



ASSESSMENT AND MONITORING OF VILLAGE FOREST RESOURCES

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Abstract: The area of village forest (0.27 million hectare) is very limited in comparison with government forest land (2.14 million hectare). But the village woodlot area contributes 85% of the total consumption and the remaining 15% is contributed by government forest land. Need for correct assessment and monitoring is discussed. The main objective of this paper is to recommend appropriate sampling design for correct assessment of village forest resources. A case study was undertaken in the district of Chittagong located at the south-east corner of Bangladesh. A study population of 900 households was formed consisting of 14 rural thanas in the district. The seven parameters defined under five variables were calculated for complete enumeration. The parameters were estimated through Cluster Sampling, Two Stage Sampling and Stratified Two Stage Sampling (Self-Weight) taking 250 sample households in each method. The estimates were compared with the enumerated values on the basis of percentage standard error, percentage accuracy, percentage bias and 95% confidence interval. Stratified Two Stage Sampling (Self-Weighted) provided the best estimates for true total homestead area (78.4 ha for 97 ha), for true total compact tree garden area (49.6 ha for 49 ha), for true total volume of trees (9432.2 m³ for 9490 m³), for true total number of bamboos (53546 for 53229), for volume of compact trees per hectare (164.9m³ for 172 m³) and true number of households with bamboo plantation (413 for 407). Stratified Two Stage Sampling (Self-Weighted) was found to be a suitable technique and was recommended to apply as field sampling design for correct assessment of village forest resources. A continuous monitoring system was also suggested.

Keywords: Village forest, monitoring of village forest, assessment of village forest

Introduction

Bangladesh has 2.14 million ha land under Government forest and 0.27 million ha land under village forest. These two forest areas are about 16% of total land of the country. However, only 0.93 million ha (6.5%) is under tree cover (Anon, 1989). The maximum village forest resources (75%) are in the northern and southern regions of the country (Davidson, 1984). The village woodlot is normally a mixture of fruit trees, the smaller trees, the canes, the bamboos and the shrubs. The trees are not only planted for timber and fuel wood production, but also for food, fodder and other uses in the village communities.

It is known that the village woodlot area being about one-tenth of Government forest area, supplies bulk of sawn timber, firewood and bamboo to the nation. A village forest inventory was conducted and the contribution of saw log, fuel wood and bamboo was estimated as 48%, 70-80% and 70-80% respectively (Hammermaster, 1981). A Stratified Two Stage Sampling was followed

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for the purpose. Douglas (1982b) estimated the contribution of the same resources as 85%, 90%, and 90% respectively using Stratified Three Stage (Self-Weighted) Sampling. Bangladesh Bureau of Statistics (BBS, 1990) obtained the contribution of village woodlot as 85%. BBS followed Stratified Two Stage Systematic Sampling. It is clear that the requirement of wood and bamboo is largely met up from village forest resources.

Village woodlot plays a very important role in meeting up the requirement of wood and bamboo of the country. It is necessary to get an idea on present stocking, species composition, cropping pattern, planting and harvesting rate and land use system, etc. of village woodlot before undertaking an extensive rural forestry sector planning. But no systematic and detailed investigation was made, except Village Forest Inventory conducted in 1981 on the resources. Most of the estimates were not supported by statistical accuracy and precision. The difference in estimation might have occurred mainly due to the choice of sampling method.

The variation due to sampling method can not be accepted and a search for appropriate sampling design is necessary for accurate and precise estimates. Without appropriate sampling method proper assessment and continuous monitoring of the resource are not possible. It is, therefore, decided to choose Cluster Sampling, Two Stage Sampling and Stratified Two Stage Sampling for field testing. It is intended to recommend a suitable sampling design out of these sampling designs as a field sampling technique in assessing and continuous monitoring of village forest resources in Bangladesh.

Materials and Methods

The rural areas (14 rural *thanas*) of Chittagong district was considered as the study area. Chittagong district is one of 64 districts in Bangladesh. It has, however, almost similar type of homestead condition, household occupation, home garden with tree and bamboo plantation, etc. as in other rural areas in the country.

