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Economic Analysis and Willingness to Pay for Alternative Charcoal and Clean Cook Stoves in Haiti

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ECONOMIC ANALYSIS AND WILLINGNESS TO PAY FOR ALTERNATIVE CHARCOAL AND CLEAN COOK STOVES IN HAITI

THESIS

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ABSTRACT OF THESIS

ECONOMIC ANALYSIS AND WILLINGNESS TO PAY FOR ALTERNATIVE CHARCOAL AND CLEAN COOK STOVES IN HAITI

Conventional charcoal and firewood are the main source of energy in Haiti. They provide up to 90% of the country's energy for domestic and industrial use, resulting in severe environmental and health issues. The present study is initiated to better understand the reasons why two promising alternative technologies (improved cookstoves and alternative charcoal briquettes) have experienced low adoption in Haiti. The research was carried out in two districts in southern Haiti where the improved stoves and briquettes production units exist and where households benefited from a program distributing the improved stoves.

This project contributes to the literature by gauging interest in the improved stove and briquettes, as well as their specific characteristics. It helps understand factors that affect the adoption and dis-adoption of the technologies. Additionally, the research measures tangible benefits for households that adopted the improved stoves.

The study reveals that the use of the improved stoves lowers fuel expenditures by 14.6 cents/day to 23.6 cents/day. Haitian consumers are interested in both the stove and briquettes, but their willingness-to-pay depends on their personal characteristics such as location and income. The study has revealed two surprising results as well: Unnecessary dis-adoption of the stoves occurs because the two technologies were needlessly marketed together. Despite the target audience, which is poor and rural consumers, the improved stove is perceived as a rich, urban user's technology.

KEYWORDS: technology adoption, energy, willingness-to-pay, propensity score matching

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(Dedicated to my late mother Marguerite)

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CHAPTER 1: INTRODUCTION

1.1. Context

In Haiti, charcoal and firewood provide 85 to 90% of the energy consumption both for household domestics use and industrial use. Michel (2001) estimates charcoal consumption in Haiti to 500 kg per person per year. Charcoal production and use represent one of the principal factors in the deforestation and ecological degradation of the country (UNDP, 1991). In 2013, less than 1.5% of natural forest still remains in Haiti due to massive cutting for charcoal and firewood production (KONPAY, 2013). The use of charcoal and firewood for cooking also has important negative effects on the household members' health and on the environment. Konpay (2013) reported that thousands of people, mostly women and children, die annually as result of continuous daily exposure to smoke produced by cooking over open fires.

To address this important and urgent health and environmental issue in Haiti, researchers from the Massachusetts Institute of Technology in 2005-2006 developed a process that would convert biomass into cooking fuel briquettes. The process has been successfully tested in Haiti and continuously experimented by Konpay, a local Haitian NGO. Konpay has also developed an improved model of stove that can be combined with the alternative briquette for a more efficient and cleaner cooking. The innovative aspect of the briquettes is that they are not made of charcoal although they are similar in color, at the size of a hockey puck. They are made through a carbonization process during which organic matter such as coconut husks or mango pits are converted and compressed into a clean burning, highly efficient cooking fuel. These briquettes are a sustainable "alternative" to charcoal that can be used with conventional charcoal burning stove. Charcoal from agricultural waste can also be paired with complementary technologies, like fuel-efficient stoves designed by Konpay, to further reduce fuel consumption. The improved stove is composed of two main parts: a circular pot-opening part on the top of a cylindrical

combustion chamber featuring a clay layer in between two metal sheets insulation allowing the stove to converse heat and burn more efficiently.

Widespread adoption of these paired technologies has the potential to simultaneously address issues of energy, environmental protection, climate, and gender. Adoption of the technologies also has the potential to improve indoor air quality and thereby improve public health. In addition, producing fuel from sources other than timber has the potential to prevent further deforestation in Haiti. In spite of the potential benefits of these two technologies they have seen a low rate of adoption

The present research intends to determine why the technologies are not being adopted. The project is initiated in collaboration with two nonprofit organizations that promote these technologies: Community Development International (New York) and Konpay (Haiti).

1.2. Deforestation and charcoal production in Haiti

In Haiti, charcoal production and use is generally viewed as one of the alarming factors in the deforestation and ecological degradation of the country (UNDP, 1991). Deforestation is also blamed on agricultural clearing but at a lesser extent (Stevenson, 1989, UNDP, 1991). Charcoal and firewood provide 85 to 90% of the country's energy for home and industrial use, with rural firewood consumption estimated at 500 kg per person per year. Similarly, in Port-au-Prince, 62% of the population relies only on charcoal for cooking and heating, amounting to roughly 0.44 kg per person per day (Michel, 2001).

The gathering of wood resources is favored by several factors. Primarily, the land ownership pattern in Haiti is different from that in many developing countries, and this affects the wood resources collection (Stevenson, 1989). In Haiti, the government does not own the

whole land, and there are few large landlords; instead, many peasants own small plots of land. Consequently, the wood collected for charcoal and firewood comes from three types of land: private open-access lands; private restricted-access lands; and some government-owned lands. The private, open-access lands in Haiti occur where family members have not subdivided land into individual parcels through the generations. As a result, no single person can control the land's use, and the typical results associated with that are lack of investment in the resource (e.g., tree planting and husbandry) and overexploitation. Moreover, government lands are poorly controlled, and as a result any peasant is able to gather wood from it. On the other hand, private, restricted-access lands are the type with more restrictions and control to wood access. Yet even in this case, with the extreme poverty, clearing land for an annual crop outweighs the benefit from investment in trees (Stevenson, 1989)

1.3. Reasons for promoting improved cookstoves

The use of unsustainably harvested biomass for cooking affects the climate because inefficient fuel combustion releases products of incomplete combustion – such as methane and carbon monoxide – with a higher global warming potential than carbon dioxide (Sagar and Kartha, 2007). The primary reason why improved cookstoves (ICSs) were developed was to address adverse health and livelihood impacts. In fact, compared to traditional stoves, ICSs improve cooking efficiency and can reduce the amount of fuel required, the fuel gathering, and cooking times – all of which have the potential to improve health and increase household welfare (Lewis and Pattanayak, 2012). Thus, the two essential benefits of most improved stoves programs are their environmental/health and socioeconomic impacts. To justify programs promoting ICSs, sponsors have cited the alleviation of the pressure on the natural resource base,

the use of energy in a cost-effective and efficient way, and the provision of a mean for the poor to decrease their high expenditures on energy (Barnes, Openshaw, Smith, and van der Plas, 1994).

In general, women and those with middle and lower-income are the main beneficiaries of ICSs programs (Eckholm 1983). Commonly, in rural areas, people collect rather than purchase fuelwood, and using more efficient stoves has the potential to reduce the time allocated to collection, which is especially significant for women. Furthermore, economic and environmental impacts of adopting improved stoves can be quite significant for communities (Barnes *et al.* 1994).

1.4. Description of the technologies

1.4.1. The improved cookstove

Konbit Pou Ayiti (Konpay) in collaboration with Community Development International (CDI) is developing a clean cookstove program to address issues of energy, environmental protection, climate, health and gender. Since 2006, Konpay has been experimenting on its cookstove model and improving it. In 2012, the Welt Hunger Hilfe, a German non-profit that operated in Southeast Haiti, financed Konpay for a stove distribution in Marbial, Jacmel. Additionally, some victims of the earthquake located in Pinchinat Camp benefited from stove distribution.

The improved cookstove model promoted by Konpay is a charcoal stove type with a lower cylindrical combustion chamber and an upper circular pot opening. The combustion chamber is fitted with an adjustable damper serving as air inlet at the bottom and features a clay layer in between two metal sheets insulation allowing the stove to burn hotter and more

efficiently. The heat is directed to the area underneath the pot. At the bottom of the fuel chamber, an ashtray allows air to flow in, allowing fuel to burn hotter or at a high-power setting. Three metallic pot supports are fitted inside the pot opening. The stove is designed to be used with the briquettes as fuel for best performance. However, in the lack of these briquettes, people use conventional charcoal.

Key dimensions in the design include the pot opening diameter (14.5 inches), which permits pots of various sizes. The combustion chamber has an inner diameter of 8.5 inches, an outer diameter of 11 inches with a height of 6 inches for enough fuel capacity. The overall stove height is 14 inches. Photos of the stove model are presented below.

Figure 1: Improved cookstove

1.4.2. The alternative charcoal: the briquettes

As of 2011, about 1.26 billion people did not have access to electricity and 2.64 billion people relied on traditional biomass (fuelwood, charcoal, dung and agricultural residues) for cooking mainly in rural areas in developing countries (IEA, 2013). In these areas, incomplete combustion of household cooking fuel emits important quantities of harmful air pollutants and contaminants. Several contributions in terms of technology solution were made to address the issue. For instance, in 2002, D-lab at Massachusetts Institute of Technology developed a

radically different solution called “Fuel from the Fields” that addresses the problem of fuel scarcity with the economic needs of small-scale farmers in mind.

The project offers farmers a way to turn their agricultural waste into charcoal, a cooking fuel alternative that is more affordable and healthier than wood-based fuels. While charcoal-making technologies have been around for thousands of years and other charcoal initiatives exist, they are often based on a centralized production and distribution model that can require a capital investment of tens of thousands of dollars. This charcoal can be made locally and inexpensively and has positive health, environmental and economic benefits: it burns cleanly, reducing exposure to the smoke that causes respiratory infections; it uses agricultural waste materials, and therefore does not contribute to deforestation; and it transforms waste into a high-value, income-generating product – in Haiti, a bag of charcoal sells for US$10 (2002 price). By producing their own charcoal, farmers can not only save money that would have been spent on cooking fuel, but they can sell excess charcoal in the market for an additional source of income (D-Lab, 2003).

To make the alternative charcoal, agricultural waste appropriate to the season and the region are carbonized. The carbonized material is then crushed and formed into briquettes using a small press and a binder made from a source of starch such as cassava or clay. The process takes a few hours and requires only simple devices, which can be made from local materials. A farmer can produce enough charcoal to pay for the equipment and start making a profit in less than a month. Microcredit institutions can also provide loans to help entrepreneurs that cannot afford the initial investment, or farmers can form charcoal-making cooperatives with a group ownership model. The decentralized approach of Fuel from the Fields helps minimize transportation costs and ensure that the producers – small farmers – retain the profits of their labor (D-Lab, 2003).

Figure 2: Alternative charcoal briquettes

1.5. Research questions and objectives

To better understand the low rate of adoption of the improved stove and the alternative charcoal, our research aims to analyze the adoption and the potential economic effects of the technologies and to elicit household willingness to pay for various attributes of the technologies. Specifically, the study intends to answer the following questions:

- How do Haitian consumers perceive the improved cookstoves and briquettes?
- How have the technologies impacted users? Precisely, what are the effects of the use of the improved cookstove on the fuel expenditure of the 'adopting' households?
- What is the willingness-to-pay of consumers for certain characteristics of the stove and briquettes?

CHAPTER 2: BACKGROUND AND LITERATURE REVIEW

2.1. Overview of Haiti

The Republic of Haiti is a Caribbean country occupying the western third of the Island of Hispaniola in the Greater Antilles which it shares with the Dominican Republic. As expressed by its indigenous name *Ayiti* (land of high mountains), the island boasts of the highest mountains in the Caribbean at over 3,000 meters. Forests once covered this mountainous land; in 1940, forested land was estimated at 30% of the country total area; it was 10% in 1970 and, today, various estimates agree on a range of 1.4 to 2% (Michel, 2001).

The total area of Haiti is 27,750 km² with 1770 km² of agricultural area (FAOSTAT, 2011). Its population is estimated at 10,388,000 inhabitants (FAOSTAT, 2013). The country GDP is estimated at 7,843 million USD in 2012 (World Bank, 2013). Haiti is the poorest country of the Latin America and the Caribbean as measured by the Human Development Index (HDI) which is estimated at 0.456 in 2012 (UNDP - HDRO, 2013). The average income per capita per day is estimated at $2.4 and the average Haitian household is composed of 5 members (World Bank, 2013).

