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Analysis of the Effect of Women's Perceptions on Improved Cookstoves in Rural Areas of Benin

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Original Artical

Abstract. Introducing a new improved cookstove called the "Guev Cooker" in rural areas of Benin requires an analysis of women's perceptions of the currently improved cookstoves they use in their households. Qualitative studies are essential to provide insight into cookstove users' perspectives and to inform research and the development of technologies that are effective in reducing the time spent on unpaid activities by women. Thus, the analysis of the effect of women's perceptions of improved cooking stoves regarding domestic and remunerated activities in rural areas of Benin was the subject of this research. The effect of perceptions (favourable/unfavourable) of improved cookstoves on the use of traditional cookstoves is estimated using a probit regression applied to a sample of 531 women randomly selected in five communes of Benin, namely: Adjarra, Avrankou, and Dangbo located in the department of Ouémé; Ifangni and Sakété located in the department of Plateau. At the end of the results analysis, as declared favourable perception, there is a time saving for cooking food (51.5%) and a time saving for the collection of fuel (49%) with the use of improved stoves. The estimated results showed that the index of unfavourable perception of improved cookstoves has a positive effect on the use of traditional cookstoves. On the other hand, the index of favourable perception relating to improved cookstoves has a negative effect on the use of traditional cookstoves. Our results emphasise the importance of implementing policies by public decision-makers to increase the favourable perception of improved cookstove users.

Keywords: *Perception; Women; Cookstoves; Rural; Benin.*

JEL Classification: *D13, J22, Q55*

INTRODUCTION

Economically improved stoves have been set up through development projects and programs, including the "Firewood Project Phase II" and the "Support for Rural Wood Markets", to save cooking time and collect firewood at the household level in Benin (Akouehou et al., 2012). However, the penetration rate of these improved stoves is only 19% (Goussanou, 2018). This rate still seems quite low given the time constraints related to the execution of various domestic tasks by women, especially by women in rural areas. The improvement of cooking conditions for women and the reduction of the time they spend on

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domestic tasks has led to the development of an improved stove called the "Guev Cooker", which is more advanced and more economical than its predecessors.

In Benin, various programs and projects have focused on improving cookstoves to reduce the time needed to collect fuel and cooking time for over twenty years. However, there is no study on user perceptions of improved stoves in use in rural areas in Benin. It is essential to understand what users value in an intervention and to gain a better insight into how cookstoves are perceived and used in real-life contexts. This calls for further research that would explore the effect of women's perceptions of improved cookstoves in rural areas of Benin. In addition, the Guev Cooker is a new and improved stove that is more advanced and has not been the subject of previous research. Therefore, it is necessary to conduct in-depth research to find out women's points of view on the existing improved cooking stoves in these rural areas to assess the added value of this new and improved stove. In doing so, the study will contribute to the empirical literature in this field, the objective of which is to analyse the effect of women's perceptions of improved cookstoves in rural areas of Benin. The aim is to contribute to the alleviation of the domestic work performed by women in rural areas of Benin, especially for the collection of fuel and the cooking of food.

Thus, the availability of a new and improved stove called the "Guev Cooker" in rural areas of Benin requires an analysis of women's perceptions of the current improved cooking stoves they use in their households. Therefore, this research aims to analyse women's views on the effectiveness of improved cookstoves as they accomplish various domestic and paid tasks. According to Kabré quoted by Ouoba (2017), perception can be defined as the action of grasping, understanding, representing, or interpreting phenomena or realities through the senses and/or the mind. For Aho et al. (2006) and Agossou et al. (2012), two types of perceptions are generally considered, which are collective perception and individual perception. According to Yegbemey et al. (2014), individual perceptions can be psychic or sensory. In the context of this study, emphasis is placed on the individual psychic perceptions of the respondents. This study uses perceptions to measure the use of cookstoves. Perceptions concern the amount of time that using improved cookstoves imposes on women to accomplish various domestic and paid tasks.

The research poses two questions:

1. What is the perception of women's time allocation for the current improved cookstoves used in rural areas of Benin?
2. What is the effect of women's perception of improved cookstoves on the use of traditional cookstoves in rural areas of Benin?

The objectives of this study are to:

1. Analyse the favourable or unfavourable perceptions of women on the currently improved cooking stoves used while performing unpaid and paid tasks in rural areas in Benin.
2. Estimate the effect of the perception relating to improved cooking stoves on the use of traditional stoves in rural areas of Benin.

Given the existing literature on the notion of the users' perception of improved stoves, the general hypothesis put forward is that improved stoves save time for women. Thus, the specific research hypothesis is that women's favourable perception of improved cookstoves is the time saved by cooking food and collecting fuel (Simon et al., 2021; Gould et al., 2018; Poonia, 2022). Also, a favourable perception relating to improved stoves acts negatively on the use of traditional stoves and an unfavourable perception relating to improved stoves acts positively on the use of traditional stoves (Düvel, 1997; Msuya and Düvel, 2007).

The rest of the article is organised as follows. The second section presents a critical review of the theoretical and empirical literature. The perception (favourable, unfavourable) of

women on currently improved cooking stoves used to the allocation of time relating to domestic and remunerated tasks in rural areas of Benin is analysed in the third section. The fourth section presents the methodology adopted, and the analysis of the descriptive and econometric results. The effect of perception (favourable, unfavourable) of improved cookstoves declared by women on the use of traditional cookstoves in rural areas of Benin is estimated in the same section. The fifth section discusses the results. Finally, the conclusion and the implications of the results for economic policies are presented in the last section.

1. LITERATURE REVIEW

This section presents a review of the theoretical and empirical literature relating to the importance of analysing women's perceptions of the use of cookstoves.

