University of Geneva

Geneva School of Economics and Management

Master of Science in Economics

Master Thesis

Household Demand for Rural Waste Management Services
Evidence from Burkina Faso

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May 29, 2019

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Abstract

In this master thesis I study the reasons why municipal solid waste (MSW) management services in medium and small cities of Burkina Faso are faced with low household demand. I estimate the demand for these services in Nobéré, a rural city of the Center-South region of Burkina Faso with survey data and find that this demand is price elastic. A reduction of the price for these services would therefore have a large impact on demand. Moreover, awareness of health-related effects of waste mismanagement has a positive yet limited effect on demand. This indicates that awareness-raising activities are not likely to completely internalize the externality on MSW management markets. I then provide predictions for subscriptions to the services in the upcoming waste management project given expected levels of prices, awareness of health-related effects of waste mismanagement, and other household characteristics.

Contents

1 Introduction

In high-income countries, municipal solid waste (MSW) management is an environmental service provided by public sectors. It is often subsidized or entirely paid for by means of mandatory taxation. As a result, rates of collected waste are almost flawless: a recent report by Kaza et al. (2018) shows that 100% and 98% of waste is collected in these countries for urban and rural areas, respectively. In Sub-Saharan Africa, however, rates of waste collection fall to 43% in cities and to 9% for rural areas as a result of municipalities lacking enforcement and financial capacities, at least partly due to the impossibility to raise taxes.

In this context, external support is often needed to build MSW management systems. This is what Centre Écologique Albert Schweitzer (CEAS), a Swiss NGO specialized in poverty reduction and environmental action, undertakes. CEAS currently works on several waste management projects in medium- and small-sized cities of Burkina Faso and Senegal along with other partners.

The usual process of building waste management systems in these projects involves supporting a local association for collection, sorting, recycling and landfilling of MSW. Households who want to have their waste collected and treated are asked to pay a subscription, while infrastructure is built thanks to foreign aid and different degrees of participation from municipal funds. The association fixes the price of collection in accordance with local public institutions and NGO representatives. However, subscription is not mandatory and therefore take-up rates from households are very low: 10.8% on average over the 6 cities where collection has already started in Burkina Faso (Nebie et al., 2018).

Part of the problem is that MSW management, a public-sector policy in high-income countries, becomes a user-paid, private-service market that contains a significant positive externality – environmental quality along with its health-related consequences.[1] This externality is of the consumer-to-consumer type, according to the typology of Perman et al. (2003): all the households of a city would be better-off if other residents subscribed to MSW management services. The result is a market with an equilibrium below the social optimal level of MSW management.

There are generally many options for external intervention in the market in order to internalize the externality and therefore foster demand. Governments can usually design policies based on command and control (CAC) that see to the setting up of a legislative framework with fines and penalties to sanction illegal actions. Other policies include economic incentives such as taxes and subsidies (Nahman and Godfrey, 2010). Alternatively, awareness-raising programs and information campaigns can be used to stimulate demand (Perman et al. 2003). Yet, in the context of small- and medium-sized cities of Sub-Saharan Africa, and particularly in Burkina Faso, municipal budgets are too small to implement CAC or economic instrument policies (Doan, 1998; Parrot et al.,

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[1]There is a substantial literature on the health effects of mismanaged waste. For a general review, see Rushton (2003). For literature specializing on middle- and low-income countries, consult e.g. Cointreau (2006), Al-Delaimy et al. (2014) or Ziraba et al. (2016).

2009). Municipalities and their partners thus have to rely on awareness-raising programs to stimulate demand. Moreover, if the demand for MSW management services is price-elastic, large benefits to the residents of a city could be achieved by keeping the price of these services at a low level. This could be done in two ways. The first possibility is to simulate competition before the implementation of the project through an auction system for the selection of the firm collecting MSW and operating the sorting center and the landfill. The second possibility is to allow several firms to operate in MSW management during and after the project. In addition to these two options, the municipality and the NGOs implementing the project usually have a say in the determination of the price for these services.

The objective of this master thesis is twofold. The first objective is to determine the factors that influence demand for MSW management services and assess their individual impact on the level of demand for these services. The second objective is to predict reachable shares of subscribers to these services in Nobéré and to simulate the impacts that different policies could have, so that the municipality, project officers, funders and other partners have a sense of what outcomes to expect on the upcoming project.

Therefore, in this paper I assess the demand for MSW services in the rural city of Nobéré, located in the Zoundwéogo province, in the Center-South region of Burkina Faso. Since the MSW management project in Nobéré had not yet began at the time of surveying, I was not able to use revealed preferences techniques such as price randomization. Instead, I relied on stated preferences of the residents of the city. I estimate the price and income elasticities as well as marginal effects of other determinants of demand with a latent variable model. I find that demand for MSW management is price-elastic, and that awareness of health-related effects of mismanaged waste, proxied by a constructed index, has a positive yet limited effect on demand. This allows me to predict different shares of subscribers to the MSW services according to price and awareness levels in the population.

The rest of the thesis is structured as follows. A more detailed account of the city of Nobéré and the project about to be implemented is given in Section 2. Section 3 explains how data was collected in Nobéré. I present the empirical strategy in section 4. Next, results of the estimation and predictions of the success of the project are presented in Section 5. Section 6 concludes this master thesis with a discussion on the implications of the results.

2 Context

2.1 Nobéré

Nobéré is a municipality located in the Zoundwéogo province of the Center-South region of Burkina Faso. It lies on the road connecting Ouagadougou to the south border of Burkina Faso with Ghana (see figure 1). According to the last national census, the population of the municipality, which encompasses many villages, was of 32'814 inhabitants in 2006 (Bonkoungou and Moussa, 2009). In the absence of reliable and

Figure 1: Map of Burkina Faso

official sources, unofficial predictions used by NGOs for 2018 currently approximate to 60'000 the inhabitants of the municipality. However, the different villages on the territory of Nobéré are very sparse: the same approximations yield a predicted population density of 115 habitants per square kilometer.

The local economy is principally based on subsistence farming: 90,2% of the active population were working in agricultural activities for the whole region in 2006, still according to Bonkoungou and Moussa (2009). Local NGOs explain that economic activities revolve mostly around cereal production for self-consumption, with surpluses being sold on local markets. Vegetable production is also widespread around the several dams of the region and is mostly transported to be sold in Ouagadougou.

Beside agriculture, a small percentage of the population undertakes different economic activities, in which most of them are self-employed. These businesses are mainly located close to the national road connecting Ouagadougou to Ghana. The greatest density of these businesses for the Nobéré municipality can probably be seen in the city of the Nobéré, located at the center of the municipality of the same name. However, without reliable sources, it is difficult to assess that with certainty.

2.2 The WASH project

The municipality of Nobéré, along with CEAS and its main partner, a NGO named Morija, are implementing a water, sanitation and hygiene (WASH) program on the municipality's territory. The three components of the program are access to clean water, sanitation through the construction of latrines, and MSW management. CEAS is only

involved in the two latter parts of the program given its experience with other Burkinabe cities. Due to the issue of low subscription rates for MSW management services in the other cities, this study only looks at the MSW part of the program. Moreover, while these three topics are assembled into the same program, the implementation differs a lot across subjects. These activities are not profoundly related at least in their implementation. In fact, they are only bound by common financial partners and funding. They deserve to be studied separately if need be.

The MSW management part of the program is unfortunately not going to encompass the entire territory of the municipality of Nobéré, at least during the first years of the project. It focuses on the five neighborhoods of the city of Nobéré (Benego, Watinoma, Quartier Nobéré, Balonghin and Samanadin) in addition to the city's closest village (Doncin). Residents in the area of implementation of the project showed concerns about the situation of MSW. A survey from Morija interviewed 196 households in October 2016 and resulted in 80% of the household assessing the city as being too dirty.[2] The inquiry also identified the habits of MSW management and showed that household treat MSW individually, most often by burning or dropping them in uncontrolled and unauthorized open dumps. The municipality had played no part in it until the planification of the project and the only actions undertaken were those of informal waste recyclers who collect recyclable waste such as metal or glass to be used or sold. Furthermore, the inquiry showed the existence of 19 unauthorized dumps in the area. Because of winds and rains, waste from unauthorized dumps spread to a least 6 open fields and created what are called "plages de déchets" (*waste beaches*) in French. These are mostly composed of plastic bags.

