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Understanding adoption decisions as India scales up the use of Improved Cookstoves – Lessons from Odisha

Household air pollution is a major health risk in South Asia. One of the most promising solutions to this problem is the introduction of improved cook stoves (ICS). However, the adoption of these stoves by Indian households has met with somewhat limited success and there are significant bottlenecks that continue to curtail the scaling up of ICS and related technologies. A new SANDEE study addresses the topic and may help assist Indian policymakers in encouraging the efficient utilization of renewable energy resources.

The study looks at the adoption of ICS in households in Odisha, one of the country's poorest states. The results show that improved cook stoves, in particular those powered with fuel produced by biogas plants, have the potential to reduce firewood use, the time spent gathering fuel, and the prevalence of respiratory disease. Households that adopt ICS generally have a higher socioeconomic and educational status than those that do not. The Odisha government's generous subsidy policy for biogas plants is a significant motivation for adoption. But, its main role is in adding ICS as an additional, and not exclusive, source for cooking. Thus, even in households with ICS, use of traditional stoves dominates.

Research in Odisha suggests that while improved cook stoves have multiple benefits, their large-scale uptake will depend on whether implementation programs target the right population, offer subsidies for setting up biogas plants in particular, and provide extension services for any required construction and maintenance support.

Indian Cooking Practices and the ICS Initiative

About 40% of the global population (three billion people) relies on solid biomass fuels for cooking. India leads the world in the number of people using such traditional fuels; over two thirds of the national population (772 million people) uses biomass for cooking.

The main biomass fuels used by households include fuelwood, crop residues, charcoal, coal, and dung. Inefficient combustion of these fuels produces high concentrations of particulate matter and other harmful emissions. Such household air pollutants have been linked to acute lower respiratory infections in children, and chronic obstructive lung disease and lung cancer in adults. Pollution from burning solid fuels in primitive cook stoves accounts for an estimated 3.5 million deaths every year.

As many as 3.5 milllion people die each year from lung disease caused by primitive cook stoves.

The less efficient, traditional cooking practices can adversely affect people's livelihoods as well, since women and children must spend time cooking and gathering fuel –time that could be spent on income-generation or school. The use of biomass for cooking can also be environmentally unsound. Traditional cooking methods can exacerbate forest

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Biogas Plants – Promise and Problems

Biogas plants capture gas (methane and carbon dioxide) released from animal manure for use as a household fuel for both cooking and lighting. In the biogas, dung is inserted through an inlet into a sealed mixing pit, where biogas is generated through anaerobic digestion. The gas is collected in an outlet pipe and piped to the household where it is burned in a gas-burning stove (biogas stove), identical to an LPG stove. After digestion, the slurry released from the plant is often used as an agricultural fertilizer. Buffalo and cow dung is readily available in rural India, providing many households with a steady and accessible supply of this fuel.

Biogas stoves can deliver numerous benefits over traditional cooking practices: 1) the mitigation of indoor air pollution-related disease by decreasing household air pollution; 2) the reduction of firewood use; and 3) the reduction of methane emissions (a key greenhouse gas). The biogas slurry can be used as a substitute for cow and buffalo dung as a fertilizer.

Almost four million biogas plants have been constructed across India through the Indian National Biogas and Manure Management Program from 1982 through 2007. There is a potential for up to 12 million more plants to be installed in the future.

However, biogas plants are prone to many operational and structural problems that can lead to early malfunctions. Rates of functionality of biogas plants in India are as low as 40% in some areas, meaning that 60% of the biogas plants there are non-functional.

Operational problems include the plants' arduous operation and maintenance requirements. For example, households must regularly add dung and water in specified proportions and stir the slurry at regular intervals. What's more, some households have a limited understanding of the proper use and maintenance of the plants and are unable to diagnose or resolve failures. These factors are also barriers to biogas plant use.

Structural problems usually relate to constructional defects, such as cracks in the plant vessel or breaks in the pipe carrying gas to the house. Both problems can allow captured biogas to escape, rendering cooking with a biogas stove impossible.

Biogas plants also tend only to be an option for households with a sufficient income, educational status, and access to quantity of dung. Biogas plants have a high construction cost and can be prohibitively expensive both to construct and operate. The generation of enough biogas to cook food for a family of five requires about five cows. To address these barriers, successful biogas programs often include the provision of repair and maintenance programmes, subsidies or financing.

