EMPIRICAL YIELD TABLE FOR CHIR PINE (*PINUS ROXBURGHII*) OF GUZARA FORESTS OF HAZARA

E.B. Glennie and Raja Walayat Hussain*

1. **Basic Data.** This yield table has been prepared for chir pine (*Pinus roxburghii*) of the Guzara forests of Hazara civil division. The table is based on data from 74 temporary sample plots laid out in Guzara forests. Location of the plots is shown in Figure 1. The size of the plots ranged from 0.1 acres (0.04 hectares) to 0.6 acres (0.24 hectares) and the age of the plots ranged from 12 years to 72 years.

2. **Sample size.** In order to determine the number of plots required, an initial sample of 20 plots was taken out in evenaged chir pine crops on private lands on the Abbottabad—Mansehra and Abbottabad-Sherwan roads. The basal area per unit area was considered the criterion for determining the number of plots required. Allowing a permissible error of 10% with t(.05,19)=2.093, the number of plots required worked out to 58. Since the initial sample did not cover all the chir pine area it was decided to take 70-80 plots, about 10-15 in each 10 year age class upto 60 years. Thus 74 plots were finally selected for this study.

3. **Selection of plots.** The plots were laid out in crops taht appeared to be fully stocked and even aged. Since 10-15 sample plots were to be selected for each decade throughout the tract, a record was kept of the number of plots as the field work progressed. The distribution of sample plots by age classes and localities is given in Table 1 below:

TABLE 1

Distribution of sample plots by age classes and localities

Range	Age classes (years)													
	8-12	13-17	18-22	23-27	28-32	33-37	38-42	43-47	48-52	53-57	58-62	63-67	68-72	Total
Abbottabad	—	1	1	6	2	1	1	1	1	—	—	—	—	15
Manshera	—	3	—	—	—	1	2	1	1	1	—	—	—	9
Garhi Habibullah	—	—	—	—	2	1	—	—	—	1	—	—	—	4
Balakot	—	—	—	—	—	1	—	—	—	—	—	—	—	1
Giddarpur	—	—	1	—	1	1	1	2	1	—	—	—	—	7
Shinkiari	—	1	3	1	—	—	2	4	2	—	—	—	—	13
Battal	—	2	—	—	1	1		—	—	—	—	—	—	4
Oghi	—	—	2	—	1	—	1	—	—	1	—	1	—	6
Shergarh	1	3	1	1	—	1	2	1	1	1		2	1	15
Total:	1	10	8	8	7	7	9	9	6	4	—	3	2	74
Number rejected	—	—	—	2	—	—	—	1	—	—	—	—	—	3
Number used in the study	1	10	8	6	7	7	9	8	6	4	—	3	2	71

*The first author is receiving a grant from the Pakistan Science Foundation to work at the Pakistan Forest Institute, Peshawar. The second author is Forest Mensuration Officer at the Pakistan Forest Institute, Peshawar.

4. **Plot measurements.** The diameters at breast height of all the trees on the lopt were measured. About 10 sample trees covering all diameter classes were chosen and subjected to the following measurements:

(*i*) height

(*ii*) age

(*iii*) the 5 year diameter increment under bark at breast heigt

(*iv*) bark thickness

5. **Individual plot calculations.** For each plot the basal area, number of trees, total volume to 2 inches diameter outside bark and volume increment were calculated on acre basis. Also the mean diameter and mean height were calculated. The standard volume tables for Guzara chir pine (2) and the method described by Kuusela (3) were used.

Due to the absence of data on past thinning and mortality, the influence of stand density on volume increment could not be ascertained. The volume increment calculations were therefore not used in making the yield table.

6. **Preparing the yield table.** Because of the limited number of plots, no division into different site qualities was made. The plots were divided into age groups as shown in Table 1.

There was a big variation in the number of trees on unit area basis within each group upto the age of 42 years. Three plots were rejected because they contained more than three times the average number for their age group.

The variation in basal area, volume, mean diameter and mean height was less, perhaps because the basal area and volume growth is limited by the amount of light, water and nutrients available.