1.1 Theoretical review

A more comprehensive model for understanding the modernization of household cooking technologies can be developed from the literature on the diffusion of innovations originally formulated by Rogers (2003). It can also benefit from the theoretical contributions of other authors (Msuya and Düvel, 2007; Düvel, 2007, 1997, 1991; Abrahamse, 2007). Behavioural change becomes central to successful energy-saving projects (Abrahamse, 2007). Behaviour is seen as a function of a large number of dynamically interdependent personal and environmental factors, which depend on the situation (Düvel, 1997); and can potentially become functional in various combinations. According to the Düvel (1991) model, entitled "Behaviour Analysis and Change", the determinants of behaviour are divided into independent and intervening variables and indicate that perception is the only determinant of behaviour change among the intervening variables. The model indicates that the causes of poor or non-adoption of innovation are either because an individual is unwilling or unable to adopt an innovation. It has been conceptualized by Düvel (1997) that an unfavourable perception is the cause of unwillingness to adopt a practice or an innovation. According to Düvel (2007, 1997, 1991) household's perception of a technology will influence adoption if the adopting unit perceives the technology to be relatively advantageous or more important and compatible with the lifestyle of the adopting units. The prospective users' perception captures more effectively the key attributes of the innovation, which is then translated into their relative ranking of the technology. In addition, the adoption of energy-conserving technologies can be achieved by changing energy-related behaviour and/or adopting energy-saving technologies (Abrahamse, 2007).

The relative advantage of the technology can influence perception through awareness or concern of disadvantage or lack of awareness regarding the advantages related to the technology (Düvel, 1997). In this view, if the potential adopters are aware of the disadvantages of improved cookstove they are less likely to adopt the technology. Unfavourable perception of a cookstove can also be influenced by a lack of awareness about the benefits associated with cookstoves. Meanwhile, the relative advantage of a technology reflects how the cookstove is perceived relative to the alternative technology it expects to replace. Unfavourable perception can be caused by insufficient relative advantage of the technology, which is defined as a degree to which an improved cookstove is perceived as being not better than an idea it supersedes (Msuya and Düvel, 2007). In this case, if the traditional cooking stove is perceived to be more advantageous than the improved one, the probability of adopting the improved cookstove will be low and vice versa. As mentioned before, having an unfavourable perception regarding the compatibility of a cookstove with a specific individual situation (cultural or economic situation) will lead to the likelihood that the technology will not be adopted. The application of Düvel's model by previous researchers has shown that there is a direct link between perception and adoption behaviour (Annor-Frempong and Düvel, 2009; Düvel and Botha, 1999; Düvel, 2007; Düvel, 1997; Msuya and Düvel, 2007).

1.2 Empirical review of cookstoves

Few studies have been conducted on women's perceptions of cookstoves based on the distribution of time for carrying out various domestic activities. Some works were identified with mixed perceptions.

Seguin et al. (2018) found that reducing cooking time was among the most discussed reasons why improved cookstoves were adopted in urban Rwanda. One participant said, "The time I spent cooking with charcoal has gone down. Before, it took three hours to cook the beans, whereas now I only take one hour". The work of Loo et al. (2016) describes women's views of six improved cookstoves compared to the traditional three-stone fire in western Kenya. Overall, the women preferred the improved cookstoves to traditional three-stone stoves for a variety of reasons, including increased cooking speed and energy efficiency compared to their traditional stoves. Furthermore, Sovacool and Drupady (2011) report from a study in Grameen Shakti, Bangladesh that an improved cookstove facilitates shorter cooking time. One participant in their survey said, "I can save time, save money and keep watch of my children all at the same time." Also, Poonia (2022) who conducted a study in the Bundi district in Rajasthan revealed that the majority (57.33%) of respondents had a favourable perception of the benefits of using improved cookstoves and had replaced the use of traditional cookstoves with improved cookstoves partially. Saving fuel and saving time are the stated benefits of using improved cookstoves.

Survey respondents of the research of Simon et al. (2021) reported almost unanimously (92%) a decrease in cooking time since receiving the improved cookstove. 83% of women said the time they spent collecting firewood had decreased since receiving the stove. Additionally, Gould et al. (2018) found from Carchi, Ecuador, that liquefied petroleum gas stoves allowed for better time management of cooking tasks, including time savings for the collection of firewood. Additionally, Calzada and Sanz (2018) found in Hua Manga, Peru that switching from biomass to a liquefied petroleum gas stove saved time spent cooking and collecting firewood. These authors report from their surveys that the saved time is used for childcare, other domestic activities, and engaging in professional activities. Studies by Jagger and Jumbe (2016) in Malawi report that improved cookstoves save cooking time (87.8%) and reduce the time spent collecting wood (98.9%).

Mudombi et al. (2018) analysed user perception of the adoption and use of ethanol stoves in Maputo, Mozambique. Their survey results show that compared to those cooking with charcoal, a large proportion of ethanol stove users saved cooking time. Similarly, Wilson et al. (2018) found that women in Kalahandi, India reported that one of the main benefits of using an improved electric cooker was the reduction in total meal preparation time. Additionally, Pollard et al. (2018) through their study from Puno, Peru, reported that people who cooked with a liquefied petroleum gas stove saved enough time to allow them to cook faster and more often. The report of the work of Lg et al. (2018) showed that the declared important characteristics of the improved stove were a large cooking capacity and rapid heating. Also, Kimemia and Annegarn (2016) highlighted the benefits of the free distribution of liquefied petroleum gas equipment in Atteridgeville Township, South Africa. Saving time was reported as the biggest area of impact as 93.6% of users found liquefied petroleum gas cooking to be faster than electricity.

