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Measuring the Impact of Kisangas' Biodigester

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Measuring the Impact of Kisangas' Biodigester

by
Francis Brooke
Liyara Senadheera



Miller Center
for Social Entrepreneurship

November 2023

MILLER CENTER LEWIS FAMILY FELLOWSHIP

Undergraduate Action Research for Social Justice

This research was prepared thanks to the Miller Center Lewis Family Fellowship that accelerates leadership by providing students with opportunities to learn and work with social enterprises that are on the front lines of poverty eradication and sustainable development in Africa, Asia, Latin America, and the United States through the [Miller Center Lewis Family Fellowship](#). The Lewis Family Fellowship is a fully-funded summer field experience along with two-quarters of classwork and academic research for Santa Clara University junior-level students. The action research model of the fellowship simultaneously supports rigorous, transformative undergraduate student learning and the scaling of social enterprises in developing countries that participate in our world-class accelerator programs. Action research is a practice-led approach that emphasizes learning from working with social enterprises. This provides a robust value exchange between students and social enterprises.

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Abstract

Kisangas provides sustainable organic waste management solutions for farmers and empowers them to use cow dung as an asset. They achieve this by offering a low-maintenance biodigester that converts cow waste into net-zero emission gas, utilized for cooking, heating water, and in some instances, generating electricity. Their product also produces a slurry which can be used as organic fertilizer to replace synthetic chemical fertilizers on their farms. Kisangas is a small startup so they lacked concrete data on their clients and data on their overall impact on the farmers who have their biodigester. To address this challenge, our team conducted semi-structured interviews in the states of Maharashtra and Rajasthan with clients to assess the impact that Kisangas' biodigester has on their daily lives and how it benefits the environment. After conducting these interviews, our findings show that it takes about one year for farmers to begin to properly utilize the slurry, and once it is utilized, they see higher crop productivity and an improvement in soil health in their farms. In addition, the biodigesters help contribute to long term savings on energy and fertilizer. Our final finding from our research is that their product generally benefits the daily lives and health of the farmers, especially the women in terms of health and quality of life.

Author Bios

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Introduction

Our research addresses the impact that Kisangas biodigesters have on their customers, as well as the environmental impact of the product. Biodigesters anaerobically digest organic matter to produce biogas, which mainly consists of methane and carbon dioxide. To assess the impact the product has on customers, we measured these two forms of impact: changes for customers (daily life improvements, money saved, etc.) and environmental benefits such as improvements in soil health and some carbon emissions offset (data provided in the index). We completed this project with our partner Kisangas. Kisangas is a social enterprise based in Pune, India which develops low maintenance biodigesters that generate gas and fertilizer for farmers to utilize. We gathered data through semi-structured interviews with farmers to learn about how working with Kisangas has impacted their lives and economic wellbeing. Our findings show that farmers experience substantial savings on energy and fertilizer, and the organic fertilizer leads to higher crop productivity. We conclude that Kisangas has a significant positive impact on the lives of their customers alongside positive environmental impacts.

Social Enterprise's Mission

The mission of Kisangas is to equip farmers to be able to utilize waste as a commodity and provide long term organic waste management solutions. Kisangas was founded in 2016 and is based in Pune, India in the state of Maharashtra. Additionally, Kisangas has grown to greater geographical reach to the state of Rajasthan. At time of writing, they are also starting to explore the West Indies as well. Kisangas recognizes the challenges of cow dung waste management and they mitigate it by replacing traditional dung use, which involves leaving it to release methane, with organic slurries. To this end, the biodigester provides an affordable solution that allows farmers to have a self-reliant fuel source and have their own organic bio fertilizer generated from the organic slurry. Furthermore, these plants turn the cattle dung to a net zero emission form of energy, and contribute to a decline in the use of chemical-based fertilizers. To grow their impact, Kisangas also partners with nonprofit organizations such as Sustain Plus Energy Foundation, an organization that provides training on sustainable farming practices for farmers across the state, to increase their impact by gaining access to farmers who are interested in entering the biogas market. Our research findings provide evidence-based analysis that will be of use to Kisangas as they seek to provide more farmers with their biodigester in order to optimize their resources through increased fuel efficiency and the use of organic fertilizer.

