

Household perceptions on biogas as a sustainable energy source. A focus group study in Hadejia Valley, Nigeria

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Abstract

Invasive cattail (*Typha spp*) weed in channels, rivers, and agricultural lands of Hadejia Valley irrigation schemes in northern Nigeria has become an environmental challenge with important social and economic implications for local communities that depend on agriculture and livestock for a living.

As of today, communal efforts and government actions to eradicate this invasive plant are costly and have had little impact. In this context, the goal of this research is to convert this threat into economic opportunities to improve the livelihoods of local communities. Specifically, the project seeks to develop and implement a novel technology that uses Typha as feedstock for the production of biogas based on a model of rumen selected microorganisms. Hence, this is a multifaceted proposal with important environmental and socio-economic impacts occurring both at local and global scales.

Participation and engagement of potential beneficiaries and of other stakeholders has a pivot role from the initial stage of the project and is considered key to project success. This implementation approach is based on action research, also known as participatory research or collaborative inquiry, which motivates people to more willingly apply what they learn when they do it themselves. It aims to turn local community members into co-researchers to give input and to help solve perceived and specific problems that are affecting them every day. To this end, a participatory approach was conducted through focus group discussions with potential direct beneficiaries of biogas. The project was presented to stakeholders and followed by a dynamic participatory discussion session. Five simultaneous guided focus group discussions identified barriers, constraints, and opportunities for successful project development. Particular emphasis was given to participation of women.

A total of 54 women and men participated as potential beneficiaries to assess the novel use of Typha as feedstock for biogas. Due to cultural reasons women and men were split in different groups. Face-to-face focus group discussions were oriented around a semi-structured survey to assess potential demand for the novel use of Typha for biogas and to define strategies and incentives to promote adoption. Our findings reveal that focus group discussion is a useful tool to engage potential beneficiaries in the early stages of a project, and also ensures that local constraints and bottom-up ideas are considered in product development and technology adaptation phases of the project. Results allow to understand and identify constraints and opportunities to guide project development and identify strategies to foster adoption.

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Introduction

Invasive cattail (*Typha spp*) weed in channels, rivers, and agricultural lands of Hadejia Valley irrigation schemes in northern Nigeria has become an environmental challenge that poses important threats to economic activities, health and welfare of local communities. This aquatic weed reduces productivity in rice lands (Sabo et al, 2016; Salako et al. 2016), blocks water canals thus impeding water flows, and hinders boating and fishing activities (Abubakar et al. 2012, Chiwaula et al, 2009). Obstruction of canals and water infrastructure has also resulted in an increased risk of flood (Ahmed et al, 2017; Goes, 2002). Invasive *Typha* also decreases diversity and promotes persistence of waterborne diseases such as malaria, which is first cause of death in Nigeria (Salako et al, 2016).

As of today, communal efforts and government actions to eradicate this invasive plant are costly and have had little impact (Salako et al, 2016). In this context, the World Bank and the Nigerian government have set a priority to develop alternative management and economic uses of invasive *Typha* biomass.

The objective of this work is to assess household perceptions and willingness to adopt a novel technology to convert the threat posed by this aquatic weed in the Hadejia Valley Irrigation Scheme (HVIS) into an opportunity to improve the living conditions of the people in the area. Specifically, this technology proposes a method to ferment the *Typha* biomass to produce biogas for cooking and for lighting in local communities of Hadejia Valley. This research is a spearheading component of the TYPHA project³ focused on developing economic uses of invasive *Typha* biomass.

Expanding access to affordable and clean energy is critical for realizing the Millennium Development Goals and enabling sustainable development in poor regions. However, UN (2017) reports progress fall short of what is needed and claims further commitment and financing is needed. Yet, nearly 3 billion people continue to rely on traditional biomass and coal for cooking and heating at tremendous cost to productivity, health and the

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environment. The situation is particularly dramatic in Nigeria where most of the population still lacks access to clean and affordable energy.

Cooking smoke poses a serious threat to health that especially affects women and children. In addition, widespread use of wood for cooking is a major cause for deforestation and forces people to travel farther to acquire wood that becomes more expensive to buy. Biogas production from fermenting Typha can provide a source of clean energy for lighting and for cooking. The use of Typha for biogas is an innovative solution that has the potential to not only provide affordable power for Nigerians in rural areas, but also to greatly improve the health and livelihoods of families.

