Impact of the Utilization of the Biodigester in the Populations of Bambey and Perspectives for Mass Adoption and Valorization

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Abstract. This paper is a preliminary report on the impact of the biodigester in the department of Bambey, Senegal. The analysis is based on data gathered as part of a join study between the University Alioune Diop of Bambey and the Union of Farmers' Associations of the Region of Diourbel. A survey was undertaken during the month of January 2017 among 24 households, half of the families owning a biodigester and half not having one. The analysis of the data has revealed that the biodigester has very high potentials to get families out of poverty. We analyze parameters such as self-sufficiency, ability to invest on and develop additional activities, having savings, and even commercialization of agricultural production and we have found a clear contrast between families that own a biodigester and families that do not. However, despite the opportunities offered by the biodigester, most households find it difficult to own one. The study has also shown that the tasks needed to operate the biodigester are mainly manual and that an automatization of the process presents high potentials. Furthermore, the lack of market information constitutes an obstacle to the commercialization of the agricultural products. With regards to this aspect, the survey has shown that the implementation of an information system that disseminate market and demand information will highly benefit the populations.

Keywords: Biodigester · Clean energy · Agriculture · Information systems Finance

1 Introduction

For decades now, Senegalese agriculture has been facing persistent difficulties that are due to many factors such as a deficit of rainfall, a degradation of the natural resources, a decline in soil fertility and a low valorization. This is despite many financial and material efforts by the government and its development partners to support the agriculture sector.

Similar difficulties are observed in the energy sector which is characterized by a deep contrast between urban and rural areas. Conventional energy supply is mostly concentrated in cities while 60% of the population live in rural areas and have little or

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no access to energy. As a consequence, 87% of the households use firewood and animal dung as fuel for cooking and lightning. Because of the severe deforestation, rural women (who are mostly in charge of cooking tasks) are finding it increasingly difficult to collect necessary firewood for daily cooking. In addition to accelerating deforestation, the use of this fuel also poses health issues to women and children.

Faced with all these problems, one of the solutions adopted by the Senegalese government (as well as many other African governments) was the setting up of a national biogas program whose objective was not only to provide an adequate response to climate deficits but above all to meet the subsistence needs of the populations. The program, started in 2009, aimed at providing biogas energy services to 8,000 households in rural and urban areas over five (5) years.

The expected benefits of such a program are countless. They include (among others): a significant reduction of domestic energy expenses, a direct transfer of efforts from the traditional system (collect of firewood) to more profitable economic activities, the substitution of petroleum products which allows the country to reduce its needs of foreign aids, the exploitation of the bio-fertilizer (see Sect. 2) which increases agricultural production while reducing expenditure related to the use of synthetic fertilizer, the reduction of respiratory diseases caused by greenhouse gas (especially among women and children), and indeed, the reduction of the drain of wood reserves as well as a cleaner environment.

Unfortunately, despite all the potentials of the biodigester, a 2014 report [1] has shown that on the 8,000 units planned in 2009, only 587 was built in 2013. The reasons for this, according to the report, were financial and technical. First, despite a subvention of 35% by the state, the total price of the biodigester was way above the annual revenue of an average household. Second, the technicians did not follow technical recommendations and the families were not properly trained for the maintenance of the units. This low performance of the program prompted the government to start a second phase in which 80% of the building cost was supported by the state, with a new target of 10,000 units with 1000 of them to be built in 2015. Although this has the potential to boost the number of biodigester in the country, the total target of 10,000 units would only cover 2% of the population. Furthermore, a recent survey [2] operated among 138 households in the regions of Diourbel, Fatick, Louga and Ziguinchor has shown that 57% of the biodigesters are not functional.

Hence, to enable an effective mass adoption of the biodigester, which is necessary for a qualitative transformation of the opportunities it offers, one needs to undertake a serious study of the repetitive failures and proposes alternative solutions. The study in [2] has found that finance remains to be a big issue with the farmers. In fact, many families with non-functioning biodigester could not finish the construction of the biodigester and had to abandon in the middle of the process. Others, who were able to finish, did not have the bovines, which provide the raw materials (dung) needed to keep the biodigester functional.