A target population was formed in the study area. A preliminary survey was conducted with a sample of 45 households. A field sheet containing homestead area, compact tree garden area, diameter at breast height, height measurement of trees in both compact and scattered areas, number of bamboos with culms, general information, economic status, etc., of a household was developed. A total of 11 major tree and 3 common bamboo species were selected for data collection. A number of many minor tree species was also grouped as others. Similarly a number of a few uncommon bamboo species was grouped as others.

A total of 7 parameters and 5 variables were considered for the study. The seven parameters of total homestead area (ha), total area (ha) of compact tree garden, total volume (m³) of trees, total volume (m³) of compact trees, total number of bamboos, volume (m³) of compact trees per ha and number of households with bamboo plantation were considered. The five variables of area of compact tree garden (x_2), homestead area (x_4), volume of standing trees (y_2), volume of standing compact trees (y_3) and number of standing bamboos (y_4) of a household were also considered.

The target population of 900 households was estimated by a typical formula (Chacko, 1965) on the basis of variable y_2 with 12% margin of error. Homestead area and area under compact tree garden of a household were measured by a long tape in ha and recorded in the field sheet. The diameter at breast height (dbh) measurement of all standing trees (dbh larger than 20 cm) except nariel (*Cocos nucifera*) and tal (*Borassus fiabellfer*) was taken by diameter tape. Volume of all trees was estimated by local volume tables (Aleem, 1981; Islam, 1984; Islam, 1988). A total of 22081 trees and a total of 53229 bamboos of selected species were tallied in 1996 and recorded in the field sheet. Although data of trees and bamboos were collected a long ago, it did not hamper to compare estimated values with enumerated values for selection of a best sampling method. The

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present paper deals with selection of a best sampling method rather than estimating parameters. So, it may not be necessary for recent data. Recent data serve the purpose of up to date estimation. Summary of basic data of target population is presented in Table 1.

Table 1. Summary of basic data of target population (area in ha)

Thana Name	House holds (No)	Agri-cultural Area (ha)	Com pact Garden Area (ha)	Bam-boo Area (ha)	Home Stead Area (ha)	Total Area (ha)	% Com pact Area	All Trees (dbh> 20cm)	Bam-boo (No)	Clu mps (No)	House holds %with Bamboo Plantation
1	2	3	4	5	6	7	8	9	10	11	12
Mirsarai & Sitakunda	143	83.903	9.695	0.599	19.929	114.126	8.49	3485	6046	134	45%
Sandwip	117	59.968	9.098	1.598	8.525	79.189	11.49	3000	15324	188	71%
Hathazari & Fatikchari	144	82.955	7.528	0.204	11.997	102.684	7.33	3876	3934	71	33%
Rangunia & Rawzan	128	86.509	5.793	0.168	10.174	102.644	5.64	2848	1750	56	29%
Anwara, Patiya & Boalkhali	145	115.305	6.41	0.409	29.902	152.026	4.22	3734	6902	165	54%
Satkania & Lohagara	89	53.157	4.087	0.16	6.238	63.642	6.41	1680	2711	61	47%
Banskhali & Chandanaish	134	96.093	6.405	0.334	10.041	112.873	5.67	3458	16562	91	38%
Grand Total	900	577.892	49.014	3.472	96.806	727.184	7.04	22081	53229	766	45%

