SATHI FORESTER'S MAGIC WAND[1]

by

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Summary

The stick can be used as a dendrometer, hypsometer, angle gauge, scale stick, range and direction finder besides functioning as an ordinary walking stick. Its accuracy is comparable with corresponding standard instruments.

Introduction

Walking stick has been a companion of the man since ages (1) but it has been seldom used as an instrument for measuring diameters, heights, etc. of the tree. Biltmore and scale sticks which are not walking sticks were designed in the past to measure tree diameters and log volumes respectively. Functions of these sticks are those of certain other instruments like clinometer and angle gauge have been combined in this walking stick which can prove a SATHI (stick A Tested Handy Instrument) to the foresters.

Construction

The SATHI is shown in Fig. 1(a). Its length is about 95 centimetres. It consists of a circular metallic base (A), hexagonal wooden body (B) and a wooden handle (C).

Different parts of the handle (C) are shown in Fig. 1(b). It contains a metallic head (1) having three circular metallic discs of different diameters shown as 1-i, ii, and iii in Fig. 1(b). A horizontal hole (ED) runs through the centre of the handle. The eye hole (E) is used for aligning the object with the horizontal wire fixed at the centre of (D). This is shown in the cross section of (D) in Fig. 1(b). A magnetic compass (H) is fixed at the top of the handle and a dial (G) graduated in degrees with a semi-circular disc (F) is fixed on the side as shown in Fig. 1(b). The disc (F) can be locked or set free through a control (J) which is hinged over the dial (G).

1. Urdu equivalent of 'companion'.

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Two of the sides of body (B) have linear graduations in inches and centimetres. Cross sectional areas corresponding to these linear graduations are also given. The remaining four sides of the body (B) contain technical information, e.g. limiting distances. trigonometric ratios, etc.

FUNCTIONS

As a dendrometer and range finder

The function of SATHI for determination of diameter of a tree when it functions as a dendrometer, and to find out the distance between the observer and the tree when it functions as a range finder is based upon the principle of similar triangles.

Diameter of a tree can be determined by following two methods:

(1) The stick is directed towards the tree at breast height with its and (A) touching the cheek bone and the largest step (1-iii) aligned diametrically at breast height of stem as shown in Fig. 2 (a, b). The diameter of the tree is made to coincide with the diameter of the step by moving towards or away from the tree. Half the distance in feet between the observer and the tree gives the diameter of tree in inches. For example if the distance between the observer and the tree is 40 feet then the diameter of the tree is 20 inches.

(2) The diameter can also be determined by using handle (C) in the horizontal position as shown in Fig. 2 (c, d). Instead of aligning the tree at breast height with the largest step (1-iii), handle width is used in this case. Rest of the procedure is the same as mentioned above. In this case twice the distance in feet between the observer and the tree will give the diameter of tree in inches. For example if the distance between the observer and the tree is 10 feet then the diameter of the tree is 20 inches.

Determination of diameters of small and medium-sized trees is convenient with the help of step (1-iii), while for large-sized trees handle (C) can be used.

The distance between the observer and the tree when the stick functions as a range finder is determined in the following way:

If the diameter at breast height of a tree is known then the following equations govern the relationship between the diameter and the distance between the observer and the tree or range:

$R = 2d$ when using the step (1-iii) and

$R = d/2$ when using handle (C),

where R = range or distance in feet and

d = diameter of the tree in inches.