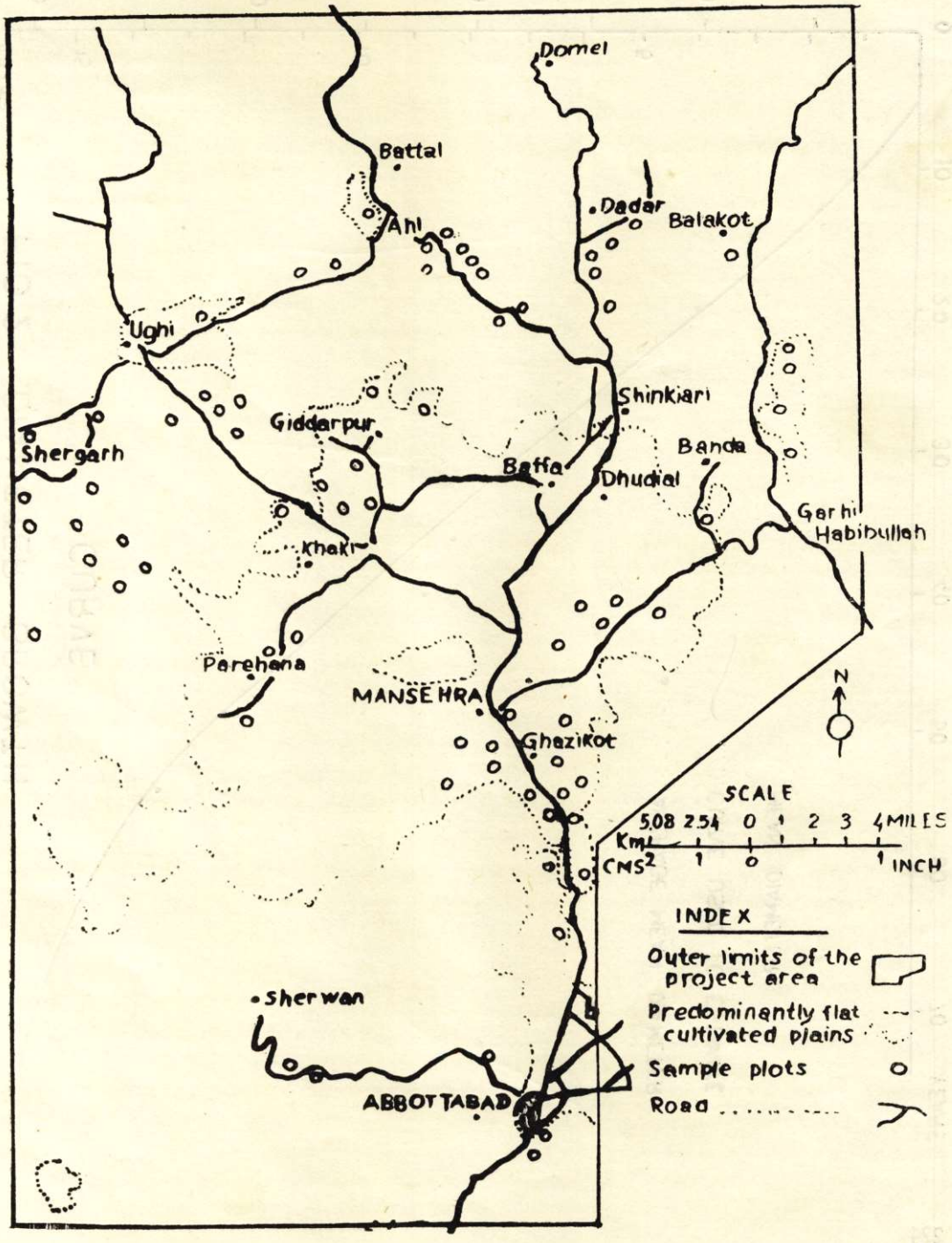
Within each group, the average value of each quantity was found. Smooth curves were drawn to fit these values as closely as possible. Adjustments were then made to satisfy the following conditions:

(*i*) Basal area = 0.005454 × number of trees × mean diameter squared. This is the standard formula linking basal area, number of trees and mean diameter.

