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An Assessment of Yield of Eucalyptus Camaldulensis in Katha Forest Area

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1987

ကသာသစ်တောနယ်ရှိ ကမာဂျူယူကလစ်စိုက်ခင်းများ၏ အထွက်နှုန်းကို စူးစမ်းလေ့လာခြင်း

ဦးစောဝင်း၊ B.Sc. (For.) (Rgn.) အကြီးတန်းသုတေသနမှူး
သစ်တောသုတေသနဌာန

စာတမ်းအကျဉ်းချုပ်

မြန်မာနိုင်ငံတွင် စိုက်ပျိုးလျက်ရှိသည့် ယူကလစ်သစ်မျိုးများအနက် ကမာဂျူယူကလစ်သစ်မျိုးသည် ကြီးထွားနှုန်းမြန်မှုနှင့် ဒေသမရွေး ပေါက်ဖော်ကိုက်နိုင်မှုကြောင့်မြန်မာနိုင်ငံအနှံ့အပြားတွင် စိုက်ပျိုးခဲ့ပါသည်။ မူလက ၎င်းသစ်မျိုးကို အပူပိုင်းဒေသများတွင် ထင်းနှင့် တိုင်ရရှိရန်အတွက် ရည်ရွယ်ပြီး စမ်းသပ်စိုက်ပျိုးနိုင်ခဲ့သော်လည်း၊ အခြားမိုးများဒေသများတွင်လည်း အပေါက်မြန်သစ်မျိုးများအဖြစ် စမ်းသပ်စိုက်ပျိုးခဲ့ပါသည်။ ယခင်လေ့လာချက်များ အရ၊ ၎င်းသစ်မျိုး၏ ပေါက်ရောက်နှုန်းမှာ ဒေသအလိုက်ကွဲပြားခြားနားမှုရှိကြောင်း တွေ့ရှိရပါသည်။ ယခုစာတမ်းသည် ကသာဒေသရှိ ၁၉၇၁-ခုနှစ်မှ ၁၉၇၅-ခုနှစ်အတွင်း၊ တည်ထောင်ထားသည့် ယူကလစ်စိုက်ခင်းများ၏ အထွက်နှုန်းကို စူးစမ်းလေ့လာထားခြင်း ဖြစ်ပြီး၊ အထွက်နှုန်းအနေဖြင့် တစ်ဧက (စုပုံတန်) တန် (၃၀)ခန့် ထွက်ရှိနိုင်မည်ဟု ခန့်မှန်း တွေ့ရှိခဲ့ပါသည်။

An Assessment of Yield of Eucalyptus Camaldulensis in Katha Forest Area.

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Abstract

Eucalyptus camaldulensis is one of the eucalyptus species introduced into Burma from Australia. Due to its rapid growth and adapatability to differing site conditions, this species has been planted at various parts of the country, from low lying areas to higher altitudes. Although the species is primarily meant for supply of fuel-wood and small timber in arid zone afforestation programmes, it is also put on trial as fast throwing species in areas with adequate rain fall and at higher altitudes. Previous growth and yield assessments indicated a comparable yield differences among sites. This is an assessment of the yield of *Eucalyptus camaldulensis* plantations in katha Forest area which were established during 1971 and 1975. They are now due for harvesting as potential pulpwood for paper mills, and the per acre pulpwood yield from this area was estimated at 30 (stacked) tons.

Contents

1. Introduction

1.1 Ever since the introduction of *Eucalyptus* species into Burma, *Eucalyptus camaldulensis* is the species most widely planted throughout the country. The total area of eucalyptus plantations in Burma by the end of 1980 was about 40,000 acres of which, *Eucalyptus camaldulensis* consisted of 90% or more (appendix 1).Primarily the species is meant for the supply of fuel wood and small timber in the arid zone a forestation programmes. Due to its rapid growth and adaptability to different site conditions it is also put on trial as a fast growing species in areas with adequate rain fall and higher altitudes.

1.2 With the rising need of raw materials for newly constructed pulp and paper mills in Burma, the alternative use of hark wood fibres in place of, or in mixture with, bamboo pulp becomes a continuing interest for the pulp and paper technicians. Among the 50 local hard wood species and two exotic species tested, *Eucalyptus camaldulensis* stands out to be a promising substitute, Currently ,ten year old stands of *E. camaldulensis* are being used as raw material for pulp and papermaking(F.D. , 1985).

1.3 Assessment of yield from these eucalyptus plantations has been conducted from time to time and this is an assessment of the yield of *E. camaldulensis* planted during 1971 and 1975 in Katha Forest Area.

2. Literature Review

2.1 *Eucalptus camaldulensis* is the most widely distributed eucalyptus over almost all the main land of Australia. It occurs between 30 to 600 m altitude, with rainfall of 250 to 625 mm and a dry season of from four to eight months. It is basically sub-humid and semi-arid zones species and shows a high variability in its growth. In its natural home it attains a height of between 25 to 30 m at maturity. The natural stands are harvested for sawn wood, railway sleepers and charcoal (CDIRO, 1978).

2.2 *E. camaldulensis* has very good reputation as plantation species overseas due to its rapid growth adaptability to different site conditions and for its good coppicing ability. About 500,000 ha have been planted throughout the world, and is the dominant exotic species introduced in the Mediterrian. Plantations are also found in Pakistan, Uraguay, Argentina, Kenya, Nigeria and Tanzania (National Academy of Sciences, 1980).

2.3 The major use of this species has been for fuel, charcoal, post and poles. In spain, Portugal and Morocco this species has been used as pulp in Kraft pulping processes (CSIRO, 1978).

2.4 Concerning the growth and yield of this species, it is stated that what the right provenance on a favorable site, it grows very fast. The mean annual growth increments of 2 m in height and 2cm in diameter can be maintained for the first 10 years. An annual wood yields of 20-25m^3 per ha have been reported from Argentina, 30 m^3 per ha from Isrel. 17-20m^3 per ha from Turkey, for the first rotation (from seedlings,) and 25-30m^3 per ha in subsequent coopice rotations. On good sites, plantations are managed on coppice rotations of 7 to 10 years. But on poor dry sites. The annual yield drops to between 2 and 11m^3 per ha and rotations of 14 to 15 years may be needed (National Academy of Sciences 1980).

