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

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Abstract. The introduction of a new improved cookstove called "Guev Cooker" in rural Benin requires an analysis of women's perceptions of current improved cookstoves they use in their household. Qualitative studies are essential to provide insight into the perspectives of cookstove users and to inform research and development of technologies that are both effective in reducing the hours spent on unpaid activities by women. Thus, the analysis of the effect of women's perception of improved cooking stoves in relation to domestic and remunerated activities in rural Benin was the subject of this research. The effect of perception (favorable, unfavorable) of improved cookstoves on 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 analysis of results, as declared favorable perception, there is the saving of time for cooking food (51.5%) and the saving of time for the collection of fuel (49%) with use of improved stoves. The estimated results showed that the index of unfavorable perception of improved cookstoves has a positive effect on use of traditional cookstoves. On the other hand, the index of favorable perception relating to improved cookstoves has a negative effect on use of traditional cookstoves. Our results emphasize the importance of the implementation of policies by public decision-makers to increase the favorable perception of users of improved cookstoves.

Keywords: Perception, women, cookstoves, rural, Benin

JEL Classification: D13, J22, Q55

INTRODUCTION

Economical improved stoves have been set up by 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 in view of 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 their time spent on domestic tasks have led to the

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development of an improved stove called "Guev Cooker", which is more advanced and more economical than the previous ones.

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

Thus, the availability of a new improved stove called “Guev Cooker” in rural areas in Benin requires an analysis of women's perceptions of the current improved cooking stoves they use in their household. This research therefore aims to analyze the views of women about the improved cookstoves they use in relation to the accomplishment of various domestic and paid activities. 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. These 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 individual psychic perceptions of the women respondents. In this study, perceptions are used as a measure of the use of cookstoves. Perceptions relate to the time that the use of improved cookstoves imposes on women for the accomplishment of various domestic tasks and paid activities.

The research questions are: i) what is the perception of women's time allocation on the current improved cookstoves used in rural areas in Benin? And ii) what is the effect of women's perception of improved cookstoves on the use of traditional cookstoves in rural areas in Benin? The objective of this study is to analyze the effect of the perception (favorable, unfavorable) of women on the current improved cooking stoves used in relation to the realization of unpaid and paid activities in rural areas in Benin. The specific objectives are therefore: i) to analyze the perception relating to women's time allocation on the current improved cooking stoves used in relation to the performance of unpaid and paid activities in rural areas in Benin and ii) then to estimate the effect of the perception relating to improved cooking stoves on the use of traditional stoves in rural areas in Benin. In view of the existing literature on the notion of the perception of users 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 favorable 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 favorable perception relating to improved stoves acts negatively on the use of traditional stoves and an unfavorable 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 organized as follows. The second section proposes a critical review of literature, theoretical and empirical. The perception (favorable, unfavorable) of women on current improved cooking stoves used in relation to the allocation of time relating to domestic and remunerated activities in rural areas Benin is analyzed in the third section. The fourth section presents the methodology adopted, the analysis of the descriptive and econometric

results. The effect of perception (favorable, unfavorable) of improved cookstoves declared by women on use of traditional cookstoves in rural areas in Benin is estimated in this same section. The discussion of the results is done in the fifth section. 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 analyzing 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), but which can benefit from the theoretical contributions of other authors (Msuya and Düvel, 2007; Düvel, 2007, 1997, 1991; Abrahamse, 2007). Behavioral change becomes central to successful energy saving projects (Abrahamse, 2007). Behavior 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 model of Düvel (1991) entitled "behavior analysis and change" the determinants of behavior are divided into independent and intervening variables and indicate that among the intervening variables, perception being one of them, is the only determinant of behavior change. 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 unfavorable perception is the cause of unwillingness to adopt a practice or an innovation. According to Düvel (2007, 1997, 1991) household's perception about 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 behavior 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 disadvantage of improved cookstove they are less likely to adopt the technology. Unfavorable perception of a cookstove can also be influenced by 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 unfavorable perception regarding the compatibility of a cookstove with the specific individual situation (cultural, 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 behavior (Annor-Frempong and Düvel, 2009; Düvel and Botha, 1999; Düvel, 2007; Düvel, 1997; Msuya and Duvel, 2007).

