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CLEAN COOKING PRACTICES AND ENVIRONMENTAL PROTECTION IN RWANDA
A CASE OF ECO GREEN SOLUTIONS PROJECT IN NYARUGENGE DISTRICT KIGALI-RWANDA

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Abstract

World-wide it is estimated that A third of the population lacks access to clean, contemporary fuels and cooking technologies. This study's primary goal is to assess how clean cooking affects environmental protection using the Eco Green Solutions project in Kigali, Rwanda's Nyarugenge district as a case study. This study was undertaken with three distinct goals, including to assess the utilization of biogas on environmental protection, to assess the role of Liquefied Petroleum Gas (LPG) on environment protection and to examine the contribution of Biomass on environmental protection with a case of Eco Green Solutions. The target population and sample size for this descriptive study were the 136 project staff members and beneficiaries. A mixed

approach of qualitative and quantitative data was used to collect the data through the use of an interviewing guide and a questionnaire. Tables have been used to display the results, and the pilot study's value for assessing the validity and for the impact of Clean Cooking Practices on the use of biogas on environmental protection in Nyarugenge District, 42.7% strongly agreed and 51.0% agreed that Carbon Dioxide enhances environmental protection in Nyarugenge district at r=0.875. Further, the clean cooking project on role of LPG on environmental protection in Nyarugenge district, 49% of respondents and 47.9% strongly agreed and agreed respectively that water waste treatment increase environmental protection while there is strong positive correlation between role of LPG on environmental protection at r=0.804. At the end, pellets accelerate environmental protection in Nyarugenge district, 53.1% strongly agreed and 37.5% agreed that biomass contribute on environmental protection in Nyarugenge district facilitates beneficiaries to get biomass with strong positive correlation between contribution of biomass and environmental protection at r = 0.840.

Keywords: Clean Cooking practices, Use of Biogas, Role of Liquefied Petroleum Gas, Contribution of Biomass, Environmental Protection

1.0 Background of the Study

Globally, many project developers clean cooking practices in various projects to enhance utilization of resources and manage project effectively and efficiently. Improved Cook Stoves in East Africa extends a successful project from Malawi to Rwandan women so they may build those stoves locally, improving their quality of life and addressing the issue of climate change. The relationships within households, the ability to earn a living, the quality of the environment, and the climate are all negatively impacted by the lack of access to contemporary cooking fuels and technologies. This study examines Rwanda's current energy-related laws with an emphasis on electric cooking in particular and contemporary energy cooking solutions in general. It displays the perspectives from institutions, corporations, and organizations towards modern energy cooking in Rwanda through the interviews conducted with pertinent stakeholders, highlighting existing initiatives and programs on clean cooking.

The NST's goal is to establish the groundwork for decades of steady growth and change that will hasten the transfer of all Rwandans to high levels of life. With this new approach, Rwanda's public

policy will put an emphasis on fostering the growth of capable, knowledgeable Rwandans who are prepared to compete in a global setting. The government of Rwanda has adopted measures to protect the environment, including protecting forests, building additional greenhouses, organizing campaigns to encourage people to use clean cooking techniques and technology, and implementing interim measures that can give some environmental and health benefits.

Multi-sectoral coordination and action between the health, climate, and energy sectors should be encouraged and fostered. To ensure that the broader objectives of SDG 7—universal access to contemporary energy services—are realized by 2030, Eco Green Solutions' involvement in this research is to assist the populace in gaining access to clean and modern cooking fuels and technologies. Other SDGs, such as combating climate change and ending deforestation, are advanced by clean cooking technologies.

1.2 Research Objectives

(i) To evaluate the use of biogas on environmental protection in Rwanda with a case of Eco Green Solutions project in Nyarugenge District,

(ii) To determine how Liquefied Petroleum Gas affects environmental protection in Rwanda through a Case of Eco Green Solutions project in the Nyarugenge District,

(iii) To **e**xamining the role of biomass in Rwanda's efforts to safeguard the environment via the lens of the Eco Green Solutions project in the Nyarugenge District.

