5. Feasibility Study of Social Forestry

5.1 Definition of Social Forestry and Methods of Feasibility Study

5.1.1 Definition of Social Forestry

Social forestry is expressed as "social forestry" in India, "community forestry" in China and North Korea and "village forestry" in Tanzania, all of which may be interpreted to be synonymous. Its objective is to perform the tree planting, forest plantation, improvement of natural forest and maintenance in order to supply what are indispensable to the life of the local inhabitants mainly by the efforts of self help, for example, production of fuelwood, building materials, fruits and fodder, etc., conservation of water sources, manual cultivation and prevention of soil erosion through shade trees for crops and soil improving trees, maintenance and cultivation of the soil productive capability and improved living environment, etc. through shade trees for houses, preparation of roadside trees and parks.

In Tanzania, large industrial plantations covering over 70,000 hectares have been established in 18 national forest projects in order to produce forest industrial raw materials. The other afforestation efforts all over the country may be said to be social forestry. Even the Natural Forest Reserves, most of them once used to produce sawmill raw materials as the primary objective but recently the objectives have shifted to the conservation of water sources. Production of wood for the local inhabitants is limited to supplying of fuelwood, to some extent some parts of the reserves have been encroached in an effort to open new farms. The sawmills in the study area are of exceedingly small scale coupled with carpentry works for production of furniture for local market within the area. In this respect, the study area of 200,000 hectares is thought to be suitable for social forestry.

5.1.2 Methods of Feasibility Study

This study was performed for as an exceedingly vast area as 200,000 ha which is very diversified from highland intensive agricultural zones to lowland savanna grazing zones in as short a period of time as about one year. Therefore, we adopted a method of analysis by using computers, by the mesh method.

In view of the given period and objective area, the size of the mesh was decided to be 500 m × 500 m = 25 ha, reaching a total of 8,326 meshes. This size has a tendency to be too large especially for the highland agricultural zone with steep slope and intensively used land. Also since the number of factors to be sufficiently taken, a portion which is more or less unclear appears in the analysis result. But this method is sufficiently useful to generally for grasping the whole picture of a vast area in a short period of time.

If a sufficient time was given, it was possible to analyze with much higher accura-

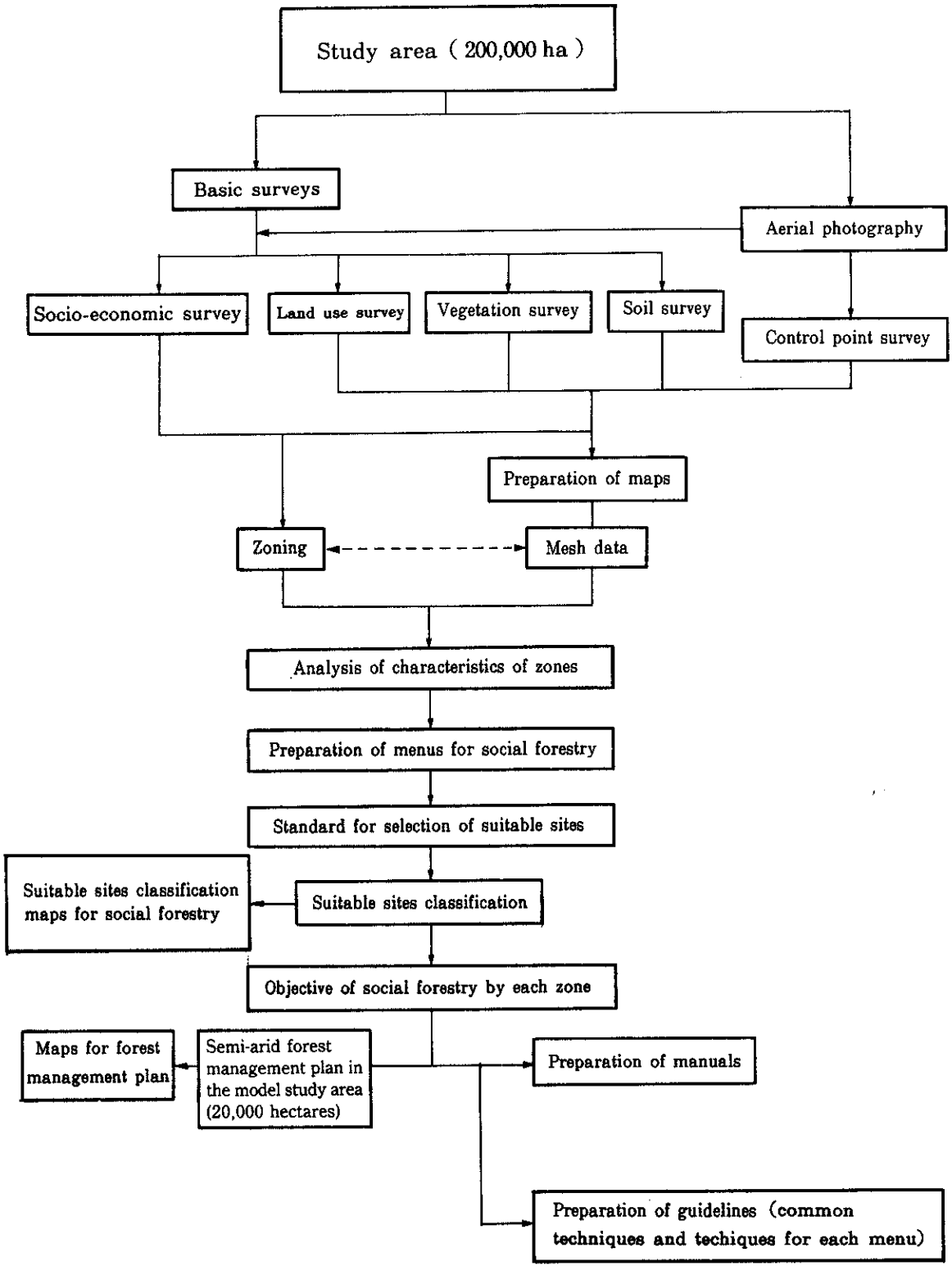


Fig. 5-1 Flow of the Feasibility Study

cy by setting the smaller mesh and increasing the factors to be input. We used computers to perform this operation in a short period, but it can be manually calculated. If sufficient time to perform the study at the site was given, we would have divided the study area to adapt to the local conditions and natural feature as the forest management plan diagram for the model study area as will be mentioned later instead of the mesh method. In this way, it is possible to formulate more precise plan.

The flow of method for zoning of social forestry is shown below with explanation in order.

5.2 Zoning of the Study Area and Characteristics of Each Zone

5.2.1 Zoning Method

The conditions of social forestry to be adopted differ according to the natural conditions such as topography, weather and the socio-economic conditions such as land use situation and inhabitants' intention.

Accordingly, 200,000 ha of the Study Area was classified in the following 14 zones mainly from the following standpoints: ① topography, ② weather, ③ soil, ④ land use, ⑤ legal regulations, ⑥ distribution of villages, ⑦ inhabitants' intension of social forestry, etc. on the basis of the aerial photographs, basic survey results and interview survey information. The way of thinking is shown on the following Table 5-1.

The division into 14 zones is described in Fig. 5-2.

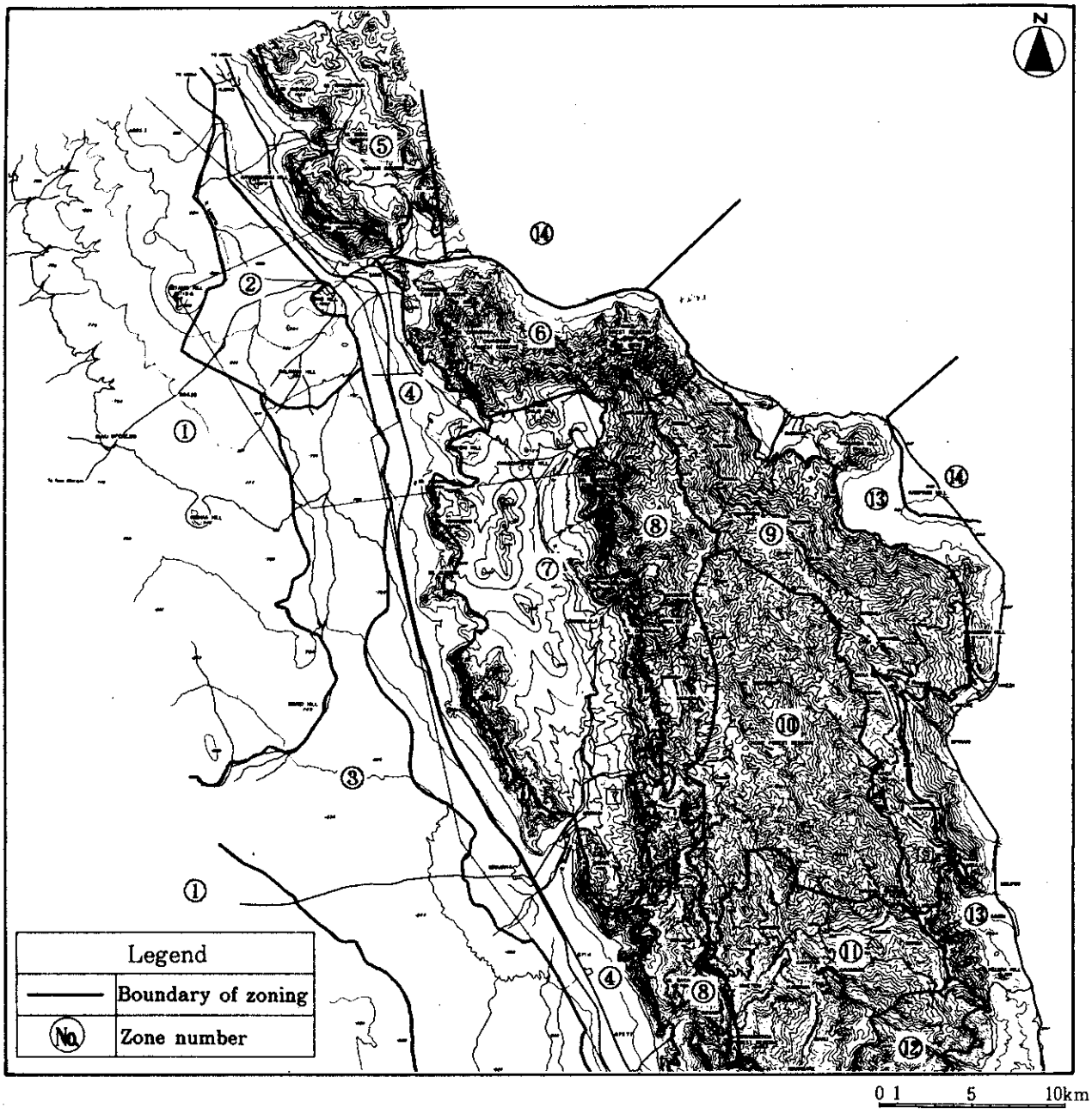


Fig. 5-2 Zoning Map

Table 5-1 The Way of Thinking about Zoning

Zone	Way of thinking about zoning	Border with the adjacent zones	Area (ha)	Name of town or village where questionnaire surveys were conducted.
1	Savanna zone is werstern end of the Study area, Hilly zone with small undulations more than 3° in inclination, Few houses, Utilized for grazing.	Borders with zones 2 and 3: 3° in inclination	40,150	RUVU JIUNGENI, RUVU MFERENJINI
2	Flat land located in the northern part of Zone 3, Used mainly for grazing, but agricultural development is gradually in progress along road from Same. Few houses	Border with Zone 4: 3° in inclination. Border with Zone 3: Presence of agricultural development	7,100	KIWANJA
3	Flat land less than 3° in inclination, Though water remains in rainy season, utilized for grazing in dry season. Few houses	Borders with Zones 1 and 4: 3° in inclination	27,650	—
4	Western piedmont of the Central Pare Mountain Range and South Pare Mountain Range, Many houses with dry crop fields and sisal estates	Borders with Zones 5, 7 and 8: Top of the first west fault scarps	26,425	NJORO, SAME, MAKANYA, HEDARU
5	Hilly zone in the southern end of the Central Pare Mountain Range and in northeastern end of the Study area, Slightly high precipitation, Highland and lowland type agriculture is partially implemented, Used mostly for grazing	Borders with Zone 6: borders with Chambogo forest reserve	7,475	VUMARI
6	Chambogo forest reserve and Kwizu forest reserve	—	8,875	—
7	Hilly zone on the western lowland slope of the South Pare Mountain Range and in Mwembe river basin. Lowland type agriculture and grazing has been implemented for rather a long period of time.	Borders with Zone 8: Top of the second west fault scarps	20,424	MWENBE, BANGALALA
8	Strip of plateau on the western highland in the South Pare Mountain Range, Densely populated, Highland type agricultural zone	Borders with Zone 9: Watershed, Borders with Zone 11: Top of the third west fault	12,975	GWANGA, MALINDI
9	Northeast slope of the South Pare Mountain Range, Densely populated, Highland type agricultural zone	Borders with Zone 13: North; 5° in inclination, South; Top of the east fault scarps	14,325	KWIZU, MANKA, MBAKWENI, NTENGA, VUJE, MTII
10	Chome forest reserves	—	14,525	—
11	Central highland in the South Pare Mountain Range, Most densely populated area with intensive agriculture	Borders with Zone 12: Extending to area with many houses, Borders with Zone 13: Top of the east fault scarps	9,875	BWAMBO, GOHA
12	Southern highland in the South Pare Mountain Range, Intensively dry, few houses and used for grazing.	—	2,500	—
13	Eastern piedmont of the South Pare Mountain Range, Agriculture advanced, Water paddy field and palm plantation found.	—	14,325	KISIWANI, MAORE, MHEZA, NDUNGU
14	Mkomazi game reserve	—	1,525	—
Total			208,150	

5.2.2 Characteristics of Each Zone

(1) Factors for characteristics analysis

In order to clarify the natural characteristics and socio-economic conditions for 14 zones, the mesh information was added up and analyzed using computers. The classification of the input information is as shown below. The areas in each classification and their percentages are described below. When several classifications are included in 1 mesh, the majority classification is adopted. Since the area is mesh data, the unit is 25 ha.

① Altitude

Code number	Classification (m)	Area (ha)	Percentage (%)
1	~ 750	67,275	32.3
2	751 ~ 1,000	64,275	30.9
3	1,001 ~ 1,250	27,300	13.1
4	1,251 ~ 1,500	17,275	8.3
5	1,501 ~ 1,750	15,125	7.3
6	1,751 ~ 2,000	13,000	6.2
7	2,001 ~	3,900	1.9
Total		208,150	100.0

② Inclination

Code number	Classification (degree)	Area (ha)	Percentage (%)
1	0— 5	96,475	46.4
2	6—10	14,600	7.0
3	11—20	17,050	8.2
4	21—30	33,775	16.2
5	31—40	35,400	17.0
6	41—	10,850	5.2
Total		208,150	100.0

③ Soil

Code number	Classification	Area (ha)	Percentage (%)
1	Nitosols	81,425	39.1
2	Cambisols	87,375	42.0
3	Vertisols	14,975	7.2
4	Rendzinas	2,750	1.3
5	Lithosols	21,300	10.2
6	Fluvisols	325	0.2
Total		208,150	100.0

④ Vegetation and Forest Type

Classification				Symbol	Area (ha)	Percentage (%)
Tropical evergreen forest (Wet-high forest)	Lowland forest			Eℓ	175	0.1
	Mountain forest (Alpine forest)			Em	15,925	10.0
	Riverine forest & gallery forest			Er	50	0.0
Tropical deciduous dry forest (Tropical rain-green forest)	Middle-height forest	Dense forest		Dd (h_1)	1,925	1.2
		Scattered forest		Dd (h_2)	850	0.5
	Low forest and bush	Dense forest		Dd (ℓ_1)	20,750	13.0
		Middle density forest		Dd (ℓ_2)	6,150	3.9
		Scattered forest		Dd (ℓ_3)	7,150	4.5
	Riverine forest & gallery forest			Dd (r)	375	0.2
Tropical savanna (Tropical steppe)	Wet-dry savanna	High-stem grassland	Wooded grassland	Sd (g_1)	1,575	1.0
			Swampy grassland	Sd (g_2)	750	0.5
		Riverine forest & Gallery forest		Sd (r)	225	0.1
	Thornbush savanna (Thornbush steppe)	Dense thornbush savanna (Density 70% or more)	Dense bush and shrub	St (d_1)	13,325	8.3
			Dense thicket	St (d_2)	9,475	5.9
		Middle density thornbush savanna (Density 40% through 69%)	As dots	St (m_1)	7,350	4.6
			As groups	St (m_2)	7,150	4.5
		Scattered thornbush savanna (Density 10% through 39%)	As dots	St (S_1)	29,875	18.8
			As groups	St (S_2)	10,950	6.9
		Dry grassland		St (g)	2,775	1.7
		Rocky Savanna		St (r)	525	0.3
	Seasonally water-logged savanna			Sw	10,000	6.3
Forest plantation				Fp	325	0.2
Secondary growth				Sg	725	0.5
Mountainous grassland				Mg	10,375	6.5
Rocky zone				Rc	775	0.5
Total					159,625	100.0

⑤ Land Use Condition

Code number	Classification	Area (ha)	Percentage (%)
1	Forest (Grazing intensity; low)	48,525	23,3
2	〃 (〃 ; middle)	34,075	16.4
3	〃 (〃 ; high)	77,025	37.0
4	Grazing land	5,825	2.8
5	Dry crop field	38,625	18.6
6	Sisal plantation	3,275	1.6
7	Village	725	0.3
8	Water bodies	25	0.0
9	Other land	50	0.0
Total		208,150	100.0

⑥ Number of Houses (number of homesteads found in one unit mesh)

Code number	Classification (number of houses)	Area (ha)	Percentage (%)
1	0	160,275	77.0
2	1—10	34,350	16.5
3	11—30	10,675	5.1
4	31—50	1,900	0.9
5	51—	950	0.5
Total		208,150	100.0

⑦ Distance From Village (that have more then 31 homesteads)

Code number	Classification (km)	Area (ha)	Percentage (%)
1	~0.5	9,400	4.5
2	0.6~2.0	34,075	16.4
3	2.1~5.0	70,675	34.0
4	5.1~	94,000	45.1
Total		208,150	100.0

⑧ Legal Regulation

Code number	Classification	Area (ha)	Percentage (%)
1	Forest Reserve	25,975	12.5
2	Game Reserve	1,500	0.7
3	Controlled Area	80,600	38.7
4	Non-regulated land	100,075	48.1
Total		208,150	100.0

(2) Characteristics of natural conditions

The foregoing are summarized for each of 14 zones as shown on the following table:

Table 5-2 Characteristics of Natural Conditions

Zone	Altitude	Inclination	Soil	*	Forest vegetation and forest type
1	620 m ~ 1,120 m Less than 750 m: 50%	5° or less for 95%	Nitosols: 81%	100	Thornbush savanna: 99%
2	740 m ~ 890 m	5° or less for 97%	Nitosols: 79% Vertisols: 20%	77	Thornbush savanna: 73%, Seasonally water-logged savanna: 27%
3	620 m ~ 790 m Less than 750 m: 87%	Under 3°	Nitosols: 65%, Vertisols: 35%	100	Thornbush savanna: 72%, Seasonally water-logged savanna: 28%
4	640 m ~ 1,740 m 751 m to 1,000 m: 50%, 750 m or less: 37%	5° or less: 60%, 41° or more: 7% since the first fault scarps are included.	Nitosols: 67%, Lithosols: 16% mostly rocky area	72	Thornbush savanna: 69%, Deciduous dry forest: 25%, Seasonally water-logged savanna: 4%
5	940 m ~ 1,740 m 1,001 m to 1,250 m: 68%, 1,251 m to 1,500 m: 37%	Considerably undulating, 11° to 20°: 42%, 21° to 30°: 31%, 31° to 40°: 6%	Cambisols: 90%, Lithosols: 9%	77	Tropical deciduous dry forest: 74%, Mountainous grassland: 10%, Thornbush savanna: 9%, Evergreen forest: 7%
6	780 m ~ 1,920 m 1,251 m to 1,500 m: 87%	21° to 40°: 65%, 41° or more: 9%	Cambisols: 56%, Lithosols: 34% Mostly rocky area	99	Deciduous dry forest occupies a majority: 53%, Savanna: 18%, Mountainous grassland: 14%, Evergreen forest: 14%
7	720 m ~ 1,860 m 750 m to 1,000 m: 55%, 1,001 m to 1,250 m: 35%	Various inclinations. 10° or less: 44%, 11° to 30°: 33%, 30° or more: 23%	Cambisols: 79% Lithosols: 20%	69	Deciduous dry forest: 67%, Savanna: 28%, Rocky area: 3%
8	810 m ~ 2,050 m 1,250 m to 2,000 m: 95%	20° or less: 9%, 31° to 40°: 37%, 41° or more: 24% (The steepest zone in 14 zones)	Cambisols: 90%, Lithosols: 10%	44	Mountainous grassland: 61%, Deciduous dry forest: 35%, Evergreen forest: 12%, Rocky area: 5%
9	560 m ~ 1,980 m A division of 1,250 to 1,500 m is the largest (29%). 1,001 to 1,750 m accounts for 92%.	Steep-sloped: 21° or more accounts for 97% and 31° to 40° for 50%.	Cambisols: 95%	27	Since there were many dry crop fields, some were changed into forests, of which 69% is mountainous grassland, 23% deciduous dry forest and 7% evergreen forest.
10	1,240 m ~ 2,460 m Area with the highest altitude: 1,750 m to 2,000 m is 46% and 2,000 m or more 23%.	Steep-sloped: 21° to 40° accounts for 92%.	Cambisols: 100%	100	Evergreen forest accounts for 86% and mountainous grassland 13%
11	1,000 m ~ 2,010 m 1,001 m to 2,000 m accounts for 96%.	Steep-sloped: 21° to 40° accounts for 92%.	Cambisols: 100%	21	In addition to evergreen forest of 31% and mountainous grassland of 36%, there is also man-made forests such as Acacia mollissima of 22%.

