



Household collection and use of biomass energy sources in South Asia



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ABSTRACT

Lack of access to clean, affordable and adequate energy and large scale use of solid fuels such as firewood and cow dung cake is one of the reasons for a lower quality of life in developing countries. It is observed that majority of households in the world that uses solid fuels are located in south Asian countries. The objective of this paper is to examine the pattern of household energy uses, and identify and analyze the factors influencing household choices of energy, sources of fuelwood collection, and family members involved in fuelwood collection. The paper uses primary data collected from three Asian countries: India, Bangladesh and Nepal. A multivariate model is employed to analyze the data. Age, gender and education levels of a household head influence a household's choice of energy sources. Wealthy households are found to use clean energy sources such as liquid petroleum gas (LPG) and electricity, whereas poorer households tend to use solid fuels such as fuelwood and dung cake. Sources of fuelwood collection are largely influenced by a family's labor supply, education, and household wealth status. Females and children are employed by households for fuelwood collection. Nepal and Bangladesh engage mostly female members for fuelwood collection.

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1. Introduction

Access to clean, affordable and adequate energy is essential to attain a good quality of life and sustainable economic and social development. This has been a major global issue in discussions about sustainable economic development and environment for the last several decades [1–5]. Studies reveal that globally about 2.7 billion people still rely on traditional biomass as their main source of energy for cooking and heating, and 1.3 billion people do not have access to electricity [1,4,6]. The majority of these people live in sub-Saharan Africa and South Asia [7]. In the sub-Saharan African countries, biomass accounts for nearly three-quarters of the total energy consumption [1]. Even in urban areas where alternative energy sources are presumed to be available, many people continue to use solid fuels such as fuelwood at least for cooking food [8].

A study of the Wolong region of China reveals that a considerable majority of households is still dependent on fuelwood

despite their access to electricity [3]. One of the main reasons for this lack of inter-fuel substitution is that household choice, and the use of a given source of fuel, hinges on a host of socioeconomic (e.g. income, and wealth), demographic (e.g. family size, household composition, lifestyle, and culture) and location attributes (e.g. proximity to sources of modern and traditional fuels) in addition to fuelwood availability [1,8–11]. However, it should be pointed out that the increasing use of solid fuels and the absence of efficient energy options limits the development scope of households in developing countries significantly [12] and has implications for the local and global environment, as well as the health of those who prepare meals subjected to indoor air pollution [13–16].

Collection and use of biomass is largely influenced by socioeconomic and demographic factors of households [17]. Fuelwood from the forest and the village commons is available almost free of financial cost [18] as the society as a whole has traditionally not placed a monetary value on the benefits derived from these environmental resources since they are not marketable [3]. However, there exists a two-way relationship between fuelwood collection and deforestation [18,19]. Demand for fuelwood from village commons is the prime cause of forest degradation. Fuelwood scarcity is the result of the perpetuation of forest degradation as it is

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the main source of energy for local people [18,20–22] and ultimately this puts pressure on the environment in the form of loss of biodiversity, climate change and so on. A study conducted by Ref. [23] shows that the challenge of bridging the gap between demand and supply of about six million tons per year led to the depletion of forests and consequent loss of soil fertility. However, alternative sources of domestic energy like animal dung, crop residues, wood from farms, biogas, kerosene and the use of improved stoves, etc. do not cause forest degradation and reduce pressure on the protected areas [18].

The private cost¹ structures of all domestic energy sources differ significantly [18]. Besides, the collection of fuelwood has a large opportunity cost in terms of collection labor and time that varies according to the density, distance and availability of local forest resources [18]. Alternative energy sources have both financial as well as opportunity costs. In many south Asian and African countries animal dung is used for burning but dung is also an important source of manure and the use of it as fuel can have an adverse impact on soil fertility [18,24]. However, in many developing countries fuelwood is depleting rapidly, mainly due to rapid population growth as the demand for wood biomass often exceeds its production [25]. Again, people may find less time for agricultural production because of the increased time needed for fuelwood collection and this would have an adverse effect on crop production² [26].

The objective of the present study is to examine the pattern of household energy uses in three major south Asian countries, namely India, Bangladesh and Nepal, where the use of solid fuels is predominant. The study identifies and analyzes the factors that influence a household's choice of energy, collection and consumption of biomass in these countries. The paper is structured in the following ways: Section 2 reviews the existing literature relating to household collection and use of biomass systematically and comprehensively; data collection and methodologies used in the models are described in Section 3; in Section 4, results and discussions are presented; Section 5 concludes with policy implications.