2.1 Theoretical Literature

2.1.1 Clean Cooking Project

A healthy and productive life requires a number of essential services, including clean cooking, which also successfully and efficiently protects the environment. In African countries, clean cooking system organizes a stakeholder consultation and plan its support to activities for scaling up the clean cooking sector and the purpose was to discuss the unique constraints and issues practitioners face in the clean cooking sector, prioritize key interventions for cooking and to discuss the supporting ways through key implementing stakeholders (Dakar, 2012).

Biogas, electricity, and enhanced high-efficiency biomass cook stoves such as pellet, briquette, and burning stoves are also recommended alternatives to LPG for achieving the total 42% target

(Sooksunt et al. 1981). In Rwanda, biomass continues to be the primary energy source, accounting for 85% of all final energy use. The country's biomass supplies would be under pressure due to households' heavy reliance on biomass, mostly for cooking, and the fast pace of forest reproduction (Pounoum et al., 1982).

2.1.2 The Role of Liquefied Petroleum Gas and Environmental Protection

Many rural households are forced to use wood fuel for everyday cooking needs because they lack the financial resources to transition to more affordable energy sources. Since many people experience the direct effects of cooking with fuel wood, the research shows that reducing overall national fuel wood consumption will indirectly reduce the pace of deforestation. Therefore, increasing the usage of LPG will be crucial for protecting the environment. Because households' transition from using fuel wood to LPG, forests will be considerably enhanced.

According to Wang L. & Shahbazi A. (2013), lowland coastal forests in the east of the country, which are by law under the authority of the central government, and montane evergreen forests, which are home to high biodiversity, make up 57% of the 1.6 million ha of land covered by joint forest management agreements in 2006. Comparatively, woodland habitats contain more than two-thirds of the 2.6 million acres managed through community-based forest management.

2.1.3 The Theory of Constraints

The theory of constraints is an overarching managerial ethos when a project or activity doesn't execute to expectations, it enters a constraint stage. A limitation is defined as "anything that prevents an individual or organization from moving toward or achieving its goal." Dr. Goldratt *et al*, (2017)

It postulates that any complex system, including industrial processes, is made up of a number of interconnected activities, one of which imposes constraints on the others (the constraint activity is referred to as the "weakest link in the chain"). TOC is a highly concentrated methodology for generating rapid improvement in contexts where there is an immediate demand for improvement.

