

ESTIMATION OF DIAMETER BREAST HEIGHT OF KIKAR (*ACACIA ARABICA*, WILLD.) FROM STUMP MEASUREMENTS

by

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Summary. Diameters of kikar (babul) trees were measured at 6 inches (15 cm) interval from ground level upto breast height 4.5 feet (1.37 meters). Each set of diameters exhibited a strong linear correlation with diameter breast height. Separate straight line regression equations were developed using sets of diameters at different heights as independent variables and diameter breast height as dependent variable. Estimations of diameter breast height were done from these equations against diameters ranging from 0.5 to 40 inches (1 cm to 100 cm) at different heights along the stem from ground level upto 4 feet (1.22 metres).

Introduction. The necessity for estimation of dbh from stump measurements of kikar is the same as for shisham which has been discussed in an earlier study. (2)

Basic data. 172 trees of kikar ranging in diameter breast height from 2 inch (5 cm) to 27 inch (69 cm) were selected from irrigated and linear plantations of the Punjab and Sind. Diameter measurements overbark at 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0 and 4.5 feet heights above ground level were recorded. The number of trees measured in each one inch diameter class are given in Table 1.

Table 1
Number of trees measured in each diameter class

Diameter Class (inch)	No. of Trees	Diameter Class (inch)	No. of Trees
2	13	15	6
3	12	16	9
4	2	17	6
5	4	18	7
6	10	19	5
7	8	20	8
8	8	21	6
9	8	22	5
10	9	23	5
11	6	24	3
12	9	25	1
13	12	27	1
14	9		
		Total:	172

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Method. Diameters measured at a particular height from ground level formed one set. Thus there were 8 sets of diameters. Each set was separately correlated with the set of diameters at breast height. A strong linear correlation between dbh and each set was observed indicating derivation of simple linear regression equations for each set of diameters. Taking dbh (Y) as dependent variable and diameters at 0.5, 1.0, 1.5 feet upto 4.0 feet ($x_i=1$ to 8) above ground level as independent variable eight separate equations were developed.

The regression equations alongwith values of correlation coefficients (r) are given in Table 2.

Table 2

Regression equations for estimation of dbh (Y) from diameters taken at different height from ground level (x_i , 1 = 1 to 8)