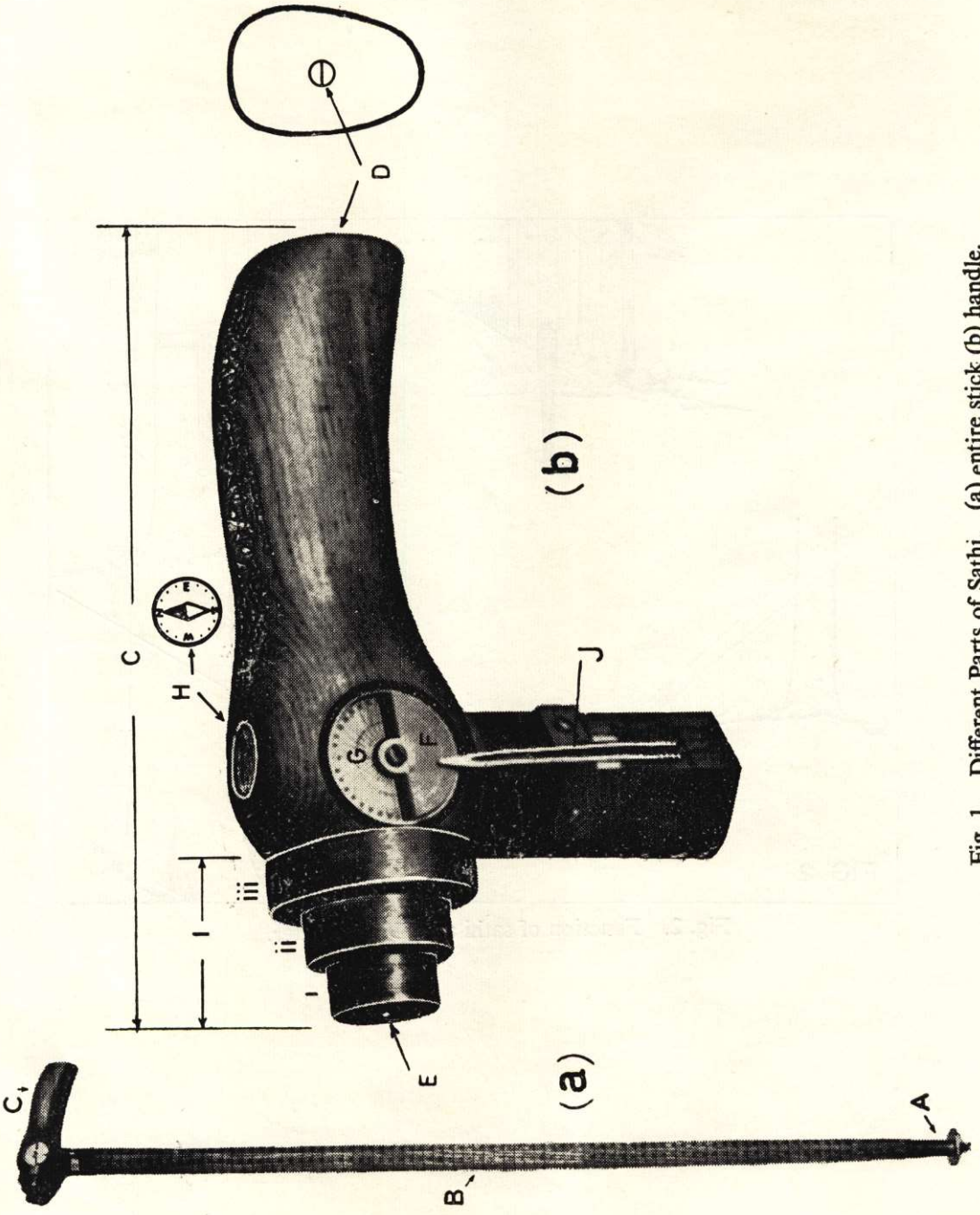

Fig. 1. Different Parts of Sathi. (a) entire stick (b) handle.