2.3 Conceptual Framework

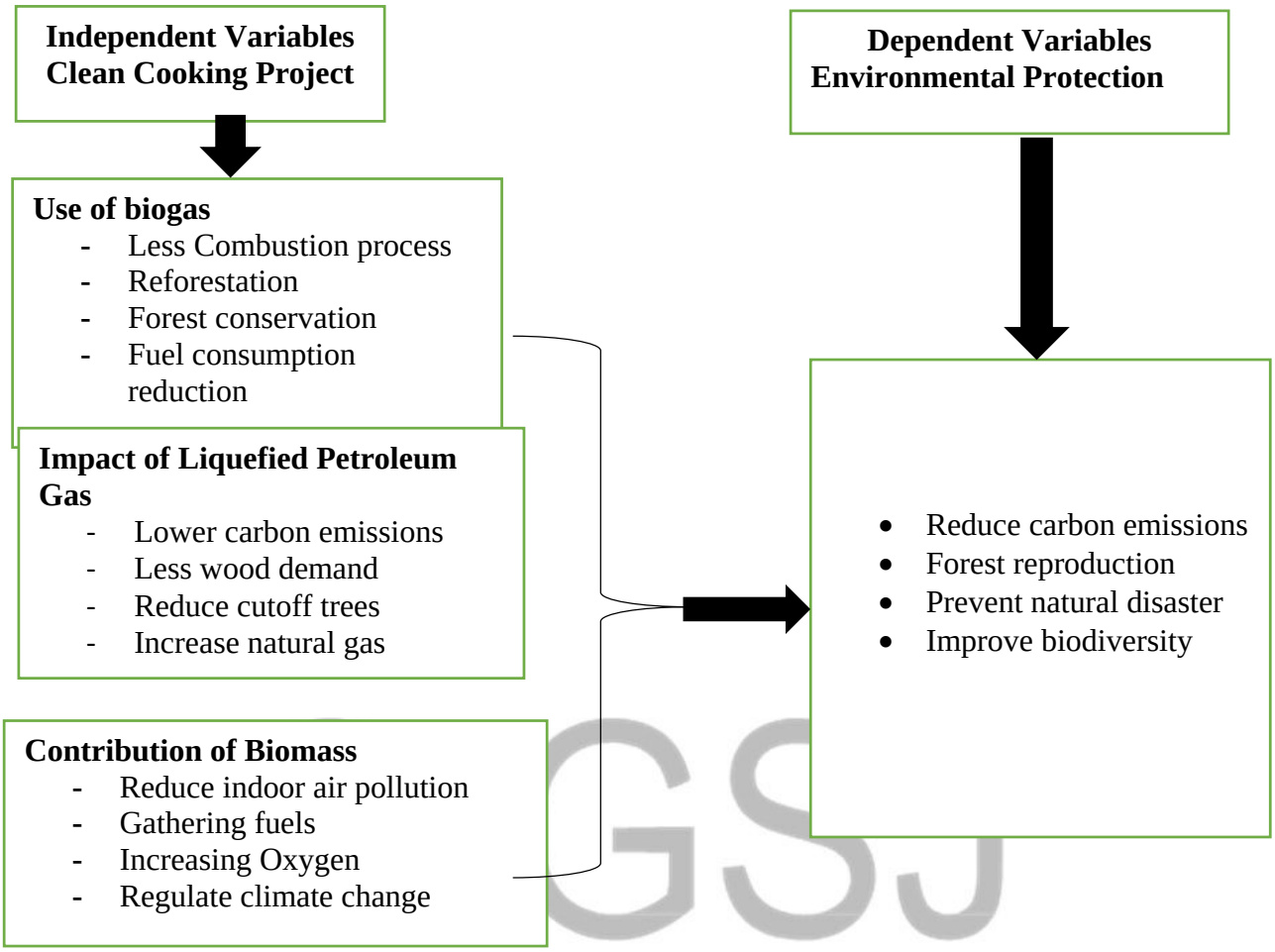

Figure 1: Conceptual Framework

3.1 Data Collection Instruments

Instruments used to collect data from the field are referred to as data collection instruments. In order to gather data, the researcher employed both a questionnaire and an interview guide.
The questionnaire's third section included questions pertaining to the study's second objective, which concerns the effects of liquefied petroleum gas and environmental protection, the part four of the questionnaire entailed the questions related to objective three of this research which was related to the contribution of Biomass and environment protection.
For the case of interview, the 5 staff respondents were interviewed after the quantitative data was collected and the interviewees' talks with the researcher were all recorded, and later the interviewees were given the transcripts of records to confirm if the recorded data are right and later be analyzed by use of thematic analysis into narratives supporting the quantitative data.

Data from a subject sample of the study, it means all clean cooking companies in Rwanda will use to test a theory of change about environment protection situation Bhatacherjee, (2012).

The mean, median, and mode, which are the three most popular central tendency methods, will also be used by the researcher conducting the descriptive statistical analysis. Mean is the sum of all the values, Medium is the value that falls in the middle of the data set, and Mode is the quantity of the value that appears the most frequently. T-tests, commonly referred to as student's t-tests, are used in inferential statistical analysis by researchers to compare hypotheses to group means or averages. Regression analysis is used here, and the regression model is Y=o+ 1X1+ 2X2+ 3X3) +, where Y stands for Environmental Protection.

4.0 Findings and Discussions

4.1 Descriptive Analysis

Table 1: The Use of Biogas on Environmental Protection in Nyarugenge District

Responses	SD	D	NS	A	SA	Mean	St. Dev
Biogas eliminate combustion process in cooking	1.0	3.1	2.1	51.0	42.7	4.31	.75
Biogas reduce fossil fuel consumption usage	2.1	5.2	3.1	50	39.6	4.20	.89
Biogas protect greenhouse reforestation	1.0	2.1	1.4	49.0	47.9	4.44	.59
Biogas increase oxygen balance caption	2.1	6.3	1.0	46.9	44.8	4.34	.69
Biogas maintain forests conservation	1.0	3.1	5.2	50	40.6	4.26	.78

Source: Primary Data (2023)