The inherent problems of burning biomass for cooking have led to the development of improved cook stoves. Designed to burn fuel more efficiently, ICS lead to a reduction in pollution, fuel use and cooking times.

degradation. What's more, residential biofuel cooking is the second greatest source of black carbon, a significant greenhouse gas pollutant that has been linked to the melting of Himalayan glaciers.

In 2009, the Indian government developed the National Biomass Cookstove Initiative to distribute 160 million ICS, including biogas, LPG, kerosene and electric stoves. Yet, there is limited understanding of why households adopt these technologies and factors that influence adoption. Thus, the path to help the millions who currently rely on solid fuel is still unknown. The best policy ideas about how to reduce exposure to indoor air pollution also remain unclear.

Understanding Sustainable Rural Energy Use in Odisha

In Odisha, 85% of households rely on solid fuels as their primary cooking fuel (compared to a national average of 67%). Thus, as part of its efforts to promote sustainable energy use, the Odisha Renewable Energy Development Agency (OREDA) assisted with the installation of over 200,000 household biogas plants at subsidized rates throughout the state. These plants use local waste products – primarily cow and buffalo dung – to produce a clean fuel that can be burnt by a biogas stove.

This study analyzed household adoption of ICS in Odisha, examining the use of biogas stoves along with LPG, kerosene and electric stoves. The authors sought to understand the factors that may influence ownership of ICS and assessed how many hours per day households used their ICS versus traditional stoves. The study also considered how ICS ownership affected the amount of firewood that households used.

Factors that Determine Stove Ownership

The study collected information from selected households in eight districts in Odisha. Whenever possible, research interviews were conducted with the head of the household and the primary cook. The survey collected data on household cooking behaviour, fuel use, demographics, socioeconomic characteristics and fuel consumption. It also asked respondents to answer a series of hypothetical questions to gauge their attitude to risk.

The study found that most of the households selected in the study owned multiple stoves (figure 1). The majority of households (94%) owned a traditional stove. 71% owned an ICS, with the most common types being biogas (46%), kerosene (21%) and LPG (19%). Every household that owned a biogas plant had received a subsidy from OREDA. The average biogas plant cost about 7,000 rupees (115 USD); the average subsidy covered about 50% of this cost.

Figure 1: Multiple stove use among households in Odisha

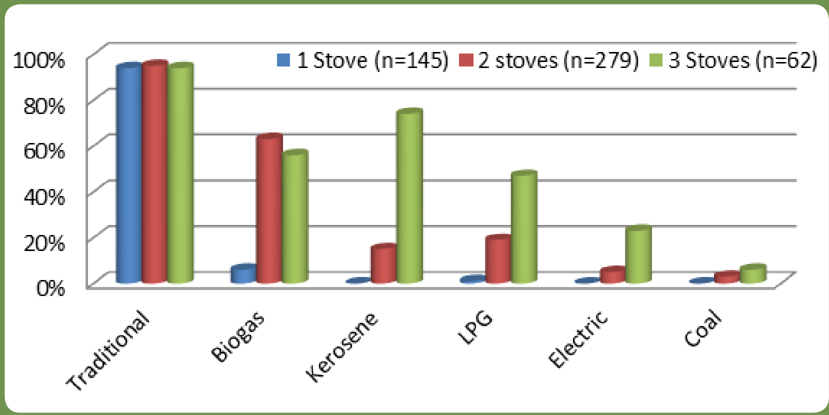
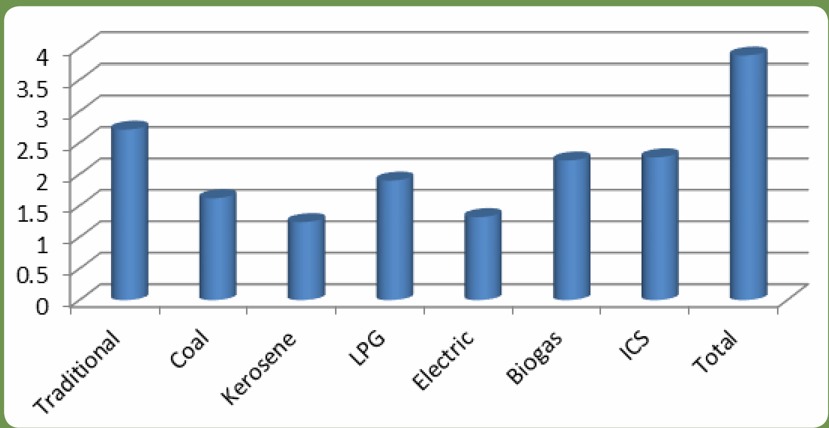


