Energy Policy 66 (2014) 379–389

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Diffusion of non-traditional cookstoves across western Honduras: A social network analysis

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HIGHLIGHTS

- We build a chain of referrals to track spread of information about non traditional cookstoves.
- We find differences among gender and occupations that should inform policy.
- People hear about the stoves twice before becoming suppliers of information.
- Government officials play a substantial role in the diffusion.
- Males play leading role in diffusion over long distances, females in short distances.

ARTICLE INFO

Article history:
Received 7 June 2013
Accepted 1 November 2013
Available online 2 December 2013

Keywords:
Social networks
Non-traditional cookstoves
Diffusion of innovations

ABSTRACT

A third of the world's population uses inefficient biomass stoves, contributing to severe health problems, forest degradation, and climate change. Clean burning, fuel-efficient, non-traditional cookstoves (NTCS) are a promising solution; however, numerous projects fail during the diffusion process. We use social network analysis to reveal patterns driving a successful stove intervention in western Honduras. The intervention lacks formal marketing, but has spread across a wide area in just a few years. To understand the process, we map the social network of active community members who drove diffusion across a large swath of the country. We find that most ACMs heard about stoves twice before sharing information about it with others and introducing the stove into their own communities. On average, the social distance between ACMs and the project team is 3 degrees of separation. Both men and women are critical to the diffusion process, but men tend to communicate over longer distances, while women principally communicate over shorter distances. Government officials are also crucial to diffusion. Understanding how information moves through social networks and across geographic space allows us to theorize how knowledge about beneficial technologies spreads in the absence of formal marketing and inform policies for NTCS deployment worldwide.

Abbreviations and definitions: ACM, Active Community Member, person that takes the initiative to fill out an application on behalf of a community; Seed, randomly selected ACM that allowed us to start collecting information; Ego, person that is interviewed. An Ego can also be an Alter, if it is mentioned by another Ego; Alter, people that provided (Type 1) or received (Type 2) information, as recalled by the Ego; Type 1 edge, an information flow in which an Alter provides information to an Ego; Type 2 edge, an information flow in which an Ego provides information to an Alter; Student, a person whose main occupation is to go to school; Radio, a message spread through the radio. Usually local stations in which an individual is interviewed; Internet, information about the stoves posted on Proyecto Mirador's Website; Maquila, a person that works at a factory for an international company, textile and food processing factories are usual; Agriculture, a peasant that works on agriculture, regardless of land tenancy; Health, a nurse, doctor or other health worker; Church, a priest, nun, minister or person who works as a minister of a faith; Education, a person who works as a school teacher or university professor; PM or PM associates, direct employees of Proyecto Mirador and its Implementers; Other NGO, a person that works on other non-governmental organizations. For example, Peace corps, Hivueras, Plan Honduras; Local, a local leader that has an appointment in the community but does not receive a monetary compensation. For example, members of the water board, village councils; Housewife, a woman whose main occupation is to keep the house; Business, a person that does commerce or services, includes people that sell food informally, artisans, masons, etc.; Government, a person who works directly for the government (except education and health practitioners); PM employees, direct employees without the implementers

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0301-4215/$ - see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.enpol.2013.11.008

1. Introduction

The diffusion of beneficial technology is as important as its design and development. While design of new technologies is primarily a technical endeavor, diffusion is mainly social in nature, and is a frequently neglected element in development interventions. This paper provides insights into the diffusion of information about a fuel-efficient non-traditional cookstove (NTCS) in western Honduras, a Central American country of roughly eight million people. The case study focuses on a project promoted by Proyecto Mirador (PM), a Honduran nongovernmental organization (NGO) that has successfully disseminated thousands of stoves using no formal marketing tools (Ramirez et al., 2012). The diffusion of information about their stove occurs largely by word of mouth and by January 2013, over 40,000 stoves had been installed.[1]

This research is particularly timely as the Global Alliance for Clean cookstoves (GACC) embarks on an effort to disseminate 100 million new stoves by 2020 (Smith, 2010). Successful cookstove interventions are rare; an understanding of the diffusion process may assist program designers and policy makers to implement future interventions. In order to understand the diffusion process, we analyzed the structure and composition of the network of social actors driving the project's rapid expansion. We recognize that the use of social networks to understand the diffusion of innovations is not new, but to the best of our knowledge, this assessment is the first to map social networks responsible for cookstove diffusion.