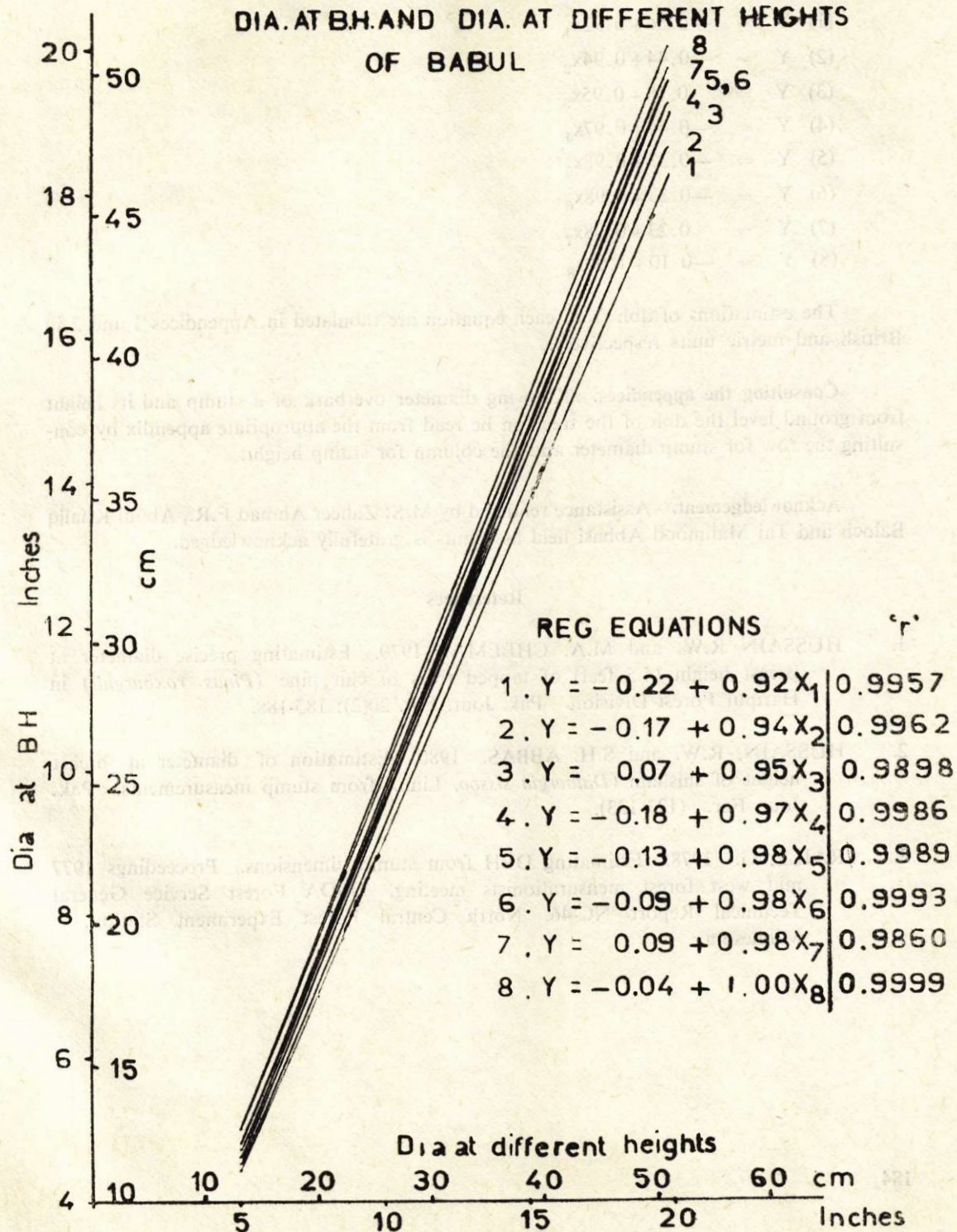
S. No.	Regression equation	Correlation coefficient (r)
1	$Y = -0.22 + 0.92x_1$	0.9957
2	$Y = -0.17 + 0.94x_2$	0.9962
3	$Y = 0.07 + 0.95x_3$	0.9898
4	$Y = -0.18 + 0.97x_4$	0.9986
5	$Y = -0.13 + 0.98x_5$	0.9989
6	$Y = -0.09 + 0.98x_6$	0.9993
7	$Y = 0.09 + 0.98x_7$	0.9860
8	$Y = -0.04 + 1.00x_8$	0.9999

Where

- x_1 is diameter measured at 0.5 feet above ground level.
- x_2 is diameter measured at 0.1 feet above ground level.
- x_3 is diameter measured at 1.5 feet above ground level.
- x_4 is diameter measured at 2.0 feet above ground level.
- x_5 is diameter measured at 2.5 feet above ground level.
- x_6 is diameter measured at 3.0 feet above ground level.
- x_7 is diameter measured at 3.5 feet above ground level.
- x_8 is diameter measured at 4.0 feet above ground level.

The relationship between diameters at different heights and dbh is shown graphically below.

GRAPH SHOWING RELATIONSHIP BETWEEN DIA. AT B.H. AND DIA. AT DIFFERENT HEIGHTS OF BABUL



The regression equations after conversion to metric units are given below:

$$(1) Y = -0.56 + 0.92x_1$$

$$(2) Y = -0.44 + 0.94x_2$$

$$(3) Y = 0.18 + 0.95x_3$$

$$(4) Y = -0.46 + 0.97x_4$$

$$(5) Y = -0.33 + 0.98x_5$$

$$(6) Y = -0.23 + 0.98x_6$$

$$(7) Y = 0.23 + 0.98x_7$$

$$(8) Y = -0.10 + 1.00x_8$$

The estimations of dbh from each equation are tabulated in Appendices 1 and 2 in British and metric units respectively.

Consulting the appendices. Knowing diameter overbark of a stump and its height from ground level the dbh of the tree can be read from the appropriate appendix by consulting the row for stump diameter and the column for stump height.