Dhaka et al. (2012) conducted a study in the Bundi district, Rajasthan to find out rural women's perceptions of the benefits of using improved cookstoves. The study revealed that the majority (57.33%) of the respondents had a favourable perception of the benefits of using the improved cookstoves and had partially replaced the use of traditional cookstoves with improved cookstoves. Saving time was rated among the benefits of using the improved cookstove. Ramirez et al. (2012) conducted research based on strengths, weaknesses, threats and opportunities relating to the non-traditional cookstove. The time spent preparing the wood has been identified as the main weakness of non-traditional stoves.

The study results of Yayeh et al. (2021) in the Dilla district, southern Ethiopia revealed that household income and stove availability had a significant effect on stove adoption. Jan (2012) in rural northwest Pakistan and Pine et al. (2011) in rural Mexico find that education and household income are the most important factors determining a household's willingness to adopt improved biomass stoves. Based on a duration analysis for urban Ethiopia, Beyene and Koch (2013) find that household income is the key determinant of the adoption of clean fuel-saving technologies. Massawe et al. (2014) further assessed respondents' perception of the benefits of the improved cookstove. The results show that all the benefits had a positive effect on the decision to adopt an improved cookstove. Reducing cooking time is one of the benefits rated as important by 54.8% of respondents.

Troncoso et al. (2019) found a complex picture for time savings in a 2017 study of transitions from firewood to liquefied petroleum gas in two communities that had recently urbanized in Mexico. Some respondents claimed that the use of liquefied petroleum gas reduced cooking time and fuel collection time. Furthermore, a study by Massawe et al. (2014) in Tanzania shows that improved cookstoves are not considered important by 58.8% of respondents, which implies that most respondents do not perceive improved cookstoves as better than traditional stoves. As for the work of Amashiga (2014) in the Karusi Province region in Burundi, surveys of households in which improved stoves were introduced revealed that improved stoves have advantages such as the reduction of wood collection time as well as reduced cooking time. Levine et al. (2018) conducted a household survey in Kampala and Barara and reported that Ugandan households in 2010 understood the value of saving time by using improved fuel-efficient cookstoves. These improved stoves used charcoal and biomass more efficiently. The results of the study by Stanistreet et al. (2014) relate to user perceptions and highlight the importance of fuel and time savings. Also, Christiaensen and Heltberg (2014) reported that almost all (98%) of rural smallholder farmers in China who had adopted biogas said that biogas saved them time in the kitchen.

2. ANALYSIS OF WOMEN'S PERCEPTIONS OF THE CURRENTLY IMPROVED COOKING STOVES CONCERNING THE ALLOCATION OF TIME FOR UNPAID AND PAID TASKS IN RURAL AREAS OF BENIN

The general objective of this research is to analyse the perceptions of women on their current improved cooking stoves concerning the allocated time for the unpaid work accomplished in their households and paid activities. The analyses are based on descriptive statistics, cross-tabulations between certain variables of the study such as age and level of education, and variables relating to the perceptions of women. Descriptive statistics related to women's perceptions are presented by municipalities and the global data. This sub-section presents the sampling, the data used and its sources, and the perceptions of women regarding improved cookstoves, respectively. Another part is devoted to the degree of women's satisfaction in terms of time allocated to various domestic activities carried out in their households with the use of improved cooking stoves.

2.1 Sampling and data sources

2.1.1. Sampling

Sampling first consisted of the reasoned selection of two departments based on three criteria, namely:

1. The availability and diversity of agricultural residues that can be used as fuel
2. The proximity to the stove production centre "Guev Cooker" (based in Ifangni)
3. The financial limit

At the end of the ranking, the departments of Plateau and Ouémé were selected. Then, five communes were randomly selected, including two in the Plateau department (Sakété and

Ifangni) and three in the Ouémé department (Adjarra, Avrankou and Dangbo). To be included in the study, three criteria are considered:

1. Be at least 18 years old
2. Be married and live in a household
3. Use a traditional cooker and/or improved cooking stove at home, and/or have an income-generating activity

2.1.2. Data sources

The reference data was collected in July 2021 and the additional reference data in the period covering the months of March - April 2022 in the five municipalities of the study. The number of women surveyed during the baseline and complementary data collection is 531. The data used combines qualitative and quantitative data. Qualitative data comes from focus groups conducted with women and opinion leaders from women's groups before the collection of initial and additional baseline data. Quantitative data is collected using an automated structured questionnaire. The data also consisted of identifying the perceptions of female users of cooking stoves on the allocation of time relating to the execution of domestic work. The sample includes women aged 18 and over, married and using an improved or traditional cookstove at home. These data also show the level of satisfaction of women with their cooking stoves in terms of time allocated to various domestic tasks.

2.2 Women's perception of improved cookstoves

This subsection analyses the favourable and unfavourable perceptions of women regarding improved cookstoves. The brazier, the gas, the oil stove, the gas or electric cooker, and the sawdust stoves are considered improved cooking stoves (Akouehou et al., 2012; IEPF, 2012; RCD, 2013). Out of 531 female users of these improved cooking stoves, 183, or 34.5% were surveyed. 167 out of 183 shared their perceptions (favourable, unfavourable) of the improved cooking stoves, that is 91.26% of the participants. 16 respondents (8.74%) did not present their views on the improved cookstoves. The answers given by the latter were: "Nothing to report" and "None". Overall, about a third of the women surveyed (31.45%) used an improved stove. In the commune of Adjarra, 14.56% of the women surveyed used an improved stove; 37.25% in the commune of Avrankou; 7.84% in the commune of Dangbo; 49.11% in the commune of Ifangni and 45.54% in the commune of Sakété. There were more improved stove users in the commune of Ifangni than in any other commune. The commune of Dangbo had the lowest number of improved stove users.

