Household preferences for cooking fuels and inter-fuel substitutions: Unlocking the modern fuels in the Nepalese household

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ABSTRACT

Different cooking fuels are associated with various economic and environmental challenges such as increased economic costs, indoor air pollution, deforestation, and deterioration of public health. In this study, we assess the impact of various socioeconomic factors in a household's cooking fuel choice and motive for making a transition toward cleaner fuels. This study uses household level cross-sectional data (2011) and pooled data (1996, 2004, and 2011) from the Nepal Living Standard Survey. We use multinomial and binomial logit models for the empirical analysis. The results suggest that along with household income, other social and ecological factors play a critical role in inter-fuel switching decisions. We find that transferring property rights of government-owned forests to the communities encourages households to move towards cleaner cooking fuels. We also find that household head's education, distance to the firewood sources, energy access status and household income are significant factors influencing the households' fuel choice decisions. The policy implication is that increasing information spillover, involving local communities in forest management, and expanding alternative socioeconomic opportunities such as jobs and modern fuels in the remote regions play a vital role in encouraging the households to move towards cleaner energy sources.

1. Introduction

Reliable access to different cooking fuels is a critical determinant of social wellbeing and economic development (Reddy et al., 2000). Living standards and overall economic progress of a country in the current world are often measured on the scales of accessibility and ability to use modern energy services (OECD/IEA, 2014, 2006). Heavy reliance on the traditional cooking fuels results in adverse environmental and public health impacts; it also worsens the energy poverty situation and impedes the economic and social development of a developing country (Parikh, 2011; van der Kroon et al., 2013). This is backed by the fact that developing countries often have limited access to the modern cooking fuels (e.g. liquefied petroleum gas - LPG). More than 2.5 billion people in the developing countries (representing 52% of the developing countries' population) still rely on traditional fuels (e.g. firewood, plant residue and animal dung) as a primary cooking fuel (OECD/IEA, 2014). In Nepal, about 70% of the households at the national level and 90% of the families in the rural areas depend on traditional cooking fuels (CBS-Nepal, 2011).

Public policies aiming to enhance energy security and energy transition towards modern fuels, in part, requires superior understanding of consumer preferences for different cooking fuels. The objective of this research is to quantify the impacts of the households' economic and non-economic attributes on its cooking fuel choice decisions in Nepal. Nepal is a least developed and land-locked country situated between China and India. Modern fuel supply in Nepal is vulnerable to its political instability as well as geopolitically sensitive relations with the neighboring countries. Nepal relies heavily on India and a route through India to access the international market for the supply of essential goods (e.g. food, fuels and medicines) in the country. While the existing geographic and cultural challenges with China makes it difficult for Nepal to diversify its international trade risks through the Chinese route (Kantha, 2014; Sharma, 2015). For example, besides the socio-economic hardship, the excessive pressure on forest resources from the overreliance on firewood was observed recently due to fuel crisis in Nepal following the extensive infrastructures damages by the 2015 earthquake, as well as the disruptions in the trade route through India due to geopolitical volatility in the same year (Herington and Malakar, 2016; Khadka, 2015). Thus, in the context of Nepal's reliance on foreign fuels and pre-existing energy poverty, these geopolitical complexities contribute to the energy insecurity problem in the country; this signifies the need for the

contextual empirical studies based on the households' attitudes towards different cooking fuels to inform relevant policy guidance.

A significant body of extant literature exists in explaining the impacts of various economic and social characteristics of the households (e.g. income and education) as the important determinants of cooking fuel choice in the developing country context (e.g. Heltberg, 2005; Kowsari and Zerriffi, 2011; Lee et al., 2015; O. R. Masera et al., 2000). Forest characteristics (e.g. institutions regarding ownership and management, and distance traveled to collect firewood) are also expected to influence cooking fuel choice (as forests are the primary source of cooking fuels in the developing countries). There are also several studies covering the issues of the effectiveness of community institutions (e.g. forest user group) in optimal management of forest resources (e.g. Gautam et al., 2004b; Ostrom, 2005; Prasad Timsina, 2003; Springate-Baginski et al., 2001; Yadav et al., 2003). However, the impacts of forest institutions (e.g. types of forest and location from the household) on cooking fuel choice are not well understood due to the lack of studies covering these prominent issues. This study makes two significant contributions following the existing literature in the field. first, we provide policy guidelines on the household cooking fuel choice for a transition toward modern fuels in the absence of such studies in Nepal. Second, we bridge the gap in the literature with empirical analysis on the probabilistic impacts of the forest sector institutions (e.g. sources of firewood collection and distance to the forest) on cooking fuel choice and inter-fuel transition.