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References

1. HUSSAIN R.W. and M.A. CHEEMA. 1970. Estimating precise diameter at breast height (4.5 feet) of tapped trees of chir pine (*Pinus roxburghii*) in Haripur Forest Division. Pak. Jour. For. 20(2): 185-188.
2. HUSSAIN, R.W. and S.H. ABBAS. 1980. Estimation of diameter at breast height of shisham (*Dalbergia sissoo*, Linn.) from stump measurements. Pak. Jour. For. (123-133).
3. RAILE, G. 1978. Estimating DBH from stump dimensions. Proceedings 1977 mid west forest mensurationists meeting. USDA Forest Service General Technical Report NC-46. North Central Forest Experiment Station, Minnesota.

Appendix 1

**DIAMETER BREAST HEIGHT ESTIMATED FROM DIAMETER STUMP HEIGHT
IN BRITISH UNITS**
Stump Height (Feet)

Dia (inches)	x ₁	x ₂	x ₃	x ₄	x ₅	x ₆	x ₇	x ₈
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
Diameter Breast Height (Inches)								
0.5	0.2	0.3	0.5	0.3	0.4	0.4	0.6	0.4
1.0	0.7	0.8	1.0	0.8	0.8	0.9	1.1	0.9
1.5	1.2	1.2	1.5	1.3	1.3	1.4	1.6	1.4
2.0	1.6	1.7	2.0	1.8	1.8	1.9	2.0	1.9
2.5	2.1	2.2	2.4	2.2	2.3	2.4	2.5	2.4
3.0	2.5	2.6	2.9	2.7	2.8	2.8	3.0	2.9
3.5	3.0	3.1	3.4	3.2	3.3	3.3	3.5	3.4
4.0	3.5	3.6	3.9	3.7	3.8	3.8	4.0	3.9
4.5	3.9	4.1	4.3	4.2	4.3	4.3	4.5	4.4
5.0	4.4	4.5	4.8	4.7	4.8	4.8	5.0	4.9
5.5	4.8	5.0	5.3	5.2	5.3	5.3	5.5	5.4
6.0	5.3	5.5	5.8	5.6	5.7	5.8	6.0	5.9
6.5	5.8	5.9	6.2	6.1	6.2	6.3	6.5	6.4
7.0	6.2	6.4	6.7	6.6	6.7	6.8	6.9	6.9
7.5	6.7	6.9	7.2	7.1	7.2	7.3	7.4	7.4
8.0	7.1	7.3	7.7	7.6	7.7	7.7	7.9	7.9
8.5	7.6	7.8	8.1	8.1	8.2	8.2	8.4	8.4
9.0	8.1	8.3	8.6	8.6	8.7	8.7	8.9	8.9
9.5	8.5	8.8	9.1	9.0	9.2	9.2	9.4	9.4
10.0	9.0	9.2	9.6	9.5	9.7	9.7	9.9	9.9
10.5	9.4	9.7	10.0	10.0	10.2	10.2	10.4	10.4
11.0	9.9	10.2	10.5	10.5	10.6	10.7	10.9	10.9
11.5	10.4	10.6	11.0	11.0	11.1	11.2	11.4	11.4
12.0	10.8	11.1	11.5	11.5	11.6	11.7	11.8	11.9
12.5	11.1	11.6	11.9	11.9	12.1	12.2	12.3	12.4
13.0	11.7	12.0	12.4	12.4	12.6	12.6	12.8	12.9
13.5	12.2	12.5	12.9	12.9	13.1	13.1	13.3	13.4
14.0	12.7	13.0	13.4	13.4	13.6	13.6	13.8	13.9
14.5	13.1	13.5	13.8	13.9	14.1	14.1	14.3	14.4
15.0	13.6	13.9	14.3	14.4	14.6	14.6	14.8	14.9
15.5	14.0	14.4	14.8	14.9	15.1	15.1	15.3	15.4
16.0	14.5	14.9	15.3	15.3	15.5	15.6	15.8	15.9
16.5	15.0	15.3	15.7	15.8	16.0	16.1	16.3	16.4

Stump Height (Feet)

