SELECTION OF SUITABLE FORMULA FOR VOLUME MEASUREMENT OF SHISHAM LOGS

Muhammad Afzal[1], Sahibzada M. Hafeez[2] and Aqeela Mobeen Akhter[3]

Abstract

Among different formulae i.e. Smalian, Huber and Quarter Girth tested for suitability for volume measurement of the same lot of Shisham logs, Smalian's formula gave the highest volume over the other two. For under bark volume measurement, percent ratio of Smalian, Huber and Quarter Girth formulae came to be 100:86:68 while Huber and Quarter Girth formulae gave 100:79 ratio, respectively. It is preferable to use Smalian's formula, which besides other advantages gives more accurate result i.e. the result nearer to the actual one. Forest Department, at Changa Manga plantation has an economic benefit on sale of Shisham timber by giving 2.54 cm bark allowance per foot girth instead of selling it on under bark volume basis. Moreover, results revealed better quality timber production at Changa Manga as compared to Chichawatni plantation.

Keywords: Formula, olume measurement, shisham logs.

Introduction

In ancient times, the forest resources were in abundance. Wood demands were negligible as compared to supplies due to low population and non-industrialization. The standards of measurements if existed anywhere, were very crude and rough and varied from locality to locality. Mostly, the people entered in the nearby forest and cut as much wood as required. Forests were considered as common wealth and no law for the protection and management of the forests existed.

As the population increased with increasing rate, demand for the basic necessities such as food, cloth and shelter increased with the same rate. Wood especially the timber became economic rather than free good and the forest law to channelize the supply of wood came into existence. The advancement in civilization resulted in increased use and higher demand for timber. All this made the owners, the middlemen and the end consumers quantity-conscious. Nevertheless, Howard (1925) and Bakshi (1941) recorded height and diameter

[1] Senior Research Officer, PFRI, Faisalabad.
[2] Project Director, PFSDP, Lahore.
[3] Research Officer, PFRI, Faisalabad.

growth figures in computing yield tables for *Dalbergia sissoo*. Furnival (1961) tried different regression models to select the best one for preparation of the volume tables. Measurement of timber is needed not only to quantify forest produce for sale but is also required in management, notably for planning purposes and for control of resources.

Small wood (thicker end diameter < 20.3 cm) having comparatively less economic value is measured by somewhat rough measures. Timber, being more useful and precious good needs more accurate measurements. The most accurate method of measuring the volume of wood is by measuring the volume of water it would displace. This method is fairly good for irregularly shaped and small pieces of wood and cannot be used for bigger logs. In case of bigger logs, the volume can be rapidly computed from the measurements of dimensions of the logs, which approach nearly regular geometric solids. Thus, the volume of a parabolic log can be computed with the methodologies of Huber, Smalian, Quarter Girth; etc. The most common method of volume computation of felled timber in the field is by Quarter Girth formula. Present study was undertaken with the objective to compare different methods of volume determination of felled timber in the field and find out the best one. The study was conducted in Chichawatni and Changa Manga plantations, which are famous for high quality timber production of Shisham (*Dalbergia sissoo*) in Punjab.

Materials and methods

Data were collected during 1994. Ten (10) logs from each class of timber were taken for volume computation by different methodologies in each of the above plantations. Timber was classified as under:

Class I	=	160 cm and above mid girth
Class II	=	134.6 cm – 157.5 cm mid girth
Class III	=	96.5 cm – 132.1 cm mid girth
Class IV (Undersized)	=	61 cm – 94 cm mid girth
Length of logs	=	3.1 m (For all classes)

Forty (40) logs in each plantation were taken for study. Volume of single log in each and every class was calculated with the following six methods in m^3 and was exaggerated to avoid decimal fraction:

1. Smalian Over-bark (SO) (Standard)
2. Quarter Girth Over-bark (QO)
3. Smalian Under-bark (SU)

4. Quarter Girth Under-bark (QU)
5. Quarter Girth Over-bark with 2.54 cm bark allowance per 30.5 cm girth (QA)
6. Huber Under-bark (HU)

Smalian: $$V = \frac{A1 + A3}{2} \times L$$

Where,

V	=	Volume of the log.
A1	=	First end cross-sectional area.
A3	=	Second end cross-sectional area.
L	=	Length of the log.

Quarter Girth: $$V = \frac{(G)^2}{4} \times L$$

Where,

V	=	Volume of the log.
G	=	Mid girth.
L	=	Length of the log.

Huber: $V = A2 \times L$

Where,

A2	=	Mid cross-sectional area.
L	=	Length of the log.

Randomized Complete Block Design (RCBD) was used for data analysis. Data were analyzed separately for each plantation and class with the above six methods as treatments and number of logs in each class as replications. Duncan Multiple Range (DMR) test was applied to test the variation in each method.

