortage of fuelwood. To manage the shortage of fuelwood for household energy consumption, the respondents noted that they used different methods. For example, about 40% of the respondents used to manage the shortage of fuelwood by purchasing additional fuelwood from the market (Table 1).

A majority of the respondents (about 66%) used fuelwood to satisfy their household energy consumption. The respondents also noted that they used different types of stove for various purposes including baking “injera”, bread, cooking stew, and boiling sauce. However, a considerable percentage (about 41%) of the respondents preferred to use traditional enclosed mud stove for baking “injera” and bread though some of them used electric based or “Mirit” or improved “injera” baking stove. In contrast, about 51% of the respondents used modern stove for cooking stew and boiling and sauce (Table 1).

Variable	Descriptive Results	Proportion (%)
Locality	Kebele 06 (75 households)	50
	Kebele 09 (75 households)	50
Total sample size (n)	150 households	
Sex	Male	45
	Female	55
Age	Mean = 38.6 years; SD = 13.2	
Family size	Mean = 4.32 persons; SD = 1.98	
Level of education	Illiterate	11
	Literate	12
	Elementary	19
	Secondary school	25
	Diploma	22
	Degree	10
	Masters	1
Occupation type	Crop cultivation	0
	Livestock rearing	0
	Mixed farming	17
	Others (e.g. student, daily employment, merchant and government jobs)	83
Annual income	Mean = 10,963.96 ETB; SD = 13,170.01	

Livestock ownership	Yes	28
	No	72
Wanted to keep more livestock than had at present	Yes	21
	No	79
Reason to keep more livestock	Enough grazing land	10
	Insurance during crop failure	7
	Dairy production	2
	No	81
Length of residence in the area (years)	Mean = 30.35; SD = 16.82	
History of settlement in the area	Inherited land from my ancestor	22
	Settled by my own interest	4
	Settled by the state	28
	Bought land	24
	Others	22
Had the plan to stay in the area in the future	Yes	73
	Unsure	19
	No	8
Had private land ownership	Yes	53
	No	47
Had allocated land for woodlot plantations	Yes	23
	No	77
Purpose of planting trees	For fuelwood	23
	No planting tree	77
Get enough supply of fuelwood throughout the year from their land with the existing trees	Yes	21
	No	79
Had a shortage of fuelwood	Yes	75
	No	25
Method used to manage fuelwood shortage	Purchasing additional fuelwood	40
	Using electrification	29
	Collection of fuelwood	23
	Other	7
The main source of fuelwood for household consumption	Fuelwood	66
	Electrification	34
The type of stove that the respondents use for baking “injera”, bread, etc.	Traditional enclosed mud stove	41

The type of stove that the respondents use for cooking stew and boiling sauce	Mirit or improved injera baking stove	28
	Electric based "injera" baking stove	31
	Modern stove	51
	Open fire	8
Familiarity with improved stove	Enclosed clay/mud	15
	Traditional metal tri-pond stove	31
	Yes	61
	Unsure	6
Knew to use improved stove	No	33
	Yes	61
	No	39
	Income constraint	25.3
The main reason that restrained the respondents not to use improved stove	Too expensive	11.3
	No supply	3.3
	Lack of interest	1.3
	Others	59
Knew about the contribution of improved stove to reduce the problem of fuelwood shortage and thereby contributing to the conservation of the forest resource	Yes	78
	Unsure	7
	No	15
	High efficiency	65
The fuelwood and energy consumption efficiencies of improved stove over traditional stove	Low efficiency	7
	Unsure	19
	No idea	9

Table 1: Sample characteristics and descriptive results of the study area.

A large proportion (about 61%) of the respondents confirmed that they were familiar with improved stove. Moreover, about 61% of the respondents knew how to use improved stoves. In contrast, the larger proportion (59%) of the respondents appealed that they were not able to use improved stoves due to various reasons including low income, lack of supply, unaffordable cost, and lack of interest. Majority of the respondents (about 78%) knew about the contribution of improved stoves to reduce the problem of fuelwood shortage and thereby contributing to the conservation of the forest resources in the study site. For example, as compared to traditional stoves, about 65% of the respondents confidently noted that the fuelwood and energy consumption efficiencies of improved stoves are relatively greater (Table 1).