Dia (inches)	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
17.0	15.4	15.8	16.2	16.3	16.5	16.6	16.7	16.9
17.5	15.9	16.3	16.7	16.8	17.0	17.1	17.2	17.4
18.0	16.3	16.7	17.2	17.3	17.5	17.6	17.7	17.9
18.5	16.8	17.2	17.6	17.8	18.0	18.0	18.2	18.4
19.0	17.2	17.7	18.1	18.2	18.5	18.5	18.7	18.9
19.5	17.7	18.2	18.6	18.7	19.0	19.0	19.2	19.4
20.0	18.2	18.6	19.1	19.2	19.5	19.5	19.7	19.9
20.5	18.6	19.1	19.5	19.7	20.0	20.0	20.2	20.4
21.0	19.1	19.6	20.0	20.2	20.4	20.5	20.7	20.9
21.5	19.6	20.0	20.5	20.7	20.9	21.0	21.2	21.4
22.0	20.0	20.5	21.0	21.2	21.4	21.5	21.6	21.9
22.5	20.5	21.0	21.4	21.6	21.9	22.0	22.1	22.4
23.0	20.9	21.4	21.9	22.1	22.4	22.4	22.6	22.9
23.5	21.4	21.9	22.4	22.6	22.9	22.9	23.1	23.4
24.0	21.9	22.4	22.9	23.1	23.4	23.4	23.6	23.9
24.5	22.3	22.9	23.3	23.6	23.9	23.9	24.1	24.4
25.0	22.8	23.3	23.8	24.1	24.4	24.4	24.6	24.9
25.5	23.2	23.8	24.3	24.5	24.9	24.9	25.1	25.4
26.0	23.7	24.3	24.8	25.0	25.3	25.4	25.6	25.9
26.5	24.2	24.7	25.2	25.5	25.8	25.9	26.1	26.4
27.0	24.6	25.2	25.7	26.0	26.3	26.4	26.5	26.9
27.5	25.1	25.7	26.2	26.5	26.8	26.9	27.0	27.4
28.0	25.5	26.1	26.7	27.0	27.3	27.3	27.5	27.9
28.5	26.0	26.6	27.1	27.5	27.8	27.8	28.0	28.4
29.0	26.5	27.1	27.6	27.9	28.3	28.3	28.5	28.9
29.5	26.9	27.6	28.1	28.4	28.8	28.8	29.0	29.4
30.0	27.4	28.0	28.6	28.9	29.3	29.3	29.5	29.9
30.5	27.8	28.5	29.0	29.4	29.8	29.8	30.0	30.4
31.0	28.3	29.0	29.5	29.9	30.2	30.3	30.5	30.9
31.5	28.8	29.4	30.0	30.4	30.7	30.8	31.0	31.4
32.0	29.2	29.9	30.5	30.9	31.2	31.3	31.4	31.9
32.5	29.7	30.4	30.9	31.3	31.7	31.8	31.9	32.4
33.0	30.1	30.8	31.4	31.8	32.2	32.3	32.4	32.9
33.5	30.6	31.3	31.9	32.3	32.7	32.7	32.9	33.4
34.0	31.1	31.8	32.4	32.8	33.2	33.2	33.4	33.9
34.5	31.5	32.3	32.8	33.3	33.7	33.7	33.9	34.4
35.0	32.0	32.7	33.3	33.8	34.2	34.2	34.4	34.9
35.5	32.4	33.2	33.8	34.2	34.7	34.7	34.9	35.4
36.0	32.9	33.7	34.3	34.7	35.1	35.2	35.4	35.9

36.5	33.4	34.1	34.7	35.2	35.6	35.7	35.9	36.4
37.0	33.8	34.6	35.2	35.7	36.1	36.2	36.3	36.9
37.5	34.3	35.1	35.7	36.2	36.6	36.7	36.8	37.4
38.0	34.7	35.5	36.2	36.7	37.1	37.1	37.3	37.9
38.5	35.2	36.0	36.6	37.2	37.6	37.6	37.8	38.4
39.0	35.7	36.5	37.1	37.6	38.1	38.1	38.3	38.9
39.5	36.1	37.0	37.6	38.1	38.6	38.6	38.8	39.4
40.0	36.6	37.4	38.1	38.6	39.1	39.1	39.3	39.9

Appendix II

DIAMETER BREAST HEIGHT ESTIMATED FROM DIAMETER STUMP HEIGHT
IN METRIC UNITS

Stump Height (centimetres)

