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Research paper

Adoption of improved cookstoves in Pakistan: A logit analysis

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ABSTRACT

About three billion people worldwide use solid fuels for cooking and space heating. This fueling practice contributes to global forest depletion and disease prevalence. To abate the environmental and health threats caused by the inefficient burning of biomass fuels, large-scale initiatives were undertaken globally for the dissemination of fuel-saving and energy-efficient stoves, known as improved cookstoves (ICS). This paper examines the adoption of ICS in northwest Pakistan by using a logit analysis. The results show that the education of the respondent, number of working household members, and total income of the household had significant effects on the adoption of ICS. Conversely, the age of the respondent and possession of land did not exhibit any significant influence on adoption. The overall model was significant with $p < 0.001$ which reveals that the selected socioeconomic variables have a statistically significant relationship with the adoption of ICS. The paper concludes that the efforts to improve health and environmental conditions may be more successful if ICS programs take the socioeconomic, contextual, and market related factors into account.

1. Introduction

1.1. Energy consumption and economic development

Energy plays an important role in the socioeconomic development of a nation by contributing to improvements in the standard of living and quality of life. Therefore, the state of economic development of a country can be partly assessed by analysing the pattern of its energy consumption [1]. However, with the rapid surge in global population, energy needs are increasing day by day. The projected world population is expected to reach 9.35 billion in 2050 (Fig. 1), and it is anticipated that the total world energy consumption will increase by 33.5% from 2010 to 2030 [2].

The global energy problems will affect developing countries more severely, particularly their rural areas. In recent years, due to the inflated prices of fossil fuels and their environmental shortcomings, public and political interests have shifted from fossil fuels to renewable fuels [4,5]. Renewable energy sources include hydropower, solar energy, wind energy, geothermal energy, and energy from biofuels such as biomass [6].

Globally, more than 3 billion people use biomass fuels for

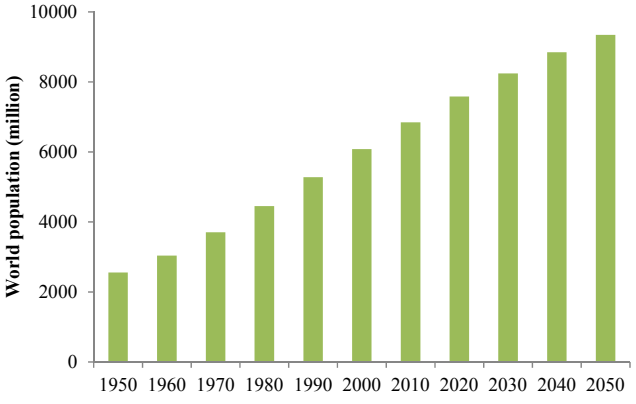

Fig. 1. Total world population (historical and projected) from 1950 to 2050 [3].

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cooking and heating their homes [7,8]. This is one of the major sources of forest depletion in the world [9]. Furthermore, these fuels are burnt in traditional devices which have poor combustion efficiency. The smoke released due to these inefficient cooking and heating practices includes a range of damaging pollutants such as fine particles and carbon monoxide [10–12]. Ambient air pollution, which is mainly caused by the burning of fuelwood, is responsible for about 4.3 million annual deaths [13] and accounts for an estimated 4.5% of the global prevalence of disease [14]. Similarly, more than 50% of premature deaths among children less than 5 years of age are due to pneumonia caused by particulate matter (soot) inhaled from household air pollution [13]. Wood smoke has also been reported to be carcinogenic [15,16]. The rural poor, particularly women and children, are more vulnerable to health hazards caused by the burning of solid fuels [17].

To reduce health problems caused by the incomplete combustion of biomass fuels in traditional cooking devices, improved cookstoves (ICS) programs were launched [18]. The ICS programs were initiated and supported in many countries such as China [19,20], Guatemala [21], India [22], Kenya [23], Malawi [24], Mexico [17], Nepal [25,26], Pakistan [27], Peru [28], Sudan [29], and Thailand [30].