For these research objectives, we use a multinomial logit model (MNL) and a binomial logit model (BNL) utilizing cross-sectional (2011) and pooled (1996, 2004 and 2011) data from the Nepal Living Standard Survey (NLSS). We find that forest location, household head's education level, and household's economic status significantly influence the household's fuel choice decisions. With the increase in firewood collection time, an increase in head's education level, and an increase in income, the households are more likely to switch to modern cooking fuels. Our results also illustrate that assigning property rights of government-owned forest to the community motivates households to switch to transitional fuels. These results provide multifold policy implications to achieve energy security coupled with sustainable energy management in Nepal: (i) decentralize forest management institutions to the community level; (ii) ensure reliable and affordable access to modern fuels; (iii) put restrictions on easy access to the firewood sources; (iv) promote social awareness regarding additional economic costs of using firewood (e.g. health and environmental costs) through education and networking; and (v) mobilize extensive economic opportunities across the country through public investment.

2. Background

Nepal is an agriculturally dominant economy where about 74% of the households rely on the subsistence-based agricultural sector (Joshi et al., 2017). Nepal's total primary energy supply (TPES) is 0.4 million tons of oil equivalent (Mote) per capita, which is far below the global per capita TPES of 2 Mote (IEA, 2015). Nepal contains over 6000 rivers and rivulets with a drainage area of 194,471 square kilometers and the combined length of the rivers is more than 45,000 km with an average annual flow of 7125 m^3 per second (Sovacool et al., 2011a). The hydropower production capacity from the annually available fresh water of 225 billion cubic feet is about 83,000 MW (Sovacool et al., 2011a; WECS and E, 2011). However, Nepal has been unable to use its water resources to meet its development targets due to a variety of constraints such as mass poverty, lack of initial capital (e.g. high upfront cost of such projects demands abundant investment capability), and the lack of high-tech marketplace (Sovacool et al., 2011b). Due to the insufficient supply of electricity (less than

700 MW) coupled with low income, households with access to electricity often consume it for only lighting purposes. Development of other renewable energy sources such as wind and solar is also getting a considerable promotion. This is particularly evident in the off-grid area of rural Nepal due to various policy measures such as subsidy and governmental technical support to the small-scale renewable energy development, but the efforts are mainly targeted to supply energy for lighting purposes only (Bhusal et al., 2007; Gurung et al., 2011; WB, 2014; Zahnd and Kimber, 2009).

The major cooking fuel sources available in Nepal are traditional fuels (such as firewood, animal dung, and plant residue), transitional fuels (such as kerosene and biogas), and modern fuels (such as LPG). While traditional fuels are available domestically, transitional and modern fuels come from foreign countries. More than 70% of the Nepalese households rely on traditional cooking fuels as a primary fuel (CBS-Nepal, 2011). About 80% of the households are located in rural areas, and about 90% of rural households use traditional fuel as a primary cooking fuel (CBS-Nepal, 2011). Various studies (e.g. Pokharel, 2007; Malla, 2013) illustrate that the energy consumption and energy access situations in Nepal are far below the level of basic human needs, and firewood is expected to remain the dominant fuel source for the foreseeable future.

Excessive dependence on traditional cooking fuels is considered one of the leading causes of deforestation and ecosystem degradation in developing countries (Bensch and Peters, 2013; Bhatt and Sachan, 2004; Hosonuma et al., 2012; Sunderlin et al., 2005). Nepal has gone through several structural changes in forest management administration since the 1950s. Between 1957 and 1976, the forests were nationalized, and forest products became the main source of government revenue. Due to widespread deforestation resulting from poor governance, the Nepal government began transferring property rights to communities in the late 1970s (A. P. Gautam et al., 2004b). Currently, about 40% of the land is covered by forest, including the shrub area in Nepal of which about 25% is community owned (MoF-Nepal, 2014; UN-REDD, 2015). Nepal has adopted pro-environmental, forest and ecosystem conservation policies based on people's participatory approach with the amendments to the forestry sector master plan of 1989 and the forest act of 1993, and the revised forest policy of 2002 (FSP, 2000). The carbon sequestration potential of Nepal's forest is 14.738 million tons of CO2, which can generate annual revenue of up to $86.95 million through carbon trading under the United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation (UN-REDD)(UN-REDD, 2015). With a motive to preserve the forest, ecosystem and other natural resources, the UN-REDD aims to create a market for the carbon sequestrated by a forest in the developing countries (e.g. carbon credit market). The UN-REDD allows capital flows from the industrialized countries to offset their emitted emissions. Thus, while encouraging conservation of the forest and ecosystem services, the UN-REDD is also expected to contribute to the poverty alleviation efforts in the developing countries (Campbell et al., 2008, 2008; Lawlor et al., 2010).

The forest management institutions such as community forests and government forests can have a different impact on households' cooking fuel choice. Nepal contains three types of forests based on property rights: private forest, government forests, and community forest. Households have property rights on the private forest. The private forest is also the wealth of the household, mainly as the household can switch private land from firewood farming to best alternative productive activity. Government forests, owned and managed by the Government of Nepal, are the common pool resources (CPRs) (Adhikari et al., 2004). Local communities manage the community forests. Several studies have pointed out that the community managed forests are often effective in conser-