2.2. Emergence of stove program

Development of improved stoves is not a recent phenomenon. Over the past one hundred years, middle and upper-income families have adopted different type of stoves, especially when access to petroleum-based fuels was a problem. Among the industrialized countries, enclosed wood or charcoal stoves were used both to cut down on indoor air pollution and to facilitate cooking. Several designs were developed largely by trial and error. Efficiency was not an important factor of stoves models due to the relatively cheap price of woodfuels. However, the

increase of urban population, difficulties in woodfuel supply, and increase in market prices sparked efforts to design more fuel-efficient models (Barnes *et al.* 1994).

The recent spate of improved stove programs focusing on energy efficiency began in the 1970s after the huge rise in oil prices. In addition to a desire to rationalize the continuing reliance on biomass fuels, a desire to prevent or mitigate deforestation contributed to the growth of stove programs. With higher oil prices, increasing deforestation, and talk of an impending "fuelwood crisis," governments, donors, and nongovernmental organizations (NGOs) started to finance and develop stove programs (Barnes *et al.* 1994). Another motivation was that the increasing pressure on biomass resources often results in the burning of crop residues and dung, thus reducing their return to maintain the fertility of the soil (Anderson and Fishwick 1985).

2.3. Improved fuel and cookstove adoption

The overall focus on improved cookstoves and clean fuels increased because of their triple advantages: household health, local environmental quality, and regional climate benefits. Regardless of its benefits, no stove program can achieve its goals unless people adopt and use the stoves in the long term. In fact, there seems to be little information available about the factors that have been most important for the successful adoption of cookstoves in practice. Anecdotal information indicates that initially households respond most to fuel savings (when fuel is very scarce or monetized), speed of cooking, convenience, compatibility with local cooking practices, status of modernity, and relatively less so to pollution-related issues (Ruiz-Mercado, Masera, Zamora, and Smith, 2011).

Household firewood consumption decisions are still the subject of a growing literature. Hyde and Kanel (1996) use data from rural households in Nepal to explain the conditions under

which households either only collect, or both collect and purchase their firewood, to estimate firewood demand and supply functions, and to examine the use of improved stoves. Heltberg, Arndt, and Sekhar (2000) use data from rural India to analyze household substitution between forest and non-forest fuels, as well as households' response to firewood collection time, common property management institutions, and availability of improved stoves.

In a broader frame, literature on technology adoption is currently moving in three directions according to Doss, (2006). These directions include i) innovative econometric and modeling methodologies to understand adoption decisions; ii) examinations of the process of learning and social networks in adoption decisions; iii) and micro-level studies based on local data collection intended to shed light on adoption decisions in specific contexts for policy purposes. Our study fits in this last category.

According to Lewis and Pattanayak (2012) empirical (quantitative) literature of adoption studies remains narrow, thin and scattered. Quality of improved stoves and clean fuel adoption research varies very much in terms of design, measurement approaches, statistical analysis, and sample sizes. Lewis and Pattanayak (2012) conclude that the literature on adoption of clean energy sources by households in developing countries remains largely qualitative. This qualitative literature discusses influence of factors such as affordability (Slaski and Thurber 2009), funding source (Bailis *et al.* 2009), user engagement (Pohekar *et al.* 2005), technology design that responds to consumer preference (Sinton *et al.* 2004), local scarcity of fuelwood, and stove manufacture by local artisans (Barnes *et al.* 1993). Lewis and Pattanayak (2012) systematically reviewed results from 146 analyses of 32 papers from studies conducted in 22 countries. The review shows evidence of a systematically and theoretically consistent relationship between adoption of clean energy products and socioeconomic status (including

income, education, and social marginalization) and urban location. Also, income is the most widely studied determinant; although it was inconclusive in a few studies, most studies find that households with greater income are more likely to use more expensive (and cleaner and healthier) energy (Lewis and Pattanayak, 2012).

2.4. Improved fuel and stove demand: consumer willingness-to-pay

Kalish and Nelson (1991) define the willingness-to-pay (WTP), or reservation price, as the maximum amount of money a consumer is willing to pay for a given quantity of a product. A high WTP for a certain attribute is considered to lead to increased demand for the new technology while a low WTP for other attributes may prevent individuals from adopting the technology (Useche *et al.* 2005). In estimating the demand for improved cookstoves and alternative fuel, a valid procedure for measuring consumer's WTP is essential.

Concerning WTP for improved stoves, Hanna, Duflo, and Greenstone, (2012) evaluate an improved stove program run by an NGO in India. The stove considered in their study is a relatively inexpensive improved stove developed and tested by the Appropriate Rural Technology Institute, an NGO specializing in energy innovation for rural areas. They find that target households appear to have a relatively low WTP for improved stoves and conclude that the relevance of studies of expensive stoves may be limited. In their study, despite the fact that stoves were highly subsidized, essentially free, many households refused to install them. In a different setting, Miller and Mobarak (2011) also measure consumer WTP and also find that even a small cost discourages stove adoption.

CHAPTER 3: RESEARCH METHODOLOGY

3.1. Survey design and sampling framework

For the purpose of the study, a survey was conducted during March of 2014 across two districts of Haiti: Jacmel in the South and Les Cayes in the South-West. In the district of Jacmel, the sample was drawn from the town of Jacmel and its suburbs, mostly urban areas, where stoves and briquettes production units exist and where households that benefited from the stoves distribution relocated after the earthquake. In the district of Les Cayes, the survey was conducted in Cance, a mainly rural area, targeted because of a future stove production project and an important briquette production initiative that took place in 2011.

The first week of the fieldwork was devoted to planning (translator and enumerator training) and contacting the local NGOs. The following weeks focused on data collection: survey and informal focus groups. A total of 150 participants were randomly selected and interviewed. Some of the interviewees were those who received a cookstove in the aftermath of the 2010 earthquake.

The design of the questionnaire and the selection of the relevant stove/briquette attributes took place in two main steps. Prior to the fieldwork, several working sessions with the technologies' promoters/designers along with investigation helped identify the most salient attributes and realistic attribute levels. At the start of fieldwork, the survey instrument was refined via focus groups with stakeholders of the technologies and/or consumers in both districts. Price levels were also chosen with the technologies' promoters in each district. The questionnaire was translated into French with a few Creole expressions; the wording and layout were improved for adaptability reasons with the technologies' promoters.

The survey questionnaire was organized in two main parts: the first part was devoted to collecting demographic information about the households, their current cooking technology, fuel, and experience with the technology (if any), as well as the technology's advantages and disadvantages. The second part of the questionnaire consisted of choice experiments to elicit Haitian consumer willingness-to-pay for the improved cookstoves and the briquettes.

Since the cookstoves and briquettes were still fairly rare in the communities, and in order to elicit willingness-to-pay and attitudes toward adoption, the respondents needed to have at least seen or used the technologies. To ensure a minimal level of familiarity, enumerators carried with them an actual stove and some briquettes during the surveys and respondents were able to have a clearer idea of the characteristics of the products discussed.

3.2. Choice experiment

The attributes used in the choice experiment were chosen in collaboration with the technologies' designers and the public, through work sessions and focus groups, respectively The selected attributes are those deemed most relevant to consumers when choosing the type of stove as well as the type of fuel.

In the choice experiment, respondents received instructions before being asked to choose the option they prefer most between two options in four different choice sets. Respondents could also specify that they do not prefer either option. Thus each choice set effectively had three options: option A, option B or opt out. Figure 3 presents an example of a choice set.

Option A	Option B	Opt out
Small size	Large size	I do not prefer either stove
Clay covered with steel	Steel only	
High charcoal consumption	Low charcoal consumption	
1200 Gds	1500 Gds	
☐	☐	☐

Figure 3: Example of a choice set

For both the stove and briquette choice experiments, the price, along with three other attributes were presented, and for each attribute, two attribute levels were considered.

3.2.1. Improved stove choice experiment

In Haiti, several types of charcoal stoves are used. Traditional charcoal stoves include simple circular and square stoves made of sheet metal, which cost approximately US$1 to $10 depending on the size; a multiple-hearth, iron-frame stove, which costs more; and a multiple-hearth, masonry-framed stove, which is the most expensive. All of these stoves are basically grates (sheet metal with holes punched in it) on top of which the charcoal is placed. There is no fuel compartment or damper. Food is cooked by placing pots directly on top of the charcoal (Stevenson, 1989). The improved cookstoves developed by Konpay differ from conventional stoves in many ways. Its double material (clay cover with a metal sheet) increases the stove's efficiency and durability. The clay inside keeps fuel heat longer making it more efficient and thus less fuel consuming. This attribute is relevant for fuel efficiency and, consequently, environment protection.

Stove size is a relevant attribute to consider because it determines the kinds of size and types of pots that can be used for the stove. In other words, it is important for homemakers to have a stove that is suitable for their existing cookware.

For the choice experiment (a.k.a. conjoint experiment), three attributes of the stove are considered: the size, the fuel consumption and the material. Prices associated with each combination of characteristics are determined by the stove designers, based on production costs in the two different locations. For example, stoves prices are higher in Jacmel compared to Les Cayes because the materials used to make the stove are costlier in Jacmel compared to Les Cayes. Table 1 presents the attribute levels and descriptions used in the conjoint analysis.

Table 1: Stove attribute levels and descriptions

Attribute	Levels	Variable	Descriptions
Prices	$15 $17.5 $25 $30 $37.5 $43.5 $50	PRICE	Per-unit price of the stove
Stove size	Big size (=1) Small size (=0)	SIZE	The size of the stove
Fuel consumption	Fuel conserving (=1) High consumption (=0)	CONSUMP	Refers to the stove efficiency in terms of fuel use
Stove material	Clay cover with steel (=1) Steel only (=0)	MATERIAL	Refers to the material of the combustion chamber

3.2.2. Briquettes choice experiment

The choice experiment technique described earlier is also used to elicit willingness-to-pay for the briquettes and their attributes. Individuals are asked to choose their preferred briquette alternative from a choice set of two options and opting out (i.e. the status quo). Three attributes are considered: the material used, smoke emission, and ashes production. These attributes were determined via focus groups with consumers and with Konpay. Consumers

pointed these out as the most important traits they considered when choosing among conventional charcoal alternatives.

The actual material used to make a particular briquette depends on the organic matter that is most readily available in its production location; the most commonly used materials are coconut husks, discarded scrap paper, and agricultural waste such as mango pits and bagasse. The material used has implications for both smoke emission, durability, and the amount of ashes produced. In general, briquettes made with denser material (e.g. coconut husks) last longer than briquettes made out of paper. For example, in our study area, a program trained local residents to produce briquettes using discarded lottery tickets, with the dual purpose of controlling litter and recycling an abundant material. However, the resulting briquettes did not last as long as those produced using other materials and methods sometimes produced more smoke. Finally, consumers who cook in indoor areas place value on low ash production.

Prices of the briquettes vary significantly from a location to another. In the more urban Jacmel, prices are more than ten times higher than those in rural Les Cayes. This difference in the prices is due to the type and cost of the material used to produce the briquettes in the two locations. In rural Les Cayes, biomass is more abundant. Also, producers use clay – which is free – as binder and the equipment used is relatively simple. On the other hand, in urban Jacmel, most of the briquettes are produced by Konpay using salaried labor, starch– which is not free – as binder, and biomass that is more costly to collect. All these factors make the price levels higher in Jacmel compared to Les Cayes. Thus, a wide range of prices is considered in the choice experiment.

Table 2 describes the attributes and the levels used.