* Rate which forest (including savanna) occupies (%)

Zone	Altitude	Inclination	Soil	*	Forest vegetation and forest type
12	650 m ~ 1,250 m 751 m to 1,250 m accounts for 95%.	Very steep area, of which 62% is occupied by land of inclination from 31° to 40° and 17% by land of inclination over 41°.	Cambisols: 89%, Lithosols: 11%	90	Deciduous dry forest account for 96% and the rest is mountainous grassland.
13	520 m ~ 1,500 m Less than 750 m accounts for 70% and more than 1,001 m only 9%.	Sloped areas with various inclinations ranging less than 5° to more than 41° are distributed almost evenly.	Nitosols: 38%, Cambisols: 33%, Lithosols: 26%	65	Deciduous dry forest accounts for 92% being an overwhelmingly majority and evergreen forest: 2% and savanna: 2%.
14	590 m ~ 1,290 m Less than 1,000 m accounts for 88%.	Less than 5° accounts for 66%.	Nitosols: 52%, Cambisols: 23%, Vertisols: 25%	92	Wet-dry savanna: 66%, Deciduous dry forest: 29%

* Rate which forest (including savanna) occupies (%)

(3) Characteristics of Socio-economic Conditions

Table 5-3 Characteristics of Socio-economic Conditions

Zone	Number of houses (Number of homesteads found in one unit mesh)	Distance from villages (that have more than 31 homesteads)	Land use condition	Legal regulations
1	No house: 97%, 1 to 10 houses: 3%	5.1 km or more: 96%	All are savannas where grazing is common. No mesh such as dry crop field. Savanna with high grazing intensity: 66%, Savanna with medium grazing intensity: 31%.	Game control: 100%
2	No house: 76%, 1 to 10 houses: 20%, 11 to 30 houses: 10 mesh, 50 houses or more: only 1 mesh	2.1 to 5.0 km: 52%, 5.1 km or more: 35%	Dry crop field: 9%, Savanna with high grazing intensity: 76%, Grazing land: 13%	Game control: 100%
3	No house: 96%, 1 to 10 houses: 4%	5.1 km or more: 84%, 2 km or less: only two meshes	Dry crop field: only 3 meshes, Other land: savanna with high grazing intensity	Game control: 100%
4	No house: 82%, 1 to 10 houses: 13%, 51 houses or more: 5 mesh	Since Same and Makanya are included, some are near, 5.1 km or more: 41%	Dry crop field: 15%, Sisal plantation: 8%, Savanna for grazing: 72%, However, 35% for small grazing intensity remains in this area.	No regulation except game control: 23% and forest reserve: 5%.
5	No house: reduced to 52%, 1 to 10 houses: 44%, 11 to 30 houses: 12 meshes (4%)	5.1 km or more: 62%, 2.1 to 5.0 km: 37%	Dry crop field: 11%, Grazing land: 11%, In addition to these, there is deciduous dry forest. Area with small grazing intensity remains 17%.	Forest reserve is 10% and there is no regulations for others.
6	Forest reserve. Houses are found in 8 meshes.	2.1 km or more: 98%	Though good forest of 52% is maintained, 46% is seemingly for grazing. Dry crop field of 3 mehses and grazing land of 1 mesh are found.	Forest reserve: 100%
7	No house: 74%, 1 to 10 houses: 21%, 11 to 30 houses: 4%, In addition, 31 houses or more and 51 houses or more have 1 mesh each.	2.1 to 5.0 km: 57%, 2.0 km or less: 29%	Dry crop field: 17%, Grazing land: 12%, Sisal: 2%, Out of deciduous dry forest, area with small grazing intensity remains 29%.	No regulation
8	No house: 41%, 1 to 10 houses: 43%, 11 to 30 houses: 14%, 31 to 50 houses: 4 meshes, 51 houses or more: 3 mesh, Dense population	0.5 km or less: 8%, 0.6 to 2.0 km: 30%, 2.1 to 5.0 km: 62%	Dry crop field: 55%, Forest and mountainous grassland with small grazing intensity: 19%, One with medium grazing intensity: 24%	Only 3 meshes of forest reserve.
9	No house: only 30%, 1 to 10 houses: 42%, 11 to 30 houses: 21%, 31 to 50 houses: 7%, 51 houses or more: 3 mesh	0.5 km or less: 23%, 0.6 to 2.0 km: 50%, 2.1 to 5.0 km: 27%, 5.0 km or more: 0	Dry crop field: as dominant as 73%, Forest with small grazing intensity: 7%, Forest with medium grazing intensity: 20%	No regulation
10	Chome forest reserve, 1 to 10 houses: 19 meshes, 11 to 30 houses: 1 mesh	2.1 to 5.0 km: 76% (majority)	Good forest of 84% is maintained. Forest with medium grazing intensity: 15%, Dry crop field: 3 meshes	Forest reserve: 100%

Zone	Number of houses (Number of homesteads found in one unit mesh)	Distance from villages (that have more than 31 homesteads)	Land use condition	Legal regulations
11	No house: only 25%, 1 to 10 houses: 38%, 11 to 30 houses: 32%, 31 to 50 houses: 15 meshes, 51 houses or more: 2 meshes	0.6 to 2.0 km: 50%, 2.1 to 5.0 km: 35%, 0.6 km or less: 15%	Dry crop field accounts for 79% and this area has most dry crop fields in 14 zone. Good forest: 11%, Forest with medium grazing intensity: 10%	Forest reserve: 5%, No regulation
12	No house: 82%, 1 to 10 houses: 16%, 11 to 30 houses: only 2 meshes	5.1 km or more: 47%, 2.0 km or less: 0	Covered with deciduous dry forest except dry crop field of 10%. Affected by overgrazing.	No regulation 100%
13	No house: 73%, 1 to 10 houses: 21%, 51 houses or more: 15 meshes. Houses found along old trunk road.	2.1 to 5.0 km: 44%, 0.6 to 2.0 km: 26%, 5.1 km: 22%, 0.5 km or less: 8%	In addition to dry crop field of 26% and sisal plantation of 6%, there are water paddy field and palm field. Deciduous dry forest accounts for 85% and area with small grazing intensity remains 43%.	In addition to forest reserve of 4 meshes, no regulation
14	Game reserve, No house: 90%, 1 to 10 houses: 5 meshes, 11 to 30 houses: 1 mesh	5.1 km or more: 80%	In addition to dry crop field of 4 mesh and grazing land of 1 mesh, grazing seems to be practiced.	Game reserve: 100%

(4) Summary of characteristics for 14 zones

The stated characteristics concerning each zone were used for analysis to obtain these results, together with the local inhabitants' requests for social forestry developments, as obtained from the questionnaire surveys were adopted to formulate the following summary.

Table 5-4 Characteristics for 14 Zones

Zone	Characteristics of Zone
1 Western low hilly zone	• Hilly zone with small undulations about 750 m in altitude • Covered with thornbush savanna and the soils area Nitosols which account for more than 80%. • Scarce houses. Few dry crop fields and maize, beans, sweet potatoes, cassava, cotton, etc. are cultivated. • Overgrazing is conducted by the local inhabitants and Masai in the entire zone and therefore wind erosion is found here and there. • The entire zone is designated as game controlled area. • While afforestation of firewood forests is desired because of shortage in fuelwood in the north, its necessity is not recognized in the south. • Afforestation of shade tree species for houses and the planting for prevention of wind erosion is desired. • Fuelwood is carried out to other zones.
2 Zone behind Koko Hill	• Almost flat zone of about 800 m in altitude. • Though agricultural development is in progress, thornbush savanna accounts for 3/4. Nitosols are 80% and Vertisols 20%. • Dotted with houses along roads. • Maize, beans, millet and cotton are cultivated in dry crop fields. • Overgrazed and wind erosion is found. • Since they have difficulties in collecting firewood, they strongly desire afforestation for fuelwood production, and also desire afforestation on field borders, etc. for prevention of wind erosion and the planting of shade trees for houses and fruit trees.
3 Western low flat land	• Mostly less than 750 m in altitude and almost all flat. • Water remains in a lot of places in the rainy season and seasonally waterlogged savanna—Vertisols occur about 1/3. The others are thornbush savanna—Nitosols. • Houses are few and only dotted. • There are also few dry crop fields and maize, beans, sweet potatoes, etc. are cultivated. Overgrazing is conducted in the eintire zone and wind erosion is found. • No questionnaire surveys have been performed. (No central place of the village exists)
4 Western foot	• Western piedmont of Pare Mountain Range with altitude of about 750 m. Mostly gently sloped and fault scarps stand upright. • Thornbush savanna accounts for 70% and deciduous dry forest appears 25%. Mostly Nitosols. • Houses are scattered along the trunk road as well as Same and Makanya. • There are dry crop field and Sisal plantations of 23%, and the rest is savanna for grazing. In the dry crop field, maize and beans are mainly cultivated and sorghum, millet, castor oilseed and sunflower are also produced. Milk cows are raised in pens. Erosion by rain and wind is common. • We are thinking of converting the fault scarps and mountain foot into water source forests. Windbreak and fodder trees for the protection of dry crop field are strongly requested. Establishment of environment conservation forests for urban areas is also strongly called for.
5 Hilly zone in southern end of Center Pare Mountain Range	• A considerably undulating zone with altitude of about 1,250 m. • Deciduous dry forest accounts for three quarters. Evergreen forest occurs. Cambisols occupies 90%. • Though there are no large urban area, houses are scattered everywhere. • In addition to dry crop field and grazing land of 10% each, there is deciduous dry forest for grazing. Maize, beans, cassava and castor seed are mainly cultivated. • Precipitation slightly higher and some parts are being devastated by overgrazing. • Establishment of erosion prevention forest and the planting of fodder trees are desired.

Zone	Characteristics of Zone
6 Forest reserve	• A steep mountainous area with altitude of about 1,500 m • The majority is deciduous dry forest and the rest are evergreen forest, mountainous grassland and thornbush savanna. Though Cambisols covers the greater part, there is a rocky area and Lithosols are also abundant. • Though this is a forest reserve, houses are dotted, there are partially dry crop field and nearly a half of the forest seems to be utilized for grazing.
7 Hilly zone in Mwembe river basin	• Gently sloped hilly zone with altitude of about 1,000 m • Deciduous dry forest accounts for 2/3 and thornbush savanna 1/3. Cambisols accounts for 8%. • Houses are scattered in 1/4 of the area in addition to Mwembe village. • Dry crop field and grazing land accounts for 30%. In the dry crop field, mainly sorghum and maize, millet and cotton are cultivated and coffee is also produced at high altitudes. In the south, beekeeping is actively carried out. The western and southern mountainsides are being devastated by over-grazing. Forests with small grazing intensity remain 30%. • Afforestation for fuelwood production, fruit tree planting in dry crop field boundary and mixing forest and afforestation of riverine erosion controll are required.
8 Western highland	• Highland with altitude of 1,250 m to 2,000 m having steep topography. • Forest accounts for 44%. Spacious mountainous grassland with evergreen forest and deciduous dry forest. There is old plantation of Acacia mollissima and tannin is collected from the secondary stands of black wattle. The soil is Cambisols for 90%. • The area where there are houses accounts for 60%, and is a highland type agricultural zone densely populated. • Dry crop field covers as a majority as 55%. Coffee, banana, potato, wheat and sweet potato, etc. are actively cultivated. Maize and beens are also abundant. • Though fuelwood is not so insufficient currently, they are thinking of afforesting some places where it is not cultivated and heath where there is a spacious land on the plateau, and desire the planting of shade trees and fruit trees in the farm lands.
9 Eastern highland	• A highland with altitude of 1,000 m to 1,750 m having steep topography. • Forest accounts for only 27%, the greater part of which is mountainous grassland with evergreen forest and deciduous dry forest. There is an old plantation, which is achieving good growth. The soil is almost Cambisols. • The area where there are houses accounts for 70%, and is the same highland type agricultural zone densely populated as zone 8. The farm products are the same as those for zone 8, and cardamom is also found. • Dry crop field accounts for 73% and various farm products are cultivated. Though there are few livestock, cows are raised in pens. Soil erosion is found on the steep slope because of high precipitation. • The planting of shade trees for coffee field and fruit trees in field boundary, etc., large-scale afforestation in heath and planting for the prevention of soil erosion are desired. • Since fuelwood is required also for heating, fuelwood production forest is insufficient.
10 Forest reserve	• An area with the highest altitude: 1,750 m to 2,000 m for nearly half, 2,001 m or more for 23% and 2,462 m at highest having steep topography. • Evergreen forest accounts for 86%. Mountainous grassland is found 13%. The entire area seems to be Cambisols. • Good forest accounts for 84%, but it is partially used as a dry crop field and for grazing. • Though it is forest reserve, 20 places with houses are found.

Zone	Characteristics of Zone
11 Central highland	• A highland 1,000 to 2,000 m in altitude with steep topography. • Forests cover more than 20% of the zone (evergreen forests; 1/3, mountainous grassland; 1/3, plantations of Acacia mollissima; 22%), the smallest forest area among 14 zones. Cambisols are distributed over the entire zone. • Mesh without house accounts for only 25%. Most densely populated area in 14 zones. • Dry crop field for highland type agriculture accounts for nearly 80% and it seems that almost all has been developed. The farm products are the same as those for Zones 8 and 9. • The inhabitants are thinking of large-scale afforestation in heath and afforestation for preventing land slides and sand from being washed away in devastated regions in the south in addition to shade trees such as boundary trees and coffee, fruits trees around houses and fruit trees for beekeeping. • There is also a demand for fuelwood for heating.
12 Southern highland	• Steep-sloped area about 1,000 m in altitude • Though forest accounts for 90%, the air is exceedingly dry and this zone is scattered with deciduous dry forests. Mostly Cambisols. • Few houses and dry crop fields also account for only 10%. • No questionnaire surveys have been conducted.
13 Eastern foot	• Mostly less than 750 m in altitude and diversified in inclination. • Forests account for 65%, all of which is almost deciduous dry forest, and few ever-green forests are found in forest reserves. Nitosols, Cambisols and Lithosols account for 1/3 each. • There are urban areas such as Kisiwani, Gonja Maore and Ndungu along old trunk roads and in addition, dotted with houses. • In addition to dry crop field of 26% and sisal cultivated land of 6%, water paddy fields and palm forests are found here and there. In the fields, mostly maize and beans, cassava, banana and sweet potato are cultivated. For fruits, citrus fruits are generally cultivated. • The inhabitants strongly desire for prevention of soil erosion in the foot and afforestation for fuelwood production. They go to distant places for collecting fuelwood because of serious shortage in fuelwood. In addition, they desire planting fruit trees in field borders, etc., afforesting roadside trees along old trunk roads and greening the urban areas.
14 Game Reserve	• Gently sloped area below 1,000 m in altitude. • Deciduous dry forest accounts for 29% and wet-dry savanna accounts for 66%. In respect of soils, Nitosols occupies 50% and Cambisols and Vertisols occupies 25% respectively. • Although this zone is the game reserve, there are a few houses, part of area are utilized for dry crop field and grazing.

5.3 Menu of Social Forestry

Following nine menus were selected for the Study area of 200,000 hectares in view of the characteristics of 14 zones as analyzed as above, and comments and opinions obtained from forestry administrative staff at the central gevernment of Tanzania, regional government of Kilimanjaro and district government of Same:

① Establishment and conservation of fuelwood forests
② Agro-forestry in lowlands
③ Agro-forestry in highlands
④ Restriction of grazing and silvo-pastoral system
⑤ Establishment of fodder tree forests
⑥ Improvement of land conservation forests
⑦ Improvement of water catchment forests
⑧ Establishment urban environment conservation forests
⑨ Conservation of forest reserves

5.3.1 Reasons for Menu Selection

Reasons for selecting nine menus are as follows:

(1) Conservation and establishment of fuelwood forests

Rapid population growth causes sudden increase in the demand for fuelwood, which leads to overcutting of forests and increase in the number of livestock, consequently results in overgrazing.

The consequencies of such deterioration in natural regeneration of the forests due to overgrazing and rapid deforestation, it is obvious that cutting trees for fuelwood by far outweighs the annual productive capacities of these forests as spel-tout before.

In this case, it is predicted that it will be nearly impossible to obtain fuelwood in some areas within easy reach in the near future, if this situation continues unabated, unless the inhabitants succumb to wasting many hours in search and collection of fuelwood, hours which could be used productively elsewhere.

Therefore, the establishment and conservation of the forests was selected as Menu 1. In this case, fuelwood production forests will be established by positively implementing afforestation in the suitable sites. In addition, the productivity of natural forests will be enhanced by planting in necessary places in the existing forests, to say easy of preventing overcutting. This is also economical and much more can be expected in respect of natural resources than man-made forests for the time being. Therefore, it is necessary to take measures to increase the annual productive capacities of natural forests after obtaining the consent from the villages and hamlets in addition to establishing legal regulations if necessary.

(2) Agro-forestry

Secondarily, in comparatively large-scale lowland agricultural zones as well as highland intensive agricultural zones, there is no land left to implement large-scale

afforestation though afforestation for fuelwood production is necessary. In addition, since deterioration in productivity occurs because of soil erosion due to rain or wind in the agricultural zone, planting trees for prevention of soil erosion and increasing the productivity by planting soil improving tree species, is desired.

Therefore, the lowland type agro-forestry was taken up as Menu 2 and the highland type agro-forestry as Menu 3.

(3) Restriction of grazing and silvo-pastoral system

As repeatedly mentioned, forests which amount to 77% of this Study area have exceedingly inferior forest productivity because of noticeable overgrazing with the exception of part of the forest reserves. Though the vegetation with the corresponding productivity as Miombo woodlands and savannas could be essentially maintained even in lowlands, the upper trees are noticeably deteriorating because of overcutting of fuelwood forests and the under growth is also noticeably deteriorating at the same time when the natural regeneration becomes impracticable by overgrazing. If this situation continues as it is, the capacity to raise the livestock in lowlands will be greatly reduced in the near future, and livestock rearing as a major industry in the lowlands will be at the critical point. Accordingly, the regulations on grazing and the silvo-pastoral system were selected as Menu 4.

The silvo-pastoral system is included in the agro-forestry in the broad sense, and means a land management system to manage forests in order to produce wood and raise livestock. In Miombo and savanna forests in lowlands, the rotational grazing system should be introduced in accordance with the carrying capacity so that overgrazing is regulated. When the site conditions are comparatively good near the villages, planting fodder trees and introducing pasture grass should be positively considered. In areas such as Zone 5 especially where the tall trees still exist with rather high density, it seems that the land productivity will be rapidly recovered if this menu is positively practiced.

(4) Establishment of fodder tree forests

Promotion of livestock rearing is an important problem even for highland agricultural zones. The highland zones are essentially blessed with high precipitation, light and heat of the sun, and is an area with high productivity covered with dense forests of tropical evergreen forests or deciduous dry forests. When viewing forest land other than cultivated areas as dry crop field, there are many forests which are on the verge of devastation because of serious soil erosion. This is considered to be mainly due to overgrazing. Therefore, it is necessary to establish fodder tree forests in order to promote raising livestock in pens while preventing overgrazing. These forests will supply the raw materials for fuelwood and charcoal making. (Menu 5)

(5) Improvement of land conservation forests

In highland agricultural zones, erosion of the soil occurs mainly by overgrazing and partially by the exploitation steep-sloped land and signs for land slides are

found from place to place. Also in lowlands, wind erosion occurs due to reduced forest and overgrazing. In order to cope with these conditions, prevent the erosion and maintain and cultivate the land productivity, the maintenance of land conservation forests was put as Menu 6.

