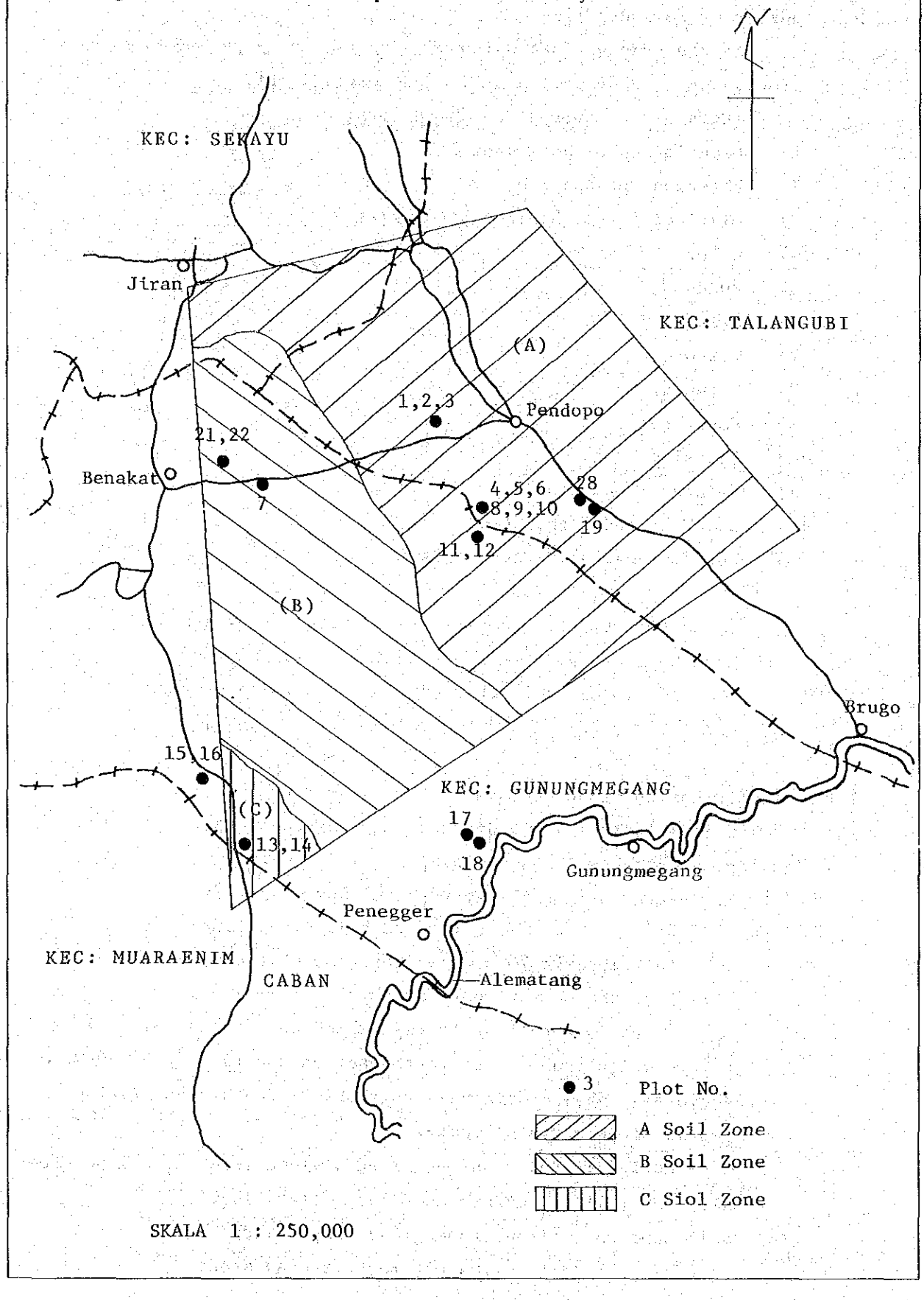
Fig. I-2 Location Map of Soil Survey



This zone is located in the western part of the area. The River Benakat runs through the central part and the River Reman runs from the northeast to the south in this district, then these 2 rivers merge into River Lematang.

Unlike A soil zone, soil in this zone has no iron stone gravel layer.

Topography of the northern part of this zone is as follows: the width of top of rolling terrain is narrow, the slope length is short, and flat valley floor is wide having abundant swampy places.

Undulation is scarcely seen in the middle course of the rivers, and alluvial plain spreads widely in the lower course of the rivers.

(c) Soil zone where quartz sand contains (C)

- Parent rock is Tuff

This zone is located in the south-western corner of the area. There is flat top in the neighbourhood of natural forest, and divided slopes are not developed. The distinctive feature of this zone is that there is no iron stone gravel layer but grain of quartz sand exists in soil profiles.

3-4 Classification of Soil Series

Different type soil in terms of rough topography, parent rock, topographical position, and vegetation, is considered to exist in this area. Soil was classified as follows based on the result of soil sample investigation.

No.of Series	Vegetation	Topographical Position	Existence of Iron Stone Gravel Layer	Existence of Grain of Quartz Sand	No. of Sample	Note
1	Grassland	Top of rolling terrain	+	-	1.4.5.12.	
2	Grassland	Slope of rolling terrain	+	-	2.8.9.11.	
3	Grassland	Foot slope of rolling terrain	+	-	3.6.	
4	Secondary forest, brushland	Top of rolling terrain	-	-	22.	

No. of Series	Vegetation	Topographical position	Existence of iron stone gravel layer	Existence of grain of quartz sand	No. of Sample	Note
5.	Secondary forest, brushland Merkusii pine man-made forest	Slope of rolling terrain	-	-	7.21.	
6	Natural forest	Top of hill	-	+	15.	
7	Natural forest	Slope of hill	-	+	18.	
8	Secondary forest	Top of rolling terrain	-	+	13.	Alang^2 exists
9	Secondary forest	Slope of rolling terrain	-	+	14.	Alant^2 exists
10	Secondary forest, place after cultivation	Alluvial	-	-	16.17 19.20.	
11		Flat valley floor, swamp along river	-	-	10.	

The soil profile and the results of investigation of every soil series are shown in the attached "Collected Illustrations of Soil Profile".

3-5 Nature of Soil

Solid capacity rate of soil in this area is extremely high, and the high value of volume weight is shown in attached table on physical characters.

As the total porosity of soil is low and soil texture is clayey, the greater part of this soil experiences fine porosity, while the lesser part of it shows porosity of a coarse kind.

Therefore, its aeration and permeability are extremely poor. The soil of gentle slope or flat topography is poor in drainage, because of the above-mentioned reason, and even at the top of rolling terrain, it becomes very humid during the rainy season, from the surface to the lower layer, and it has a tendency of stagnoglei.

There are comparatively many cases where the pale white or

Soil series	No.of soil profile	Vegetation	Horizon	Thick-ness of horizon	Volume weight	Composition of 3 phases			Max. water capacity	Min. water capacity	Composition of porosity			Amount of (c.c.) permeability	Note
						Solid%	Water%	Air%			Total%	Fine%	Coarse%		
1	A-1	Alang grassland	A_g	10	113	43.3	45.0	11.7	52.1	4.6	56.7	42.1	14.6	13	
			B_{1g}	10	132	49.2	43.0	7.8	48.7	2.1	50.8	39.1	11.7	8	
			B_{2g}	20	136	47.3	41.3	11.4	45.1	7.6	52.7	37.6	15.1	0.25	
			B_{3g}*	20	155	47.0	42.4	10.6	48.1	4.9	53.0	41.6	11.4	15	*gravel layer
			BC_{1g}	30	132	44.2	41.9	13.9	51.0	5.8	55.8	42.9	12.9	4	
	A-4 (trial area)	Alang grassland	A_g	9	123	46.5	41.9	11.6	50.5	3.0	53.5	39.6	13.9	3	
			B_{1g}	23	139	51.7	44.2	4.1	49.4	-0.1	48.3	40.9	7.4	3	
			B_{2}*	38	158	55.9	39.1	5.0	45.3	-1.2	44.1	37.8	6.3	65	*gravel layer
			B_3	13	125	39.6	53.2	7.2	58.4	2.0	60.4	49.9	10.5	2	
	A-5 (trial area)	Alang grassland	A_g	10	127	50.4	33.4	16.2	42.4	7.2	49.6	31.9	17.7	10	
			B_{1g}	16	137	46.5	40.1	13.4	46.6	6.9	53.5	36.1	17.4	4	
			B_{2g}	14	138	49.7	35.7	14.6	42.0	8.3	50.3	31.7	18.6	8	
2	A-2	Alang grassland	A	9	121	43.4	43.0	13.6	48.7	7.9	56.6	39.2	17.4	14	
			B_{1g}	30	144	46.9	42.8	10.3	46.1	7.0	53.1	37.8	15.3	0.25	
			B_{2g}*	30	161	50.2	37.4	12.4	42.1	7.7	49.8	35.9	13.9	34	*gravel layer
			B_{3g}	30+	142	47.3	46.6	6.1	51.2	1.3	52.7	44.6	8.1	2	
3	A-3	Alang grassland	A_g	15	102	38.3	36.8	24.9	49.3	12.4	61.7	36.4	25.3	44	
			B_{1g}	30	127	45.4	48.5	6.1	51.1	3.5	54.6	43.2	11.4	8	
			B_{2g}	35	123	42.4	46.1	11.5	50.6	7.0	57.6	43.6	14.0	6	
	A-6	Alang grassland	A	9	117	42.2	34.2	23.6	47.7	10.1	57.8	36.9	20.9	9	
			B_1	14	118	42.5	39.2	18.3	48.5	9.0	57.5	37.5	20.0	10	
			B_2	22	136	41.1	37.6	21.3	43.8	15.1	58.9	34.8	24.1	35	

Soil series	No.of soil profile	Vegetation	Horizon	Thick-ness of horizon	Volume weight	Composition of 3 phases			Max. water capacity	Min. Water capacity	Composition of porosity			Amount of (c.c.) permeability	Note
						Solid%	Water%	Air%			Total%	Fine%	Coarse%		
4 Slope of rolling terrain	A-7	P.Merkusii man-made forest	$A_{(g)}$	10	129	48.0	33.1	18.9	43.9	8.1	52.0	32.9	19.1	18	
			$B_{1(g)}$	19	130	45.1	37.6	17.3	44.9	10.0	54.9	35.9	19.0	3	
			$B_{2(g)}$	36	145	52.3	39.6	8.1	43.1	4.6	47.7	37.1	10.6	0.5	
			BC_g	45+	143	51.4	43.0	5.6	46.5	2.1	48.6	41.0	7.6	2	
5	S-15	Natural forest	$A_{(g)}$	15	103	36.3	36.1	27.6	47.8	15.9	63.7	34.1	29.6	160	
			$B_{1(g)}$	17	112	40.4	42.6	17.0	53.1	6.5	59.6	41.1	18.5	85	
			B_{2g}	15	118	42.0	47.4	10.6	54.7	3.3	58.0	45.9	12.1	32	
			B_{3g}	33	117	39.8	50.9	9.3	55.1	5.1	60.2	48.6	11.6	9	
6	H-18	Natural forest	A_2	16	104	41.1	29.9	29.0	57.2	8.4	65.6	40.3	25.3	410	
			B_1	42	113	41.7	20.9	37.4	50.1	11.2	61.3	34.6	26.7	250	
			B_{2g}	28	119	43.4	21.0	35.6	55.9	2.6	58.5	-	-	81	
7	S-13	Secondary forest,after burning of secondary forest (Alang grassland)	A	15	86	33.0	56.6	10.4	65.6	1.4	67.0	55.4	11.6	14	
			$B_{1(g)}$	17	99	34.3	56.7	9.1	61.2	4.5	65.7	53.7	12.0	4	
			$B_{2(g)}$	28	105	36.1	57.4	6.5	61.6	2.3	63.9	55.1	8.8	2	
8	S-14	Secondary forest,after burning of secondary forest (Alang grassland)	A	10	79	30.9	53.0	16.1	65.5	3.6	69.1	50.8	18.3	131	
			B_{1g}	21	89	31.6	56.1	12.3	64.9	3.8	68.4	55.1	13.3	67	
			B_{2g}	22	101	35.0	56.9	8.1	62.9	2.1	65.0	55.1	9.9	3	
			B_{3g}	16	94	33.4	56.9	9.7	64.0	2.6	66.0	55.2	11.4	0.5	
9	H-16	Secondary forest (old stand)	A_1	19	104	41.1	29.9	29.0	51.9	7.0	58.9	29.3	29.6	89	
			B_1	21	113	41.7	20.7	37.6	44.4	13.9	58.3	14.9	43.4	43	
			B_2	46	119	43.4	21.0	35.6	48.2	8.4	56.6	18.7	37.9	112	

orange colored mosaic spots appear at the transition part to C horizon. This is called pallidzone.