Table 2: Briquettes attribute levels and descriptions

Attributes	Levels	Variable	Descriptions
Prices	0.25¢ 0.5¢ 0.625¢ 5¢ 6.25¢ 7.5¢ 12.5¢ 15¢ 30¢ 50¢	PRICE	Per dozen price of the briquettes
Material	Coconut husk (=1) Paper (=0)	MATERIAL	Material used to produce the briquettes
Smoke emission	No smoke (=1) Smoke emission	SMOKE	Refers to whether the product emits or not smoke
Ashes production	Less ashes (=1) More ashes (=0)	ASHES	Refers to the amount of ashes produced

CHAPTER 4: DESCRIPTIVE STATISTICS

4.1. Demographic characteristics

4.1.1. Gender and age

The sample comprises 73% of female respondents and 27% of male respondents. The mean age of the respondents is 39.43 years old.

4.1.2. Educational level

A total of 36% of the respondents attend high school and 31% attend primary school. 22% of the respondents have never been to school. Only 1% of the sample has a master degree and 10% attends university with or without a bachelor degree. Overall, the educational achievement distribution shows a low educated sample.

4.1.3. Household size and income

The average household size is 5 (± 2.27) members with the sample household size varying from 1 member to 15 members. The average per capita monthly income of the sampled households is 182.94 (± 154.64) US dollars (7317.96 Haitian Goudes) with a range from $6.25 US dollar (250 Haitian Goudes) to $ 875 US dollar (35000 Haitian Goudes). Each sampled household has, on average, 1 to 2 persons employed at the time of the survey (mean = 1.23 employed) with the number of employed members in the household ranging from 0 to 6 persons. This high level of income is due to the fact that 2/3 of the sample is drawn from Jacmel and Cyvadier (in the district of Jacmel), which are urban and touristic areas. In Haiti, the average monthly per capita income is about $29 for the country and about $34 per month for the 37% of the population living in urban areas.

4.2. Stoves and cooking characteristics

4.2.1. Cooking practices

In 86% of the cases, the mother or the household head's wife cooks the meals. In only respectively 3% and 2% of the cases a cook or the father (the household head) cooks. In terms of cooking area, the majority (73.29%) of the households surveyed cook in a fitted kitchen outdoor. 8.90% cook outdoor without an actual kitchen. A total of 13.70% cook indoors in a kitchen. On average, 1 to 2 meals are cooked in the households (mean = 1.93 (± 0.55) meals) for a total of 3.09 hours on average for cooking time per day. This implies an average of 1.60 hours of cooking time per meal.

4.2.2. Type of stove used

In general, households use multiple stoves and stove types. Almost half of the sample (47.95%) states that they use two types of stoves to cook their meals. 11.64% state that they use three different types of stoves and 40.41% use only one type of stove for all meals. The three main types of stoves used by the sampled households are a traditional stove, a three-stone set-up, and and the improved stove. Gas stoves and kerosene stoves appear infrequently in the sample. The traditional stove is made of welded iron supported with three or four legs, depending on the design. The three-stones set-up is essentially three big stones placed on the ground, with woodfuel placed in the middle. The placement of the stones can be adjusted according to the size of the pots. Figure 4 shows two types of the traditional stove and of the three-stones stove respectively.

In Jacmel, 79.21% of the respondents use a traditional stove while 36.64% use the three stones method, and 35.64% use an improved cookstove. Gas stoves are used only by 5.95% of the respondents in these two areas. In Les Cayes, 93.33% use the traditional stove and 88.89% use three stones to cook. None use the improved stove, a kerosene stove or a gas stove.

The improved stove is a fairly new technology. Out of all persons interviewed, 57.53% have heard about it. These respondents heard about it primarily through Konpay (84.52%). Only 9.52% of the sample heard about the improved stove from a friend or a relative and 2.38% heard about it during a training session or a seminar.

Generally, there is a preference for a particular type of stove to cook certain types of food. A total of 40.41% of the respondents state they do not use the same type of stove for all types of food and that certain types are better suited for certain foods. The main factors for using different types of stoves are that some are suitable for larger pots (three-stones), some cook faster (improved stove and traditional) and some require more fuel than others. Of the multiple-stove respondents, 76% prefer to cook food such as rice and sauces with the traditional stove while 27% use the improved stove for the same group of foods. Foods such as plantain, yam, what is generally called *viv* in Haitian Creole is cooked by 69.49% with the three-stones. Foods with long cooking times, such as beans, are cooked exclusively using the three-stones by 57.63% of this subgroup. This is a function of easy access to woodfuel.

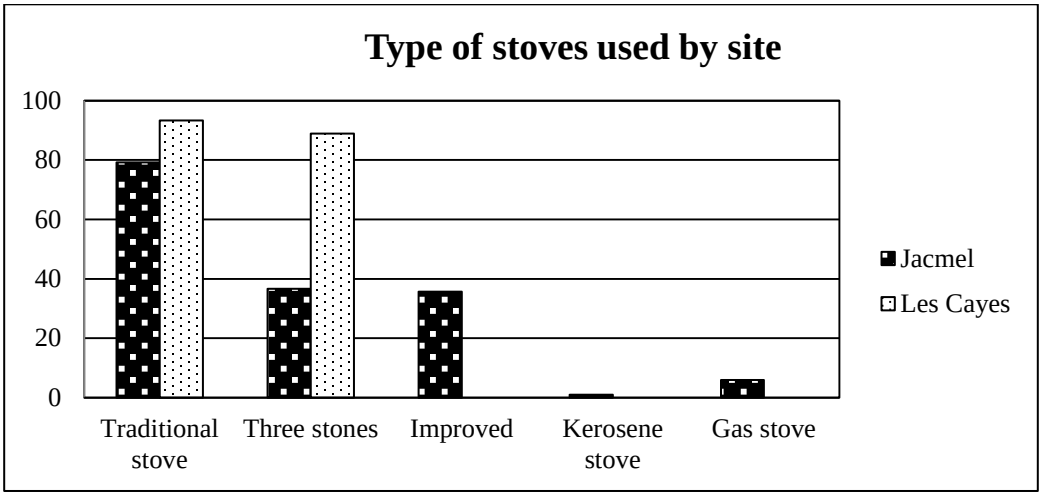


Figure 4: Type of stove used by site

Figure 5: Traditional stoves (left) and three stones stoves (right)

4.3. Cooking fuel characteristics

4.3.1. Type of fuel used

In Haiti, the type of fuel used depends greatly on the type of stove. Woodfuel is used in conjunction with three-stones, charcoal is used in the traditional stove and the briquettes are suitable for the improved stove. However the latter can be fueled with charcoal in the absence of briquettes. The use of different type of fuel depends also on the period of the year. In the dry season, charcoal is abundant and cheaper. In rainy season, charcoal becomes expensive and people prefer to collect wood to cook. Wood is considered a free resource but its availability is diminishing.

Overall, 91.03% of the respondents use charcoal to cook, 66.21% use wood and 15.17% use coconut husks and corncobs. Propane gas is used by 5.52% of the sample. Figure 8 illustrates the different types of fuel used.

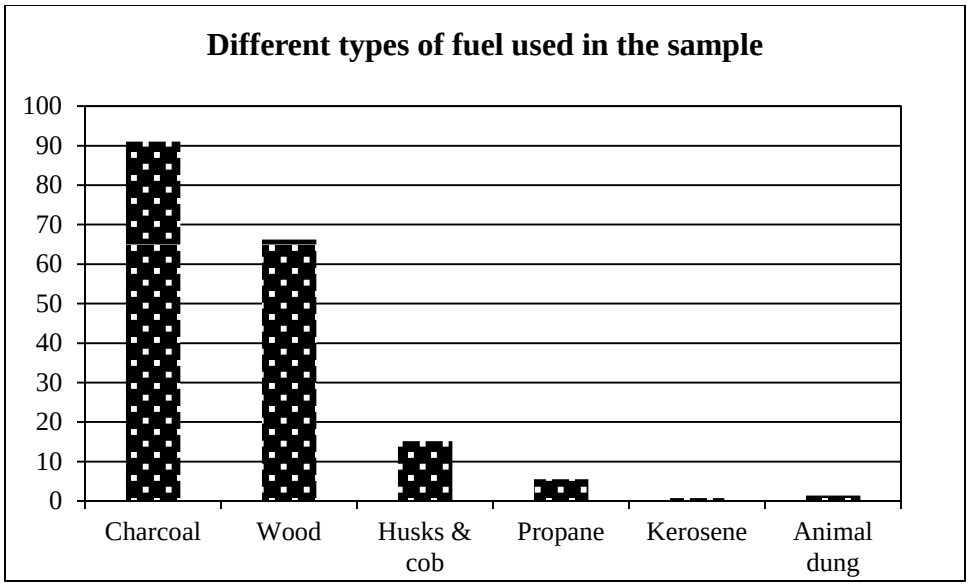


Figure 6: Different types of fuel used in the sample

4.3.2. Alternative charcoal in the study area

Briquettes were introduced to the study area (Les Cayes and Jacmel) in 2005. Amy Smith, an instructor at Massachusetts Institute of Technology (MIT), who designed several appropriate technologies for developing countries, developed a method to convert bagasse into charcoal. From 2009 to 2011, through a program implemented in partnership with a few local non-governmental organizations (NGOs), MIT trained a total of 500 Haitian trainers to not only produce the briquettes with any organic material available in their area, but to train others to do so as well.

In the sample, 60.69% have heard about the briquettes. Among these, 94.31% cite the training program or one of the local NGO trainers as their source of information. Only 5.68% of those who have heard of the briquettes cite a friend or a relative as source of information. 10.34% of the respondents state that they used the briquettes at least once before and still use them occasionally, but none of the respondents were using the briquettes at the time of the survey. The main reason is that the briquettes are not available on the market. Out of these

‘‘users’’, 40% obtain the briquettes during a training session or via distribution, and 26.66% make them at home.

4.3.3. Fuel expenditure

On average, the respondents estimate that they spend a total of $7.17 (± 6.65) on fuel per week. Total fuel expenditure depends on the household size, the number of meals cooked in the household per day, as well as the type of fuel used. In general, fuel costs are lower for households that mainly use wood, since most wood does not require any cash expenditure. To minimize their (cash) fuel expenditures, the sampled households use different types of fuel depending on the type of stove they use and the time of the year, as explained above. On average, the sampled households use one to two different types of fuel (mean = 1.8).

Table 3 summarizes and describes the main variables used.

Table 3: Summary statistics

		Jacmel (N=100)		Les Cayes (N=46)	
Variable	**Description**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
COOKPLACE	Whether cooks Indoor (=1) or Outdoor (=0)	0.188	0.393	0.089	0.288
USEDBRIQ	Whether use the briquettes (=1) or not (=0)	0.069	0.255	0.178	0.387
HEARDBRIQ	Whether heard of the briquettes before (=1) or not (=0)	0.604	0.492	0.600	0.495
DISTRICT	District: Jacmel (=1) or Les Cayes (=0)	1.000	0.000	2.000	0.000
AGE	Age in years	38.644	12.262	41.133	14.732
MALE	Gender: Male(=1) or Female (=0)	0.287	0.455	0.244	0.435
MARRIED	Marital status: Married (=1) or Single (=0)	0.713	0.455	0.889	0.318
HIGHSCHOOL	Education level: Below high school (=0) or Above high school (=1)	0.465	0.501	0.444	0.503
HHSIZE	Household size (number of members)	4.931	2.201	5.333	2.431

Table 3 (Continued): Summary statistics

		Jacmel (N=100)		Les Cayes (N=46)	
Variable	**Description**	**Mean**	**Variable**	**Description**	**Mean**
HHSTATUS	Status in the household: Head (=1), Wife (=2) or Other (=3)	1.762	0.650	1.956	0.767
PROFESSION	Activity: Unemployed (=0), Independent worker (=1), Farmer (=2) or Salary (=3)	1.129	1.026	1.089	0.949
NBRCHILD	Number of children	2.208	1.768	2.500	1.533
NBRADULT	Number of adults in the household	2.723	1.379	2.864	1.322
NBREMPLOY	Number of employed in the household	0.941	1.047	1.867	1.120
INCOME	Average daily income per capita in US dollar	1.912	2.170	1.714	1.706
USEDSTOV	Whether used the stove for at least 6 months (=1) or not (=0)	0.416	0.495	0.022	0.149
RECEIVEDSTOV	Whether received the stove (=1) or not (=0)	0.614	0.489	0.022	0.149
FUELEXPDTRE	Average daily fuel expenditure in US dollar	0.743	0.577	1.511	1.332
NBROTHSTOVE	Number of other stoves owned than the improved stove	1.030	0.768	1.844	0.367
COOKTIME	Average daily cooking time in hours	3.293	1.023	2.610	1.339
NBRMEAL	Number of meals cooked per day	1.832	0.584	2.156	0.367

CHAPTER 5: WILLINGNESS-TO-PAY ANALYSIS

5.1. Theoretical model

The literature mentions a wide range of factors that influence household's choice of cooking fuel and cookstoves. In our basic model, a household's choice of cooking energy and cookstove is determined by

- socio-economic factors such as income, education, size and age of the household, etc. (Pachauri and Jiang, 2008),
- external factors such as household's location, familiarity with the cooking fuel and stove, availability of fuel, gender, and
- characteristics of the technologies.