(6) Improvement of water catchment forests

The entire lowland has small precipitation and is always suffering from drought. If only the water source is obtained, the daily life will be stable and the agricultural production capacity will be rapidly increased since irrigation can be done.

It is the maximum hope for community development that the irrigation agriculture will be available in a wider range even in the highlands. In the eastern piedmont of South Pare Mountain Range, the construction of the dam and maintenance work for the irrigation facilities has been started under the Japanese assistance. Even so, in order to prevent sedimentation of the dam and hence less of its usefulness the maintenance of the upstream forests is important. Under these circumstances, the improvement of water catchment forests was taken up. (Menu 7)

(7) Improvement of urban environment conservation forests

Urban areas have been established in several areas such as Same and Kisiwani and have been developing at a considerable rate. These houses are located in lowland along the new and old trunk roads and only the houses stand close together. However, this may not be said to be desirable as living environment. The living environment should be improved by the following ways: greening around the houses with shade trees, greening the parks and planting roadside trees. (Menu 8)

Though Menu 4 and after had no particular references, in forests established in accordance with any of the menus, the respective major objectives should be accomplished. It goes without saying that thinning trees, pruning branches and leaves can be utilized as fuel.

(8) Conservation of forest reserves

In the study area, about 25,900 ha of forest reserve and about 1,525 ha of game reserve are designated. Since illegal use for field cultivation and grazing, etc. is found in part of these forests as already mentioned, it is necessary to immediately evacuate trespassers and implement afforestation and improvement of natural forest in the illegal used sites.

Also since areas with inferior forest type such as the area where forest fire occurred are distributed over rather a large area even other than those illegal areas, it is necessary to take measures such as afforestation scheme for these areas. In this way, the reserved forests should be turned into good forests and the respective objectives completely fulfilled.

For forests where good forest type is maintained, timber and fuelwood should be positively produced by properly practising selective cutting, weeding and pruning in order to supply them to the local enterprises. (Menu 9)

5.3.2. Contents of Each Menu

For the foregoing 9 menus the subjective area, objectives and methods for working, and the entity of the enterprise are as follows.

A. Establishment and conservation of fuelwood forests:

Subject: — Areas in highly productive forest land where a shortage of fuelwood supply is emerging

Objectives: — Growing of multi-purpose trees (for fuelwood, fodder, lumber, poles, beekeeping, fruit, medicine and other products) mainly for production of fuelwood

Methods: — Establishment of forests for fuelwood
— Restricting felling and improving scattered forests by extending the planting areas, and other possible measures
— Improving and spreading both charcoal production techniques and cook-stoves

Implemented by: — Individual inhabitants, the communities, schools, churches, and the government

B. Agro-forestry in lowlands

Subject: — Relatively large-scale farming areas in the lowlands where mechanization is in progress

Objectives: — Maintaining and increasing the productivity of farmlands by shading, fertilization, soil conservation and other measures; preventing wind damage of farm products
— Protecting crops from animals
— Growing multi-purpose tree species

Methods: — Establishment of windbreaks for the protection of farmlands
— Establishment of densely grown hedges
— Practicing line planting at intervals in fields
— Planting soil improving tree spicies capable of improving the carrying capacity in fallow fields

Implemented by: — Individual inhabitants, the community, and the government

C. Agro-forestry in highlands

Subject: — Highland areas where intensive agriculture is prevailing

Objectives: — Growing multi-purpose trees with the main purpose of fuelwood production in parallel with agricultural production
— Maintaining and increasing the land productivity

Methods: — Practicing the planting multi-purpose tree (shade trees, soil improvement etc.)
— Practicing row planting in the fields, contour planting, terracing on the hillsides and the sowing of forage crops
— Planting trees along boundaries and roads

Implemented by: — Individual inhabitants and the community

D. Restriction of grazing and the silvo-pastoral system

Subject: — Mainly lowland area affected by overgrazing

Objectives: — Conserving land and increasing the productivity of forests and pastures
— Growing multi-purpose trees for the production of fuelwood and other products

Methods: — Promoting natural regeneration and the recovery of productivity of forests and grasslands by introducing a rotational grazing system
— Planting fodder trees
— Establishing grasslands

Implemented by: — Individual inhabitants and the community

E. Establishment of fodder tree forests

Subject: — Agricultural areas mixed with pastures and/or scattered forests

Objectives: — Promoting livestock rearing in pen
— Growing multi-purpose trees for the production of fuelwood and other products

Methods: — Developing fodder tree forests in the vicinity of livestock pens
— Establishing grasslands

Implemented by: — Individual inhabitants and the community

F. Improvement of land conservation forests

Subject: — Areas threatened by erosion by rain, wind or running water

Objectives: — Protecting land by preventing erosion

Methods: — Restricting grazing and farming on the steep slopes
— Practicing forest conservation measures and afforestation including the installation of structural works such as network shelves and the improvement of the forest by the planting of trees
— Conserving and developing riverine forests

Implemented by: — Community and the government

G. Improvement of water catchment forests

Subject: — Water source for settlements and farmland

Objectives: — Developing the functions of water catchment forest

Methods: — Restricting grazing and/or felling of trees
— Improving scattered forests by enrichment planting and other appropriate measures

Implemented by: — Community and the government

H. Establishment of urban environment conservation forests

Subject: — Populated areas of cities/towns and vicinities of trunk traffic lines

Objectives: — Improving the living environment
— Growing multi-purpose trees for the production of fuelwood and other products

Methods: — Building parks
— Planting trees for revegetation in the builtup areas

— Planting roadside trees

Implemented by: — Individual inhabitants, community, schools, churches and the government

I. Conservation of Forest Reserves

Subject: — Forest Reserves and Game Reserve

Objectives: — Developing intended functions of Forest Reserves and Game Reserve

Methods: — Eliminating trespassers

— Improving scattered forests by planting and other appropriate measures

Implemented by: — Government

5.4 Standard for Selection of Suitable Sites for Each Menu of Social Forestry

5.4.1 Setting the Standard for Selection of Suitable Sites

In order to select what the suitable sites for menus of social forestry as determined in 5.3, the standards in which the following are used as the factors have been set as below:

① Classification of zone

When formulating a precise plan, it is desirable to select the suitable sites by respectively setting the standard for the factor such as situation of land use for each classification of the zone. Since, however, this is a general plan for as a vast an area as 200,000 ha, the following classification was adopted. And code number shown as below was used by mesh analysis.

i Zone in which the entire zone is designated as reserve area Zone 6, 10, 14

ii Highland Zone 8, 9, 11, 12

iii Lowland Zone 1, 2, 3, 4, 5, 7, 13

② Legal regulations

i Area designated as forest reserve, Code No. 1

ii Other areas, Code No. 2, 3, 4

③ Situation of land use

5.2.2.⑤ was divided into the following:

i Forests where grazing intensity is not recognized, Code No. 1

ii Forests with high grazing intensity and grazing area, Code No. 2, 3, 4

iii Dry crop fields or sisal plantations, Code No. 5, 6

iv Village Code No. 7

v Water bodies, Code No. 8

vi Others, Code No. 9

④ Inclination

5.2.2.② was divided into the following:

i Gently-slope, 10° or less, Code No. 1, 2

ii Slightly steepslope, 10°~20°, Code No. 3

iii Steepslope, 21° above, Code No. 4, 5, 6

⑤ Distance from village (Area with 31 or more houses within 1 mesh)

5.2.2.⑦ was divided into the following:

i Around, within 0.5 km, Code No. 1

Table 5-5 Selection Standard of Suitable Sites for the Social Forestry's Menus

Menus	Selection Standard (mesh data)
A. Establishment and Conservation of fuelwood forests	— Forests and grazing lands — Inclination: less than 20° for lowland and less than 30° for highland — Rocky lands and Lithosols are excluded — Distance from settlements: Distance may be disregarded for all forests scarcely affected by grazing. Distance shall be more or less 2 km in lowland area and more than 2.1 km for forests seriously affected by grazing. (Grazing lands and forests seriously affected by grazing are classified as A'. Class A area needs only conservation of natural forests, but class A' area requires afforestation and supplementary planting due to its scattered forest.)
B. Agro-forestry in lowlands	— Lowland (Zones 1, 2, 3, 4, 5, 7 and 13) — Fields (Areas with an inclination of more than 21° are classified as B', where particular attention shall be paid for soil conservation.)
C. Agro-forestry in highlands	— Highland (Zones 8, 9, 11 and 12) — Fields (Areas with an inclination of more than 21° are classified as C', where particular attention shall be paid for soil conservation.)
D'. Restriction of grazing and the silvo-pastoral system	— Lowlands — Grazing lands and forests seriously affected by grazing — Inclination: less than 20° — Nitosols, Vertisols and Fluvisols — Distance from settlements: more than 2.1 km (Since all the areas is forests seriously affected by grazing, all the areas is classified as D' and no area is designated as D.)
E'. Establishment of fodder tree forests	— Highlands — Grazing lands and forests seriously affected by grazing — Inclination: less than 30° — Cambisols and Rendzinas — Distance from villages: within 2 km (Since all the areas is forests seriously affected by grazing, all the areas is classified as E' and no area is designated as E.)
F. Improvement of land conservation forests	— Forests and grazing lands — Inclination: more than 21° for lowland area and more than 31° for highland area — Distance from settlements: less than 2 km — Rocky land and Lithosols throughout the areas (Grazing lands and forests seriously affected by grazing are classified as F'. An extensive planting shall be carried out to improve scattered forest.)
G. Improvement of water catchment forests	— Forests, grazing lands and reservoirs — Inclination: more than 21° for lowland area and more than 31° for highland area — Distance from settlements: more than 2 km (Grazing lands and forests seriously affected by grazing are classified as G'. An extensive planting shall be carried out to improve scattered forests.)
H. Establishment of urban environment conservation forests	— More than 51 households
I. Conservation of forest reserves	— Forest reserves and game reserve

ii Short distance 0.6～2.0 km, Code No. 2

iii Slightly far distance 2.1～5.0 km, Code No. 3

iv Far distance 5.1 km and more Code No. 4

⑥ Type of soil

5.2.2.③ was divided into the following:

i Lithosols, steep-sloped thin layer of soil with rocks Code No. 5

ii Others Code No. 1, 2, 3, 4, 6

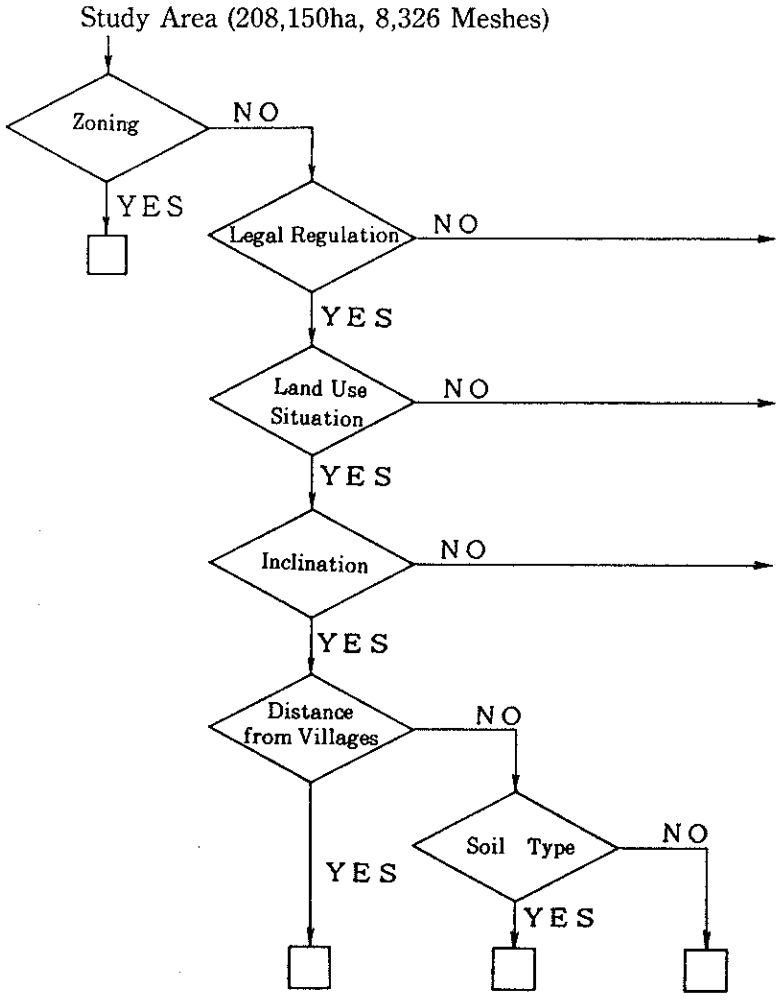
The relationship between the above standards and menus is as shown below.

5.4.2 Selection of Suitable Sites Mesh and preparation of Suitable Sites Classification Maps for Social Forestry

The suitable site classification map was prepared by selecting the suitable sites (mesh) for each menu by means of computers in accordance with the following procedure on the basis of the standard for selection of suitable site. (See Appendix)

Full details of mesh analysis are shown as appendix 8.

Table 5-6 shows area of suitable site for social forestry by each zone selected by computer.



<Flow chart for the Selection of Suitable Sites (Meshes)>

Table 5-6 Area of Suitable Site for Social Forestry by Each Zone*

Unit ; ha
( ) ; Percentage

Menu \ Zone		1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Establishment and Conservation of Fuelwood Forests	A	1,000 (2.5)	25 (0.4)	1,000 (3.6)	6,275 (23.7)	275 (3.7)	0 (0.0)	2,375 (11.6)	500 (3.9)	500 (3.5)	0 (0.0)	175 (1.8)	400 (16.0)	2,375 (16.6)	0 (0.0)	14,900 (7.2)
	A′	75 (0.2)	600 (8.5)	25 (0.1)	1,250 (4.7)	25 (0.3)	0 (0.0)	1,600 (7.8)	1,400 (10.8)	300 (2.1)	0 (0.0)	75 (0.8)	100 (4.0)	525 (3.7)	0 (0.0)	5,975 (2.9)
	Sub total	1,075 (2.7)	625 (8.9)	1,025 (3.7)	7,525 (28.4)	300 (4.0)	0 (0.0)	3,975 (19.4)	1,900 (14.7)	800 (5.6)	0 (0.0)	250 (2.6)	500 (20.0)	2,900 (20.3)	0 (0.0)	20,875 (10.1)
Agro-forestry in Lowlands	B	0 (0.0)	650 (9.3)	75 (0.3)	5,725 (21.6)	750 (10.0)	0 (0.0)	3,175 (15.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2,400 (16.8)	0 (0.0)	12,775 (6.1)
	B′	0 (0.0)	0 (0.0)	0 (0.0)	50 (0.2)	125 (1.7)	0 (0.0)	625 (3.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1,950 (13.6)	0 (0.0)	2,750 (1.3)
	Sub total	0 (0.0)	650 (9.3)	75 (0.3)	5,775 (21.8)	875 (11.7)	0 (0.0)	3,800 (18.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	4,350 (30.4)	0 (0.0)	15,525 (7.4)
Agro-forestry in Highlands	C	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	575 (4.4)	300 (2.1)	0 (0.0)	250 (2.5)	0 (0.0)	0 (0.0)	0 (0.0)	1,125 (0.5)
	C′	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	6,600 (50.9)	10,075 (70.3)	0 (0.0)	7,525 (76.2)	250 (10.0)	0 (0.0)	0 (0.0)	24,450 (11.7)
	Sub total	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	7,175 (55.3)	10,375 (72.4)	0 (0.0)	7,775 (78.7)	250 (10.0)	0 (0.0)	0 (0.0)	25,575 (11.7)
Grazing Control and Silvo-pastoral System	D′	35,725 (89.0)	5,725 (81.4)	26,550 (96.0)	7,200 (27.2)	3,050 (40.8)	0 (0.0)	6,200 (30.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1,750 (12.2)	0 (0.0)	86,200 (41.5)
Establishment of Fodder Tree Forests	E′	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	425 (3.3)	1,000 (7.0)	0 (0.0)	325 (3.3)	0 (0.0)	0 (0.0)	0 (0.0)	1,750 (0.8)
Improvement of Land Conservation Forests	F	250 (0.6)	0 (0.0)	0 (0.0)	1,800 (6.8)	75 (1.0)	0 (0.0)	2,950 (14.4)	925 (7.1)	375 (2.6)	0 (0.0)	225 (2.3)	275 (11.0)	2,950 (20.5)	0 (0.0)	9,825 (4.7)
	F′	3,100 (7.7)	0 (0.0)	0 (0.0)	2,025 (7.6)	450 (6.0)	0 (0.0)	1,825 (8.9)	950 (7.3)	1,125 (7.9)	0 (0.0)	350 (3.5)	0 (0.0)	675 (4.7)	0 (0.0)	10,500 (5.0)
	Sub total	3,350 (8.3)	0 (0.0)	0 (0.0)	3,825 (14.4)	525 (7.0)	0 (0.0)	4,775 (23.3)	1,875 (14.4)	1,500 (10.5)	0 (0.0)	575 (5.8)	275 (11.0)	3,625 (25.2)	0 (0.0)	20,325 (9.7)
Improvement of Water Catchment Forests	G	0 (0.0)	0 (0.0)	0 (0.0)	425 (1.6)	400 (5.4)	0 (0.0)	600 (2.9)	925 (7.1)	100 (0.7)	0 (0.0)	225 (2.3)	1,400 (56.0)	825 (5.8)	0 (0.0)	4,900 (2.4)
	G′	0 (0.0)	0 (0.0)	0 (0.0)	375 (1.4)	1,550 (20.7)	0 (0.0)	900 (4.4)	425 (3.3)	475 (3.3)	0 (0.0)	150 (1.5)	75 (3.0)	350 (2.4)	0 (0.0)	4,300 (2.1)
	Sub total	0 (0.0)	0 (0.0)	0 (0.0)	800 (3.0)	1,950 (26.1)	0 (0.0)	1,500 (7.3)	1,350 (10.4)	575 (4.0)	0 (0.0)	375 (3.8)	1,475 (59.0)	1,175 (8.2)	0 (0.0)	9,200 (4.5)
Establishment of Urban Environment Conservation Forests	H	0 (0.0)	25 (0.4)	0 (0.0)	350 (1.3)	0 (0.0)	0 (0.0)	175 (0.9)	75 (0.6)	75 (0.5)	0 (0.0)	50 (0.5)	0 (0.0)	425 (3.0)	0 (0.0)	1,175 (0.6)
Conservation of Forest Reserve	I	0 (0.0)	0 (0.0)	0 (0.0)	1,025 (3.9)	775 (10.4)	8,875 (100.0)	0 (0.0)	175 (1.3)	0 (0.0)	14,525 (100.0)	525 (5.3)	0 (0.0)	100 (0.7)	1,525 (100.0)	27,525 (13.2)
Total		40,150 (100.0)	7,050 (100.0)	27,650 (100.0)	26,500 (100.0)	7,475 (100.0)	8,875 (100.0)	20,425 (100.0)	12,975 (100.0)	14,325 (100.0)	14,525 (100.0)	9,875 (100.0)	2,500 (100.0)	14,325 (100.0)	1,525 (100.0)	208,150 (100.0)

* Area is calculated by multiplying the size of one mesh by the number of meshes.