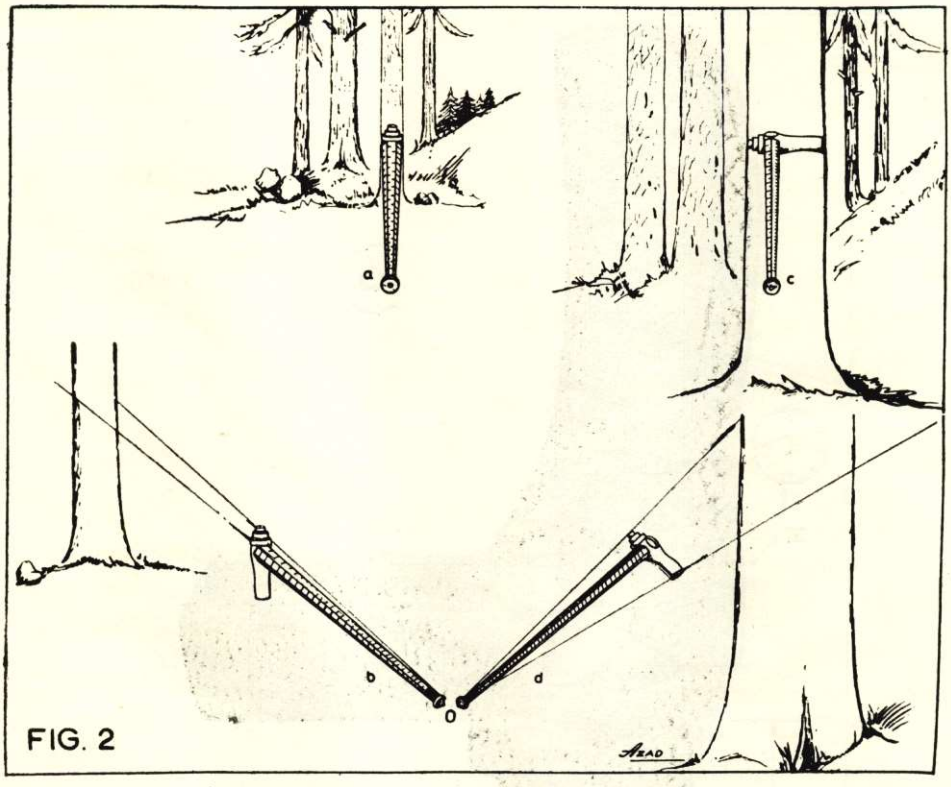

Fig. 2. Function of sathi as a Dendrometer.

Example: (*i*) Using step (I-iii)

$d = 20$ inches

$\therefore$ R $= 2 \times d = 2 \times 20 = 40$ feet

(*ii*) Using handle (C)

$d = 20$ inches

$\therefore$ R $= d/2 = 20/2 = 10$ feet

Comparison with other instruments

Diameters at breast height of 22 shisham (*Dalbergia sissoo*) trees ranging from 8″ to 40″ were measured with diameter tape, steel calliper and SATHI using step and handle separately. The observations are given in Table 1 below:

TABLE 1

Comparison of D.B.H. measurements taken by different instruments on 22 Shisham (*Dalbergia sissoo*) trees

S.No.	Tape	Calliper	SATHI with	
			handle	step
1	2	3	4	5
		Diameter (inches)		
1.	8.6	8.2	8.0	8.2
2.	9.0	8.7	8.2	8.4
3.	10.0	9.3	9.2	9.2
4.	10.7	10.5	10.3	10.8
5.	11.7	11.6	12.0	11.8
6.	13.4	14.0	13.7	13.8
7.	14.2	14.4	14.5	14.2
8.	14.6	15.4	15.4	15.0
9.	15.0	15.6	15.8	15.6
10.	16.3	16.3	15.9	16.0

Table 1 (*continued*)

1	2	3	4	5
11.	17.0	17.2	17.3	17.2
12.	18.1	18.0	18.1	18.0
13.	20.5	19.1	19.5	20.6
14.	20.8	20.7	20.4	20.5
15.	23.4	23.8	23.5	23.4
16.	24.6	24.5	24.8	25.0
17.	25.6	26.9	25.1	26.2
18.	27.8	27.5	27.7	27.6
19.	28.8	28.4	28.5	28.6
20.	32.6	32.9	32.7	32.6
21.	37.8	37.8	37.8	37.8
22.	39.7	40.0	40.3	40.2

As is evident from the above table, the observations recorded with SATHI compare favourably well with the standard instruments in use.