5.2. Empirical model

The random Utility Model (McFadden, 1974) is applied to our choice experiment design to estimate Haitian consumers' willingness-to-pay for improved cookstoves and alternative fuel in Haiti. The random utility model (RUM) assumes that utility maximization is the underlying incentive behind an agent's decision to choose among available options (McFadden, 1981). The fundamental axiom of utility theory is that an option is preferred to another if this preferred option provides the consumer with higher utility (Bates, 1988).

Suppose individual *i* faces options *j* (*j*= 1, 2, 3… J), with each option being a bundle of various attributes. In our experiment, respondents are asked to state their preferences in response to three different choice sets. It is assumed that the individual will choose the option *j* over others, if that option provides him/her with the maximum utility, *ceteris paribus*. The indirect utility U associated with option *j* is assumed to be a linear combination of the traits of the product in that option, plus en error term:

$$U_{ij} = \alpha P_j + \mathbf{X'}_{ij}\boldsymbol{\beta} + e_{ij}$$

$\mathbf{X'}_{ij}$ represents the vector of product attributes and individual-specific characteristics, P_j is the price of option *j*, and α and $\boldsymbol{\beta}$ are unknown coefficients to be estimated. Assuming the error terms are independently and identically distributed and drawn from a maximum extreme value Type I distribution, the probability of individual *i* selecting option *j* can be specified in a form of a conditional logit model (CL):

$$\prod_{ij} = \frac{\exp(\alpha P_j + X\prime_{ij}\beta)}{\sum_1^J \exp(\alpha P_j + X\prime_{ij}\beta)}$$

The conditional logit model has limitations: i) it cannot represent random taste variation and ii) does not avoid restrictive pattern suggested by the independence of irrelevant alternatives (IIA) property (Train, 2003). To address these two limitations, the mixed logit (ML) specification is estimated as well. The mixed logit model allows for preferences and difference across individuals. It also accounts for individual-specific correlation.

A mixed logit model, unlike the conditional logit model, assumes the unknown coefficients $\boldsymbol{\beta}$ to be random, rather than fixed, and to vary across respondents. The probability of individual *i* selecting option *j* is:

$$\prod_{ij} = \int \frac{\exp(\alpha P_j + \beta X\prime_{ij})}{\sum_1^J \exp(\alpha P_j + \beta X\prime_{ij})} h(\boldsymbol{\beta})\, d\boldsymbol{\beta}, \text{ where } \beta \sim N(\mu, v)$$

where $h(.)$ is the joint density function for the random coefficients $\boldsymbol{\beta}$ and is assumed to be normally distributed. Note that price coefficient is set as fixed to avoid the estimation of a positive value on price (Meijer and Rouwendal, 2006).

Households' process of converting preference into choice is not only determined by the technologies' attributes, but may also be affected by the household characteristics. To evaluate

the demographic information effect, interaction terms are created between respondent demographic variables and product attribute variables.

The marginal value, or willingness-to-pay, for an attribute *a* is the negative of the ratio between the attribute coefficient and the price coefficient (α). In the case of demographic characteristic *c* interacted with the attribute or the price, the formula includes the coefficient of these interactions as in the following general formula:

$$\text{Marginal value} = \text{WTP}_{ca} = -\frac{\beta_a + \beta_c * X_c}{\alpha + \beta_c * X_c}$$

where X_c is a demographic characteristic, β_c is the coefficient on the characteristic, β_a is the coefficient on the attribute, and α is the coefficient on the price.

5.3. Improved clean cookstove willingness-to-pay

Consumer willingness-to-pay for the improved clean cookstoves and their attributes are estimated using the conditional logit model and mixed logit models described in section 5.2 ('Empirical model'). The attributes are those described in section 3.2.1 ('Improved stove choice experiment').

5.3.1. Results

Table 4 presents the estimation results of the conditional logit and the mixed logit models. Judging by the log likelihood, the mixed logit (ML) model explains better the variation in the data than the conditional logit (CL) model (log likelihood = - 400.797 in CL and log likelihood = - 365.836 in ML). Nevertheless, conditional logit model results are consistent with the mixed logit estimation results in terms of signs and range of the coefficients.

In both specifications, the coefficient of the alternative specific variable BUYNO is negative and highly significant suggesting that not choosing any stove would significantly reduce consumers' utility. Likewise, the price coefficient is significantly negative, indicating preference for lower cost stoves. On average, Haitian homemakers prefer more fuel-efficient stoves, stoves made with clay *and* steel, as well as bigger size stoves, as illustrated by the strong positive sign on all the variables except the variable SIZE which is positive but only significant at 10% in the mixed logit model.

Table 4: Conditional Logit and Mixed Logit without interaction terms

	Conditional Logit		**Mixed Logit**	
Variables	Coefficient	Std. Err	Coefficient	Std. Err
MATERIAL	3.140***	0.454	4.115***	0.676
MATERIAL-SD			1.153*	0.598
CONSUMP	1.393***	0.291	1.688***	0.346
CONSUMP-SD			0.690	0.565
SIZE	0.603	0.417	0.940*	0.498
SIZE-SD			-0.019	0.554
PRICE	- 0.054**	0.024	- 0.075***	0.028
BUYNO	- 3.053***	0.567	- 6.985***	1.403
BUYNO-SD			3.664***	0.895
Log Likelihood	- 400.797		- 365.836	
n	146		146	

Note: * ** Significant at 1%; **significant at 5%, * significant at 10%.

In the literature, a wide range of factors are mentioned that influence households' choice of cookstoves. Understanding key determinants of households' cookstoves choices is important for the design and implementation of effective policies to enhance access to clean cooking. The next step of this analysis incorporates some of the factors identified in literature to better explain Haitian preferences and willingness-to-pay for the improved cookstove. Socio-economic factors such as income, education, household size, as well as external factors such as

location (district) and availability (whether sampled household benefited or not from the improved stove distribution program) are included in the mixed logit model. In this final specification, all attribute coefficients including, the BUYNO variable, are specified as random and normally distributed, with the exception of the price coefficient. The model is fitted using 5000 Halton draws per iteration. Halton draws are used to compute the standard error on the standard deviation variables.

The log likelihood of the new specification with demographic interaction variables shows that the model fit is better. Based on the highly significant coefficient on the standard deviation of the variable BUYNO, we can infer that there is significant heterogeneity in consumer preference for the stoves.

Intuitively, the coefficient on the demographic interaction variable SIZE-HHSIZE is positive and significant at 10%, indicating that households with more members have a preference for bigger stoves. Households located in Les Cayes are more price sensitive than those in Jacmel, according to the significant negative coefficient on the interaction variable PRICE-DISTRICT. Surprisingly, the coefficient on the interaction variable between price and income is not statistically significant. Analysis of marginal values may help understand how income affects consumer stove choice.

Table 5: Mixed Logit Model Estimation results

Variables	Coefficient	Std. Err
SIZE-HHSIZE	0.088*	0.053
PRICE	-0.102***	0.030
PRICE-INCOME	0.006	0.004
PRICE-EDUCATION	0.000	0.012
PRICE-BENEFIT	0.010	0.014
PRICE-DISTRICT	- 0.032*	0.017
BUYNO	-7.609***	1.461
MATERIAL	4.763***	0.772
CONSUMP	2.055***	0.405
SIZE	1.054	0.648
BUYNO-SD	3.451***	0.862
MATERIAL-SD	1.059*	0.606
CONSUMP-SD	0.788	0.516
SIZE-SD	-0.008	0.445
n	146	
Log Likelihood	- 361.454	

Note: * ** Significant at 1%; **significant at 5%, * significant at 10%.

Willingness-to-pay estimation

Table 6 reports the marginal attribute values, or willingness-to-pay (WTP) values, calculated at the sample average using coefficients from the final mixed logit specification. According to these values, the most valued attribute for Haitian consumers is the stove material. Consumers are willing to pay $43.70 for a stove with a chamber wall that is clay covered with steel (as opposed to steel alone), *ceteris paribus*. For a low-fuel-consuming stove or a bigger size one, consumers are willing to pay on average $18.86 and $13.75, respectively.

Additionally, we used the alternative specific constant (would not buy) coefficient to compute the WTP for a plain stove using the general formula presented above. On average, consumers are willing to pay $69.82 for a basic stove that does not have any of the additional features. In other words, for a small size stove, made with steel only, and that is not efficient, consumers are willing to pay on average $69.82. This value appears to be high, especially in a poor country like Haiti, but could be explained by the following observations. In the choice

experiment, respondents are asked to choose the alternative of stove they prefer among two stoves in four different choice sets. They also have the option not to choose any of the two stoves. In 33.33% of the cases, consumers choose not to buy any of the stoves presented to them, meaning that a third of the respondents choose not to buy the stoves in at least one of the situations. The ubiquity of the 'buy no stove' response may have skewed the results, resulting in the estimation of a high WTP value for the basic stove.

Table 6: Willingness-to-pay values estimated by the Mixed Logit model

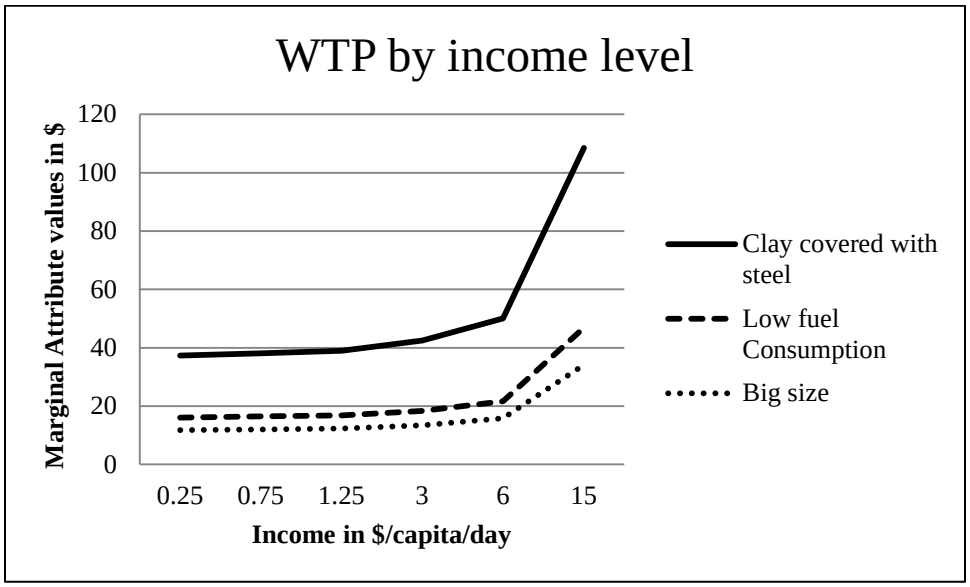
Attribute	Mean	Std. Err
Clay covered with steel	43.707***	8.928
Low fuel consumption	18.861***	3.432
Big size	13.755***	1.592
Plain stove	69.829***	16.637

Note: * ** Significant at 1%; **significant at 5%, * significant at 10%.