5.5 Objectives of Social Forestry by Each Zone

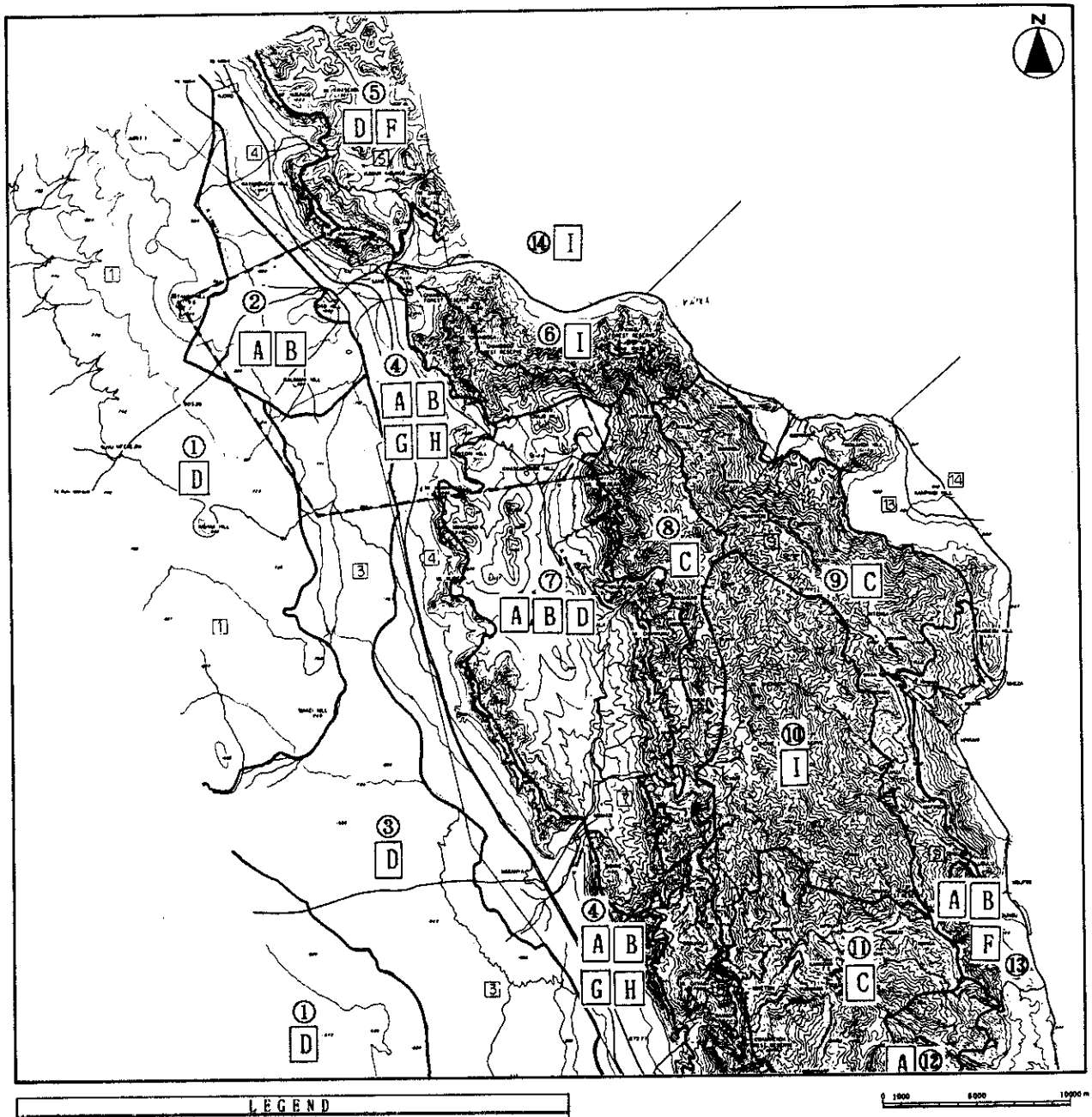
On the basis of 1) the selection of suitable sites (Table 5-6) which resulted from the flow chart for selection of suitable sites meshes; 2) carrying-out of preliminary and basic field surveys; 3) and as a result of verification in the field; menu of priority and menu of higher priority were selected for 14 zones. Based on the results of this study suitability of social forestry in each zone was decided (Table 5-7).

Table 5-7 Priority of Suitability of Social Forestry in Each Zone

	Menu \ Zone	1	2	3	4	5	6	7	8	9	10	11	12	13	14
A	Establishment and conservation of fuelwood forests	○	◎	○	◎	○		◎	○	○		○		○	
B	Agro-forestry in lowlands	○	◎	○	○			○						◎	
C	Agro-forestry in highlands					○			◎	◎		◎			
D	Establishment of grazing and silvo-pastoral system	◎	○	◎	○	◎		◎					○	○	
E	Establishment of fodder tree forests					○		○	○	○		○			
F	Improvement of land conservation forests	○		○	○	◎		○	○	○		○	◎	◎	
G	Improvement of water catchment forests				◎	○		○	○	○		○		○	
H	Establishment of urban environment conservation forests		○		◎			○	○	○		○		○	
I	Conservation of forest reserve						◎				◎				◎

○ : The menu of priority in each zone.
◎ : The menu of higher priority in each zone.

To clarify the classification of social forestry in the study area, the summarized map (Fig. 5-3) which shows menu of higher priority in each zone was prepared.



LEGEND			
———	Boundary of zoing and zone number		
- - - -	Boundary of the Model Study Area		
Symbol	Menu	Symbol	Menu
A	Establishment and Conservation of Fuelwood Forests	F	Improvement of land Conservation Forests
B	Agro-forestry in lowlands	G	Improvement of Water catchment Forests
C	Agro-forestry in Highlands	H	Establishment of Urban Environment
D	Grazing Control and Silvo-pastoral system	I	Conservation of Forest reserves
E	Establishment of land conservation forests		

Note : These symbols indicate the menu with high priority in each zone.

Fig. 5-3 Summarized Map of Suitable Sites for Social Forestry

To clarify the classification of social forestry in the study area, the summarized map (Fig. 5-3) which shows menu of higher priority in each zone was prepared.

The objectives of social forestry by each zone is as shown below.

(1) Zone 1 (Low hilly zone in the west)

As mentioned in 5.2.2 Characteristics of Zone, this zone is located at the houses and the western end of the study area. There are a few houses and as a few dry crop fields as may not be calculated in mesh. The entire area is used for grazing. Since this zone has essentially not so high carrying capacity but noticeable overgrazing has been conducted, the vegetation is seriously deteriorated. Therefore, the high priority menu is the restriction of grazing and silvo-pastoral system in this zone. For the restriction of grazing, it is considered that the zone is divided into 3 to 5 subzones and the rotational grazing system is implemented for each subzone: grazing will be regulated for several years for one of subzones while recovery of the vegetation will be lifted and shift from the subzone to one of the other subzones.

Since they don't have such technique and custom as this in this zone, but the Masai keep a lot of livestock, this should be practiced immediately by persuading them that this should be absolutely conducted in order to earn their living by livestock rearing also in future though it seems very difficult to obtain the understanding of the inhabitants. If the deterioration of vegetation advances further unabated, it seems that the recovery will be next to impossible.

In order to adopt the self-support system for food by expanding dry crop field, the agro-forestry in lowlands is required and prevention of wind erosion by improving the windbreaks and conservation of land by improving the riverine forests is required.

Especially in the north of this zone, shortage of fuelwood is severe, it is important to conserve the existing good forests and not to utilize them for fuel until the trees have grown sufficiently in terms of standing volumes.

(2) Zone 2 (Behind the Koko Hills)

Since agricultural development is in progress along several roads extending to the west from Same and this zone is contiguous to Same town, the high priority menu is the agro-forestry in lowlands and establishment and conservation of fuelwood production forests.

Since this zone is an area where wind passes through the valley between Central Pare Mountain Range and South Pare Mountain Range, it is exceedingly important to prevent wind damage to crops and wind erosion. For these areas to be cultivated in future, it is desirable to first establish windbreaks at intervals of about 200 m and to establish farmland after the windbreaks start to take effect. For cultivated area, it is desirable to establish roadside tree forests in the borders.

Next since this zone is contiguous to Same urban area where fuelwood is ex-

ceedingly in shortage supply, the establishment of fuelwood production forests requires immediate attention. Same District Authorities should deliberately intimate their intention to set up about 1,000 ha of fuelwood production forests in this zone. In this case, man-made forest will become main afforetation method because much fuelwood cannot be expected to be supplied by the natural vegetation in this zone. Since, however, this zone has small precipitation and exceedingly wind, the afforestation technique should be established immediately.

As the present problem, since the greater part of this zone is used for grazing and is in overgrazing state, the restriction on grazing and silvo-pastoral system should be implemented immediately. Also since urban area starts to be built, the improvement of urban environment conservation forests is required.

(3) Zone 3 (Western low flatland)

Zone 3 is quite as flat area which extends north and south on the western side of the main road and railway.

Since the land use conditions are similar to Zone 1, the menu for social forestry to be selected is also the same as that for Zone 1. However, areas where water remains during rainy season are considerably distributed and the soil is Vertisols (black cotton soil) in this Zone 3, the soil condition is inferior to that of Zone 1. Therefore, when performing any work, it is desirable to select a suitable site for implementation after carefully surveying the soil, etc.

(4) Zone 4 (Western piedmont)

Zone 4 is an area which extends north and south from the western foot of Central Pare Mountain Range and South Pare Mountain Range to the gently-sloped area along the main roads and railway. Since this area is under diversified conditions, the number of the menus to be selected was set to 7 kinds.

As high priority menus, menus for the following have been selected: the establishment and maintenance of fuelwood production forests, the lowland type agro-forestry, the maintenance of water catchment conservation forests and the improvement of urban environment conservation forests.

It is important to secure fuelwood for the inhabitants in Same and Makanya urban areas. Also since this area is along the main roads and railway, if fuelwood production forest is established, it is expected that its display effect will be great. Since nearly 1/4 of the dry crop field has been prepared and further development is predicted, the lowland type agro-forestry to promote it is a priority subject. Also, since both urban areas are suffering from serious water shortage, the maintenance of water catchment conservation forests behind the urban areas is important.

In addition, the following have been taken up: the implementation of the regulations and silvo-pastoral system for grazing which is performed over the area of more than 70%, the maintenance of land conservation forests in fault scarp in the eastern end of the area and the implementation of forest reserves behind Same urban area.

(5) Zone 5 (Hilly zone in southern end of Central Pare Mountain Range)

Since Zone 5 is at a little higher in altitude and lies on the eastern side of Central Pare Mountain Range, it has slightly higher precipitation than Zone 1 to 4 and Zone 7. For this reason, highland type agriculture is performed in some limited area. However, the area is used mainly for grazing and still overgrazing occurs also in this area. So, the high priority menu for this area is the restriction of the grazing and introduction of silvo-pastoral system. The steep-sloped area under overgrazing is being devastated and therefore the land conservation forest should be improved immediately. Since this area has slightly high precipitation as mentioned above, tall trees should remain even in the forest land under overgrazing. Therefore, we think that vegetation recovery by restriction of grazing will be comperatively easy in the study area.

To facilitate the restriction of grazing, the following are necessary: to induce the livestock rearing inhabitants to raise their animals in pens by planting fodder trees, to implement the lowland type agro-forestry to the field cultivation zone and to improve the water catchment conservation forests. Though firewood production forests are also necessary, it is more effective to utilize the natural forests than the man-made forests in this area. Also, the conservation of forest reserve which amounts to about 10% is necessary.

(6) Zone 6 (Forest reserve)

Zone 6 are Chambogo Forest Reserve and Kwizu Forest Reserve. To accomplish the specified objective, good forest should be maintained. The farm cultivation and grazing is illegally used in part of the area as mentioned above. These restricted areas should be immediately planned to be restored to forests. Also as a result of frequent fires in these areas, a large part of it has been converted into grasslands which covers about 14% of the area. Therefore such improvement of the forest type by enrichment planting is of immediate priority. The menu of zone is conservation of forest reserve.

(7) Zone 7 (Hilly zone in Mwembe River basin)

Zone 7 is a hilly zone which extends on both sides of the Mwembe River in lower hill side on the western side of South Pare Mountain Range. This is a rather severe area though it is not so dry as the lowland plain.

As the menus to be selected, we thought 7 menus except the highland type agro-forestry and conservation of reserve. Together with Zone 4, Zone 7 has most menus within 14 zones.

The high priority menus are the lowland type agro-forestry, restriction on grazing and silvo-pastoral system, and establishment and conservation of fuelwood production forest.

This area is an agricultural zone which has been cultivated for a rather long period of time and has a dry crop field of 17%. Since deteriorated soil productive capability is found, we would positively introduce the lowland type agro-forestry

which aims at production of agricultural crops and fuelwood together. Boundary forest establishment is being implemented in part of Bangalala and we would plan the extension.

Next, the establishment and conservation of fuelwood forest is important around Mwembe urban area, and the implementation of the restriction of grazing and silvo-pastoral system to get away from the overgrazing state is pressingly needed. In order to back up the implementation of this menu, furthering the animal rearing in pens should be planned by establishment of fodder tree forests.

Since soil erosion is found several places in steep-sloped area such as fault scarp and riversides, the improvement of land conservation forests is necessary. Though the water condition is better than Same, etc., water is drawn to Mwembe urban area from as distant a place as 5 km, the conservation of water catchment forest is desirable around Mwembe. Further, water source in Same urban area is obtained mainly from deep wells. Since, however, Same urban area is strongly thinking of drawing water from the mountain around Mwembe in future if possible, the improvement of water catchment conservation forests in this area is important in this sense.

Beekeeping is one of the economic undertakings of the inhabitants in this area, and that it is equally important in other areas, it is imperative that efforts are made to introduce some tree species that will promote high honey and beeswax production in the cause of implementing each menu.

(8) Zone 8 (Western highlands)

Zone 8 is an area where a highland mountainous range which have been settled for a very long time and have been engaged in stable agriculture. It is an belt-like area with altitude of 1,250 m to 2,000 m and looks like a plateau as a whole. However, the individual slopes are rather steep.

In this zone, the high priority menu is the highland type of agro-forestry in dry crop field which account for 55%. The agro-forestry with various contents is considered, for example, shade trees planting for the production of coffee, and boundary planting with fruit tree also to prevent soil erosion, etc. Actually, shade trees are planted in the fields at some areas. There are so many steep lands where log fences and/or stone-piled retaining walls are constructed. Satisfactory improvement of land conservation forests are required at such areas.

The supply and demand of fuelwood is not so tight as the lowland currently, however it is considered that the shortage will be surely serious in near future. Accordingly, the correspondence to the shortage should be worked out from now on. Since usual way of stock farming is that livestocks graze in the vicinity of houses in daytime and are kept in pen in nighttime, establishment of fodder tree forests is needed. In addition, the improvement of water catchment conservation forests is desirable in order to promote irrigation system in more spacious area. In places where urbanization is occurring, it is necessary to endeavour to maintain good liv-

ing environment by building houses and to improve the urban environment conservation forests. It is necessary to maintain the present fairly green condition in VUDEE.

(9) Zone 9 (Eastern highlands)

Since Zone 9 lies in the eastern slope of South Pare Mountain Range though slightly lower than Zone 8 in altitude, it has higher precipitation and the dry crop field reaches 70% of the entire area. Since almost all conditions are similar to those of Zone 8, the menu to be selected and priority are also the same as Zone 8.

In the northern part of this zone, agro-forestry have been traditionally implemented using *Azadirachta indica*, coffee and banana are extensively grown throughout the zone. The zone is characterized by typical agro-forestry in highland. As one of the menus for promotion of social forestry, plantation of eucalyptuses at a rather limited space rangig from 50 to 100m^2 are found throughout the zone.

(10) Zone 10 (Forest reserve)

Zone 10 is Chome Forest Reserve which is the largest forest reserve in this study area and its area is about 14,500 ha. Tropical rain forest develops and this area is an important water catchment area in Mkomazi River basin. Since the same illegal use lands as Zone 6 are found in this area, the afforestation should be planned immediately in these place to improve water catchment and soil conservation.

(11) Zone 11 (Central highlands)

Zone 11 is a highland intensive agriculture zone similar to Zone 8 and Zone 9, and is more intensive than both areas, reaching dry crop field area of nearly 80%. It is considered to have reached the limit. Accordingly the menu to be selected and its high priority are the same as both areas. Since, however, the land use has reached the limit, it is desired to implement each menu more positively and more minutely.

(12) Zone 12 (Southern highlands)

The high priority menu of this zone is the establishment and conservation of fuelwood production forests. Though there are a small number of inhabitants in this area, the production of fuelwood for the inhabitants in Zone 11 and Zone 13 is expected even in this area. Also since overgrazing occurs, the restriction of grazing, introduction of silvo-pastoral systems and improvement of land conservation forests for slope which is being devastated are important. According to the computer analysis, the improvement of water catchment conservation forests amounts to nearly 60%. This is because this area is in the water source zone of Mkomazi River basin. If good forests are restored and maintained—though it seems to take a very long period of time—we think that the water source will be abundant and a guarantee to increase the agricultural production. So the improvement of water catchment conservation forests is important.

10 and 14); ⑥ (Zone 7); ⑦ (Zones 8, 9 and 11); ⑧ (Zone 12) and ⑨ (Zone 13). In consideration of future, 14 zones were adopted and integration was not performed.

5.6 Technical Manual on Social Forestry

Of technical manual on social forestry in the study area, manual on a large scale afforestation project mainly for fuelwood production will be presented later in the section devoted to the semi-arid forest management plan. Therefore, this section will give a technical manual on small scale afforestation, centred on agro-forestry.

Recently the research on agro-forestry techniques in semi-arid zones has been progressing very fast, and many technical reports and books have been published in this field. Among these, Reforestation in Arid Lands by F.R. Weber is one of the excellent book.

This book contains many illustrations concerning planting method, and techniques discussed throughout this book are practical and easy to understand.

In this study for the preparation of technical manual on social forestry, one of the illustrations from this book has been quoted.

5.6.1 Technical Manual Common to Each Menu on Social Forestry

(1) Nursery

① Location of nursery

Nursery sites should be selected, taking into consideration the availability of the source of water and conditions of location convenient for management and transportation.

Because roads have not yet been developed fully in the study area, it is necessary to set up as many nurseries as possible, each on a small scale, near forest sites intended for planting. If demonstration effect is to be considered, these nurseries should be located in the vicinities of assembly halls, schools, etc. in villages. In lowlands that are affected by strong prevailing winds, sites for nursery should be selected by avoiding windswept areas and should also be provided with fences and hedges. Fig. 5-4 shows a typical layout of nursery.

② Nursery practice

Standard techniques and work schedule for potted seedlings will be described later. Tree species for social forestry are many and varied. Therefore, nursery techniques suited for each of these species are required. Observation of local nursery practices indicates that rather lanky seedlings are often produced due to excess watering and shading.

To improve this situation, the amount of watering should be reduced and spacing between pots be increased before planting so that seedling will fully be exposed to the sun and thereby hardened off.

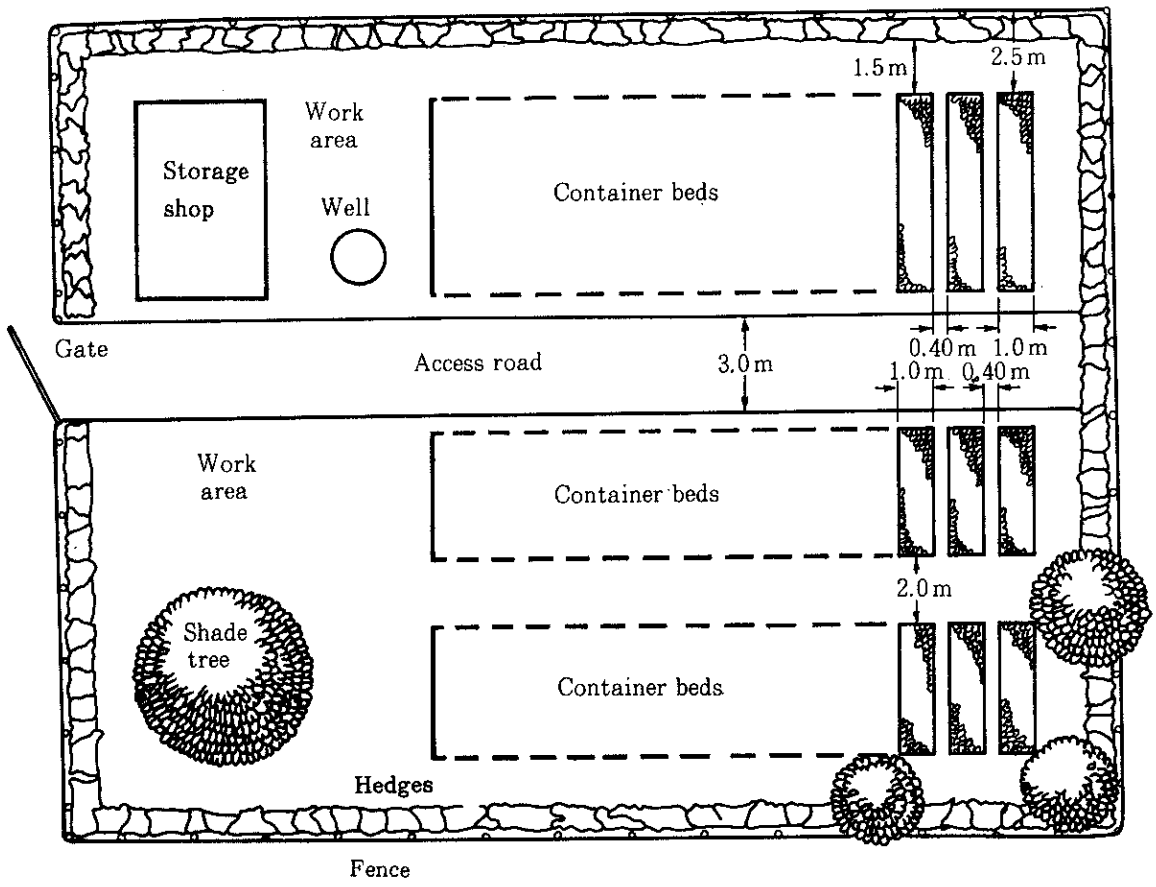


Fig. 5-4 Typical Layout of Nursery (after F.R. Weber)

(2) Planting

Planting in wet highlands will present no problem if healthy seedlings are carefully planted in the optimum planting season. In lowlands, extra care is needed in planting because the terrain is extremely dry. Planted seedlings will be placed under harsh conditions if there is no water available for them for a soil depth of more than 1 m when the dry season sets in. Consequently, it is critical that seedlings be made to develop their root systems as much deeper into the ground as possible. The planting method employed should also allow water to be retained in the soil for as long as possible after the end of the rainy season. For this purpose, planting holes should be dug with more emphasis on depth than on width (to a depth 40 to 50 cm) and seedlings be planted deep but kept low above the ground. In addition, rain water should be supplied to the planting hole and the deeper layer of soil by employing various water collecting processes including trench method, semicircular ridge forming method and "taungya" method. Water may have to be sprinkled over planted holes depending on situation. If it is possible to drive pipes, bamboo tubes, etc. into the ground and introduce water directly to the soil in the lower layer (about 25 cm in depth), this will be most effective, requiring only a small quantity of water for irrigation.