Results and discussion

Variation in different methods of volume measurement taken as treatments and the number of logs in each class considered as replications for all of the four classes at Chichawatni and Changa Manga Plantations (Table-1 & 2) was significant at 1% level of significance. DMR test was applied to quantify the variation among different methods of volume measurement. Smalian's formula significantly gave 32% and 14% (Chichawatni), 28% and 9% (Changa Manga) excess volume (under bark) over Quarter Girth and Huber formulae, respectively. Huber's formula showed almost the same significant difference of 21% excess volume (under bark) over Quarter Girth at both plantations sites.

Table 1. DMR test for difference in Means at Chichawatni Plantation

Method	Difference in Means				Excess Volume (%)				Average
	Class I	Class II	Class III	Class IV	Class I	Class II	Class III	Class IV	
SO-QO	14.76* (4.36)	6.84* (1.66)	3.69* (1.43)	2.42* (0.86)	31.98	29.74	26.86	31.63	30.05
SU-QU	14.16* (4.60)	5.68* (1.75)	3.01* (1.51)	2.00* (0.88)	36.77	31.87	28.67	31.40	32.18
SU-QA	12.14* (4.49)	4.26* (1.71)	2.05* (1.47)	1.97* (0.86)	31.52	23.91	19.52	30.93	26.47
SU-HU	7.62* (4.36)	2.41* (1.66)	0.97^{NS} (1.43)	0.81* (0.79)	19.79	13.52	9.24	12.72	13.82
SO-SU	7.64* (4.15)	5.18* (1.58)	3.24* (1.36)	1.28* (0.79)	16.55	22.52	23.58	16.73	19.85
QO-QU	7.04* (4.49)	4.02* (1.71)	2.56* (1.47)	0.86* (0.84)	22.43	24.88	25.47	16.44	42.31
QA-QU	2.02^{NS} (4.15)	1.42^{NS} (1.58)	0.96^{NS} (1.36)	0.03^{NS} (0.79)	7.66	12.79	11.36	0.68	8.12
HU-QU	6.54* (4.36)	3.27* (1.66)	2.04* (1.43)	1.19* (0.86)	21.17	21.22	21.41	21.40	21.30

* = Significant at 5% level of significance.
N.S. = Non-significant.
( ) = Figures in parentheses indicate LSR values.

Table 2. DMR test for difference in Means at Changa Manga Plantation

Method	Difference in Means				Excess Volume (%)				Average
	Class I	Class II	Class III	Class IV	Class I	Class II	Class III	Class IV	
SO-QO	8.79* (1.42)	5.25* (0.82)	3.08* (0.56)	1.57* (0.31)	26.53	26.95	25.56	25.95	26.25
SU-QU	7.75* (1.45)	4.46* (0.86)	2.79* (0.59)	1.27* 0.32	28.44	29.13	29.28	27.02	28.47
SU-QA	6.80* (1.42)	3.36* (0.84)	1.99* (0.58)	0.94* (0.32)	24.95	21.95	20.88	20.00	21.95
SU-HU	2.40* (1.31)	1.43* (0.82)	0.95* (0.56)	0.32* (0.31)	8.81	9.34	9.97	6.81	8.73
SO-SU	5.88* (1.31)	4.17* (0.78)	2.52* (0.54)	1.35* (0.29)	17.75	21.41	20.91	22.31	20.60
QO-QU	4.84* (1.38)	3.38* (0.84)	2.23* (0.58)	1.05* (0.32)	19.88	23.75	24.86	23.44	22.98
QA-QU	0.95^{NS} (1.31)	1.10* (0.78)	0.80* (0.54)	0/33* (0.29)	4.65	9.21	10.61	8.78	8.31
HU-QU	5.35* (1.42)	3.03* (0.82)	1.84* (0.50)	0.95* (0.37)	21.53	21.83	21.45	21.69	21.63

* = Significant at 5% level of significance.
N.S. = Non-significant.
( ) = Figures in parentheses indicate LSR values.

Smalian's formula showed 20% while Quarter Girth gave 4% bark portion both significant at 0.05 probability level at Chichawatni plantation. This bark share was 21% and 23%, respectively at Changa Manga plantation. This means bark constitutes a significant component ($1/5^{th}$) of the total volume of a log. The difference in bark portions between both the formulae depicts non-uniformity of bark thickness on Shisham logs. While comparing volume measurement taken through Quarter Girth over bark with 2.54 cm bark allowance per 30.5 cm girth with Quarter Girth under bark, no significant difference was noted in any timber class at Chichawatni plantation. However, this difference was significant in all classes except class I at Changa Manga plantation which showed comparatively thicker bark layer on Shisham logs at this plantation. Class I gave non-significant adverse result due to the fact that at older stages bark looses its firmness and partly sheds away.

