

Appendix H: Estimation of Indian Household Fuel Consumption

The limitations in available estimates are listed below.

- In India a wide variety of fuels such as liquid petroleum gas (LPG), kerosene, biogas, coal, coke, charcoal, fuelwood, dungcakes, rootfuel and crop residues (mustard stalks, jute stalks, cotton stalks, rice straw, etc.) are used for cooking purposes.
- A variety of improved stoves such as metal stove, mud stove (with single pot, two pots) and ceramic stoves are now in use through efforts of the Ministry of Non-conventional Energy Sources (MNES).
- The life of the improved stoves is limited (not more than 2 years). So the number of improved stoves in working condition is far less, but by an uncertain number, than the total disseminated to date.
- In India due to the large variation in the agricultural climatic conditions and life style, the types of crop produced also vary from region to region. Depending on the type of crops produced, the crop residues used as fuel also vary.
- There is a considerable variation in the types of food cooked, cooking practices etc. For example the stove known as Hara, employed for simmering milk and fodder preparation, consumes large quantities of dungcake as a fuel and is common in northern states of India. This stove is not in use in southern region.
- Energy consumption levels also vary for different agricultural climatic regions (397-1393 useful kcal/person-day). The biofuel consumption database for India which was made based on the rural energy surveys is found to be quite inadequate. There is a wide variation in the existing rural energy database of India (Joshi and Sinha 1993).

Keeping in mind these limitations, we attempted to estimate the amount of fuel used in India for the year 1990/91.

Biofuel estimation. Large amounts of biofuels are used in rural areas. Three different sources of biofuel consumption estimates for rural India are available. They are:

Rural Energy Database (REDB). REDB is based on the analysis of data compiled for 638 villages in 17 states spread over 14 agricultural climatic regions and covering 39000 households.

Integrated Rural Energy Planning Programme (IREP). IREP database, compiled by the Planning Commission, Government of India, is based on block level surveys covering nearly 250 blocks. (Blocks are the local administrative subdivision under the district. Each block consists of groups of villages.)

National Council for Applied Economic Research (NCAER) database. The NCAER data are based on surveys conducted in 7500 households (in rural areas) selected from 600 villages in 300 districts.

Among these three estimates, the REDB estimates are on the higher side and NCAER estimates are on the lower side. So we have used IREP estimates in our fuel use estimation of rural India even though IREP database has the following uncertainties.

1. The IREP estimate of crop residues for West Bengal is zero, whereas it is known that crop residues are used extensively in the state.
2. There are no estimates for Goa.
3. There are no data for dungcake and crop residues for the northeastern states.

Steps involved in biofuel consumption estimation by stove type for rural India (see **Figure H-1**).

- The state biofuel figures given by IREP estimates are divided by the total number of households in different states of rural India to get the per household consumption.
- The state data distribution of improved stoves till March 1991 was collected from MNES.
- From the total number of improved cookstoves installed, the number of improved cookstoves in working condition was calculated based on the assumption that only 60% are functional.
- In the improved stoves, 10% of the improved cookstoves are assumed to be improved metal and 90% of the improved cookstoves are mud stoves.
- The remaining households are assumed to be using traditional stoves.
- It is estimated that there is only one stove in use in each household.
- It is assumed that each stove consumes the three biofuels in the same proportion given by IREP.
- For biofuel consumption in traditional stoves the number of stoves are multiplied by the household consumption of biofuels.
- The total biofuel in improved cookstoves biofuel consumption is estimated by multiplying the household consumption by 0.80 assuming that the improved cookstoves save 20% fuel consumption and further multiplied by the total number of improved stoves working.

The number of rural households, improved stoves and biofuel consumption in each stove in rural India for the year 90/91 are given in **Table H-1**.

Table H-1. State list of rural households, penetration of improved stoves, and biomass fuel consumption

State/Union territories	No. of rural households	No. of improved stoves installed until 31.Mar.91	No. of improved stoves working			No. of traditional stoves	Total consumption of biofuels (million tons/year)			Per household consumption of biofuels (tons/year)		
			Metal stoves	Mud stoves	Total		Fuel-wood	Dung-cake	Crop residues	Fuel-wood	Dung-cake	Crop residues
Andhra Pradesh	9579605	762598	45756	411803	457559	8817007	10.8	2.9	3.6	1.13	0.30	0.38
Arunachal Pradesh	129956	6042	363	3263	3626	123914	0.5	0.0	0.0	3.85	0.00	0.00
Assam	3265110	101357	6081	54733	60814	3163753	12.3	0.0	0.0	3.77	0.00	0.00
Bihar	10682935	509946	30597	275371	305968	10172989	26.9	9.9	13.0	2.52	0.93	1.22
Goa	120758	48429	2906	26152	29058	72329	0.0	0.0	0.0	0.00	0.00	0.00
Gujarat	4289530	534200	32052	288468	320520	3755330	9.1	2.2	3.0	2.12	0.51	1.70
Haryana	1825870	569136	34148	307333	341481	1256735	1.7	2.9	4.3	0.93	1.59	2.36
Himalchal Pradesh	830856	360886	21653	194878	216531	469971	3.3	0.4	0.2	3.97	0.48	0.24
Karnataka	4920170	470886	28313	254818	283132	4448285	8.3	1.8	3.2	1.69	0.37	0.65
Kerala	3908425	220333	13220	118908	132200	3688092	10.0	0.0	1.6	2.56	0.00	0.41
Madhya Pradesh	8243710	845023	50701	456312	507014	7398687	13.1	1.8	1.5	1.59	0.22	0.18
Maharashtra	8410655	662639	39758	357825	397583	7748016	16.0	6.7	5.8	1.90	0.80	0.69
Manipur	203193	21576	1295	11651	12946	181617	0.8	0.0	0.0	3.94	0.00	0.00
Meghalaya	256914	10200	612	5508	6120	246714	0.9	0.0	0.0	3.50	0.00	0.00
Mizoram	60348	7694	462	4155	4616	52654	0.2	0.0	0.0	3.31	0.00	0.00
Nagaland	168918	7000	420	3780	4200	161918	0.6	0.0	0.0	3.55	0.00	0.00
Orissa	4773275	339528	20372	183345	203717	4133747	11.2	0.6	0.4	2.50	0.13	0.09