Table 5-9 Summary Table of Uses and Adaptability of Species Described

Species	Uses														
	Pulpwood	Fodder	Timber	Poles	Fuelwood	Cash crop	Fruit	Charcoal	Soil improvement	Land reclamation	Shade for homesteads	Shade for crops or animals	Animal barrier	Ornament	Medicinal	Other uses
Acacia albida		++	+	+	+		+		++			++	++		+	+
A.mearnsii		+		+	++	++		++	++	+						++
A.melanoxylon			++													
A.tortilis		++	+		++		++			+						
Acrocarpus fraxinifolius			++											+		
Albizia lebbeck		++	+		+				++			++				++
Anacardium occidentale			+		++	++	++	++		++		+				+
Azadirachta indica			+	+	++				+	++	++			+	++	
Carica papaya			+			+	++								+	+
Cassia siamea			+	+	++									++	+	
C.spectabilis				+										++		
Casuarina cunninghamiana	+		++		++				++							+
C. equisetifolia			++	++	++			++	++	++				+		+
Cinchona ledgerana				++	+	++										
Citrus spp.					+	++	++									++
Cocos nucifera			+			++	++									+
Cupressus lusitanica			++	++										+		+
Dalbergia melanoxylon																++
Delonix regia																+
Eriobotrya japonica				+	+	+	++									+
Erythrina abyssinica												+		++	+	+
Eucalyptus camaldulensis	+			++	++			+		++						
E.globulus	+		++	++	+			+								
Ficus benjamina																
Grevillea robusta			++		+							++				
Jacaranda acutifolia														++		
Leucaena leucocephala	++	++		+	++				++							
Maesopsis eminii			++									++			+	
Mangifera indica		+	+		+	++	++	+			++				+	
Olea capensis		+	++	+	++			++								
Parkinsonia aculeata		+			++				++				++	+		
Persea americana						+	++				+					+
Psidium guajava					+											
Purunus spp.															+	+
Rauvolfia caffra		+		+			++				+				++	
Schinus molle										++						+
Syzygium cumini					+						++					+
Tamarindus indica			+		+	+	++	+								+
Trema orientalis				+								+			+	
Trichilia emetica			+							++	++	++			+	++

++ ; major potential

+ ; moderate or minor potential

(Trees for village forestry, 1984)

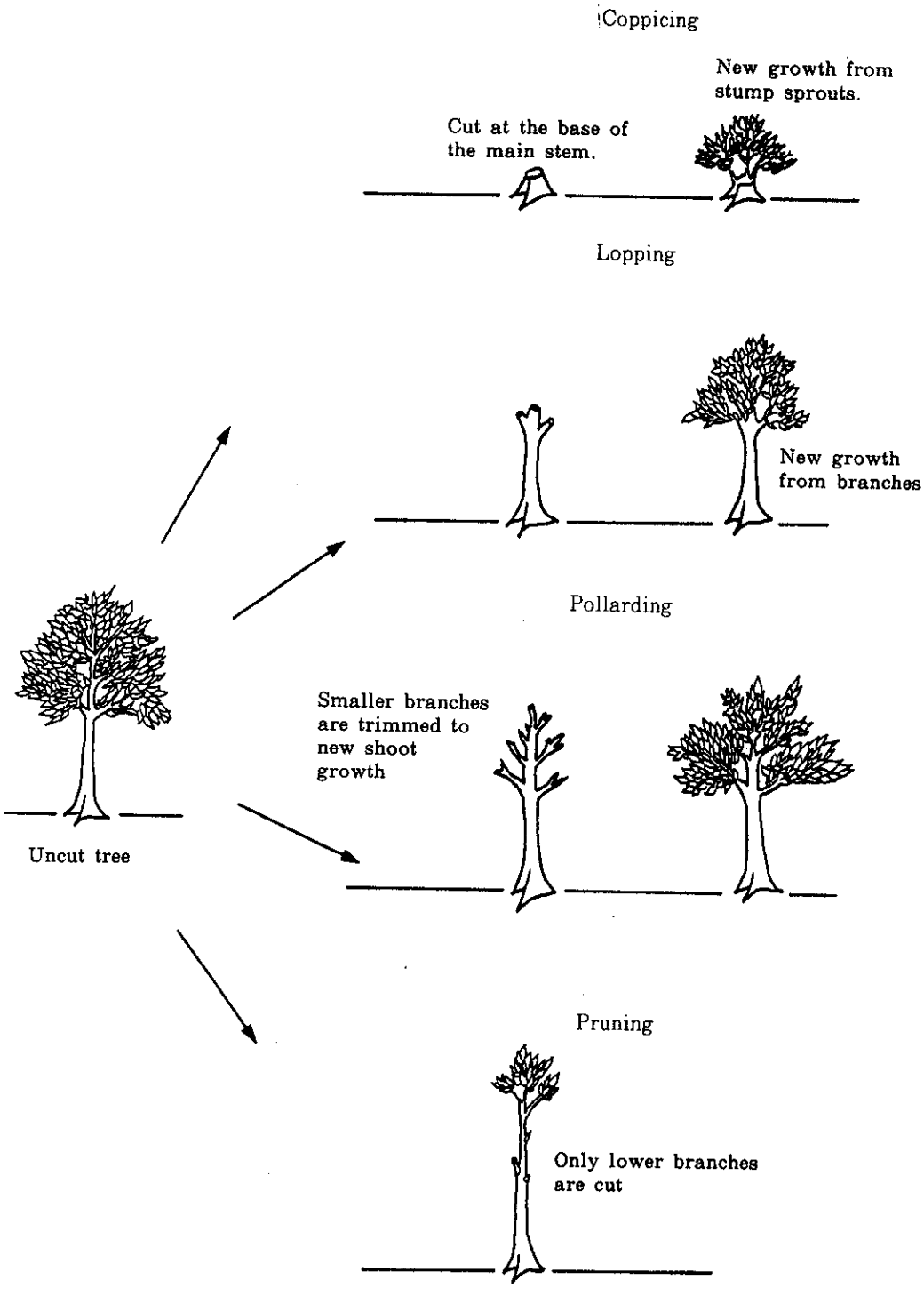


Fig. 5-5 Harvesting Methods (after F.R. Weber)

sprouting after harvesting.

Here we explain the method of sprouting implemented by using multi-purpose tree species in social forestry.

The terms shown in Fig. 5-5 are based on recommendations from FAO/IUFRO Technical Term Committee.

(5) Protection of trees

Nursery stocks and planted trees forests are often damaged or destroyed by forest fires or herbivorous animals, both livestock and wild animals. This is a serious problem affecting the results of planting. Local residents' understanding and cooperation are indispensable to protection of trees from such damage. It is thus imperative that residents understand the significance of afforestation and be motivated to actively participate in patrol and protection work. As measures against damage from grazing, patrol alone is not enough and fences, hedges, etc. should also be built in important places.

5.6.2 Technical Points by Menu

Major technical points by menu for social forestry will be given below.

(1) Establishment and conservation of fuelwood forests

Technical points on establishment and conservation of fuelwood forests will be described in the forest management plan in section 6.

(2) Agro-forestry in lowlands

The site being studied for agroforestry in lowlands in the area under review is relatively wide farming land where introduction of mechanization is in progress. Moreover, this site is located adjacent to grazing land and is affected by soil erosion in places.

Aside from harvesting of crops, important subjects that must be covered for this site include line planting for harvesting of fuelwood, poles and fodder from planted trees, growing of hedges for protection of crops from livestock, and establishment of windbreaks for protection of farm land and populated area from winds. Technical points on each of these subjects will be discussed later.

① Line planting

This is a method of crop cultivation and features more spacing between lines of planted trees than alley cropping method which will be described in item (3). As shown in Fig. 5-6, a spacing of 7 to 10 m is provided between lines as the standard practice, and multi-purpose tree species and fodder grasses are planted to harvest fuelwood, poles and fodder.

Multi-purpose tree species include *Acacia albida, Azadirachta indica, Mangifera indica* (mango), and *Leucaena leucocephala*. Fodder grasses and low trees will be planted between lines of tall trees to supply fodder to livestock. Crops to be grown between lines of these trees will mainly consist of maize. Other crops include potato and beans.

livestock animals by erecting protective fences with thorny branches at the time of planting or sowing.

After planting, hedges can be tended as shown in Fig. 5-7. Hedges should be protected with protective fences until hedge trees grow to about 1 m in height. After their growth to more than 1 m, they should be pruned so that paralleled from cut branches will thickly grow and fill up spacing between branches.

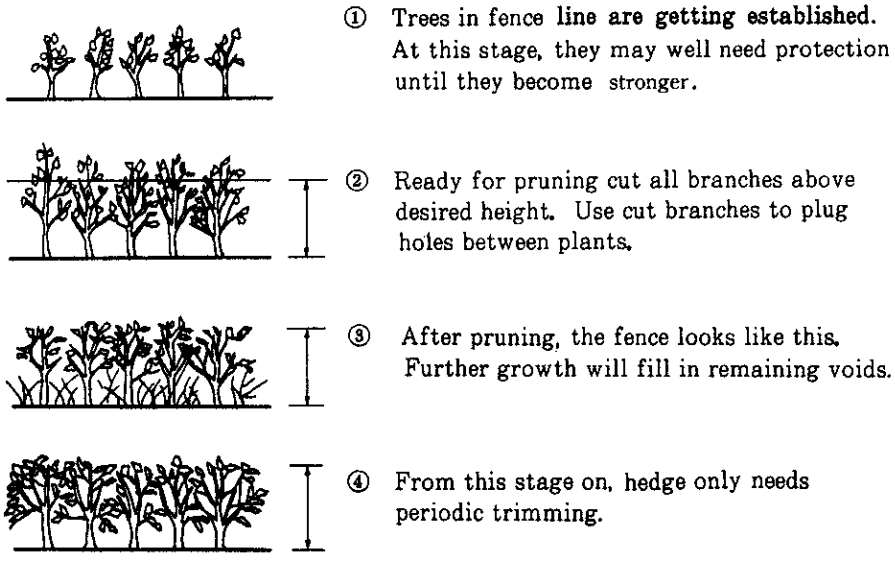


Fig. 5-7 Proper Fence Pruning (After F.R Weber)

③ Establishment of wind breaks

Wind breaks should be established near windswept farm land and villages areas to protect farm land and urban environment.

Only basic technical points on establishment of wind breaks will be described here because this subject will be fully discussed in the section dealing with the forest management plan.

Wind breaks are effective against winds for a height 10 to 20 times that of trees.

Wind breaks are generally formed at a right angle to the wind. Thus, it is necessary to find the direction and velocity of the prevailing wind before establishing these wind breaks.

Wind breaks are considered to sufficiently serve their purpose with a width of only about 10 to 20 m. However, a wider wind breaks is desirable, taking regeneration into acount. Wind breaks planned to be planted in the western lowland of the study area basically will have a width of 40 m and one third of this width will be regenerated at the harvesting period.

It is desirable that wind breaks have a density of 60 to 80%.

Fig. 5-12 shows a typical layout of relatively narrow wind breaks. To be effective as wind breaks, species growing high should be planted in the centre and low trees on both sides. In this arrangement, high trees in the centre will provide barri-

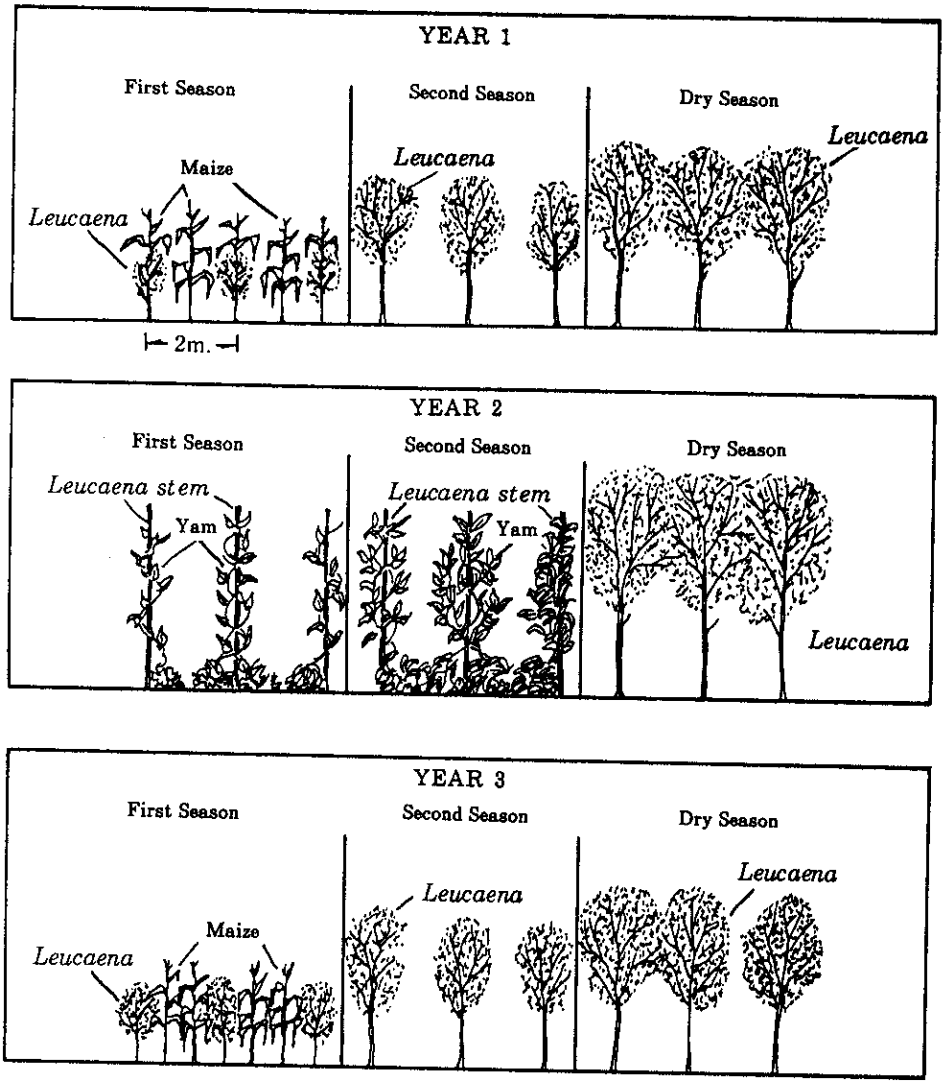


Fig. 5-10 Row Planting

Row planting with maize and yam. *Leucaenasp leucocephala* functions as a prop for yam's vine. (After B.T. Kang, et al, 1984)

tional grazing system should be considered to recover vegetation, along with vigorous efforts to grow fodder grasses.

To properly practice rotational grazing, the system should flexibly be applied by taking into consideration the present carrying capacity of forests and the number of livestock animals to be raised. The system should also be operated in close coordination with land use to other purposes.

(5) Establishment of fodder tree forests

To plant trees in small plots of land mainly around houses to secure fodder for livestock raised in pens has become increasingly important in lowlands. This is of course very important in highlands. In the study area, it is desirable that species which grow leaves in the dry season, such as *Acacia albida*, be planted to meet the fodder shortage during the dry season. *Acacia tortilis* and *Leucaena leucacephala* are also suited for establishment of fodder tree forests. Twigs are harvested and

coppicing are used for regeneration.

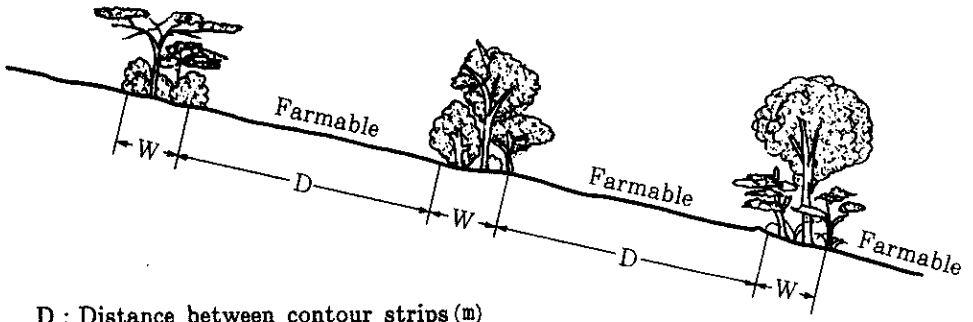
(6) Improvement of land conservation forests

Some forests in the study area are affected by soil erosion due to overgrazing and excess use of land for farming. To protect land from erosion, the techniques of contour strips and slope terracing can be used.

① Contour strips

This method for preventing surface erosion is used in crop fields on mountain slopes. Under this method, trees are planted at the spacing and in the width as shown in Fig. 5-11.

Slope (%)	W	D
0	2	50
10	5	13
20	8	38
40	13	28
60	20	20



D : Distance between contour strips (m)
W : Width of the band of vegetation in the contour strip (m)

Fig. 5-11 Contour Strips (After F.R. Weber)

Tree species that can be used include *Casuarina equisetifolia* and *Tectona grandis*. Guinea, Napier, and Elephant grasses can also be grown for fodder production.

② Trees along contour ridge

a. Trenches

This method consists of digging trenches along contour lines, heaping up excavated earth on the slope and sowing seeds of fodder grasses and planting fruit and fodder trees, thereby protecting soil from erosion.

b. Rock wall terraces

After the slope is benched, rocks are laid to secure crop farmable land as well as to control erosion, in combination of trees.

c. Bench terraces

As different from rock wall terraces, this method protects raised slopes by covering them with grasses to provide erosion control.

Grasses can be used as both food and fodder.

5.7 Guideline for Extension Measures of Social Forestry

5.7.1 Factors for Inhibiting the Extension Work in Social Forestry

Twenty years have lapsed since the government started to extend and expand the social forestry in Tanzania in 1967. In spite of strenuous efforts of many people during this period of time, the present situation of social forestry is far from below the expected target. Since clarifying the factors for inhibiting the extension reveals the objectives and contents of the extension, we would like to divide the field survey results and numerous published papers into two parts: inhabitant side and administration side and summarize the factors.

(1) Inhabitant side

① They hardly realize the shortage of fuelwood.

Though the leader class such as chairman and secretaries well recognize the shortage of fuelwood it seems that the inhabitants generally think that fuelwood collected in natural forests will permanently meet the requirements and do not recognize the necessity of taking any countermeasures themselves. This is considered to be for the following reasons:

Firstly, it was possible until now to collect fuelwood by going to a distant place though less fuelwood was found near the houses. (They cannot predict that the problem will be severe after 5 or 10 years to come.)

Secondly, collecting the fuelwood is women or children's job and the heads of families have scarcely feelings for fuelwood shortages.

In this area, women hardly participate in village assemblies and seminars and the rate of perticipation to these meetings is reported to be 7%.

Therefore it is difficult to be reflected in political set-up and administration that collection fuelwood has been a tedious and time-consuming job. The National Women's Organization—U.W.T. does not work strenuously and positively towards afforestation efforts in the country. Worse still the society does not seem to realize that people's livelihoods could be improved tremendously if women's and children's services in fuelwood collection were turned into other alternative productive jobs such agricultural farm work.

② They have no full understanding of the functions of trees and forests.

Since they think in every country that forest is a gift from Heaven, it is difficult for them to recognize the functions of forests. They are generally suprised at the great influence only when the functions of the forests are lost and also know that a very long period of time will be required in order to restore the forest.