(*ii*) The following regression equation was obtained linking total volume, basal area and mean height. Total volume = 0.4662 × basal area × mean height. Correlation coefficient = 0.991.

(*iii*) The mean height and mean diameter approximately follows the height—diameter relationship given by Hussain and Ghauri (2).

FIG. 1 MAP OF THE TRACT SHOWING
LOCATION OF SAMPLE PLOTS



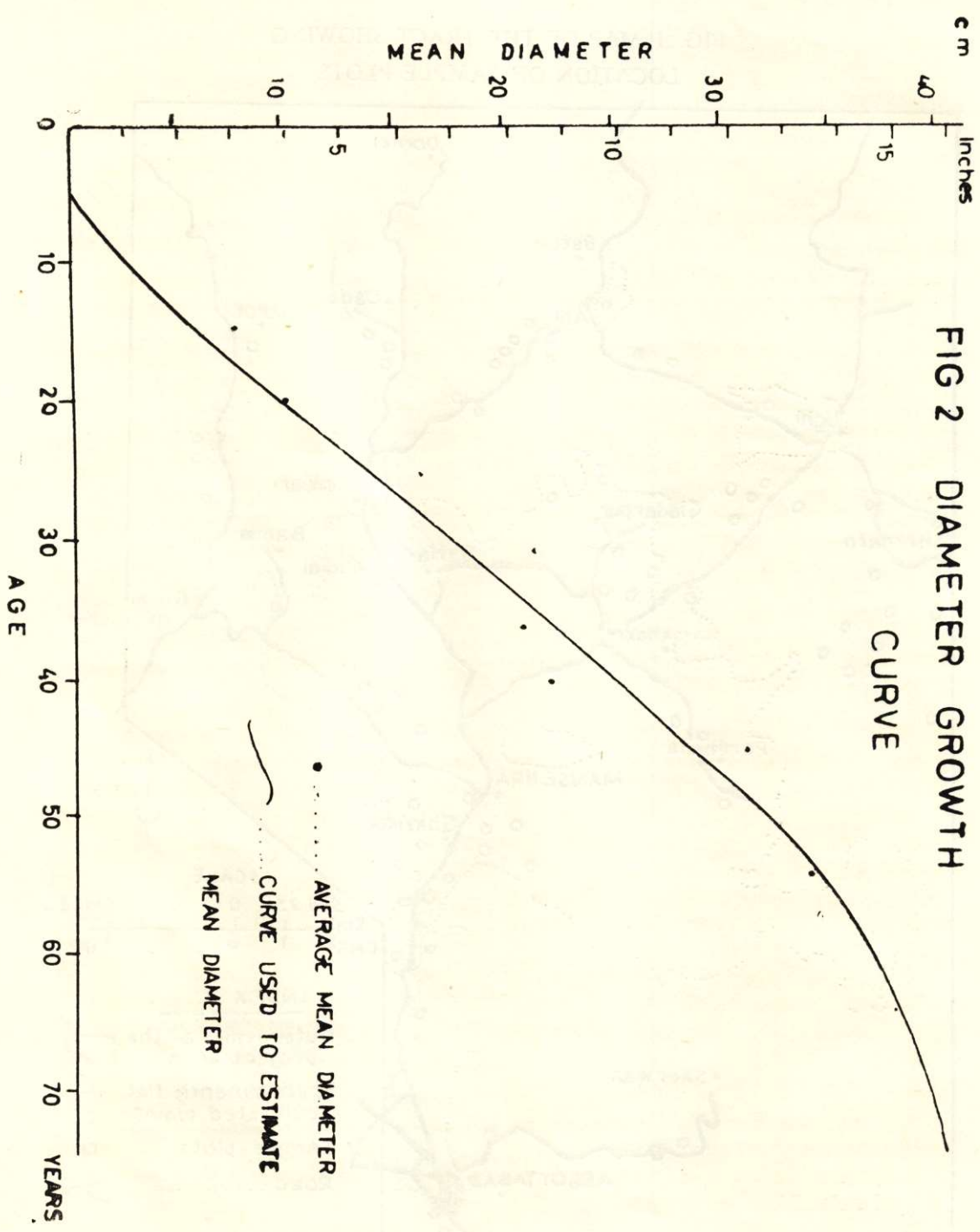


FIG 2 DIAMETER GROWTH CURVE

Age at breast height was determined in the field. To get age of a tree at ground level, five years were added to age at breast height since it was estimated from seedling data that a chir plant took five years to attain breast height in good soil.