The project sees to the implementation of a number of activities to fight against unmanaged MSW. First, the municipality and its partners must define a MSW collection and treatment plan that is financially and technically viable for them. A determining step for the implementation of this plan is hiring a municipal technical officer for MSW management. His role is to act on behalf of the municipality and to monitor the different agents involved in this matter. Then comes the construction of suitable infrastructure: a MSW sorting center and a landfill. A call for proposals must be held to select the best organization able to exploit this infrastructure and undertake door-to-door MSW collection. The training of the staff of this organization for collection, sorting, landfilling and recycling of MSW is also planned. Lastly, the implementation of awareness-raising activities and information campaigns about MSW will be undertaken simultaneously to other activities.

A part of the overall activities that is not going to be studied here is public markets that this organization might earn the right to exploit, such as the implementation and regular clearing of MSW dumpsters for public buildings.[3] More generally, the removal and treatment of MSW generated by any other entity than household members at home is not part of the scope of this study. The reasoning behind that is that we aim to determine household demand for MSW management and its determinants. Any other

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[2] Documents such as project reports stating these figures are available upon request.

[3] These buildings might include the police station, the city hall and schools, among others.

activity enters the supply side of this market, and leaves household demand relatively unaffected.[4] Moreover, we cannot exclude the possibility that these organizations are given only the market of household MSW management. Therefore, we only consider the market of collection and treatment of MSW produced by households.

By the time interviews for this study were held in Nobéré, from February 18th to March 4th, few of the above activities had started. The municipal technical agent had just been hired, the location of the landfill had been selected, and studies to determine its environmental impact on groundwater tables had begun. Donkey carts for waste collection and waste baskets for households were manufactured, but the start of MSW collection and treatment is not planned to begin before later in the summer of 2019. Only awareness-raising activities took place the week prior to the start of interviews, mostly to discuss the features of the upcoming project and to inform residents that a survey was about to take place.

3 Data

3.1 Revealed vs stated preferences

The central goal of this study being to estimate the demand for the upcoming MSW management services, the main variable to obtain from households is willingness-to-pay (WTP) for these services. There are two ways WTP can be retrieved: using stated preferences techniques or with revealed preferences techniques. The former retrieve WTP through surveying the individuals of interest. They are widely used in contingent valuations, choice experiments or even evaluations of demands for market goods (even though these 3 methods require different types of surveys).[5] On the other hand, demands are estimated with revealed preferences techniques through direct observations of the choices of consumers. It can be done by observing price variations or by modelling price randomization, e.g. with auctions designs.

Revealed preferences techniques are usually preferred because they observe the behavior of individuals. Stated preferences techniques have been criticized for inducing results that may comprise a hypothetical bias, due to a number of factors such as yeah-saying, interviewers effects, warm-glow effects, and questions asked being hypothetical (Arrow et al., 1993; Carlsson and Martinsson, 2001). However, in a review of 83 studies comprising 616 comparisons between WTP measured with contingent valuation methods and WTP retrieved with revealed preferences, Carson et al. (1996) show that the

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[4]The likelihood of residents bringing their waste to their workplace for adequate treatment seems too small to have an effect on demand. In addition to that, businesses are very unlikely to face smaller prices than households (it was generally the same or a higher price in the other cities where CEAS implements this project), which is the only case in which behaviors might deviate. Lastly, public officers represent less than 9% of the sample. Multiplying this with the probability of some of them bringing their waste to their workplace leaves an effect on household demand seem small enough to be dismissed.

[5]For a review of the contingent valuation technique, see Mitchell and Carson (2013). Explanations and reviews of choice experiments are found in Hanley et al. (1998) and Adamowicz et al. (1998). For WTP of market goods retrieved with stated preferences, two examples are De Pelsmacker et al. (2005) and Loureiro and Hine (2002).

average of ratios of contingent valuation results to revealed preferences results are close to but statistically lower than 1. Furthermore, if there is still one, List and Gallet (2001) show that concerns of hypothetical bias in a study are much reduced when the good in question is private.

Unfortunately, revealed preferences techniques to find household WTP for MSW management were not usable in this study: the project had not yet started in Nobéré, and price randomization on the MSW management services in the other cities where CEAS operates was not feasible. Thus, we rely on stated preferences. However, the risk of hypothetical bias is minimized. We asked questions about a problem that is common to all and related to environmental quality, which could raise concerns of warm glow effect and hypothetical questions being answered by hypothetical responses since these responses were not constraining. Yet, people were asked about how much they would pay for a service that was about to be available to them, and not how much they value an environmental good. In this sense, we took care of expressing MSW management as a private service and not as a policy option to improve overall environmental quality in the area. One might retain that respondents took these questions as more constraining than they were in the fact that some of them (although very few) were reluctant to give a WTP, even after being explained that this was not going to be the price they were going to pay. They answered that the organization should first propose a price and that they were going to evaluate whether they would accept it. Furthermore, to ensure that there is no major hypothetical bias in our results, I replicate the same test that Cropper et al. (2004) provide for the internal validity of their results. They verify that demand is negatively related to price, and positively to income. As can be seen below, the results indicate that our estimation of the demand is not overly biased.

3.2 The survey

We captured WTP and other variables from households in Nobéré through a survey instrument.[6] The survey was administered by hired interviewers through an open source application, named ODK collect, on their mobile phone. They asked questions to the respondents and marked themselves the answers of the households on the mobile phone application.

The definition of the survey targets was the first challenge. Since our goal was to understand the choice to subscribe to MSW management, the natural unit of decision would be the household. However, in Nobéré, as in other rural parts of Burkina Faso, large families that live in a single courtyard are not likely to buy many subscriptions. So, we decided that the unit of investigation would be the courtyard as a whole (or compound), even if we knew that this unit would cover many members of the same family for some, down to possibly a single person in some rare cases. But the baseline is that we wanted to simulate the way the decision to subscribe to MSW management services was going to be made. Therefore in this study, household is used as in compound, meaning the members of a family sharing a courtyard and using a single waste bin if

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[6]A print copy of this survey is found in the appendices.

any.

The second challenge was to define how and when to interview these households. After several discussions with representatives of project partners who had experience in implementing surveys, we decided to interview the members of a household exclusively in their homes. This decision has three benefits. First, we feared that people interviewed at their workplace or in public spaces would be reluctant to give us sensitive information such as WTP and income levels. Second, this would allow interviewers to facilitate the tracking of household members, to avoid interviewing the same household twice and neglecting to interview one of them. Third, as we wanted to know the shared income level of the household, this would make the interviewers's task easier since they would be more likely to question all the members of the household that earn an income.

The third challenge was to define the scope of the interviews. Since the last census is more than ten years old (2006), and in the absence of reliable projections, it was difficult to know how many households were living in the zone of implementation of the project. Our partners talked of 500 to 600 households. For statistical reasons, we decided to try to interview all of them.

After a brief explanation of the project to be implemented in the upcoming months and some identification questions, we asked respondents about their waste production and whether they produce their own compost or not. Then came a question to measure how aware the respondents were of the effects of mismanaged waste. More precisely, this question was about negative health effect. I borrowed this technique from Longo et al. (2008), who assess WTP for clean energy in a city of England. They ask respondents if some electricity sources are environmental-friendly and verify the answers with a study from Komisyonu (2003). I used a similar technique to construct our index. We asked respondents if they knew any negative effect of mismanaged waste, clarifying that we had a list of 8 of the main ones. This list was created from a literature review and is shown in Table 1.[7] Interviewers only had to check which one of these hazards were mentioned by the respondents. We then summed the number of mentioned hazards to construct our index that we will be mentioned below as *waste score*.

Next, we asked respondents how much they were willing to pay per month for a weekly collection and treatment of their MSW. It was an open-ended question, so that we could retrieve the reservation price of all of the respondents. We then asked questions to assess the income level for the grouped household. Our questions were divided in five categories: income from agricultural activities (including livestock farming), income from businesses, wages of employees in the private sector, wages of public officers, and other sources of income. Since we asked questions for the household as a whole, respondents sometimes had to reply to the questions related to many of these categories. To reduce the risk of measurement error due to respondents not knowing the income level of other members of the household, interviewers proposed to take appointments with household members, so that they could talk to most of them.[8] Income questions for the agriculture

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[7]The studies from which these hazards are taken are the same as cited before: Rushton (2003); Cointreau (2006); Al-Delaimy et al. (2014); Ziraba et al. (2016).