Figure 2: Use of different stoves among surveyed households in Odisha



Focus Groups Discuss the Challenges of Fuel Transition

The study conducted focus group discussions in Odisha that identified several issues of specific concern regarding biogas adoption. People appear worried about the quality of the construction of biogas plants. They were also concerned that there was no maintenance provision for the plants, and that this would lead to durability and repair issues. The cost of the plants was also considered to be high for the rural poor, even after the partial subsidy provided by OREDA. Households also felt that a small household biogas plant would not make enough fuel for cooking all meals. In addition, the dung required for biomass plants is utilized for producing organic fertilizer and making dung patties that are burned in traditional stoves; alternatives that do not require the investment needed for a biogas plant.

Cost, quality of construction and maintenance support are major reasons why households seem reluctant to adopt biogas.

On average, households with traditional mud stoves used them for 2.71 hours per day (figure 2). Kerosene pump stoves were used 1.24 hours per day, LPG stoves for 1.9 hours per day and biogas stoves for 2.22 hours per day.

On average, households that owned an ICS had higher average income or wealth than households with only traditional stoves. They also had a relatively higher educational level, owned more land, used more electricity as a main source of fuel and spent less time collecting fuel. In addition, ICS users were more likely to take risks and found it easier to get a loan than households without ICS.

With respect to biogas-powered stoves, the study found that wealthier households (who owned land and had a greater number of rooms in their houses) were more likely to have a biogas plant and stove. A vast majority (91%) of households with biogas plants reported that the amount of dung available to them was one of the main factors that persuaded them to install their plant. Another reason was the possible reduction in the amount of fuelwood they would need (cited by 85% of households with biogas plants). The subsidy that households received for biogas installation was also important: 54% of households reported that the lower cost of subsidized biogas plants was a positive factor in their decision-making.

SANDEE

The South Asian Network for Development and Environmental Economics (SANDEE) is a regional network that seeks to bring together analysts from the different countries in South Asia to address their development-environment problems. Its mission is to strengthen the capacity of individuals and institutions in South Asia to undertake research on the inter-linkages among economic development, poverty, and environmental change, and to disseminate practical information that can be applied to development policies. SANDEE's activities cover Bangladesh, Bhutan, India, Nepal, Pakistan, and Sri Lanka.

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Continued Use of Biogas Plants and Cook Stoves

Households with a working biogas plant were found to be substantially different from households with a nonfunctional biogas plant. For example, on average, households with working biogas plants had significantly greater monthly expenditures than those with broken plants. Their household heads also had more years of education.

Maintenance of ICS is a critical issue. Households with a higher spending capacity and education are better able to afford repairs and understand how to use their biogas plants properly. Working biogas plants are found in such households.

Once a household has an ICS, the time spent using it is correlated with a number of household factors and behaviors. For example, larger households spend more hours using a stove (regardless of type). Household expenditures (an indicator of income), on the other hand, have a positive impact on the length of ICS use and a negative impact on traditional stove use. Also, the number of hours per day households spend collecting traditional fuel is positively linked to traditional stove use, as is the number of days that these stove users spent in hospitals getting treatment for respiratory illness.

Conclusions and Policy Recommendations

This study offers three clear results and recommendations. First, households with ICS have higher socioeconomic and educational status. Thus, programs that target such households are more likely to be successful.

The benefits of ICS are also clear. Households with only a traditional stove spend more money on fuel, more time collecting fuel, and more time in hospitals getting treatment for respiratory disease. Thus, there is a need for continued investments in ICS.

However, there are barriers to the up-take of ICS and biogas technologies and their long-term use. Policies such as subsidies that encourage the adoption of ICS and services that support construction and maintenance of biogas plants have the potential to remove these barriers and provide tremendous health and environmental gains.

Households owning traditional stoves use about 25 kilograms of fuelwood per week more than households without a traditional stove. Those households with a working biogas plant consume about five kilograms of firewood less per week than households with a nonfunctional plant. Thus, biogas can be a substitute for fuelwood. In general, biogas plants in particular have the potential to reduce firewood use, the time households spend gathering fuel, and the incidence of respiratory disease caused by household air pollution.

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