(Continued)

Table H-1 (continued)

State/Union territories	No. of rural households	No. of improved stoves installed until 31.Mar.91	No. of improved stoves working			No. of traditional stoves	Total consumption of biofuels (million tons/year)			Per household consumption of biofuels (tons/year)		
			Metal stoves	Mud stoves	Total		Fuel-wood	Dung-cake	Crop residues	Fuel-wood	Dung-cake	Crop residues
Punjab	2257090	515796	30948	278530	309478	1741295	1.9	3.4	5.0	0.84	1.51	2.22
Rajasthan	5441095	1080764	64846	583613	648458	4360331	4.3	2.1	0.8	0.79	0.39	0.15
Sikkim	67318	18597	1116	10042	11158	48721	0.2	0.0	0.0	2.97	0.00	0.00
Tamil Nadu	8027750	742420	44545	400907	445452	7285330	8.5	2.0	2.5	1.06	0.25	0.31
Tripura	430649	5971	358	3224	3583	424678	1.4	0.0	0.0	3.26	10.00	0.00
Uttar Pradesh	16784590	1209179	72551	652957	725507	15575411	21.9	17.2	17.3	1.30	1.02	1.03
West Bengal	8384490	317179	19031	171277	190307	8067311	4.4	0.0	0.0	0.52	0.00	0.00
Union Territories	285878	151096	9066	81592	90658	134782	0.4	0.3	0.4	1.40	1.05	1.40
TOTAL	103049088	9519475	571169	5140517	5711685	93529617	168.7	54.2	62.6	54.96	9.55	12.03

The 1991 census found that only 30% of the urban population use biofuels, which we assume to be nearly all fuelwood in traditional stoves with a consumption norm of 1 kg/person-day. The total urban consumption of fuelwood is thus calculated to be 23.8 million ton/year.

Charcoal consumption in cookstoves for the year 1990/91 is calculated from the charcoal production data. FAO (1994) reported that in India about 2 million ton of charcoal was produced in the year 1991. Most of the charcoal was used for small-scale industries such as bakeries, laundries, silk re-reeling, jewelry making, etc. so it is assumed only 25% was used in cookstoves.

Biogas consumption is estimated from the number of family biogas plant installed. Up to 1990/91, 1.4 million family type biogas plants were installed (TERI 1997). The plant capacity is 2m³/day. The NCAER survey indicates that only 66% of the biogas plants installed are in working condition (NCAER 1992). Based on the assumption that 66% of the installed biogas plants produce biogas with a 70% of the plant capacity, 666 million m³ of biogas was consumed in India.

Commercial Fuels (LPG, kerosene). Commercial fuels such as LPG and kerosene are used by 30% of the population, mainly in urban areas. For the year 1990-91 total LPG consumption was 2.4/5 million ton. Out of which, 78.4% (1.894 million ton) was used for domestic purpose (MoPNG, 1993).

In 1990/91, kerosene consumption was 8.4 million ton/year, but it is unclear what fraction was used for cooking. In 1991, 60% of the kerosene was used in rural sector (MoF 1992), where most is used for lighting. NCAER (1985) indicated a cooking: lighting ratio of 0.186:1 in rural areas and 3.46:1 for urban areas. Kishore and Joshi (1995) reported that the predominant use of kerosene for lighting in rural areas and for cooking in urban areas continues. It is thus estimated that 3.98 million ton of kerosene was used for cooking during 1991, of which 29% is used in rural areas. In the absence of data on how much is used in each kind of stove, it is assumed that in urban area 60% of the kerosene is used in wick stoves and 40% in pressure stoves. The reverse percentages are assumed for rural areas.

The estimated fuel consumption by stove in India for 1990/91 is in **Table H-2**.

Table H-2. Fuel consumption by stove type in India (million tons/year)

<i>Stove</i>	<i>Fuel-wood</i>	<i>Dung cake</i>	<i>Crop residues</i>	<i>Charcoal</i>	<i>Kerosene</i>	<i>LPG</i>	<i>Biogas (million m³)</i>
Traditional mud (tm)	193.4	31.6	58.6				
Improved metal (imet)	0.71		0.3				
Improved mud (ivm)	6.36	2.77	2.9				
Hara		19.1					
Angethi				0.5			
Kerosene-pressure					1.82		
Kerosene-wick					2.16		
LPG						2.1	
Biogas							666
Total	200.5	53.5	61.8	0.5	3.98	2.1	666