2. As an angle gauge

The circular metallic steps 1(i, ii, iii) shown in Fig. 1(b) are of different diameters and when aligned horizontally at breast height of the tree, by holding the stick with its end (A) touching the cheek bone, subtend different angles as shown in Fig. 2(b). By using these steps which have been calibrated in such a way that steps, i, ii and iii act as basal area factors (BAF) 5, 10 and 20 respectively, the basal area of the crop per acre can be determined in the following way:

Let us use step 1 (i) for determination of basal area. We direct this step towards the breast height of the tree and align it horizontally. If this step completely covers the width of stem (diameter) then the tree is considered to be 'OUT' and is not counted. If it cannot cover the diameter of the tree then the tree will be counted and taken as 'IN' tree. By

making a sweep of 360° at the point all 'IN' trees will be counted. Number of 'IN' trees multiplied 5, i.e. basal area factor of step 1(i), will give the basal area in square feet per acre. Similarly steps 1(ii) and 1(iii) can be used which correspond to BAF 10 and 20 respectively.

Comparison of basal area

Basal area per acre was calculated from field data using BAF prism 5, 10, 20 using steps 1(i, ii, iii) of SATHI and measuring actual basal area from 30 points. The comparison is shown in Table 2 below:

TABLE 2

Comparison of basal area measurements taken by SATHI and Prism with actual tally

S. No.	Actual	Prism	SATHI
1	2	3	4
	Basal area per acre square feet		
	B.A.F.-5		
1.	65	65	75
2.	60	60	60
3.	95	100	100
4.	50	50	50
5.	90	95	90
6.	90	95	95
7.	100	100	97.5
8.	85	82.5	80
9.	100	100	100
10.	75	70	70

1	2	3	4
	B.A.F.-10		
11.	110	120	120
12.	110	110	105
13.	70	75	80
14.	100	100	95
15.	110	110	110
16.	80	70	70
17.	80	90	90
18.	110	100	110
19.	70	70	70
20.	80	80	80
	B.A.F.-20		
21.	100	100	100
22.	140	140	140
23.	80	80	80
24.	140	160	160
25.	120	140	140
26.	70	60	60
27.	60	70	60
28.	80	80	80
29.	140	140	140
30.	100	100	100