Social Enterprise's Context

In India, where Kisangas is located, the agricultural sector operates on a different scale than it does in more developed economies such as the United States. While farming in the U.S. is increasingly moving away from small-scale farming in favor of large scale agriculture, India continues to rely on millions of smaller scale farmers. These farmers grow various crops such as sugar cane, corn, rice, peppers, etc., in tandem with animal husbandry of bovine stock, such as cows or buffalo. Unlike in the United States, cows in India are not slaughtered as a food source due to the dominance of Hinduism in India and the theological tenants surrounding the sacred status afforded to cows.

Nonetheless, cow manure produces methane, which is a greenhouse gas 25x more potent than carbon dioxide. The Kisangas biodigester takes in the manure and, instead of the methane being released into the atmosphere, it is anaerobically digested by certain bacteria in the “plant” to produce a net-zero emission form of gas to be used for cooking and even electricity, if the plant is large enough.

The two states we visited, Maharashtra and Rajasthan, are culturally distinct and are impacted differently by Kisangas because they differ in energy consumption habits. This is because in Rajasthan wood continues to be used more often than liquefied petroleum gas (LPG) cylinders as a fuel source. By contrast, according to Kisangas, farmers in Maharashtra are more likely to use emergent agro-technologies including biodigesters. To expand their product to new regions and farmers, Kisangas and the NGOs they work with host outreach events and workshops where farmers with the product can share their knowledge and practices. Once farmers learn these sustainable practices with Kisangas, they also receive economic benefits, as described in this research, that make the continued use of sustainable fuels attractive.

Background and Previous Work

Many researchers have studied the emerging biogas industry in India and how biodigesters impact the lives of farmers. This section intends to synthesize findings from other research projects to understand the various benefits of both the biogas and slurry as products of biogas technology.

Economic Benefits of Biogas

One of the major reasons why biogas is impactful to farmers in India is because of the economic benefits it provides to them. In a study on the biogas industry in India, Gita Surie (2017) used a case study approach with a social enterprise called Rajasthan Gow Seva Sangh, and one of the results from her case study was that biogas can meet energy needs for cooking, especially in rural areas where grid access can be low. The article also discusses how biogas allows for better self-sufficiency among farmers (Surie, 2017). Our research had a similar case study approach with Kisangas, and our results support Surie’s findings because many of the farmers we visited were able to eliminate their need for outside energy sources for cooking, such as LPG. In our review of previous literature, one important aspect of the economics of biogas was the willingness to pay (WTP). Andriamanohiarisoamanana et al. (2022) studied the WTP of livestock farmers in Madagascar and found that, as the cost of energy for cooking went up, the WTP for a biodigester also went up because long-term savings are a large factor in purchasing a plant. In India, Talevi et al. (2022) builds on this conversation by exploring farmers’ past experiences with biogas and how that influences WTP. They find that farmers with no previous experience have the lowest WTP. This research is something that we did not get the chance to explore for Kisangas, however, it can be helpful for future research. This information can be used to help biogas companies such as Kisangas price their products and find new clients.

Environmental Benefits of Biogas

A critical environmental benefit resulting from biogas is the reduced methane and carbon emissions. Many farmers in rural areas in India rely on firewood and LPG tanks to satisfy their basic needs (Minde, Magdum, Kalyanraman 2014). Having access to and being able to utilize a biodigester for these farmers would allow them to have a significant reduction of CO₂ and methane. Additionally, Minde, Magdum, Kalyanraman et al. (2014) continue to bring attention to how biowaste only contributes to a small fraction of greenhouse gas emissions in comparison to fossil fuels. Along with environmental benefits, the use of biogas also contributes to an improvement in public health. A study by Gross (2017) on the local environmental impacts of biogas found that the health benefits are especially promising for rural areas that rely on firewood collection for cooking because it reduces indoor air pollution and deforestation from collecting wood. Our results expand on this research because our results show that farmers (especially women) noticed an improvement of respiratory health while cooking indoors with biogas, as well as a significant decrease in wood use.