1.2 Empirical review of cookstoves

Few studies have been done 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". As for 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 stove. Furthermore, Sovacool and Drupady (2011) report from a 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 my children all at the same time." Also, Poonia (2022) who conducted a study in Bundi district in Rajasthan revealed that the majority (57.33%) of respondents had a favorable perception of the benefits of using improved cooking 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 through 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 survey that the time saved is used for childcare, other domestic activities and engaging in professional activities. Studies by Jagger and Jumbe (2016) report in Malawi that improved cookstoves save time when cooking (87.8%) and reduce the time spent collecting wood (98.9%).

Mudombi et al. (2018) analyzed user perception on the adoption and use of ethanol stoves in Maputo, Mozambique. They found from their survey that a large proportion of ethanol stove users saved time cooking compared to those cooking with charcoal. 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. As for 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. 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 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 in Bundi district in Rajasthan to find out rural women's perception of the benefits of using improved cookstoves. The study revealed that the majority (57.33%) of the respondents had a favorable perception of the benefits of using the improved cookstove and had partially replaced the use of traditional cookstoves with improved cookstoves. Saving time was rated among the benefits of using the improved cookstove. Research by Ramirez et al. (2012) is 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 the non-traditional stove.

The study results of Yayeh et al. (2021) in Dilla district, southern Ethiopia revealed that household income and stove availability significantly affected 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 are the important determinants of 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 with the decision to adopt an improved cookstove. The reduction in cooking time is one of the benefits by guesswork important by 54.8% of respondents.

Troncoso et al. (2019) found a complex picture with respect to 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, Massawe et al. (2014) show in Tanzania that 58.8% of respondents expressed a low importance of improved cookstoves, which implies that most respondents do not perceive the improved cookstove as better than the traditional stove. 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 reducing cooking time. Levine et al. (2018) conducted a household survey in Kampala and Barara and report 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 PERCEPTION OF CURRENT IMPROVED COOKING STOVES USED IN RELATION TO THE ALLOCATION OF TIME RELATED TO UNPAID AND PAID ACTIVITIES IN RURAL BENIN

The general objective of this research is to analyze the perception of women on current improved cooking stoves they use in relation to the allocation of time related to the domestic work accomplished in their household and paid activities. The analyzes are based on descriptive statistics, cross-tabulations between certain variables of the study such as age, level of education and variables relating to the perceptions declared by women. Descriptive statistics relating to the perceptions declared by women are presented by municipality and then globally. This sub-section presents respectively the sampling, the data used and its sources, the perceptions of women regarding improved cookstoves. Another part is devoted to the degree of satisfaction of women in terms of time allocated to the various domestic activities carried out in the household 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 (i) the availability and diversity of agricultural residues that can be used as fuel; (ii) the proximity to the stove production center “Guev Cooker” (based in Ifangni) and (iii) 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. (a) Be at least 18 years old, (b) Be married and live in a household and (c) 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 women 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 made it possible to know the level of satisfaction of women with the use of cooking stoves in terms of time allocated to the various tasks of domestic work.

2.2 Women's perception of improved cookstoves

The analysis of the favorable and unfavorable perceptions of women regarding improved cookstoves is made in this subsection. The brazier, the gas, the oil stove, the gas or electric cooker and improved stove with sawdust are considered an improved stove (Akouehou et al., 2012; IEPF, 2012; RCD, 2013). The number of women users of improved cooking stoves out of 531 women surveyed is 183, or 34.5%. 167 out of 183 women users of improved stoves gave their perception (favourable, unfavorable) relative to the improved cooking stoves used, that is a percentage of 91.26. The number of women who did not present their views on the improved cookstoves used is 16, i.e. a percentage of 8.74. The answers given by the latter are: “Nothing to report” and “None”. Overall, about a third of the women surveyed (31.45%) use an improved stove. In the commune of Adjarra, 14.56% of the women surveyed use 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 are more improved stoves in the commune of Ifangni than in the other communes. In the commune of Dangbo, there are fewer improved stoves.