In this project, we take an innovative and holistic approach to addressing the issues that hampers the development of the biogas in the department of Bambey. First, in the quest of solutions to the problems, we choose to directly collaborate with the farmers (through the Union of Farmers' Associations of the Region of Diourbel (URAPD)) who are full partners in the project. Second, instead of simply running a survey to identify the problems, we closely work with the farmers to pinpoint their root causes and jointly engineer solutions. Third, we leverage a recently established partnership between the university and the farmers' union to together build a support system and develop the training necessary to build, maintain and fully exploit the biodigester. Finally, we have put together an interdisciplinary team that includes economists, chemists, engineers, as well as practicians from the URAPD.

The present paper is a preliminary report on the work of the join team and is organized as follows. After this introduction, we give a brief presentation of the biodigester in Sect. 2. Our survey is presented in Sect. 3, which contains a theoretical model of our study as well as a discussion of the empirical results. In Sect. 4, we then explore possible ways to enhance the whole ecosystem around the biodigester (from finding finances, to building, exploiting and even commercializing agricultural products). We then conclude this preliminary report in Sect. 5.

2 The Biodigester

The biodigester is often presented as a mechanical stomach [3]. It is fed with organic material, which is decomposed by micro-organisms in an oxygen-free environment to produce biogas (methane and carbon dioxide). The decomposition follows a four step bio-transformation process that lasts for about 4 weeks. The biogas is then used as a source of energy (mostly for cooking and lighting) and the leftover solid waste can be directly used as bio-fertilizer or mixed with other vegetal materials to produce compost. Any organic material can be used to feed the biodigester. In Senegal, biodigesters are mainly fed with animal (mostly bovine) and human waste. The biogas produced by the system has no odor and dissolves very easily with ambient air, which makes it less hazardous than the gas commonly used in Senegal.

There exists different technical designs for the biodigester [4]. In Senegal, the most widespread design is the GGC2047 [5] model shown in Fig. 1 and which is built underground. It has several main components. The **inlets or feeders**, mostly composed of human latrine (1) and animal dung mixer (2), are the entry point where human/ animal wastes are introduced into the biogas system. Theses wastes then follow an entrance tube that enters the **biodigesters tank** (3) where the 4-step bio-transformation process occurs. The produced biogas consists of about 60% methane, 40% carbon dioxide. It is first accumulated and stored in the biodigesters. Then it exits the system via a gas pipe, which is connected to the final utilization system (cooking or lighting). The digested slurry flows to the outlet tank through the **manhole** (4). It is a nutrient rich fertilizer and is collected via an exit tube into the **compost pit** (5), where it is mixed with vegetal elements to produce the compost.

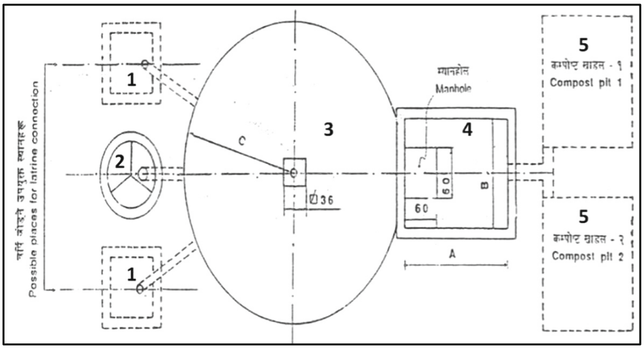

Fig. 1. Schema of the biodigester

3 Survey and Results

A survey was undertaken during the period of January 15–21, 2017 among 24 households. It was carried after a stratification of these households into 2 groups: 12 households with a biogas and 12 without. Among the households without biogas, 5 have cattle and the rest do not have cattle.

The goal of the survey was to derive a first comparative analysis of the households based on the availability or not of a biogas considering different factors such as: need and motivation, perception of the biogas as a mean to alleviate life condition, the possibilities it offers with respect to market gardening, awareness about the drip watering system, self-sufficiency and quality of life, the ability of families to commercialize their products in the market, and the impact of gender in the activities of the populations.

1. Theoretical Model Specifications

We adopt a *logistic* model [6] to test the impact of the different factors on the probability of an increased agricultural profitability. In this model, we are interested in factors (personal, institutional, economic cultural, and social) that might impact agriculture profitability. As such, we consider, in our model, a variable y_i that represents the profitability of a given farmer, and a vector X(1 × K) of variables that is composed with the different factors (personal, institutional, economic cultural, and social). Considering that y_i is a binary variable (profitability of not), the non-linear probabilistic model to be estimated is given by:

$$y_i^* = \alpha_i + \beta X_i + e_i,$$

where y_i^* is an estimation of y_i β is defined as the ratio of the probability p_i that event i occurs and the probability that it does not occur $(1 - p_i)$, α_i is a reference value when all the X_i are set to be equal to zero, and e_i represent the noise and are considered to iid with a logistic distribution (as discussed next).

