# Programmes promoting improved household stoves in China

*China Improved Stove Program Review Team with participants from the University of California, Berkeley and San Francisco; Tsinghua University; Renmin University; and the Chinese Centers for Disease Control.*

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## Introduction

In rural China, crop wastes and wood are the main household fuels. The use of these fuels burdens rural residents and ecosystems in many ways. This is one of the reasons why China has undertaken programmes to improve the welfare of rural residents, including several aimed at household stoves. In the early 1980s, the Chinese government organized the world's largest publicly financed initiative to improve stoves – the National Improved Stove Program (NISP). It aimed to provide rural households with more-efficient biomass stoves (Figure 1) and, later, improved coal stoves, for cooking and heating. The Ministry of Agriculture (MOA) ran the NISP, supporting 860 of the country's approximately 2,100 counties.

The Ministry of Agriculture (MOA) claimed that, in 1998, 185 million of China's 236 million rural households had improved biomass or coal stoves. In recent years, the MOA has turned towards integrated household welfare programmes. Other agencies also have improved-stove programmes, including the Ministry of Health (MOH) and the State Development Planning Commission.

A qualitative review of NISP implementation done in the early 1990s showed that the programme has succeeded in putting stoves in the home (Smith, *et al*. 1993). However, the impact on air quality and health were not assessed. Now, nearly a quarter century after the programme's inception, the question remains, 'What have been the benefit of NISP?'

This independent multidisciplinary review, funded by the Household Energy and Health Programme of the Shell Foundation, and carried out by a multidisciplinary team from the University of California and several Chinese institutions, had three major objectives:

1. to evaluate the implementation methods used to promote improved stoves;
2. to evaluate the commercial stove production and marketing organizations that were created during the same period; and
3. to measure the household impacts of the programmes.

To address the first two objectives, the team implemented a *facility survey* of 108 government agencies and enterprises at different levels. To address the third objective, a *household survey* of 3476 households was undertaken that included measures of:

- health
- stove performance
- socioeconomic factors
- indoor air quality – in a subsample of the households

Three provinces were chosen to represent, respectively, high, medium, and low adoption rates of improved stoves and improved fuels. They also represent a significant range of income and climate conditions.

Figure 1 Improved stoves for biomass – chimney built into wall (*photo: Kirk Smith*)

## Summary of major results

### *Stoves and fuels*

- China implemented broadly successful programmes that delivered better stoves to majority of households in targeted counties. That success was based on strong administrative, technical, and outreach competence, and resources situated at the local level, motivated by sustained national-level attention.
- Based on the household survey, it appears that claims for penetration of improved stoves were somewhat overstated, partly due to unclear definitions for improved stoves. On this limited survey, it would seem reasonable to adjust official figures downward by around 20%.

- Although most biomass stoves now in use have flues, grates, and other 'improved' aspects, most coal stoves lack flues and cannot be considered improved from the standpoint of indoor air quality and health.
- Field tests indicate improved stoves built some years ago are probably not now reaching the 20% to 30% efficiency levels targeted by government programmes, but they are on average somewhat more efficient than existing traditional stoves.
- Efficiency of hand-built improved stoves may deteriorate over time due to materials, construction techniques, and maintenance practices. Commercial, mass-produced stoves that retain improved efficiency and emissions characteristics over time have begun to appear in many rural areas.
- In most areas, where stoves in the marketplace would once have been called 'improved' they are now accepted as the normal conventional stove – people now expect 'improved' stoves and do not regard them as special.
- A wide variety of stoves and fuels are used in rural areas (Figure 2); in winter in the three provinces surveyed, 28 different fuel combinations were used in the kitchens, and in summer, 34 different fuel combinations were used. This made comparisons difficult among many combinations within the sample size of this study.

### *Indoor air quality*

- For nearly all the household stove/fuel groupings, the levels of health-damaging particles were higher than the national standard for indoor air (150 μg PM10/m3) – sometimes more than twice as high.
- Even in summer, many households using coal experienced levels of carbon monoxide several times the national indoor air quality standard of 10 mg/m3 (equivalent to 9 ppm), and in winter the situation was worse, particularly for households also using biomass.
- If these results are typical of rural households using solid fuels, then a large fraction of China's rural population is currently chronically exposed to levels of pollution significantly higher than those determined by the Chinese government to harm human health.
- Because many households use multiple fuels (Figure 3) in multiple stoves for both cooking and space heating, improved biomass stoves alone may not result in reduced indoor air pollution in all seasons. Improved stoves in the surveyed households, however, did result in reduced concentrations indoors of the very small and most dangerous smoke particles for biomass fuel combinations.
- Since many households change fuels daily and seasonally, health implications from fuel use are difficult to assess. Further research is needed to analyse health impacts, as well as other effects such as regional and global air quality impacts in more depth. Larger sample sizes would also be needed.
- The contribution of tobacco smoke to indoor pollutant levels in houses using solid fuels seemed to be small compared to the magnitude and variability due to stove use. As contributions from stoves decrease the relative contribution of environmental tobacco smoke will increase.