The mean annual increment and current annual increment were calculated from the following formulae:

$$\text{Mean annual increment} = \frac{\text{Total volume}}{\text{Age at ground level}}$$

$$\text{Current annual increment} = \frac{\text{Volume increment in 5 years}}{5}$$

Table 2 below shows the estimated values of all the quantities in British units, and Table 3 in metric units. Figures 2 to 5 show graphs of the mean diameter, mean height, basal area and volume growth respectively.

TABLE 2

Yield Table for Guzara Forests of Chir pine in British units.

Age (years)	Mean diameter (inches)	Mean height (ft)	Per acre: Number of trees	Basal area (ft^2)	Total volume (ft^3)	Mean annual increment (ft^3)	Current annual increment (ft^3)
15	2.3	14	2218	64	500	33	64
20	3.8	22	1003	79	820	41	
25	5.3	29	614	94	1230	49	84
30	6.9	36	420	109	1830	61	120
35	8.4	44	320	123	2520	72	138
40	9.9	52	256	134	3250	81	146
45	11.3	59	205	142	3920	87	134
50	12.7	65	165	148	4510	90	118
55	13.9	70	145	152	5000	91	98
(60*	14.6	75	135	156	5480	91	96)
(65	15.1	80	127	160	5950	92	94)
(70	15.6	84	123	164	6400	91	90)

*Values at ages 60, 65 and 70 are not reliable because of lack of data.

TABLE 3

Yield Table for Guzara Forests of Chir pine in metric units.

Age (years)	Mean diameter (cm)	Mean height (m)	Per hectare: Number of trees	Basal area (m^2)	Total volume (m^3)	Mean annual increment (m^3)	Current annual increment (m^3)
15	5.8	4.3	5481	14.7	35	2.3	4.4
20	9.7	6.6	2478	18.1	57	2.9	
25	13.6	8.8	1517	21.6	86	3.4	5.6
30	17.5	11.1	1038	25.0	128	4.3	8.4
35	21.3	13.4	791	28.2	176	5.0	9.6
40	25.1	15.7	633	30.8	227	5.7	10.2
45	28.7	18.0	507	32.6	274	6.1	9.4
50	32.3	19.8	408	34.0	316	6.3	8.4
55	35.3	21.3	358	34.9	350	6.4	6.8
(60*	37.1	22.8	334	35.8	383	6.4	6.6)
(65	38.4	24.3	314	36.7	416	6.4	6.6)
(70	39.6	25.6	304	37.6	448	6.4	6.4)

*Values at ages 60, 65 and 70 are not reliable because of lack of data.

6. **Comments.** The diameter and height growth and the total voume increments are almost the same as for interim yield table of chir pine of reserved forests in NWFP (1). But there is difference in number of trees and basal area since the present tables are based on plots where no previous thinnings were carried out, whereas in reserved forests thinnings are carried out under management plans. However volume growth in the guzara forests seems not to be adversely influenced by the higher density.

These forests, therefore, may be thinned when the trees are big enough to be saleable but non-commercial thinning should be avoided as far as possible.

7. **Acknowledgement.** Authors are thankful to the staff of Mensuration Branch who remained associated with the study, particularly Messrs. Zaheer Ahmad and Mohammad Ishaq, Forest Rangers.

References

1. HUSSAIN, R.W., M.A. CHEEMA and E.B. GLENNIE. 1978. Interim yield tables of chir pine of reserved forests in N.W.F.P. Mensuration branch publication No. 48, PFI, Peshawar (under print)

2. HUSSAIN, R.W. and M.J. GHAURI. 1977. Local and standard volume tables for chir of guzara forests of Hazara. Mensuration branch publication No. 42, PFI, Peshawar.

3. KUUSELA, K. 1969. Forest Mensuration. UNDP-FAO. Pakistan National Forestry Research and Training Project Report No. 9, PFI, Peshawar.