[8]However, the head of the household often has an idea of the income of other members.

part were mostly based on other surveys used in the country to evaluate incomes in the Burkinabe agricultural sector.

Table 1: Health hazards from waste used to construct *waste score*

Number	List of health hazards	Times mentioned	Percentage of mentions
1	Inhalation of fumes from burned waste may cause respiratory problems	89	15.8
2	Pollution of groundwater bodies due to the infiltration of rainwater contaminated with waste	150	24.0
3	Proliferation of rodents in the vicinity of waste which may transmit diseases to residents	125	20.9
4	Mosquitoes grow in the water contained in the waste and may transmit diseases to residents	147	23.7
5	Livestock feed on waste, which may kill them or cause problems when people eat meat	168	26.2
6	Children may ingest hazardous material when playing near waste piles	87	15.5
7	Waste left abandoned may create a risk of injury to the population	101	17.6
8	Waste left abandoned may create a risk of wildfire	73	13.3

3.3 Data collection

Throughout the preparation of the interviews, we conducted three survey tests to ensure that the survey would allow us to retrieve the exact information we needed. All took place in villages in the Nobéré municipality, but outside of the zone of implementation of the project.[9] The respondents of the survey tests were living in zones somewhat

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[9]The locations of the three tests are Pissy, Nobili and Bion, respectively.

more rural than the targets of the study, but this rather played to our advantage since the most difficult questions to express were the ones about agricultural income. The timespan from the first test to the start of interviews was of a bit less than three weeks. Two training sessions for the 7 interviewers were organized within this time period. While we had planned only two tests and one training, we determined that we had to extend our preparation period and increase the numbers of tests and trainings until our interviewers were ready for data collection on the target population. To make sure that the interviews were taking place correctly, my colleagues from CEAS and I accompanied the interviewers on their first 'true' interview and then kept track of answers that were stored on an online drive. We contacted and verified the work of interviewers every day. The interviewers were fully cooperative and did not object to explain in greater details some of the answers if we had some reflections about them.

During the interviews and even after that they were finished, we looked for complementary data which would allow us to create our variables. Most of these complementary data are related to the calculation of agricultural income and include, e.g. the price of the different crops that households had produced. As we estimated the income of farmers by evaluating the value of their production and subtracting their costs (to have an idea of total consumption, rather than surplus after consumption of their own production), we needed to know what the value of their production was. Therefore, we needed to know the prices of the crops they had grown. This part was perhaps a bit overlooked at first and soon proved to be among the most demanding challenges. We looked for weeks for all the data we could find using different sources such as different ministries, the statistical office, and even sometimes private firms and their local branches in Nobéré (e.g. for the price of herbicides and pesticides). Because of missing complementary data, we had to drop some observations.

3.4 The data

The interviewers conducted 474 interviews in 15 days. From all these filled surveys, only 369 could be kept. This is due to a series of factors. First, some surveys were not answered correctly (e.g. when people did not want to reveal their income or did not want to answer the WTP question). Second, as explained above, we sometimes lacked complementary data to recreate our variables. Another issue arose when farmers had not yet weighted their production. This happened mostly for cotton. As we were trying to estimate the income of the preceding year, some cotton producers did not know how much their production was worth.[10] In that case, I averaged the productivity of cotton producers given how many kilograms of seeds they had planted and how many kilograms of cotton they had produced. Among 39 cotton producers, average productivity was of 24.08 kilogram produced per planted kilogram. I then multiplied the amount planted by producers who still had not weighted their production by this average productivity.

The same issue came up with people living in *celibatoriums*. This term designates rented apartments or rooms, usually by employees or public officers who come to Nobéré

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[10]There were 11 cotton producers in this situation.

during the week and commute home for the weekend. Since I had not understood that these people commuted with their family, I withdrew the question about the number of children for their surveys.[11] Because this data was missing, I replaced their number of children by the sample means for this variable. I created a dummy for *celibatoriums* and another for cotton producers who had not weighted their production yet. I perform below robustness checks for the trimmed samples.

Table 2: Summary statistics

	mean	sd	min	max
Montly WTP for MSW services (CFA)	344.59	349.56	0	2000
Household income (thousands CFA)	1571.81	1766.30	12	19439
Waste score	2.33	1.80	0	8
Compost	0.48	0.50	0	1
Waste Production (buckets/week)	3.53	3.08	0	25
Number of people	8.99	5.99	1	50
Number of children	3.72	2.76	0	16
Celibatoriums	0.06	0.23	0	1
Head of household	0.68	0.47	0	1
Agricultural activities	0.90	0.30	0	1
Livestock farming	0.85	0.36	0	1
Own businesses	0.54	0.50	0	1
Private sector employees	0.03	0.17	0	1
public officers	0.09	0.28	0	1
Observations	369			

The summary statistics of the final dataset are shown in Table 2. As can be seen, most of the households undertake economic activities in agriculture and approximatively half of them own at least one business. Employees are somewhat rare. However, income might be a problematic variable. Its mean level approximatively corresponds to 7.37 USD per day. Dividing by the mean number of people per household yields 0.82

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[11]In the surveys, questions appear conditional on answers from previous questions.

USD/capita per day. This number seems quite low and we might deduce that there is some measurement error in the income variable, especially given how difficult it is to collect. Unfortunately, we did not collect information on consumption levels that could have been used to instrument for income. Yet, the estimation results presented below show that the coefficient associated to the income variable is of the expected sign and statistically significant. Given that measurement errors tend to drive coefficients towards zero, we might argue that if a bias exists, it appears not to have completely invalidating effects for this study.

4   Estimation Strategy

There are many methods to estimate demands depending on a number of factors such as the type of the good, the origin and type of the data and the assumptions related to the model used. According to Deaton and Muellbauer (1980), among all the methods, the best technique for the estimation of a single good is the linear expenditure model (LEM) developed by Stone (1954). However, this model possesses a number of features that reduce its appeal such as the fact that it does not account for individual characteristics of the consumer, or that income elasticities tend to be close to twice the own-price elasticity of the good. We also have to account for the specific type of demand that we are trying to estimate and the specific data that comes with it: our good cannot be accumulated so that demanded quantity is either 1 or 0. In addition to that, the data comes from stated preferences and therefore we do not observe expenditure on the good. Using the LEM in our case would come down to two choices: either we assume a market price, but then all consumers have the same expenditure since there cannot be accumulation of the good and therefore the dependent variable is 0 or the market price, or we interact demanded quantity with household WTP as the dependent variable. In this case, we have what is called a value function in the contingent valuation literature, that is regressing WTP on the determinants of demand. This would give WTP elasticities to price instead of demand elasticities. However, we would not really know what they account for, since expenditure would only be increasing in price until households refuse to subscribe and there would not be any effect from reduced demanded quantity as price increases. Therefore, this model is not of great use with our data.

An alternative that is commonly used for the estimation of a single good is to use a representative-consumer model, such that we model the demand of a single consumer that would be representative of the demand for all the consumers in the market. The benefit of this procedure is that we can use a demand form that is directly derived from consumer theory (Varian, 2004). One of the most used technique of this type is to model demands as if they came from quasilinear utility functions. Yet, the restriction is that these demands have to satisfy exact linear aggregation: we must be able to write average demands that do not vary with the distribution of income but only with its average level (Deaton and Muellbauer, 1980). For that to hold, each consumer must have the same marginal propensity to spend, so that any redistribution of income between consumers does not alter the average demand. This can only happen if average demand is linear

in average income, a property that was defined by Gorman (1961). This would lead all consumers to have the same Engel curves. Demands fulfilling these properties have indirect utilities said to be taking the Gorman form (Varian, 2004).

However, the problem is that this restriction does not suit our case well: it is unlikely that households have the same marginal propensity to spend (or the same Engel curve) because this would take away probable heterogeneity in preferences. Some of the household in Nobéré probably do not wish to spend to have their waste collected and treated independently of their income level.

The literature of discrete choice has developed some models to account for this heterogeneity in preferences, starting with McFadden et al. (1973) and then improved by, e.g. Berry et al. (1995). This models use difference in products and in consumer characteristics to model preference heterogeneity. Yet we cannot use their techniques directly, as they use the choice of consumers over a range of products in the same market.