This pallidzone is considered to have an unfavorable influence upon the growth of plants, because of its reductive, anaerobic and compact soil, which are known to have a tendency to inhibit the elongation of plant roots. In addition, the data on chemical properties of the soil which is closely resemble the soil in this area are as follows (Attached table). These data are results of the soil survey of the transmigration project area, Beturaja-Martopmra district, South Sumatera (about 70 km of east-southern part of Pendopo) which was carried out by the Soil Research Institute, Ministry of Agriculture, Directorate General of Food Crops in Bogor.

Soil is strongly acidic and its pH is about 5.0, and the degree of base saturation are very low. Also the content of organic matters and the amount of nitrogen are low.

3-6 Soil in the Trial Afforestation Site

There are 4 kinds of soil in the trial afforestation site: soil series 1,2,3,11.

Their distribution is shown in separate "Soil Map".

The characters of sample plots in each soil series are as follows.

No. of soil series	No. of sample plot	Topographical position	Characteristics
1	4	Top of rolling terrain (Gentle slope)	-Iron stone gravel exists in a horizon of 38cm thickness under 30 cm from land surface -Iron stone gravel is scattered in every horizons -Stagnoglei appears only in upper horizon -Very compact in all horizons -Aeration and permeability are very poor
	5	Top of rolling terrain (Flat)	-This represents flat at the top of rolling terrain in this site -There is a tendency of Glei (reduction) -Very compact and permeability is poor
	12	Top of rolling terrain (Flat)	-Same topography as sample plot No.5 and closely resembles its soil -A horizon is thin compared with sample plot No.5

No. of soil series	No. of sample plot	Topographical position	Characteristics
			-Clay amount changes much toward the lower horizon -Clay skin is recognized at B_3 horizon
2	8	Slope of rolling terrain	-Cracks are weak -Reduction is weak in all horizons -Light-colored tendency is not seen in lower horizon
3	6	Foot slope of rolling terrain	-Vertical cracks develop well -Hardness of $A_{(g)}$, B_1 B_2 horizons are irregular -Comparatively high permeability, especially in B_2 layer -Canals caused by earthworms appear in upper horizon -Spots develop well, BC_{2g} horizon is light-colored mosaic
11	10	Flat valley floor (Glei soil)	-Water springs from the depth of 84 cm -Light pale yellow-colored tendency in all horizons -Many black colored spots (Fe+Mg) in BG Horizon -Roots are seen only in upper horizon

4. Vegetation

4-1 Classification of Stand Types

Natural forest, secondary forest and brushland in this area were classified into stand types.

Stand types were decided according to the following standard of height grade and crown density.

Tree height (m)	Mark
Under 10	H_1
11-20	H_2
21-30	H_3
Above 31	H_4

Crown density (%)	Mark
Under 10	D_1
11-40	D_2
41-70	D_3
Above 71	D_4

Result of classification is shown in separate "Vegetation Map". The stand types are expressed as follows in the map.

Area Table of Vegetation

No.of Block	No.of Compart-ment	Hr (ha)						Hb (ha)								Total (ha)
		H_2D_2	H_2D_3	H_3D_2	H_3D_3	H_4D_2	H_4D_3	H_1D_1	H_1D_2	H_1D_3	H_2D_1	H_2D_2	H_2D_3	H_2D_4	H_3D_2	
I	1			17.5				537.5	467.5	60.0		327.5	612.5			2022.5
	2			825.0		650.0	812.5	102.5	25.0					50.0		2465.0
	3							250.0	10.0		2.5	12.5	25.0			300.0
	Total			842.5			812.5	890.0	502.5	60.0	2.5	340.0	637.5	50.0		4787.5
II	1								30.0		15.0	67.5	50.0			162.5
	2			100.0				185.0	365.0	55.0		442.5	220.0		50.0	1417.5
	3			120.0				157.0	695.0		25.0	265.0	197.5			1460.0
	4			30.0				167.5	187.5			55.0				440.0
	5							355.0	275.0	60.0		110.0	50.0		57.5	907.5
	Total			250.0				865.0	1552.5	115.0	40.0	940.0	517.5		107.5	4387.5
III	1			25.0				210.0	285.0	70.0		12.5	12.5			615.0
	2							72.5	245.0		250.0	295.0	250.0			1112.5
	3		2.5					82.5	202.5	352.0	82.5	162.5	150.0			1035.0
	4								67.5	50.0		37.5	332.5			487.5
	5			42.5					977.5		50.0	242.5	317.5			1702.5
	6			57.5					220.0	45.0		135.0	207.5		25.0	690.0
	7			77.5				77.5	402.5	12.5		17.5	30.0			617.5
	8	17.5	10.0	217.5	12.5			105.0	240.0			317.5	30.0	42.5	42.5	1035.0
	9		7.5	25.0					262.5			410.0	20.0	187.5		912.5
	10							5.0	495.0			127.5	545.0	60.0		1232.5
	11			50.0				102.5	45.0			362.5	132.5	110.0	75.0	827.5
	12			2.5	25.0			127.5	80.0			92.5	75.0			375.0
	Total	17.5	20.0	497.5	37.5			855.0	3527.5	530.0	382.5	2207.5	2102.5	400.0	142.0	10720.0
G.Total		17.5	20.0	1590.0	37.5	650.0	812.5	2610.0	5582.5	705.0	425.0	3487.5	3257.5	450.0	247.5	19895.0

Examples of expression: $H_rH_4D_2$, $H_bH_2D_2$,

The size of each classified area, by stand type, in each block and compartment is shown in the following table. The size of detail classified area of each stand type is shown in separate attached "Area Table of Vegetation".

4-2 Vegetation

a) Investigation Method

Vegetation was investigated by setting a quadrate on each sample plot of soil survey. The size of quadrate was $2_m \times 2_m$ in grassland, and $5_m \times 5_m$ of $10_m \times 10_m$ in ligneous plant community.

BRAUN-BLANQUET's dominant method was used in the investigation, and all higher (vascular) plants were examined.

b) Classification of Plant Community

According to the investigation, plant community was divided into the following 4 types:

1) Grassland type represented by Digitaria
2) Grassland type represented by Alang^2
3) Secondary forest type
4) Natural forest type

Each type of plant community is described as follows:

1) Grassland type represented by Digitaria

This type is a mat-like plant community which appears at the places which are influenced by the treading down of soil and by eating up of grass by cattle.

In this type, tall Alang^2 does not appear. Low and dense community of Digitaria compressus appears with sporadic Mimosa and Paspalum spp.

2) Grassland type represented by Alang^2

Alang^2 is dominant species, and one of the following spp., Hyptis capitata or Polygala paniculata, etc. appears in underlayer of Alang^2 without exception.

2)-(i) Alang^2 sub-type

When the plant community of Digitaria compressus which is usually seen along the roads becomes less influenced by the treading by cattle, this sub-type appears there.

However, as these places are burned frequently for grazing, in spite of high dominance of Alang^2, the height of

them is comparatively short, and invasion of Euphatorium odoratum can not be seen.

Judging from the corespondence of topography, this sub-type appears abundantly at the top of rolling terrain.

2)-(ii) Alang^2-*Euphatorium odoratum sub-type*

Characteristics of this sub-type are that the upper storey of plant community is Euphatorium odoratum, and lower storey of them is Alang^2.

This sub-type appears widely at gentle slope where the influences of treading down of soil and eating up of grass by cattle are lesser than Alang^2 sub-type. Also the invasion of shrubs such as Lantana canara and Melastoma polyauthush etc. can be seen.

2)-(iii) Melastoma palyauthush-Alang^2 sub-type

Plant community of this sub-type has almost the same constitution of species with E.odoratum-Alang^2 sub-type, but characteristics of this sub-type are that the height of Melastoma or Lantana are almost the same as Alang^2 or Euphatorium or higher than them, and the dominance of Melastoma or Lantana is high. Although the height of Alang^2 is tall, they show useless growth and the vigor of some of them seems to be decreasing, because they grow under the storeies of shrubs such as Melastoma.

This sub-type appears where the burning is difficult due to the topography, such as at the foot slope of rolling terrain, or where the burning occurs scarcely.

3) Secondary forest type

This type is the plant community which is made up of the pioneer high species such as Mollotus spp., Macalanga gigantea, Callicarpa arborea, and Plenia ovata etc.. Some of grassland type plants such as Alang^2 and Euphatorium odoratum etc. are remaining, but most of them lose vigor or wither on account of screening of light by upper storey.

The invasion of these pioneer species occurs more rapidly in the region which is nearer to natural forest.

4) Natural forest type

This forest type consists of the species such as Dipterocarpaceae and Lauraceae etc. whose upper storey is 40-60 m high.

The species of floor plants in these natural forest is quite different from that of grassland. The component species are mostly ligneous plants, and the herbaceous plants are few.

4-3 Grouping of Sub-Type of the Grassland Type Represented by Alang^2

As is already mentioned, Alang^2 exists in every 3 sub-types. Seeds of this species are disperced by wind, and they germinate, take roots, and grow widely by its strong rhizome.

These rhizomes become storage organ, and regenerate easily even in the case of loss of terrestrial stems by burning or by eating up by cattle, and also grow fast. Also, Alang^2 regenerates by sprouting rhizomes even when they were into parts by cultivation.

Therefore, Alang^2 forms the plant community more easily than any other competitive species which invade simultaneously as Alang^2, after the burning or abandonment of cultivation. However, the growth of Alang^2 decreases rapidly after the formation of upper tree crown. *Melastoma and Lantana, which are shrubs, regenerate comparatively* easily by sprout, but considerable long time is necessary till they grow into adult tree, since they are ligneous plant. Therefore, by frequent burnings, their storage substance are used up, then their regeneration power by sprout becomes difficult.

However, in the places where burning does not occur, brushes grow higher than Alang^2, without branching at first stage. So, brushes grow to upper storey of Alang^2 at a stretch, and they profit by the sun light. From this growth condition point of view, as is mentioned above, it can be said that this sub-type appears at the places where there are no influence by burning.

On the other hand, as for Euphatorium odorata which are broad-leaved herbaceous plants, seeds are scattered by winds and they grow there, and they also spread vigorously with rhizome after that. As they are herbaceous, their life cycle is also comparatively short. Therefore, they have more resistancy to frequent burning, compared with shrubs, but less resistant than Alang^2. For this reason, it makes possible to appear such a intermediate plant community. This plant community is recognized in wide area.