2.2.1. Women's unfavorable perception of time allocation on improved cookstoves

The unfavorable perception of women regarding the improved cooking stoves they use in their household are recorded. In conclusion, out of 167 women respondents, 16% mentioned a loss of time for collecting fuel, 35.3% declared a loss of time for cooking food, 21% indicated less time allocated to other domestic tasks, 10% mentioned less time allocated to the care of children and/or the elderly, 12% indicated less time allocated to income-generating activities (trade, agriculture and others) and 2.4% reported a loss of time for lighting the fire in the communes of Dangbo and Sakété. In Dangbo, no woman reported less time spent caring for children and/or the elderly when using improved cooking stoves. Table 1 shows the results of women's unfavorable perception of time allocation on improved cookstoves.

Table 1- Unfavorable perception of women's time allocation on improved cookstoves

Unfavorable 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 allocated to other domestic work	20 %	39.47 %	12.5 %	12.73 %	17.65 %	**21 %**
Less time allocated to the care of children and/or the elderly	20 %	15.8 %	0	7.27 %	5.88 %	**10 %**
Less time allocated to income-generating activities (trade, agriculture and others)	0	13,2 %	0	11 %	17,65 %	**12 %**
Time wasting for lighting the fire	0	0	12.5 %	0	5.88 %	**2.4 %**
Total of women users of improved cookstoves	**14.56 %**	**37.25 %**	**7.84 %**	**49.11 %**	**45.54 %**	**31.45 %**

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

2.2.2. Women's favorable perception of time allocation on improved cookstoves

Women's favorable perception of the improved cookstoves they use in their household 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 more time allocated to other domestic chores, 25% of women mentioned more time spent caring for children and/or the elderly and 28% mentioned more time allocated to income-generating activities (trade, agriculture and others). Table 2 reveals the results of women's favorable perception relating to the allocation of time on improved cookstoves.

Table 2- Favorable perception of women's time allocation on improved cookstoves

Favorable 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 allocated to other domestic work	86.67 %	39.5 %	50 %	43.64 %	33.33 %	**44.3 %**
More time allocated to the care of children and/or the elderly	60 %	44.74 %	25 %	14.55 %	7.84 %	**25 %**
More time allocated to income-generating activities (trade, agriculture and others)	26,7 %	42,1 %	25 %	16,4 %	29,4 %	**28 %**
Total of women users of improved cookstoves	**14.56 %**	**37.25 %**	**7.84 %**	**49.11 %**	**45.54 %**	**31.45 %**

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

Table 3 summarizes the favorable and unfavorable perception relating to the allocation of women's time on improved cooking stoves. With improved cookstoves, the favorable perception of women is more advanced on the saving of time for cooking food (51.5%). Next, there is the perception of women on saving time for fuel collection (49%), the second most important favorable perception declared by women. And finally, more time allocated to other domestic tasks (44.3%) constitutes the third important favorable perception declared by women. The unfavorable perception of women focused more on the loss of time for cooking food (35.3%). Next, women's perception of less time allocated to other domestic tasks (21%), the second unfavorable perception least declared by women. And finally, the loss of time for fuel collection (16%) constitutes the third unfavorable perception least declared by women.

Table 3- Summary of Perception of Women's Time Allocation on Improved Cookstoves

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

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

2.3 Level of satisfaction of women in terms of time allocated to domestic activities with the use of improved cooking stoves

The level of satisfaction of women in terms of time allocated to various domestic work activities carried out in the household with the use of improved stove is analyzed in this subsection. 183 women answered these questions relating to the improved stove. Table 4 gives an overview of percentage of women's level of satisfaction in terms of time allocated to domestic activities carried out in the household with the use of improved stoves. There are five levels of satisfaction indicated in the answers given by the women surveyed, namely: very satisfied, satisfied, not very satisfied, not at all satisfied and finally indifferent. It should also be noted that unpaid care includes child care, care for the elderly and/or the disabled.

Many women users of improved stoves (44.26%) said that they are satisfied in terms of time allocated to collecting firewood. Other women also a small number (31.69%) reported that they are not satisfied. With the collection of water linked with the use of improved stoves, many women (43.72%) admitted that they are satisfied, and other women (33.88%) declared themselves to be 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 are not very satisfied. A significant number of women (51.91%) said that

they are satisfied in terms of time allocated to cleaning the house with improved stoves. Other women (32.24%) revealed that they are not very satisfied.