Table 1 indicated that use of biogas in clean cooking on environmental protection in Nyarugenge district. The study was interested in knowing whether biogas eliminate combustion process in cooking. The results showed that 3.1% and 1.0% disagreed with the assertion, respectively. However, 2.1% were unsure if 51.0% agreed, and 42.7% ultimately strongly agreed. With a strong mean of 4.31 and a standard deviation of 0.75, the respondents agreed with the assertion. The majority of respondents strongly disagreed at 2.1% and 5.2%, according to the research, when asked whether biogas reduces the consumption of fossil fuels. Despite the fact that the majority of respondents (50%) agreed, a small percentage (3.1%) were unsure, and 39.6% strongly opposed,

the results also showed that respondents agreed on average (4.20), with a standard deviation of 0.89.

The study's participants were questioned if biogas shields greenhouse reforestation. 2.1% disagreed and 1.0% strongly disagreed, according to the results. On the other hand, respondents agreed at a mean rate of 4.44 and a standard deviation of 0.59, with 1.4% disagreeing and 49.0% agreeing and 47.9% strongly agreeing. The following replies were collected in relation to the biogas enhance oxygen balance caption: 2.1% strongly disagreed and 613% disagreed. Despite 1.0% disagreeing and 46.9% agreeing, 44.8% ultimately strongly agreed with the statement, which was verified by the statement's mean of 4.34 and standard deviation of 0.69. The survey found that, with 1.0% strongly disagreeing and 3.1% agreeing, biogas maintains the conservation of forests. In contrast, 5.2% disagreed with the assertion, 50% agreed, and ultimately 40.6% strongly agreed. However, respondents concurred.

Table 2: The Role of Liquefied Petroleum Gas on Environmental Protection

Responses	SD	D	NS	A	SD	Mean	St. Dev
LPG use lower carbon emissions	2.1	4.2	8.3	53.1	32.3	4.09	.87
LPG Eliminate wood demand	3.1	5.2	4.2	44.8	42.7	4.18	.96
LPG participate in use of natural gas extraction	1.0	2.1	8.3	50	38.5	4.23	.77
LPG phase out process of cutting off trees	2.1	4.2	11.5	41.7	40.6	4.14	.93

Source: Primary Data (2023)

Table 2 illustrates the impact liquefied petroleum gas has on environmental protection. Concerning the usage of fewer carbon emissions, 2.1% and 4.2% of respondents expressed disagreement. In contrast, 8.3% disagreed with the statement, 51.3% agreed, and 32.3% strongly agreed. Additionally, respondents agreed with the statement with a mean of 4.09 and an SD of 0.87. Remove the lessening of the demand for wood at a 3.1% strongly disagreed and a 5.2% disagreed level. 4.2% of respondents were unsure, compared to 44.8% who agreed and 42.7% who strongly agreed. Respondents also concurred, with a mean of 4.18 and a standard deviation of 0.96. The results showed that 1.0% of respondents strongly disagreed with the statement that they participate

in natural gas production, 2.1% disagreed, and 8.3% were unsure. But accordingly, 50% and 38.5% strongly agreed and concurred. Results also indicated that, with a mean agreement rate of 4.23 and a standard deviation of 0.77, respondents agreed. However, when the question of whether to phase out tree-cutting was put to the respondents, 2.1% and 4.2% of them strongly opposed, while 11.5% were unsure about the answer. Nevertheless, 40.6% strongly agreed and 41.7% agreed with the assertion. Respondents, however, were in agreement, with a mean agreement rate of 4.14% and a small standard deviation of 0.93.

Table 3: The Contribution of Biomass on Environmental Protection

Responses	SD	D	NS	A	SA	Mean	St. Dev
Biomass reduce indoor air pollution	2.1	3.1	4.2	46.9	43.8	4.26	.88
Biomass gathering fuels	1.0	3.1	6.3	47.9	41.7	4.21	.79
Biomass increasing the oxygen	2.1	4.2	7.3	51.0	35.4	4.13	.87
Biomass regulate climate change	0	3.1	6.3	53.1	37.5	4.25	.71
Biomass increase the conservation of plants	2.1	5.2	4.2	47.9	40.6	4.19	.90

Source: Primary Data (2023)

Table 3 shows that contributions biomass reduces indoor air pollution at agreement of 2.1% strongly disagreed and 3.1% disagreed, 4.2% not sure to the statement. However, 46.9% agreed the average response rate was 4.26, with a standard deviation of 0.88, and 43.8% of respondents strongly agreed with the statement.