The development and implementation of this novel technology in Hadejia Valley is based on the idea that action research, also known as participatory research or collaborative inquiry, motivates people to more willingly apply what they learn when they do it themselves. It aims to turn local community members into co-researchers that give input and help solve perceived and specific problems that are affecting them every day (Berg, 2007).

Hence, we propose a participatory approach based on focus group discussions to engage stakeholders in project implementation and assess willingness to adopt elicit household perceptions on the novel economic use of Typha biomass to produce biogas, and assess opportunities and constraints to adoption.

At a first stage, the benefits and social acceptance of the project and the willingness of the community to adopt biogas technology based on biomass feedstock will be assessed using a focus group discussion approach.

At a second stage of project implementation, stated preference approach will be combined with field experiments, in which the effect of different information treatments about benefits of Typha based biogas and the role of incentives for adoption will be tested. There is an increasing number of studies proposing the use of to assess policy impacts in developing countries (Duflo et al, 2006; Field et al, 2010, among many others). In particular, the impact of seminars and demonstration units as drivers of adoption will be assessed via randomized field experiments contrasting results among participants and non-participants. A household survey, based on stated preference methodology, will be designed to evaluate willingness to adopt the new biogas technology (Allo, Loureiro and Iglesias, 2015).

The setting

According to the Energy Access Outlook 2017, 38% of the world's population lack access to clean cooking and typically use inefficient stoves or open fires in poorly ventilated spaces. In 25 countries, mostly in sub-Saharan Africa, more than 90% of households rely on wood, charcoal, and waste for cooking. Specifically, 94% of population in Nigeria does not have access to clean energy. This situation is particularly acute and poses an enormous threat to poor and vulnerable populations in Northern Nigeria.

Traditional firewood cooking is related to severe health risks, causes deforestation and climate change, and is unnecessarily expensive to some of the world's poorest people. According to the Nigerian Alliance of clean Cookstoves⁴, nearly 90 million Nigerians cook with wood on the traditional "three-stone fire", which is causing severe health impacts, deforestation, and climate change. In addition, as resource scarcity increases so does the cost of firewood resources, threatening affordability and living conditions of people in communities with high or extreme poverty levels.

Sadly, Nigeria experiences the highest number of smoke-related deaths in Africa. This silent killer causes 95,300 deaths annually in Nigeria where cooking smoke is reported as third cause of death, after Malaria and HIV/AIDS. Cooking smoke causes severe health problems which particularly affects women and children. In addition, children born to women who were exposed during pregnancy are at risk to low birth weight, impaired mental abilities, and birth defects.

Furthermore, 102 million Nigerians live in poverty, 1/4 of Africa's extreme poor. The traditional cooking method is expensive, burning up to 90% more wood than is necessary and costing poor families money that could be put to better use on education, health, and nutrition.

The use of wood for cooking is a major cause of deforestation in Nigeria, which is happening at an alarming rate. Carbon dioxide emissions from millions of cooking fires are contributing to greenhouse gases. Desertification, caused in part by deforestation, is contributing to poverty by forcing groups from ancestral lands to move in search of fertile pastures and has resulted in violent ethnic disputes.

⁴ <http://nigeriacleancooking.org/about-us/issue>

Mass land clearings and logging in Nigeria — both legal and illegal — have contributed to the significant deforestation of rainforests and woodlands across the country and the African continent as a whole. And yet, wood logging remains one of the most important tools for providing fuel and power to over 120 million Nigerians who rely on its practice for firewood and cooking⁵. According to U.N. data, Nigeria experiences an alarming deforestation rate and has lost over 2 million hectares of forest annually between 2005-2010 due to agricultural expansion, logging, and infrastructure development.

This dramatic picture reveals that the success of this novel biogas technology based on Typha biomass can help to convert a serious threat posed by Typha invasion into an opportunity to improve the livelihood of people in local communities.

Successful development and implementation of Typha based biogas technology may help to preserve deforestation and desertification at the local scale while contributing to mitigate climate change at the global scale. Last, but not least, it will provide economic incentives to harvest and control Typha invasion in HVIS.

This is a truly innovative technological approach, with very little knowledge or experience on biogas technology in the area of study. The engagement of stakeholders and potential beneficiaries at early stages of the project is considered a critical issue to successful adaptation and adoption.