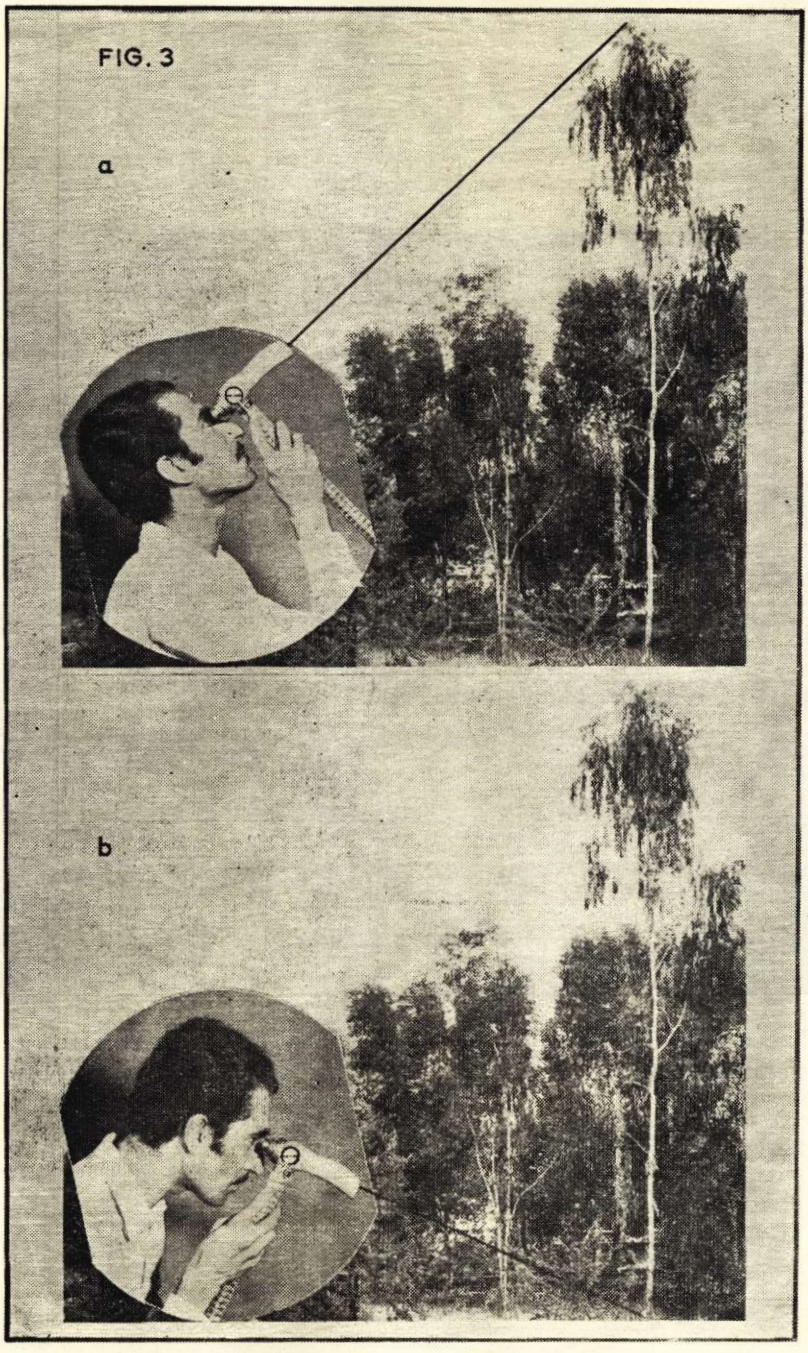

Fig. 3. Function of sathi as a Hypsometer.

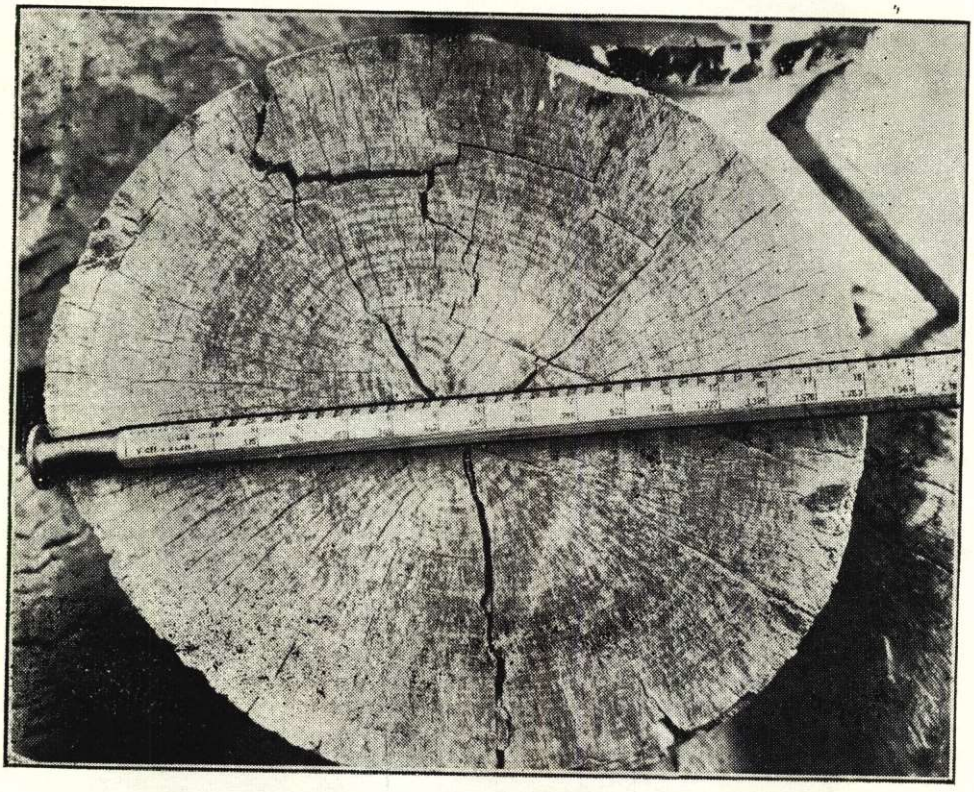

Fig. 4. Measurement of cross sec.ional area with SATHI.