The five variables are generated through computer. The complete enumeration is carried out and the seven parameters are calculated. Cluster Sampling, Two Stage Sampling and Stratified Two Stage Sampling (Self-Weighted) were chosen for field testing in order to recommend appropriate sampling design. The chosen sampling designs were applied on the target population for estimating the parameters. Stratification was done on the basis of location, land use system and homestead wood and bamboo resources so that each stratum was internally homogeneous. The 14 rural thanas were thus stratified as stratum-I (Mirsarai + Sitakunda), stratum-II (Sandwip), stratum-III (Hathazari+ Fatikchari), stratum-IV (Rawzan+ Rangunia), stratum-V (Anwara+ Patiya+ Boalkhali), stratum-VI (Satkania+Lohagara), stratum-VII (Banskhali+Chandanaish). The 22 villages and 900 households were distributed among the 7 strata. A sample of 250 households was considered to estimate the parameters by the chosen sampling designs. The population total and ratio were estimated by the formula of total estimate and ratio estimate (Obaidullah, 1980). The population proportion was estimated by the formula of proportion estimate (Islam, 1994). The study is to compare the estimates done by chosen sampling designs with the enumerated values of the parameters in respect of percentage standard error (%SE), percentage accuracy (%AC), percentage bias (%bias) and 95% confidence interval. The cost of the survey was not considered in the study. The percentage standard error of the estimate was estimated by $(SE/estimate) \times 100$. Similarly the percentage bias was estimated. The percentage accuracy was estimated by $100 - \{(population\ value - estimate)/population\ value\} \times 100$. The 95% confidence interval was estimated by usual formula. The sample of 14 villages (600 households) and 250

households selected randomly from seven strata were considered as first stage and second stage units respectively.

Results and Discussion

Complete enumeration was carried out and the mean, the standard deviation (SD) and the coefficient of variation (CV) of each of the variables were calculated for the target population (Table 2). Average area of both compact tree garden (0.05 ha) and homestead land (0.11 ha) showed very small figure with high coefficients of variation (1.33 and 6.75). The averages for volume of standing trees (10.54 m³) and number of bamboos (59) are reasonable with also high coefficients of variation (1.11 and 4.31). Here the standard deviations of all variables are larger than the means. It is an indication that the target population was heterogeneous and the stratification was justified. Total area (ha) of compact trees was about half of total homestead area (ha). It means that village people had limited areas for compact tree plantation. Volume(m³) of compact trees per ha was not promising because of perhaps two reasons. One reason was that the smaller trees (less than 20 cm dbh) were not tallied. Another reason could be of dense spacing. Total number of bamboos and number of households with bamboo plantation were not encouraging. Only 407 households out of 900 were interested to plant bamboos. The village people had limited bamboo plantation in comparison with their daily demand. The target population was actually a variable population. Table 2, gives the present situation of wood and bamboo resources in Chittagong which shows an overall picture of village forest resources in Bangladesh.

Table 2. Results of complete enumeration

Sl.No.	Parameter	Total	Mean	SD	CV
1.	Total area(ha) of compact tree garden (Σx_2)	49	0.05	0.07	1.33
2.	Total homestead area (Σx_4)	97	0.11	0.73	6.76
3.	Total volume (m ³) of trees (Σy_2)	9490	10.54	11.57	1.09
4.	Total volume (m ³) of compact trees (Σy_3)	8308	9.23	11.04	1.19
5.	Total number of bamboos (Σy_4)	53229	59.14	254.69	4.31
6.	Volume (m ³) of compact trees per ha ($R_1 = \Sigma y_3 / \Sigma x_2$)	170*	-	-	-
7.	Number of households with bamboo plantation ($NP = N_1$)	407	-	-	-

* Indicates ratio.

The seven parameters were estimated on the basis of 250 sample households using Cluster Sampling, Two Stage Sampling and Stratified Two Stage Sampling (Self-Weighted). The total, ratio and proportion estimates of the parameters with corresponding percentage standard error, percentage accuracy and percentage bias are presented in Table 3.

Table 3. Comparison of cluster sampling, two stage sampling and stratified two stage sampling (self-weighted) with complete enumeration

Sl. No.	Para meter	True value	Cluster			Two Stage			Stratified Two Stage		
			Est.	%Ac	%SE	Est.	%Ac	%SE	Est.	%Ac	%SE
1.	Σx_2	49	52.2	94	10	42.5	87	6	49.6	99	3
2.	Σx_4	97	167.3	27	34	63.4	65	8	78.4	81	2
3.	Σy_2	9490	8668.8	91	6	9076.5	96	6	9432.2	99	3
4.	Σy_3	8308	7614.1	92	6	7707.8	93	7	8182.5	98	3
5.	Σy_4	53229	59242.0	89	41	35261	16	17	53546.0	99	4
6.	R_1	170	179.3	1.5*	15	181.5	0.3*	6	164.9	0.3*	10
7.	NP	407	441.0	92	16	421.0	97	8	413.0	99	7

* Indicates % bias.