2.2.1. Women's unfavourable perceptions of time allocation for improved cookstoves

The unfavourable perceptions of women regarding the improved cooking stoves used in their households are recorded. Out of 167 female respondents, 16% mentioned a loss of time for collecting fuel, 35.3% declared a loss of time for cooking food, 21% indicated having less time for other domestic tasks, 10% mentioned having less time to care for children and/or the elderly, 12% indicated less time allocated to income-generating activities (trade, agriculture, etc.), and 2.4% reported a loss of time for lighting the fire. In Dangbo, no one reported having less time to care for children and/or the elderly when using improved cooking stoves. Table 1 shows the results of women's unfavourable perceptions of time allocation for improved cookstoves.

Table 1. Unfavourable perceptions of women's time allocation for improved cookstoves

Unfavourable perceptions	Adjarra	Avrankou	Dangbo	Ifangni	Sakété	*Percentage*
Time wasting for collecting fuel	20%	13.16%	25%	10.91%	13.73%	**16%**
Time wasting for cooking food	40%	21.05%	50%	30.91%	45.1%	**35.3%**
Less time for other domestic tasks	20%	39.47%	12.5%	12.73%	17.65%	**21%**
Less time to care for children and/or the elderly	20%	15.8%	0	7.27%	5.88%	**10%**
Less time for income-generating activities (trade, agriculture, etc.)	0	13.2%	0	11%	17.65%	**12%**
Time wasting for lighting the fire	0	0	12.5%	0	5.88%	**2.4%**
Total female improved cookstove users	**14.56%**	**37.25%**	**7.84%**	**49.11%**	**45.54%**	**31.45%**

Source: Reference survey data "Guev Cooker" (2022).

2.2.2. Women's favourable perceptions of time allocation for improved cookstoves

Women's favourable perceptions of the improved cookstoves used in their households are recorded. In summary, out of 167 women respondents, 49% reported saving time for fuel collection, 51.5% reported saving time for cooking food, 44.3% mentioned having more time for other domestic chores, 25% mentioned having more time spent caring for children and/or the elderly, and 28% mentioned more time allocated to income-generating activities (trade, agriculture, etc.). Table 2 reveals the results of women's favourable perceptions relating to the time allocation for improved cookstoves.

Table 2. Favourable perceptions of women's time allocation for improved cookstoves

Favourable perceptions	Adjarra	Avrankou	Dangbo	Ifangni	Sakété	*Percentage*
Time-saving for fuel collection	33.33%	65.8%	50%	38.2%	47.06%	**49%**
Time-saving for cooking food	80%	57.9%	50%	40%	39.22%	**51.5%**
More time for other domestic tasks	86.67%	39.5%	50%	43.64%	33.33%	**44.3%**
More time to care for children and/or the elderly	60%	44.74%	25%	14.55%	7.84%	**25%**
More time for income-generating activities (trade, agriculture, etc.)	26,7%	42,1%	25%	16,4%	29,4%	**28%**
Total female improved cookstove users	**14.56%**	**37.25%**	**7.84%**	**49.11%**	**45.54%**	**31.45%**

Source: Reference survey data "Guev Cooker" (2022).

Table 3 summarizes the favourable and unfavourable perceptions related to the allocation of women's time for improved cooking stoves. The most mentioned favourable perception of women on improved cookstoves is saving time for cooking food (51.5%). Next is saving time for fuel collection (49%). Finally, more time allocated to other domestic tasks (44.3%) constitutes the third most mentioned favourable perception declared by women. The unfavourable perceptions of women focused more on the loss of time for cooking food (35.3%). Next is having less time to do other domestic tasks (21%), the second most unfavourable perception declared by women. And finally, losing time for fuel collection (16%) constitutes the third most unfavourable perception declared by women.

Table 3. Summary of perception of women's time allocation for improved cookstoves

Favourable perception	Percentage	Unfavourable perception	Percentage
Time-saving for cooking food	51.5%	Time wasting for cooking food	35.3%
Time-saving for fuel collection	49%	Less time for other domestic tasks	21%
More time for other domestic tasks	44.3%	Time wasting for collecting fuel	16%
More time for income-generating activities	28%	Less time for income-generating activities	12%
More time to care for children and/or the elderly	25%	Less time to care for children and/or the elderly	10%
		Time wasting for lighting the fire	2.4%

Source: Reference survey data "Guev Cooker" (2022).

2.3 The level of women's satisfaction with improved cooking stoves in terms of the time allocated to domestic tasks

In this subsection, the level of women's satisfaction with improved cooking stoves regarding the time allocated to various household chores is analysed. 183 women participated in the survey about the improved stoves. Table 4 gives an overview of women's satisfaction with using the improved stoves while carrying out their usual domestic tasks. There are five levels of satisfaction indicated in the answers given by the respondents, namely: very satisfied, satisfied, not very satisfied, not at all satisfied, and indifferent. It should also be noted that unpaid care includes child care, and care for the elderly and/or the disabled.

Many female users of improved stoves (44.26%) said that they were satisfied in terms of time allocated to collecting firewood. However, 31.69% of respondents reported that they were not satisfied. With the collection of water linked to the use of improved stoves, many women (43.72%) stated their satisfaction, while others (33.88%) declared that they were unsatisfied. The majority of respondents (52.46%) said they were satisfied with the use of improved stoves in terms of time allocated to cooking. Other respondents (31.69%) said they were not very satisfied. A significant number of women (51.91%) said that they were satisfied with improved stoves in terms of time allocated to cleaning the house. Others (32.24%) were not very satisfied.