Majority of the respondents strongly agreed (about 55%) that they had positive attitudes towards 'the use of improved stove over traditional stove' (Table 2).

Belief statements	Strongly	Agree	Unsure	Disagree	Strongly	M (SD)*
Agree that they had positive attitudes towards 'the use of improved stove over traditional stove'	54.55	30.91	8.48	5.46	0.6	4.35 (0.87)

Table 2: Items measuring the attitudes of the respondents towards 'the use of improved stove over traditional stove'. *Scale values (Strongly agree = 5 through strongly disagree = 1) were used to calculate mean (M) and standard deviation (SD) values, where higher values indicate more positive attitudes towards 'the use of improved stove over traditional stove'.

The multiple linear regression model revealed that several socioeconomic variables significantly affected the attitudes of the urban residents towards 'the use of improved stove over traditional stove'. As revealed from their coefficients, those who were more educated ($\beta = 0.12$), familiarity with improved stove ($\beta = 0.17$), knowledge on the use of improved stove ($\beta = 0.25$), knew about the contribution of improved stove to reduce the problem of fuelwood shortage and thereby contributing to the conservation of the forest resources ($\beta = 0.32$), and the preference of the use of fuelwood and energy consumption efficiencies of improved stove over traditional stove ($\beta = 0.62$) significantly had positive attitudes towards 'the use of improved stove over traditional stove'. In contrast, those who had livestock ownership ($\beta = -0.17$) and the type of stove that the respondents use for cooking stew and and boiling sauce ($\beta = -0.25$) significantly had negative attitudes towards 'the use of improved stove over traditional stove' (Table 3).

Variable	Attitude towards 'the use of improved stove over traditional stove'		
	β	t	P value
Intercept	5.16	48.08	-
Sex (Male = 1; Female = 2)	0.03	0.5	0.622
Age	0.09	1.22	0.225
Level of education	0.12	1.71*	0.04
Family size	-0.08	-1.2	0.232
Annual income	0.06	0.86	0.392
Livestock ownership (Yes = 3; No = 1)	-0.17	-2.58*	0.011
Wanted to keep more livestock than had at present (Yes = 3; No = 1)	0.07	0.98	0.328
Length of residence in the area (in years)	0.05	0.66	0.513
History of settlement in the area	-0.1	-1.44	0.151
Had the plan to stay in the area in the future (Yes = 3; ; Unsure = 2; No = 1)	-0.03	-0.37	0.715
Private land ownership (Yes = 3; No = 1)	0.05	0.69	0.491

Had allocated land for woodlot plantations (Yes = 3; No = 1)	0.02	0.33	0.741
Get enough supply of fuel wood throughout the year from their land with the existing trees	-0.01	-0.1	0.92
Had a shortage of fuel-wood (Yes = 3; No = 1)	-0.04	-0.65	0.518
The type stove that the respondents use for baking "injera", bread, etc.	0.11	1.56	0.121
The type of stove that the respondents use for cooking stew and boiling sauce	-0.25	-3.43*	0.001
Familiarity with improved stove	0.17	2.34*	0.021
Knowledge on use improved stove	0.25	3.47*	0.001
Knew about the contribution of improved stove to reduce the problem of fuelwood shortage and thereby contributing to the conservation of the forest resources	0.32	3.76*	0.001
The fuelwood and energy consumption efficiencies of improved stove over traditional stove	0.62	5.56*	0.0001

Table 3: Multiple linear regression models to predict the attitudes of the respondents towards 'the use of improved stove over traditional stove', + indicates a positive change in attitude and - a negative change in attitude. aStandardized coefficients were reported; *represents significance at the 95% confidence level; bAdj. R²=0.34, df=19; F=75.55, overall P<0.0001.

Overall, the multiple linear regression model revealed that socioeconomic variables had significant effects on the attitudes of the urban residents towards 'the use of improved stove over traditional stove' (34% variance explained) (Table 3).