5. Analysis of Topography

5-1 Drawing Up of Mesh Map

Using the topographic map of 1/10,000 scale, square lines of $200_{m} \times 200_{m}$ ($2_{cm} \times 2_{cm}$ on the map) were set up in the whole objective area.

The area of 1 unit (1 mesh) is 4 ha.

The survey area is where the contour line map exists, and its size is about 51,000 ha.

5-2 Analysis of Topography

On each set up mesh, as mentioned above, the area was classified as follows by the reading of topography, such as inclination and elevation.

(a) Classification of topography

Classification	Mark
Top of hill	M_R
Slope of hill	M_S
Foot slope of hill	M_F
Top of rolling terrain	P_U
Slope of rolling terrain	P_M
Foot slope of rolling terrain	P_L
Flat valley floor	D

(b) Classification of inclination

Classification (°)	Mark
Under 3°	I_1
3 - under 8°	I_2
8 - under 15°	I_3
Above 15°	I_4

(c) Classification of elevation

Classification (m)	Mark
Under 50 m	a
51 - 60 m	b
61 - 70 m	c
Above 71 m	d

5-3 Drawing up of Topographical Classification Map (Morphographic Map)

Using the result obtained from above mentioned (a), topographic classification map (scale 1/10,000) was drawn up by zoning the homogeneous range. The map is separate "Morphographic Map". Each classified area is as follows.

Classification of Topography		Area (ha)	Percentage (%)
Top of hill	(M_R)	1,180	2.3
Slope of hill	(M_S)	2,590	5.1
Foot slope of hill	(M_F)	610	1.2
Top of rolling terrain	(P_U)	7,680	15.1
Slope of rolling terrain	(P_M)	29,580	58.0
Foot slope of rolling terrain	(P_L)	4,920	9.6
Flat valley floor	(D)	4,440	8.7
Total		51,000	100.0

The distribution of topography in Benakat area are as follows;

(1) 8.6% presents hill topography

(2) 8.7% is flat valley floor which is economically infeasible to afforestation

(3) Remaining 82.7% belongs to rolling terrain

(4) Among those rolling terrain, 15.1% of its top is not expected to have a good growth of afforested trees

(5) Among those rolling terrain, remaining 67.6% of slope and foot slope can be expected to have a general growth

6. Selection of right tree on right site

6-1 Drawing up of Score Table of Right Tree on Right Site

(1) Sampling

Sample plots were set up at the places near where soil survey was carried out. Forest land productivity of right tree on right site in above-mentioned plots were decided from the field survey on classification of soil and vegetation etc.

On the other hand, each mesh was used as sample mesh by folding above-mentioned sample plots on the meshes which were established as mentioned 4-1.

The number of the sample mesh is 378.

(2) Drawing up of data table

On the sample mesh of 378, the table was prepared regarding external standard or forest land productivity on afforestation sites, and main factors such as topographical analysis (topography, inclination, elevation), soil zone and vegetation.

Classification of forest land productivity on afforestation sites and categories of every factor are described in the following table.

Item		Classification		Code
External standard	Decision of afforestation sites Y	Forest land productivity	I	1
		Forest land productivity	II	2
		Forest land productivity	III	3
		Forest land productivity,	IV	4
Factor	Topography X_1	Top of hill	M_R	1
		Slope of hill	M_S	2
		Foot slope of hill	M_F	3
		Top of rolling terrain	P_U	4
		Slope of rolling terrain	P_M	5
		Foot slope of rolling terrain	P_L	6
		Flat valley floor	D	7
	Inclination X_2	Under 3°	I_1	1
		3 - under 8°	I_2	2
		8 - under 15°	I_3	3
		Above 15°	I_4	4
	Elevation X_3	Under 50m	a	1
		51 - 60 m	b	2
		61 - 70 m	c	3
		Above 71m	d	4
	Soil zone X_4	Zone with iron stone gravel layer	A	1
		Zone without iron stone gravel layer	B	2
		Zone with quartz sand	C	3
		Zone without quartz sand	D	4

Item		Classification		Code
	Vegetation X_5	Grassland 1	Al	1
		Grassland 2	Al+U	2
		Grassland 3	Al+M+R	3
		Secondary forest (including rubber plantation)	Hb	4
		Man-made forest	Ht	5
		Natural forest	Hr	6
		Swamp and others	r	7

(3) Drawing up of score table

(3)-(i) On the sample meshes of 378, factor analysis by multivariate analysis of quantification II were carried out.

(3)-(ii) The obtained result of multi-correlation coefficient derived from calculation on 4 factors of topography, inclination, elevation and soil zone, is 0.8562.

Note: On the factors of 3 sub-types of grassland, as the score values were almost the same, it is not necessary to classify the score. Therefore, the factor of vegetation was eliminated.

Partial correlation coefficient and correlation coefficient are as follows.

	Partial correlation coefficient	Correlation coefficient
Topography	0.3323	0.447
Inclination	0.2474	0.386
Elevation	0.0738	0.124
Soil zone	0.2867	-0.405

The adapted result of the analysis was calculated with these 4 factors, because there was no extraordinary high value of partial correlation coefficient, and also the values on correlation coefficient have almost the same influence power except a factor of elevation.

(3)-(iii) From the result obtained from abovementioned (3)-(ii), score table classified by factors were drawn up as follows:

Factor	Category	No.	Score	Parcial correlation coefficient
Topography	Top of hill	1	1.81	
	Slope of hill	2	1.77	
	Foot slope of hill	3	1.91	
	Top of rolling terrain	4	1.52	0.3323
	Slope of rolling terrain	5	1.46	
	Foot slope of rolling terrain	6	-8.77	
	Flat valley floor	7	-11.78	
Inclination	Under 3	1	-0.29	
	3 - under 8	2	-0.01	0.2474
	8 - under 15	3	0.42	
	Above 15	4	0.10	
Elevation	Under 50 m	1	-0.75	
	51 - 60 m	2	-0.83	0.0738
	61 - 70 m	3	-0.00	
	Above 71 m	4	-0.04	
Soil zone	With iron stone gravel layer A	1	-1.47	
	Without iron stone gravel layer B	2	-1.00	0.2867
	With quartz sand C	3	-0.92	
	Without quartz sand D	4	9.00	

(3)-(iv) From the result of factor analysis, identification graph as shown in separate "Map on Afforestation of Site Classification" was obtained.

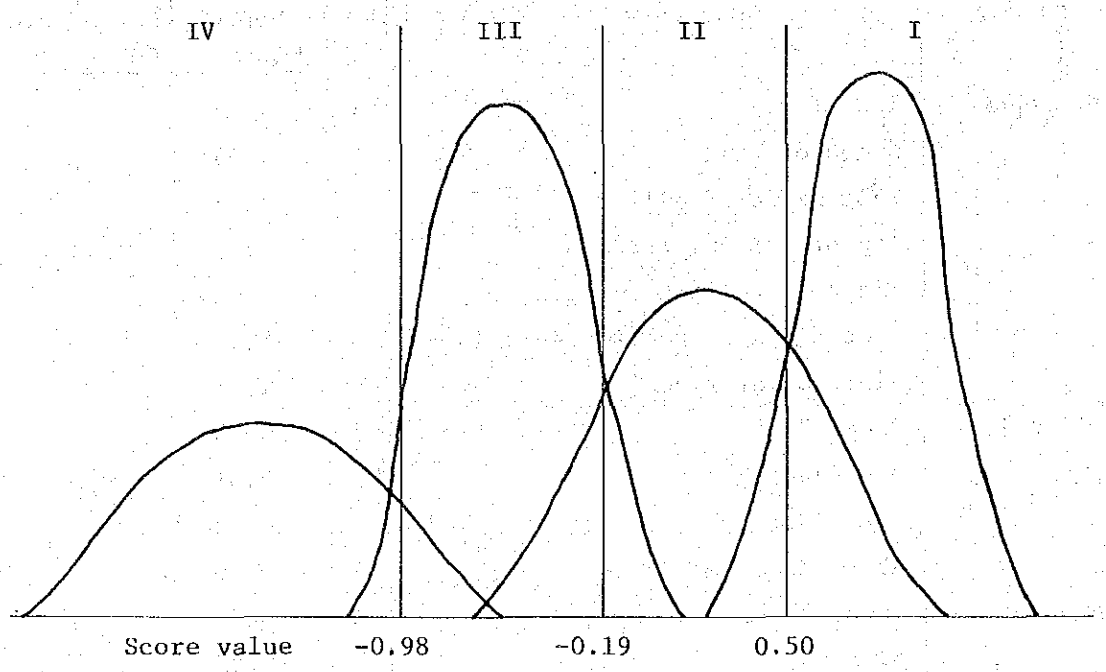
From this graph, values (X_1, X_2, X_3) of afforestation site classification were calculated.

Each standard value is as follows:

$X_1 = 0.50$ Afforestation site classification value between I and II

$X_2 = 0.19$ Afforestation site classification value between II and III

$X_3 = 0.98$ Afforestation site classification value between III and IV



6-2 Selection of Right Site for Afforestation

(1) Calculation of score values

Score value of afforestation site classification on each mesh were calculated, adapting score table of category on each factors through all meshes, except Pendopo town and some parts in the area.

Score value (Y) = (Score of topographical category)
+ (Score of inclination category)
+ (Score of elevation category)
+ (Score of soil zone category)

(2) Classification of selected afforestation site

The classification on decision of afforestation for each mesh was carried out according to the standard values of them which identified score values on each mesh.

Classification of the decision of afforestation sites

I	$Y \geqq 0.50$
II	$0.50 > Y \geqq -0.19$
III	$-0.19 > Y \geqq -0.98$
IV	$-0.98 > Y$

(3) Drawing up of decision map of afforestation sites

(3)-(i) The map on classification of afforestation sites was drawn up on the contour line map of scale 1/50,000, by identified mesh figure which was classified as was mentioned.

In the course of drawing up the classification map, alluvial soil zone, which appears among soil zone factors, was carried out by the following treatment. Alluvial soil zone exists on each A, B, C soil zone, and yet it includes 2 kinds of alluvial and glei soil.

Alluvial soil exists at the foot slope of rolling terrain and glei soil exists both at the foot slope of rolling terrain and flat valley floor. Therefore, these relations are shown in the following table.

Topography	Soil	Classification
Foot slope of rolling terrain	Alluvial soil	2-3
	Alluvial+Glei soil	4
Flat valley floor	Glei soil	5

Ultimately, afforestation site classification is shown as follows:

Afforestation site classification	Mark
Most suitable place	1
Suitable place I	2
Suitable place II	3
Suitable place III	4
Unsuitable place	5

(3)-(ii) Area of each afforestation site classification on each block was measured from the map of afforestation site classification. Collected result is shown in the following table.

		I (ha)	II (ha)	III (ha)	Total (ha)	Percentage (%)
Afforestation site classification	I	1,575.0	849.0	1,288.0	3,712.0	7.1
	II	2,564.0	3,444.0	4,393.5	10,401.5	19.9
	III	2,294.0	6,443.5	16,071.5	24,809.0	47.6
	IV	861.0	910.0	2,477.5	4,248.5	8.2
	V	906.0	10,934.5	2,921.0	5,761.5	11.1

Total	8,200.0	13,581.0	27,151.5	48,932.5	93.9
Left over area from forest management	-	431.5	2,723.5	3,155.0	6.1
Grand total	8,200.0	14,012.5	29,875.0	52,087.5	100.0

Chapter II

Design of Trial Afforestation

Chapter II
Design of Trial Afforestation

1. Basic Conception

1-1 A Line of Basic Plan

In Benakat area, topograph belongs to rolling terrain and hill with gentle undulations (refer to Chapter I, 5).