It is observed that the percentage accuracy of all estimates except estimate of R_1 are increased in Stratified Two Stage Sampling (Self-Weighted) compared to Cluster Sampling and Two Stage Sampling. It indicates that the estimated values are very close to the true values. The percentage bias of the estimate of R_1 is also improved and negligible in the same sampling design. The percentage standard errors of all estimates are decreased in comparison with other two sampling designs except R_1 . The estimate of R_1 has a standard error 10 which may be accepted in the present homestead condition of Chittagong. All population values (true values) lie within the intervals estimated at 95% confidence interval estimated by a separate sample. In view of all these measures of reliability of the estimates Stratified Two Stage Sampling (Self-Weighted) yields reliable estimates.

After selecting the suitable sampling design, it is important to discuss about method of monitoring village forest resources. A continuous monitoring system is required for planning purposes. It needs re-measurement data about felling and growth of village forest at every certain period after first measurement is done by a suitable sampling design. The Double Sampling technique may be advantageously used to estimate growing stock at a subsequent period of 5 years or on two or more successive occasions after the first initial survey is done. It is possible to couple Double Sampling with selected Stratified Two Stage Sampling (Self-Weighted) for economy and enhancing the accuracy of the estimates. Two stage sample of villages and households may be taken for the estimation of the effective households having homestead tree resources and a sub-sample of households may be taken for estimating growing stock. In estimating the change in growing stock, it is suggested to take 10% sample of original samples at the second occasion at 5 years interval of time. In this way Stratified Two Stage Sampling (Self-Weighted) design may be used for both assessment and monitoring of present village forest resources.

The selected sampling design may be easily applied in the field. It will provide quick estimates with improved precision and accuracy as well as with reduced cost. It was tested with field data through computer. So, there was no scope of having non-sampling error. Sampling error was, however, obvious. The sampling units, frame, sampling intensity, stratification and self-weighting techniques may be easily used in present homestead situation depending on the cost and time factors. Therefore, Stratified Two Stage Sampling (Self-Weighted) may be recommended for the assessment and monitoring of village forest resources in Bangladesh.

References

- Aleem, S.A. 1981. *Tree volume tariff and bamboo weight tariff for village forest inventory of Bangladesh*. Project report, UNDP/FAO Project BGD/78/020
- Anon, 1989. *Strengthening the Bangladesh Forest Research Institute, Chittagong*. Project digest
- BBS, 1990. *Survey of farm forestry, 1988*. Report, Bangladesh Bureau of Statistics, Statistics Division. Ministry of Planning, Dhaka
- Chacko, V.J. 1965. *A manual on sampling techniques for forest surveys*. Forest Research Institute, Dehra Dun, India
- Davidson, J. 1984. *Research in the forest management branch of the Bangladesh Forest Research Institute*. Field Document No. 4. Volume No. 1. UNDP/FAO Project BGD/79/010
- Douglas, J.J. 1982b. Traditional fuel usage and the rural poor in Bangladesh. *World Development* 10(8): 669-678

- Hammermaster, E.T. 1981. *Village forest inventory of Bangladesh*. Inventory results. UNDP/FAO Project BGD/78/020
- Islam, S.S. 1984. *Volume tables for some indigenous forest species in Bangladesh*. Bulletin No. 3. Forest Inventory Series. BFRI, Chittagong
- Islam, S.S. 1988. Commercial volume table for teak (*Tectona grandis* Linn. f.) in Bangladesh by regression technique. *Bano Biggyan Patrika* 17 (1&2): 53-67
- Islam, S.S. 1994. *Sampling design for assessing village wood and bamboo resources in Bangladesh: an exploratory study*. Ph.D. Thesis
- Obaidullah, M. 1980. *Consultant's report on sampling design and statistical analysis consideration for national village forest inventory of Bangladesh*. UNDP/FAO Project BGD/78/020