Discussion

The study revealed that most of the respondents preferred to use traditional enclosed mud stove for baking "injera" and bread. Previous studies also reported that about 93% of the energy for baking "injera" and bread in Ethiopia comes from fuelwood using enclosed mud stoves [26,27]. This suggested that the residents in Debre Berhan town preferred to use high amount of biomass as a source of energy for household consumption. The energy usage inefficiencies for "injera" baking are also reported in the southern parts of Ethiopia [19]. For example, instead of using other source of modern energy (e.g. electricity), the respondents mostly use fuelwood, such as cow dung, leaves, and crop residues for cooking and heating purposes. As fuelwood collection represents a major driver of forest degradation, the major impact of fuelwood collection is expected to be on forest degradation rates rather than deforestation rates [19]. This also leads to the decline in household welfare caused by increased use of inferior fuels, higher fuelwood costs, reduction in quality and number of cooked meals, and also aggravate the degradation of the forest resources in Ethiopia [4,5,19,26,27]. One of the possible reasons could be the ease of accessing the biomass energy source in the surrounding

environment. Previous studies also noted that many rural people living in several sub-Saharan countries including Ethiopia rely on biomass fuel to satisfy the household energy demands [11,12,19]. Moreover, as compared to the modern source of energy (e.g. electricity), the market cost of biomass fuel is relatively affordable by many poor people in the developing countries [27] including the present study site to accomplish their day to day cooking activities (e.g. "injera" and bread baking).

This study is the first attempt that tried to quantitatively evaluate the attitudes of the urban residents towards 'the use of improved stove over traditional stove' in Debre Berhan town. Generally, the study demonstrated that a greater percentage of the respondents had positive (71.4%) rather than negative (28.6%) attitudes towards 'the use of improved stove over traditional stove'. This could be explained by the knowledge of the respondents on the contribution of improved stove to reduce the problem of fuelwood shortage and thereby contributing to the conservation of the forest resources in the study site. For example, as compared to traditional stoves, about 65% of the respondents efficiently noted that the fuelwood and energy consumption efficiencies of improved stoves are relatively higher (Table 1). Moreover, majority of the respondents (about 78%) knew about the contribution of improved stove to reduce the problem of fuelwood shortage and thereby contributing to the conservation of the forest resources. Previous studies also noted that the use of improved stoves mitigate the shortage of fuelwood for the users via increasing energy usage efficiencies and thereby contribute to the conservation of the forest resources especially in several sub-Saharan developing countries [18-20].

The present study revealed that socioeconomic variables are found to be powerful predictors of the attitudes of the urban residents towards 'the use of improved stove over traditional stove'. For example, the multiple linear regression model revealed that socioeconomic variables had significant effects on the attitudes of the urban residents towards 'the use of improved stove over traditional stove' (34% variance explained) (Table 3). Previous studies noted that attitudes of respondents towards the use of improved stove can be positively influenced by increasing their knowledge about its use and contribution towards the conservation of the forest resources [19,20,28]. Informing the local communities about the use and the importance of improved stove can help raise the positive attitudes, and thereby increase the support of the urban residents in forest conservation [20-22,28-30]. This is because creating public awareness will increase the understanding and insights of the urban residents on the usage of improved stove over traditional stove [20,28]. For example, the usage of improved stoves has various benefits to the local communities including saving time for cooking, increasing fuelwood and energy usage efficiencies, reducing the number of labor and time required to collect fuelwood (e.g. the time in turn could be used for other activities), reducing indoor house pollution and thereby reducing the negative impacts of emitted smoke on the health of the residents in households and ultimately reduce forest degradation [15,20-22,26,28-32]. In another study, it was reported that the use of improved cooking stove under field conditions led to fuelwood savings of 38.9% for "injera" baking in the southern part of Ethiopia [19].