The choice of the logistic model is motivated by the binary nature of the dependent variable. More precisely, the variable is specified as follow: $y_i = 1$ in case of an affirmation and $y_i = 0$ otherwise.

The model that links the two variables (y_i and X(1 × K)) can then be written as:

$$P_r(y_i = 1) = F(\alpha_i + \beta X_i); \qquad P_r(y_i = 0) = 1 - F(\alpha_i + \beta X_i)$$

In the above equation, $P_r(y_i = 1)$ is the probability that the event "Augmentation of agricultural profitability" and is given by the logistic formula:

$$Prob\{y_i = 1\} = \frac{e^{\alpha_i + \beta X_i}}{1 + e^{\alpha_i + \beta X_i}} = \frac{1}{1 + e^{-\alpha_i - \beta X_i}}$$

a. Empirical Approach

Based on the above theoretical model, we test the hypothesis of "Augmentation of agricultural profitability" using the following equation:

$$ACOVI^* = f(PCOMM, DIVENTE, SDEMA, RESEAU, PROCOMM, FORMCOM \\ GENRE, MOTIVATION, EPARGNE, ECLAIR)$$

Where the variables in the right hand side of the equation are described in the following table (Table 1):

Table 1. Description of the variables

Variable	Description
PCOMM	Communication infrastructure/Information
DIVENTE	Selling opportunities
SDEMA	Market Demand
RESEAU	Network and Information System
PROCOMM	Commercialization
FORCOMM	Formation in commercialization/marketing techniques
GENRE	Gender
MOTIVATION	Motivation
EPARGNE	Savings
ECLAIR	Lighting for market gardening during evening time

A summary of the statistical analysis is shown in Table 2.

As suggested in the table above, some of the statistics obtained with the data are not significant. This might be due to the representativeness of the sample which consists of a very small percentage of the population. Another reason might be the model. In fact, in this preliminary report, we have used the logistic model for pre-analysis, without any guarantee that it is the best fit. These represent some limitations that we plan to address in subsequent reports of this study. However, despite the cited weaknesses, the

Table 2. Statistical analysis

Dependent Variable: ACOVI				
Method: logistic				
Date: 01/22/17 Time: 22:42				
Samples: 24				
Included observations: 24				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
PCOMM	−0.320444	0.440582	−0.727319	0.4790
DIVENTE	0.653665	0.478291	1.366669	0.1933
SDEMA	0.573974	0.462306	1.241547	0.2348
RESEAU	0.039677	0.520818	0.076182	0.9404
PROCOMM	0.098184	0.305687	0.321192	0.7528
FORMCOM	0.528917	0.463648	1.140773	0.2731
GENRE	0.623403	0.428617	1.454453	0.1679
MOTIVATION	0.388366	0.432264	0.898446	0.3841
EPARGNE	0.420646	0.290773	1.446647	0.1700
ECLAIR	−0.695360	0.455505	−1.526570	0.1491
R-squared	0.169992	Mean dependent var		0.625000
Adjusted R-squared	−0.363585	S.D. dependent var		0.494535
S.E. of regression	0.577482	Akaike info criterion		2.034058
Sum squared resid	4.668796	Schwarz criterion		2.524914
Log likelihood	−14.40869	F-statistic		0.318589
Durbin-Watson stat	1.501898	Prob(F-statistic)		0.955117

empirical results offer a wide range of differences and paradoxes in the comparative impacts between the families that own a biogas and those that do not own one. The main goal of the present paper is to relate those observations without dwelling into their interpretation. As a way to cross-validate the observations, work sessions have been held with the URAPD actors, who, in many cases gave explanations why certain phenomenon were observed.

b. Data Analysis

At first sight, an overall analysis of households with biogas have shown that, despite the fact that almost all those families have indicated that they had an extra source of income before owning a biogas, they have acknowledged that it is thanks to the biogas that they have seen a marked improvement in their living conditions. For 83% of the families that own a biogas, it has given them the opportunity to do poultry farming, selling fertilizer, market gardening, and fish farming (the last two still not yet implemented). However, they survey have shown that the (extra) activities related to the biogas do not constitute a handicap to the other activities and tasks the families used to have. In fact, only 25% have affirmed that they indeed needed to borrow time destined for other activities to efficiently operate the biodigester. On the other hand, all respondents consider that it would be pertinent to automatize the different tasks needed to operate the biodigester. When it comes to the ability for families to sustain themselves throughout the year, 42% of the families having a biodigester needed to have out-of-season activities, while 58% of families without the biogas needed out-of-seasons activities.