Environmental Benefits of Slurry

While in India doing interviews in the field, one of our main research focuses was assessing the impact of the slurry on the farms. Gross (2017) mentions that quantitative studies on how the slurry affects soil health is limited, however, the study found that farmer testimonials and field evidence show that it does help improve soil health. Yadav (2023) studied the nutritional value of organic fertilizer in comparison to synthetic fertilizer. The study tested non-breeding cows versus gestated cows and used seasonal variation and 45-55 day fermented soil samples. They were able to see how much nutritional value would actually hold up in the soil based on the fertilizer which would impact the growth of the crop. This is helpful to us as Kisangas heavily promotes its slurry and the organic fertilizer it produces. Seasonally, compared to synthetic fertilizer, the fertilizer created by the biodigester, leads to more nutrients, nitrogen, potassium, and phosphorus in the soil.

Team Challenges, Goals, and Research Questions

Through our research with Kisangas, we addressed the social problem that many farmers in India do not have access to sustainable energy and technology. Because of this, they need to rely on outside sources of energy such as LPG cylinders and wood burning stoves. Also, many farmers do not have a way to manage their farm waste, especially from cow dung. A Kisangas biodigester provides a way for them to dispose of their animal waste while also making energy for them to cook.

Our goal for addressing this problem is to assess the impact that current biodigester installations have on the people who have them. This allows us to see if the product is making a positive social impact and it allows us to see where Kisangas can improve so that in the future they can be more effective in addressing the social problems in India.

To study these foci, we oriented our study with the following focus questions:

1. To what degree does the Kisangas biodigester reduce LPG cylinder use?
2. How much do farmers save on both LPG and fertilizer?
3. Do farmers use the slurry as fertilizer for their crops?
4. What are the overall daily life improvements of farmers as a result of Kisangas?

Team Research: Data Collection and Research Methods

Prior to Data Collection

Before collecting data from Farmers in Pune, Maharashtra, we met with Dhanajay Abhang, the founder of Kisangas, to connect us with non-profit organizations he works with and with farms to visit in the field. On July 7th, 2023, we met with the Sustain Plus Energy Foundation to gather background information about their experience within the biodigester sector of India and to assess the ways in which they go about gathering data from the farmers they work with. The representatives from this organization were able to inform us of their focus, which is to provide sustainable energy sources to rural farmers and enhance women's empowerment. They explained the process they went through to distribute their own survey to rural farmers in Maharashtra. This helped improve our study design by allowing us to rethink some questions and to catered questions to the specific context of each interview. We are grateful to them for providing insight on our data collection strategies and measurement design. We also met with BAIF (Bharatiya Agro Industries Foundation) Development Research Foundation, another nonprofit organization that works with the government and Kisangas with the goal to build self-reliant rural societies with a clean environment, food security and safe drinking water. BAIF provided insight on what nonprofit partners would want to see out of the social enterprises they partner with and what they value alongside the impact data that met their criteria.

Research Methods:

After speaking with the nonprofit organizations and Kisangas' founder, we built our interview questionnaires. To collect data and information on the impact that Kisangas's product has on farmers, we conducted seven 1-1.5 hour semi-structured interviews with farmers in Maharashtra, starting on July 7th, 2023, and concluded on July 18th, 2023, regarding their personal experiences and testimonies, and we were also able to gather quantitative data on their biogas and slurry usage. Dr. Shoba Krishnan was our interpreter when we spoke with the farmers and their families. Both researchers took field notes and pictures of all the sites and farms. We went through the same process by conducting 16 semi-structured interviews with farmers in Rajasthan, which started on July 24th, 2023, and concluded on July 25th, 2023 we went to about 8-9 farms on each of those days as we were able to visit a village and many of those farmers lived in close proximity to each other.

Questions included:

“How long have you had your Kisangas plant?”