Dia (cm)	x ₁	x ₂	x ₃	x ₄	x ₅	x ₆	x ₇	x ₈
	15	30	46	61	76	92	107	122
Diameter Breast Height (centimetres)								
1	0.4	0.5	0.8	0.5	0.6	0.7	1.2	0.9
2	1.3	1.4	1.7	1.5	1.6	1.7	2.2	1.9
3	2.2	2.4	2.7	2.4	2.6	2.7	3.2	2.9
4	3.1	3.3	3.6	3.4	3.6	3.7	4.1	3.9
5	4.0	4.3	4.6	4.4	4.6	4.7	5.1	4.9
6	5.0	5.2	5.5	5.4	5.5	5.6	6.1	5.9
7	5.9	6.1	6.5	6.3	6.5	6.6	7.1	6.9
8	6.8	7.1	7.4	7.3	7.5	7.6	8.1	7.9
9	7.7	8.0	8.4	8.3	8.5	8.6	9.0	8.9
10	8.6	9.0	9.3	9.2	9.5	9.6	10.0	9.9
11	9.6	9.9	10.3	10.2	10.4	10.5	11.0	10.9
12	10.5	10.8	11.2	11.2	11.4	11.5	12.0	11.9
13	11.4	11.8	12.2	12.1	12.4	12.5	13.0	12.9
14	12.3	12.7	13.1	13.1	13.4	13.5	13.9	13.9
15	13.2	13.7	14.1	14.1	14.4	14.5	14.9	14.9
16	14.2	14.6	15.0	15.1	15.3	15.4	15.9	15.9
17	15.1	15.5	16.0	16.0	16.3	16.4	16.9	16.9
18	16.9	16.5	16.9	17.0	17.3	17.4	17.9	17.9
19	16.9	17.4	17.9	18.0	18.3	18.4	18.5	18.9
20	17.8	18.4	18.8	18.9	19.3	19.4	19.8	19.9
21	18.8	19.3	19.8	19.9	20.2	20.3	20.8	20.9
22	19.7	20.2	20.7	20.9	21.2	21.3	21.8	21.9
23	20.6	21.2	21.7	21.8	22.2	22.3	22.8	22.9
24	21.5	22.1	22.6	22.8	23.2	23.3	23.7	23.9
25	22.4	23.1	23.6	23.8	24.2	24.3	24.7	24.9
26	23.4	24.0	24.5	24.8	25.1	25.2	25.7	25.9
27	24.3	24.9	25.5	25.7	26.1	26.2	26.7	26.9
28	25.2	25.9	26.4	26.7	27.1	27.2	27.7	27.9
29	26.1	26.8	27.4	27.7	28.1	28.2	28.6	28.9
30	27.0	27.8	28.3	28.6	29.1	29.2	29.6	29.9
31	28.0	28.7	29.3	29.6	30.0	30.1	30.6	30.9
32	28.9	29.6	30.2	30.6	31.0	31.1	31.6	31.9
33	29.8	30.6	31.2	31.5	32.0	32.1	32.6	32.9

Stump Height (centimetres)