The demand for our good is rather particular: it is a good which has no substitutes and which is hypothetical since the market is not already in place. In addition to that, it cannot be purchased in multiple quantities by the households. The only study of a hypothetical demand for a good with no other substitute in rural areas of a low-income country is (to my knowledge) Cropper et al. (2004). They define the demand for a vaccine against malaria in rural parts of Ethiopia if such vaccine existed. The main difference is that in their case, households may purchase several units of vaccines for their members. This leads them to use a truncated Poisson model. Since in our case subscriptions to MSW management services are unique per household, we are restricted to binary response models.

Therefore, I use a latent variable model, where consumer heterogeneity is accounted for. In order to use this model, my dependent variable must be a dummy. This dummy takes the value of 1 if the household decides to subscribe to MSW management services for a given price and 0 otherwise. By knowing household WTP and assuming that it corresponds to its reservation price for the services, I create for each household several dependent variables equal to 1 if the price variable is equal or below its WTP and 0 otherwise.

Then, using an approach similar to Van de Ven and Van Praag (1981), I assume that the household subscribes to MSW management if it has an expected utility gain from doing so. I define expected utility as varying in two dimensions. First across households, where $i = 1, \ldots, N$ is the household number. All variables but price vary in this dimension. Then, the data varies in price levels, since every data line has an associated price. Therefore, the data can be seen as panel data, with the time variation being only expressed with price. The variable of price here is similar to a time trend, since it is price levels from 0 to 2000 CFA francs, with increments of 25 CFA francs each time and where $j = 1, \ldots, M$ is the price number. Expected utility gain can therefore be defined as:

$$v_{ij}^* = \beta_1 p_{ij} + \beta_2 m_i + \gamma_k \mathbf{X}_i + \varepsilon_{ij}, \tag{1}$$

where p_{ij} is the proposed price, m_i is annual household income, $\mathbf{X}_i$ is a vector of

household characteristics including a constant term, waste score, waste production, a dummy for compost production, the number of people in the household, the number of children in the household and a dummy for households living in a *celibatorium*. Lastly, ε_{ij} is the stochastic error term. As the expected utility gain cannot be observed, what is observed is the choice of the household, which follows the following index function:

$$
v_{ij} = \begin{cases} 1 & \text{if } v_{ij}^* > 0 \\ 0 & \text{if } v_{ij}^* \le 0 \end{cases} \tag{2}
$$

This indicates that the household subscribe to MSW management services if it has a positive expected utility gain from doing so ($v_{ij} = 1$). If the household is indifferent or expects a loss in utility, it will not accept to subscribe ($v_{ij} = 0$). Given this rule and following Cameron and Trivedi (2005), the probability of accepting to subscribe is defined as:

$$
\begin{aligned}
Pr(v_{ij} = 1) &= Pr(v_{ij}^* > 0) \\
&= Pr(\beta_1 p_{ij} + \beta_2 m_i + \gamma_k \mathbf{X}_i + \varepsilon_{ij} > 0) \\
&= Pr(-\varepsilon_{ij} < \beta_1 p_{ij} + \beta_2 m_i + \gamma_k \mathbf{X}_i) \\
&= F(\beta_1 p_{ij} + \beta_2 m_i + \gamma_k \mathbf{X}_i)
\end{aligned} \tag{3}
$$

where $F(\cdot)$ is the cumulative distribution function of the distribution of $-\varepsilon_{ij}$ and must be defined. I first assume $-\varepsilon_{ij}$ to follow a normal distribution centered in 0. In that case ε_{ij} must be divided by its variance, say σ, to reach a standard normal distribution. The expression for expected utility gain for each choice of the households $\beta_1 p_{ij} + \beta_2 m_i + \gamma_k \mathbf{X}_i$ can be grouped in a single expression $Z_{ij}\Omega$, where Z_{ij} is a $(1 \times K)$ vector of independent variables and Ω is a $(K \times 1)$ vector of parameters. Using this notation yields:

$$
\begin{aligned}
F\left(\frac{1}{\sigma}Z_{ij}\Omega\right) &= \Phi\left(\frac{1}{\sigma}Z_{ij}\Omega\right) \\
&= \int_{-\infty}^{\frac{1}{\sigma}Z_{ij}\Omega} \phi(z)dz
\end{aligned} \tag{4}
$$

Where Φ is the cumulative distribution function of the standard normal distribution, and ϕ is its probability distribution function. This comes down to a probit model. To see which of the two models between probit and logit the data fits best, I then make the assumption that $-\varepsilon_{ij}$ follow a logistic distribution with mean 0 and variance $\frac{\rho\pi^2}{3}$. Dividing by the variance to reach the standard logistic distribution, this case yields (Cameron and Trivedi, 2005):

$$
\begin{aligned}
F\left(\frac{1}{\rho}Z_{ij}\Omega\right) &= \Lambda\left(\frac{1}{\rho}Z_{ij}\Omega\right) \\
&= \frac{\frac{1}{\rho}e^{Z_{ij}\Omega}}{1 + e^{\frac{1}{\rho}Z_{ij}\Omega}}
\end{aligned} \tag{5}
$$

13

where Λ is the cumulative distribution function of the standard logistic distribution.

5 Results

5.1 Estimation of the demand for waste management services

The results from the regressions of the two models are presented in Table 3. In the two models, all coefficients have expected signs. Household income, awareness of health effects of waste, waste production and the number of children of the household all have a positive effect on the probability to subscribe to MSW management services. On the other hand, prices, compost production, the number of people in the household and the dummy for households living in celibatoriums have a negative effect. The number of people in the household is probably negatively related to subscription because of a wealth effect: more numerous households share their joint income between more members. Cropper et al. (2004) find a similar result.

However, not many of these variables are significant. This can be caused by the low number of observations in the sample: there are 29'889 observations, but only 369 households (with 81 prices proposed to them). To account for correlations among observations of the same household, standard errors are clustered at the household level. This rightfully reduces the significance levels of the estimation. The significant variables, although some at low levels, are price, income, waste score and the number of people in the household.

Comparing the two models, one can see that the logit model appears to fit the data better. Its log pseudolikelihood (not reported in the table) is also lower, inducing a higher pseudo R-squared. Therefore, this model will be used for further inference.

The interpretation of the effect of a change in a variable on the dependent variable can be conducted in two ways. Some of these effects are best understood using elasticities, that is the percentage change in the dependent variable caused by a percentage change in one of the independent variables. For other variables, the effect of a marginal change (i.e. an increase of one unit) is easier to interpret. Elasticities in a logit model are estimated with regard to a specific variable, say p_{ij} for price, in the following way:[12]

$$(\theta/\rho)\, p_{ij} \left[\frac{\Lambda'\left(\frac{1}{\rho} Z_{ij}\Omega\right)}{\Lambda\left(\frac{1}{\rho} Z_{ij}\Omega\right)} \right]$$

where Λ' is the probability distribution function of the logistic distribution and Λ its cumulative distribution function. However, as can be seen from the formula above, values of the variables in the Z_{ij} vector need to be included to compute elasticities. Usually, sample means of the regressors are used to retrieve the elasticities of the dependent variable to the regressors. This is what is done in the first column of Table 4. In the

---

[12] All formulas to compute elasticities, average elasticities, marginal effects and average marginal effects are taken from Cameron and Trivedi (2005).

Table 3: Demand estimation: probit and logit models

Dependent variable:	Subscription decision	
	Probit	Logit
Price (CFA)	-0.00211***	-0.00422***
	(0.000209)	(0.000418)
Household income (thousands CFA)	0.000102**	0.000173**
	(0.0000434)	(0.0000780)
Waste score	0.0456*	0.0949**
	(0.0266)	(0.0437)
Compost	-0.168	-0.331
	(0.126)	(0.206)
Waste Production (buckets/week)	0.0188	0.0207
	(0.0220)	(0.0344)
Number of people	-0.0324**	-0.0513**
	(0.0136)	(0.0240)
Number of children	0.0401	0.0675
	(0.0301)	(0.0508)
Celibatoriums	-0.227	-0.319
	(0.176)	(0.308)
Constant	0.494***	1.077***
	(0.134)	(0.230)
Observations	29889	29889
Number of household clusters	369	369
Pseudo R^2	0.381	0.398

Robust standard errors adjusted for clustering at the household level are reported in parantheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

second column, average elasticities over the whole sample are computed. The formula to retrieve the average of the elasticities for each variable is the following, e.g. for p_{ij}:

$$\frac{1}{NM} \sum_{i=1}^{N} \sum_{j=1}^{M} (\theta/\rho) \, p_{ij} \left[\frac{\Lambda' \left(\frac{1}{\rho} Z_{ij} \Omega \right)}{\Lambda \left(\frac{1}{\rho} Z_{ij} \Omega \right)} \right]$$

As can be seen, the elasticites are computed for a variable and for each of the $N \times M$ observations in the sample, 29'889 in our case, before being averaged. The first column

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of Table 4 is therefore the elasticity at the mean, while the second column displays the mean of the elasticities. The coefficients show our main result: MSW management services are price elastic overall, both at the mean (when the price is equal to 1000 CFA francs) and in average. The elasticity is close to -4 in both cases.[13] This already indicates the potential impact of having a policy instrument which lowers prices.