The responses from responders to the researcher's question about biomass collection fuels were 1.0% strongly disagreed, 3.1% disagreed, and 6.3 not sure. Despite the fact that 47.9% of respondents agreed and 41.7% strongly agreed, respondents' overall agreement was at a mean of 4.21 and a standard deviation of 0.79. When researchers looked into whether biomass increased oxygen levels, 2.1% strongly disagreed, 4.2% disagreed, and 7.3% weren't sure. On the other hand, 51.0% agreed with the statement, and 35.4% strongly agreed. At a strong mean of 4.13 and a standard deviation of 0.87, respondents were in agreement.

The survey found that 0% of respondents strongly disagreed, 3.1% disagreed, and 6.3% were unsure about the claim that biomass regulates climate change.

Table 4: Results of Environmental Protection

Responses	SD	D	N.S	A	SA	Mean	St. Dev
Environmental Protection reduce direct emissions of climate pollutants	0	1.0	2.1	52.1	44.8	4.41	.59
Environmental Protection accelerate forest reproduction	0	0	5.2	53.1	41.7	4.39	.62
Environmental Protection prevent natural disasters	0	2.1	1.0	52.1	44.8	4.36	.58
Environmental Protection improve biodiversity	0	1.0	3.1	52.1	43.8	4.38	.60
Environmental Protection increase the coexistence of animals	1.0	2.1	1.0	56.3	38.5	4.41	.52

Source: Primary Data (2023)

Measures for environmental protection are shown in Table 4, The majority of respondents strongly disagreed with the statement, with 0% strongly disagreeing, 1.0% disagreeing, and 2.1% not sure, according to a study on whether lowering carbon emissions improves environmental protection. However, with a mean of 4.41 and a standard deviation of 0.59, 52.1% and 44.8% agreed and strongly agreed with the statement.

Additionally, the study found that 5.2% of respondents were unsure of the notion that forest reproduction promotes environmental preservation, with 0% strongly disagreeing and 0% agreeing. However, with a strong mean of 4.39 and a standard deviation of 0.62, 53.1% agreed and 41.7% strongly agreed with the assertion.

Among the responses, 0% strongly disagreed, 2.1% disagreed, and 1.0% were unsure about the statement that clean cooking projects assist environmental protection and prevent the waste of natural resources. The statement had a maximum mean of 4.36 and a lowest standard deviation of 0.58, and 52.1% agreed with it and 44.8% strongly agreed.

Results show that respondents mostly agreed. Additionally, the clean cooking initiative enhances plant conservation and expedites environmental protection. The findings indicated that 0.0% of respondents strongly disagreed with the statement, 1.0% disagreed, 3.1% were unsure, 52.1% agreed, and 43.8% agreed, with a mean of 4.38 and a standard deviation of 0.60. Additionally, the results showed that 1.0% of respondents strongly disagreed with the proposition, 2.1% strongly agreed, and 1.0 was unsure. Clean cooking projects help animals coexist. On the other hand, with

a mean of 4.41 and a standard deviation of 0.52 the statement was agreed upon by 56.3% and highly agreed upon by 38.5%.

4.2 Correlational Analysis

To determine the relationship between independent factors and the dependent variable, researchers used correlational analysis. Because communities use the money made by clean cooking businesses to enhance socioeconomic standards, those who take part in the project profit more and are able to minimize carbon emissions. Additionally, liquefied petroleum gas plays a significant part in the clean cooking project, with a high positive correlation of 0.824 (82.4%). The clean cooking initiative aids the petrochemical industry in obtaining the Liquefied Petroleum Gas-required facilities for research that will enhance their efficiency while also boosting forest regrowth.

Furthermore, the results showed a coefficient correlation of.0.831 (83.1%), indicating that the contribution of biomass to the protection of the environment. Due to the assistance of Clean Cooking Companies through various support options provided by the project, beneficiaries of the Clean Cooking Project are helped to enhance utilization of pellets and wood branches as well as organic materials on environmental preservation.