Dia (cm)	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8
	15	30	46	61	76	92	107	122
34	30.7	31.5	32.1	32.5	33.0	33.1	33.5	33.9
35	31.6	32.5	33.1	33.5	34.0	34.1	34.5	34.9
36	32.6	33.4	34.0	34.5	34.9	35.0	35.5	35.9
37	33.5	34.3	35.0	35.4	35.9	36.0	36.5	36.9
38	34.4	35.3	35.9	36.4	36.9	37.0	37.5	37.9
39	35.3	36.2	36.9	37.4	37.9	38.0	38.4	38.9
40	36.2	37.2	37.8	38.3	38.9	39.0	39.4	39.9
41	37.2	38.1	38.8	39.3	39.8	39.9	40.4	40.9
42	38.0	39.0	39.7	40.3	40.8	40.9	41.4	41.9
43	39.0	40.0	40.7	41.2	41.8	41.9	42.4	42.9
44	39.9	40.9	41.6	42.2	42.8	42.9	43.3	43.9
45	40.8	41.9	42.6	43.2	43.8	43.9	44.3	44.9
46	41.8	42.8	43.5	44.2	44.7	44.8	45.3	45.9
47	42.7	43.7	44.5	45.1	45.7	45.8	46.3	46.9
48	43.6	44.7	45.4	46.1	46.7	46.8	47.3	47.9
49	44.5	45.6	46.4	47.1	47.7	47.8	48.2	48.9
50	45.4	46.6	47.3	48.0	48.7	48.8	49.2	49.9
51	46.4	47.5	48.3	49.0	49.6	49.7	50.2	50.9
52	47.3	48.4	49.2	50.0	50.6	50.7	51.2	51.9
53	48.2	49.4	50.2	50.9	51.6	51.7	52.3	52.9
54	49.1	50.3	51.1	51.9	52.6	52.7	53.1	53.9
55	50.0	51.3	52.1	52.9	53.6	53.7	54.1	54.9
56	51.0	52.2	53.0	53.9	54.5	54.6	55.1	55.9
57	51.9	53.1	54.0	54.8	55.5	55.6	56.1	56.9
58	52.8	54.1	54.9	55.8	56.5	56.6	57.1	57.9
59	53.7	55.0	55.9	56.8	57.5	57.6	58.0	58.9
60	54.6	56.0	56.8	57.7	58.5	58.6	59.0	59.9
61	55.6	56.9	57.8	58.7	59.4	59.5	60.0	60.9
62	56.5	57.8	58.7	59.7	60.4	60.5	61.0	61.9
63	57.4	58.8	59.7	60.6	61.4	61.5	62.0	62.9
64	58.3	59.7	60.6	61.6	62.4	62.5	62.9	63.9
65	59.2	60.7	61.6	62.6	63.4	63.5	63.9	64.9
66	60.2	61.6	62.5	63.6	64.3	64.4	64.9	65.9
67	61.1	62.5	63.5	64.5	65.3	65.4	65.9	66.9
68	62.0	63.5	64.4	65.5	66.3	66.4	66.9	67.9
69	62.9	64.4	65.4	66.5	67.3	67.4	67.8	68.9
70	63.8	65.4	66.3	67.4	68.3	68.4	68.8	69.9
71	64.8	66.3	67.3	68.4	69.2	69.3	69.8	70.9
72	65.7	67.2	68.2	69.4	70.2	70.3	70.8	71.9

73	66.6	68.2	69.2	70.3	71.2	71.3	71.8	72.9
74	67.5	69.1	70.1	71.3	72.2	72.3	72.7	73.9
75	68.4	70.1	71.1	72.3	73.2	73.3	73.7	74.9
76	69.4	71.0	72.0	73.3	74.1	74.2	74.7	75.9
77	70.3	71.9	73.0	74.2	75.1	75.2	75.7	76.9
78	71.2	72.9	73.9	75.2	76.1	76.2	76.7	77.9
79	72.1	73.8	74.9	76.2	77.1	77.2	77.6	78.9
80	73.0	74.8	75.8	77.1	78.1	78.2	78.6	79.9
81	74.0	75.7	76.8	78.1	79.0	79.1	79.6	80.9
82	74.9	76.6	77.7	79.1	80.0	80.1	80.6	81.9
83	75.8	77.6	78.7	80.0	81.0	81.1	81.6	82.9
84	76.7	78.5	79.6	81.0	82.0	82.1	82.5	83.9
85	77.6	79.5	80.6	82.0	83.0	83.1	83.5	84.9
86	78.6	80.4	81.5	83.0	83.9	84.0	84.5	85.9
87	79.5	81.3	82.5	83.9	84.9	85.0	85.5	86.9
88	80.4	82.3	83.4	84.9	85.9	86.0	86.5	87.9
89	81.3	83.2	84.4	85.9	86.9	87.0	87.4	88.9
90	82.2	84.2	85.3	86.8	87.9	88.0	88.4	89.9
91	83.2	85.1	86.3	87.8	88.8	88.9	89.4	90.9
92	84.1	86.0	87.2	88.8	89.8	89.9	90.4	91.9
93	85.0	87.0	88.2	89.7	90.8	90.9	91.4	92.9
94	85.9	87.9	89.1	90.7	91.8	91.9	92.3	93.9
95	86.8	88.9	90.1	91.7	92.8	92.9	93.3	94.9
96	87.8	89.8	91.0	92.7	93.7	93.8	94.3	95.9
97	88.7	90.7	92.0	93.6	94.7	94.8	95.3	96.9
98	89.6	91.7	92.9	94.6	95.7	95.8	96.3	97.9
99	90.5	92.6	93.9	95.6	96.7	96.8	97.2	98.9
100	91.4	93.6	94.8	96.5	97.7	97.8	98.2	99.9