The soil in this area is mostly Red-yellow Podzolic Soil (Ultisol), and its conditions are not always favorable (refer to Chapter I, 3).

Vegetation inculudes grassland, brushland, secondary forest and natural forest in every stage of plant succession. However, there appears vast area of grassland which has been derived from past shifting cultivation by destruction of natural forest. Namely, this district belongs originally to Tropical Rain Forest Zone (refer to Chapter I, 4).

And, in this area, houses and rubber plantations etc. which are settled down are found here and there as shown in attached Fig. II-1, and field burning is now being carried out for cattle grazing.

Therefore, land productivity differs much according to topography, soil zone and grassland's history in the past (refer to Chapter I, 6). However, possibility of establishment of large scale excellent man-made forests would be expected with the development of suitable technical system, such as selection of tree species or races, mixed planting of soil improving trees and fertilization. Moreover, we must pay our attentions to following present conditions for the realization of afforestation in this area.

Namely, as this region is South Sumatera which has a comparatively small population and also since labour competes with oil drilling, it is necessary to promote a mechanical grassland afforestation technique system in view of labour shortage as well as technical development of infertile grassland soil amendment.

When we make a decision of right tree on right site for the development purpose of large scale industrial afforestation, it is necessary to try species elimination trial by means of trial and error with courage.

Although the conclusion of technical aspects in this region is mentioned above, ameliorations of social condition in this region are more important problems.

Essentially, forests provide with social functions such as flood control and soil conservation etc. and contribute to the promotion of

living standard, securing national land safeguard and water-source conservation, as well as they supply necessary saw logs and fuel wood in accordance with the increase of population and advancement of civilization.

Therefore, it is necessary to fulfil the following problems professing above-mentioned social functions of forest.

(1) In addition to shifting cultivation, burnings are carried out repeatedly for the purpose of getting young Alang^2 sprout as feed for grazing cattle in this district. Then, as this district is exposed to danger of field fire, it is absolutely necessary to arrange fire prevention system such as firebreak, road nets, and look-out tower etc., prior to implementation of afforestation. Simultaneously, as basic means of its prevention, fixed agriculture or vocational reconversion of people must be done.

(2) For the realization of this proposed plan, this project must be intend to aim the elevation of local people's income level by creating mutual supplementary relations, by means of increasing income which would be derived from the employment by afforestation and by breakaway from present extensive their land use. Then, the concept that people's present extensive land use is not confronted with the afforestation project, which is planned to develop hereafter, and the project must be deepened by local people's understanding.

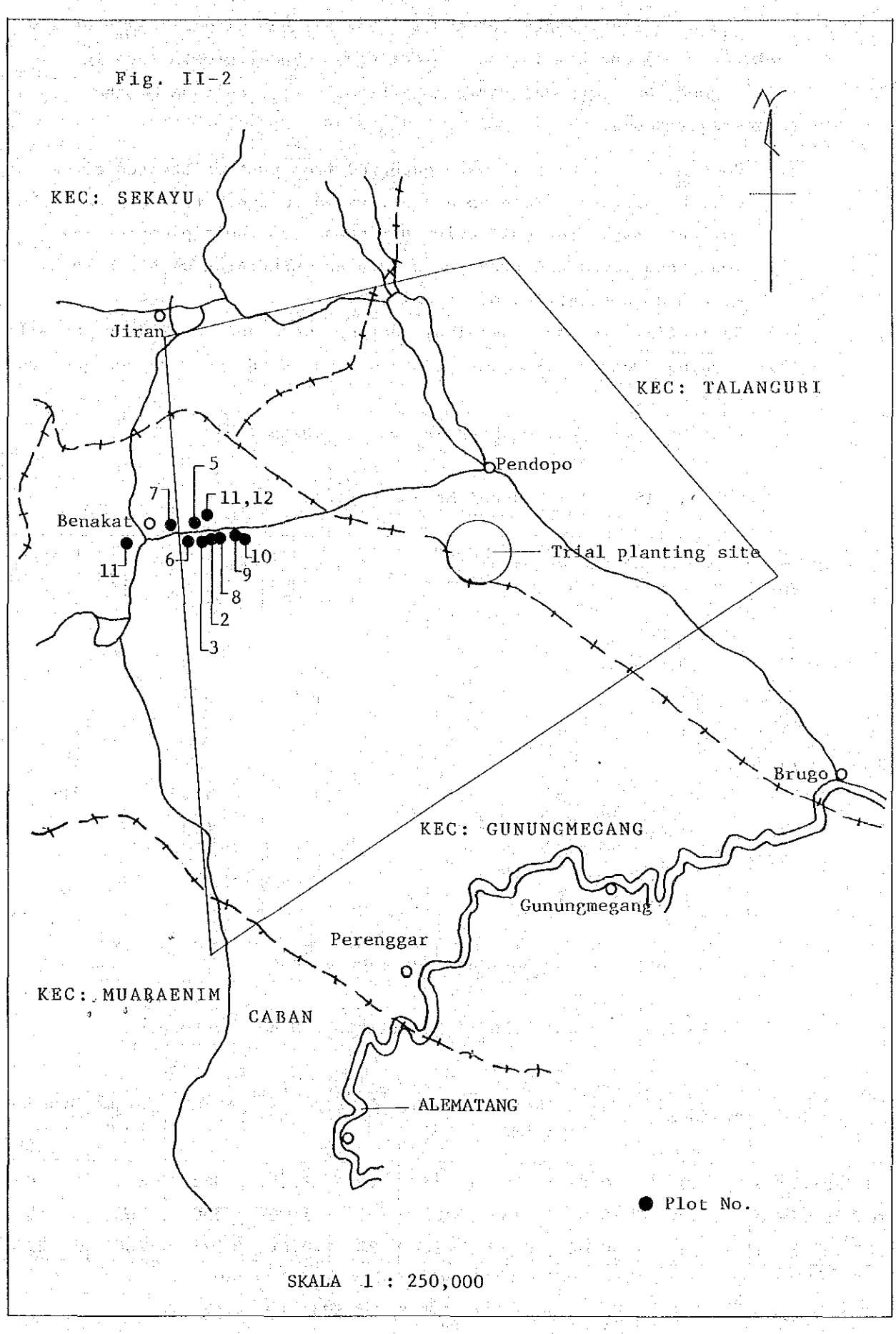
1-2 Outline and the Growth Results of Afforested Area

Experimental man-made forests of Pinus merkusii (see plot 8, 10 in Fig. II-2) and Albizzia falcata (plot 9) exist in western afforestation area of this area. To the further west, there are man-made forest of Peronema canescens (Sungkai) (planted during 1972-1977) and experimental middle-aged man-made forest of P. Merkusii (plot 11).

These past experimental and afforested forests exist in soil zone B, so the growth results would be inapplicable directly to forest zone A and C. However, the growth results obtained in soil zone B are shown in table II-1, II-2, and II-3, and they will be useful for us to study the feasibility of afforestation.

Among them, Sungkai man-made forests (1972-1977) were established by direct-slip-planting after land preparation on Alang^2 grassland. At the time of land preparation, grasses were cut down in row of 1 m width along slope direction at every 3 m.

Fig. II-2


KEC: SEKAYU
Jiran
KEC: TALANGUBI
Pendopo
5
7
11,12
Benakat
11
6
10
9
8
2
3
Trial planting site
Brugo
KEC: GUNUNGMEGANG
Gunungmegang
Perenggar
KEC: MUARAENIM
CABAN
ALEMATANG
● Plot No.
SKALA 1 : 250,000

The number of planted trees is 1,667 per ha, with distance of 3 m (between rows) and 2 m (between seedlings). Their growth rate is fairly good, but survival ratio is extremely poor because of the following reasons:

(1) Used scions of Sungkai were gathered from past afforested trees etc. by private companies and delivered to the Forest Office. The period between the collection of scions and their planting was long, and technical treatments such as submerging of scions etc. were also not carried out completely.

(2) Replantings to the unservival cuttings were not carried out at all.

(3) Weedings were carried out about once, so tendings were not good and sufficient.

Obtained results are shown in the following table.

Table II-1 Sungkai Man-made Forest

Plot No.	Planted year	Date of survey	Estimated stand age	Mean Hight (m)	Mean diameter (cm)		Survival percentage (%)
					1.3m height	0.3m hight	
1-1	1972/73	July, 1978	5	2.2	2.6	3.0	27
1-2	72/73	ditto	5	2.6	3.1	3.9	22
2	71/72	ditto	6	6.1	8.4	9.8	76
3	75/76	ditto	2	-	-	-	35
4	73/74	ditto	4	3.1	3.9	4.9	71
5	72/73	ditto	5	3.1	3.6	4.5	86
6	75/76	ditto	3	2.9	4.3	6.0	-
7*	76/77	ditto	1	-	-	-	29

Note: Plot No. 7 is P. Merkusii Man-made Forest

Table II-2 Pinus Erkusii Experimental Man-made Forest

Plot No.	Date of survey	Estimated stand age	Sample area (ha)	Mean height (m)	Mean d.b.h. (m)	Trees (No.)	Volume (m^3)	Number	per ha	
									Volume (m^3)	Mean increment (m^3)
8	Jul.1978	17	0.08	20	27	29	11.456	362	143	8
10	Jul.1978	12	0.02	18	20	7	1.262	350	63	5
11	Jul.1978	12	0.04	22	24	23	10.624	575	266	22

Table II-3 Albizzia Falcata Experimental Man-made Forest

Plot No.	Date of survey	Estimated stand age	Sample area (ha)	Mean height (m)	Mean d.b.h. (m)	Trees (No.)	Volume (m^3)	Number	Per ha	
									Volume (m^3)	Mean increment (m^3)
9	Jul.1978	12	0.1256	33	33	20	40.767	159	325	27

2. Trial Afforestation Project

2-1 Outline of Trial Afforestation Project

The conception of afforestation planning in Benakat district is intended to establish the valuable forest resources by plantation on extending vast area of grassland. However, there are many remaining problems in this area which must be solved hereafter, concerning natural, social and legal conditions.

Therefore, as preliminary step for the solution of technical, economical and systematic problems before the future steady and effective implementation of industrial planting, it is desirable to commence the Trial Planting as early as possible under the cooperation between Indonesian and Japanese Government rather than immediate commencement of industrial planting.

Based on the obtained results from trial afforestation planting, Pilot Planting must be carried out for establishment of afforestation technique system, and the feasibility study which is necessary for industrial planting must be examined. When the arrangement of above-mentioned conditions are realized, implementation of large scale industrial afforestation is desired to be commenced.

Concerning the Planning of Trial Afforestation, planned area is 698 ha, and net area for them is 339 ha. Afforestation per year is 63-180 ha, and duration of total afforestation is 6 years (considering planted trees' evaluation, it will be 9 years). These details are described later in 2-2.

After projected trial afforestation finished, Pilot Planting must be carried out with the scale of about 10,000 ha, with about 1,000 ha of annual plantation and about 10 years duration.

Then, realization of normal forest in the Industrial Plantation would be considered in economical scale based on data of cutting period which would be determined from the results of trial and pilot planting project. However, concrete planning of Pilot and Industrial Planting would be examined all over again according to the evaluation of Trial

Planting's results, therefore this time, only Trial Planting Planning and its operations are being planned as the subject of the investigation.

2-2 Design of Trial Afforestation

(1) Establishment of site for trial afforestation

In this area, every factor of environment varies according to the blocks as described in Chapter I. Considering these conditions, it is desirable to select a Trial Afforestation site in each block.

Now, as one of them, the site for Trial Afforestation (total area is about 700 ha) has been selected in Block A, 5 km southwest from Pendopo. Concerning this site, we would like to set forth the design of trial afforestation.