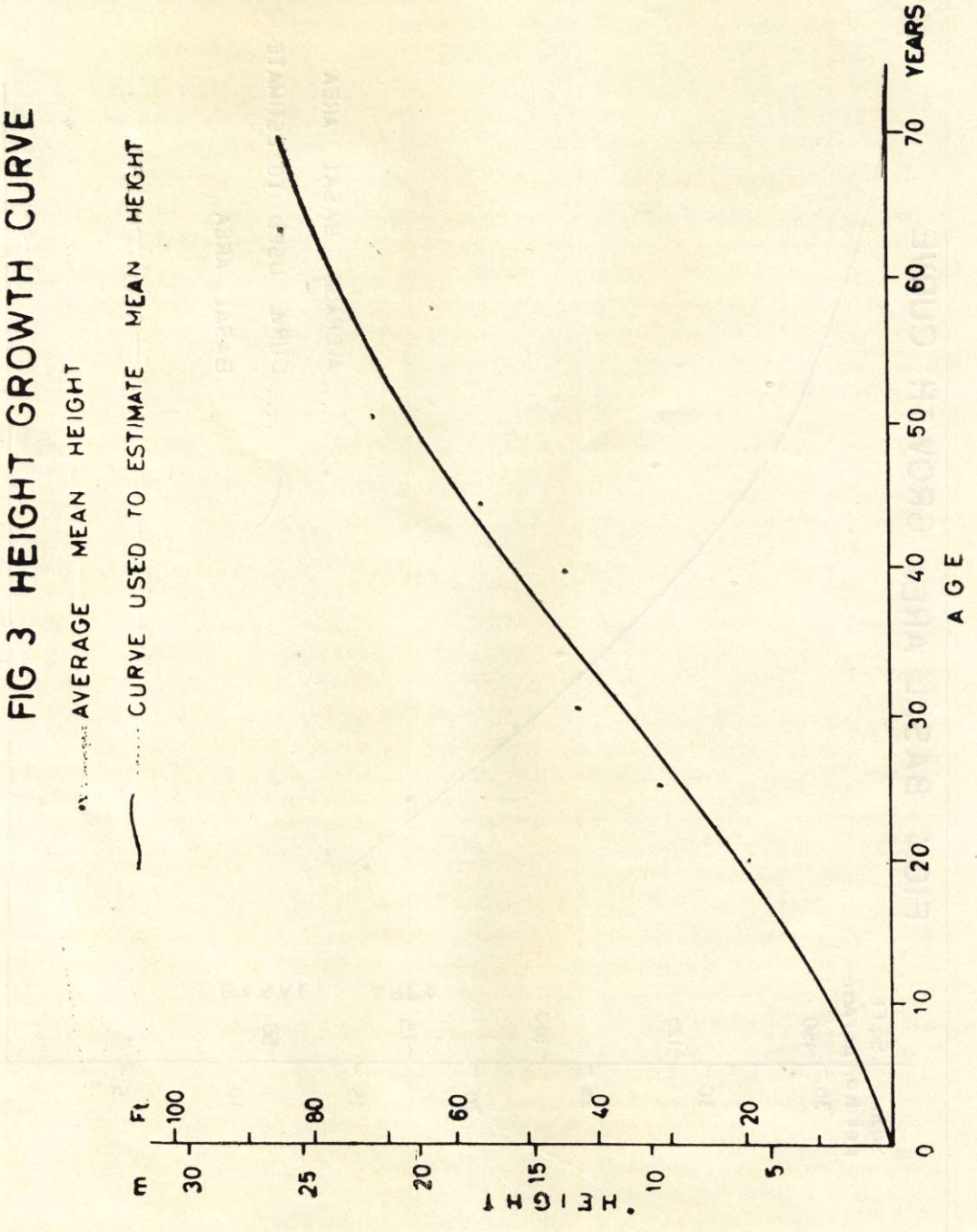


FIG 3 HEIGHT GROWTH CURVE
AVERAGE MEAN HEIGHT
CURVE USED TO ESTIMATE MEAN HEIGHT
m
Ft
30
25
20
15
10
5
100
80
60
40
20
0
10
20
30
40
50
60
70
YEARS
AGE

