

Appendices to Chapter 3

Appendix 3.1

Fuel wood estimates: a consumption approach NSSO (50th round)

The substantial quantum of unauthorized removal of fuel wood removal is the basis for using the consumption approach in quantifying fuel wood extraction. The Quinquennial Surveys of Consumer Expenditure, conducted in the National Sample Survey Organization of the Ministry of Statistics and Programme Implementation are the source of data for quantities of household fuel wood consumption. The results of the survey conducted during 43rd (1987-88) and the 50th round (1993-94) results of the NSSO form the basis for the current series of national income accounts. The annual growth rate observed in fuel wood consumption during 1987-88 and 1993-94 is used to extrapolate the estimated consumption (state-wise) for the years subsequent to 1993-94. The prices are collected from State forest departments and refer to the prices prevailing at the assembling centers, which is the first point of fuel wood transaction. Since the total fuel wood consumption, arrived at by the above method, includes agricultural crop residues an adjustment is done to net out the contribution of forestry sector from the total. Some other adjustments depending on the estimated uses of fuel wood for cremation etc. is also done.

The survey reveals that 80% of the rural population depends totally on firewood while 28% of the urban population use wood and wood scraps for fuel. The total data reveals that out of the average per household consumption of 84.55 Kg per month 27.61 Kg was home grown while only 10.67 Kg was cash purchase, leaving 46.27 Kg (52 % of total consumption) as free collection.

Another sample survey under the 54th round (January-June, 1998), however re-estimates the annual collection by all households to be 67.4 million tons as against 78.5 million tons figure according the 50th round survey.

The incremental growth rate of Indian's forests is about 26.3 million cu m (FSI 1995), of which around 17 million tons is available on sustainable basis. On the other hand of the total fuel wood requirement in the country is about 201 million tons and out of this 103 million tons (51%) come from forest (Including Plantation). Thus nearly 86 million tons of fuel wood is being removed from the forest and plantation of India every year in excess of what they are capable of producing on sustainable basis. ...Rai, S. N and Chkraborty S. K., (1996), "Demand and supply of Fuel wood, Timber and Fodder in India", Forest Survey of India, Ministry of Environment and Forests, Government of India.

The two sources give different annual figures of fuel wood consumption in India. However the issue of unsustainable practices in fuel wood extraction is supported by both the figures. Given the incremental rate is 26.3 million tons in terms of fuel wood the annual consumption figures of 103 million tons (FSI 1996) and 78.5 million tons (NSSO 50th round) are both unsustainable.

The sample size in the 50th round survey covered in all, 115354 households spread over 11601 sample village blocks. A total of 46148 households were surveyed in the urban blocks and 69206 households were surveyed in the rural blocks with 208248 and 356289 persons respectively in the blocks. The survey covered all the States and the Union territories in India and was conducted from July 1993 to June 1994 & was published in March 1997.

The results of the 50th round of survey are the latest published document on Energy used by Indian Households.

Appendix 3.2

Data Sources for NTFP Model

The Model for obtaining value per hectare of NTFP had been estimated at a district level. A total number of 196 districts were chosen from the different states, which has significant forest covers. Finally 172 districts of those 196 were used for running a regression equation regressing the value of NTFP per hectare (Value) on the biomass per hectare of that district (bioperhec), agricultural wage in that district (agriwag) and a population index (popperhec) obtained by dividing the total population of a particular district by the total forest cover in that district.

Sources and Method: -

The Value of NTFP per hectare of any state was first calculated and the same figure was put across all the districts of that state. For any state (i) the formula generating the NTFP is given by:

$$VNTFP_i = \sum_j^n \left[\frac{GS_{ij}}{TG_i} \right] \times [VNTFP_j]$$

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The Value of NTFP for each stratum is obtained from a collection of Studies including the Study of the Yamuna Basin by the centre for Minor forest products and the study of the BR Hills by Sharad C Lele, ...

The weights used here are the ratio of Growing stock (GS_j) of any Particular stratum in a state to the total growing stock (TG_i) in that state. Note that the suffix for GS is (i), which stands for a particular state and that for the TGS is (j), which stands for the particular stratum.

The Agricultural wages refers to the wages of Reapers and Harvesters (in most of the cases) and other agricultural workers (in a few cases where the former was not available) in rupees per day in the different districts.