2.5 As regards the growth and yield of eucalyptus plantations in Burma, there was a great variation in yield among sites so far studied. The mean annual increment of

eucalyptus stands varies from 164 cft per acre in the Northern Shan States, while the yield drops drastically to about 10 cft per acre in plantations near Pegu (see appendix 2, Win, 1983).

2.6 Pulp wood extractions made from 10 year-old *E. camaldulensis* at Maymyo yields 16 stacked tons per acre (Win, 1986), while the pulp wood, possibility from Yupadaung area, Thazi township, was estimated to be around 50 stacked tons (Tint, 1984).

3. Materials and Methods

3.1 The study area consists of a series of *E. camaldulensis* plantations, established in Indaw township, Katha Forest Area, during 1971 and 1975. The spacing used, system of planting and extent of areas planted are shown in the following table. Science plantations were formed in three separate locations in large blocks, the data are presented by three different blocks, namely, Pinmalut block, Namakyaing block and Nandayan block.

Table 1. *Eucalyptus camaldulensis* plantations in Katha Forest Area, Indaw township

Block	Year of formation	Reserve/Public Forests	Area (acres)	Spacing	System of planting
Pilmalut	1971	Petsut Res.	64	9 x 9	Normal
	1972	Petsut Res.	225	9 x 9	Planting
	1974	Petsut Res.	305	9 x 9	Without
	1975	Petsut Res.	151	12 x 12	Uprooting
Namakyaing	1971	Petsut Res.	55	9 x 9	Uprooting
	1972	Petsut Res.	302	9 x 9	Uprooting
	1974	Petsut Res.	319	9 x 9	Uprooting
	1975	Petsut Res.	195	12 x 12	Uprooting
Nandayan	1971	Petsut Public Forests	98	9 x 9	Uprooting
	1972	Petsut Public Forests	227	9 x 9	Uprooting
	1974	Petsut Public Forests	702	9 x 9	Uprooting
	1975	Petsut Public Forests	141	12 x 12	Uprooting

3.2 In general the terrain is even in Pinmalut block with sandy loam type to soil and is situated quite close to the Indaw - Katha High way. Namakyaing block is named after the Namakyaing village, which is forest village established during the formation of the eucalyptus plantations in that area, which is still existing. The soil is also of sandy loam type and the ground is some what undulated. The Nandayan block is situated in the public forest Coupe No.10, which is quite close to the near by town of Mawlu, where the soil is sandy loam in some places with clayey soils in low lying areas.

3.3 The area has an average minimum temperature of 60 degrees and an average maximum temperature of 100 degrees with an annual rain fall of about 60 inches.

3.4 Within each block, 12 sampling units were laid out systematically, the dimension of each sampling unit being 72' x 72' (0.119 acres). Within each sampling unit, breast height girth measurements were made for all trees exceeding 8 inches in

girth. For average height determination, five trees were measured using a suunto clinometer. The number of trees tallied in the 36 sampling units were grouped into 6 inch girth classes, and within each class 3 to 12 trees were felled for volume assessment leaving 6 inch stumps. Fifty two trees were selected based on the distribution of trees in the different girth classes. The trees selected were divided into 6' sections and girth over bark and under bark determined for each section to a top girth limit of 6 inches including the branch wood.

3.5 The distribution of trees felled for volume determination was shown below, by 6 inch girth classes:

Girth class	Namakyaing	Pinmalust	Nandayan	Total
0'6"-0'11"	2	3	2	7
1'0"-1'5"	2	5	4	11
1'6"-1'11"	2	4	5	11
2'0"-2'5"	2	4	6	12
2'6"-2'11"	2	2	4	8
3'0"-3'5"	-	1	2	3
Total	10	19	23	52

4. Results and Discussion

4.1 Based on the enumerated data, the relationship between girth at breast height and height (length) was determined using regression analyses and the following relationship was obtained.

$H = 8.1005 + 1.62466\ G$ $\quad R = 0.920759$

Where, H = Height in feet

G = Girth at breast height in inches

4.2 In volume determination, volume was measured down to 6 inch top girth and the under bark and over bark volume were determined using the Samalian formula.

4.3 Relationship between girth at breast height and volume over bark as well as under bark were determined using regression analyses and the following single variable functions are obtained

$Vob = 0.00454566\ G^{2.41099}$ $\quad R^2 = 0.9592$

S.E. = ± 0.20699

where,

Vob = volume over bark in cft (solid)

G = girth at breast height in inches

$Vub = 0.00173747\ G^{2.55837}$ $\quad R^2 = 09579$

S.E. = ± 0.22359

where,

Vub = volume under bark in cft (solid)

G = girth at breast height in inches

4.4 Per acre volume in terms of solid wood and stacked volume as estimated from the regression functions developed are shown in table 2 by individual plantations and by plantation blocks.

Table 2. Per acre volume of E. camaldulensis in Katha Forest Area.

NANMAKYAING BLOCK

Year of formation	Volume (cft.) o.b	u.b	Volume (solid ton) o.b	u.b	Volume (stk. Ton) o.b	u.b
1971	1684	(1377)	33.7	(27.5)	47.2	(38.5)
1972	1749	(1429)	34.9	(28.6)	48.9	(40.0)
1974	1109	(903)	22.2	(18.1)	31.1	(25.3)
1975	908	(726)	18.2	(14.5)	25.5	(20.3)

PINMALUT BLOCK

Year of formation	Volume (cft.) o.b	u.b	Volume (solid ton) o.b	u.b	Volume (stk. Ton) o.b	u.b
1971	1452	(1095)	29.0	(21.9)	40.6	(30.7)
1972	1184	(895)	23.7	(17.9)	33.2	(25.1)
1974	1027	(756)	20.6	(15.1)	28.8	(21.1)
1975	901	(672)	18.0	(13.4)	25.2	(18.8)

MANDAYAN BLOCK

Year of formation	Volume (cft.) o.b	u.b	Volume (solid ton) o.b	u.b	Volume (stk. Ton) o.b	u.b
1971	981	(677)	19.6	(13.5)	27.4	(18.9)
1972	1093	(855)	21.9	(17.1)	30.7	(23.9)
1974	820	(627)	16.4	(12.5)	22.9	(17.5)
1975	479	(430)	9.6	(8.6)	13.4	(12.0)