Even in this area, the inhabitants do not have sufficient understanding of the functions of trees and forests. For example, almost all farmers recognize that the soil productive capability is reducing year by year, but do not know that it can be prevented by the conservation and establishment of forests and trees. The functions in this area are listed as follows:

— Maintenance of soil fertility, use of green manure by planting soil improving tree species will greatly guarantee security in terms of soil productive capability by prevention of soil erosion and wind erosion, assure soil stabilization. Generation of incomes from fuelwood, fruits, fodder, honey and beeswax, poles, charcoal, and wood for furniture, increased yields in coffee and banana by introduction of shade trees. Amelioration of climate and general improvement of the living conditions by planting shade tree around households and improvement of water sources through the conservation of water catchment areas.

③ Land for tree planting is lack.

In the intensive agricultural zone in highlands, especially Zone 11, nearly 80% of the entire area is dry crop field and there is shortage of land to be planted.

Even planting in a field boundary, in many cases, is rejected because the shade will reduce the yields. Also in grazing lands, most of them do not want to change it to forest land since emphasis is placed on the income from livestock rearing.

One of the reasons for these facts is that they have no knowledge of the effect and techniques of the agro-forestry and silvo-pastoral systems.

④ The ownership and apportionment of yield and income for the trees planted is not clear.

Since the ownership for the trees planted in the cultivated land recognized as Kihamba belongs to the person who planted them, there is no problem. When a national land other than Kihamba is planted by an individual and communities, it is generally not clear to whom the ownership, yield and income should belong, and therefore it provides with a feeling of resistance to positive planting. In addition, it is pointed out that the cutting income for the trees which were jointly planted is, in many cases, used for construction of public facilites and it was hardly allocated to the inhabitants or invested in reforestation.

⑤ It takes a very long period of time to obtain the yield.

While the fuelwood production requires a short cutting period of 6 to 10 years, it is one of factors for inhibiting the attitude towards tree planting as it require much longer period than farm products and livestock rearing.

⑥ The operation season falls on the agricultural operation season.

The season suitable for tree planting and cultural operations falls on the same season, and the agricultural operation which is directly connected with the food production and cash income is given priority. Especially in lowlands where the season suitable for planting is as exceedingly short as 10 days to 2 weeks, this is considered to be a maximum inhibiting factor.

⑦ Cash income is difficult.

In this area, fuelwood is almost used for home consumption and hardly sold. Charcoal production has not yet been an important cash income source partly because it has a small yield because of unskilled production methods and partly be-

be produced and distributed to the inhabitants with the public funds. However, only a quantity less than 10% of the necessary quantity is produced.

In this area, there are nurseries only in Mwembe, Gonja Maore, Suji and Kisiwani because other areas have insufficient water supply. Therefore, in order to implement social forestry in the study area, a long-distance transportation for seedlings will be required. However, few vehicles required for the transportation are provided. For this reason, it is difficult to timely distribute seedlings full of vitality under the present conditions and there are many complaints from the inhabitants.

The road conditions are not good. Since it is considered difficult to rapidly materialize the argument of the transport capacity, though it is necessary to vigorously make efforts to improve these, it is necessary to disperse these nurseries into a number of areas for the time being.

It is supposed that it is necessary to make efforts in order to provide a small scale nursery near the villages by obtaining cooporation from non-governmental organizations such as schools and churches and people who are eager to plant trees. However, this has not yet materialized.

⑥ Working on non-governmental organizations such as churches is insufficient.

In order to supplement the activities of the government, region, district, village, school, etc., the activities of churches and women's and youth groups, etc. are expected. However, working on these from the public organizations seems to be insufficient.

⑦ The contents of the activities of forestry extension officers have points to be improved.

Since the forestry administration in Tanzania started from the conservation of forest reserve, shifted to the industrial afforestation and recently the emphasis has shifted to social forestry, the social forestry is a new field for foresters in Tanazania. For this reason, we hear that there were such failures that they placed so great importance on the fuelwood production that they advised the Masai to afforest for fuelwood production, and that they ignored the desire of tree species from farmers. Also its necessary not only to establish man-made forests, but also to protect and manage natural forests to practical utilization.

Then, a system in which the excution result is monitored and evaluated for improvement has not yet been established. This is also considered to inhibit effective fact in the promotion of social foresry.

Further unlike the administration of forest reserve based on the laws and industrial afforestation exclusively performed on the government basis, the inhabitants carry out themselves base on their intention with the exception of supply of seedlings and technical guidance under the social forestry. Therefore, it is necessary to have a full understanding of the intentions of the inhabitants by surveying the socio-economic conditions beforehand and to determine the contents to meet their desires. For this purpose, it is necessary to allow the inhabitants to partici-

pate from the planning stage. However, it seems that some might have missed in such a procedure.

5.7.2 Points for Extension of Social Forestry

As the major factors for inhibiting the extension of social forestry, 8 items for inhabitants side and 7 items for administration side have been given. It is necessary for promotion of the extension to take countermeasures against each of these inhibiting factors.

(1) The countermeasures against the inhabitants side problems

① Clear explanataion to inhabitants

By nationwide, abstract explanation, it is difficult for the inhabitants to understand the meaning and necessity of social forestry. Because this does not constitute a personal experience for them and therefore it does not motivate them to act by themselves. It is essential to narrow down the subject within the range of the individual operations and to explain by showing concrete numerical values while giving examples.

② The demonstration by small wood lots

It is a shortcut to give an understanding by exhibiting at as many places as possible even with in small areas. It is necessary to perform the following exhibitions and allow them to look at the effect directly with their own eyes: wood lots implementing various types of agro-forestry, recovery of vegetation by regulating grazing for a certain period of time and establishing grassland by seeding grass, etc. Study visit to advanced areas of social forestry, visit to see the actual conditions of devastated forests, are an exceedingly useful means. It is for the same reason that a movie and picture is more useful than talk and letters.

③ Seeking understanding about long term and overall problems.

The vital statistics of the study area show that the rate of annual increase of population exceeds 3% and that children under fourteen account for more than 50% of the population.

When these children grow up and start economic activities, the demand for fuelwood and food increases and forest and land resources come under pressure. It is important to explain the consequences of this to inhabitants by giving numerical values and to make them an understand that a very serious situation is likely to develop in the near future though when things could not be coped with in same ways. It is also important to point out to them that the total profit of overall land use should not be lost sight of because a great emphasis is attached to seeking only the immediate interests.

④ The study for establishement of a new system

It will be necessary to establish Kihamba system for land where trees are planted by an individual and to establish rules for ownership, yields and incomes when planting is jointly performed. On the other hand, it is also necessary to study long

term loans in order to cope up with shortage of funds.

(2) The countermeasures against the administration side problems

① The increase in number of forestry extension officers and utilization of the agricultural extension officers.

Since the present number of forestry extension officers is one person per 9,000 villagers, it should be increased to one person per 2,000 villagers. This opinion is considered to be reasonable, and the people concerned should concentrate their efforts on the materialization of the extension programme. At the same time, we think that the utilization of the agriculture extension officers who are allocated at a rate of one person per 700 villagers should be studied. In this area, almost all inhabitants are farmers with the exception of a small number of town inhabitants, and the social forestry mostly agro-forestry and silvo-pastoral systems are predominant. Therefore, it may be said that the extension of social forestry is the improvement and extension of agriculture as well.

We should give training to the agricultural extension officers for the meaning and technique of social forestry and plan the extension with them. We think that this is more realistic and good results will be achieved. Though the promotion of social forestry partially competes with the agriculture and livestock rearing in respect of land use, the extension of social forestry by the agricultural extension officers has also a benefit to facilitate the adjustment in this respect.

② The expansion of the education system and training course for extension officers

It is essential to improve the quality of the extension officers and to train excellent extension worker as well as to secure a number of agent. It will be discribed by 5-8.

③ The information and instruction for general administration related staff

Persons in charge of general administration who are engaged in extension of social forestry in Tanzania have very important roles and may be said to hold almost the key to the success or failure of social forstry programmes.

They should, through meetings, seminars and study tours, promote the understanding of the following:

- how important the promotion of the social forestry is for the development of the area and the improvement of the inhabitants' lives.
- a very serious situation is likely to occur in near future unless positive countermeasures are taken immediately.

They should acquire the measures to extend to the inhabitants and others. Also, in promoting the social forestry, the adjustment with the land use plan should be performed as the prerequisite. It is advantageous also in this respect to enlighten the persons in charge of general administration.

As the object persons, the following people are considered:

a. District level — District commissioner
— District excutive director

— District administrative officer and agricultural officer

b. Division level — division secretary

c. Ward level — Ward secretary

d. Village level — Chairman

— Secretary

For the contents of seminar for the administration related people, the exmaple of seminar "Tree Planting and Agro-forestry" for the administration related people and inhabitant leaders held during November 9th to 13th, 1987 is helpful.

1. Opening Speech, Participants' Introduction & Registration
2. Objectives of seminar
3. Present state of forest and tree planting in Kilimanjaro Region
4. Experience of tree planting in three Regions such as Arusha Region sponsored by SIDA
5. Establishment and management of nursery
6. Meaning of tree planting-tree species, use and felling period
7. Utilization of radio program
8. Agro-forestry
9. Damage by forest felling, forest fire and overgrazing
10. Meaning of mobilization of inhabitants for tree planting
11. Survey of the Japanese survey team in Same District
12. Energy saving and use of improved stoves
13. Soil conservation and tree planting
14. Proper dry crop field management
15. Meaning of women's participation in tree planting
16. Land use plan
17. Declaration of seminar participants
18. Closing Speech

④ The information and instruction for the school education related people

It is desirable to promote the acquisition of the meaning and technique of social forestry as regular curricula in primary schools, middle schools and women's junior colleges. The students and pupils are anxious to acquire new knowledge, techniques and it is possible to widely extend to each home through the children. The children are allowed to plant and tend trees around the schools and in each school garden. If they are further able to produce seedlings, in schools, their students and pupils will fulfill their great duties in extending social forestry.

⑤ The information and instruction for the non-governmental organizations such as churches and women's groups

Many of these organizations are steadily performing activities adhered closely to the area. It is necessary to enlighten them so that the extension of social forestry is introduced as one of these activities. Especially since many of the churches have fund and transportation capability, they can fulfill their great duties. Since

some churches have already been planning establishment of nurseries even in the study area, it is necessary to actively work with them by supplying necessary information and materials. On the other hand, in view of the close connection of women to fuelwood problem, it is preferable that women will promote social forestry at the hand of the extension by assisting the women's group.

⑥ The information and instruction for the inhabitant leaders

As mentioned before, the Pare perform a village cooperative operation called "Msaragambo" once a week. If cooperative planting work is performed by enlightening this operation leader, the social forestry will be promoted in one breath. Especially since the seniors of the Masai are said to have exceedingly great leadership, the seniors of the Masai should be enlightened in order to introduce the restriction of grazing and the silvo-pastoral system.

⑦ Various methods should be used for extension activities.

The enlightenment and extension activities should use effective means adapted to the target group and actual conditions of the land. These means are illustrated by examples as follows:

- meetings, seminars, assemblies, movie meetings, study tours
- posters, calenders, stickers
- pamphlets, leaflets, newspapers, magazines, books
- movie, video, taperecorder, radio

⑧ The study of incentives to inhabitants

We promote the positive working on the social forestry of the inhabitants through these extension and enlightenment activities. In this case, however, providing some incentives to them facilitates obtaining their understanding.

What may be considered as incentive in this area is illustrated as follows:

a. Mechanized cultivation in farmland around large scale man-made forests
b. Permission for farming in the man-made forests
c. Providing farmers who are going to establish nurseries with seeds, seedlings, polythene tube, fertilizer, etc., technical guidance and finance
d. Providing grass seeds and fodder tree seedlings to villagers as a means of controling overgrazing.
e. Afforestation on public lands by villagers on the basis of sharing the profits from the sale of forest products with the government.

5.7.3 Points of Extension for Each Social Forestry Menu

The points for motivation for 9 social forestry menus and major technical points to be extended are described below.

(1) Establishment and conservation of fuelwood production forests

① Points for motivation

- State of reduced forest resources and their prospects
- Current demand for fuelwood and their prospects

- Labor and time required for collecting fuelwood and effectiveness when these are turned to production activities such as agriculture
- Problems at issue when fuelwood could not be collected (economic burden when coverted to petroleum, reduced fertility when husk and stalk of crops and manure are used as fuel)
- Cash income by charcoal production

② Technical points

- Selection of tree species adapted to the natural conditions
- Planting time and spacing
- Time for thinning
- Extension of felling period (increased yearly increment per hectare and production of saw timber)
- Planting methods of semi-arid zone
- Prevention of damage by disease, insects and fires
- Regeneration under coppice method

(2) Agro-forestry in lowlands

① Points for motivation

- Fertilization by introduction of soil improving tree speices and leaf-fall (increased agricultural production)
- Prevention of wind erosion by establishment of windbreaks and hedges (securing fertility)
- Fuelwood production at short distance of villages
- Production and income of fruits and poles, etc.

② Technical points

- Selection of tree species
- Interval of windbreaks
- Planting methods of semi-arid zone
- Prevention of damage by livestock
- Regeneration under coppice method

(3) Agro-forestry in highlands

① Points for motivation

- Prevention of soil erosion (securing fertility)
- Soil improvement by leaf-fall (increased farm products yield)
- Shading (increased yield of coffee, banana, etc.)
- Production of fuelwood, fruits, poles, etc. at short-distance of village and income from it

② Technical points

- Selection of tree species and combination of planting tree with farming crops
- Interval of planting
- Pruning time and height
- How to grow grass

(4) Restriction of grazing and silvo-pastoral system

① Points for motivation

- Current bad influences due to overgrazing (reduced carrying capacity due to deteriorated forest and declined vegetation) and their prospects
- Possiblity of vegetation recovery due to grazing regulation
- Reduced grazing labor due to increased carrying capacity
- Effect of pasture grass seeding

② Technical points

- Method of rotational grazing (such as space, rotation, period)
- Selection of tree species
- Objective for vegetation recovery
- Selection of pasture grass species

(5) Establishment of fodder tree forests

① Point for motivation

- Profit from livestock rearing in pens (cash income by light labor, fertilization by farmyard manure)
- Vegetation recovery by suspended overgrazing
- Production such as fuelwood and poles, etc at short-distance of villages.

② Technical points

- Selection of tree species
- Planting space and working methods
- Pruning time and method
- How to grow grass on forest floors

(6) Improvement of land conservation forests

① Points for motivation

- Fear of land erosion (landslides, river pollution, dam sedimentation)
- Prevention of erosion by forest and trees

② Technical points

- Soil conservation method
- Selection of tree species and planting method
- Tending method
- How to grow grass

(7) Improvement of water catchment forests

① Points for motivation

- Forest conservation of water catchment (even in Same District there was plenty of spring water when it was covered by forests of good vegetation formerly, according to cases)

② Technical points

- Soil conservation method
- Tending method
- How to grow grass

(8) Establishment of urban environment conservation forests

① Points for motivation

- o Effect of planting in towns (protection against wind, sound isolation, dust prevention, landscape, green shower (Refreshing in forest or woods))
- o Effect of shading (houses, roads)
- o Production of fuelwood, fruits, poles, etc. at short distance of villages

② Technical points

- o Selection of tree species
- o Spacing
- o Pruning time and height

(9) Conservation of forest reserve

① Points for motivation

- o Meaning of reserve designation
- o Effectiveness of reserve

② Technical points

- o Selection of tree species
- o Spacing
- o Tending
- o How to grow grass

5.8 Education and Training of Extension Officers

(1) Education and training programs

One of the most important measures to promote social forestry in the country is to secure necessary number of staff who will be engaged in extending social forestry among the people. As stated above, Sokoine University, Olmotonyi Forestry Training Institutes and Training Center located at Sao Hill and Rongi have education and training programs for forestry technical staff and experts, but such forestry education system in this country is not enough to extend social forestry, one of the most modern fields of forestry, throughout the country within a rather shorter period of time.

Under the circumstances, education and training facilities for promotion of social forestry in Kilimanjaro Region or northern Tanzania shall be duly taken into consideration in order to extend social forestry in the study area.

Following four categories of administrative staff shall be educated and trained under the programs:

(a) Forestry extension officers to be newly employed

(b) Forestry administrative staff including foresters

(c) Agricultural extension officers

(d) Other administrative staff

Since social forestry is one of the newest forestry technology to be further deep-

ened and to require application oriented measures to satisfy actual needs of respective area, a training program mainly composed of practical works instead of a training program stressed on classroom instruction will be effective. The program should consist of repetition of a cycle of short classroom instruction period and short practical work period. Any questions raised should be discussed and clarified before proceeding to each period. Practical ways and measures for promotion and extension of social forestry shall be elaborately instructed to the trainees in addition to the forestry technology and engineering.

It is needless to say that the newly established education and training facilities shall promote R & D of technology for social forestry and shall improve and develop various ways and measures for extension of social forestry, cooperating with Sokoine University and Olmotonyi Forestry Training Institute.

(2) Education and training facilities

Headquarters education and training facilities shall be set up at Mosi and field training facilities shall be installed at Same. Proposed equipment and facilities therefore are as follows:

(1) Headquarters (at Mosi)

a. Education and Training Facilities

- Education and training building
  - Lecture room (3 rooms)
  - AV education room (1 room)
  - Workshop (1 room; including a darkroom)
  - Library (including a stock room and an AV material room)
  - Manager's office (including a reception room)
  - Instructors' room
  - Secretary's office (next door to Manager's office)
  - Clerks's office (including a storage room)
  - Conference room (3 rooms)
  - Typewriter room (copy machines are also installed.)
  - Warehouse for small items
  - Warehouse for materials and equipment
  - Lavatory
  - Machinery room
- Lodging houses
  - Trainees' bedrooms
  - Conversation room
  - Recreation room
  - Shower room, lavatory
  - Linen room
  - Caretaker's room
- Dining room
  - Dining room
  - Cookroom

- Garage — Parking lot
  Repairing shop
  Warehouse
- Fuel depot — Inflammable park

In addition to the above listed facilities, a guest house, staff's house, fence, outdoor lamps are provided.

b. Equipment and facilities for training

- Equipment for training
  Videotape recorder: one (1) set
  16 mm movie projector: one (1) set
  Slide projector
  Portable microphone
  Taperecorder and other audio equipment
  Typewriters
  Copy machines
  Printing and bookbinding machine: one (1) set
  Bookshelves and cabinets
  Film processor
  Surveying instruments
  Draftsman's outfit
  Distance and area measuring instrument
  Desk-top calculator
  Tools for illustration
- Equipment and instruments for meteorological observation
  Instrument shelter
  Thermometer
  Hygrometer
  Rainfall gauge
  Sunshine recorder
  Underground thermometer
- Vehicles and related equipment
  Medium-size bus
  Small-size bus
  Wagon (for liaison purpose)
  Wagon (for training purpose)
  Equipment for vehicle repair
- Others — Radio communication equipment
  Generator and distribution equipment: One (1) set
  Pumping equipment
  Hot water supply equipment

(2) Same Training Facilities

a. Education and Training Facilities

- Education and training building
  - Lecture room (2 rooms; a videotape recorder and a movie projector are provided)
  - Manager's office
  - Instructors' room
  - Clerks' office (including storage room)
  - Conference room (2 rooms)
  - Typewriter room
  - Warehouse for small items
  - Warehouse for materials and equipment
  - Lavatory
  - Machinery room (for pumping equipment, water tank and generator)
- Lodging houses
  - Trainees' bedrooms
  - Conversation room
  - Recreation room
  - Shower room, Lavatory
  - Linen room
  - Caretaker's room
- Dining room
  - Dining room
  - Cookroom
- Garage
  - Parking lot
  - Repairing shop
  - Warehouse
- Fuel depot
  - Inflammable park

In addition, nursery facilities, guest house and staff's house are provided. The nursery facilities will be utilized for seedling nursery facilities under the semi-arid forest management plan to be implemented.

b. Equipment and facilities for training

- Equipment for training
  - Same as those listed for headquarters except tools for illustration
- Equipment for meteorological observation
  - Equipment to be provided under the semi-arid forest management plan shall be utilized.
- Vehicles and related equipment
  - Wagon (both for liaison and training purposes)
  - Small-size truck (for transportation of equipment and materials)

Small-size four-wheel drive car (for liaison and transportation of small items)

Wheel-type tractor

Spare parts for major components of heavy machinery

Equipment for vehicle repair

- Equipment for nursery works

  Plastic pipes

  Sprayers (back-carrying type)

  Plastic cases

  Belt conveyor

  Pressure-type splinklers

  Farming tools

- Others — Same as those listed for headquarters at Mosi.