When it comes to doing the laundry, a significant number of women (47.54%) reported that they were satisfied in terms of the time they had for this chore while using improved cookstoves. Other women (32.79%) said that they were not very satisfied. For ironing clothes, some women (42.62%) said that they were indifferent, and others (26.78%) said that they were satisfied. Many women (40.44%) stated that with the use of improved stoves, they were satisfied while shopping for household essentials, while others (28.96%) responded that they were not very satisfied. As for unpaid care, many respondents (37.16%) declared satisfaction in terms of time allocated to this task. Other women (32.79%) said that they were not very satisfied.

By focusing on the percentages relating to the different levels of satisfaction, it is necessary to note the general satisfaction in terms of time allocated to the various domestic activities with the improved stoves.

Table 4. Summary of women's level of satisfaction in terms of time allocated to household domestic activities with improved cooking stoves

Activities	Level of Satisfaction	Percentage	Activities	Level of Satisfaction	Percentage
Wood collection	Very satisfied	9.29%	Laundry	Very satisfied	3.28%
	Satisfied	44.26%		Satisfied	47.54%
	Unsatisfied	31.69%		Unsatisfied	32.79%
	Not at all satisfied	6.56%		Not at all satisfied	2.73%
	Indifferent	8.20%		Indifferent	13.66%
Water collection	Very satisfied	4.92%	Ironing the clothes	Very satisfied	2.19%
	Satisfied	43.72%		Satisfied	26.78%
	Unsatisfied	33.88%		Unsatisfied	21.31%
	Not at all satisfied	3.28%		Not at all satisfied	7.10%
	Indifferent	14.21%		Indifferent	42.62%
Cooking	Very satisfied	9.84%	Shopping for the household	Very satisfied	3.28%
	Satisfied	52.46%		Satisfied	40.44%
	Unsatisfied	31.69%		Unsatisfied	28.96%
	Not at all satisfied	3.83%		Not at all satisfied	10.93%
	Indifferent	2.19%		Indifferent	16.39%
Cleaning	Very satisfied	4.37%	Unpaid care	Very satisfied	2.19%
	Satisfied	51.91%		Satisfied	37.16%
	Unsatisfied	32.24%		Unsatisfied	32.79%
	Not at all satisfied	1.09%		Not at all satisfied	5.46%
	Indifferent	10.38%		Indifferent	22.40%

Source: Reference survey data "Guev Cooker" (2022).

3. THE EFFECT OF PERCEPTIONS RELATING TO IMPROVED COOKSTOVES ON THE USE OF TRADITIONAL COOKSTOVES IN RURAL AREAS OF BENIN

This part of the research estimates the effect of women's perceptions (favourable, unfavourable) about the improved stoves on their use of traditional cooking stoves. It includes the theoretical reference model, the estimation method for obtaining the results, and the descriptive and econometric results, respectively.

3.1 Theoretical framework of analysis

According to neoclassical theory, women in households use a traditional cookstove if it brings them net economic benefits. Thus, the use of a certain type of cooking stove by women can be analysed within the framework of utility maximization theory (Menger, 1871; Jevons, 1872; Walras, 1874, 1877). A woman's rational behaviour leads her to use a traditional cooking stove, giving her more utility. Let U_{i1} be the utility derived from using a traditional cookstove and U_{i0} the utility that derives from not using it. The difference in utility between the use of a traditional cookstove and not using a traditional cookstove is denoted U_i. Household' woman will decide to use a traditional cookstove when it provides her with greater utility than in the case of non-use.

Mathematically, we have:

$U_i = U_{i1} - U_{i0} > 0$ (1)

Since its utilities are not observable, this choice preference of the women of household can be represented by the latent variable P_i***** for the index of women of household's perceptions following the use of an improved cooking stove:

$P_i^* = \partial Z_i + \mu_i$ (2)

$$P_i = \begin{cases} \mathbf{1} & \mathbf{si} \quad P_i^* > \mathbf{0} \\ \mathbf{0} & P_i^* \leq \mathbf{0} \end{cases}$$

With P_i the variable of the index of women's perceptions (favourable, unfavourable) which takes the value 1 if the female users of an improved cooking stove declare one or more perceptions (favourable, unfavourable) and 0 if the female users of an improved cooking stove do not declare any perceptions (favourable, unfavourable), Z_i is a vector of characteristics of women's household supposed to influence the decision to declare one or more perceptions (favourable, unfavourable) following the exploitation of an improved cookstove by women and μ_i the error term.

The result variable (the use of a traditional cooking stove) is considered a linear function of the binary variable of the index of women's perception (favourable, unfavourable) following the use of an improved cooking stove with the other explanatory variables.

The model of the index of perception reported by women on the use of a traditional cookstove is presented as follows:

$Y_i = \delta_1 X_i + \delta_2 P_i + \varepsilon_I$ (3)

With $\boldsymbol{Y_i}$ the use of a traditional cooking zone, $\boldsymbol{X_i}$ the explanatory variables, $\boldsymbol{\delta_i}$ the parameters to be estimated, and $\boldsymbol{\varepsilon}$ the error term.

Also, to achieve results, the probit regression model is used.

3.2 Estimation method

In the relevant literature, studies on perceptions relating to cookstoves have been based on analyses of descriptive statistics of the various favourable and/or unfavourable perceptions recorded (Ramirez et al., 2012; Dhaka et al., 2012; Massawe et al., 2014; Yayeh et al., 2021). It should be noted that there are very few studies that have evaluated the effect of perception on the use of cookstoves. To estimate the effect of perceptions (favourable, unfavourable) relating to improved stoves on the use of traditional stoves, the work of Yayeh et al. (2021) served as a reference. They used a binary logistic regression to analyse the adoption and the energy efficiency of a stove in the district of Dilla, South Ethiopia. Since the use of a traditional cookstove is a binary variable that takes a value of 1 for women who use it and 0 otherwise, this research uses binary probit regression. The three-stone cooking stoves and the fixed argil cooking stoves are considered traditional cookstoves (Akouehou et al., 2012; IEPF, 2012; RCD, 2013).