4.5 The relationship between under bark and over bark volume can be shown by the following relationship:

Girth class	Over bark volume (cft.)	Under bark volume (cft.)	Percentage %
9	0.7086	0.4799	0.677
15	2.4280	1.7733	0.730
21	5.4646	4.1942	0.768
27	10.0162	7.9777	0.797
33	16.2487	13.3302	0.820
39	24.3074	20.4385	0.841
45	34.3226	29.4665	0.859

4.6 It will be seen that there is a strong relationship between the size of the tree and the bark percent; the bigger the size the more bark it contains. Four types of single variable regression analysis of volume under bark on volume over bark were tried. The four types were:

No.	Regression types	Coefficient of determination
1.	VUB = a + b VOB	.99
2.	VUB = a + exp b VOB	.79
3.	VUB = a + bln VOB	.78
4.	VUB = a VOB^b	.99

4.7 Of the four, the fourth type gives the best fit, having the standard error of 0.0019531 against 0.253976 from the first expression.

$VUB = 0.691548\ VOB^{1.06125}$

where,

VUB = volume under bark in cft.

VOB = volume over bark in cft.

4.8 Size class distribution for individual plantations were given in appendix 3. Among the three plantation sites, in terms of distribution of stems, the Namakyaing block appears to be in the most desirable state, while in the Pinmalut block may accure from coppice regrowth of illicit fellings.

4.9 Based on per acre volume data, the estimated yields from the whole survey area was calculated and presented in table 3. In estimating the yield, area estimates were taken as being given by the Indaw township as effective against the book area. The yield as estimated from the effective area of 2000 acres would produce 60,000 tons (stk.) of pulp wood from the whole survey area.

Table 3 Estimated Yield of *Eucalyptus camaldulensis* in Katha Forest area

NAMAKYAING BLOCK

Year of formation	Area Total	(acres) Effective	Volume o.b	(ton) u.b	Volume o.b	(stk. Ton) u.b
1971	55	55	1854	1513	2596	2118
1972	302	302	10540	8637	14768	12080
1974	319	319	7082	5774	9921	8071
1975	195	195	3549	2827	4972	3959
			23025	18751	32257	26228

PINMALUT BLOCK

Year of formation	Area Total	(acres) Effective	Volume o.b	(ton) u.b	Volume o.b	(stk. Ton) u.b
1971	64	64	1856	1402	2598	1965
1972	225	225	5333	4028	7470	5648
1974	305	300	6180	4350	8640	6330
1975	151	140	2520	1876	3528	2631
			15889	11656	22236	16575

NANDAYAN BLOCK

Year of formation	Area Total	(acres) Effective	Volume o.b	(ton) u.b	Volume o.b	(stk. Ton) u.b
1971	98	50	980	675	1370	945
1972	227	150	3285	2565	4605	3585
1974	312	230	2208	1978	3082	2760
1975	140	90	1521	1188	2133	1665
			7994	6406	11190	8955

5. Conclusion

5.1 Compared with other E. camaldulensis plantations so far surveyed for pulp wood potential, the yield from the present study, though not as favourable as that from Yupadaung area far exceeds the yield of E. camaldulensis plantations from Maymyo. (Win, 1986).

Locality	Average girth (inches)	Average height (feet)	Per acre number	Per acre volume (stk.)
Katha	19.60	47	193	30
Yupadaung	16.6	38	n.a	59
Maymyo	16.0	44	231	17

5.2 During the preparatory stages of the East Yoma Flantation prohect,field investigations werecarried out for growth and yield studies in various Eucalyptus camaldulensis plantations established all over Burma (F.D, 1978).Height growth and girth attained from Age-Height and Age –Girth gave an indication that the plantations so established in Kathagr5ew well at the age of three and four years, and they are still putting on a satisfactory growth at the time of survey.

5.3 Though a standard volume table3 for E.Camaldulensis was developed by U Saw Han and U Aung Kyaw Myint (F.D, 1978),the majority of the data base was focused on three and four year old stands.Extrapolations had to be made on trees of girth classes out side the range which makes these tables less applicable for this study.

5.4 Eucalyptus camaldulensis has been recognized and assessed as one of the most promising species for dry zone afforestation in burma, particularly for the production of fuel wood and small timber for the rural people. This study demonstrates the fact that this specie4s performs equally well in areas with high rain fall and at higher elevation producing pylp wood yield of about 30 stacked tons peracre.

Appendix I. Eucalyptus Plantation Areas in Burma.

State/ Division Year	Kachin	Karen	Mon	Arakan	Shan	Sagaing	Pegu	Magwe	Rangoon	Mandalay	Irrawaddy	Total
1	2	3	4	5	6	7	8	9	10	11	12	13
1922												
1934					42					556		598
1963										5		5
1966										9		9
1967										30		30
1968										75		75
1969	5	5			100				5	122		237
1970			5	4	140	5	227		10	1036		1477
1971					244	217	471	4	50	1037		2023
1972	5				705	1614	456	172	200	1939	50	5146
1973	50				563	1475	402	343	200	1043	119	3195
1974	50				650	1337	60	150	50	2352	155	4804
1975	50			5	640	848	298	350	125	1599	205	4120
1976	50				580	320	353	300	125	1610	155	3493
1977					790	240	250	400	175	2215	200	4270
1978			50		795	300	152	500	300	2392	300	4789
1979			300		2300	400	200	600	500	3500	700	8500
1980			300				150			500		650
Grand Total	210	5	355	9	7549	5756	3069	2824	1740	20020	1884	43421

Source: - Forest Plantation in Burma.
Forest Department, Rangoon Burma. (March-1981)