NTCS have been the focus of several waves of development interventions since the 1970s. Policies responding to the social and environmental impacts of solid fuel use[2] have been implemented repeatedly, with little success. Currently, roughly 40% of the world's population continues to rely on solid fuels for their energy needs (Bonjour et al., 2013). The majority use simple inefficient stoves that cannot fully combust solid fuels, causing emissions of harmful pollutants. The health burden associated with exposure to smoke from solid fuel is staggering, surpassing the burden of HIV or malaria (Lim et al., 2012; Murray et al., 2012). Moreover, in some regions, woodfuels are harvested at a rate that exceeds the ability of forests and woodlands to regenerate, leading to forest degradation and an overall increase in greenhouse gas emissions (Bailis, 2004).

In principle, the problem is technically easy to solve. Teams of designers have developed relatively inexpensive cookstoves that can boost fuel efficiency and improve indoor air quality for solid fuel users. Indeed, over the past four decades, governments and aid organizations have invested heavily in technical solutions. However, the results have been mixed at best (Bailis, 2004; Hanna et al., 2012). Some projects have failed due to inappropriate stove designs, but other failures were due to misunderstandings of the social drivers of technology adoption (Mobarak et al., 2012). The aim of this case study is to reveal the underlying social processes that have driven the expansion of a successful NTCS project. Such insights can support improved policies and help overcome the social barriers to stove diffusion worldwide.

In the following section, we examine the role that social networks play in the diffusion of innovation. Then we describe the research location and our methodological approach. In section four, we present our results. After that, we discuss our results and their implications on NTCS policy and program design. In the last section, we examine limitations of the study and discuss plans for future work.

2. Social networks and diffusion of innovations

Social networks consist of the totality of "friendship, advice, communication or support which exists among the members of a social system" (Valente, 1996). Communication between adopters of an innovation, potential adopters, and promoters are important drivers of adoption rates (Caird et al., 2008; McEachern and Hanson, 2008). People who are socially close to one another tend to know similar information while new information comes mainly from people outside their immediate social circle, or "weak ties" (Granovetter, 1973). Of course, information reaches individuals through pathways other than social networks. Even in remote areas of developing countries, individuals may be bombarded by commercial advertisements, political messages, and social marketing. However, as a medium of communication, social networks differ from these information pathways in that they include trusted individuals and "opinion leaders" on whom individuals rely to vet or filter information reaching them via other means (Ryan and Gross, 1943; Lazarsfeld and Menzel, 1963).

In addition to awareness, for an innovation to diffuse through society, individuals must form a positive opinion about it. An individual's propensity to change often depends on the proportion of people in his or her social network that have already changed behavior (Coleman et al., 1957). Individuals' thresholds may vary, with early adopters having relatively low thresholds and late adopters having high thresholds (Rogers, 2003). Yet, social networks provide different levels of exposures to actors located in different positions (Centola, 2010). Thus, structural attributes may determine the number of times an individual is exposed to an idea and may better predict the temporal nature of diffusion than personal attributes like an individual's threshold (Valente, 1996).

Very few studies have examined the role of social networks in NTCS diffusion. One study of NTCS adoption (Pine et al., 2011) found that the likelihood of sustained use of a NTCS by a household is more closely correlated with whether neighbors are using it than with the individual traits of the household. A second analysis examined the differential roles of peers and "opinion leaders" in the adoption of two types of NTCS: one that was more efficient than the traditional type and one that reduced pollution but was equally inefficient (Miller and Mobarak, 2013). The authors find that opinion leaders are important in supporting adoption, particularly for the fuel-efficient stove, which the authors felt was a "less-apparent benefit" than stove that reduced pollution. They also found that the peer group was an important factor, particularly among subjects that rejected stoves, suggesting that negative experiences were readily communicated within peer groups. Both of these studies demonstrate that the behavior of peers and the social networks though which information disseminates are important determinants of stove adoption.

3. Site description and research methods

Hondurans depend heavily on biomass to meet their energy needs. In 2010, biomass supplied 43% of total primary energy and 86% of residential energy nationwide (Flores et al., 2011). About half of all households countrywide rely on fuelwood as their primary cooking fuel (Secretaría de Salud Honduras, 2006). In Honduras, several institutions address stove-related issues including the Institute of Forest Conservation and Development, Protected Areas and Wildlife, State Forest Administration, and the

[1] Project staff provided data about the number of stoves installed. Third-party auditors independently verify all claims by the project when the project seeks issuance of carbon credits. Verification reports are publically available at http://mer.markit.com/br-reg/public/project.jsp?project_id=103000000002237.

[2] Solid fuels include biomass fuels like wood and charcoal as well as coal used as a residential fuel in some developing regions (Legros et al., 2009).