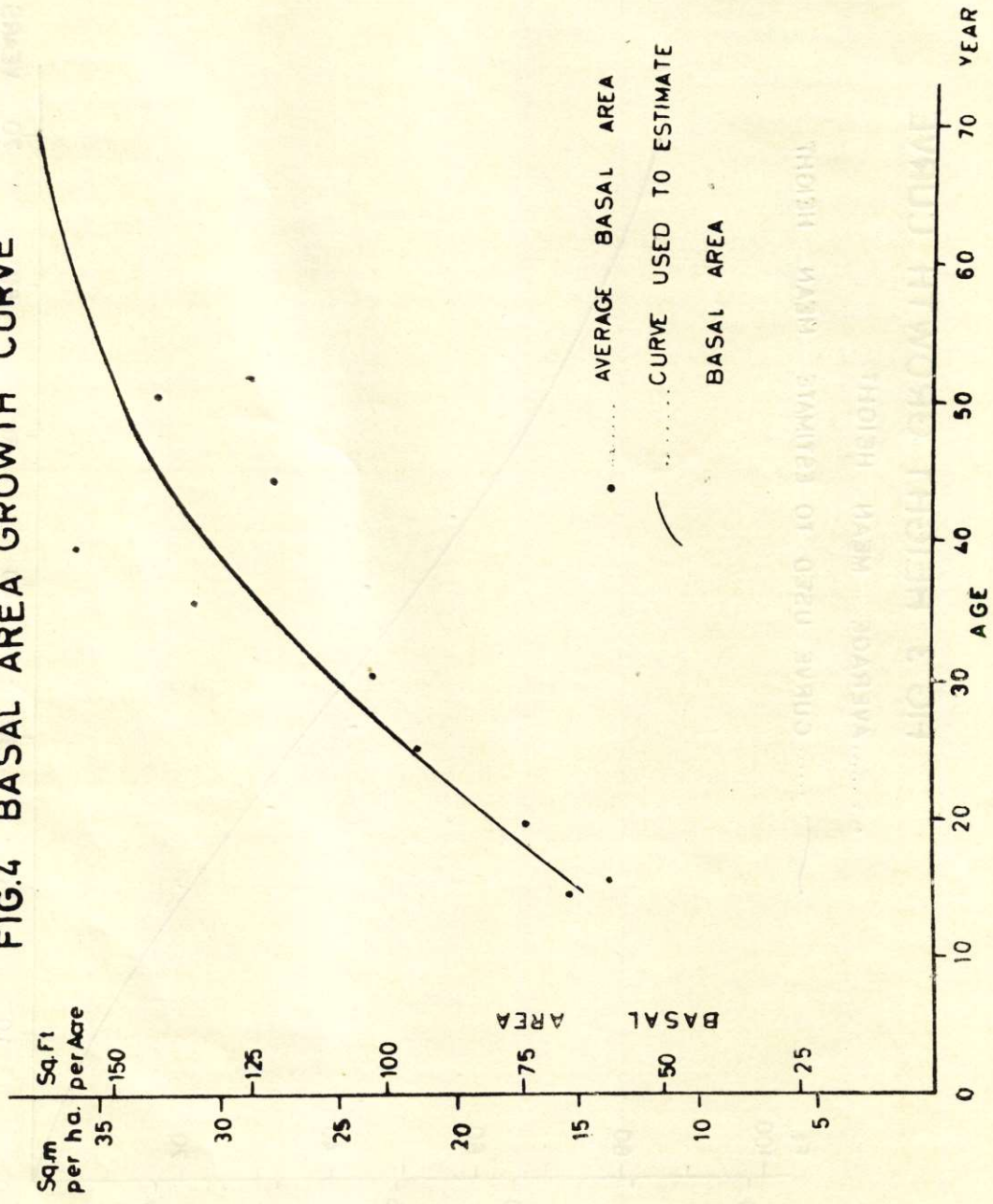


FIG.4 BASAL AREA GROWTH CURVE
Sq.m per ha.
Sq.Ft per Acre
35
30
25
20
15
10
5
150
125
100
75
50
25
BASAL AREA
0
10
20
30
40
50
60
70
AGE
YEAR
AVERAGE BASAL AREA
CURVE USED TO ESTIMATE BASAL AREA