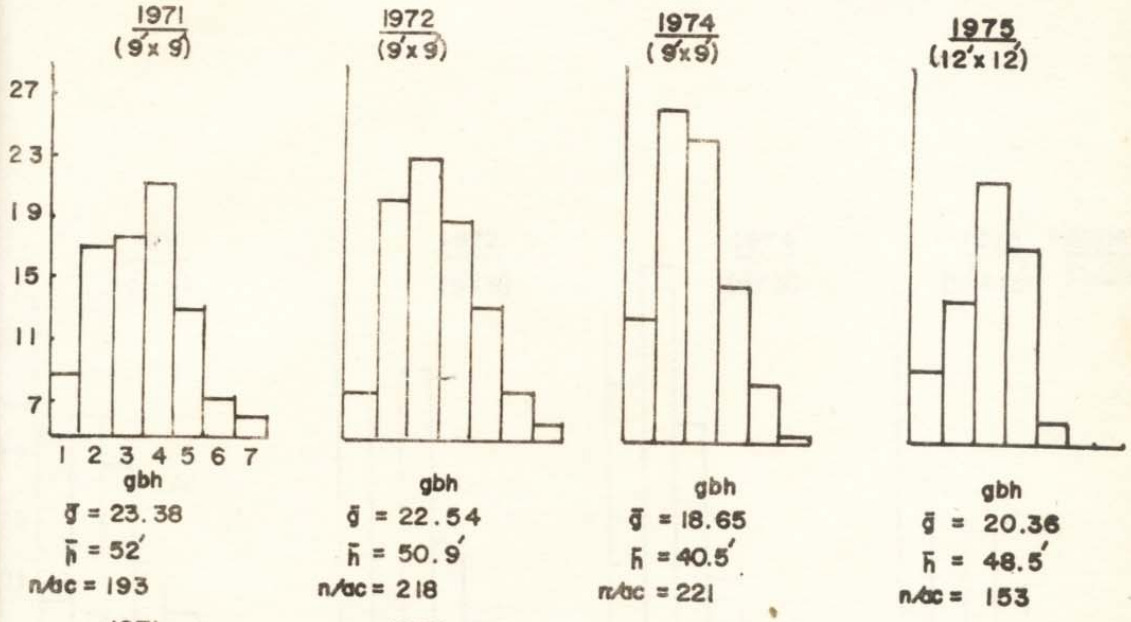
Appendix 2. Growth data for *Eucalyptus camaldulensis* in Burma.

Forest division	Reserve/UCF protected forest	Age	Av.ht. (ft.)	Av.gt. (in)	Av. vol. (cft)	m.a.i/ac. (cft.)
Meiktila	Yupadaung	3	29	8.8	356	118
		4	29	8.2	608	153
E.Katha	Petsut	3	28	9.4	267	89
		3	24	8.2	218	73
		4	27	8.0	363	90
S.Shan	Hti Thein	3	23	7.2	158	52
States	Kan	4	20	6.4	210	52
N.Shan	Naungcho	3	19	7.5	278	93
States	Payadaung	3	31	9.5	382	127
	Thibaw	3	24	8.1	360	120
	Panheile	4	19	7.0	178	43
	Thibaw	4	23	10.8	654	164
	Payadaung	4	31	9.2	350	88
Shwebo	Ma-u-daung	3	20	6.8	185	61
	Myinmu	3	19	6.3	172	57
	Cheyataw4	4	18	6.2	144	36
	Ma-u-daung	4	20	6.2	215	53
	Cheyadaw	4	16	6.1	93	23
Pyinmana	Yanaungmyin	3	27	8.5	205	69
		4	30	9.1	97	24
Dryzone	Saingpyu	3	20	6.9	168	56
		4	15	5.2	83	20

Forest division	Reserve/UCF protected forest	Age	Av.ht. (ft.)	Av.gt. (in)	Av. vol. (cft)	m.a.i/ac. (cft.)
N.Toungoo	Swa Fuel	3	9	2.3	18	6
		4	18	3.7	67	17
		6	32	10.4	157	27
		7	39	13.0	328	47
		8	31	9.6	253	32
Yamethin	Minthagyi	3	15	3.4	57	19
		4	23	4.8	93	22
		5	12	3.3	66	13
		6	12	3.5	61	10
Pegu	Indagaw	10	34	12.0	94	9
		9	34	11.0	127	14
		8	34	11.0	33	4
		7	34	9.0	21	4
Hmawbi	Magayi	10	44	12.3	555	56
		9	48	12.3	661	73
		7	42	12.1	370	53
	Thabyu	10	46	12.4	702	70
		9	46	12.3	632	71
		7	47	12.4	598	86
	Hnawbi	11	59	12.6	682	62
		10	52	12.5	588	58
		9	52	12.4	490	54
		7	46	12.3	391	54
	South	10	47	12.5	431	43
	Hlaing Yoma	9	39	13.1	272	30
E.Katha	Petsut	15	51	20.7	1372	91.4
		14	48	20.7	1342	96.9
		12	42	17.3	985	82.1
		11	47	19.7	763	69.4

Appendix 3. Size class distribution of E.camaldulensis in Katha Forest Area.

NAMSHIYAING BLOCK



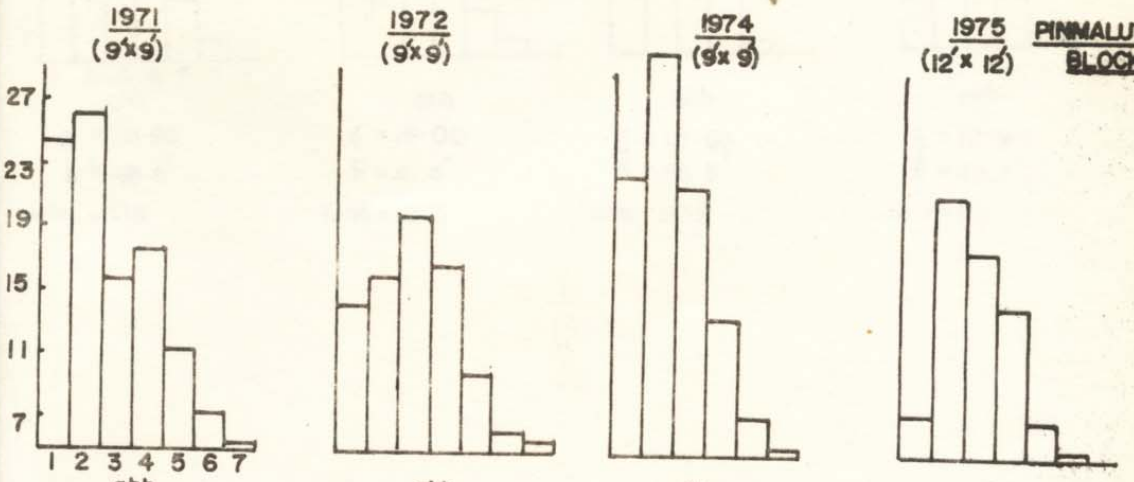
1971 (9'x 9'): $\bar{g}$ = 23.38, $\bar{h}$ = 52', n/ac = 193