For further insight into how consumer WTP varies, we decompose WTP values according to consumer socio-economic characteristics and other factors. First, we predict the marginal attribute values, fixing income at several levels. The goal is to determine how each attribute is valued by consumers of differing income levels. In the context of Haiti, where 78% of the population lives below the poverty line, this is a relevant question. Graph 1 shows the evolution of the WTP for each attribute by income level.

Even estimated at different income levels, the double material (clay and steel) remains the most valuable attribute for consumers, followed by the efficiency and the size. Overall, for each attribute, WTP increases as income increases. For low-income consumers, defined by those

living below the poverty line of $1.25 per day per capita, the WTP for each attribute of the improved stove is relatively constant. They are willing to pay approximately $38 for a stove with the double material and approximately $16 and $11 for low fuel consuming and big stoves, respectively. For consumers living above the poverty level, especially those with income between $1.25 and $6 per day per capita, there is a slight increase in WTP for each attribute. Above $6/day/capita, households' willingness-to-pay increases considerably: up to three times the WTP of the poor for the double material attribute, and up to twice for low fuel consumption and big size.



Graph 1: Willingness-to-pay for stove by income level

A significant portion of the sample did not use the improved stoves. A second step of our analysis checks for the effect of personal experience with the technology on consumer's WTP, by comparing WTP of consumers who received the stove and those who did not. Table 7 reports WTP values for respondents who received the stoves and those who did not. For all attributes, respondents who have some experience with the stove value the product more than respondents who have never used the stove, though this difference is not statistically significant.

Table 7: Willingness-to-pay by first-hand experience with the stove

Attributes	Has some experience (N = 63)		No experience (N = 83)	
	Mean	Std. Err	Mean	Std. Err
Clay covered with steel	46.003***	10.83	42.094***	8.375
Low fuel consumption	19.852***	4.216	18.165***	3.258
Big size	14.477***	1.931	13.247***	1.768

Note: * ** Significant at 1%; ****significant at 5%, * significant at 10%

Our next analysis looks at the WTP by location. Unexpectedly, WTP for all attributes in rural Les Cayes is higher than WTP values in urban Jacmel. Nevertheless, this result can be explained. According to Kshirsagar and Kalamkar (2014), there are three main groups of cookstoves based on the energy source: traditional (open fire or mud) stoves, improved biomass cookstoves (including the improved cookstove studied herein) and advanced cookstoves (e.g., those that use liquefied petroleum gas, natural gas, and electricity.). The last two categories are mainly found in urban areas and constitute higher levels on the cookstove hierarchy. In urban areas, people aspire to use these advanced cookstoves. That is, residents of rural Les Cayes may be evaluating the improved cookstove relative to the three-stone setup or traditional charcoal stoves, whereas those in urban Jacmel may be evaluating it relative to these advanced cookstove. This might explain why in urban Jacmel, the improved cookstove is less valued than in rural Les Cayes.

Table 8: Willingness-to-pay by location

Attributes	Urban Jacmel (N = 100)		Rural Les Cayes (N = 46)	
	Mean	Std. Err	Mean	Std. Err
Clay covered with steel	40.137***	8.073	54.923***	13.922
Low fuel consumption	17.320***	3.115	23.701***	5.509
Big size	12.631***	1.589	17.284***	2.697

Note: * ** Significant at 1%; ****significant at 5%, * significant at 10%

5.3.2. Conclusion and discussion

The study investigates Haitian consumers' preference and valuation for key attributes of the improved stove promoted by Konpay. Using a choice experiment to elicit consumer willingness-to-pay, the analysis considered three attributes, namely the size of the stove, its efficiency (fuel consumption) and the material used to make it. The material used is related simultaneously to the stove durability and efficiency while the size is related to its adaptability.

Results indicate that all three attributes significantly increase the value of the product, with the material being the highest-valued attribute. However, consumers' willingness-to-pay varies significantly depending on their personal characteristics and other external factors. It appears poor consumers (living below the poverty line) value all attributes lower than rich consumers. Among consumers living above the poverty line, richer consumers place much greater value on the chamber material than others. Survey consumers who benefitted from the stove distribution program and subsequently used the stoves value the product more than those who never used it. We also find evidence that location influences how Haitian consumers value the product. In rural areas, the stove is valued higher than in urban areas where other alternatives of more advanced type of stoves exist.

The study shows that Haitian consumers are generally enthusiastic about the attributes of the improved stove. Our observations are consistent with our results and reveal that consumers are very interested in the product, especially in rural areas. Furthermore, estimation results suggest that respondents with larger households place greater value on (larger) stove size. These results have implications for the production and successful marketing of the stoves by Konpay. Nevertheless, Haiti is one of the poorest countries in the world, where cash constraints are likely to be one of the top impediments to technology adoption. Despite the multiple long-term benefits of owning an improved stove, may people do not have enough cash upfront to buy it. Those who received a stove for free and subsequently used it have experienced its benefits and highly value the product. Taken together, these two observations raise one important question: Will Haitians purchase these stoves in real-life, at the prices reflected by their WTP values? This discussion raises the main limitation of the stated-preference method: consumers say they will buy the product for a given price but the experiment is merely an approximation of actual purchase situations. Cash constraints and/or social and behavioral factors may not have prominently figured into the choices made during the experiment.

The study results raises still other questions, related to the production aspect of the stoves: Do these values really sustain profitable production of the stove by Konpay? Given the cost of production, what will be the necessary scale of production for Konpay to recover its costs?

5.4. Alternative charcoal (briquettes) willingness-to-pay

The willingness-to-pay for briquettes and their attributes are estimated using the conditional logit model and mixed logit models described in section 5.2 ('Empirical model'). The attributes are those described in section 3.2.2 ('Briquettes choice experiment').

5.4.1. Results

Both sets of estimation results are presented in Table 9. Judging by the log likelihood, the mixed logit (ML) model performs better than the conditional .logit (CL) model (log likelihood = - 557.839 in CL and log likelihood = - 525.954 in ML). In general, the conditional logit model results are consistent with the mixed logit model. All coefficients have the same magnitude, sign and significance, except for the coefficient on PRICE, which is not significant in the CL model.

On average, both specifications show that consumers have preference for lower cost, clean burning (no smoke) briquettes that are made of coconut husk. The coefficient on the variable ASHES (1 = low ash producing) is not significant in any specification. The variable BUYNO, the alternative-specific constant, has a significantly positive coefficient on its mean as well as its standard deviation, suggesting significant heterogeneity in consumers' valuation of the basic product. We may also infer that choosing to buy the product is perceived as a utility-increasing decision for the consumers.

Table 9: Conditional Logit and Mixed Logit without interaction terms

	Conditional Logit		Mixed Logit	
Variables	Mean	Std. Err.	Mean	Std. Err.
PRICE	- 0.364	0.516	- 3.152***	1.032
SMOKE	1.438***	0.167	1.723***	0.205
MATERIAL	0.691***	0.178	1.410***	0.284
ASHES	0.030	0.203	0.113	0.211
BUYNO	1.491***	0.196	1.182***	0.309
SMOKE-SD			-0.001	0.288
MATERIAL-SD			0.494	0.370
ASHES-SD			0.001	0.377
BUYNO-SD			1.867***	0.293
Log-Likelihood	- 557.839		-525.95426	

Note: * ** Significant at 1%; **significant at 5%, * significant at 10%

We use the mixed logit model for the rest of the analysis and add interaction terms – between respondents' demographic characteristics and attributes of the briquettes – to better understand consumer choice. Table 10 presents the results of the mixed logit estimation with interaction terms. We can tell by the higher log-likelihood value (502.286) that these new variables improve the model. Recall that all interaction terms generated using the PRICE variable are specified as fixed, whereas the other variables are specified as random. The model is estimated through simulated maximum likelihood with 5000 Halton draws per iteration.

All coefficients are statistically significant and have the same sign as in previous specifications, except for those on ASHES and SMOKE, which have been interacted with other variables. The significantly negative coefficient on PRICE indicates that consumers are very sensitive to the price of the briquettes. All the interaction variables created are significant, with the surprising exception of the interaction between price and income. Unsurprisingly, the coefficient on the interaction variable SMOKE-cooking place is positive, confirming our hypothesis that households that cook indoors have a strong preference for smokeless briquettes. Likewise, the coefficient on ASHES-cooking place suggests that households that cook indoors

prefer briquettes that produce less ash, as ashes must be regularly discarded. By interacting the variables SMOKE and ASHES with the district dummy, we see that households located in an urban area prefer clean-burning briquettes (no smoke emission) and briquettes that will not produce too much ash. These results are intuitive and consistent with general observations made during the fieldwork.

Table 10: Mixed Logit Model estimation result

Variables	Coefficients	Std. Err.
PRICE	-3.159***	0.922
SMOKE-cooking place	1.232***	0.408
SMOKE-arrondisment	1.643***	0.304
ASHES-arrondisment	1.317***	0.458
ASHES-cooking place	1.397***	0.465
PRICE-INCOME	-0.077	0.203
SMOKE	0.410	0.266
SMOKE-SD	0.000	0.229
MATERIAL	1.463***	0.234
MATERIAL-SD	0.002	1.464
ASHES	-1.009**	0.393
ASHES-SD	-0.000	0.365
BUYNO	1.245***	0.256
BUYNO-SD	1.371***	0.217
Log-Likelihood	-502.286	
n	146	

Note: * ** Significant at 1%; **significant at 5%, * significant at 10%

Willingness-to-pay estimation

WTP values are reported in Table 11. All the values are significant except the WTP for the attribute ASHES. This suggests that this attribute does not matter that much for respondents and that they are indifferent between briquettes with or without this attribute. Additionally, on average, consumers are willing to pay an additional 53 cents for a dozen *smokeless* briquettes, *ceteris paribus*. They are willing to pay a premium of 44.3 cents/dozen if the briquettes are made with coconut husk instead of a lighter material such as paper. For basic briquettes (made with

paper, high ash production, smoke-producing), consumers are willing to pay a price of 37.7 cents/dozen.

These values are fairly affordable for Haitian consumers. The conventional unit for charcoal in Haiti is a "marmit". The equivalent of a *marmit* of charcoal is approximatively 9 alternatives briquettes. A *marmit* of conventional charcoal costs between 60 – 110 cents (24 – 44 Haitian Goudes) depending on the location. The equivalent of a marmit of briquettes with all the studied features would cost $1.02 (41.1 Haitian Goudes), which is still cheaper than the conventional charcoal.