Motivation and Needs

The survey have shown that the population are strongly motivated to acquire a biodigester. In fact, among the households without biogas, we have notice that the quasi-totality (92%) have taken actions destined to earning one. The actions include: inquiring about the biodigester (100% of the respondents), saving money to get one (42%), and looking for alternate funding (8%).

Impact on the quality of life

Overall, the survey has shown that having a biogas is a determinant factor in improving people's quality of life. In fact, among all respondents, 63% have observed an improvement in their life quality; and the large majority of people who have observed such improvement own a biodigester. Also, 67% of people with biodigester have observed an improvement in their life quality, while 58% without biogas have declared having observed some improvement in their life style in the last years.

The analysis has shown a clear difference in the possibility of savings between the population owning a biodigester (50%) and the population not having one (17%). In economic theory, savings is an important indicator because it shows the capability of the families to invest and their aptitude to create and develop income generating activities. Regarding this aspect, the analysis has shown that 58% of families with biogas have projects to develop new activities, while 42% of the households without biogas have new activity projects. Investments by families with biogas have mainly been on activities that are related to the biodigester, while investment among other families are mostly on activities unrelated to the biogas such as selling of firewood. There is a large gap between families who consider that they are in a difficult situation and they will not be able to get out of it: 58% of people without biogas against 25% of respondent with biogas. When asked the question "*what do you think will help you get out of it*", 42% of families without biogas respond that they will need an external fund while 8% of the people with biodigester feel that they need to develop the activities related to the biodigester.

Market gardening, drip watering, and working during evening time

The analysis of the data has revealed the farmers are well aware of market gardening and drip watering technics. In fact, among all the surveyed families, only 4% affirm not knowing about market gardening and only 13% did not know about drip watering. The paradox observed at this level is that households that have more resources to develop market gardening, have done less: 8% of the families with biogas are doing market gardening, against 25% of the households without the biogas. A similar phenomenon is observed when people are asked about the "pertinence of night time lightening of the gardens". In fact, only 17% of the families with biogas had a favorable opinion about night time lightening, while 58% of the families without biogas feel that night time lightning will be useful for market gardening. This indicates that we are in a situation where either a family is into biogas or it is into market gardening. This is surprising because it is the families with biogas that are more encouraged to getting into market gardening because of their ability to produce organic fertilizer, which is known to be very efficient for market gardening. Overall, 46% of the respondents feel that night time lightning will improve productivity, and the majority of that group (80%) think that this improvement will be more than 50% of the current productivity. One important reasons given by some of the interviewers is the following: because of the insufficiency of water, families have to take turns to water their plants (if many families use the watering system at the same time, the rate will drop a lot and each one will suffer). But, currently, watering has to be done during the day time. If however, a there were light during the evening, some families will be able to use the system during the day while others in the evening.

Quality of life and Self-sufficiency

The quality of life in the studied localities depends on local factors including (and not limited to) the ability of the households to ensure food self-sufficiency throughout the year, their propensity to remain debt-free and what kind of roof they own.

The overall observation is that, with regard to the number of families who have food self-sufficiency, there is a ratio of 3-to-1 between families with biodigester (88%) and families without (33%). With regard to the level of indebtedness, the data suggests with high confidence that it is a very good indicator on whether the biodigester can help families get out of poverty. In fact, our survey has revealed that 92% of families without biogas are indebted against only 25% of families owning one.

The hypothesis that the type of roof is an indicator of poverty is not confirmed by the data. Here, the observed paradox is that none of the surveyed families owning a biodigester have a brick house, while among the families without biodigester, 4 out of 12 (33%) are living in a brick house. In general, most of the houses are built in zinc. They represent 67% of the surveyed population. In second position, come the straw-roofed houses that represent 29% of the households. Only a tiny fraction of the respondents live in a bricked roof.