1972 (9'x 9'): $\bar{g}$ = 22.54, $\bar{h}$ = 50.9', n/ac = 218

1974 (9'x 9'): $\bar{g}$ = 18.65, $\bar{h}$ = 40.5', n/ac = 221

1975 (12'x 12'): $\bar{g}$ = 20.36, $\bar{h}$ = 48.5', n/ac = 153

PINMALUT BLOCK

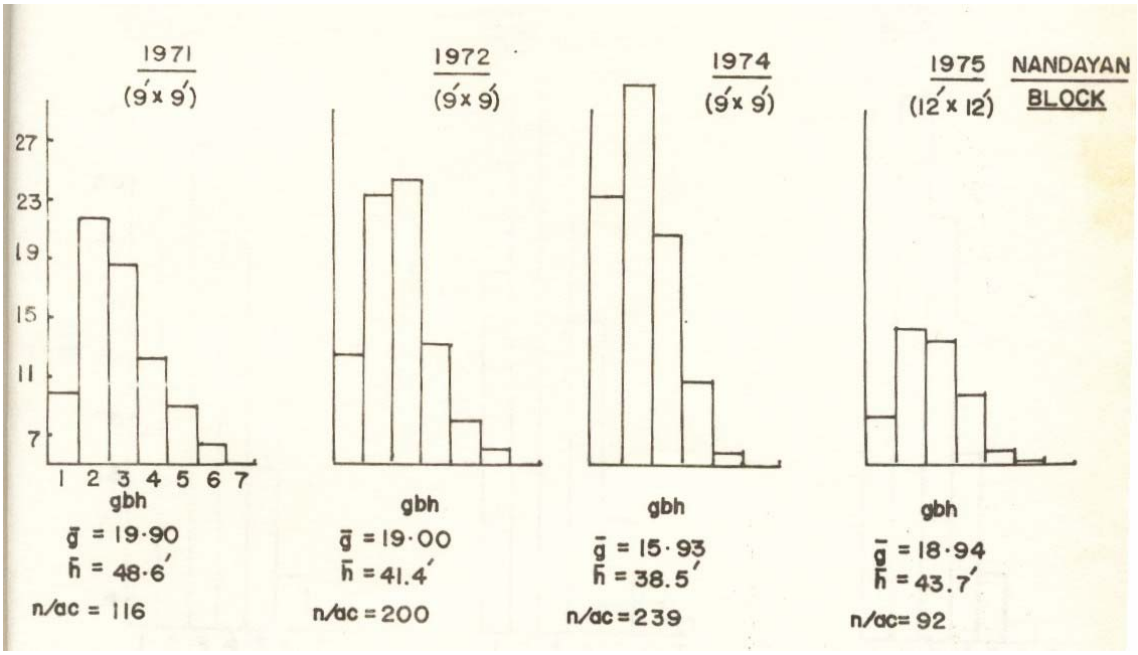


1971 (9'x 9'): $\bar{g}$ = 18.95, $\bar{h}$ = 51.4', n/ac = 256

1972 (9'x 9'): $\bar{g}$ = 20.59, $\bar{h}$ = 51.3', n/ac = 181

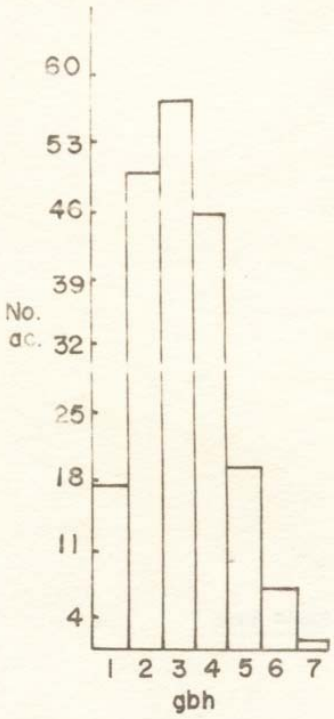
1974 (9'x 9'): $\bar{g}$ = 17.15, $\bar{h}$ = 45.2', n/ac = 248

1975 (12'x 12'): $\bar{g}$ = 19.93, $\bar{h}$ = 48', n/ac = 156


1971
(9′x 9′)
27
23
19
15
11
7
1 2 3 4 5 6 7
gbh
ḡ = 19·90
h̄ = 48·6′
n/ac = 116
1972
(9′x 9′)
gbh
ḡ = 19·00
h̄ = 41.4′
n/ac = 200
1974
(9′x 9′)
gbh
ḡ = 15·93
h̄ = 38.5′
n/ac = 239
1975
(12′x 12′)
NANDAYAN
BLOCK
gbh
ḡ = 18·94
h̄ = 43.7′
n/ac = 92