The probit probability model looks like this:

$\Pr(Y_i = 1|X_i) = \Pr(X_i \beta + \varepsilon_i \geq 0|X_i) = \Pr(X_i \beta \geq -\varepsilon_i |X_i)$ (4)

Where Pr is the probability that a woman uses a traditional cookstove given X_i, the explanatory variables.

In general, the model we use in our work can therefore be represented by the following expression:

$$\text{Probit} = Zi = \alpha + \beta 1X1 + \beta 2X2 + \cdots + \beta kXk \quad (5)$$

If we consider the notion of disturbance $\boldsymbol{\varepsilon i}$, the probit model becomes:

$$Zi = \alpha + \sum_{i=1}^{k} \beta iXi + \varepsilon i \quad (6)$$

Xi being the explanatory variables; α and βi are parameters to be estimated.

Description of study dependent variables: Outcome variables

- **Traditional stove:** this is a binary variable that takes the value 1 if the woman in household uses a traditional stove and 0 otherwise.

Description of treatment variables:

- **The index of favourable perception of improved stoves** is a binary variable that takes the value 1 if the woman in household who uses an improved stove declares one or more favourable perceptions of the improved stove and 0 otherwise.

- **The index of unfavourable perception of improved stoves** is a binary variable that takes the value 1 if the woman in household who uses an improved stove declares one or more unfavourable perceptions of the improved stove and 0 otherwise.

Description of control variables:

Control variables include age, level of education, household size, the logarithm of household wife's income, training on an income-generating activity, sensitization sessions on the reorganization of domestic tasks to save time, being a member of an association or group, having access to electricity in the village, having access to drinking water, and having knowledge of the improved cook stove, the "Guev Cooker" (Poonia, 2022; Dhaka et al., 2012; Massawe et al., 2014; Jan 2012; Yayeh et al., 2021). The description of variables that are used in this study is presented in Table 5.

Table 5. Description of variables

Variables and Description	Unit
The outcomes variable	
Whether the household's woman uses a traditional cookstove	0=No and 1=Yes
The treatment variable	
Index of favourable perceptions of improved cookstoves	0=No and 1=Yes
Index of unfavourable perceptions of improved cookstoves	0=No and 1=Yes
The control variables	
Age: the age of the woman in the household	Years
Level of education: the level of education of the woman's household	0= None 1= Primary 2= First cycle and more
Household size: the number of living household members	Number of people
Logarithm of household wife's income	The continuous value expressed in CFA Francs
Take training on an income-generating activity	0=No and 1=Yes
Sensitization session on the reorganization of domestic tasks to save time	0=No and 1=Yes
Be a member of an association or group	0=No and 1=Yes
Have access to electricity in the village	0=No and 1=Yes
Have access to drinking water	0=No and 1=Yes
Knowledge of the improved cook stove, the "Guev Cooker"	0=No and 1=Yes

Source: Reference survey data "Guev Cooker" (2022).

3.3 Effect of the perception of improved cookstoves on the use of traditional cookstoves

This subsection evaluates the effect of perception (favourable, unfavourable) relating to improved stoves on the use of traditional stoves.

3.3.1. Descriptive statistics

The results of descriptive statistics presented in Table 6 show that female users of traditional stoves are slightly younger (39.6 years) than those in the total sample of cookstoves

(39.7 years). Female users of traditional stoves have a lower income (9.6) than women in the total sample of cookstoves (9.7). They are more likely to have primary education (65%) and none (20.7%) than women in the total sample of cookstoves, which are 63% and 20.5%, respectively. Less than half of the women in the total sample of cookstoves reported more favourable perceptions of improved cookstoves (31.45%), while women in the sample of traditional cookstoves were even less (28.25%). On the other hand, more than half of the women in the sample of traditional cookstoves declared more unfavourable perceptions of improved cookstoves (71.75%), while the women in the total sample of cookstoves with the same opinion were 68.55%.

Table 6. Descriptive statistics – Traditional cookstoves

	Total sample of cookstoves (N=531)		Sample of traditional cookstoves (N=492)	
Variables	**Mean**	**SD**	**Mean**	**SD**
Index of favourable perception of improved cookstoves	0.3145	0.4648	0.2825	0.4507***
Index of unfavourable perception of improved cookstoves	0.6855	0.4648	0.7175	0.4507***
Age	39.67	9.36	39.64	9.37
Education: None	0.63	0.483	0.65	0.478***
Education: Primary	0.205	0.40	0.207	0.41
Education: First cycle and more	0.164	0.370	0.146	0.354***
Household size	4.9962	1.9230	5.0285	1.9187*
Have access to electricity in the village	0.5461	0.4983	0.5467	0.4983
Have access to drinking water	0.5951	0.4913	0.5976	0.4909
Logarithm of household wife's income	9.6553	1.1448	9.6071	1.1259***
Take training on an income-generating activity	0.2335	0.4235	0.2317	0.4224
Sensitization on domestic tasks to save time	0.1733	0.3788	0.1728	0.3784
Be a member of an association or group	0.9228	0.2672	0.9207	0.2704
Knowledge of the improved cook stove, the "Guev Cooker"	0.2486	0.4326	0.2337	0.4236***

Source: Estimates based on reference survey data "Guev Cooker" (2022).
Note: Level of significance is indicated with *** p<0.01, ** p<0.05, * p<0.10.