1.2. Efforts for ICS commercialization and scale-up

Currently, more than 160 ICS programs are operating worldwide [31,32]. The Global Alliance for Clean Cookstoves (GACC) is the largest public-private partnership hosted by the UN Foundation working on the production and dissemination of clean, efficient cookstoves and fuels in developing countries [33]. The GACC has set an ambitious goal of enabling 100 million households to adopt clean and efficient cookstoves by 2020 [20]. To foster achieving this goal, the GACC is collaborating with 1600 partners and eight focus countries of Bangladesh, China, Ghana, Guatemala, India, Kenya, Nigeria, and Uganda. The current GACC statistics show that an estimated 53 million cookstoves have been distributed from 2010 to 2015 [34].

Although, increasing proportions of improved stoves and fuels are being distributed each year by all of the partners, China presents the most successful story. The Chinese National Improved Stoves Program (NISP) is the largest stove promotion project in the world. The project follows a market-based approach and has achieved tremendous success in cookstove dissemination [20]. Statistics show that cookstove dissemination programs promoted 179 million cookstoves during 1982 and 1992 [35], including 129 million installations in China [36]. The International Energy Agency (IEA) reports that, by 2030, about 280 million people in China will still rely on solid fuels for cooking and heating [37,38]. Hence, larger disseminations of ICS are important for the Chinese people from both the health and environmental perspectives. Based on the continuing trends of future biomass fuel utilization, the GACC is coordinating with China's National Development and Reform Commission (NDRC) and a few selected ministries to promote the adoption of clean cookstoves and fuels for 40 million more households by 2020 [39]. This is the reason why the Chinese government has added a clean cookstoves provision to the country's 13th Five-Year Plan [34] and is committed to achieve the target by 2020.

1.3. A typology of cookstoves in Pakistan

In Pakistan, rural and semi-urban populations largely depend on biomass fuels for cooking, space heating, and lighting. There is no doubt biomass fuels provide a cheap and easily accessible source of energy for rural population, yet the fact remains that the use of these traditional energy sources brings harm that far outweighs the benefits. The problem is exacerbated by the adoption of inefficient cooking technology in rural areas. Traditional cooking devices such as locally produced three-legged metal stoves (tripod), three-brick hearths, or home-made clay stoves are used in most parts of Pakistan (Fig. 2). Traditional biomass fuels such as dung cakes, twigs and leaves, fuelwood, or a combination of these fuels are fed in these stoves. These stoves are known for their low thermal efficiency, high fuelwood consumption, and increased emission of smoke and particulate matters (PM). It is explicitly evident that inefficient fuelling practices worldwide have emerged as a significant threat to the environment, quality of life, and human health. In most of the rural areas in developing countries, including Pakistan, people use the same room for cooking and living purposes. The occurrence of smoke related diseases such as lung cancer, pulmonary tuberculosis, asthma, and low-birth-weight babies, is quite common in such circumstances [40,41].

Fig. 2. Traditional stove (clay stove) being used in rural areas of Pakistan.

The social, economic, environmental, and health related threats caused by the use of inefficient biomass fuels are serious policy concerns for government of Pakistan. However, due to increased emphasis on electricity and gas in Pakistan's energy policy, due attention has not been provided to promoting efficient biomass cookstoves. Nonetheless, a few NGOs namely Agha Khan Rural Support Program (AKRSP), National Rural Support Program (NRSP), and Kalam Integrated Development Program (KIDP) have initiated ICS dissemination programs in their respective project areas [27,42]. In these areas, particularly in Chitral (the project area of AKRSP), the ICS, referred to as the project stoves (Fig. 3), are provided to communities at subsidized rates. However, local artisans have developed (copied) ICS referred to as 'market stoves'. These stoves are manufactured without any standardization measures and hence are less efficient and durable. The price of a market stove varies from PKR* 1000 to 3,000, whereas the price of a project stove is PKR 10,000 to 12,000. However, in Chitral, these stoves are provided to the community on a pilot basis at the subsidized rate of PKR 3000. The rest of the cost is met from the project fund. In all these stoves, fuelwood is used which is collected from the nearby forest (see Table 1).