6. SEMI-ARID FOREST MANAGEMENT PLAN

6.1 Policies for Formulation of the Plan

6.1.1 Objectives

The semi-arid zone of the Tanzania mainly comprises lowland plains dominated by savanna and steppe in terms of vegetation. Deforestation is rapidly increasing in Tanzania due to collection of fuelwood and excessive grazing associated with the growth of population, shift cultivation and bushfires. If various tree growing techniques were developed and maintained in the semi-arid area through afforestation and other means, it will lead not only for the promotion of forestry but also to the development of livestock rearing and agriculture through social forestry and serve to improve standards of living, and regional environmental conditions.

Formulation and implementation of the plan for the estabishment and management of productive forest in a model study area of 20,000 ha set up in the semi-arid zone in and around Same will contribute to the set up of the techniques for the establishment of forests in vast semi-arid regions and to the development of local communities.

6.1.2 Policies and Contents

The plan will be based on the concept of social forestry, in other words, the management of forest will be strictly for the benefit of community development.

The primary object of this plan is to increase supply of fuelwood which is an important problem for the forestry of Tanzania.

Furthermore, in order to prevent progressing environmental deterioration, efforts will be made to improve conservation of catchment forests and preventing soil erosion.

As Tanzania has had very little experience in establishment and management of large scale forests in semi-arid zones, the required techniques have not been well established. In view of this, efforts will be made to establish those techniques for the establishment and management of forests in semi-arid areas by setting up trial forests, and providing technical and educational backstopping through the implementation of the management plan.

Under the foregoing policies, characteristics of the natural conditions such as vegetation, forest type and soil, and social conditions (such as land use and form of land ownership) as well as the intention of local communities of the model area were investigated in detail to acquire necessary information for formulating this management plan. Especially, the feasibility of afforestation and the plan on selection of sites for trial forests were reviewed in detail on the field.

In this planning, the various plans such as for nursery practices, afforestation, forest protection, harvesting, facilities, forest roads, and technical training were systematically compiled for both production forests and conservation forests and, at the same

time, studies were made on agro-forestry and silvo-pastoral system.

Also, the implementation system this plan necessary for implementing the social forestry was studied.

The period covered by the forest management plan will be 10 years for the time being which will be divided into two phases, the first phase will consist five years and the second phase, another five years. The plan for the first five years of Phase I will be named as the "plan for the development and management of trial forests" and was examined in concrete terms accordingly.

6.2 Classification by Management Unit

6.2.1 Characteristics of the Model Study Area

The results obtained by analyzing using computers the natural characteristics and socio-economic characteristics for about 20,000 hectares of the model study area in the same manner as item 5.2.2 Characteristics of Areas are as shown below.

The altitude of the model study area is 740 m to 1,850 m and a portion below 1,000 m accounts for 75% since the greater part is a plain zone. The inclination of 5° or less accounts for 64%, 6° to 20° 19% and 21° or more 17%. The steep-sloped area is in Chambogo forestry reserve. For the soil, Nitosols accounts for 52%, and Cambisols 26%. Since, however, Vertisols and Lithosols occur in 2,400 ha (12%) and 2,100 ha (10%) respectively, care should be taken.

For the situation of land use, forests amounts for as a greater part as 79%. Though two-thirds of the area is affected by grazing, forests with good forest type such as Chambogo Forest Reserve are also conserved. There is a dry crop field of about 2,700 ha, which amounts for 13% of the entire area, and in addition, grazing land of 1,250 ha (6.1%) is found.

Since the greater part is lowland, meshes without house amount for 80% of the entire area and 95% if meshes with 1 to 10 houses per mesh are added. This area has few houses except Same and Mwembe urban areas.

Trunk roads and railway run north and south in the center of the model study area. Same town located along the trunk road in the northern part of the area is at a traffic strategic point where the old trunk road from Kisiwani and district road form highland passing through Mwembe run. Although this area is a lowland with the severest climatic condition along trunk roads from Dar es Salaam to Moshi, the population has been rapidly increasing in recent years. As the population increases, development of farmland advances from Same along the trunk road north and south and also extends behind Koko Hill. Since, however, the climatic condition is severe, measures such as establishment of windbreaks are required.

In the forest reserves with good forest type, strict conservation is required to secure water sources. For other areas, since these have been already developed as farmland, or strongly affected by grazing, or intense logging has been performed for

collecting fuelwood, resources for fuelwood are exceedingly scarce. Therefore, establishment of fuelwood forests is the urgent necessity.

6.2.2 Classification by Management Unit

For the convenience of forest management in the model study area, the management area was divided into six units as shown on Fig.6-1. Each unit was demarcated to approximately conform with land classification according to the feasibility study of social forestry, but some of smallest areas were merged into other classifications.

(1) Unit ①: Located around Zone 2 by suitable sites classification. A part of Zone 1 on the western side was also included. The unit was developed recently as an agricultural area and settlements are increasing along the roads. Thornbush savannas which have encroached upon this unit are intensevely utilized for grazing.

(2) Unit ②: The northernmost part of Zone 4 according to the suitable sites classification for feasibility of social forestry (hereinafter referred to as suitable sites classification). The unit is located around Same Town, the administrative center of Same District, and included agricultural areas around the town, Koko Hill Forest Reseve and Mt. Vumari Forest Reserve.

(3) Unit ③: Corresponds to the northern part of Zone 3 by suitable sites classification. It centers around Vertisols zone which becomes waterlogged during the rainy season and also includes the surrounding Nitosols zone. Agricultural development is almost nil.

(4) Unit ④: It is a part of Zone 4 by suitable sites classification and contiguous to Unit① on the south. Neither settlement nor cultivated suitable sites is hardly distributed. Vegetation mainly consists of dry savanna and thornbush savanna with rain green deciduous forest also occurring in part. As suitable sites productivity is relatively high, this unit is expected to become a forestry area in the future.

(5) Unit ⑤: It is the northern part of Zone 7 by suitalbe sites classification and which constitutes an agricultural area located around Mwembe Village whice has a long history of development. Also includes a part of Zone 8.

(6) Unit⑥: Zone 6 by suitable sites classification. It is the Chambogo Forest Reserve.

6.3 Major Points in Forest Management Plan for Each Management Unit

6.3.1 Suitable Site Classification for Social Forestry in Each Management Unit

The forests in the model area were classified according to the following classification of intended utilization, using the classification by mesh data as a reference and taking their natural conditions and socio-economic conditions which were identified in the field survey into consideration.

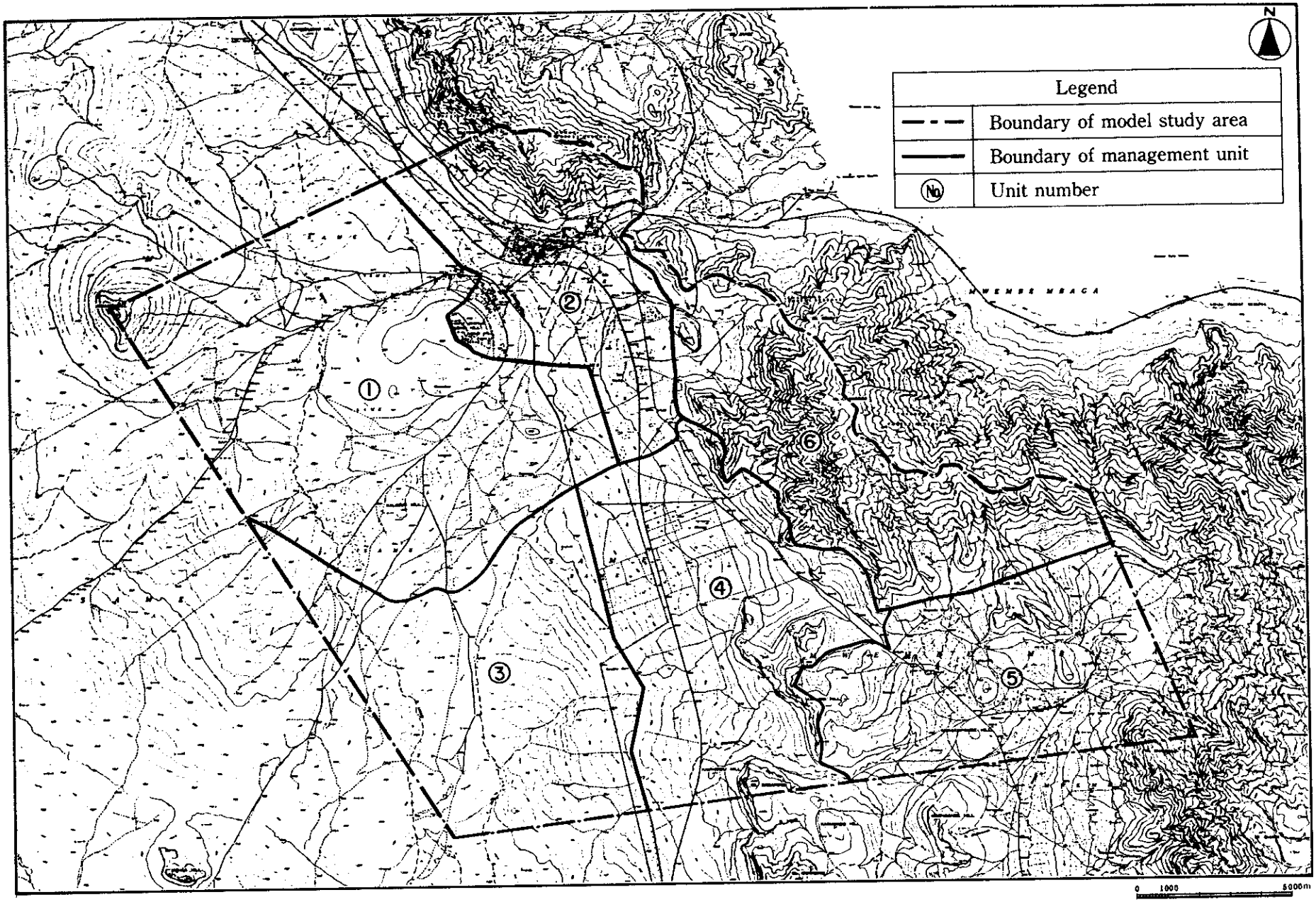


Fig. 6-1 Map of Management Unit

Table 6-1 The Area of Suitable Site for Social Forestry by Each Management Unit

(ha)

Menus \ Management Unit	①	②	③	④	⑤	⑥	Total
A. Establishment and conservation of fuelwood forests	–	175	534	2,718	616	–	4,043
B. Agro-forestry in lowlands	2,329	1,458	–	–	1,525	–	5,312
D. Restriction of grazing and silvo-pastoral system	2,996	–	2,794	148	–	–	5,939
E. Establishment of fodder tree forests	–	–	–	–	30	–	30
F. Improvement of land conservation forests G. Improvement of water catchment forests	222	–	61	575	580**	–	1,438
H. Improvement of urban environment conservation forests*	16	189	–	–	46	–	251
I. Conservation of Forest Reserves	–	702	–	–	–	2,823	3,525
Total	5,563	2,524	3,389	3,441	2,797	2,823	20,537

* Area of urban or town. ** Included a 26 ha of the mine site.

6.3.2 Major Points in Forest Management Plan for Each Managament Unit

As shown in the classification of forest and bush land utilization, major points in the forest management plan for each unit are as follows.

(1) Unit ①

Unit ① a newly established agricultural area, is inferior to Unit ② and ④ in terms of environmental suitability for agricultural production and forestry production since the amount of rainfall is smaller and the prevailing wind (easterly wind during November-March and southerly wind during May- September, and April and October being the change period) is stronger, but its soils are relatively more fertile. Here, the following points are considered important.

a. Development of farmlands by establishment of a windbreaks

The windbreaks must be developed with adequate belt width (approximately 4 m) in consideration of regeneraion and to be capable of not only conserving farmlands but producing firewood and charcoal.

Farmland development will be carried out systemetically through large scale, systematic establishment of windbreaks by some government agency.

b. Promotion of agro-forestry in lowlands

Villagers must be encouraged to practice row planting multi-purpose tree species as well as in the fields establishing farmland windbreaks (of a few lines of trees) and windbreak hedges.

c. Planting trees to improve environment of agricultural settlements

d. Systematic utilization of natural forests (thornbush savannas) for livestock rearing

In forest lands close to farmlands and settlements, disorderly grazing should be regulated. Instead, guidance on rotational grazing with due regard to the carrying capacity must be introduced. Also, attempt must be made to convert natural

forests into fodder tree forests.

(2) Unit ②

Unit ② located around Same Town, the administrative center of District, the population is rapidly increasing. Its urban area as a result has expanded as far as the foot of the mountain. The problem of water supply is becoming serious, and not only the deep wells but also spring water from the mountains have become precious resources. In view of the above, the following issues would be important in the forest management plan for unit ②.

a. Utilization of forests and trees for the improvement of urban environment

Planting of park trees and roadside trees for improvement of landscape and urban environment.

b. Improvement of water catchment forests and soil conservation forests

Koko Hill and Mt. Vumari in the back of the urban area constitute forest reserves. Forest lands which must be preserved shall be strictly administered.

c. Setting up of demonstration plots for social forestry

In addition a demonstration plots for tree species selection will be established for the development of forests in semi-arid zones, tree growing by schools, churches, government offices and other shall be implemented.

d. Establishment of nurseries, management facilities and training facilities

It is desirable to establish the afforestation facilities in Unit ② as it is to will become the base for the development and management of forests in the semi-arid zone.

e. Establishment of fuelwood forests

It would be difficult to develop fuelwood forests for the local inhabitants by themselves in Unit ②. Suitable sites are also few. Thus, the inhabitants would have to rely on some government establishing of fuelwood forests in Unit ④ and in other places.

(3) Unit ③

Vertisols (black cotton soil) mainly distributed in Unit ③ which become water-logged during the rainy season and dry during the dry season and are therefore unsuitable for the growth of trees, but can be utilized for farming during the rainy season. Only a part of the unit will be utilized as farmland while natural forests and bushlands will be used for grazing for the time being.

(4) Unit ④

The development of farmland has not reached this section of the model study area yet. The section abounds in gentle slopes and flat land which stretch along the mountain spurs, its soil condition is favorable for the growth of trees.

This unit of the model study area is most suitable for the establishment and management of large scale fuelwood plantations by the government. Along with the establishment of man-made forests, many forests can be managed as natural forests.

Many of the forests are currently utilized for grazing also, but in order to

regenerate those forests, their utilization for grazing must be regulated.

(5) Unit ⑤

This unit is located around Mwembe Village which has long been established as an agricultural area.

a. Promotion of agro-forestry suitable for land conservation

There are many lands where soil erosion is taking place and where land productivity is declining due to many years of improper cultivation practices and grazing. Introduction of intensive agro-forestry accompanied by planting of trees and pasture grasses along the contour lines and establishment of terraces and digging of horizontal ditches must be promoted. For this purpose, provision of seedlings for fodder trees, soil improving trees and fruit trees and also seeds of pasture plants is necessary.

b. Improvement of conservation forests

As many forest lands and grass lands on the steep slopes near the settlements and farmlands have become devastated due to excessive grazing, establishment of conservation forests must be considered and their utilization for grazing must be regulated.

c. Establishment of fodder trees forests and fuelwood forests

Fodder tree forests and fuelwood forests must be established jointly by the community by utilizing abandoned farmlands and sisal plantations near the settlement. Establishment of fuelwood forest by the government shall also be implemented.

d. Improvement of nurseries

Along with the new nursery to be established in Same, existing nurseries will become the bases of seedling production for establishing forests in the semi-arid lowlands. Since the Mwembe Nursery will be partly responsible for the production of seedlings for agro-forestry in the surroundings of Mwembe and on the highlands, its expansion and improvement would become necessary.

(6) Unit ⑥

This is the Chambogo Forest Reserve. Collection of fuelwood, grazing and farming in the reserve must be controlled in order not to decline the functional role of water catchment and land conservation. The deteriorated forests due to felling and grazing should be planted to improve conservation of water catchments.

6.4 Forest Management Plan

6.4.1 Management Plan for Fuelwood Production Forests

(1) Management methods

The production forests in the model study area were roughly classified into Man-made forest management and Natural forest management in consideration of the site conditions, forest types and the local characteristics of forest administration.

a. Site classification of the forest lands for fuelwood production

Forest lands for fuelwood production in unit ①, ②, ④ and ⑤ of the model area were classified by site based on investigaion of soil, vegetation and topography, and judgement as to the feasibility of afforestation was rendered on each site.

Particularly since the soil condition governs the success or failure of afforestation, soil structure, thickness of A horizon, consistency, soil type and root conditions of 50 survey plots were studied.

Nitosols and Cambisols are mainly distributed on the lands classified as production forests, where wet and dry conditions recur with the rainy season and dry season respectively. A blocky structure is developed deeply in the soils on the mountain spurs where the moisture environment is favorable. As a result the root system of trees becomes well developed and deep, and both permeability and aeration may be satisfactory. Soils with a shallow blocky structure are so massive that they are poor in moisture movement. Semi-arid soils are generally hard and this consistency also can affect the success or failure of afforestation and tree growth.

In view of the above, site classification was made on the feasibility of afforestation according to the two factors, (1) the depth at which the blocky structure is seen and (2) the consistency of soils at the depth of 25 cm below surface. (Table 6-2) When the result of site classification differed by each factor, the lower grade was selected in the judgement of site classification. Vertisols were excluded as being difficult for afforestation.

Table 6-2 Site Classification

(1) Depth at which blocky structure is seen	Within 30 cm I	Within 20 cm II	Within 10 cm III
(2) Soil consistency at the depth of 25 cm (Yamanaka type hardness tester)	Up to 30 mm I	Above 30 mm II	Above 35 mm III

Of the fifty survey plots, 20 plots were classified as Class I sites, 14 plots as Class II sites, 14 plots as Class III sites, and two plots comprized Vertisols. Afforestation becomes more difficult in the order of Class I sites to Class II sites to Class III sites. Sites comprised of Vertisols must be difficult for afforestation. The distribution of each site class based on the distribution of these survey plots and

field observations is as shown on Fig. 6-2. Class I sites are distrubuted on the spurs of the mountain range, while Class II sites and Class III sites are distributed closer toward the plains. Approximate areas of the site classed in the production forest lands are 700 ha for Class I sites, 1300 ha for Class II sites and 2000 ha for Class III sites.

The government planted area in Same Town is the only example of mass planting (5 ha) in the model study area, which was judged to be a Class I site, where is the mean tree height of 8 m to 10 m and nine years after planting indicates a satisfactory growth for a semi-arid zone. Judging also from the examples of small scale planting in settlements and schools within the area, planting of trees on Classes I and II sites is considered feasible even with the current technologies as long as the trees are of the species adaptable to the semi-arid climate (with annual rainfall of 400 mm to 600 mm). Even on Class III site, planting is expected feasible if that site is close to the mountainous zone and the moisture condition of the soil is relatively favorable, although growth may be poor, and this feasibility would be even greater if the silviculture techniques for the semi-arid area are to be advanced.

b. Man-made forests management

As a result of the site survey, it becomes evident that forest lands where afforestation is feasible are fairly well distributed in the model study area. In order to cope with the rapidly growing demand for firewood and charcoal and to prevent devastation of forests on account of excessive felling, it is desirable to proceed with the afforestation in the model study area as quickly as possible.

Afforestation so far accomplished in the Same District has been in the tune of 50 to 60 ha per year (which was estimated on the basis of annual seedling production between 1984 and 1986) for the whole Same District, almost all of it being small scale planting around settlements, fields and schools. The only sizable planted area is the goverment planted forest mentioned previously. Thus, Same District has had no experience of large scale afforestation as yet.

Accordingly, many difficulties are likely to be encountered if attempts are to be made to quickly expand the planted area immediately. In consideration of this, the planning period of this plan was divided into two phases. During the first five years, the technology of afforestation would be systematized by advancement and experiment of large scale afforestation in trial forests. In the second five years, it will be expanded to a scale of a pilot project in order to firmly extend semi-arid afforestation project.

c. Natural forests management

Management of natural forests and savannas which are now distributed extensively is just as important as intensive afforestation in the future. Though there are many forests and savannas which are becoming devastated due to excessive grazing and firewood felling, a few forests can be managed as production forests.

These natural forests may be divided into two types. One is deciduous dry forests which are with good cover and high stand volume classified as Dd (h_1), (h_2), (ℓ_1) in terms of vegetation types. According to the results of the survey on forest type, the stock volume was around 40 m^3/ha for high and medium height dense forests (Dd(h_1)) and around 30 m^3 ha for scattered forests (Dd(h_2)), and the effect of grazing and felling was relatively small. Low forests (Dd(ℓ_1)) indicated a dense forest cover but the stock volume was small. These forests therefore ought to be administered as natural forests from now on, and their stock volume ought to be enhanced by regulating excessive grazing and felling. Even on deciduous dry forests such as Dd(ℓ_2) and Dd(ℓ_3) whose forest cover has deteriorated by overgrazing and felling ought to be developed as man-made forest. Another type of forests is some of the thornbush savannas. Even though they may possibly be converted into man-made forest, those forests with unfavorable locations for afforestation work ought to be administered as natural forests for the time being.