(2) Classification of productivity

The site is divided into meshes with the E-W lines which are drawn every 10 m respectively as shown in attached Fig. II-3, with the cardinal crossing point on the river which is located at the entrance of the site from Pendopo. Consequently, 1 mesh represents 100 m x 100 m = 1 ha.

Then, each mesh is indicated A, AB, B, BC, C, ABC, or AC according to the appearance in Top of rolling terrain (A), Slope of rolling terrain (B), and Foot Slope of rolling terrain (C).

The meshes are divided into the following 2 groups. One is A-mesh and AB-mesh group which represent relatively low productivity, and the other is B-mesh, BC-mesh and C-mesh group which represent medium to high productivity. And, these 2 groups will be used as the criterions for judging right species on right site.

(3) Classification of experimental method

Fire break or fire bread tree belt must be established at the circumference, central E-W line, and other necessary places in the total area of 698 ha as shown in Fig. II-3.

The area of 359 ha including the campus of dwelling house, rubber plantation, fire break and flat valley floor, etc. were excluded from the total area.

Then, the following experiments will be carried out on remaining area of 339 ha.

The site is divided into 3 blocks, I, II, III, as shown in Fig. II-3.

The Block I should be established as the experiment area for

mechanical afforestation technique system of grassland.

The Block II is established as the area for the selection of right fast growing species on right site.

The Block III is established as the area for the selection of right valuable timber tree species on right site.

(4) Tree species for experimental afforestation

In the Block I, comparative experiment should be carried out with Pinus merkusii (Merkusii pine) and Peronema canescens (Sungkai).

In the Block II, comparative experiment should be carried out using the following 10 fast growing species.

1. Pinus merkusii (abbreviation: PINM)
2. Pinus carinaea var. hondurensis (PINC)
3. Albizzia falcata (ALBF)
4. Eucalyptus deglupta (EUCD)
5. Gmelina arborea (GMEA)
6. Terminalia catapa (TERC)
7. Campnosperma auriculata (CAMA)
8. Melaleuca leucadendron (MELL)
9. Acacia auriculaeformis (ACAA)
10. Acacia catechu (ACAC)

In the Block III, comparative experiment should be carried out using the following 6 valuable timber tree species.

1. Peronema canescens (PERC)
2. Swietenia macrophylla (SWIM)
3. Maesopis eminii (MAEE)
4. Cordia alliodora (CORA)
5. Dalvergia latifolia (DALL)
6. Cassia siamea (CASS)

Besides these, at the flat valley floor, the planting tree species are limited because of its glei soil. But, Lagerstroemia speciosa (LAGS) would be planted as the useful tree species at this area.

Concerning soil improving tree, Leucaena glauca (Ipil-ipil, LEUG) would be planted with row mixed planting between row of planted trees.

(5) The points of experimental operations and planning of implementation of experiment

(5)-(i) Key points on planting operations

In the trial afforestation site, development of soil structure

is weak, and permeability and aeration are poor due to the characteristics of clayey compact soil of Alang^2 grassland. So, deep plowing is necessary for planting.

In the case of spot planting hole, there is a possibility of stimulating water bearing, then terracing is desirable to prevent it. And plowing of terrace also has an advantage to make widen a space for roots to develop. In the case of row plowing, embankment along planting lines by furrowing is desirable for better permeability and aeration. Moreover, for stimulation and maintenance of them, addition of organic matter such as farmyard or stable manure is desirable. Under existing circumstances, plow or farmyard manuring of Alang^2 are to be considered.

Considering the better permeability of the soil in natural and secondary forest than in Alang^2 grassland, vertical cracks in soil of slope type, which are formed by the development of planted trees' roots, are supposed to promote the permeability of the soil.

As chemical properties of soil in this site are also poor, the fertilization is desirable. However, as nutrient maintenance of soil in this site is poor, fertilization of high concentration has some unfavourable problems such as injury by high concentration, or waste of fertilizer by flowing away, etc. As the counter-measure for this fact, fertilization of fresh bone dust, phosphate rock or organic manure etc. are considered, but, if it is difficult to obtain them, fertilization of general chemical fertilizer of low concentration with many times (every 1 to 2 years) in young stage might be appropriate. Fertilization with base manure of large quantities causes a damage to planted trees, so the fertilization after the survival of planted tree is better than before planting. The amount of fertilizer required per ha is N 20-30 kg at every 1-2 years, and composition ratio of $N:P_2O_5:K_2O$ is about 1:1:1.

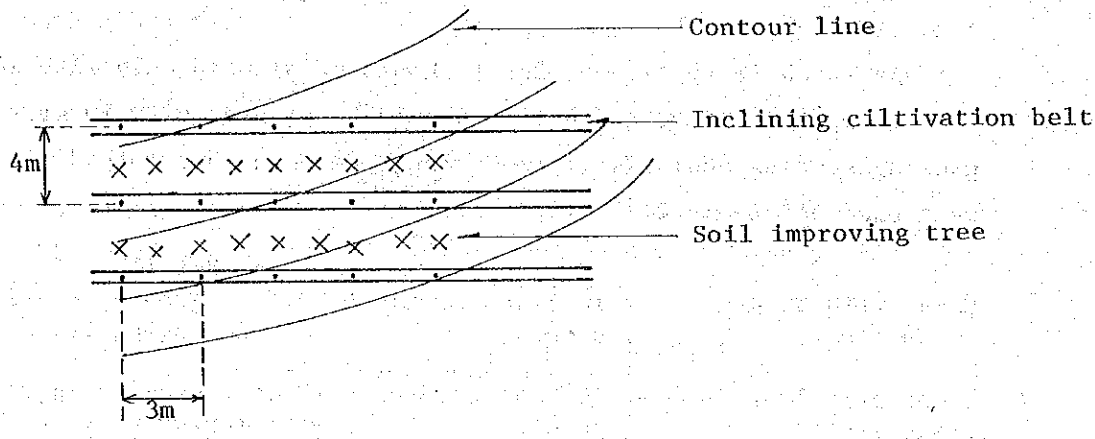
In the case of no A_o-horizon soil, soil is easy to be eroded by dispersion and by flowing away. Therefore, in the case of road construction, reinforcement of roads is very important. But, when the roads are not used so much as managing road, it is desirable to maintain them with cover grass on A horizon.

(5)-(ii) Block I; Experimental block on the mechanical afforestation technique of grassland.

Inclined cultivation belts at slope are set up every 4 m

width in horizontal distance, declining slightly to lower place. Considering drainage, they are not set along the contour line. This is shown in Fig. II-4.

Fig. II-4



Inclined cultivation belt should be established by cutting grove (30-50 cm width and 35cm depth) by machine and by plowing Alang^{2} grass.

The belt should be harrowed up after cultivation, and then, seeds of cover plants are sowed on the belt and straws are spread on the belt.

Merkusii pine should be planted in the half of the block, and at the other half of it, Sungkai should be planted. The plantation should be carried out on the line in the direction of inclination every 3 m, and the distance between seedlings is 4 m on the line.

Soil improving tree (Leucaena glauca) should be reforested with direct sowing every 1 m on the central belt which is set up between seedlings.

Then, refilling and fertilization must be carried out, and weeding can be done by bush-cleaner.

(5)-(iii) Block II: Experiment for the selection of right fast growing species on right site

10 meshes which belong to comparatively low productivity (nemely A and AB), and 10 meshes which belong to comparatively high productivity (namely B, BC and C) should be set up in regular series as Set I. With same method, II to IX-Set are set up.

Plantation of fast growing 10 species (refer to 2-2, (4)) should be carried out at random in each 10 meshes of comparatively low productivity and in each 10 meshes of comparatively high productivity.

Distance on the row plantation should be 3 m to the direction of slope, and the distance between seedlings on the row should be 4 m.

As shown in Fig. II-3, Set I should be planted only with 10 fast growing species, and Set II should be planted with 10 fast growing species adding soil improving tree with same method as mentioned before in 2-2. (5)-(ii).

	Set I	Set II
Comparatively low productivity	10 fast growing species	10 fast growing species + Soil improving trees
Comparatively high productivity	10 fast growing species	10 fast growing species + Soil improving trees

Fig. Experimental Design on Each Set

The results of the experiment would be examined by 3 repeated tests with the combination of Set I, II, Set III, IV and Set V, VI. And Set VII, VIII, IX are reserved for unexpected damages of other sets.

At every mesh, refilling and fertilization must be done.

(5)-(iv) Block III: Experiment for the selection of right valuable timber tree species on right site

With the same method of 2-2. (5)-(iii), experiment should be carried out on 6 valuable timber tree species (refer to 2-2, (4)).

Then, the results of the experiment would be examined by 3 repeated tests with the combination of Set I, II, Set-III, IV, and Set V, VI.

And Set VII, VIII are reserved for unexpected damages of other sets.

Refilling and fertilization at every mesh must be done.

3. Outline of the Necessary Machines, Equipment and Facilities

3-1 List of Machines and Equipment

A. Nursery and planting machinery

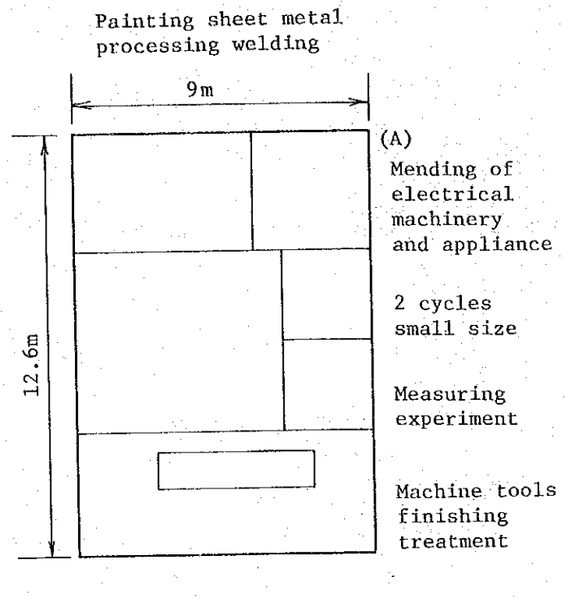
Item	Purpose of use
(1) Wheel tractor (Attachment: plow, disk harrow, subsoiler and others)	Planting and nursery
(2) Auger	Planting
(3) Auto-auger	Planting
(4) Bush cleaner	Planting, weeding
(5) Chain saw	Planting
(6) Dump truck	Transportation
(7) Truck	Transportation
(8) Clawler-dump	Transportation
(9) Trencher	Nursery management
(10) Soil heating machine	Nursery management
(11) Fork-lift	Loading
(12) Sprinkler	Irrigation
(13) Conveyer	Loading
(14) Auto-seeder	Seeder
(15) Auto seedling selector	Seedling select
(16) Hand tractor	Field management
(17) Others	

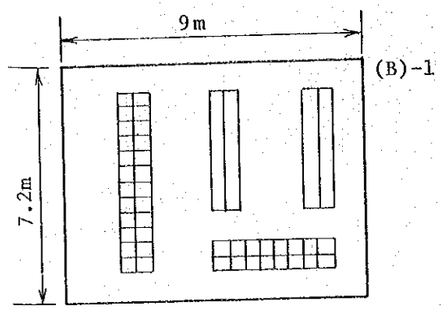
B. Road construction and soil conservation machinery and material

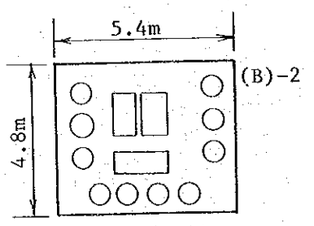
Item	Purpose of use
(1) Angledozer (Attachment: back hoe, clipper, anglerake)	Road construction
(2) Shoveldozer (Attachment: back hoe, clipper)	Road construction
(3) Rammer	Road construction
(4) Motor grader	Road management
(5) Road roller	Road management
(6) Dump truck	Transportation
(7) Clawler dump	Transportation
(8) Truck	Transportation
(9) Trencher	Road construction
(10) Conveyer	Transportation
(11) Road mark	Road construction
(12) Others	