Research method

The use of a participatory approach was proposed to engage potential beneficiaries in the early stages of the project and to ensure that local constraints and bottom-up ideas are considered in product development and technology adaptation phases of the project.

A participatory approach was implemented in the very beginning of the project with the organization of an inception workshop and focus group discussions with potential beneficiaries. A Focus Group Discussion (FGD) is a qualitative research method particularly fitted to elicit perceptions and understand stated preferences on adoption of new technology, which have not been observed before in the study area. It has been extensively used to assess policy implementation in numerous contexts. In particular, Amigu et al.

⁵ https://www.washingtonpost.com/news/in-sight/wp/2014/11/21/deforestation-vs-daily-life-the-logging-industry-in-nigeria-is-fueling-both/?utm_term=.b20cad0cb4f2

(2011) and Ates et al. (2017), among others have used this approach to assess energy policies. FGDs are conducted with a semi-structured questionnaire led by a skilled moderator. The moderator asks broad questions to elicit responses and generate discussion among the participants.

Focus group discussions were oriented to identify households perceptions, to assess potential demand for a Typha based biogas technology, and to define strategies and incentives to promote adoption of new Typha uses.

As a first step, an initial mapping of stakeholders was used to identify potential direct beneficiaries, farmers and households, and other relevant stakeholders such as: farmers associations and cooperatives; municipality representatives; neighborhood associations; women associations; feed industries and related animal feed suppliers; rice mill industries; input suppliers; extension services and relevant civil servants related to agriculture; and livestock, biomass and energy matters.

The inception workshop was organized in the study area in order to present project objectives, scope, and activities to local communities. An invitation was extended to potential beneficiaries and stakeholders and more than one hundred people attended the workshop. Particular diligence was aimed at engaging women as potential beneficiaries attending the inception workshop and participating within subsequent focus group discussion.

After project presentations and questions, a breaking-out session was organized to conduct face-to face focus group discussions with farmers and household wives as potential direct beneficiaries of biogas during 45 minutes. Those participants were split into groups and brought together in round tables. In each group one moderator invited participants to express and to discuss their opinions according to a semi-structured survey. Survey design oriented discussion to identify barriers, constraints, and opportunities for successful project development. Moderators were instructed to give room for bottom-up ideas. Guided discussion aimed to elicit their household attitudes and perceptions on the novel use of Typha as feedstock for biogas, providing alternative energy source for cooking and lighting. Particular attention was also given to assess strategies and incentives to promote adoption among potential beneficiaries.

A total of 54 participants were split into 5 focus groups involving potential beneficiaries and active community members, with a particular emphasis on the participation of women. Due

to cultural reasons, women and men were split into different groups: 42 women formed 4 groups, with 9-13 participants in each group, while 12 men formed another group.

QUESTIONS TO GUIDE WORKING GROUPS DISCUSSION ON BIOGAS (45')
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| <ol style="list-style-type: none">1. Which are the problems related to current energy use in your household or in your local community?2. Which energy sources are most often used for cooking and lighting?3. How much does a family household (6-8 members) spend per week on energy for cooking and lighting? Who in the family usually collects fuelwood? (Please, indicate nairas per week spent to buy fuel-wood or time per week spent by a family member collecting fuel-wood.)4. Would you consider installing and using biogas as an energy source for cooking and lighting?5. Which are the main reasons why you would decide to adopt and to use biogas?

(hints: avoiding pollution and negative health effects, saving time, saving costs and improving your economy, reducing deforestation, others...?)6. Which are your main concerns regarding biogas installation and use? (Explicitly mention the need to buy specific kitchen and kitchen utensils.)7. Would you be interested in attending a practical demonstration in a pilot installation? Which other actions would you recommend to ease biogas adoption? |
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At a second stage of project implementation, stated preference approach will be combined with field experiments, in which the effect of different information treatments about benefits of Typha based biogas and the role of incentives for adoption will be tested. In particular, the impact of seminars and demonstration units as drivers of adoption will be assessed via randomized field experiments contrasting results among participants and non-participants. A household survey, based on stated preference methodology, will be designed to evaluate willingness to adopt the new biogas technology.