When it comes to laundry, a significant number of women (47.54%) admitted that they are satisfied in terms of time allocated to this activity with improved cookstoves. Other women (32.79%) said they are not very satisfied. For ironing clothes, some women (42.62%) said they were indifferent, and others (26.78) said they were satisfied. As for household shopping linked with the use of improved stoves, many women (40.44%) admitted that they are satisfied, and other women (28.96%) said they were not very satisfied. As for unpaid care, a large number of women (37.16%) declared satisfaction in terms of time allocated to this activity with improved stoves. Other women (32.79%) said they are not very satisfied.

By focusing on the percentages relating to the different levels of satisfaction, it is necessary to note in general a 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 %	Household's shopping	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 PERCEPTION RELATING TO IMPROVED COOKSTOVES ON THE USE OF TRADITIONAL COOKSTOVES IN RURAL BENIN

This part of research consists in estimating the effect of perception (favorable, unfavorable) relating to improved stoves and declared by women on use of traditional cooking stoves. It includes respectively the theoretical reference model, the estimation method for obtaining the results and the descriptive and econometric results.

3.1 Theoretical framework of analysis

According to neoclassical theory, women in household use a traditional cookstove if the cookstove brings them net economic benefits. Thus, the use of a type of cooking stove by women can be analyzed within the framework of utility maximization theory (Menger, 1871; Jevons, 1872; Walras, 1874, 1877). The woman's rational behavior leads her to exploit a traditional cooking stove which gives 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 the non-use of a traditional cookstove is denoted U_i. Household' woman i will decide to exploit a traditional cookstove when it provides her with greater utility than in the case of non-use.

Mathematically, we have:

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

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 perceptions declared by women of household following the use of an improved cooking stove:

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

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

With Pi the variable of index of perception (favorable, unfavorable) declared by the women which takes the value 1 if the women users of an improved cooking stove declare one or more perceptions (favorable, unfavorable) and 0 if the women users of an improved cooking stove do not declare any perception (favorable, unfavorable), Z_i is a vector of characteristics of women's household supposed to influence the decision to declare one or more perceptions (favorable, unfavorable) 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 as a linear function of binary variable of index of perception (favorable, unfavorable) declared by women following the exploitation of a cooking improved stove with the other explanatory variables.

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

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

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

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

3.2 Estimation method

In the literature, studies on perceptions relating to cookstoves have been based on analyzes of descriptive statistics of the various favorable and/or unfavorable 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 use of cookstoves. To estimate the effect of perception (favorable, unfavorable) relating to improved stoves on the use of the traditional stove, the work of Yayeh et al. (2021) served as a reference. Indeed, they used a binary logistic regression to analyze the adoption and the energy efficiency of a stove in the district of Dilla, in the South of Ethiopia.Thus, this research used binary probit regression since the use of a traditional cookstove is a binary variable that takes a value of 1 for women who use traditional cookstoves and 0 otherwise. The three-stone cooking stoves

and the fixed argil cooking stoves are considered a traditional cookstoves (Akouehou et al., 2012; IEPF, 2012; RCD, 2013).

The probit probability model looks like:

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

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

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

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

If we consider the notion of disturbance ***εi***, the probit model becomes:

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

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

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

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

Description of control variables:

Control variables include age, level of education, household size, logarithm of household wife's income, take training on an income-generating activity, sensitization session on the reorganization of domestic tasks to save time, be a member of an association or group, have access to electricity in the village, have access to drinking water and knowledge of improved cook stove "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 are presented in table 5.

Table 5- Description of variables

Variables and Description	Unit
The outcomes variable	
The household's woman uses a traditional cookstove	0=No and 1=Yes
The treatment variable	
Index of favorable perceptions of improved cookstoves	0=No and 1=Yes
Index of unfavorable 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 members living's household	Number of persons
Logarithm of household wife's income	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 improved cook stove "Guev Cooker"	0=No and 1=Yes

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

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

It is a question here of evaluating the effect of perception (favorable, unfavorable) relating to improved stoves on use of traditional stoves.