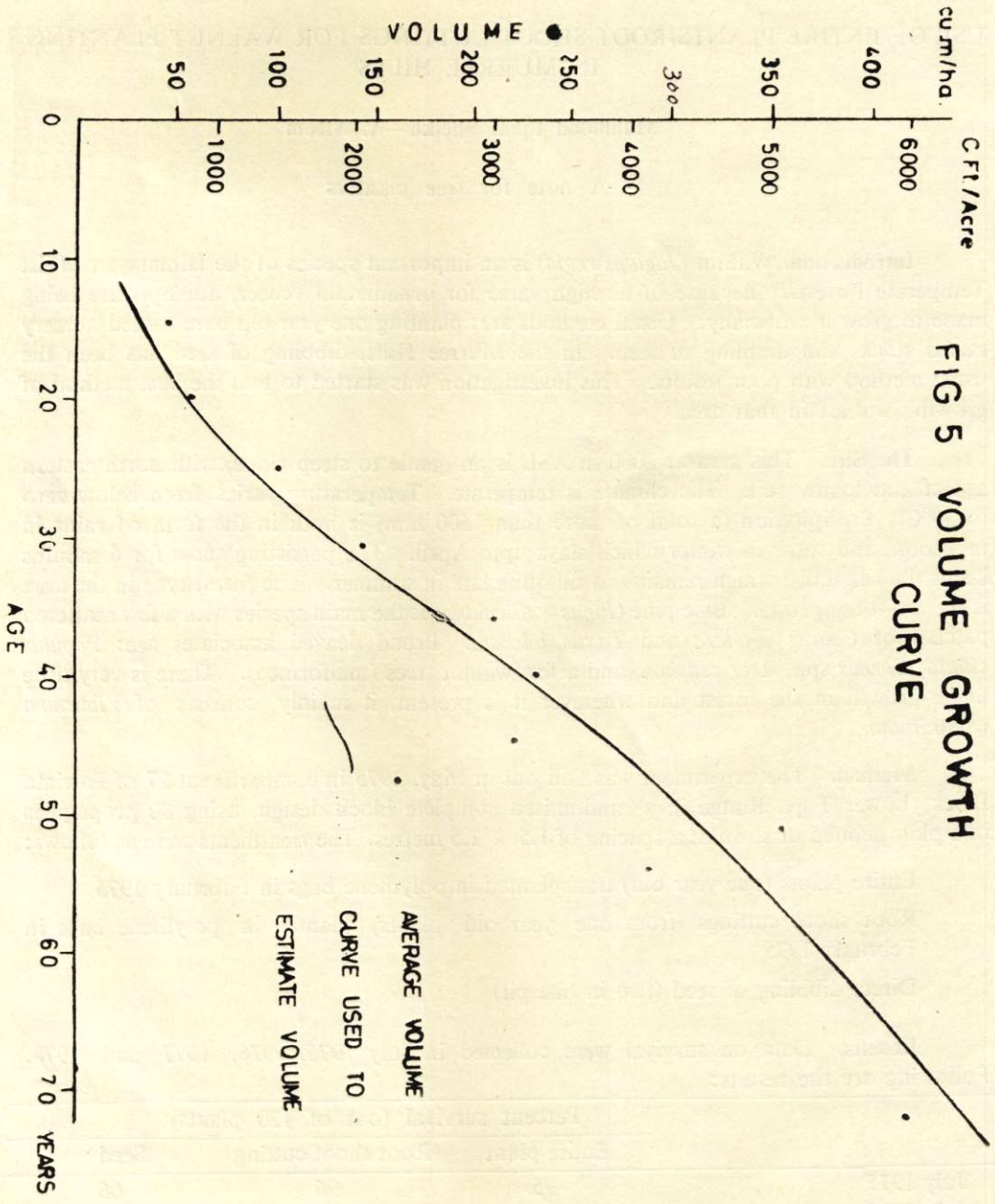


FIG 5 VOLUME GROWTH CURVE