3.3.2. Effect of favourable perception of improved cookstoves on the use of traditional cookstoves

Table 7 shows the results of the effect of favourable perception relating to improved stoves on the use of traditional stoves. The estimates made it possible to retain certain explanatory variables from the analysis of this table whose coefficients are significant: the index of favourable perception relating to improved cookstoves, level of education (first cycle and more), household wife's income and knowledge of the improved cookstove, the "Guev Cooker". All these significant variables negatively influence the use of traditional stoves.

Table 7. Effect of favourable perception of improved cookstoves on the use of traditional cookstoves

Probit			Traditional cookstoves	
Variables	**Coefficient**	**Robust standard errors**	**p-values**	**Marginal effects**
Index of favourable perception of improved cookstoves	-0.8792***	0.179	0.000	-0.101***
Age	-0.0069	0.0093	0.458	-0.0008
Education: None (Reference)				
Education: Primary	-0.0593	0.234	0.800	-0.006
Education: First cycle and more	-0.4302*	0.221	0.052	-0.058*
Household size	0.0751	0.047	0.107	0.009
Have access to electricity in the village	-0.0410	0.173	0.812	-0.005
Have access to drinking water	-0.1051	0.177	0.552	-0.012
Logarithm of household wife's income	-0.1840**	0.077	0.017	-0.0212**
Take training on an income-generating activity	-0.1529	0.265	0.564	-0.018
Sensitization on domestic tasks to save time	-0.0611	0.292	0.834	-0.007
Be a member of an association or group	0.0397	0.382	0.917	0.005
Knowledge of the improved cook stove, the "Guev Cooker"	-0.4225**	0.200	0.034	-0.049**
Constant	3.9424***	0.958	0.000	
Log-likelihood	-114.08975			
$\chi 2$	51.69***			
Observations	531			

Source: Estimates based on reference survey data "Guev Cooker" (2022).
Note: Level of significance is indicated with *** p<0.01, ** p<0.05, * p<0.10.

3.3.3. Effect of unfavourable perception of improved cookstoves on the use of traditional cookstoves

The results of the effect of unfavourable perception of improved stoves on the use of traditional stoves are presented in Table 8. The estimates made it possible to retain certain explanatory variables from the analysis of this table whose coefficients are significant: the index of unfavourable perception of improved cookstoves, level of education (first cycle and more), household wife's income and knowledge of the improved cookstove, the "Guev Cooker". The index of unfavourable perceptions relating to improved stoves has a positive impact on the use of traditional stoves. The other variables such as level of education (first cycle and more), household wife's income and knowledge of the improved cookstove, the "Guev Cooker" significantly and negatively influence the use of traditional cookstoves.

Table 8. Effect of unfavourable perception of improved cookstoves on the use of traditional cookstoves

Probit	Traditional cookstoves			
Variables	**Coefficient**	**Robust standard errors**	**p-values**	**Marginal effects**
Index of unfavourable perception of improved cookstoves	0.8792***	0.179	0.000	0.101***
Age	-0.0069	0.009	0.458	-0.0008
Education: None (Reference)				
Education: Primary	-0.0593	0.234	0.800	-0.006
Education: First cycle and more	-0.4302*	0.221	0.052	-0.058*
Household size	0.0751	0.047	0.107	0.009
Have access to electricity in the village	-0.0410	0.173	0.812	-0.005
Have access to drinking water	-0.1051	0.177	0.552	-0.012
Logarithm of household wife's income	-0.1840**	0.077	0.017	-0.0212**
Take training on an income-generating activity	-0.1529	0.265	0.564	-0.018
Sensitization on domestic tasks to save time	-0.0611	0.292	0.834	-0.007
Be a member of an association or group	0.0397	0.382	0.917	0.005
Knowledge of the improved cook stove, the "Guev Cooker"	-0.4225**	0.200	0.034	-0.049**
Constant	3.0632***	0.937	0.001	
Log-likelihood	-114.08975			
χ^2	51.69***			
Observations	531			

Source: Estimates based on reference survey data "Guev Cooker" (2022).
Note: Level of significance is indicated with *** p<0.01, ** p<0.05, * p<0.10.

4. DISCUSSION

More than half of the survey respondents (51.5%) declared that using an improved stove helped them in saving cooking time. The results were consistent with those of Simon et al. (2021) whose survey respondents in rural south India almost unanimously (92%) reported a decrease in cooking time since receiving improved cookstoves. In addition, Séguin et al. (2018) report from a study in urban Rwanda, that improved cookstoves facilitate shorter cooking times. One participant said, "The time I spent cooking with charcoal has gone down. Before, it took three hours to cook the beans, whereas now I only take one hour". Additionally, Clemens et al. (2018) report that one of the most appraised advantages of using improved cookstoves was "easy cooking" and "saving time and money" from interviews conducted in Kenya (61%), Tanzania (86%) and Uganda (69%). Also, Kimemia and Annegarn (2016) highlighted the benefits of free distribution of liquefied petroleum gas equipment in Atteridgeville Township, South Africa. Saving time was reported as the biggest area of impact as 93.6% of users found liquefied petroleum gas cooking to be faster than electricity. Moreover, Christiaensen and Heltberg (2014) reported that almost all (98%) of rural smallholder farmers in China who had adopted biogas said that it saved them time in the kitchen. Pollard et al. (2018) report in their study from Puno, Peru, that people who cooked with a liquefied petroleum gas stove saved time, allowing them to cook faster and more often. According to Wilson et al. (2018), women in Kalahandi, India reported that one of the main benefits of using an improved electric cooker was the reduction in total meal preparation time.