E. camaldulensis – 10 years & up.

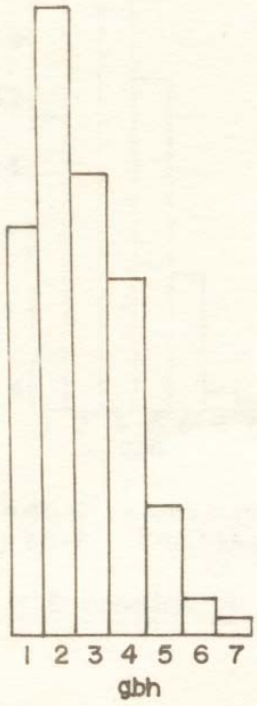
Namakyaing Block



$\bar{h}$ = 48·9′ Stk.V/ac = 31.9 tons

$\bar{g}$ = 19·16″ no/ac = 210

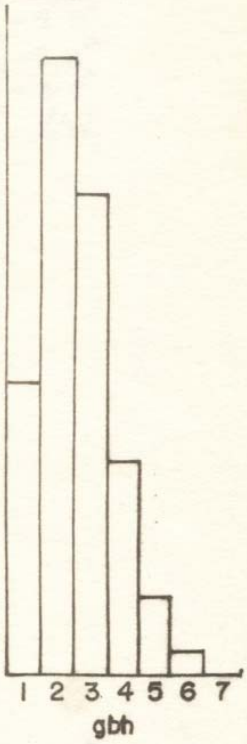
Pinmalut Block



$\bar{h}$ = 47.9′ Stk.V/ac = 38.22 tons

$\bar{g}$ = 21·23″ no/ac = 196

Nandayan Block



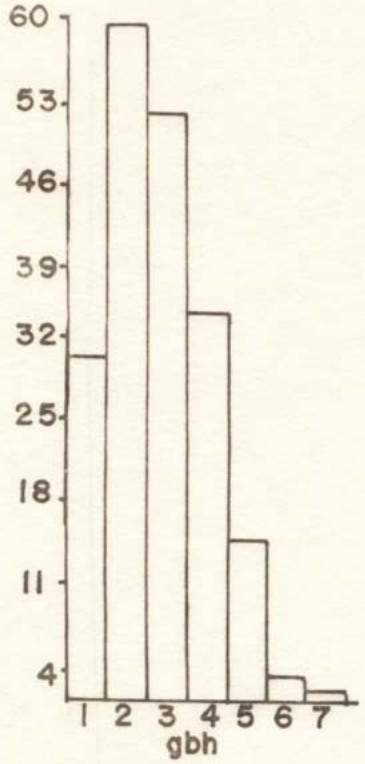
$\bar{h}$ = 49.1′ Stk.V/ac = 23.7 tons

$\bar{g}$ = 18·4″ no/ac 173

Indaw Township

E. camaldulensis

10 years & up



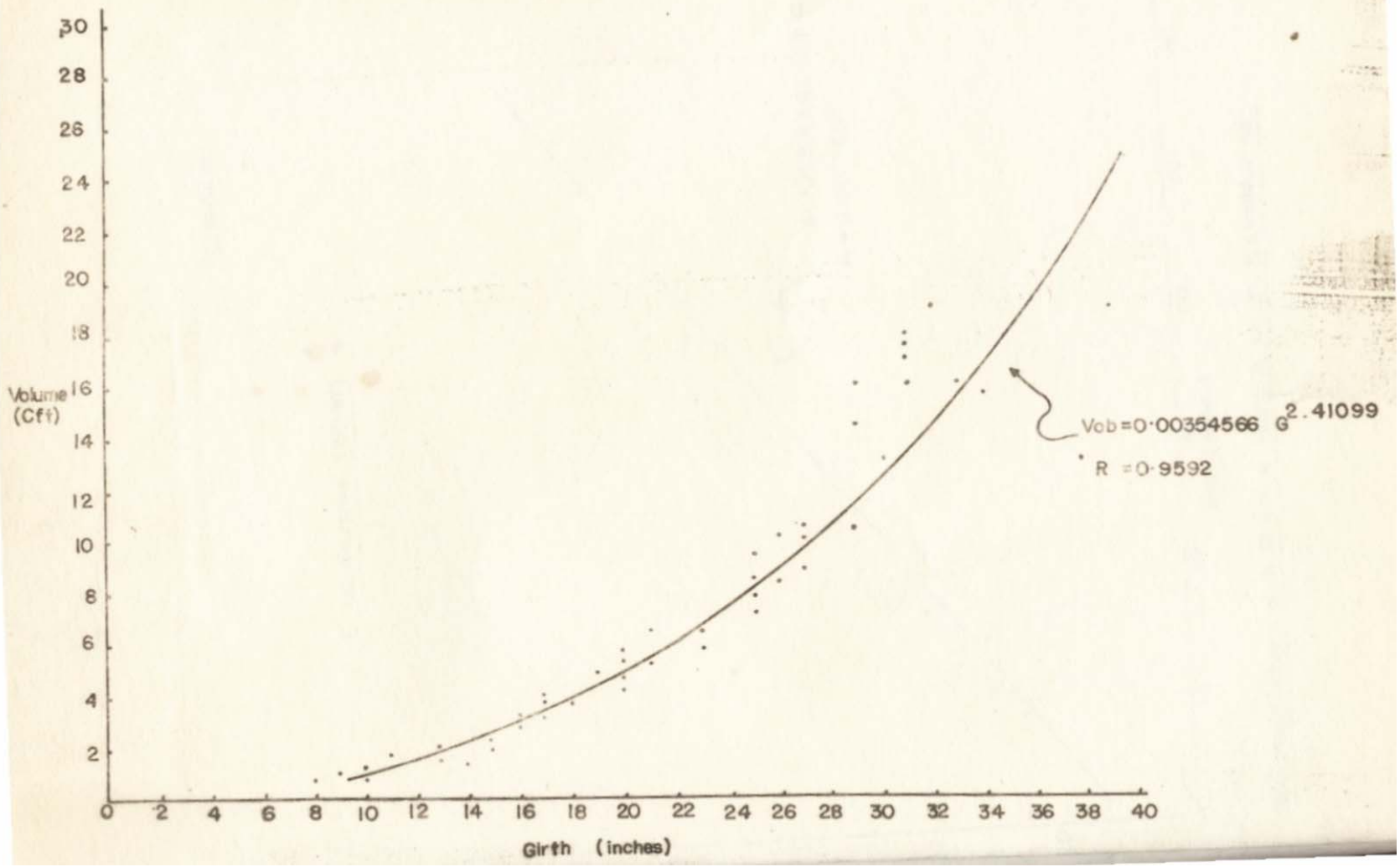
GBH Class

1= 0'·6" – 0'·11"
2= 1'·0" – 1'·5"
3= 1'·6" – 1'·11"
4= 2'·0" – 2'·5"
5= 2'·6" – 2'·11"
6= 3'·0" – 3'·5"
7= 3'·6" – 3'·11"

$\bar{h}$ = 46·6 no/ac = 197
$\bar{g}$ = 19·7 V/ac(Stacked) = 31 tons.