2. Review of related literature

Which energy source to use, like any other commodity, is primarily determined by the price of the inputs including time, labor, capital and technological advances [3,27]. Microeconomic theory states that a range of factors determines how much will be demanded of any given commodity at any given price: average levels of income, the size of the population (e.g. household size), the prices and availability of related goods (in this case, kerosene, cooking gas and coal), individual and social tastes, special influences (e.g. distance of household to common forests and region), and season [3,27,28].

The question of the determinants of biomass collection and consumption cannot be studied in isolation from other forms of energy sources [29]. Depending on the degree of access to other sources of energy and the specific conditions of households, people decide the amount of energy to be used [29]. Furthermore, the rural sector cannot be studied in isolation from the urban sector [1,29] for two reasons. First, urban and rural areas trade in wood, oil, and gas. Second, urbanization influences both the rural energy

consumption and the energy situation in and around towns in developing countries.

With increasing concerns about the effects of global warming and climate change across the globe, more emphasis is now being given to shift energy use from so called 'dirty energy' towards cleaner energy sources, especially in the context of developing countries [17]. Studies show that households in developing countries typically face socio-economic, cultural and environmental barriers in changing the pattern of their energy use [17].

Households face an array of energy supply choices which can be arranged in order of increasing technological sophistication. At the top of the list is electricity, while the low end of the range includes fuelwood, dung, and crop wastes. As a household's economic well-being increases, it is assumed that the household moves 'up' the energy ladder to more sophisticated energy carriers. If the economic status decreases, through either a decrease in income or an increase in fuel price, the household is expected to move 'down' the energy ladder to less-sophisticated energy carriers. Thus, the energy ladder serves as a stylized extension of the economic theory of the consumer: as income rises (falls) households consume not only more (less) of the same goods, but they also shift to consuming higher (lower) quality goods.

Access to and use of clean energy is a widely discussed topic among policy makers from the first Earth Summit in 1992 to the recently concluded Earth Summit in June 2012. This is important particularly in the context of developing countries where the lack of access to clean energy is found to be associated with ill health and the prevalence of poverty [30]. It is now well understood that in order to achieve sustainable economic development and environmental conservation, which are the main objectives of the Earth Summits, provision of clean energy sources is a prerequisite [1,5], as modern economies cannot run without using energy [31]. Moreover, provision of clean, efficient, affordable, and reliable energy sources is also necessary for improving the standards of living of millions of impoverished people in developing countries [3].

It is estimated that around 2.4 billion people in developing countries are still dependent on traditional energy sources such as fuelwood, cow dung cake, and coal, as their main energy source [32]. In the sub-Saharan African countries, biomass fuels account for nearly three-quarters of the total energy consumption [1]. Even in urban areas, where alternative energy sources are likely to be frequently and sufficiently available, many people continue to use traditional fuels for cooking food and heating [8]. Interestingly, in a recent study in the Wolong region of China, it was found that a vast majority of households in the region use fuelwood as their main energy source, despite the fact that they have access to sufficient electricity [3].

Few fundamental research questions arise in this context. Why do households in developing countries not like to switch from traditional energy sources to clean energy? Or what are the determining factors that may induce households to change their energy use pattern? Several studies exist that have attempted to answer these questions and found various factors which could be attributed to the lack of inter-fuel substitution. A household's choice and use of a given source of fuel depends on a host of socio-economic (e.g. income, and wealth), demographic (e.g. family size, household composition, lifestyle, and culture) and location attributes (e.g. proximity to sources of modern and traditional fuels) in addition to fuelwood availability [1,10,11]. What follows is a brief review of related literature on the determinants of household choice of use of energy.

In developing countries, households collect fuelwood mainly from forests and village commons. The wood is available almost free of financial cost [18], as these resources are typically from common land, which lacks clearly defined property rights among

¹ Heltberg et al. (2000) defined private cost of a good as the sum total of financial cost and opportunity cost in terms of resource forgone (including own time) in order to obtain the good.

² Studies revealed that labor shortage is a constraint on crop production (Opschoor, 1981).

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