Commercialization and Market Opportunities

We made the hypothesis that a family that is more self-sufficient will be better able to commercialize larger portions of its production. In other terms, if a family is able to commercialize part of its production, it is because it has some level of self-sufficiency in its production. After the analysis of the data, we observed that 42% of the households commercialize no less than 20% of their production. However, we have noticed that a large fraction of the households (33% among the ones with biodigester and 58% among the ones without) have difficulties in the commercialization. These difficulties are more due to the lack of appropriate communication means that would enable families to acquire good information about market and demand. In fact, among the respondents, 38% use words-of-mouth to get information about the market, 25% use the telephone, and most of the families have no prior information before going to the market. Almost, all the households are aware of such difficulties and 63% of them are convinced that having a communication network that would provide information will help them to better sell their products. Also, 15 out of 24 respondents believe that a formation in marketing and commercialization techniques will provide substantial help. Despite the constraints mentioned above, more than half of the households (58%) consider that their production is flexible enough to adapt to most market demand.

Women Empowerment

In developing countries, especially in rural areas, people rely on biomass, such as fuelwood, charcoal, agricultural waste and animal dung, to meet their energy needs for cooking. Cooking is mostly a women's task, who need to go into the bush to collect the woods and/or animal dung and carry them back home, usually on their head, in a trip that can take hours of walk. During the cooking process, they expose themselves and sometime their children to the air pollution caused by the smoke. In fact, the World Health Organization (WHO) estimates that 7 million premature deaths per year are directly attributable to indoor air pollution from the use of solid fuels [7]. That is more than 4 000 deaths per day, more than half of them children under five years of age. This means that indoor air pollution associated with biomass use is directly responsible for more deaths than malaria, almost as many as tuberculosis and almost half as many as HIV/AIDS.

Our survey has shown that women in household with a biogas benefits from it in many ways. First, by using the gas produced from the biodigester, women no longer need to spend hours and kilometers of walk to cut, get and carry the firewood. This gives them time to engage into other activities such as education for themselves or for their children and revenue generating activities (e.g. home gardening). Also with the biogas, cooking time becomes much shorter. Moreover, with the biogas, women can now cook in a smoke-free environment (see Fig. 2). This drastically participates in improving their health. Overall, the survey has clearly shown that the biodigester is an effective means to empower women.

Fig. 2. (Left) Woman cooking with biogas (source URAPD). (Right) Kitchen with firewood (source APS).

4 Future Perspectives

a. Automatization

The study has shown that the most manual and labor-intensive task of the biodigester system is the production of bio-fertilizer. When the residual waste gets into the compost pit, it needs to be mixed with vegetal elements in order to produce the compost. This is a very labor-intensive process that that can even be dangerous because for a good mix, the farmers needs to get into the compost pit, while the compost is still wet. Once the compost is mixed and dried, it needs to be dug out the hole. This process is as intensive as the mixing (or even heavier labor because now the compost pit is full). In addition to that, the quantities to be mixed (vegetal elements and residual waste) are determined using bare approximation. This can lead to a compost that is sub-optimal or even sometime unusable, as it was the case with one of our visited household (see Fig. 3).

Fig. 3. (Left) Farmer mixing compost. (Right) Suboptimal compost due to wrong mixed quantities

The main problem with the current design is that the compost pit is a big hole dug into the ground. We envision to automatize the mixing and unloading process by using: a temporary storage system for the leftover waste, a transport belt, a "leaky bucket" for the vegetal elements, and a mixer bowl. The storage system will be equipped with a metered pump with a constant rate. Waste will be pumped out of the storage and carried over the belt. The "leaky bucket" will constantly pore the needed amount of vegetal substances to produce optimal fertilizer. Mixing will then be done in the mixing bowl and the final product will be unloaded to a final storage unit for drying. The whole system will be powered by solar energy.

b. Rural Network

Our survey has elucidated the importance of a networking infrastructure in rural areas. Such network would enable many applications such as: (1) a rural online marketplace where farmers could find information about products demand and prices, (2) an IoT-based information system that can enable remote monitoring of farms and smart agriculture, (3) telemedicine services that will enable doctors from the urbans areas to diagnose/monitor patients in rural areas, and (4) a system to collect and disseminate environment data (just to name a few).

As network infrastructure, we propose a solution that is based on a simple opportunistic principle: *given any situation, use the best connectivity solution available; and when no solution is available at the moment, use delay/intermittent tolerant (DTN) solutions to offer "offline" services*. Our network will be backboned using point-to-point Long Distance Wifi links [8]. On the access links, it will use cellular data services wherever available. If none of the data services is available, we will use (compressed) SMS services as a support for data communication. In areas with no network coverage, we will use DTN solutions [9]. For the seamless integration of all these technologies, we implement our lightweight platform on NDN (Named Data Networking) [10], a new architecture proposed for the future Internet.