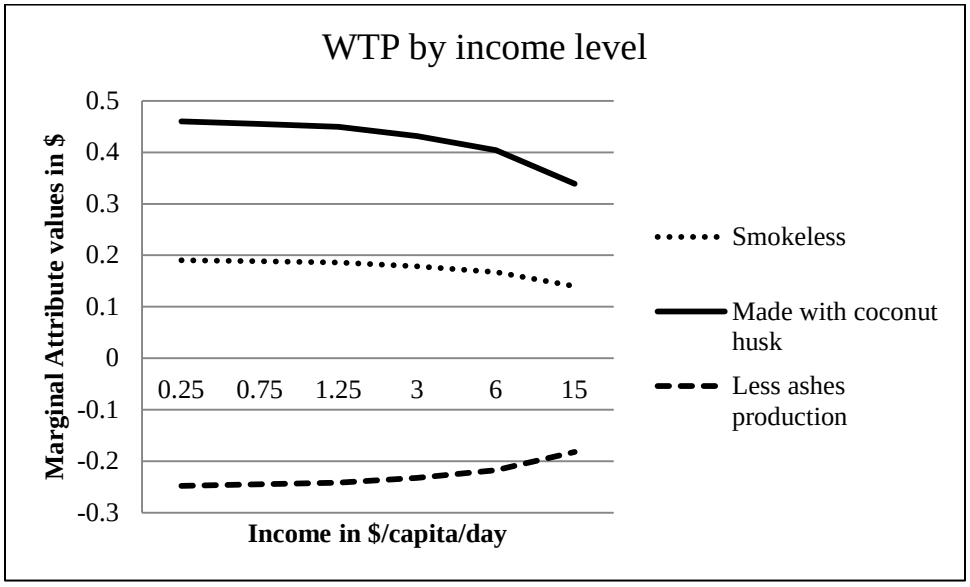
Table 11: Willingness-to-pay values suggested under Mixed Logit model

Attributes	Mean	Std. Err
Smokeless	0.530***	0.132
Made with coconut husk	0.443***	0.073
Less ashes production	0.039	0.066
Plain briquette	0.377***	0.142

Note: * ** Significant at 1%; **significant at 5%, * significant at 10%

Another step of our analysis looks at how consumers WTP values change depending on their income level. We plot the predicted marginal attribute values computed using the variable coefficients at varying income levels. Graph 2 illustrates the evolution of the WTP for each attribute by income level. For all attributes, WTP is practically constant for consumers living below the poverty line of $1.25/day/capita. These poor consumers are willing to pay on average approximately 19 cents for a dozen of smokeless briquettes and 45 cents for a dozen of briquettes made with coconut husk as material but they will discount a dozen of briquettes with less ashes by approximately 24 cents (negative WTP). Consumers living above the poverty line, surprisingly, have lower WTP values for each attributes and the more their income level

increases, the less they are willing to pay for each attribute. In other words, rich consumers value the product less than poor consumers. This result is unexpected and counterintuitive. Nevertheless it can be explained. As described in the stove WTP section, rich consumers aspire to use advanced cookstoves. The type of fuel depending on the type of cookstove, these high income consumers desire advanced fuel such as petroleum, natural gas and electricity. That is, poor respondents may be evaluating the briquettes relative to woodfuel, animal dung or conventional charcoal whereas rich respondents may be evaluating them relative to these advanced cooking fuels.



Graph 2: Willingness-to-pay for briquettes by income level

Finally, we look at how consumers value the product based on their location. Table 12 presents WTP values by district. Looking at WTP for each attribute in the two districts reveals that consumers value differently the product depending on whether they live in a urban or rural area. The material used to make the briquettes is valued the same in the two locations with the same value of WTP: 44.3 cents. Briquettes that burn cleaner without smoke are highly preferred in urban areas (WTP = 68.1 cents) compared to rural area (WTP = 18.3 Cents). This result is

expected since most people in urban areas cook indoors and having a fuel that does not emit smoke is important.

It is noteworthy that ash itself is valued differently in the studied areas and within Jacmel. Konpay conducts a latrine program simultaneously with the stove and briquettes program. For the latrine program, households are encouraged to use ashes from briquettes (and other cooking fuels) in latrines for sanitation purposes. This can explain why the amount of ashes produced by the briquettes is differently valued throughout the sample. The different signs and levels of significance on the ‘‘Less ashes’’ variable are consistent with this observation, as well as the differences in cooking areas by locality, as described above.

Table 12: Willingness to pay by location

Attributes	Urban Jacmel (N = 100)		Rural Les Cayes (N = 46)	
	Mean	Std. Err	Mean	Std. Err
Smokeless	0.681***	0.165	0.183**	0.092
Made with coconut husk	0.443***	0.073	0.443***	0.073
Less ashes production	0.160**	0.079	-0.239*	0.126

Note: * ** Significant at 1%; **significant at 5%, * significant at 10%

5.4.2. Conclusion and discussion

We used a choice experiment to investigate how consumers value different attributes of the alternative charcoal. The study considered three attributes in its analysis: material used to make the briquettes, whether it emits smoke or not, and the amount of ashes they produce. Results indicate that Haitian consumers, in general, highly value the first two attributes while preference for ash production is mixed. We find that consumers in urban areas and those who

cook indoors place higher value on low ash production, as well as smokeless combustion. For consumers in rural areas, the material used to make the briquettes (in other words, the burning time of each briquette) matters more than how clean it burns. This is consistent with the fact that, in rural areas, cooking typically takes place outdoors, with woodfuel that produces more smoke than briquettes of conventional charcoal. In other words, consumers in urban areas are more accustomed to smoke, and smoke poses less of a nuisance due to the open nature of the cooking areas. Thus, rural consumers are more interested in the durability, associated with tougher material like coconut husk, than in low smoke production. Results also suggest that in rural areas, producing a lot of ashes after cooking does not bother consumers. Finally, our results also suggest that poor consumers value the briquettes more than rich consumers.

In the context of Haiti, the alternative charcoal appears to be a great solution; it can mitigate deforestation and indoor air pollution, it is adaptable to local customs, and is affordable to the population. However, producing the briquettes has costs, some of which are apparently not taken into account by the program promoting the technology. For instance, Konpay does not account for the cost of collecting biomass which may include transportation cost, labor cost or time cost. The cost of production includes biomass, equipment to carbonize, equipment to crush the carbonized organic material, molds to form the briquettes, as well as labor and costs for the binding material (either starch or clay). On the consumption side, a big question is whether consumers will effectively buy the briquettes for the price reflected by their willingness-to-pay values, especially in a country where the population is used to cutting and using wood for free. All this provides Konpay with ideas to include in their marketing plan for the promotion of the stove, which, eventually can lead to improved overall health of the population.

CHAPTER 6: IMPACT OF THE USE OF THE IMPROVED COOKSTOVE ON HOUSEHOLDS

6.1. Introduction

A large number of empirical studies identify different benefits as well as costs associated with a household's decision to use improved cookstoves and fuels. From the users' perspective, benefits include reduction in air pollution, time saved from collecting fuels, and fuel cost savings, as well as aesthetic gains and improved social standing (Malla and Timilsina, 2014). The literature on cookstove adoption reveals that initially, households respond most – with a high rate of adoption – to fuel savings (when fuel is very scarce or monetized), to the speed of cooking, convenience, compatibility with local cooking practices, and status of modernity , and relatively less so to indoor-air-pollution-related issues (Ruiz-Mercado, Masera, Zamora,and Smith, 2011).

The current chapter assesses the early effects of the use of the improved stove promoted by Konpay. It takes advantage of the fact that the stoves were distributed to a number of households in 2012 and that many of these households could be located and their members interviewed.

6.2. Users' perceptions of the improved cookstove

In the sample, 56 interviewees (37.83%) received an improved stove through the distribution program in 2012. Five individuals stated that they were given the stove by someone who had received it during the distribution program. Finally, two respondents bought the improved stove.

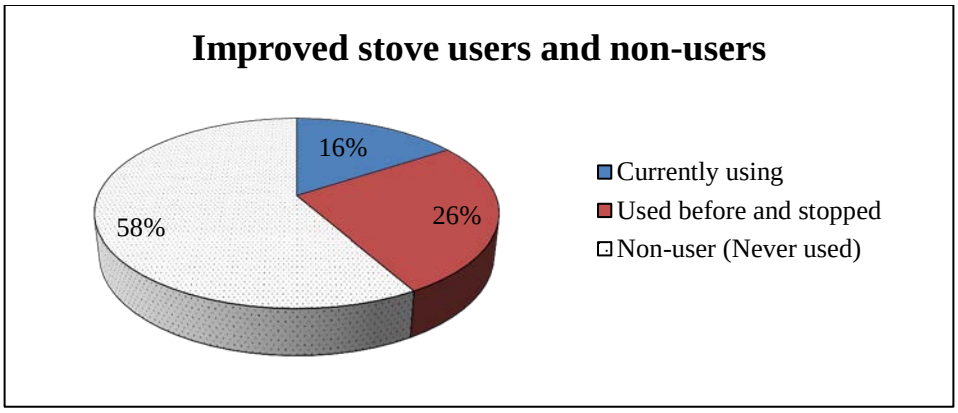


Figure 7: Proportion of improved stove users and non-users

Despite 42% of the sample having, at one point, owned the improved stove, only 16% of the sample was using the improved stove at the time of the survey. 26% stopped using their stove sometime between 2012 and the time of the survey. These represent the majority (63.31%) of those who possessed the improved stove at one point. The main reason stated for dis-adoption is that it had broken (stated by 54.28% of the dis-adopters). People also stopped using the technology because they gave it to a relative, typically a relative living in an urban area or who has financially better off. This fact is interesting in that it implies that the stove is perceived as a ‘‘rich people’’ technology while it was originally developed for everyone, and especially the poor. It is important to note that beneficiaries of the distribution program were told that they should use the new stove with the briquettes; an unintended consequence is that 14.29% of the dis-adopters stopped using their improved stoves when the accompanying briquettes ran out. Figure 8 summarizes the reasons why people stopped using the improved stoves.

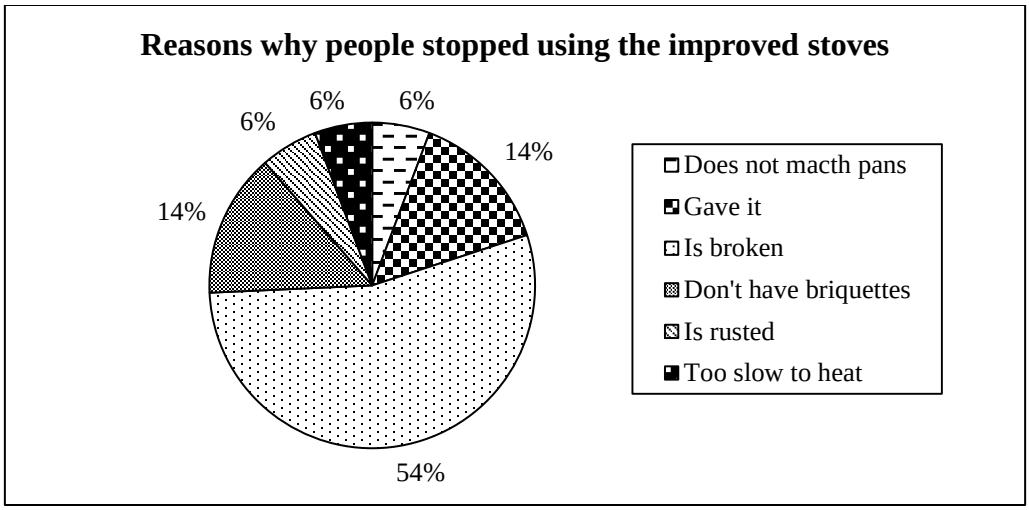


Figure 8: Reasons why people stopped using the improved stoves

6.3. Estimating changes in fuel costs

The objective of this analysis is the estimation of the effect of the use of the improved stove on the sampled households. To do so, treatment evaluation methods are applied. Our outcome of interest is average household fuel expenditure over the one-year period preceding the survey, measured in dollars per day. Fuel expenditures are the average daily amount of money spent to purchase cooking fuel (charcoal, woodfuel or kerosene). Wood freely collected or other fuel freely obtained is not counted.

The treated group represents households that received the stoves and effectively used them between the time of distribution and the survey. A total of 24 households (16.44%) meet that condition in our sample. The control group comprises households that did not receive the stove or stopped using them before the time of the survey. A total of 122 households (83.56%) are in the control group.

As a first step, a simple t-test is used to compare the mean fuel expenditure over the past year of households which used the stove and households which did not. Based on a statistically significant result of a mean comparison we can conclude that fuel expenditure of households that used the stove differ from fuel expenditure of households that did not use the stove. However, a t-test simply compares the means of the two groups and does not account for any potential sample selection.