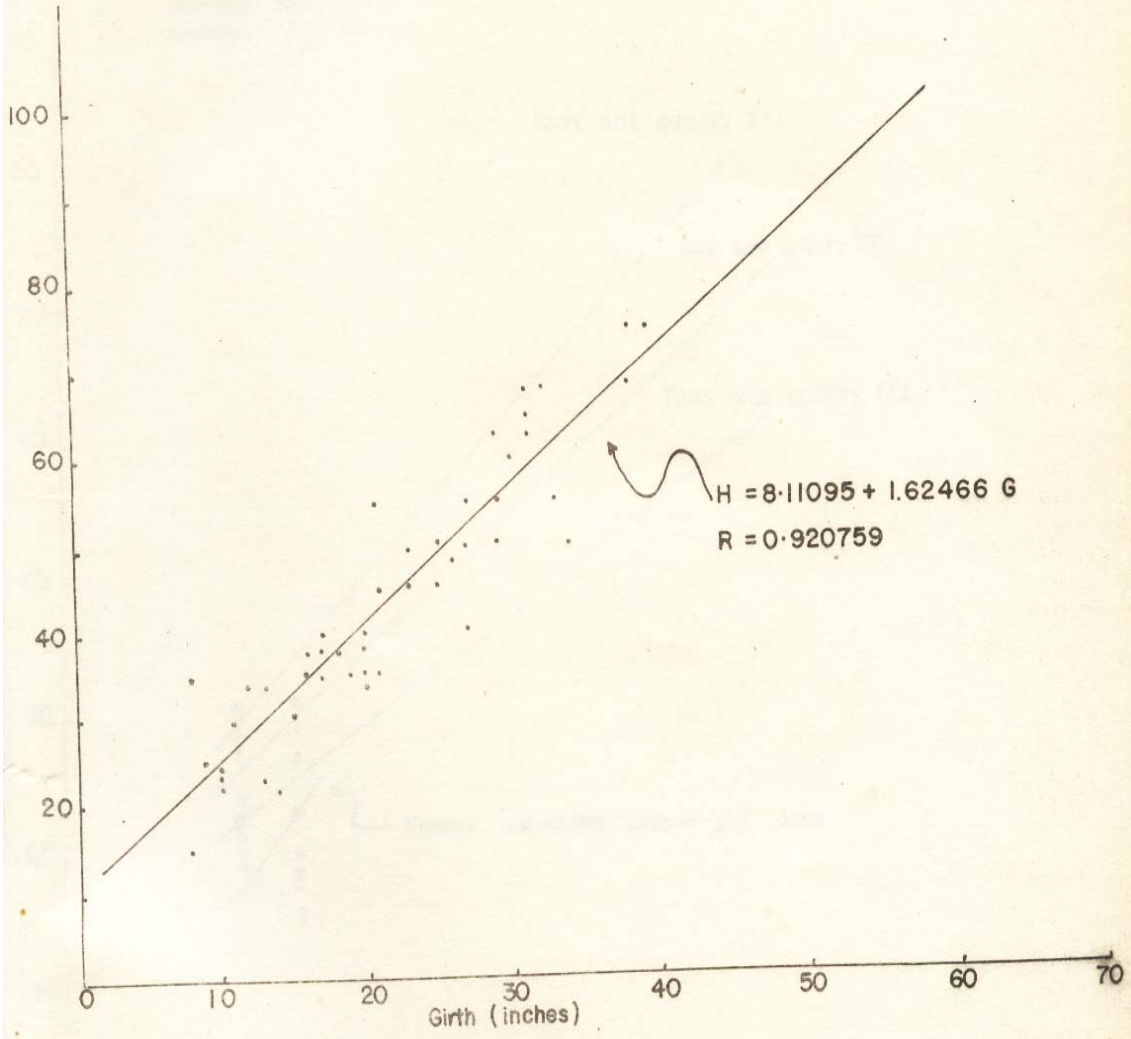
Size class distribution of E. camaldulensis 10 years +

Appendix 4. Relationship between girth at breast height & volume over bark



Appendix 5.