There is, to my knowledge, no other study of demand for MSW management services in low- and middle-income countries that estimates price elasticites. However, in a rather similar area, take-up of sanitation services, Houde et al. (2016) find price elasticities of -3.8 for mechanized desludging in Dakar, Senegal. Even though it is a different service in a different context, this hints at our results being of appropriate magnitude.

Table 4: Elasticities of the probability of subscription

	at means	average
Price (CFA)	-4.016***	-3.963***
	(0.454)	(0.419)
Household income (thousands CFA)	0.259**	0.215**
	(0.116)	(0.0924)
Observations	29889	29889

Robust standard errors adjusted for clustering at the household level are reported in paranetheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The second elasticity of interest is the income elasticity. As mentioned above, the co-efficient on income should be interpreted with caution because of the risk of measurement error. Yet, both the sign and the magnitude come out as expected: MSW management services are likely to be a normal good, and more precisely a necessity, since their income elasticity is between 0 and 1. Demand is therefore not very sensitive to income changes, although households with higher incomes are more likely to subscribe.

To interpret the effects of the coefficient associated with the other variables, marginal effects must be computed. They are defined in a logit model as follow, e.g. for price:

$$(\theta/\rho) \left[\Lambda' \left(\frac{1}{\rho} Z_{ij} \Omega \right) \right]$$

where Λ' is once again the pdf of the logistic distribution. Here again, a value must be used for each variable and it is common to report estimates at the mean level of each variable. This is what the first column of Table 5 displays. The second column of the Table shows the average marginal effect. Here is how these are computed, once again taking price as an example:

---

[13]A good is inelastic in price when $0 > \varepsilon_p > -1$, where ε_p is own-price elasticity. When $\varepsilon_p = -1$, the good is said to be unit-elastic. Lastly, the good is elastic when $\varepsilon_p < -1$ (Varian, 2014).

$$(\theta/\rho) \left[\frac{1}{NM} \sum_{i=1}^{N} \sum_{j=1}^{M} \Lambda' \left(\frac{1}{\rho} Z_{ij}\Omega \right) \right].$$

Once again, what is computed here is the average of each marginal effect taken at the values of the 29'889 observations of our sample.

Table 5: Marginal effects on the probability of subscription

	(1)	(2)
	at means	average
Waste score	0.00442**	0.00866**
	(0.00200)	(0.00382)
Compost	-0.0154	-0.0302
	(0.00978)	(0.0184)
Waste Production (buckets/week)	0.000965	0.00189
	(0.00170)	(0.00318)
Number of people	-0.00239*	-0.00468**
	(0.00137)	(0.00225)
Number of children	0.00315	0.00616
	(0.00251)	(0.00464)
Celibatoriums	-0.0149	-0.0291
	(0.0156)	(0.0285)
Observations	29889	29889

Robust standard errors adjusted for clustering at the household level are reported in parantheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

As can be seen from Table 5, *waste score*, that is the level of awareness of a household about health-related hazards of untreated waste, has a positive effect on the probability of subscribing to MSW management services. This is the most relevant variable for policy and this result may be used to help design a better project, in addition to clarifying its objectives. This is attempted in the next section.

Table 6 displays the robustness checks mentioned above. Column 1 shows the results of the estimation on a subsample where households living in *celibatoriums* where extracted from the sample. The second column gives the results for the same procedure, only that it is the households for which cotton production was recreated that were taken away from the sample. In the third column, results from the estimation on a sample without these 2 groups are shown.

As can be easily seen, the results are solid to every variation of the sample, meaning that the recreation of certain variables did not bias the estimates. One may there-

Table 6: Robustness checks: estimation with reduced samples

Dependent variable:	Subscription decision		
	Without celib.	Without cotton	Without both
Price (CFA)	-0.00410***	-0.00424***	-0.00411***
	(0.000413)	(0.000442)	(0.000437)
Household income (thousands CFA)	0.000171**	0.000186**	0.000183**
	(0.0000772)	(0.0000840)	(0.0000829)
Waste score	0.0876**	0.0997**	0.0923**
	(0.0435)	(0.0449)	(0.0447)
Compost	-0.324	-0.318	-0.312
	(0.202)	(0.211)	(0.208)
Waste Production (buckets/week)	0.0234	0.0225	0.0254
	(0.0339)	(0.0352)	(0.0346)
Number of people	-0.0551**	-0.0423*	-0.0466*
	(0.0241)	(0.0245)	(0.0245)
Number of children	0.0731	0.0427	0.0492
	(0.0505)	(0.0518)	(0.0514)
Celibatoriums	–	-0.218	–
		(0.308)	
Constant	1.041***	1.015***	0.977***
	(0.230)	(0.238)	(0.238)
Observations	28188	28593	26892
Number of household clusters	348	353	332
Pseudo R^2	0.387	0.398	0.387

Robust standard errors adjusted for clustering at the household level are reported in parantheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

fore consider the results to be solid enough to help understand the demand for MSW management services in Nobéré.

5.2 Predictions

Using the estimated parameters from the logit model, the probability of a household to subscribe to MSW management services can be predicted. In order to do that, the level every household has of each variable is taken, and by selecting a price level the fitted index at these levels can be calculated. Computing the logistic function of this fitted

index then yields the probability of this household to subscribe to the services.

However, more interestingly, the predicted probability to subscribe at a given price and at the mean level of every other variable can be used. This yields the average probability of the whole population to subscribe.[14] As the mean level of every variable is used to calculate it, this probability also represents the proportion of households in the population which hypothetically decide to subscribe.
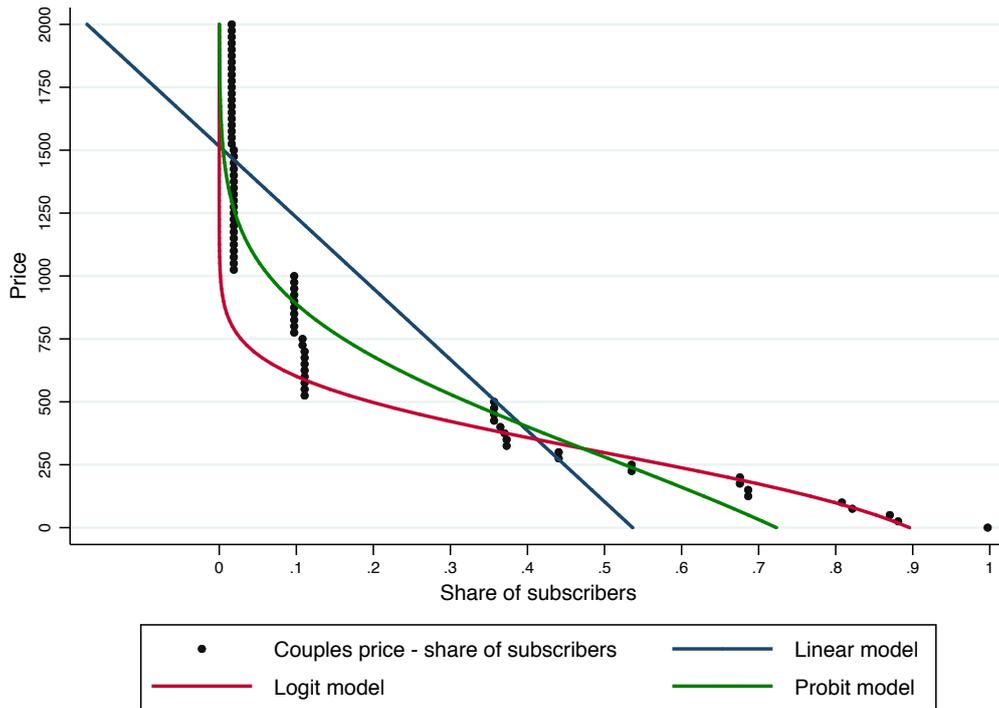

Figure 2: Demand for waste management services

The prediction of the household demand for MSW management services is displayed in Figure 2. Black dots in the figure represent the share of household subscribing to the services at a given price. These numbers were obtained by summing up all the households for which the WTP was above or equal to the given price. This figure illustrates why a linear model is not fit to estimate the demand of such a good. It yields predicted shares of subscribers that are negative and does not appear to suit the data. More importantly, the figure also shows how the logit model appears to suit the data better than the probit model.