Determination of basal area by using steps of SATHI gives results close to the actual figures as is clear from the above Table.

3. As a hypsometer

Height of the tree can be measured with SATHI in the following way:

Standing at a convenient distance from the tree, the semi-circular disc (F) and the dial (G) as shown in Fig. 1(b) is set free. The handle (C) is raised up gradually as shown in Fig. 3 till the line of sight through hole (ED) is in alignment with the top of tree. When the horizontal wire at (D) touches the top of the tree as seen from eye hole (E) the disc (F) is locked with the help of control (J). Reading on dial (G) gives the angle of elevation (x). Similarly by setting free the disc (F) and directing the handle to the base of tree the angle of depression (y) is determined as shown in Fig. 3 (b). By consulting the trigonometrical ratios for different angles given on one of the faces of the body values of cosine of **y** and tangent of **x** and **y** are noted down. Then distance 'd' between the observer and the tree base is recorded.

There can be three positions from which the observer takes the readings, viz.:

(*i*) Standing at a place which is above the base and below the top of a tree.

(*ii*) Standing at a place which is below the base of a tree, and

(*iii*) Standing at a place which is above the top of a tree.

Corresponding to above positions height of the tree can be found out by the following formulae:

(*a*) $h = d \cos y (\tan x + \tan y)$ in case of (i)

(*b*) $h = d \cos y (\tan x - \tan y)$ in case of (ii)

(*c*) $h = d \cos y (\tan y - \tan x)$ in case of (iii)

Comparison of heights

20 trees of chirpine were measured by different instruments and with SATHI. The comparison of heights obtained through these instruments is given in Table 3 below:

TABLE 3

Comparison of heights measured by various instruments

S. No.	Abney's level	Blume Liess altimeter	SATHI
	Height (Feet)		
1.	13	12	12
2.	31	31	29
3.	44	44	44
4.	48	48	45
5.	49	52	50
6.	53	48	49
7.	53	53	53
8.	55	55	56
9.	64	61	66
10.	65	65	63
11.	71	72	71
12.	71	67	67
13.	72	70	72
14.	87	89	84
15.	92	91	92
16.	98	99	98
17.	102	102	102
18.	104	104	104
19.	135	137	131
20.	163	168	168

From the table it is clear that relative performance of SATHI had been quite satisfactory.

4. As a measure of log volume

Volume of a log of given length can be determined easily with the help of SATHI. Using the linear scale given on one face of body (B) of the stick the length of log is measured in feet. Then the stick is placed along the diameter of cut end of the log with circular metallic base (A) touching the lower end of the log as shown in Fig. 4. Using cross sectional area scale given on one side of the body (B), the cross sectional area against the point where it touches the upper end of the log can be read directly from the stick. This cross sectional area multiplied by the length of the log gives the approximate volume of the log in cubic feet. Actually this volume is the volume of a cylinder of given length and cross sectional area at one end. To get accurate volume of a log it is better to get the average of cross sectional areas of both the ends and then multiply it with the length of the log.

5. As a direction finder

The white end of the compass needle shown in Fig. 1b (H) indicates north. The circular dial under it shows directions-north (N), east (E), south (S) and west (W) with further graduations on the dial. When the white end is brought on 'N' by rotating the handle the direction of north gets oriented. This way the stick helps in finding out the direction and is helpful in determining the aspects, i.e. which means the direction towards which a particular slopy area faces.

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