Bettio and Ticci (2017) who indicated that clean cooking project accelerated the rate of climate change by promoting reforestation of the national growth agenda. This was achieved by releasing the productive capacity of the population in Nyarugenge district through a combination of public works, credit packages and direct support.

4.3 Regression Analysis

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.942[a]	.888	.885	.30515

Source: Primary Data (2023)

a. Predictors: (Constant), use of biogas, impact of Liquefied Petroleum Gas and contribution of biomass.

Table 4.3 demonstrates that regression analysis revealed (R =.942), which is a favorable connection. Additionally, the study found that improving environmental protection through the combination of all independent variable components. The R square of 0.888 showed that the model's predictors—use of biogas, impact of liquefied petroleum gas, and contribution of biomass—compute 88.8% correlation with the dependent variable, environmental protection.

4.4 Analysis of Variance (ANOVA)

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	107.359	5	26.840	288.246	.000[b]
Residual	13.501	91	.093		
Total	120.860	96			

Source: Primary Data (2023)

Predictors: (Constant), Biogas, liquefied petroleum Gas, biomass

Dependent Variable: Environmental protection. The table 4.4 predicts that 88.8% of the variance in environmental protection (107.395 out of 120.860) can be accounted for by other factors, while 14.8% of the variance (13.501 out of 120.860) can be explained by variables that the model does not account for. The model's F value is 288.246, which is significantly greater than zero. P-value of 0.000 indicates statistical relevance of independent variables to the dependent variable, which is below specified level. The model should be used to show how the Clean Cooking Project has affected environmental protection in the Nyarugenge district of Kigali, Rwanda.

Table 4.5: Regression Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	.193	.180		.019	.000
Biogas	.190	.108	.245	.828	.000
Liquefied petroleum Gas	.588	.130	.301	4.511	.000
Biomass	.287	.153	.237	1.875	.001

Source: Primary Data (2023)

Dependent Variable: Environmental Protection

The recognized regression equation was:

$Y = b0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \varepsilon$, by replacing β with its value equation becomes,

$Y = 0.193 + 0.2.45\ X1 + 0.165X2 + 0.237X3 + .30515$

The determination of Standardized Coefficients () led to the establishment of environmental protection. According to the T-statistics, increased usage of biogas, the contribution of liquefied petroleum gas, and biomass all contribute to better environmental protection. The results showed that a unit change in the role of liquefied petroleum gas changes environmental protection at a rate of 0.301 times, a section change in the contribution of biomass results in the development of environmental protection at a rate of 0.237 times, and a unit change in the use of biogas improves environmental protection in the Nyarugenge district.

4.5 Results of Hypotheses Testing

The first hypothesis, the clean cooking project in the Nyarugenge district of Kigali, Rwanda, has a significant impact on the usage of biogas and environmental protection. The third hypothesis suggests that there is significance of clean cooking project on contribution of biomass on environmental protection in Nyarugenge district, Kigali - Rwanda. The second hypothesis relates that there is significance of clean cooking project on Liquefied Petroleum Gas and environment protection in Nyarugenge district, Kigali - Rwanda.

5.0 Conclusions

The study concluded that the impact of healthy cooking methods and environmental preservation in Rwanda, every respondent said that there is a need of different clean cooking practices establishment to facilitate the environmental protection in Rwanda.

The study also revealed that more use of clean cooking practices facilitates environmental protection easily and faster as it indicated strong positive correlation, therefore any organization should establish proper and clear clean cooking practices strategies to promote and enhance the projects ongoing for environmental protection.

Examining the impact of biomass on healthy cooking habits and environmental protection in the Nyarugenge district was the third research goal. Results revealed a beneficial link between biomass contribution and environmental protection. This means that the project's goals of reducing indoor air pollution, controlling climate change, raising oxygen, and gathering fuels were all achieved through the use of biomass.

6.0 Recommendations

Projects that promote clean cooking help to safeguard the environment. The research advised governmental and non-governmental institutions to use clean cooking projects effectively in

making breakdown structures because it helps project managers allocate resources in an effective and efficient manner as a way of optimizing the performance of the project. However, the majority of respondents agreed that clean cooking is used to control climate change.

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