However, the prediction of the share of subscribers is not very optimistic. After discussions between focus groups representing the population of Nobéré, the municipality and its partners were planning to implement a price for the MSW management services

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[14]Provided that our sample is representative of the overall population of Nobéré.

of 500 CFA francs. The logit model of demand predicts that at this price, only 19.66% of the households of Nobéré would subscribe. However, by simply summing up the households whose WTP is greater or equal to 500 CFA francs yields that 37.68% of households agree to subscribe. This number must however be put into perspective: for a 25 CFA francs increase, that is at the price of 525 CFA francs, the share of subscribers falls to 11.08% according to this method. Such a jump for so little a difference in price is highly doubtful. The non-continuity of this estimation is part of the reason why a continuous model must be used to predict outcomes. Yet, it could be argued that the predictions of the logit are somewhat conservative for prices higher than 500 compared to the probit model.

Another point of interest, especially for the choice of policies to be implemented, is the potential of boosting demand through awareness-raising activities. As displayed above, they have a statistically significant and positive effect on demand. However, their impact is still somewhat limited, although there is room for improvement of the mean awareness level as measured by our *waste score*. The mean level for this variable is of 2.31 over 8. At the price of 500 CFA francs, an improvement of 1 unit of the mean score for the whole population yields an increase of 2.71 percentage points in the share of subscribers. This represents 22.37% of subscribers with these levels in the variables. This result can be seen in Figure 3. The figure also illustrates the maximum bound for demand if all the households were fully aware of all the health effects of waste mismanagement.

Since the demand for the services is elastic, changes in price might yield better results. By decreasing the price to 400 CFA francs, the share of subscribers rises to 33.31%. The challenge is now to assess the marginal cost for the operating firm. Being able to estimate it correctly would help the municipality and its partners, among which CEAS, design measures to keep the price as low as possible and therefore stimulate demand to the highest possible level. Such measures coupled with effective awareness-raising activities would ensure that the highest demand is reached given the current possibilities in Nobéré.

6   Conclusion

The MSW management project is about to start in Nobéré. Given the mixed results in terms of shares of subscribers in the other cities where CEAS and its partners implement similar projects, a more formal assessment of the demand for such services was needed. This study aims to understand why the demand is low and what is to expect on the project in Nobéré.

The results found above are not very optimistic. They clearly indicate that the demand is low mostly because of the economic decisions households have to make to have their waste collected and treated: the demand is very elastic, meaning that household are quite responsive to price changes for these services. Furthermore, this study indicates that awareness-raising activities have a positive effect on demand. This effect is however limited and demand stimulation might yield larger effects if other means than awareness raising were available to the municipality in order to internalize the externality on this
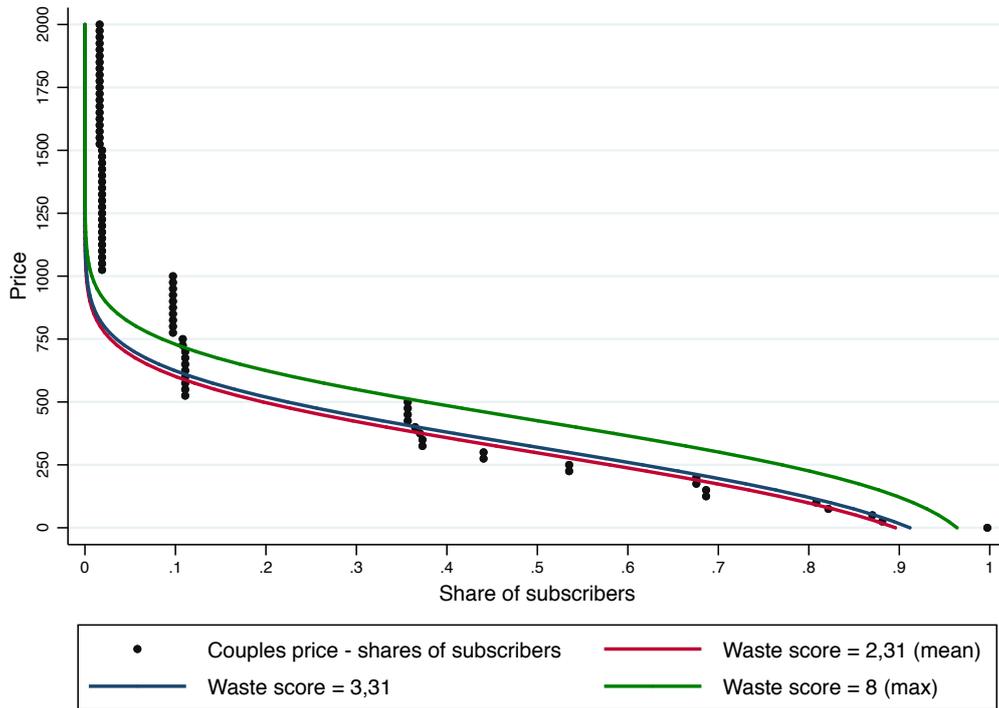
Figure 3: Demand for waste management services

market.

In the absence of other policies which require higher state capacity, the municipality as well as its partners, including CEAS, Morija and their donors, must be aware of the range of reachable levels in the share of subscribers to these services. As long as MSW management cannot be implemented as a public policy including significant subsidies as well as sanctions or other coercive measures, the share of households subscribing to these services is likely to stay below 50%, provided that subscription pays for the full range of these services (which include collection, sorting, recycling and landfilling of MSW).

Yet these results should be seen in light of what is being achieved in the region in similar contexts. As mentioned above, the percentage of MSW collected in rural Sub-Saharan Africa is of 9% Kaza et al. (2018). The project in Nobéré not only sees to collect MSW, but also aims at conducting full treatment of MSW. More than doubling this percentage and including other activities on top of that is already a greatly appreciable result.

7   Acknowledgements

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Appendices

The appendices include the survey that was used for data collection in Nobéré. Please find it on the next page.

Nobéré Study Survey

Presentation of the survey:
As the survey was administered through a mobile application, ODK collect, this print version was never used. In the application, questions appear in groups when needed and most of the time individually. Interviewers just have to swipe right to reach the next question. Some questions appear conditional on the answers of the previous questions. I tried to be as close as the application version with this print version.

Structure of the survey:

Section 1: Identity

Introduction

- Presentation of the interviewer and of the organizations:
Introduce yourself and explain that you came on behalf of the waste management project in Nobéré, which is undertaken by CEAS and Morija jointly.

- Presentation of the project:
Explain that the project sees to implement a waste management system in Nobéré. An organization will be in charge of installing a waste can for every compound and of clearing it from solid waste (plastics, textiles, …) once per week. The organization will put them into a landfill in order to clean the city. Families will be able to subscribe to this service against a monthly payment. This project will start in the upcoming months.

Presentation of the interviews:
This project also takes place in 7 other cities in Burkina Faso. As the subscription rates from households remain quite low (between 10% to 30%), we undertake a study to understand why these rates are so low. We will ask you questions on the price you would be willing to pay for the subscription to the waste management services, on your income and on your knowledge of health hazards from waste mismanagement. This study will allow Morija and CEAS to plan a project that will be more fit to the residents of Nobéré.

Data privacy:
Explain that all the data collected by this survey will strictly remain confidential and that only the people responsible of the study will have access to them. Everyone else, including Morija and CEAS staff will only have access to the results of the study.

People to be interviewed
Try to speak to the head of the household, and if possible, to all the other people in the household that this interview may concern. If the head of the household or the desired people are not available, ask the available people if they are allowed to answer on their behalf.

1) Interviewer
Who is the interviewer?