Conclusion

The study revealed that most of the respondents preferred to use traditional enclosed mud stove for baking "injera" and bread. This suggested that there is high amount of consumption of local fuelwood

in Debre Berhan town. For example, instead of using other source of modern energy (e.g. electricity), the respondents mostly used fuelwood, such as cow dung, leaves, and crop residues for cooking and heating purposes. The main reason for this exclusive dependency is attributed to the problem of reliable access to modern energy sources other than local energy sources. Moreover, the cost of modern energy sources (e.g. electricity) is higher and unaffordable to the majority of the urban poor to accomplish their day to day cooking activities (e.g. “injera” and bread baking). On top of this, income level and family size of the households force the town dwellers to use local energy sources. This is because the cost of modern energy sources is generally higher than the living standards of the poor people living in different towns of Ethiopia. This in turn is supposed to increase the rate of deforestation in the country. For example, economically poor and uneducated people are heavily reliant on the use of local energy source (i.e. fuelwood) whereas more educated and economically rich people prefer to use other source of modern energy (i.e. electrification) to meet their household energy demands. This could be one possible reason that initiated the urban residents to have developed positive attitudes towards ‘the use of improved stove over traditional stove’ in Debre Berhan town.

People who specifically initiate women’s involvement are needed for the future standards to minimize the shortage of fuelwood and thereby reducing the rate of deforestation in Ethiopia. This could be achieved by introducing and distributing improved stove technologies. Generally, the present result revealed that some respondents use improved stove, but the greater numbers of the respondents do not afford to buy improved stoves. However, introduction and distribution of improved stoves (e.g. “merit” stove technology) over the inefficient traditional stoves is more preferable in the future. This is because improved stoves save energy, fuelwood, money, reduce indoor house pollution which otherwise could affect the health of the residents and also help mitigate the negative impacts of fuelwood harvesting on forests. If improved stoves are well adapted to the local residents’ cooking habits, they can make a significant contribution to the conservation of forests and thereby reduce the carbon release from forest clearing and degradation. This, in turn, will ensure efficient energy usage that is geared towards socio-economic development and conservation of natural resources, which could be instrumental to achieve the broad goal of reducing the scarcity of fuelwood and economic poverty in Ethiopia.

Based on the finding of the present study, the following points are forwarded.

- Raising the awareness level of the urban residents about the significance of the use of improved stoves over traditional stoves is essential. This is because improved stoves can save energy, fuelwood, money, and also reduce indoor house pollution which otherwise could affect the health of the residents. Thus, public education about natural resources should be comprehensive enough ranging from the very practical definition of the management of natural resources. This may, in turn, narrow down the knowledge gaps that the local communities have about biomass energy consumption with natural resource degradation. This also helps conserve the remnant forest resources in Ethiopia.
- Introducing and distributing improved stoves by different stakeholders in Debre Berhan town is a key to the success of the use of improved stoves over traditional stoves. The government is also required to subsidize the costs of improved stoves so that

dissemination of energy efficient modern technology can be pragmatic in Ethiopia.

- There should also be collaboration between Bureau of Education, Environmental Protection Authority, energy sector, and Bureau of Agriculture and Natural Resources to disseminate energy know-how, i.e. awareness creation among the urban residents in Debre Berhan town. In addition, disseminating energy-efficient technologies (e.g. energy saving stoves) is crucial because they help reduce indoor air pollution and also decrease the amount of fuel consumption. In doing so, energy saving stoves improve health risks as well as reduce the growing pressure on the natural environment including the conservation of the forest resources. For example, creating job opportunities, family planning, strict government energy policy, and provision of alternative energy (other than biomass energy) by the government with less taxation may decrease the undesirable consequences.
- Solutions to alleviate the unsustainable use of biomass energy, in turn, reduce environmental degradation in the country. Other sources of energy, such as hydropower, wind power, solar energy, natural and biogas technologies can potentially offer Ethiopia major economic development opportunity, thereby, reducing poverty, and environmental degradation.
- Finally, I recommend that future research should also consider the season of the year since supply and consumption of energy in Debre Berhan town may vary depending on the season of the year.

Declarations

Not applicable in each section.

Ethics Approval and Consent to Participate

Not applicable in this section.

Consent for Publication

Not applicable in this section.

Availability of Data and Material

Please contact author for data requests.

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