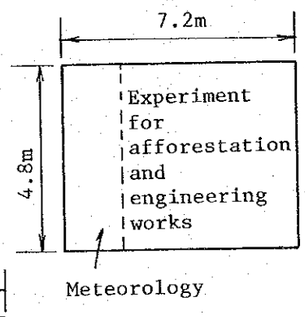
Fig. II-5 Building in affiliation

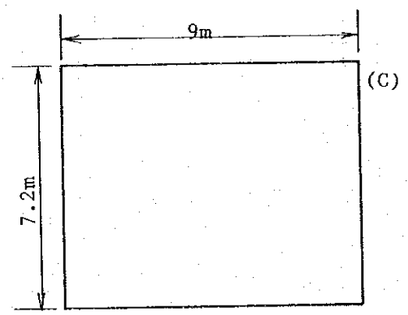
(A) Repairing practice work shop	9.0 x 12.6 m	1134.0 m^2
(B) Warehouse B-1 Parts, tools	9.0 x 7.2	64.8
B-2 Petroleum	5.4 x 4.5	24.3
(C) Woodworking place	9.0 x 7.2	64.8
(D) Electrical room	9.0 x 7.2	64.8
(E) Parking area	5.5 x 15.0	82.5
(F) Car wash	5.0 x 10.0	50.0
(G) Test room Observation room	7.2 x 4.8	34.56
(H) Training room	9.0 x 18.0	162.0
(I) Meeting room	9.0 x 18.0	162.0
(J) Guard room	3.6 x 4.8	17.28
(K) Shower room	7.2 x 1.8	12.96

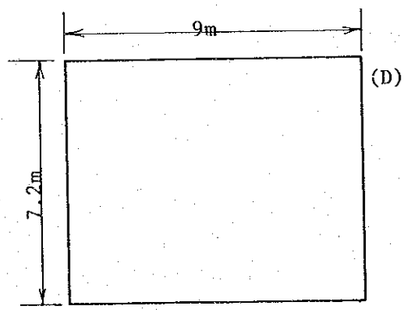












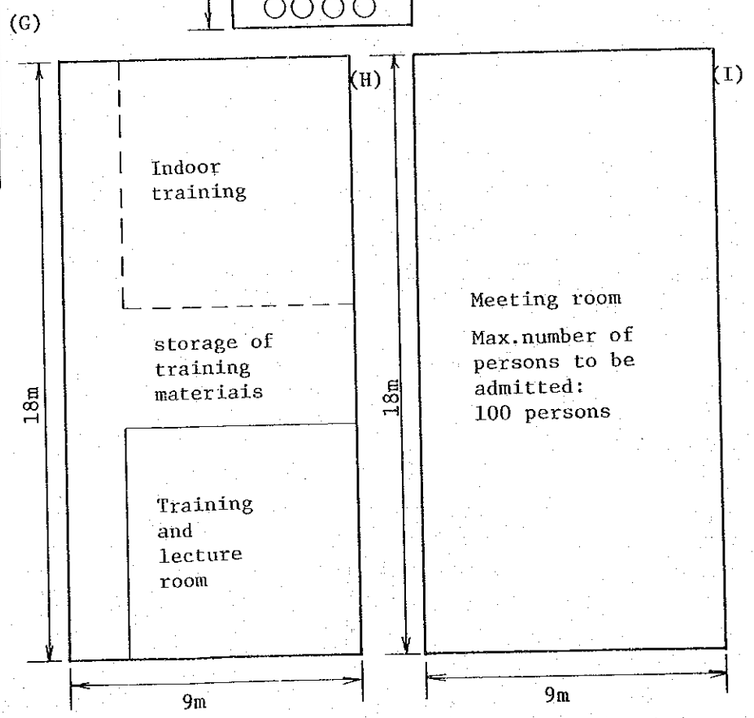
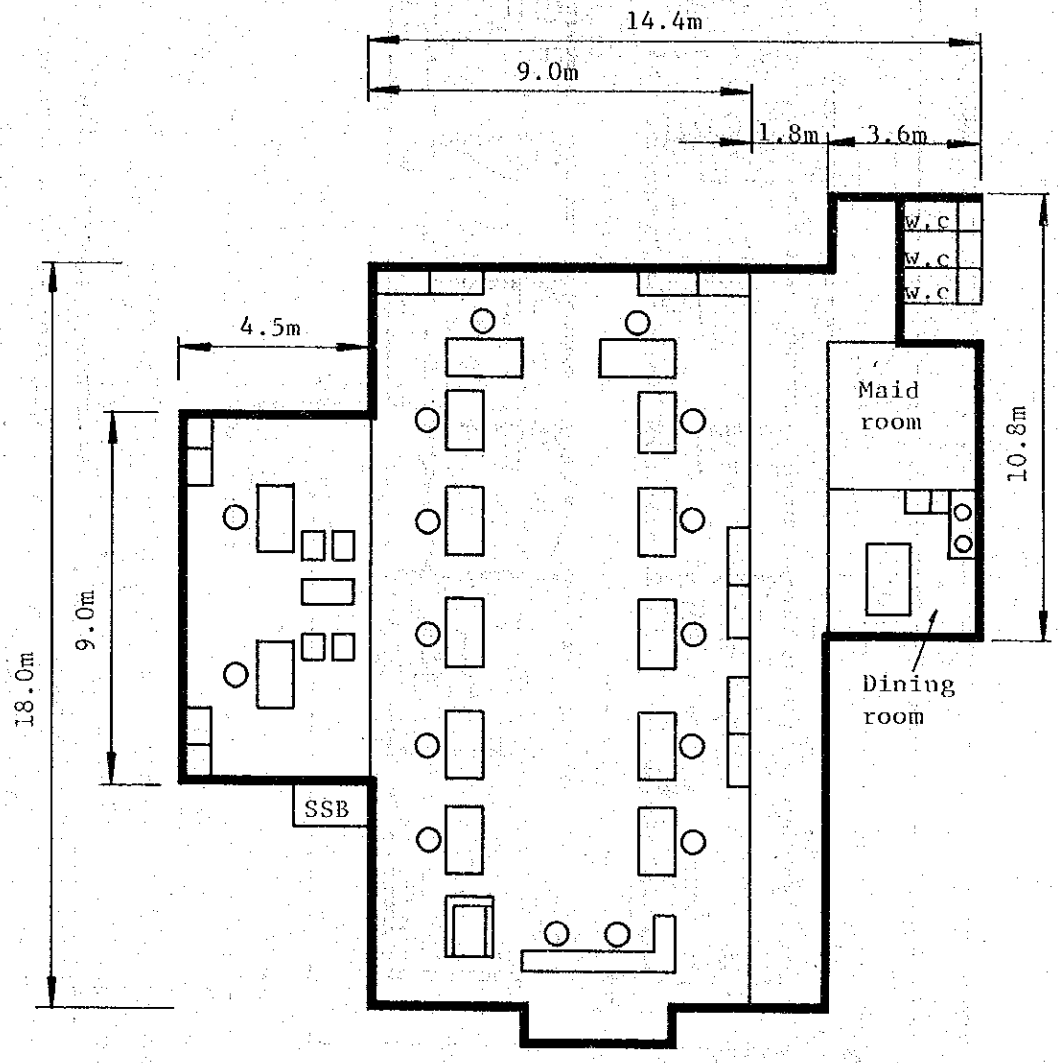
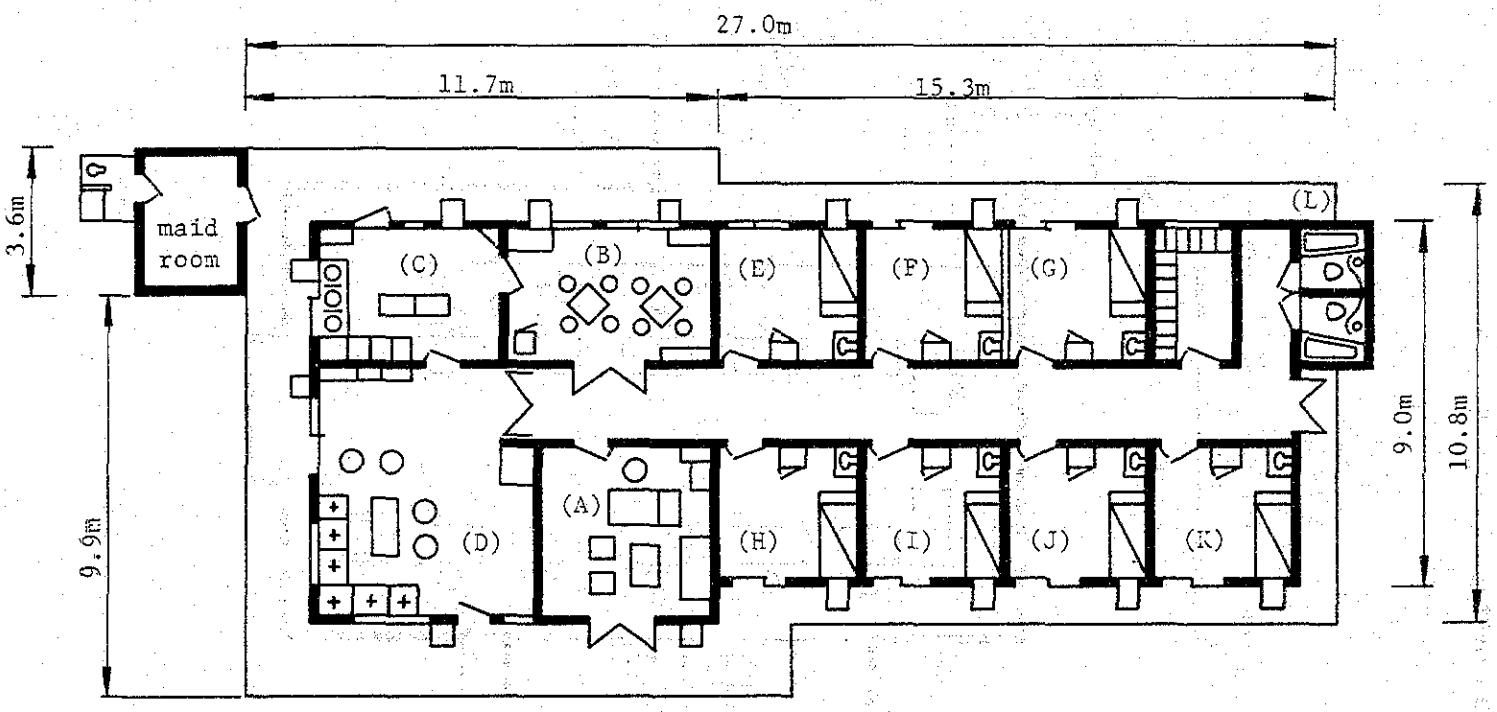


Fig. II-6 Field Office



Total area: 246.38m^2

Fig. II-7 Dormitoty



Mark	Floor Plan	Mark	Floor Plan
(A)	Offics (Leader)	(G)	Single room
(B)	Dinning room	(H)	Single room
(C)	Kitchen	(I)	Single room
(D)	Meeting room	(J)	Single room
(E)	Single room	(K)	Single room
(F)	Single room	(L)	Toilet, Bath, Shower