E. camaldulensis (INDAW)

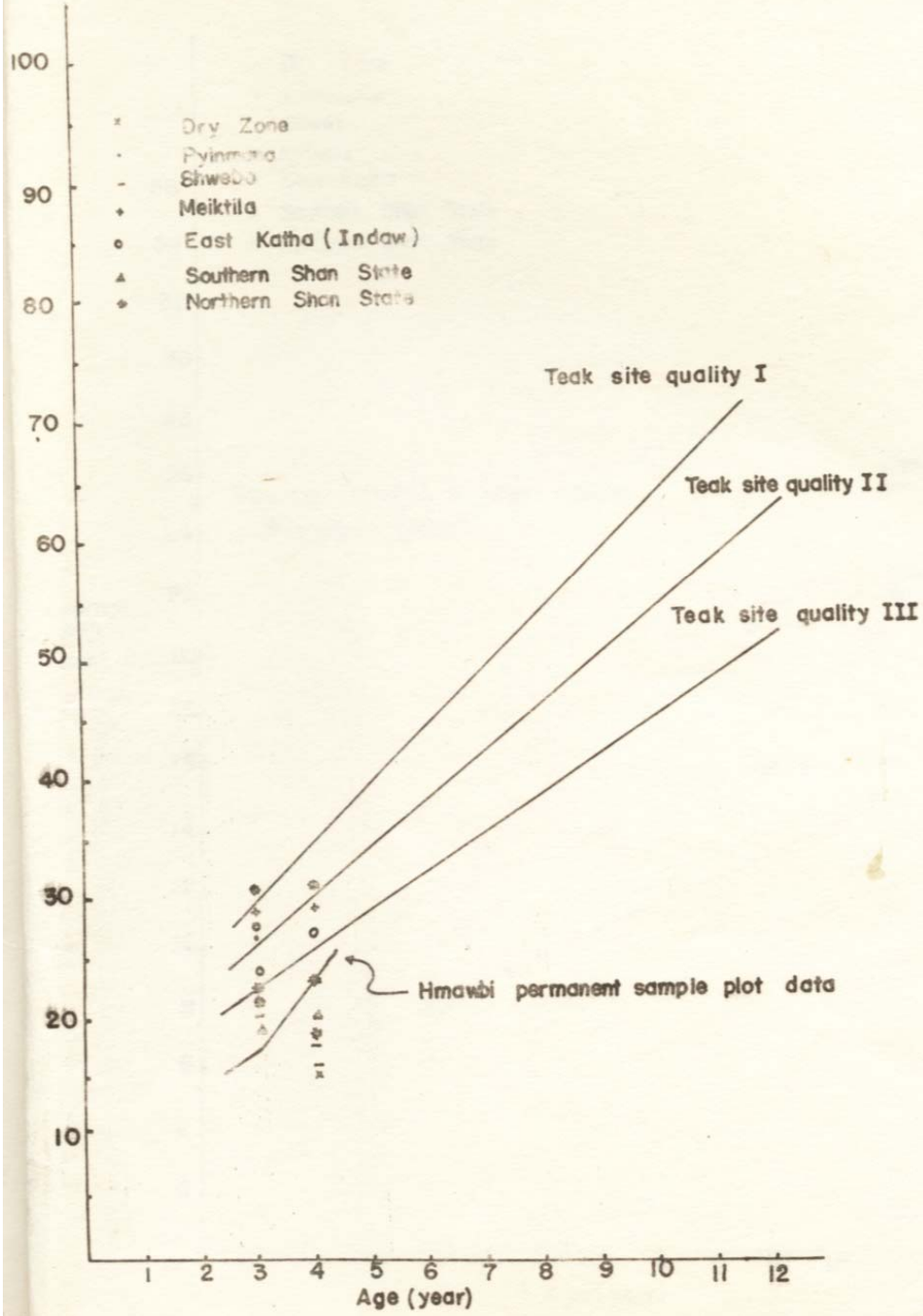


Relationship between girth at breast height & height E.camaldulensis.

Appendix 6

Eucalyptus camaldulensis

Age - height Curve

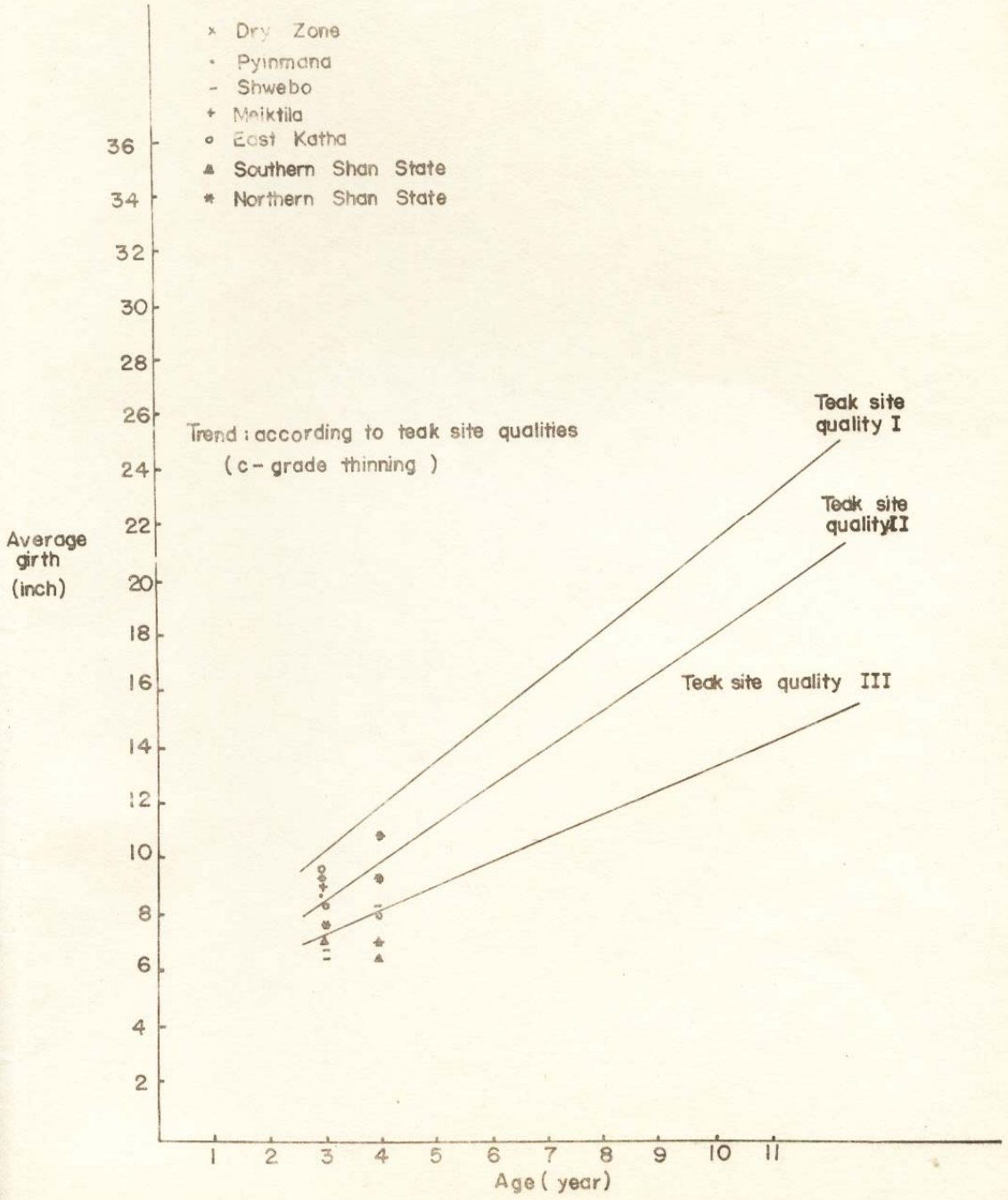


Source: East Pegu Yoma Plantation Project. Project identification report (1978) F.D.

Appendix 7.

Eucalyptus camaldulensis

Age-girth Curve



Source: East Pegu Yoma Plantation Project. Project identification report (1978) F.D.

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