Therefore, we follow the t-test with propensity score matching techniques. The propensity score is defined by Rosenbaum and Rubin (1983) as the conditional probability of receiving a treatment given pretreatment characteristics:

$$p(\mathrm{X}) \equiv \Pr(\mathrm{D} = 1|\mathrm{X}) = \mathrm{E}(\mathrm{D}|\mathrm{X})$$

where D = 1 indicates the household having received and effectively used the stove since the distribution program. (D=0 otherwise X is the multidimensional vector of pretreatment characteristics. The probability of using the stove can be rewritten as:

$$p(\mathrm{X}) = \Pr(\mathrm{D} = 1|\mathrm{X}) = F(X'\beta) \qquad (1)$$

β denotes the vector of the model parameters to be estimated and F is a cumulative density function. F can be the standard normal cumulative distribution or the logistic cumulative distribution. In case of a standard normal distribution, a probit model is fitted and equation (1) becomes

$$p(\mathrm{X}) = \Pr(\mathrm{D} = 1|\mathrm{X}) = F(X'\beta) = \int_{-\infty}^{X'\beta} \emptyset(z)dz$$

with $\emptyset(z) = \frac{1}{\sqrt{2\pi}} e^{-\frac{z^2}{2}}$ representing the density function of the standard normal distribution.

In case of a logistic distribution, a logit model is estimated and equation (1) can be rewritten as

$$p(\mathrm{X}) = \Pr(\mathrm{D} = 1|\mathrm{X}) = F(X'\beta) = \frac{\exp(X'\beta)}{1 + \exp(X'\beta)}.$$

In both cases, the models are estimated by maximizing the log-likelihood function and the resulting coefficient estimates permit the calculation of average effects of treatment on the treated.

6.4. Data

Data used in this analysis are cooking fuel expenditures, effectively use of an improved cookstove over the past year, and household demographics such as income and education. Table 13 presents summary statistics of these variables, by group.

Table 13: Summary statistics by groups

		Treatment group (N=24)		Control group (N=122)	
Variable	**Description**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
COOKPLACE	Whether cooks Indoor (=1) or Outdoor (=0)	0.292	0.464	0.131	0.339
AGE	Age in years	41.208	12.573	39.057	13.189
SEX	Gender: Male(=1) or Female (=0)	0.292	0.464	0.270	0.446
MARITAL	Marital status: Married (=1) or Single (=0)	0.708	0.464	0.779	0.417
EDUCATION	Education level: Below high school (=0) or Above high school (=1)	0.417	0.504	0.467	0.501
HHSIZE	Household size (number of members)	6.042	3.000	4.861	2.062
INCOME	Average daily income per capita in US dollar	1.275	1.035	1.964	2.163
BENEFITORNOT	Whether received the stove (=1) or not (=0)	1.000	0.000	0.320	0.468
USED	Whether used the stove for at least year (=1) or not (=0)	1.000	0.000	0.000	0.000
FUELEXPDTRE	Average daily fuel expenditure in US dollar	0.844	0.736	1.006	0.982
COOKTIME	Average daily cooking time in hours	3.333	1.204	3.043	1.153
INDWORK	Independent worker	0.333	0.482	0.467	0.501
FARMER	Farmer	0.167	0.381	0.098	0.299
SALARY	Employee (salaried)	0.083	0.282	0.164	0.372

Judging by the demographic characteristics; households in the treated group do not significantly differ from households in the control group. In other words, observationally, the population that received the stoves and used them is not different from the population who did not receive them. For instance, in both groups, approximately 70% are female, household size is approximately 5 members on average, control group mean age is 39 years old and treated group mean age is 41 years old.

6.5. Results

Results of the t-test are summarized in Table 14. Fuel expenditure for households that used the stoves is lower than those of households that did not use them. Judging only by the means, households that used the improved cookstove reduce their fuel expenditure by 16.1 cents/day (the average fuel expenditure is 97.9 cents/day). However, this difference is not statistically significant. A propensity score is used for further insight. A propensity score also helps address any eventual randomness issue in the sample.

Table 14: Difference in mean tests summary

Variables	Description	Mean All	Mean for Control group	Mean for Treatment group	Difference	p-Value
FUELEXPDTRE	Fuel expenditure/day (US $)	0.979	1.005	0.844	-0.161	0.447

A propensity score model (probit model) is estimated and the balancing property is satisfied. Propensity score model results are presented in Table 15. Most of the coefficients are not significant except for the variables COOKPLACE and HHSIZE. These results suggest that bigger households are more likely to use the improved stove, as well as households that cook indoors.

Table 15: Probit model estimation

	Probit model	
Variables	**Coefficient**	**Std. Err**
AGE	0.006	(0.012)
SEX	0.049	(0.366)
COOKPLACE	0.783**	(0.348)
EDUCATION	-0.005	(0.323)
COOKTIME	0.054	(0.120)
HHSIZE	0.103*	(0.059)
INCOME	-0.102	(0.129)
MARITAL	-0.078	(0.328)
INDWORK	-0.347	(0.340)
FARMER	-0.025	(0.527)
SALARY	-0.520	(0.605)
Constant	-1.632**	(0.702)

Note: * ** Significant at 1%; **significant at 5%, * significant at 10%

Average treatment effect on the treated estimation

Table 16 reports the average treatment effect on the treated using several matching methods. After matching treated and control households, we estimate that using the improved cookstove lowers the fuel expenditure by about 14.6 cents/day to 23.6 cents/day. In other words, households that use the improved stove have lower fuel expenditure than households that did not use one. Given the average fuel expenditure (97.9 Cents/day), this reduction is significant for households in Haiti. However, this difference is not statistically significant for all matching methods.

Table 16: Average treatment effect on the treated

Estimation method	Differences in Fuel expenditure ($/day)
T-test	- 0.161
ATE nearest neighbor	- 0.253
ATE four nearest neighbor	- 0.281*
ATE radius matching	- 0.146
ATE kernel	- 0.236*

6.6. Conclusion and discussion

We use a propensity score matching to estimate the effects of the use of the improved cookstove on households. The treated group consists of households that received the stoves during the distribution and use them regularly, while the control group is the set of households that did not use the stove. Results show that the use of the improved stove significantly reduces household fuel expenditure by about 14.6 cents/day to 23.6 cents/day. During the interviews, respondents acknowledge that the stove is efficient, cooks faster, and retains the heat of the fuel longer than conventional or traditional stoves found in the community. However, they complain about the fact the improved stove breaks easily and that the cost prevents them from buying a replacement. Cash is an important constraint that limits the adoption of the stove. To address this, solutions such as microcredit can be implemented by the promoters of the technology as components to include in a marketing plan.

Also, the improved stove and the briquettes were needlessly marketed together, resulting in unnecessary dis-adoption of the stoves, whereas they still offer improvements with conventional charcoal. Households that received the improved stoves were told to use them with the briquettes for better performance. As results, 14.29% of these households stopped using the stoves when the accompanying briquettes ran out.

CHAPTER 7: GENERAL CONCLUSIONS AND POLICY IMPLICATIONS

This research gauges Haitian consumers' interest in improved cookstoves and briquettes and their specific characteristics. The research also helps identify factors that influence dis-adoption and adoption of the technologies. Furthermore, this research measured tangible benefits for the users of the improved stoves. By evaluating the dollar value consumers place on different traits of the technologies and the effect of the use of the stoves on households, this research can provide Konpay with information that will help it to design a better marketing plan to speed up the adoption of the clean cookstove and the alternative charcoal.

In Haiti, cooking with charcoal accounts for approximately 75% of the energy use where an estimated 40 million of trees are cut down and burnt every year (CDI, 2013). The study confirms that cooking practices and technologies in Haiti are still traditional and charcoal remains the main cooking fuel. Nevertheless, some efforts have been made to change this trend, including the alternative fuel and clean cookstove program of Konpay in collaboration with Community Development International. Through their program, the two organizations intend to simultaneously address issues of energy, environmental protection, climate, health and gender. However, despite many the potential benefits of the clean cookstove and the alternative charcoal, the technologies have seen limited adoption.

The study results reveal that consumers are interested in the improved stoves as well as the briquettes. However, significant portion of the sample 'opt out' in the choice experiment, likely due to internalized cash constraints. This may be driving the high estimates of WTP values for both stoves and briquettes, both with and without special features. The study also reveals that Haitian consumers' willingness-to-pay varies significantly, depending on personal characteristics and other external factors. Richer households have higher willingness-to-pay than poorer ones;

consumers who had access to the stove and had some experience using it value it more than consumers who did not. The study also finds that the value placed on the attributes of the improved stove is higher in rural areas than in urban area.

In the case of the alternative charcoal, a consumer's preference for the listed attributes varies depending on whether he/she lives in an urban or a rural area. Urban consumers place higher value on lower smoke and ash production. They have greater disutility from those traits because of a greater tendency to cook indoors. Also, the research found that households living below the poverty line care more about the material of the briquettes (i.e. the burning time) more than households living above the poverty line. The main question that arises from the conjoint analysis in both stove and briquettes cases is whether Haitian consumers will realistically pay as much as they state they are willing to for the technologies.

The improved stove is designed to be used in association with the briquettes for higher performance. During the distribution, households that received the stoves were advised to use the two technologies together. This led 14.3% of the stoves recipients to stop using the stoves when their briquettes ran out, despite the fact that the stoves could be used with conventional charcoal. This finding illustrates the pitfall in paired technologies and shows how Konpay and other organizations should pay attention to the marketing of its technologies.

Also noteworthy is that 14% of the households which received the stove gave it away to a relative, typically a relative living in urban area or one who was wealthier. Such respondents mentioned that the stove would be better valued by these new recipients in the city. This fact is interesting in that it implies that the stove is perceived as a ‘‘rich people’’ or ‘‘urban’’ technology, despite the fact that it is developed for everyone and especially the poor.

Finally, further studies could evaluate the extent to which consumers are willing to buy these technologies, in order to establish bounds to refine the WTP estimation. Also, studies on the production side of these technologies may offer valuable insights to better match demand and supply.

APPENDIX

Improved cooking stove and alternative charcoal (briquettes) adoption survey

Individual & Household Survey

Department : …… District:……

Commune……. Communale section……..

Date /__/__/ /__/__/ 2014

This research will help us understand Haitian attitudes towards clean cook stoves and an alternative fuel source.

This research is initiated by the University of Kentucky, USA in collaboration with two non-profit organizations: Community Development International (New York) and Konpay (Haiti).

If you agree to take part in this research, you will be asked detailed questions about your current cooking technology, who collects firewood, your household size and how much you would be willing to pay for these new technologies, if they existed on the market. The questionnaire will take about 45 minutes.

You will not be paid for taking part in the study.

There are no risks to participating in this study. All your answers will be confidential and no one outside this research could link your answers to you or your household.

Do you have any questions?

Are you willing to participate in the research? Yes :__: No:__:

Enumerator: Sign and date this oral consent form after reading it to the interviewee.

Signature: _____ Date: _____

Participant identification

Participant Number :__:__:__:
Town : 1. Jacmel **:__ :** 2. Cyvadier **:__ :** 3. Les Cayes **:__ :**
Participant First & last Name:……..

Improve cooking stove and alternative charcoal (briquettes) adoption survey

Individual & Household Survey

Department: …… District:……..
Commune……. Communale section……..
Date /__/__/ /__/__/ 2014

1. Participant identification

Participant Number :__:__:__:
Town : 1. Jacmel **:__ :** 2. Cyvadier **:__ :** 3. Les Cayes **:__ :**
Age : **:__:__:** years
Sex: 1. Male **:__:** 0. Female **:__:**
Marital Status: 1. Single **:__:** 2. Married **:__:** 3. Widow **:__:** 4. Divorced **:__:**
Education level 0. Never been to school**:__ :** 1. Primary school**:__ :** 2. High school**:__ :** 3. College**:__ :** 4. Master**:__ :** 5. Higher **:__ :**
Status in the household: 1. Household head**:__ :** 2. Head of household's wife**:__ :** 3. Son or daughter**:__ :** 4. Other household member**:__ :**
Profession/activity: ……..