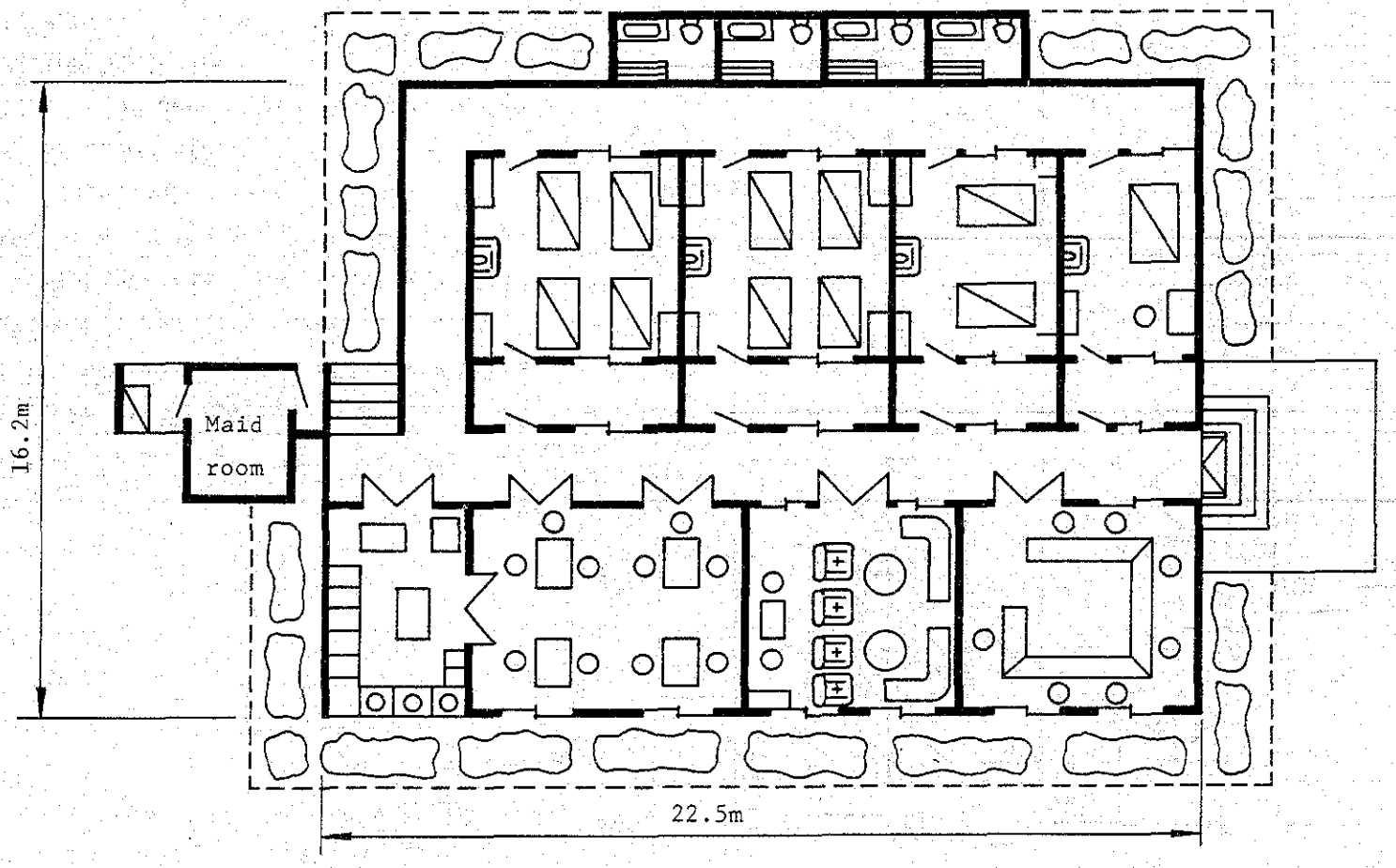
Contents of construction

One-storied house with raised floor

Base area: 227.61m^2

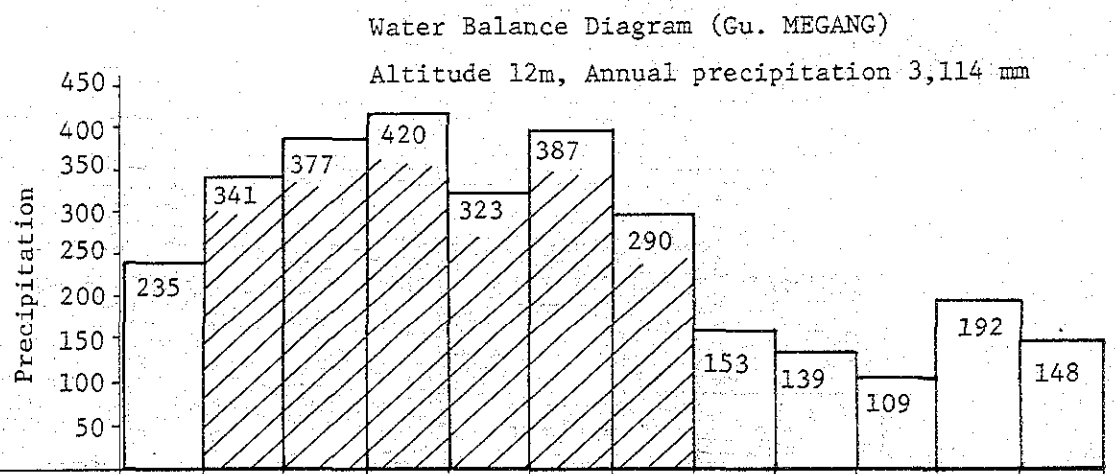
Total area including verandh: 520.76m^2

Fig. II-8 Guest-house



Total floor area: 377.46m^2

Table II-4 The Program of Operations



Annual	Item \ Month	10	11	12	1	2	3	4	5	6	7	8	9
	Season	Dry	Wet							Dry			
1	Arrangement of infra-structure												
	Partition survey in trial afforestation site												
	Establishment and arrangement of nursery												
	Acquisition of seeds for planting of I-B1												
2	Raising of planting stock for I-B1												
	Land preparation of I-B1												
	Sowing of cover plant												
	Acquisition of seeds for planting of II-B1												
3	Plantation of I-B1												
	Fertilization of I-B1												
	1st year's weeding (including replanting) of I-B1												
	Raising of planting stock for II-B1												
	Land preparation of II-B1												

Annual	Item \ Month / Season	10	11	12	1	2	3	4	5	6	7	8	9
		Dry	Wet						Dry				
3	Acquisition of seeds for planting of II-B1												
	Acquisition of LAGS seeds for flat valley floor												
4	Plantation of II-B1												
	Fertilization of II-B1												
	2nd year's weeding of I-B1												
	1st year's weeding (including replanting) of II-B1												
	Raising of planting stock for III-B1												
	Raising of LAGS stock for flat valley floor												
	Land preparation of III-B1												
	Land preparation of flat valley floor												
5	Plantation of III-B1												
	Plantation of flat valley floor												
	Fertilization of III-B1												
	Fertilization of flat valley floor												
	2nd year's weeding of II-B1												
	1st year's weeding (including replanting) of III-B1												
	1st year's weeding of flat valley floor												
6	2nd year's weeding of III-B1												
	2nd year's weeding of flat valley floor												
7	Growth survey of 5 year's planting tree of I-B1												
8	Growth survey of 5 year's planting tree of II-B1												
9	Growth survey of 5 year's planting tree of III-B1												

C. General use machinery and equipment

Item

(1) Jeep
(2) Bus
(3) Motor cycle
(4) Firepump and fire fighting equipment
(5) Generator
(6) Service equipment
(7) Meteorological observation equipment
(8) Experimental equipment and teaching materials
(for nursery, afforestation, road construction, soil conservation)
(9) Radio and electric equipment
(10) Others

3-2 List of Facilities

List of facilities is shown in Fig. II-5, 6, 7, 8.

4. Program of Operations

The trial afforestation project is carried out according to the annual program as shown in Table II-4. The operation is scheduled to come to an end in the 6th year. The evaluation of growth result of planted trees must be done at the 5th year after they are planted.

In the table II-4, I-B1, II-B1 and III-B1 indicate Block I, Block II and Block III respectively.

5. Calculation of Necessary Expenses

5-1 Number of Necessary Seedlings

(1) Block I

Pinus merkusii (northern part of I-B1)

833/ha x 31 ha = 26,000 seedlings

adding 20% for replanting: 31,200 seedling

Peronema cascens (southern part of I-B1)

833/ha x 32 ha = 27,000 seedlings

adding 20% for replanting: 32,400 seedlings

Soil improving trees

2,500 seedlings/ha (4 x 1 m)

2,500/ha x 63 ha = 157,500 seedlings

(2) Block II

10 fast growing tree species

833/ha x 18 ha x 10 species = 150,000 seedling

adding 20% for replanting: 180,000 seedlings

Soil improving trees

2,500/ha x 9 ha x 10 species = 225,000 seedlings

(3) Block III

6 valuable timber tree species

833/ha x 16 ha x 6 species = 80,000 seedlings

adding 20% for replanting: 96,000 seedlings

Soil improving trees

2,500/ha x 8 ha x 6 species = 120,000 seedlings

(4) Flat valley floor

Lagerstroemia speciosa (LAGS)

Meshes of flat valley floor cover 91 ha.

However, secondary forests which is developing around and along the rivers in this site, must be remained as much as possible from the erosion control point of view. So the estimation of necessary seedlings of LAGS for plantation is as follows:

833/ha x 91 ha/2 = 39,000 seedlings

Note: As the maximum number of necessary seedlings for this trial plantation in one year is 180,000 for fast growing tree species and 225,000 for soil improving trees (total 405,000 seedlings), so the area of about 1.5 ha is sufficient for the necessary area of nursery for the raising of these planting stock.

The 2nd Nursery of South Sumatera Province Office, which is now used for the raising of plant stock for the Afforestation Area, might be possible to be used also for this project.

Concerning the nersery practice, following 2 points are recommended:

(1) Acquisition of seeds must be introduced from as similar environmental district as possible, and should be obtained with identified seed origin. Also, effort must be done to get the seeds of plus-trees under the cooperation of the places where seeds are produced.

(2) Mechanization of nursery is necessary, especially for irrigation, shading, burning of soil as well as to fulfil seed storage and other experimental equipment.

5-2 Basic Data on Calculation of Necessary Expenses for Trial Afforestation

5-2-1 Calculation of annual costs for trial afforestation

(1) The 1st year

Establishment of partition in the trial afforestation site.

The site ranges from the maximum length of 2,500 m in N-S line, and 3,600 m in E-W line. This site is partitioned by meshes with the N-S lines and E-W lines which are drawn every 100 m respectively as shown in Fig. II-3, with the cardinal crossing point on the river which is located at the entrance of the site from Pendopo. Consequently, 1 mesh represents 100 m x 100 m = 1 ha.

These meshes are partitioned by establishing 2 cardial lines on each N-S, and E-W direction which are set up with transit-compass and steel-tapes and marked at every 100 m on these cardinal lines.

Then, square poles (6.3 cm 2 m, made with polyvinyl chloride pole) are set up at the corners of each mesh as a guide. Necessary number of poles are calculated as being 775, but they are estimated as 1,000 considering a wastage.

Necessary expenses are as follows:

(A) 1 day labor wage:

Pole men	2 men x 1,200 Rp/day =	2,400 Rp
Stretching ropes	2 men x 1,200 Rp/day =	2,400 Rp
Total		4,800 Rp

Working days are estimated as 70 days.