The source for the above data is the Agricultural wages in India 1994-95 report by the Ministry of Agriculture.

The Biomass per hectare is obtained for all states from the Forest Survey of India report (1995), "Extent Composition, density of growing stock and annual increment of India forests." Actually

the growing stocks in each state had to be multiplier by the fraction 100/69 to convert them to the Biomass figures. This ratio is obtained from Rabindra Nath, B S Somashekar and Madhav Gadgil (October 1992), “ Carbon flows in Indian Forests.” Technical report no. 66, Centre for Ecological Sciences Indian Institute of Science, Bangalore.

Biomass estimates were derived out of the Growing stock figures. The conversion was done in the following way. First the Growing stock figures which were in thousand Cu m were converted into thousand tons by multiplying these with 0.8 (refer page one 1st page for source). Then the standard conversion factor of 100/69 was multiplied to them for converting them to the Biomass estimates in thousand tons. This ratio is actually based on the average volume per hectare of the Indian forests and so to qualify our estimated of biomass we have used the ratio of the volume per hectare in that state to the average volume per hectare for India as a whole as a weight to convert the Growing stock figures into biomass figures. So the conversion factor was in all $(x/74.42)*100/69$, where x is the volume per hectare of that state and 74.42 is the Vol per hectare for India as a whole.

$$Biomass = GrowingStock(intons) \times \left(\frac{100}{69} \right)$$

The population index is obtained by dividing the population of the Villages (with forest covers), by the total forest covered land in that village. These data were available state wise and not for districts, and so it had to be used uniformly across all the districts in a state. The source of this data is the State of Forest Report (1999) by the FSI. The population was measured in numbers and the forest area was measured in sq Km and so the ratio was in population per sq km in forest area. This data was not available for al the states and so that is why we had to do with 172 observations out of 196 observations. Mainly for the northeastern states and Jammu& Kashmir the data was not available.

However it might be noted that the states of Punjab, Haryana, Chandigarh and some of the union territories like Delhi were left out owing to the minimal forest covers in these states and UTs.

Having explained the variables used we now move on to the regression out put box.

The regression was carried out in Eviews and the regression out put box is given below. The abbreviations are explained earlier.

Estimation Equation:

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$$\text{VALUE} = C(1) + C(2)*\text{AGRWAG} + C(3)*\text{BIOPERHEC} + C(4)*\text{POPPERHEC}$$

Substituted Coefficients:

$$\text{VALUE} = -356.0894398 + 3.484854703*\text{AGRWAG} + 16.33936086*\text{BIOPERHEC} + 31.75380258*\text{POPPERHEC}$$

-356.0894 + 3.484855 (29.47959) + 16.33936 (108.6866) + 31.75380 (4.693310) = Rs 1671.54 per hectare.

The figures used in the parenthesis are the all India average figures obtained from the Table for descriptive stats given below.

Rs.1671.54 is the yield per hectare of NTFP in India as a whole as per the estimated model.

The Descriptive statistics for the series used in the model and the forecasted value of yield per hectare is given below. The table is self-explanatory and can obviously be used for further analyses:

Table 3.21 (A) Descriptive statistics for the variables used in the Model and the estimated value.

	VALUE	ESTIMATED	BIOPERHEC	AGRWAG	POPPERHEC
Mean	1584.255	1584.255	108.6866	29.47959	4.693310
Median	1268.660	1218.540	83.88406	26.00000	4.158500
Maximum	6753.642	4738.229	294.9275	85.00000	13.66440
Minimum	827.3313	475.7907	40.43478	15.00000	1.083030
Std. Dev.	1356.233	944.7540	58.62946	9.989763	2.735694
Skewness	2.979039	1.867888	1.662237	2.212870	1.266362
Kurtosis	11.20198	6.178974	5.668980	10.07374	4.924589
Jarque-Bera	839.2979	196.5055	148.4340	568.6044	72.51755
Probability	0.000000	0.000000	0.000000	0.000000	0.000000
Observations	196	196	196	196	172

Appendix 3.3

This appendix provides details of the sources of data used in estimation of carbon sequestered in Indian Forests.

Data

The Variables for which Data was necessary for estimation of Carbon flows are as follows: -

(1) Timber extraction data from 1953 to 1997.