GUIGMA Tabitha

ILBOUDO Ibrahim

ILBOUDO Salam

KOURAOGO Souleymane

LANKOANDE Diakiro

ZONGO Abdoul Rasmané

BADOULOU Lamine

2) Last name
Insert the last name of the respondent
………………………………………………………………………………

3) First name
Insert the last name of the respondent
………………………………………………………………………………

4) Phone number
Insert the phone number of the respondent. Explain to them that this is ask only in order to identify the household and to make sure that we do not interview twice the same household. No further communication with them will be attempted.
………………………………………………………………………………

5) Neighborhood / sector of Nobéré

In which neighborhood or sector of Nobéré does this household live?

Quartier Nobéré

Watinoma

Benego

Samandin

Balonghin

Doncin

6) Consent

Do you accept to answer a survey to collect information in order to implement a better-suited waste management project in the city?

Yes   Go to **9)**

No

7) Refuses to participate

If the respondent refuses to answer the survey, ask him why.

…………………………………………………………………………… Go to **Section 5**

8) Head of the concession

Is the surveyed person the head of the concession?

Yes   Go to **12)**

No

9) Celibatorium 1

Do you live in a celibatorium?

Yes   Go to **11)**

No

10) Phone number of the head of the household

If the respondent is not the head of the household and does not live in a celibatorum, ask him the phone number of the head of the household. Explain to them that this is ask only in order to identify the household and to make sure that we do not interview twice the same household. No further communication with them will be attempted.

11) Celibatorium 2

In which celibatorium do you live?

…………………………………………………………………………… **Go to 13)**

12) Number of children in the household

Among these people, how many are children (less than 16 years old)?

……………………………………………………………………………

13) Number of people living in the household

How many people live in this household?

……………………………………………………………………………

Section 2 : Waste

14) Organic waste
Do you produce compost with your organic waste?

> Yes
>
> No

15) Production of solid waste
How much waste do you produce per week? Please answer in amounts of filled buckets.
Explain here that mean waste that could be collected during the project, such as:
- Plastics: plastic bags, bottles, shoe or slipper sole, locks of hair, wrapping
- Textiles: old clothes, fabric
- Non-compostable organic waste: bones, other food waste
- Compostable organic waste: only if the household does not produce compost

Health effects of waste mismanagement

Ask the household which the dangers on the population's health could be when waste are not treated. (Explain that we have found 8 dangers).
Select "yes" if the respondent mentions this problem on his own. Otherwise, select "no".

16) Inhalation of fumes from burned waste may cause respiratory problems and allergies

> Yes
>
> No

17) Pollution of groundwater bodies due to the infiltration of rainwater contaminated with waste

> Yes
>
> No

18) Proliferation of rodents in the vicinity of waste, which may transmit diseases to residents

> Yes
>
> No

19) Mosquitoes grow in the water contained in the waste and may transmit diseases to residents

> Yes
>
> No

20) Livestock feed on waste, which may kill them or cause problems when people eat meat

> Yes
>
> No

21) Children can ingest hazardous material when playing near waste piles.

> Yes
>
> No

22) Waste left abandoned may create a risk of injury to the population

> Yes
>
> No

23) Waste left abandoned may create a risk of wildfire

> Yes
>
> No

> **Autres:**
…………………………………………………………………………………

24) Price for waste collection and treatment
How much would you be willing to pay per month for a weekly collection and treatment of your waste?

2000 CFA	Go to **Section 3**
1975 CFA	Go to **Section 3**
1950 CFA	Go to **Section 3**
…	
25 CFA	Go to **Section 3**
0 CFA	

25) Does not wish to subscribe
If the household members do not wish to subscribe to waste collection and treatment, please ask them why.
……………………………………………………………………………………

Section 3: Income

Professional activities in the concession
We will now ask the members of the concession in which of these following domains they work:
- Agriculture (self-employed)
- Commerce et artisanat (self-employed)
- Employees in the private sector
- Employees in the public sector

Section 3.1

26) Agriculture
Does anyone in the concession undertakes activities related to agriculture?

       Yes

       No   Go to **64)**

Section 3.1.1

27) Seasonal crops
Did you grow seasonal crops last year?

       Yes

       No   Go to **35)**

28) Seasonal crops: first crop
Select which seasonal crop was grown last year (only one)

corn	Go to **30)**
wheat	Go to **30)**
millet	Go to **30)**
sorghum	Go to **30)**
rice	Go to **30)**
cassava	Go to **30)**
Sweet potatoes	Go to **30)**
beans	Go to **30)**
peas	Go to **30)**
Bambara groundnuts	Go to **30)**
cowpeas	Go to **30)**
chickpeas	Go to **30)**
pineapples	Go to **30)**
watermelons	Go to **30)**
soybeans	Go to **30)**
tobacco	Go to **30)**
peanuts	Go to **30)**
cotton	Go to **30)**
other	

29) Other seasonal crops
Specify which other crop was grown last year
………………………………………………………………………………

VI

30) Quantity of the annual harvest for this crop
Enter the quantity harvested for this crop in kilograms
……………………………………………………………………………

31) Unit of measurement for the harvest
Select the suitable unit of measurement:

kilograms

dishes

bags of 25 kilograms

Bags of 45 kilograms

Bags of 50 kilograms

Bags of 100 kilograms

Tomatoe boxes

Carts

CFA

32) Seeds
How much of this seed did you plant for?
……………………………………………………………………………

33) Unit
In which unit?

kilograms

dishes

bags of 25 kilograms

Bags of 45 kilograms

Bags of 50 kilograms

Bags of 100 kilograms

Tomatoe boxes

Carts

CFA

34) Subsidies
If these seeds were subsidized, please insert the total amount of the subsidy or the total amount paid by the household for the seed. Precise which one you report.
……………………………………………………………………………

[The survey application allows us to add questions if the concession members grow other seasonal crops.]

Section 3.1.2

35) Market gardening
Did you grow any vegetables last year?

  Yes

  No   Go to **Section 3.1.3**

36) Market gardening production: first crop
Select which seasonal crop was grown last year (only one)

  potatoes

  carrots

  tomatoes

  cabbage

  spinach

  lettuce

  peppers

  squash

  cucumbers

  okra

  onions

  other

37) Other market gardening crops
Specify which other crop was grown last year
……………………………………………………………………………

38) Annual income from the sale of this crop
Enter the amount earned from the sale of this crop.
……………………………………………………………………………

39) Share of the harvest consumed
What percentage of the harvest was consumed by the concession?
……………………………………………………………………………

40) Seeds
How much did you spend for the seeds of this crop? In CFA.
……………………………………………………………………………

[The survey application allows us to add questions if the concession members grow other seasonal crops]

Section 3.1.3

Inputs
We will now ask the concession members about their expenses for their agricultural activities last year.

Inputs include:
- Product they need to grow their crops (pesticides, fertilizers, …)
- Tools and machines they rented
- Animals they rented or bought to work in the fields

41) First input
Which of these inputs did you spend for last year?

Chemical fertilizer	Go to **43)**
Natural fertilizer	Go to **43)**
Pesticides	Go to **43)**
Herbicides	Go to **43)**
Rent of tools or machinery	Go to **43)**
Employees / Labor	Go to **43)**
Leasing of agricultural land	Go to **43)**
Gasoline	Go to **43)**
Animal rental	Go to **43)**
Animal purchases	Go to **43)**
other	

42) Other inputs
Specify for which other input the members of the concession have spent last last year.
……………………………………………………………………………………

43) Quantity of the input
How much of this input have you used last year? The choice of the unity of measurement will appear at the next question.
……………………………………………………………………………………

44) Unity of measurement for inputs
Select which unit of measurement is to be used for the above quantity. If the unit is not listed below, please enter the amount in CFA.

CFA

Kilograms

Liters

Treatments

Tomatoe boxes

Bags of 100 kilograms

Bags of 50 kilograms

Bags of 45 kilograms

Bags of 25 kilograms

Carts

Oxen

Donkeys

45) Subsidies

If these inputs were subsidized, please insert the total amount of the subsidy or the total amount paid by the household for the input. Precise which one you report.

……………………………………………………………………………………

[The survey application allows us to add questions if the concession members used more inputs]

Section 3.1.4

46) Livestock
Do you own livesotck?

       Yes

       No   Go to **Section 3.1.5**

47) Types of livestock
Which ot the following types of livestock did the members of the household own last year?