The focus of our solution will be on building a "local" Internet that interconnects rural communities among themselves (*in-out approach*). This is complementary to the (*out-in approach*) effort of bringing Internet to rural communities. However, this task is harder to achieve and needs a huge preliminary investment (mostly from government to build infrastructures and lay fiber), which unfortunately have been taking too long to materialize. In the meantime, rural communities will be waiting; and hence missing tremendous opportunities that would be possible by being "locally" connected. This is what motivated our *in-out approach* to building a "local Internet" for rural communities. Bearing in mind that the ultimate end will be to connect communities to the global Internet, we plan to build a system that is "*easily pluggable to the Internet*".

c. Formation

Recently, the University of Bambey (UADB) and the farmers' union (URAPD) have signed a partnership agreement whose main objective are social development and capacity building in the region of Diourbel. This convention is part of the university community service, which is one of UADB's missions. It is based on three pillars: Training, Support and Research.

The training focuses on the know-how of the farmers and their experience. It involves both theoretical and practical aspects and is sanctioned with a professional degree from the university. For the case of the biodigesters, the training will focus on three main areas. First, farmers will be formed on the engineering techniques to build and maintain a biodigester. The second part of the formation consists of teaching to farmers about optimization and resource allocation techniques (for example, how much crop or biofertilizer should one sell/keep given current market information?). The final module will be on commercialization and marketing techniques.

The formation will involve both onsite and distance education. For the latter, the implementation of the rural connectivity network will be of vital importance.

d. Crowdfunding for the Biodigesters

Raising funds is an important step towards the realization of any development project, whether it is in economic, social or environment oriented. However, despite the existence of many sources to finance development projects, most of the funding requirements set by governments, international institutions and NGO are very selective and hard to satisfy by the majority of farmers. In addition, a big fraction of the funds usually do not reach the intended beneficiaries because of administrative expenses and sometime corruption. This has led to the development of new, participative funding methods, such as crowdfunding [11], which is based on public participation to fund projects.

Crowdfunds mostly target small scope projects such as small retailers, artisans, farmers' associations, and projects in social, economic and environmental development. The funds are usually provided by people with the willingness to help without going through the traditional processes, but rather via lending platforms, easily accessible online (e.g., Microworld, Babyloan, Wiseed, Ecobole). Despite critics, mostly due to observed dysfunctions in some platforms, crowdfunding is today considered as a credible alternative (to the traditional funding methods) that offers a direct and targeted process and is free from the many constraints observed with the traditional methods. It is a reliable and quick way to raise funds for development projects. Furthermore, in crowdfunding, the risk is very limited for the lenders because they participate in small amounts for each funded project.

As stated earlier, one of the reasons why the biodigester is still not adopted in mass is that many farmers lack the funds necessary to acquire and maintain one. As a solution, we propose to leverage the existing crowdfunding services. Funding a biodigester via crowdfunds involves three main actions. First, in crowfunding, the success of a project crucially depends on how it is presented. We aim to work with the farmers to build the case for the biodigester by putting forward the many potentially benefits (economic development, women empowerment, healthcare and environment) through a quantitative study of the cited benefits. Second we will evaluate the details of the financial needs by considering the whole chain: from building the biodigester to commercialization of the products (crops or biofertilizer). The final step will be the production of a business plan that is based on these previous studies. The business plan will also include a strategy for fund allocation once funds become available.

5 Conclusion

In this work, jointly done by the Universite Alioune Diop de Bambey (UADB) and the Union of Farmers' Associations of the Region of Diourbel (URAPD), we preliminarily report on the reasons why the biodigesters are not delivering the expected potentials benefits and propose remediation measures. Our survey has shown that the lack of finance is the main cause of the limited adoption of the biodigester. As a solution, we are exploring crowdfundings sources to provide to farmers the funds necessary to build and operate the digester. Another finding is the intensive manual labor needed to operate the systems (especially the production of biofertilizer). We accordingly propose a way to automatize this process. Finally, we discovered that farmers were lacking the market information and the marketing skills needed to make the most of their produced goods. With regards to that, we are building an information system that will enable farmers to acquire quasi-real-time price and market information. We also leverage the recently partnership framework between the university and the farmers associations to provide formation program that will give to farmers the needed technical and marketing skills to commercialize their product. Follow ups of this paper will focus on the implementation and assessment of the proposed solutions.

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