Smalian's formula gave 30% and 26% excess volume (over bark) over Quarter Girth formula at Chichawatni and Changa Manga plantations, respectively. These excess volume percentages were less by 2% as compared to under bark volume comparisons between these two formulae. This 2% variation arose

because of greater mean values of over bark volumes than under bark volumes and almost constant difference of means among the over bark and under bark comparisons. Furthermore, results showed higher values and greater variation in excess volume percentages among different classes under same method of comparison at Chichawatni plantation. This indicates irregular growth and low quality timber production at this plantation as compared to Changa Manga.

For the data pooled class wise for both the plantations (Table-3), difference between treatments (methods) as well as replications (logs) was highly significant. Excess volume percentages for Smalian and Humber formulae over Quarter Girth formula were almost the average of values from both the plantations for respective comparison. Smalian's formula gave significant excess volume (under bark) of 31% and 12% over Quarter Girth and Huber formulae, respectively. Huber's formula showed 21% excess volume (under bark) over Quarter Girth method, significant at 0.05 probability. Smalian's formula gave 20% bark portion while Quarter Girth showed 23% bark share significant at 5% level of significance. Volume difference between Quarter Girth over bark with 2.54 cm bark allowance per 30.5 cm girth and Quarter Girth under bark was significant at 0.05 probability level in class II and III. Class IV showed non-significant result because of thin bark layer on Shisham logs at their early stage of growth while the unexpected result in Class I has been explained earlier.

Table 3. DMR test for pooled data (class wise)

Method	Difference in Means				Excess Volume (%)				Average
	Class I	Class II	Class III	Class IV	Class I	Class II	Class III	Class IV	
SO-QO	11.77* (5.73)	6.05* (0.92)	3.39* (0.74)	1.99* (0.46)	29.69	28.48	26.28	29.05	28.38
SU-QU	10.86* (5.87)	5.07* (0.97)	2.90* (0.78)	1.64* (0.47)	33.13	30.60	28.94	29.60	30.57
SU-QA	9.37* (5.73)	3.65* (0.96)	2.02* (0.76)	1.45* (0.46)	28.58	22.03	20.16	26.17	24.24
SU-HU	4.91^{NS} (5.26)	1.92* (0.92)	0.96* (0.74)	0.56* (0.42)	14.98	11.59	9.58	10.11	11.57
SO-SU	6.86* (5.26)	4.67* (0.87)	2.88* (0.70)	1.31* (0.42)	17.31	21.99	22.33	19.12	20.19
QO-QU	5.95* (5.55)	3.69* (0.96)	2.39* (0.76)	0.96* (0.45)	21.35	24.29	25.13	19.75	22.63
QA-QU	1.49^{NS} (5.26)	1.42* (0.87)	0.88* (0.70)	0.19^{NS} (0.42)	6.36	10.99	11.00	4.66	8.29
HU-QU	5.95* (5.73)	3.15* (0.92)	1.94* (0.74)	1.08* (0.46)	21.35	21.50	21.41	21.69	21.49

* =Significant at 5% level of significance. N.S. = Non-significant.
( ) = Figures in parentheses indicate LSR values.

Different methods taken as treatments again showed high variation among each other when data were pooled irrespective of class and site (Table-4). Smalian's formula at 0.05 Probability gave 32% and 14% excess volume (under bark) over Quarter Girth and Huber's method, respectively. Humber's formula gave 21% excess volume (under bark) over Quarter Girth method, significant at 5% level of significance. Both the Smalian as well as Quarter Girth formulae showed significant bark portions of 19% and 23%, respectively. No significant difference was observed among the volumes taken with Quarter Girth (under bark) and Quarter Girth (over bark) with 2.54 cm bark allowance per 30.5 cm girth.

Table 4. DMR test for overall pooled data

Method	Difference in Means	Excess Volume (%)
SO-QO	5.78* (1.52)	28.67
SU-QU	5.24* (1.61)	32.05
SU-QA	4.24* (1.57)	25.93
SU-HU	2.21* (1.52)	13.52
SO-SU	3.81* (1.44)	18.90
QO-QU	3.27* (1.57)	22.74
QA-QU	$1.00^{N.S}$ (1.44)	8.26
HU-QU	3.03* (1.52)	21.43

* = Significant at 5% level of significance.
N.S. = Non-significant.
( ) = Figures in parentheses indicate LSR values.

References

Bakshi, S.R. 1941. Provisional yield tables for *Dalbergia sissoo* in irrigated plantation of Punjab. Indian For. Rec. Silviculture IV-A(2).

Furnival, G.M. 1961. An index for comparing equations used in constructing volume tables. Forest Sci., 7(4).

Howard, S.H. 1925. Preliminary yield table for *Dalbergia sissoo*. Forest Bull., 62.