       Oxen   Go to **49)**

       Goats   Go to **49)**

       Sheep   Go to **49)**

       Hen   Go to **49)**

       Guinea Fowls   Go to **49)**

       Pigeons   Go to **49)**

       Ducks   Go to **49)**

       Donkeys   Go to **49)**

       Pigs   Go to **49)**

       Other

48) Other livestock
Specify what other types of livestock the members of the concession owned.
……………………………………………………………………………………

49) Number of heads
How many heads of this type of livestock do the members of the concession own?
……………………………………………………………………………………

[The survey application allows us to add questions if the concession members owned more livestock.]

50) Purchase of livestock I
Did the household purchase livestock last year?

       Yes

       No   Go to **54)**

51) Purchase of livestock II
What type of livestock did the household purchase?

       Oxen   Go to **53)**

       Goats   Go to **53)**

       Sheep   Go to **53)**

       Hen   Go to **53)**

       Guinea Fowls   Go to **53)**

       Pigeons   Go to **53)**

       Ducks   Go to **53)**

    Donkeys   Go to **53)**

    Pigs   Go to **53)**

    Other

52) Other type of livestock purchased

What other type of livestock did the household purchase?

……………………………………………………………………………………

53) Numbers of head purchased

How many heads of this type of livestock did the household purchase last year?

……………………………………………………………………………………

[The survey application allows us to add questions if the concession members purchased several types of livestock last year.]

54) Zootechnic inputs

What type of expenses did you have last year for your livestock?

        Hay or other fodder   Go to **56)**

        Cereals or other food supplement   Go to **56)**

        Cattle cake   Go to **56)**

        Veterinary care   Go to **56)**

        Other

55) Other expenses for zootechnic inputs

What other expense did you have last year for zootechnic inputs?

……………………………………………………………………………………

56) Quantity of zootechnic inputs

How much of this input did you use last year? The choice for the unity of measurement will appear at the next question.

……………………………………………………………………………………

57) Unit of measurement for zootechnic inputs

Select which unit of measurement is to be used for the above quantity. If the unit is not listed below, please enter the amount in CFA.

……………………………………………………………………………………

[The survey application allows us to add questions if the concession members used several types of zootechnic inputs last year.]

Section 3.1.5

58) Investments for farming activities: with loans I
Did the household purchase these last years:
- Agricultural land
- Machinery
- Agricultural tools

For which it still had to repay a loan last year?

Yes

No   Go to **61)**

59) Investments for farming activities: with loans II
For which of these items did the household borrow?

Agricultural land

Tractor

Motor plow

Anima-drawn plow

Cart

Trailer

Seed sower

Combine harvester

Vaporizer

Wheelbarrow

Manual pump

Motor pump

Hose

Generator

Manga hoe

Traditional hoe

Machete

Other

60) Repayment
How much does the household have to repay annually for the loan?
………………………………………………………………………………

61) Investments for farming activities: without loans I
Did the household purchase last year:
- Agricultural land
- Machinery
- Agricultural tools

Without any loan?

Yes

No   Go to **Section 3.2**

62) Investments for farming activities: without loans II
Which of these items did the household purchase last year?

Agricultural land

Tractor

Motor plow

Anima-drawn plow

Cart

Trailer

Seed sower

Combine harvester

Vaporizer

Wheelbarrow

Manual pump

Motor pump

Hose

Generator

Manga hoe

Traditional hoe

Machete

Other

63) Cost of the investment
How much did this investment cost?
…………………………………………………………………………………

[The survey application allows us to add questions if the concession members did additional investments last year.]

Section 3.2

64) Business and crafts (self-employed)
Is there anyone in the concession owning their own business or crafts workshop?

Please do not report activities related to the sale of their own crop or vegetable production.

Yes

No   Go to **Section 3.3**

65) Number of people in the concession owning their own business or crafts workshop
How many people in the concession own their own business or crafts workshop?
…………………………………………………………………………………

66) First businessperson / craftsperson : what type of activity does he or she carries out?
Specify the type of business or crafts that corresponds.
…………………………………………………………………………………

67) First businessperson / craftsperson: annual income
Select the nearest value to his / her annual income.

25'000 CFA

50'000 CFA

75'000 CFA

…

2'475'000 CFA

2'500'000 CFA

68) Comment
Please enter a comment if needed.
…………………………………………………………………………………

[The survey application allows us to add questions if more of the concession members are self-employed in business or crafts.]

Section 3.3

69) Private Sector
Is someone in the household an employee (excluded in the public sector)?

      Yes

      No   Go to **Section 3.4**

70) Number of people employed in the private sector
How many people in the concession are employed in the private sector?
………………………………………………………………………………

71) First employee: what is your job?
Specify the domain in which the first employee works.
………………………………………………………………………………

72) First employee: monthly wage in the sector
How much does an employee with this occupation earn per month?

      5'000 CFA

      10'000 CFA

      15'000 CFA

      …

      295'000 CFA

      300'000 CFA

[The survey application allows us to add questions if more of the concession members are employed in the private sector.]

Section 3.4

73) Public officials
Is someone in the household a public official?

      Yes

      No   **Go to Section 3.5**

74) Number of public officials in the household
How many people in the household are public officials?
……………………………………………………………………………

75) First public official: occupation
Specify the occupation of the first public official
……………………………………………………………………………

76) First public official: monthly wage
How much does a public official with this occupation earn per month?

      5'000 CFA

      10'000 CFA

      15'000 CFA

      …

      295'000 CFA

      300'000 CFA

[The survey application allows us to add questions if more of the concession members are employed in the private sector.]

Section 3.5

Other sources of income
We will now ask the members of the concession if they had other sources of income last year

77) Income from rental of land or buildings
Did the members of the concession rent any land or buildings last year?

       Yes

       No

78) Amount earned from rental of land or buildings
Enter the amount in CFA
……………………………………………………………………………

79) Income from rental of machinery, tools or animals
Did the members of the concession rent machinery, tools or animals last year?

       Yes

       No

80) Amount earned from rental of machinery, tools or animals
Enter the amount in CFA
……………………………………………………………………………

81) Income from the sale of assets
Did the members of the concession sell any assets (land, machines, tools, etc.) last year?

       Yes

       No

82) Amount earned from the sale of assets
Enter the amount in CFA
……………………………………………………………………………

83) Income from state or monetary project benefits
Did the members of the household receive any state benefits (retirement plans, social assistance, etc.) or monetary benefits from NGO projects last year?

       Yes

       No

84) Amount earned from state or project benefits
Enter the amount in CFA
……………………………………………………………………………

85) Income from network financial assistance
Did the members of the household receive financial assistance from their network (family, friends, etc.) last year?

Yes

No

86) Amount earned from network assistance
Enter the amount in CFA
…………………………………………………………………………

87) Income from other channels 1
Did the concession members receive any income from other channels last year?

Yes

No

88) Income from other channels 2
Specify in which way the members of the household have received some other income.
…………………………………………………………………………

89) Amount earned from other channels
Enter the amount in CFA.
…………………………………………………………………………

Section 4: Conditional demands

90) Price for waste collection and treatment: 0%

Imagine that the project just began and that no other household in the city has yet subscribed to waste collection and treatment. At that point, how much would you be willing to pay per month for the weekly collection and treatment of your waste if no other household subscribed (0%) ?

        2000 CFA

        1975 CFA

        1950 CFA

        …

        25 CFA

        0 CFA

91) Price for waste collection and treatment: 50%

Imagine that the project has been working for some time and that halt of the household of the city have subscribed to waste collection and treatment. At that point, how much would you be willing to pay per month for the weekly collection and treatment of your waste if half of the household subscribed (50%) ?

        2000 CFA

        1975 CFA

        1950 CFA

        …

        25 CFA

        0 CFA

92) Price for waste collection and treatment: 100%

Imagine that the project has been working for some time and that all of the household of the city have subscribed to waste collection and treatment. At that point, how much would you be willing to pay per month for the weekly collection and treatment of your waste if all the household subscribed (100%) ?

        2000 CFA

        1975 CFA

        1950 CFA

        …

        25 CFA

        0 CFA

Section 5: GPS and end of the survey

   93) GPS location
Register the GPS coordinates of the location where the interview took place. Please wait for the precision to be below 20 meters to select "Register the GeoPoint".

END
Please thank the household member for their participation in this interview. Explain once again that all data will remain strictly confidential.