Nearly half of the survey respondents (49%) reported saving time for fuel collection with the use of improved stoves. These results correlate with those of Gould et al. (2018). The results of their questionnaire with 5000 households in Carchi, Ecuador, show that LPG stoves allowed better time management concerning cooking tasks, including time savings through the collection of firewood. Additionally, Jagger and Jumbe (2016) report from a sample of 383 households in 44 villages in Malawi that improved cookstoves reduce time spent collecting firewood (98.9%). Additionally, Women's perceptions in this study were similar to a work by Poonia (2022) in the Bundi district, Rajasthan, which found that the majority (57.33%) of respondents had a favourable perception of the advantages of using improved cooking, such as fuel-saving and time-saving. Troncoso et al. (2019) found in Mexico that the use of liquefied

petroleum gas reduced fuel collection time. Also, the work of Amashiga (2014) in the Karusi Province region in Burundi revealed that improved stoves have many advantages, such as the reduction of wood collection time. Levine et al. (2018) conducted a household survey in Kampala and Barara. They reported that Ugandan households understood the value of saving time by using improved, fuel-efficient cookstoves as these improved stoves used charcoal and biomass more efficiently. Furthermore, the results of the study by Stanistreet et al. (2014) relate to user perceptions and highlight the importance of fuel and time savings.

With improved stoves, women also claim to have more time for other domestic tasks (44.3%). These statements are similar to those in the study by Sovacool and Drupady (2011). These authors report from their study in Grameen Shakti, Bangladesh that improved cookstoves facilitate shorter cooking times. One participant in their survey said, "I can save time, save money and keep watch of my children all at the same time." Thus, improved stoves allow them to save time and allocate it to other domestic activities such as childcare. Additionally, Calzada and Sanz (2018) report from their survey of 221,390 people in Huamanga, Peru that the time saved is used for childcare, other domestic activities, and engaging in professional activities. Survey respondents of the research of Simon et al. (2021) reported that 83% of women said the time they spent collecting firewood had decreased since receiving the stove. Additionally, Gould et al. (2018) found from Carchi, Ecuador, that liquefied petroleum gas stoves allowed for better time management and were time-saving through the collection of firewood.

The index of favourable perception of improved cookstoves has a negative influence on the use of traditional stoves. This explains why a favourable perception of improved cookstoves can discourage or reduce the use of traditional cookstoves. The index of favourable perception of improved cookstoves reduces the probability of using traditional cookstoves by 10.1 percentage points. The household wife's income decreases the probability of using traditional stoves by 2.12 percentage points. As the income of household women increases, fewer women use traditional stoves. This explains the fact that they have the financial capacity to buy a new improved stove when their income increases. The level of first cycle and above education decreases the probability of using traditional stoves by 5.8 percentage points. The higher their education, the less they would prefer to use traditional stoves. These estimated results are comparable to those of other studies. Poonia (2022) revealed in his study that the level of education was found to have a positive and significant correlation with respondents' perception of the advantages of using improved cookstoves. Additionally, Yayeh et al. (2021) found that household income significantly affected stove adoption in Ethiopia. Jan (2012) in rural northwest Pakistan. Pine et al. (2011) in rural Mexico found that education and household income are the most important factors determining a household's willingness to adopt improved biomass stoves. Based on a duration analysis for urban Ethiopia, Beyene and Koch (2013) find that household income is an important determinant for the adoption of clean fuel-saving technologies. Knowledge of the Guev Cooker reduces the likelihood of using traditional cookstoves by 5 percentage points. The results show that the advantages (favourable perceptions) recorded on one type of cookstove by users can negatively influence the use of another type of cookstove. These results are in line with those of Massawe et al. (2014) who show that the benefits (favourable perceptions) had a positive effect on the decision to adopt an improved cookstove.

The index of unfavourable perceptions relating to improved stoves has a positive impact on the use of traditional stoves. We conclude that the unfavourable perception induced by using improved stoves can increase the use of traditional stoves. The index of unfavourable perception of improved stoves increases the use of traditional stoves by 10.1 percentage points. These results agree with those of the study by Massawe et al. (2014) who underline the importance of a decision guided by disadvantages (unfavourable perceptions) to adopt an improved cookstove. The comparison of the adoption rate (%) between the two groups of adopters and non-adopters shows that a higher proportion of non-adopters was represented

under each of the negative attributes. Thus, the disadvantages noted on one type of cookstove by users can positively influence the use of another type of cookstove.

CONCLUSION AND POLICY IMPLICATIONS

Qualitative studies are essential to understand what users value about cookstoves and to provide better insight into how cookstoves are perceived and used in real contexts. To this end, this article analysed women's perceptions of improved cookstoves regarding domestic and remunerated activities in rural areas of Benin. The effect of the perceptions (favourable, unfavourable) of improved stoves on the use of traditional stoves in rural areas of Benin is also estimated.

As a result of the analysis, favourable perceptions declare that the improved stoves save time for cooking food (51.5%) and collecting fuel (49%). The estimated results revealed that the index of unfavourable perception of improved cookstoves exerts a positive effect on the use of traditional cookstoves. On the other hand, the index of favourable perception relating to improved cookstoves has a negative effect on the use of traditional cookstoves. Overall, the women indicated satisfaction in terms of the time allocated to various domestic activities with the improved cookstoves.

Based on these results, and to improve the daily life of women with domestic work, our results emphasise the importance of implementing policies by public decision-makers to increase the favourable perception of users of improved cookstoves. Thus, this will indirectly further promote and encourage the adoption of improved stoves in rural areas of Benin.

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