“What energy source did you use before biogas?”

“How much dung in kilograms do you typically put in the biodigester per day?”

“If you used LPG cylinders before, how many did you use per month?”

“If you used wood before, on average how many kilograms of wood did you use per day?”

“How much money did you spend per month on energy before Kisangas?”

“How much money per month do you spend on energy now?”

“Do you use the slurry as fertilizer for your crops?”

“Do you sell the slurry?”

“How much money did you spend per month on fertilizer before Kisangas?”

“How much money did you spend per month on fertilizer now?”

“Do you see any improvement in soil health?”

“With the costs saved, what do you spend those savings on?”

“Do you see positive changes in your daily lives as a result of Kisangas?”

We utilized open coding to identify the following themes in our data. The codes included: savings, health benefits, slurry utilization, time, productivity, and daily life improvement. We used these codes to identify themes in the data. Once we verified the themes, we input our data into a database to organize the information on Kisangas’ impact. This data will allow them to build and attract partnerships with other investors and nonprofit organizations by providing real world evidence of the benefits of biogas. In addition, this data will allow Kisangas to track the impact they have environmentally.

Limitations and Ethics

Prior to data collection each participant was verbally asked for their informed consent to be interviewed and to have the data they have provided manually recorded. Finally, our findings cannot be generalized beyond the subject population interviewed during the temporal interval indicated and geographic location specified.

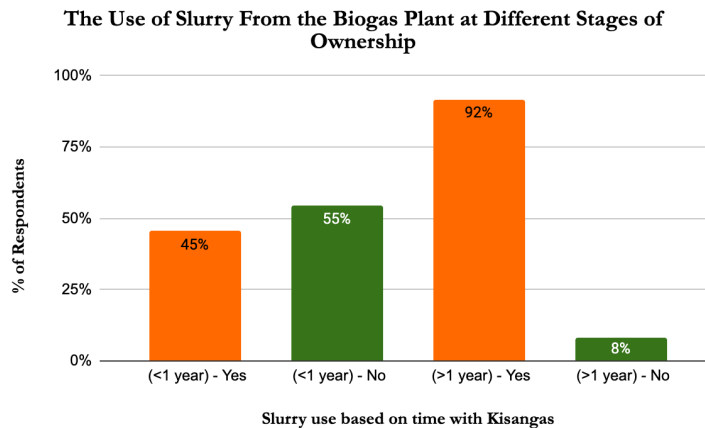
Analysis and Key Findings

The slurry takes 1 year to show positive results

Our first key finding after gathering and analyzing the data we collected in the field was that it takes around one year for farmers to learn to properly utilize the slurry made from the biogas process. Farmers properly use the slurry if they use both the solid and liquid parts as organic fertilizer for their crops or personal vegetable gardens. This aspect of the biogas is

what Kisangas wants farmers to utilize the most since it leads to more sustainable farming practices and replaces synthetic fertilizers. As seen in Figure 1, 55% of the farmers we interviewed who had a Kinsangas biodigester for less than 1 year did not use the slurry. The majority of the farmers who did not use the slurry allowed it to build up in a pile next to the plant and it would dry up because they either weren't educated on the uses of the slurry yet or knew its uses but have not had enough time to use it on their crops since it is a new product. With the farms we visited who had their biodigester for a year or more, 92% of them used the slurry while only 8% did not use it. During the semi-structured interviews, the farmers who had the plants for a longer time told us that it took some time for them to set up a system where they were able to transport the slurry to various areas of their farm and to learn how to use it.