3.3.1. Descriptive statistics

The results of descriptive statistics presented in table 6 show that women users of traditional stoves are slightly younger (39.6 years) than those of women in the total sample of cookstoves (39.7 years). Women users of traditional stoves have a lower income (9.6) than that of 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 (63%) and (20.5%) respectively. Less than half of women in the total sample of cookstove reported more favorable perceptions of improved cookstoves (31.45%) than women in the sample of traditional cookstove (28.25%). On the other hand, more than half of women in the sample of traditional cookstoves declared more unfavorable perceptions of improved cookstoves (71.75%) than women in the total sample of cookstove (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 favorable perception of improved cookstoves	0.3145	0.4648	0.2825	0.4507***
Index of unfavorable 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 improved cook stove “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 favorable perception of improved cookstoves on use of traditional cookstoves

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

Table 7- Effect of favorable perception of improved cookstoves on use of traditional cookstoves

Probit	Traditional cookstoves			
Variables	**Coefficient**	**Robust standard errors**	**p-values**	**Marginal effects**
Index of favorable 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 improved cook stove “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 unfavorable perception of improved cookstoves on use of traditional cookstoves

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

Table 8- Effect of unfavorable perception of improved cookstoves on use of traditional cookstoves

Probit	Traditional cookstoves			
Variables	**Coefficient**	**Robust standard errors**	**p-values**	**Marginal effects**
Index of unfavorable 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 improved cook stove “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 women (51.5%) declared that they obtain savings in cooking time with the use of improved stoves. The results of their views are 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 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 biogas saved them time in the kitchen. Pollard et al. (2018) report in their study from Puno, Peru, that people who cooked with an liquefied petroleum gas stove saved time, allowing them to cook faster and more often. 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.

Nearly half of women (49%) reported saving time for fuel collection with the use of improved stoves. These results related to women's points of view converge with those of Gould et al. (2018) who found from the results of their questionnaire with 5000 households in Carchi, Ecuador, that LPG stoves allowed better time management of cooking tasks, including time savings through 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%). Women's perceptions are also similar to work by Poonia (2022) which found in Bundi district in Rajasthan that the majority (57.33%) of respondents had a favorable perception of 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 advantages such as the reduction of wood collection time. Levine et al. (2018) conducted a household survey in Kampala and Barara and report that Ugandan households understood the value of saving time by using improved fuel-efficient cookstoves because 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.

With improved stoves, women also claim to have more time allocated to 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 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 of time savings through collection of firewood.

The index of favorable perception of improved cookstoves has a negative influence on use of traditional stoves. This explains why favorable perception of improved cookstoves can discourage or reduce the use of traditional cookstoves. The index of favorable 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. More of income of household's women increases, less 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. More women are educated, less they use traditional stoves. These estimated results are comparable to those of some 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 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 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 are the important determinants of adoption of clean fuel saving technologies. Knowledge of the Guev Cooker improved cookstove reduces the likelihood of using traditional cookstoves by 5 percentage points. Indeed, the advantages (favorable perceptions) recorded on one type of cookstove by users can negatively influence the use of another type of cookstove. This result confirms those of Massawe et al. (2014) who show that the benefits (favorable perceptions) had a positive effect on the decision to adopt an improved cookstove.

The index of unfavorable perception relating to improved stoves has a positive impact on use of traditional stoves. We conclude that the unfavorable perception induced 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 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 really value about cookstoves and to provide better insight into how cookstoves are perceived and used in real contexts. To this end, this article analyzed women's perception of improved cookstoves in relation to domestic and remunerated activities in rural Benin. The effect of the perception (favorable, unfavorable) of improved stoves on the use of traditional stoves in rural areas in Benin is also estimated.

At the end of analysis of results, as declared favorable perception, there is the saving of time for cooking food (51.5%) and the saving of time for the collection of fuel (49%) with the use of improved stoves. The estimated results revealed that the index of unfavorable perception of improved cook stoves exerts a positive effect on use of traditional cookstoves. On the other hand, the index of favorable perception relating to improved cookstoves has a negative effect on 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 with the intention of improving the daily life of women with domestic work, our results emphasize the importance of the implementation of policies by public decision-makers to increase the favorable perception of users of improved cookstoves.

Thus, this will indirectly further promote and encourage the adoption of improved stoves in rural areas in Benin.

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