Preliminary results

Focus group discussion (FGD) confirmed that local communities suffer from severe energy poverty and are highly dependent on firewood resources. Without exception, all participants mentioned firewood as the main energy source for cooking, and to a much lesser extent, charcoal, kerosene and gas. Having electricity for lighting purposes is rare, i.e. only one of thirteen women in one of the groups acknowledged using electricity, while the rest of groups did not even mention electricity as an energy source.

Several problems were identified in relation to current sources of energy in the household and community. All female groups mentioned smoke and related health issues as the most important problem and most female groups mentioned the difficult use of wet firewood during the raining season in second place. In contrast, the male group mentioned high cost of energy. These differing participant perceptions suggest a gender effect. Other problems mentioned were low availability and difficulties in collecting firewood as well as the high cost of energy.

Average expense of firewood for a family household of 6-8 members amounts to 2,310 Nairas/week⁶, which is relatively high considering that most family's monthly income in Hadejia valley is under 15,000 Nairas, which corresponds to extreme poverty. However, important differences were identified between groups, ranging from a highest value of 5,000 and a lowest value of 750 Nairas per week. It was also mentioned that firewood prices double during the rainy season.

All participants in focus groups were positive about adopting biogas and installing a facility. Both women and men welcomed the idea and agreed that the use of Typha to generate biogas is an interesting option, i.e. "we want it and it would be very helpful to us". The issue of who makes decisions in the household was discussed in one of the female groups. They noted that their husbands decide but that women can give information and explain to them.

⁶ Most households have monthly income below 30.000 Naira per month and an important part of household suffer extreme poverty with less than 15000 nairas per month.

Source: Environmental and Social Impact Assessment Final Report For the Hadejia Jama'are River Sub-Basin with the Kano River Irrigation Scheme (KRIS) and Hadejia Valley Irrigation Scheme (HVIS) and the associated Cumulative Impacts.

The main reasons that support their decision to adopt ranked avoiding indoor smoke pollution and negative health effects as the main advantage. Saving costs and improving the economy and saving time collecting firewood and cooking were ranked second or third in importance. Avoiding deforestation also was considered important but ranked last in the list.

Several groups mentioned that learning how to use the biogas and that affordability or high cost of installation were their main concerns about the adoption of biogas. Another group said that cost is not going to be a problem since it will be a one time purchase. Another group declared having no concerns as long as no health problems are involved. Participants in one focus group stated that biogas should be free and made available by the project.

All participants in both men and women groups showed interest and agreed to attend a practical demonstration in a pilot facility. While the men group suggested that the project should train men and they themselves would train their wives, all participants in women groups declared to be keen to be trained in this technology. Other options, such as talking to their pairs who had already experimented with this technology was also a highly valued strategy to increase confidence. This preliminary results will be used to develop a fuzzy cognitive map following the approach in Verker et al (2017)

Conclusions

The goal of Typha project is to develop and implement a novel biogas technology using a model with rumen selected microorganism to ferment typha biomass (Khon, 2015). Participation and engagement of potential beneficiaries and of other stakeholders has had a central role since the very beginning of the project and is considered key to successful implementation and adoption. The participatory approach through the use of focus group discussions has a double dividend since it allows researchers to harvest feedback, identify opportunities and barriers and assess potential demand, while it also involves the local community in the development of project, a critical component for success.

Our preliminary findings reveal that providing a sustainable biogas energy source may have profound impacts in the livelihood of local communities, mainly affecting women and children. We identified more opportunities than constraints at this first stage of project development. Particularly, household wives perceived that this novel biogas technology may bring them important health benefits and all of them showed great concern and

awareness on health risks of traditional firewood cooking. They also stated that it would avoid difficulties of using firewood during the rainy season. However cultural behavioral patterns and gender inequalities may be a constraint to adoption. We found a gender effect in participant's perceptions differed with gender. While women participants showed greatest concern for health, the main driving force to adoption for men was affordability and cost saving.

Our results suggest that strategies for adoption should consider and include an incentive scheme to promote women training and participation. In addition, attention should be given to guarantee that initial costs do not constitute a barrier to adoption. Finally, easy of maintenance should be an important criteria on bio-digester design so that either men and women could carry out or share this task.

We conclude that improving energy access in a sustainable and affordable manner may profoundly impact local communities on multiple aspects of human development, from poverty to gender equality, health, environment and climate change.

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