Figure 1:



Slurry promotes higher crop yield and soil health

Once the slurry is used as organic fertilizer to replace the synthetic fertilizer which most farmers used before Kisangas, we found that it helps lead to higher crop yields and benefits the soil health. According to the data we collected, 56% of the farmers who use the slurry for fertilizer told us that they notice an increase in soil health or crop productivity. One farmer said that he gets 30% more crops for the same plot of land than he did while using chemical fertilizers. Another farmer said that during a year with Kisangas and using the slurry as fertilizer, he increased his income from selling crops by 200,000 rupees. While conducting observations at the farm sites we visited, we noticed a difference in crop size as well. As shown in field photo 1 in the appendix, the sugar cane height on the left is higher than the sugar cane height on the right because the plot of land on the left uses the slurry while the plot on the right uses chemical fertilizer. The impact of the slurry is significant to the farmers because it keeps their soil healthy so that they can grow crops on their land for longer periods of time without degrading the soil as much, and it provides economic benefits due to the higher productivity.

Additional Economic Benefits

Along with the slurry, Kisangas provides additional economic benefits because it leads to long-term savings. Before purchasing a biodigester, farmers in Maharashtra used mainly Liquefied Petroleum Gas (LPG) as their energy source for cooking, while Rajasthani farmers used a mix of wood and LPG. LPG cylinders pose a threat to the environment as it is a fossil fuel and emits greenhouse gasses, and wood burning contributes to deforestation. Many farmers reported that their initial purchase of their biodigester was to save money on energy, particularly with the goal of eliminating their LPG consumption. Kisangas in most cases completely eliminates the use of LPG by providing biogas as an alternative energy source. Many farmers still have LPG as a backup source in case the biogas supply is low. The average amount spent on one LPG cylinder for the farmers we visited is ₹1,200, so we used ₹1,200 as an average cost for cylinders in both Maharashtra and Rajasthan. In reference to Figure 2, 35% of farmers save ₹1,200- ₹1,799 and 35% also save ₹600- ₹1199 on LPG cylinders per month. In addition to the costs saved from the LPG cylinder expenses, Kisangas’s plant also helps save money on chemical fertilizer expenses. According to Figure 3, About 54.5% of farmers saved ₹10,000- ₹50,000 on chemical fertilizer per year, and 18.2% have saved ₹50,001- ₹100,000 on chemical fertilizer per year. In addition, three of the farmers we interviewed sold their slurry for a profit as one farmer generated a total of ₹50,000 per month and the other two farmers generated a total of ₹8-15,000k per month. Farmers in both Maharashtra and Rajasthan have utilized their savings for their children’s education, expanding their farm, towards important life milestones such as marriage, and spending on household items to make their lives more comfortable overall.

Figure 2:

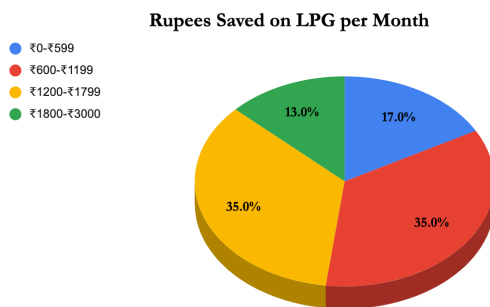
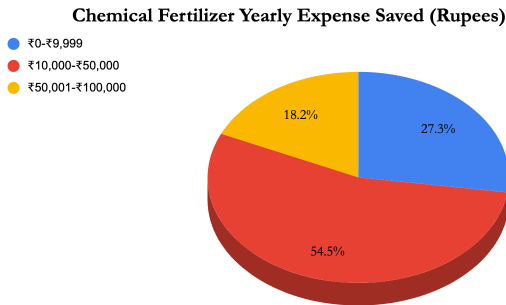


Figure 3:



Daily life improvements

Our final key finding is that Kisangas has a positive impact on the daily lives of the farmers who utilize their biodigester and their families, especially the women. These improvements range from small things such as being able to take warm baths with the extra energy to heat water to significant health improvements. In India, women are typically in charge of taking care of cooking and kitchen duties, and in Rajasthan, we observed that their primary source of fuel for cooking is wood which has been collected that day. Some of the women reported having to add plastic in the winter to help speed up the burning process which releases toxic fumes when inhaled. Wood burning creates smoke indoors which is harmful to the respiratory health of the household when inhaled in confined spaces, contributes to eye irritation, and greatly increases the indoor temperature in an already hot environment. The process of collecting wood was a common practice with the farmers we interviewed and is heavily time-consuming and tedious, sometimes taking 3-4 hours per day, according to two farmers. They would also have to break down and make sure the wood sticks were usable. With the Kisangas biodigester, each farmer who previously relied on wood burning significantly decreased the amount of wood they consumed for cooking, and in Rajasthan, 47% of farms we visited now only use wood to cook for their cows. This allows for farmers and the women who live there to have more downtime by decreasing the amount of time spent collecting wood for their fuel. The additional time for rest contributes to less strain on their bodies overall. Women within these families feel more empowered through their health and ability to have time for themselves to focus on other aspects of their lives that they used to spend on attaining their fuel source to use for their families.