2. Household characteristics

How many people live in the household? :__ : :__ : persons Number of Children**:__ : :__ :** Number of adults**:__ : :__ :**
How many people are currently employed in the household? **:__ : :__ :** persons
What are their occupations/professions? - …….. - ……... - ……...
What is the average monthly income of the household? :_____ : GDS

3. Cooking stoves

Who cooks in the household? - ……. - ……. - …….
Where do you cook your meals? 1. Kitchen inside the house**:__ :** 2. Kitchen outside**:__ :** 3. Outside (not in a kitchen) **:__ :** 4. Other**:__ :**……
How many meals are cooked in the household or by the participant per day? :__ : meals/day
How many hours do you spend on average cooking per day? ……**Hours**
Do you use the same type of stove for all meals? Yes**:__ :** No**:__ :**
If no, which type of stoves do you use and for which type of meal? Rice: 1. Traditional**:__ :** 2. Improved**:__ :** 3. Three stones **:__ :** 4. Propane**:__ :** Plantain 1. Traditional**:__ :** 2. Improved**:__ :** 3. Three stones **:__ :** 4. Propane**:__ :** Beans 1. Traditional**:__ :** 2. Improved**:__ :** 3. Three stones **:__ :** 4. Propane**:__ :** Sauce 1. Traditional**:__ :** 2. Improved**:__ :** 3. Three stones **:__ :** 4. Propane**:__ :**
Are you a food vendor? Yes**:__ :** No**:__ :** **Do you use the same stove for house cooking?** Yes**:__ :** No**:__ :**
Why do you use different types of stoves? 1. I cannot change suddenly**:__ :** 2. The traditional type is appropriate for certain meal**:__ :** 3. Some cook faster (specify which one……..) **:__ :** 4. Some are appropriate for larger pot (specify which one……..)**:__ :** 5 Other …….**:__ :**
How much do you spend on average on food per week? ..... **Gds/Week** On the fuel: …… **Gds/Week** On the meal itself: …… **Gds/Week** Other (precise): …… **Gds/Week**

4. Improved cooking stove

Have you heard about Konpay's improved cooking stove? Yes **:__ :** No**:__ :** (Show the stove) **How/where did you hear about it?** 1. Radio**:__ :** 2. Television**:__ :** 3. From a friend/parent**:__ :** 4. From Konpay agent**:__ :** 5. Focus Group**:__ :** 6. Other source **:__ :** (specify)……..
Are you currently using it? Yes**:__ :** No**:__ :** If yes, Since when? ……
How did you acquire it? 1. Purchase**:__ :** 2. Gift**:__ :** 3. Distribution**:__ :** 4. Other**:__ :** (specify)……...)
If No, have you ever used one before? Yes**:__ :** No**:__ :**

If you used one before, why did you stop using it? 1. Does not match my pans**:__ :** 2. I did not like it**:__ :** (specify why), 3. Is broken**:__ :** 4. Require too much fuel (specify which type of fuel you use) **:__ :** 5. I gave it to someone else, 6. Other (specify) **:__ :**…….
Will you use it again if this is fixed? Yes**:__ :** No**:__ :** If no, why not? …… …… ……
Can you explain why you are still using the old stoves? Or will not adopt the new one? ……. …….. ……..
What difference do you see in the improved cooking stove (compared to other stoves)? 1. Cheaper**:__ :** 2. Easy to handle**:__ :** 3. Reduce cooking time**:__ :** 4. Less smoke**:__ :** 5. Less dirt**:__ :** 6. Safer**:__ :** 7. Keep fuel heat longer**:__ :** 8. Other (specify) **:__ :**……
What improvement did it bring in your household? 1. Meals ready earlier**:__ :** 2. Do not have to watch the fire**:__ :** 3. Fewer injuries**:__ :** 4. Fewer respiratory diseases**:__ :** 5. None**:__ :** 6. Reduce the food expenses**:__ :** 7. More time to do other activities**:__ :** 8. Other (specify)…….. **:__ :**
Do you believe that adoption of improved cookstove improve your health status? Yes**:__ :** No**:__ :**
What are the inconveniences of the improved stove? 1. None**:__ :** 2. Breaks quickly**:__ :** 3. Slow to heat**:__ :** 4. Not suitable for large pot**:__ :** 5. Other……..**:__ :**

5. Improved cooking stove adoption

In the following choice situations, you will be presented with a series of options for types of stoves. Each choice situation contains three options described by their characteristics and you will be asked to indicate your preferred option but:

- **Please choose ONLY ONE OPTION in each situation**
- **Assume that the options in EACH situation are the ONLY ones available**
- **Do NOT compare options in different situations**

Situation 1

Stove A	Stove B	I do not prefer either stove
Small size	Large size	
Clay covered with steel	Steel only	
High charcoal consumption	Low charcoal consumption	
1200 Gds	1500 Gds	
☐	☐	☐

Situation 2

Stove A	Stove B	I do not prefer either stove
Large size	Small size	
Clay covered with steel	Steel only	
High charcoal consumption	High charcoal consumption	
2000 Gds	600 Gds	
☐	☐	☐

Situation 3

Stove A	Stove B	I do not prefer either stove
Large size	Small size	
Clay covered with steel	Clay covered with steel	
Low charcoal consumption	Low charcoal consumption	
1740 Gds	1200 Gds	
☐	☐	☐

Situation 4

Stove A	Stove B	I do not prefer either stove
Large size	Small size	
Steel only	Steel only	
High charcoal consumption	Low charcoal consumption	
1000 Gds	700 Gds	
☐	☐	☐

Supposed that Konpay recalculated his production cost and this is how much the stove will cost:

- **1.500 Gds** for the small size, will you buy it (in your current economic situation)? Yes:__: No:__:
- **(If no to the previous question)** If the cooking stove is sold at **1200 Gds** for the small size, will you buy it (in your current economic situation)? Yes:__: No:__:
- **(If yes to the first question)** If the cooking stove is sold at **1700 Gds** for the small size, will you buy it (in your current economic situation)? Yes:__: No:__:

6. Fuel used

Which type of fuel do you use to cook? 1. Charcoal**:__ :** 2. Wood**:__ :** 3. Husk**:__ :** 4. Animal dung**:__ :** 5. Kerosene**:__ :** 6.Propane**:__ :**7. Other**:__ :**

Do you use the same type of fuel for all meals? Yes**:__ :** No**:__ :**

If no, **Which type of fuel do you use for which type of meal?**

Rice: 1. Charcoal**:__ :** 2. Wood**:__ :** 3. Propane**:__ :**

Plantain 1. Charcoal**:__ :** 2. Wood**:__ :** 3. Propane**:__ :**

Beans 1. Charcoal**:__ :** 2. Wood**:__ :** 3. Propane**:__ :**

Sauce 1. Charcoal**:__ :** 2. Wood**:__ :** 3. Propane**:__ :**

Why do you use this (these) fuel(s)? .....
…….
…….

For the past year have you been injured or burnt while cooking? Yes :__: No:__:

Have you ever experience any health related issues to cooking with your current fuel and stove, such as respiratory problems or physical burns: Yes :__: No:__:

If yes, specify……...
…….....
…….....

How many times did it happen over the past year? …….

7. Alternative fuel (briquette) attitudes

Have you heard about the briquettes? Yes :__: No:__:

How/where did you hear about it? 1. Radio**:__ :** 2. Television, **:__ :** 3. From a friend/parent**:__ :** 4. From Konpay agent**:__ :** 5. Other source (specify) **:__ :**

Are you currently using it? Yes:__: No:__:. **If yes, Since when**?
……

How many briquette do you use (or did you use) per day? …….

How did you acquire it? 1. Purchase**:__ :** 2. Gift**:__ :** 3. Distribution**:__ :** 4. Other (specify) **:__ :**……

If No, have you ever used it before? Yes:__: No:__:

If you used it before, why did you stop using it? 1. Takes too much time to ignite**:__** : 2. I did not like it

(specify why) **:__ :** 3. Is not available on the market**:__ :** 4. Require too much kerosene to ignite**:__ :** 5. Is not dry enough**:__ :** 6. Do not burn well**:__ :** 7. Other (specify) **:__ :**
Will you use it again if this changes? Yes:__: No:__: If no, why not? …….. ……. ……
What difference do you see in the briquette (compared to other fuels)? 1. Cheaper**:__ :** 2. Easy to handle**:__ :** 3. Reduce cooking time**:__ :** 4. Less smoke**:__ :** 5. Less dirt**:__ :** 6. Safer**:__ :** 7. Last longer**:__ :** 8. Les ashes**:__ :** 9. Other (specify) **:__ :**……..
What improvement did it bring in your household? 1. Meals ready earlier**:__ :** 2. Do not have to watch the fire**:__ :** 3. Fewer injuries**:__ :** 4. Fewer respiratory diseases**:__ :** 5. None**:__ :** 6. Reduce the food expenses**:__ :** 7. More time to do other activities**:__ :** 8. Other (specify)) **:__ :**
What are the inconveniences of the briquettes? 1. None**:__ :** 2. Breaks quickly**:__ :** 3. Slow to heat**:__ :** 4. Produce too much ash**:__ :** , 5. Other**:__ :**
Do you believe that using charcoal, husk or wood is harmful to the Haitian environment? Yes :__: No:__: **How?** …… …… ……
Do you think that there is any environmental benefit related to the use of briquette? Yes:__: No:__: **What do you know?** …… …… ……

8. Alternative fuel (briquette) willingness to pay

In the following choice situations, you will be presented with a series of options for types of briquettes. Each choice situation contains three options described by their characteristics and you will be asked to indicate your preferred option but:

- **Please choose ONLY ONE OPTION in each situation**
- **Assume that the options in EACH situation are the ONLY ones available**
- **Do NOT compare options in different situations**

Situation 1

Briquette A
Made with coconut husk
Smoke emission
Less ashes
3briquettes for 5 Gds
☐

Briquette B
Made with paper
No smoke emission
Important ashes
1briquette for 1 Gds
☐

I do not prefer either briquette
☐

Situation 2

Briquette A
Made with paper
No smoke emission
Less ashes
1briquette for 1 Gds
☐

Briquette B
Made with coconut husk
No smoke emission
Important ashes
3briquettes for 5 Gds
☐

I do not prefer either briquette
☐

Situation 3

Briquette A
Made with coconut husk
No smoke emission
Less ashes
3briquettes for 5 Gds
☐

Briquette B
Made with paper
Smoke emission
Less ashes
2briquettes for 1 Gds
☐

I do not prefer either briquette
☐

Situation 4

Briquette A
Made with coconut husk
Smoke emission
Important ashes
3briquettes for 5 Gds
☐

Briquette B
Made with paper
No smoke emission
Important ashes
2briquettes for 1 Gds
☐

I do not prefer either briquette
☐

How much did you pay for the briquettes that you use (d)? ……(per briquette)
Suppose Konpay recalculated the cost to make it and this is how it will cost:

- **3briquettes for 6 Gds**, will you buy it (in your current economic situation)? Yes:__: No:__:
- **(If no to the previous question)** If the briquettes are sold for **3briquettes for 5 Gds**, will you buy it (in your current economic situation)? Yes:__: No:__:
- **(If yes to the first question)** If the briquettes are sold for **3briquettes for 9 Gds**, will you buy it (in your current economic situation)? Yes:__: No:__:

9. Clean cook stove and briquette association

Will you consider using both clean cook stove and briquette in association? Yes:__: No:__:
Why? ……....
……
……

Have you used this combination before? Yes:__: No:__:
How do you rate the combination of the clean stove and the briquettes compare to other systems? (on a 1 to 10 scale ……..

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SKILLS

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Kentucky Farm Business Management Program (KFBM) — May – August 2013
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