Then, surveying labor wages are

4,800 Rp x 70 days = 336,000 Rp

(B) Material costs:

1,000 poles 2,000 ¥ = 2,000,000 ¥

= 6,200,000 Rp (Conversion rate 1¥=3.1Rp)

(C) Total expenses: (A) + (B) = 6,536,000 Rp

(2) The 2nd Year

Note (1)

Item	Quantity	Unit cost (Rp)	Expense (Rp)	Remarks
I-B1. Raising of planting stock				
Merkusii pine	31,200 seedlings	28.2	879,840	Note (2)
Sungkai	32,400 seedlings	15.0	486,000	
Soil improving tree	157,500 seedlings	22.5	3,543,750	
Total			4,909,590	
I-B1. Land preparation of planting place	63 ha	49,800	3,137,400	
I-B1. Sowing of cover plant	63 ha	25,000	1,575,000	
Total			9,621,990	

(3) The 3rd Year

Item	Quantity	Unit cost (Rp)	Expense (Rp)	Remarks
I-B1. Plantation (Merkusii pine, Sungkai)	63 ha	12,600	793,800	
(Soil improving tree)	63 ha	37,800	2,381,400	
Total			3,175,200	
I-B1. Fertilization	63 ha	31,580	1,989,540	
I-B1. 1st year's weeding(including replanting)	63 ha	36,000	2,268,000	
1st year's weeding (twice a year)	63 ha	33,600	2,116,800	
Total			4,384,800	
II-B1. Raising of planting stock				
Fast growing tree species	180,000 seedlings	22.5	4,050,000	
Soil improving tree	225,000 seedlings	22.5	5,062,500	
Total			9,112,500	
II-B1. Land preparation of planting place	180 ha	49,800	8,964,000	
Total			27,626,040	

(4) The 4th Year

Item	Quantity	Unit cost (Rp)	Expense (Rp)	Remarks
II-B1. Plantation (Fast growing tree species)	180 ha	12,600	2,268,000	
(Soil improving tree)	90 ha	37,800	3,402,000	
Total			5,670,000	
II-B1. Fertilization	180 ha	31,580	5,684,400	
I-B1. 2nd year's weeding	63 ha	18,600	1,171,800	
II-B1. 1st year's weeding (including replanting)	180 ha	36,000	6,480,000	
1st year's weeding (twice a year)	180 ha	33,600	6,048,000	
Total			13,699,800	
III-B1. Raising of planting stock				
Valuable timber tree species	96,000 seedlings	22.5	2,160,000	
Soil improving tree	120,000 seedlings	22.5	2,700,000	
Flat valley floor (LAGS seedling)	39,000 seedlings	22.5	877,500	
Total			5,737,500	
III-B1. Land preparation of planting place	96 ha	49,800	4,780,800	
Flat valley floor. Land preparation of planting place	46 ha	49,800	2,290,800	
Total			7,071,600	
Total			37,863,300	

(5) The 5th Year

Item	Quantity	Unit cost (Rp)	Expense (Rp)	Remarks
III-B1. Plantation (Valuable timber tree species)	96 ha	12,600	1,209,600	
(Soil improving tree)	48 ha	37,800	1,814,400	
Flat valley floor. Plantaion (LAGS seedling)	46 ha	12,600	579,600	
Total			3,603,600	
III-B1. Fertilization	96 ha	31,580	3,031,680	
Flat valley floor	46 ha	31,580	1,452,680	
Total			4,484,360	

Item	Quantity	Unit cost (Rp)	Expense (Rp)	Remarks
II-B1. 2nd year's weeding	180 ha	18,600	3,348,000	
III-B1. 1st year's weeding (including replanting)	96 ha	36,000	3,456,000	
Flat valley floor. 1st year's weeding (including replanting)	46 ha	36,000	1,656,000	
III-B1. 1st year's weeding (twice a year)	96 ha	33,600	3,225,600	
Flat valley floor. 1st year's weeding (twice a year)	46 ha	33,600	1,545,600	
Total			13,321,200	
Total			21,319,160	

(6) The 6th Year

Item	Quantity	Unit cost (Rp)	Expense (Rp)	Remarks
III-B1. 2nd year's weeding	96 ha	18,600	1,785,600	
Flat valley floor. 2nd year's weeding	46 ha	18,600	855,600	
Total			2,641,200	

Note 1: Unit costs used in above calculation, were all introduced by "BIAYA STANDAR, Departement Pertanian, Jakarta, April 1977". But considering the recent inflation tendency in Indonesia, Figures are recalculated as 3 times that of 400 Rp labor wage in Propinsi Sumatera Selatan.

Note 2: Cost of seedlings, according to BIAYA STANDAR, were calculated on the basis that 400,000 seedlings could be raised on 1 ha area of nursery.

Pinus merkusii; 11,298,000 Rp ÷ 400,000 = 28.2 Rp/seedling

Peronema canescens; 6,009,000 Rp ÷ 400,000

= 15.0 Rp/seedling (Mahagoni)

Seedling cost of fast growing tree species, valuable timber tree species, soil improving tree and LAGS, are calculated from the mean cost of the following 4 species:

Pinus merkusii: 28.2 Rp

Mahagoni: 15.0 Rp

Acacia auriculaeformis: 11,292,000 Rp ÷ 400,000

= 28.2 Rp/seedling

Albizzia: 7,488,000 Rp ÷ 400,000 = 18.7 Rp/seedling

The mean is 22.5 Rp.

5-2-2 Cost of Road Construction

Item	Quantity	Unit cost (¥)	Expense (¥)
Main forest roads in trial afforestation site	12.8km	¥10,000/km	128,000
Maintenance cost of the forest roads	3% of above construction costs		3,840
Repair costs of road between trial afforestation site and Pendopo	5.0km	¥4,000/km	20,000
Total			151,840

5-2-3 Material Costs

Item	Expense (¥1,000)
For afforestation	54,642
For above experimental material	5,354
Total	59,996
For roads construction	141,511
For above experimental material	5,000
Total	146,511
For meteorological observation	2,890
(Instrument screen)	140
Total	3,030
For field fire prevention	3,659
Sum total	213,196

5-3 Calculation of Necessary Expenses

(1) Cost of Trial Afforestation

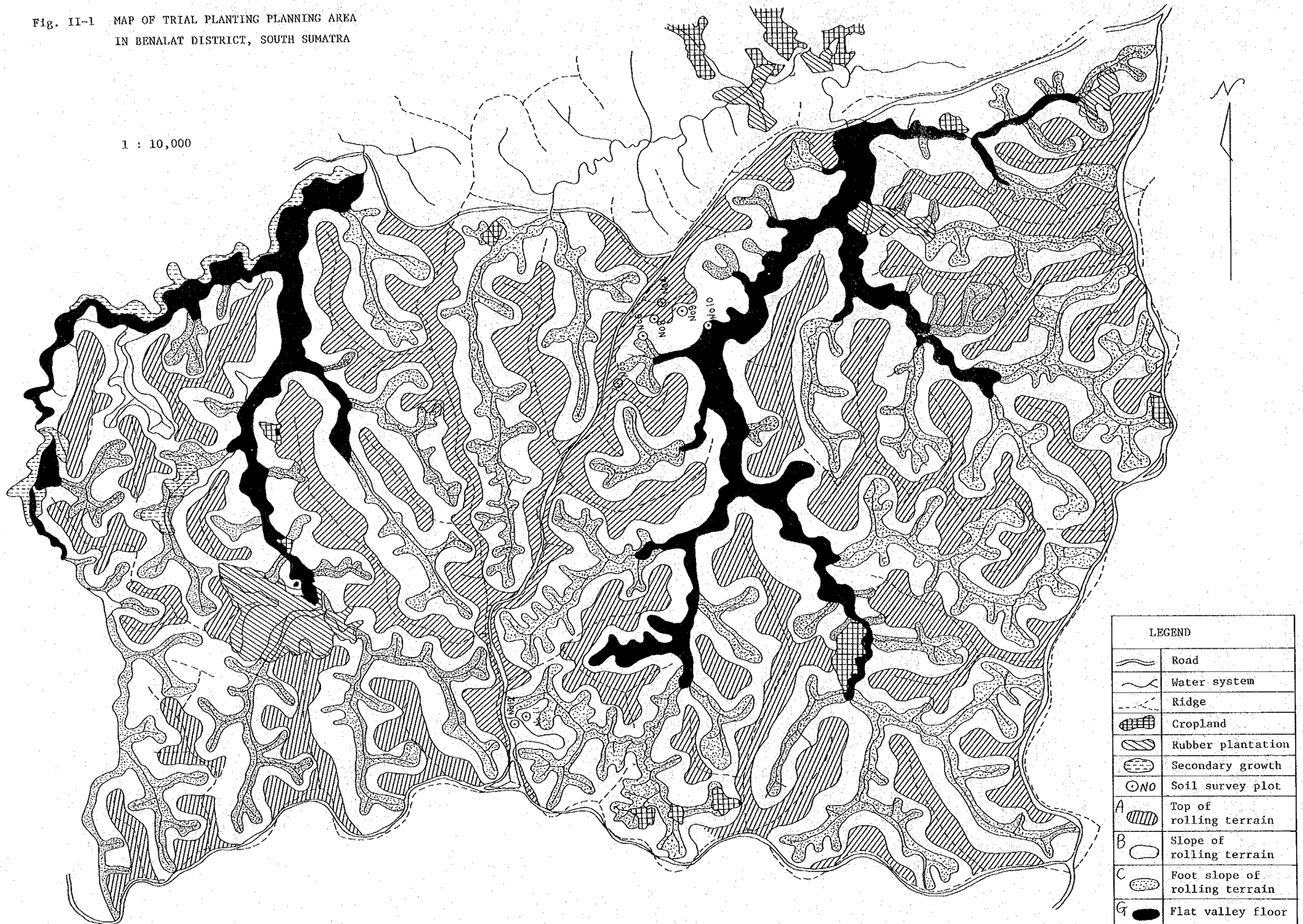
Yearly plan	Cost of seedlings (Rp)	Cost of afforestation (Rp)	Total (Rp)
1	-	6,536,000	6,536,000
2	4,909,590	4,712,400	9,621,990
3	9,112,500	18,513,540	27,626,040
4	5,737,500	32,125,800	37,863,300
5	-	21,319,160	21,319,160
6	-	2,641,200	2,641,200
Total (Rp)	19,759,590	85,848,100	105,607,690
(¥)	6,374,061	27,692,935	34,066,996

(2)	Cost of road construction	¥151,840	470,704.0 Rp
(3)	Material cost	¥213,196	660,907.6 Rp
Grand Total (1) - (3)		¥399,103	1,165,679.0 Rp

Note: Exchange rate: ¥1 = 3.1Rp

Fig. II-1 MAP OF TRIAL PLANTING PLANNING AREA
IN BENALAT DISTRICT, SOUTH SUMATRA

1 : 10,000



LEGEND	
	Road
	Water system
	Ridge
	Cropland
	Rubber plantation
	Secondary growth
⊙NO	Soil survey plot
A	Top of rolling terrain
B	Slope of rolling terrain
C	Foot slope of rolling terrain
G	Flat valley floor

Fig. II-3 Map of Experimental Design

(III-BLOCK; Valuable timber tree species ---16meshes 96ha)

(I-BLOCK; Mechanical Afforestation---60ha)

3 repeated test with 6 species

30 ha

III-BLOCK

30 ha

I-BLOCK

FIRE BREAK TREE BELT

II-BLOCK

(II-BLOCK; Fast Growing Species --- 18meshes 180ha)

3 repeated test with 10 species

poor / better — The first

poor / better — The 2nd

poor / better — The 3rd

--- Mix-planting with Soil improveing tree

A,AB Comparatively low productivity (poor)

B,BC,C Comparatively high productivity

poor / better — reserved

poor / better — reserved