The **unit** for measurement of this variable is in **thousand cubic meters**. However it had to be converted to **thousand tons** by multiplying it with a standard conversion factor of **0.8**. (1 cu m is equivalent to 0.8 tons in general). This conversion factor is the standard one and it is furnished in the conversion tables given at the end of the **ICFRE reports, “Forestry Statistics of India”** {1988-94, 1995, 1996 and 2000 reports}.

The **Source** of the extraction data is the, **“Statistical Abstracts of India”** by **CSO Department of Statistics Ministry of Planning and Programme Implementation Government of India, New Delhi**. Reports for the year {1961, 1970, 1979, 1980, 1990, and 1997} were used for data collection. The data for extraction between the period 1981 to 1987 were **FAO** estimates and they were quite large as compared to the trend value that one could expect from the data for extraction in the previous extractions, so these estimates were replaced by the fitted value of data arrived at from the linear trend fitted to the extraction data¹. The **Sources** for extraction data after 1987 are ICFRE reports, “Forestry Statistics of India” mentioned above. Reports used were for the years {1988-94, 1995 and 2000}.

(i) **Firewood** extraction figures for the same period of time were collected from the same **Source** mentioned above. From 1953 to 1980 it was collected from Statistical abstracts of India and for the period 1981 to 1987 a trend value was fitted after assuming extractions to follow a linear trend¹. For the recent years 1988 to 1997 the ICFRE reports were used. The **units** for the measurement of extraction data was in thousand tons and very rarely it had to be changed from thousand cubic meters to thousand tons and for this purpose the figures in cu m were multiplied by the same conversion factor of 0.8 as mentioned above.

¹ The estimated trend had statistically significant T-statistics and were significant at even 5% level of error.

(ii) **Poles** which were commercially extracted were collected from the same **Sources** as above. However for the more recent years Poles data was given in numbers and to convert that to the cubic contents an average height and average girth of poles were assumed. Poles of length between 3 to 4 meters were taken as standard and then an average cubic content of 1.11125 was considered for a pole with the standard length of 3-4 meters and mid-girth of 31.25 cms.

(iii) **Rounded Wood** is the terminology used for Poles in the Statistical Abstracts of India. So Poles and round wood essentially mean the same thing. So these sets of data on Poles and Rounded wood has been treated alike.

3.9 Aggregation of different series of extraction data: -

Due to the **Similarity** of the **Coefficients** through which extracted **timber and poles** effect the annual flows of carbon, we have aggregated these figures and thus arrived at a single series for Timber, Poles and Round wood (this figure also includes Pulp and match wood in certain years if they were available) thereafter we have named it as timber extractions. The focus is on the end use of the extracted output and a one to one correspondence between end use and rate of carbon emission. The analogy is easily detectable.

In the similar manner we have aggregated Fire wood and Charcoal wood Data to arrive at a single series for Firewood. All these series run from 1953 to 1997.

(iv) **Grass and Fodder** data were available only after 1988 and up to 1997 from the ICFRE reports. {Volumes used are 1988-94 and 2000}. For the earlier years this data was not available. Grass and fodder data was in tons and it had to be converted to biomass figures in thousand tons and for the conversion was in two steps. First the Grass figures were multiplied by the standard conversion factor of 100/69 and it was subsequently divided by thousand. The standard conversion factor is obtained from Rabindra Nath, B S Somashekar and Madhav Gadgil (October 1992), “ Carbon flows in Indian Forests.” Technical report no. 66, Centre for Ecological Sciences Indian Institute of Science, Bangalore.

(v) **Growing stock** was collected from the FSI (1995) report, “ Extent composition density growing stock and annual increment of India forests.” The growing stock for each state under each kind of stratum available in that state was available in thousand Cu m.

(vi) **Biomass estimates** were derived out of the Growing stock figures. The conversion was done in the following way. First the Growing stock figures, which were in thousand Cu m were converted into thousand tons by multiplying these with 0.8. Then the standard conversion factor

of 100/69 was multiplied to them for converting them to the Biomass estimates in thousand tons. This ratio is actually based on the average volume per hectare of the Indian forests and so to qualify our estimated of biomass we have used the ratio of the volume per hectare in that state to the average volume per hectare for India as a whole as a weight to convert the Growing stock figures into biomass figures. So the conversion factor was in all $(x/74.42)*100/69$, where x is the volume per hectare of that state and 74.42 is the cu m per hectare for India as a whole.