Conclusions and Recommendations Informing Deliverable

The biogas industry is a growing market in India and Kisangas is a social enterprise that specializes in manufacturing biodigesters. These products provide a waste management solution for farmers because it creates biogas out of cow dung and water which can be used for cooking, heating water, and electricity. The plant also creates a slurry that can be used as organic fertilizer. As Fellows with the Miller Center for Social Entrepreneurship, we were tasked with assessing the impact of Kisangas' product on their customers since they lacked concrete data from the farmers themselves. As a result of our research in the field, we found many environmental and

social benefits on farmers in Maharashtra and Rajasthan.

The impact Kisangas has on farmers are highlighted through our key findings and conclusions from our research and interviews. Our first two findings focus on the slurry of the plant because a key goal for Kisangas is to promote its use as a main selling point for partner organizations, such as NGOs that educate farmers. We found that it takes farmers around one year to begin to properly utilize the slurry, and once they use it on their farm, they see higher crop yields and better soil quality. This is because the slurry is used as organic fertilizer to replace synthetic chemical fertilizers, so its use creates economic benefits by generating more crops and environmental benefits by preventing soil degradation. Another impact of a Kisangas biodigester is that it provides long term savings for farmers because they no longer need to spend money on outside energy sources such as LPG or spend money on fertilizer. Our final finding is that farmers notice daily life improvements as a result of Kisangas. For example, the money saved is put to use by saving for children's education, weddings, farm expansion, etc. In Rajasthan where wood burning is common, households and especially women notice health benefits, and farmers report experiencing more free time and time to spend with family as a result of a zero maintenance energy source.

After analyzing our data, we have come up with two recommendations for Kisangas to implement. The first is to evaluate potential monetary savings in Rajasthan based on how much they spend on cow feed, LPG, etc to determine where to place the biodigester. In Rajasthan, it is common for farmers to separately cook their cow feed which uses much of their LPG or wood. One farmer uses biogas to cook the cow feed rather than to cook for the family and saves 2,250 rupees per month while 96% of the farmers we interviewed saved only 1,800 rupees or less per month by using it for household cooking. This farmer accumulated more monthly savings from this so in the pre-installment evaluations, we recommend that Kisangas analyze where more savings can be generated based on the amount of cows they have, how many family members they cook for, and if they would use the biogas to cook commodities such as ghee, or butter. This would help determine where to put the plant because proximity to the plant is important. It takes extra energy to pump the gas longer distances and in many cases farmers use electricity to do so, and having the biodigester close to where they need it eliminates the need for electricity.

Our second recommendation is to emphasize the use of the slurry more when partnering with NGOs. NGOs help provide training to farmers for using the biodigesters, however their main focus is promoting sustainable energy sources to replace greenhouse gasses. Although this is important, the organic fertilizer from the slurry has a greater positive impact on the lives of the farmers and provides more economic benefits. By having the NGOs in the training sessions teach the farmers about the slurry, they will see the benefits earlier rather than waiting a year to realize its impacts. These recommendations can be used to help Kisangas grow and gain more clients while also furthering the impact it already has on its existing clients.



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Appendix Supplementary Materials:

Field photo 1:



Carbon Emissions Offset Spreadsheet:

This spreadsheet calculates the total amount of carbon emissions offset by the use of biogas on the 23 farms we visited.

[Link Here](#)