Figure 2 Unvented stove with bellows (*photo: Kirk Smith*)

### *Health*

- In general, clean (gas) fuels and clean-fuel stoves improved health although these results were not always statistically significant; possibly due to the small number of cases.
- Coal use was associated with increased levels of carbon monoxide in people's breath, and improved biomass stoves with lower levels of breath carbon monoxide, once the analysis was adjusted for age, sex, smoking status, income, and education.
- Household-reported childhood asthma and adult respiratory disease increased with coal use and, in general, went down with use of improved stoves and good stove maintenance.

## Major recommendations

Based on measurements in three provinces and two seasons, indoor air pollution levels in rural households are substantially above the new Chinese indoor air quality standards set to protect health. Because of the dozens of combinations of stoves and fuels, a larger study would be needed to determine which combinations work best. In general, improved biomass stoves with flues produce substantially lower indoor pollution levels, but still do not meet standards. The widespread use of coal stoves without flues is associated with high levels in many households.

Although NISP did not have indoor air quality improvement as a major objective, the health impacts of indoor air pollution should be central in future efforts. It would therefore be beneficial to:

– initiate public education programmes about the health hazards of indoor air pollution from solid-fuel cooking/heating systems that do not reliably vent smoke to the outside
– conduct studies within communities to evaluate specific health impacts of indoor air pollution,.
– conduct before and after studies to evaluate the indoor air quality benefits and the cost-effectiveness of interventions. (Smith, 2002)

Support is also needed for Ministry of Health-led programmes to better sort out the persistent problems of fluorosis related to coal use. In addition to the expertise and experience of the MOA in stove dissemination, outside resources could be crucial:

– to develop stove systems, including building modifications, that serve all household needs,

Figure 3 Woman using multiple fuels – coal briquettes, straw and wood, in a rural kitchen

– to create a business model that enables a local manufacturer to supply affordable improved stove systems, and
– to apply experience gained in other countries for designing outreach programmes.

It would be valuable to support the China Association of Rural Energy Industry (CAREI) , and the stove manufacturers it represents, to pursue initiatives that would foster the market for better coal stoves with flues by:

– creating a public-private research and development partnership to create inexpensive coal-briquette stoves with flues that can compete with the currently popular portable stoves,
– protecting intellectual property rights of stove manufacturers, and
– building consensus with key government departments to design and enforce standards for stove manufacturers that will help to eliminate the worst stoves from the market and promote improvement in stove designs.

Such support would be most valuable if integrated into a larger policy of promoting improved coal stoves for rural households. Without this government-led initiative, it is likely that the large number of unvented coal stoves will continue to be sold, creating dangerously high levels of indoor pollution and consequent ill health. There is a need for a new policy interventions to encourage entrepreneurs to provide new low-cost coal stoves. Such a programme would, ideally, involve the cooperation of the Ministries of Agriculture and Health, in coordination with other government agencies, stove manufacturers and research and development organizations, with the aim disseminating improved coal stoves using a similar approach to that used for improved biomass stoves. Ways to promote use of higher-grade coal need to be found as well. Since rural electrification is now nearly universal, targeted promotion of high-efficiency electric appliances for common tasks such as water heating and rice-making could also be effective.

While coal stoves should be the focus of attention, some work remains to be done on the introduction of more advanced models, and on maintenance and repair of older biomass stoves to retain their heat efficiency and indoor air quality. This should be encouraged through promotion of self-supporting commercial ventures. Both indoor air quality protection and fuel efficiency ought to be included within the goals of this effort. As the body of older stoves is often in good condition, development of relatively inexpensive but high-quality inserts for home installation into existing stoves to improve their combustion and efficiency characteristics could be pursued.

China's experience – its relative success with biomass stoves and less-successful effort with coal stoves – demonstrates what can be achieved with a well-conceived and well-run programme that is tailored to local needs and evolves as conditions change. It also shows how continued progress in achieving rural development goals may necessitate a shift in policy focus to different fuels, actors, and mechanisms. Providing a better stove is rarely enough to achieve interlinked policy goals, as socio-economic, ecological, and fuel-supply conditions change.

Goals of programmes may include improving public health, improving safety, reducing fuel demand, and raising overall welfare levels, while continuing to serve culturally conditioned livelihood and other activities. To build long-term support for intervention programmes that may span more than a decade, it is desirable to establish clearly which goals are to be served by an improved-stoves programme, map out its relationship to other programmes with overlapping goals, and provide a means for independent tracking of programme performance in terms of changes in fuel use, indoor air quality levels, health outcomes, and other policy endpoints.

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