(2) Working Method for Fuelwood Production Forests

Though the woking technique for production forests in semi-arid zone is being developed in various countries, the technical system which could be applied to this area has not yet been established. Therefore, the implementation of production forests will be carried forward while developing and standardizing the working technique through the studies of trial forests.

The working method in this area is almost as follows:

a. Man-made Forests

- Production Object:

The production objective of establishing man-made forests is production of fuelwood, which is most expected in this area. Since there are also a lot of multipurpose tree species suitable for pole material and lumbering even in tree species for fuelwood, the production of pole and lumbering materials will also be performed together in forest lands with high productivity.

Production rotation (cutting period) for fuelwood forests differs depending upon the local conditions, and it is regarded as 10 years for the time being in this area. Since sufficient data concerning the tree growth in this area is not available, it will be necessary to study using future production experiences. In view of the local conditions in this area, it is expected that the average breast height diameter in 10 years old plants is 10 to 12 cm in Class I area and 8 to 10 cm in Class II area.

- Operating Method:

In the man-made forests,the clearcutting system will be used, but the regeneration under coppice method will be preferable depending upon the tree species when regeneration is carried out in the man-made forests again in the future. As also, the clear cutting in a short rotation period will be repeated in the production of fuelwood, the fertility of the forest and woodland tends to fall. Therefore, it will be necessary to study the introduction of the selective cutting system and two sto-

ried forest system in order to preserve the fertility.

- Afforestation Method:

The fundamentals of afforestation in tropical semi-arid zone are to allow planted trees to completely take root and start the growth quickly. For this purpose, the utilization of moisture in the forest and woodland is important. Therefore, in the semi-arid zone, afforestation requires more sufficient, intensive site preparation than in the afforestation in wet zone. In site preparation in arid zones, complete removal of weeds, furrowing for catchment, trenching and tilling on surface are required in order to suppress evapotranspiration from the forest lands and allow precipitation to sufficiently infiltration into their soils.

The site preparation was conventionally preformed by human power and was hard work. In recent years, the mechanised afforestation is becoming popular because of few difficulties in securing labour and low expenses in large-scale afforestation.

In this area, they have no experience of the mechanised afforestation and yet the labour conditions are neither severe. Therefore, this plan aims to develop and establish mechanised afforestation technique in the trial forest with human power for the time being.

The afforestation technique mainly by human power in semi-arid zone is being developed in various tropical countries. Even in Tanzania, afforestation is worked out in the semi-arid zone based on this technique, however the standard technique suitable for this area has not yet been established since they have very scarcely had such afforestation experiences as mentioned above.

Therefore it is necessary to advance standardization of the techniques by reviewing the individual techniques of afforestation while implementing the afforestation enterprise in the trial forests. For the general afforestation method in this plan, the following method will be adopted for the time being.

For site preparation, only felling is performed by manual opration and no pulling out since there are scattered existing vegetation in many cases. Further the site preparation method in which existing trees are not felled, but will be used as protection trees. The felled trunks and most of branches will be used for fuelwood. The rest are accumulated around the plantation to be used for fences to prevent livestock and wild animals from entering. The planting holes will be prepared in semicircular shape around the hole for water catchment.

In the mechanised site preparation, strip tillage by means of bulldozers is mainly performed in combination with manual pitting. (For the detail, see the item for Trial Forest as mentioned later.)

Planting will be carried out when the plant holes are sufficiently wet by rainfall at the beginning of the rainy season. There are two rainy seasons a year in this area, and suitable season for planting is the middle of March through the end of April at the beginning of long rainy season, and the middle of October through

suitable season is usually concentrated in about two weeks. Judgement of the suitable season based on forecast of rainfall is therefore very important aspect to be very irregular and not stable depending upon the year (See Chapter 3.3.2.(3)), the suitable season is usually concentrated in about two weeks. Judgement of the suitable season based on forecast of rainfall is therefore very important aspect to be conducted every year.

For the planting materials, pot seedlings will be generally used. However, other techniques such as stump plants and direct sowing method will be also developed.

It is said that it is very important to mulch the planted holes after planting in semi- arid zone afforestation. Though cleared grass are used as mulching material, it may attract termites. So it is necessary to study the material such as polyethylene tube used during planting. It is said that small stone and clod, etc. are useful.

For the spacing of 2.5 m × 2.5 m to 3.0 m × 3.0 m will be generally used, and generally sparsely planted. In fuelwood production forests, it is based on 2.5 m × 2.5 m and 1,600 seedlings per ha.

The compensatory planting will be determined by investigating the survival rate and studying the cause for the survival rate after one dry season from planting.

Weeding will be performed at the end of rainy season in order to remove competition for water between the planted trees and weeds and shrubs during the dry season. Since the weeds and shrubs are relatively few in this area, spot-weeding will be practiced depending on the circumstance. The mechannized weeding will be studied. Thinning and pruning will be studied when aiming at production of lumbering material, though these silvicultural activities are not performed for production of fuelwood.

- Afforestation Program:

Table 6-3,4 shows trend in area by the management classification of fuelwood production forests (i.e., man-made forest and natural forest) in accordance with the annual afforestation program.

440 ha of man-made forests would be set up in the first five year Phase I and 1,300 ha in Phase II with the final development objective of 2,000 ha for the model area. The establishment would be carried out with preference given to areas with favorable site condition and locational condition, then gradually proceed to where afforestation becomes increasingly difficult after the necessary techniques are established and disseminated.

The detailed annual program for the first phase will be shown in the trial forest development and management plan described below.

b. Natural forests

In the model study area, evergreen broad-leaved, natural forest with massive stocks, are distributed in the Forest Reserve and riverine deciduous forests on the riversides of large rivers. These forests are so responsible for conservation of water catchment and lands that harvesting from them are controlled.

Table 6-3 Afforestation Program for Man-made Forest

(Unit; ha)

	Phase I	Phase II
Afforestation area	440	1,300

Table 6-4 Area Trend of Fuelwood Forest by Man-made and Natural

(Unit;ha)

Forest type	Phase I	Phase II	Objective
Man-made forest	440	1,740	2,000
Natural forest	3,600	2,300	2,040
Total	4,040	4,040	4,040

Within natural forests considered as fuelwood production forest, the forest which has comparatively good forest is the vegetation type of Dd(h_1) and Dd(h_2) with average tree height of about 10 m of dry deciduous forests. The stocking volume of these forests are 30 to 50 m^3/ha. These are mostly dominated by species for fuelwood and will include species for poles and medicinal use. (See the item for investigation for vegetation and forest type). When it comes to low forest Dd(ℓ_1) of dry deciduous forest, there are more forests with as low stocks as about 10 m^3/ha.

For the time being the natural forests aim at fuelwood production like the man-made forests are used the selective cutting regeneration principally. The selective cutting rotation will be determined after grasping the growth condition. The regeneration condition by coppicing and natural seeding in the forest is generally bad because of grazing in the forest lands as things stand.

In the case of selective cutting, grazing is strictly forbidden during regeneration period (about 5 years) and if the condition is bad, useful trees will be planted in the forest.

If the forest type of which should be improved under the present condition, useful tree species will be planted. The area of natural forests where will be planted has been decided to be about 50 ha for Phase I and 100 ha for Phase II.

Thornbush savanna (on the west side along the railway in unit ③), the second type of natural forest for fuelwood, is a site where afforestation is feasible, and where locational condition is difficult. So that these forests will be managed as a natural forest for the time being and which will not be positively managed. When harvesting fuelwood, the cutting should be limited to 1 m^3/ha or less yearly to prevent overcutting. Also pay much attention to prevent overgrazing.

The trend of the working area in natural forests for fuelwood is also shown in the afforestation program in the previous item.

6.4.2 Management Plan for Agro-forestry in Lowlands

As already mentioned in the priority policy of the management plan, Unit ① and ⑤ in the model study area are agricultural districts and require promotion of agro-forestry together with the agriculture and forestry part of Unit ②. The first important problem is the afforestation of large-scale windbreaks required to promote stable development of farmland in lowlands areas where the air is extremely dry and wind erosion of the cultivated land occurs due to prevailing wind during dry season. Further the intensive agro-forestry technique should be established in order to improve the productivity of the extensive lowlands agricuture.

Windbreaks:

As to large scale windbreak, the windbreak forest of 40 m in width will be established in the form of a lattice in the north and south direction and in the east and west direction where farm land will be developed in future. The windbreak interval is 200 m (assuming the standard interval to be 10 m, 20 times). The farmland will be surrounded every 200 m × 200 m by the windbreaks. However, it is desirable that the development will be started in accordance with the separate agriculture development plan after the windbreaks has grown to a certain degree. If several rows of windbreak forests and fences are provided in the farmland, the windbreak effect will be improved. In this connection, we expect voluntarily planting by the farmers.

Such development of agricultural area with windbreaks has proved to be quite successful in Sudan Savanna District, Nigeria (amount of rainfall: 400 to 600 mm).

In addition, production of fuelwood for the surrounding farmland and villages is also expected from this windbreaks, planting species for fuelwood should be considered. Though the coordination with the farmland development plan is required, 12.5 km (50ha) will be established in Phase I, and if it is successful, approximately 12.5 km (50ha) will be planted in Phase II.

Table 6-5 Agro-forestry Program

Item	Phase I	Phase II	Remarks
Establishment of Wind Breaks	12.5km (50ha)	12.5km (50ha)	Unit ② ; West of Koko Hill

Planting in farmland:

In the farmlands and villages on highlands which were developed since a long time ago, the agro-forestry technique such as planting of shade trees and boundary trees, introduction of row planting cultivation taking the land conservation into consideration and maintenance of forests for communal utilization have been intensively introduced. In comparison with this, the agro-forestry technique is hardly introduced in farmlands and villages in Unit ① and ② of the western lowlnd areas.

It is necessary to promote the introduction of the technique also to the farmlands and villages which have been developed so far, to say nothing of farmlands which will be developed in future. In Mwembe village in Unit ⑤, the agro-forestry technique is not sufficiently introduced though it was developed since a long time ago. The management technique for cultivated land and pasture land especially taking into consideration the land conservation is required. Establishment of communal forests taking into consideration both food production and fuelwood production is urgently needed.

Promotion of such agro-forestry relies very much on farmers' voluntary efforts, however raising and distribution of tree seedlings which will be required for this purpose for the time being will be handled in this plan.

6.4.3 Management Plan for Silvo-pastoral System

In this area, grazing is widely practised and a lot of forests and savanna have been used beyond the carrying capacity, being nearly in overgrazing state.

In future forest management in this area, grazing control is prerequsite. As mentioned already, grazing should be strictly forbidden for the fuelwood production forests and windbreaks during regeneration period, to say nothing of conservation forests.

The number of grazing livestock in each unit should be adjusted by taking into consideration the carrying capacity of the forests and savanna. The establishment of the rotational grazing system in accordance with the conditions of forests and savanna is also required.

Though the radical solution for the foregoing problem has to rely on the establishment of the livestock improvement plan for the whole community, the present forest management plan is as follows:

In this area, the forests and savanna except conserved forests in the forest reserve and the conservation forests, fuelwood production forests and woods for agro-forestry in the public land are used for grazing. The fuelwood production forests should be also used for proper grazing after regeneration is complete. Entry into the restricted area and occurrence of overgrazing state should be prevented by grasping the grazing state at all times.

Planting fodder trees and cultivating grasses by farmers' is expected in order to increase the production of feed in the farmlands and around the villages. The production and distribution of seedlings for fodder trees for this purpose is handled in this plan. In addition, selection of fodder trees suitable for this area and demonstration plots of fodder trees, etc. will be practiced in the trial forest as will be mentioned later.

6.4.4 Management Plan for Fodder Tree Forests

Regulations on overgrazing are the most important problem also in this area. For this purpose, it becomes necessary to positively increase the feed, and it is important to include fodder trees in the agro-forestry and to utilize them in order to improve forests

under grazing.

The following afforestation plan was formulated in order to establish the selection of fodder trees suitable for this area, afforestation technique and management technique, and to recommend future farmers autonomous planting as the starting point by implementing demonstrative establishment of fodder tree forests especially in Unit ⑤ where increased production of fodder trees is the problem.

Table 6-6 Afforestation Program for Fodder Tree Forests

(Unit ; ha)

	Phase I	Phase II	Remarks
Afforestation area	10	20	Unit ⑤ ; Abandoned sisal plantation

6.4.5 Management Plan for Land Conservation, Water Catchment and Urban Environment Conservation Forests

In the model study area, large scale livestock grazing is widely practiced, and not only on the lowlands, but also on the hillside slope and also the forest land on the ridge are used for carring. Also deforestation expands with increased demand for fuelwood. Overgrazing and overcutting in the forest directly leads to devastation of the forest. This tendency is seen not only in public forests but also to a part of the forest reserve, and the forest lands which are likely to be devastated also appear even in conservation forests necessary for catchment area and prevention of soil erosion.

Therefore the improvement of the land conservation forests and water catchment forests play an important role in the forest management plan for this area.

Land conservation forests:

First of all, it is necessary to strictly forbid grazing and cutting in necessary conserved forests. It is desirable to allow community around them to understand the meaning and reasons of conservation forests and carry out the above forbiddance under their cooperation though it is a difficlut task. In this plan, even the zone which is very likely to be devastated on the steep hillside of the public forest has been designated as the conservation forest in addition to the forest reserve. The measure for prohibiting grazing and cutting will be considered also for these new conservation forests.

Next to the forest lands of the important conservation forests where devastation has been already seen and especially near villages such as Unit ② and ⑤, working arrangements to restore the water and soil conservation function of forests will be positively performed. In order to improve the forest type and prevent soil erosion, planting trees species such as *Acacia* sp., *Leucaena* sp., grass and providing ridges, trenches and terraces, etc. especially where severely eroded, are needed.

Riverine conservation forests:

Since dry deciduous forests Dd(r) and wet savanna Sd(r) which are found on the

riversides of major rivers are important in preventing soils from flowing into rivers and preserving water quality, they will be designated as conservation forest. However, these riverine forests are divided into sections and a part of them have been devastated in the present condition. Rehabilitation and establishment of riverine conservation forests will be implemented starting from the important sites in the utilization as water catchment.

Urban environment conservation forests:

In urban areas with high population and a rapid development is being achieved like Same town, the town planning needs to be formulated and implemented urgently in order to improve the living environment. By this means, the planting along roadside and in parks has been taken up as a part of the social forestry.

The following roadside trees will be planted.

① Both sides of trunk-road; 5 m (2-row planting), length about 22 km

② East side of high-tention wire; 10 m (4-row planting), length 8 km

③ East side of railway track; 10 m (4-row planting), length 10 km

Planting in the parks are planned for the Phase II and there after for the time being though, it is necessary to coordinate with the comprehensive plan for Same town.

Though planting trees on roadside trees, small open spaces in Same town is important for improvement of the environment, it will be performed by the inhabitants' in cooperation and in accordance with the urban plan. In this plan, only seedlings (as planting materials) will be supplied.

Annual Plan: The plan for the improvement of conservation forests is as follows.

Table 6-7 Improvement Program for Conservation Forests

(Unit ; ha)

Forest type	Phase I	Phase II
Improvement of land conservation forests	20	20
Establishment of urban environment forests	20	20

6.4.6 Conservation of Forest Reserves

In this model study area, the forest land which is legally regulated as forest reserves is concentrated on Unit ③ and Unit ⑥. The importance of forest reserves has been already described. Since there are actually places which are misused for field cultivation and grazing in part of forest reserves, it is necessary to strictly perform evacuation of trespassers, and prohibition of cultivation and grazing. For areas with worsened forest type, the forest type will be recovered by afforestation and planting in these forests. Especialy in the forest reserves near villages where devastation has advanced and erosion of soil occurs and in forest land where water source conservation function is especially expected, it is necessary to carry forward improvement of the forest type immediately.

Accordingly, the forest reserves mainteance plan was formulated as shown on the following table.

In the forest land where good forest type is maintained, proper selective cutting and salvage cutting is implemented to supply saw timber and fuelwood and attention is paid to prevent overcutting always. Further in forest reserve near urban area where the soil condition is as good as the foot zone and afforestation is possible, a tree species test planting forest, etc. was planned in expectation of demonstrative effect in order to promote future afforestation.

Table 6-8 Improvement Program for Forest Reserves

(Unit ; ha)

Forest type	Phase I	Phase II	Remarks
Improvement of forest reserves			
(for land conservation)	10	40	Unit ② ; Koko Hill Reserve
(for water catchment)	20	80	Unit ⑥ ; Chanbogo Reserve
Afforestation in forest reserves			
(trial plantation etc.)	50		Unit ② ; Vumari Reserve, Unit ⑥ ; Chanbogo Reserve

6.4.7 Nursery Management Plan

(1) Seeding production plan

In order to implement the management plan including the foregoing afforestation for man-made forest, planned production of necessary seedlings is indispensable.

The production plan for seedlings required in this plan is as follows:

The species, operating method, working and schedule, etc. will be described in the Trial Forest Plan.

Table 6-9 Seedling Production Program

Forest type	Phase I	Phase II	Remarks
Fuelwood Forests	(×1,000)	(×1,000)	(Seedlings/ha)
Afforestation for man-made forests***	749	2,500	1,600 ****
Improvement of natural forests	48	100	800
Agro-forestry			
Establishment of windbreaks	97	100	1,600
Establishment of fodder tree forests	18	40	1,600
Conservation forests, Forest reserves	84	190	1,000
Experiment of nursery cultivation, Establishment of seed orchards and arboretum	84	90	
For distribution to inhabitants**	773	1,100	10 seedlings/person
Total	1,852	4,120	

* For the number of production trees, it increased by 20% over the number of trees necessary for planting.
** The numbers of seedlings are calculated by 10 seedlings per inhabitant throughout all plans assuming the annual population growth as 3%.
*** This figure includes the amount of seedlings for the test planting forests of forest reserves.
**** The figures of the seedlings are based on these planting densities.

(2) Facilities for tree nursery

In order to accomplish the foregoing seedling production plan, the following facilities are planned.

Nursery site:

As a nursery in the model study area, there is Mwembe Nursery (about 0.6ha). This nursery has good source of water because of water from rivers and has produced seedlings (mainly for highlands) for a long time ago. However, for some reasons such as capacity of the nursery is small, and it is located at the eastern end of model study area and is far from the expected planting sites, a new nursery will be established.

It was judged that the new nursery should be located in Same town which is geographically the central part of the mode study area and will be the future, management center for forest management. Since Mwembe nursery should produce seedlings for the model study area as well as seedlings for the highland, it will be expanded.

Therefore, the facilities for nursery in the model study area will be as follows:

① Same tree nursery:

A nursery 3 ha (including incidental area) with annual seedling production ca-

Table 6-10 Space Requirements Calculation

Item	Same Nursery	Mwembe Nursery	Remarks
Annual seedling production Maximum number of seedlings to be planted a year	600,000 seedlings	200,000 seedlings	Ratio of production in Same to Mwembe is 3 : 1
Seedling production in a growing terms (Maximum requirement of seedling in a planting time)	450,000 seedlings	150,000 seedlings	Required seedlings for a long rainy season: for a short rainy season is at a ratio of 3 : 1
Area of nursery beds	4,500 m^2	1,500 m^2	100pots/m^2; one bed requires 1 m × 10 m
Area of bed spaces	8,430 m^2	2,810 m^2	Beds 53.4%; Paths 46.5%
Area of bed spaces for trial	1,690 m^2	560 m^2	20% of the bed spaces
Area of experimental beds	2,500 m^2	600 m^2	
Area of roads	8,500 m^2	3,950 m^2	
Area of facilities	7,500 m^2	6,450 m^2	
Area of other space	—	750 m^2	Bank of the river
Total area (Space requirements)	28,620 ≒30,000 m^2	15,120 ≒15,000 m^2	
Access roads	740 m	300 m	

pacity of 60 hundred thousand seedlings will be newly established in the southern part of Same town (Fig. 6-3).

The facilities for management of the nursery will be also constructed in order to function as the center of seedlings production in this semi-arid afforestation plan. The water for the nursery will be secured by establishing deep wells, and the location and depth of the wells will be further studied.

Moreover the earth dam shall be constructed by using swampland near the nursery for emergency.

② Mwembe tree nursery:

A nursery 1.5ha with annual seedling production capacity of 20 hundred thousand seedlings will be additionally established where sisal field once stood (Fig. 6-4) on the opposite bank of the existing Mwembe F. D. Nursery. This nursery will produce seedlings for semi-arid afforestation dividing the work with the Same Nursery and the production of seedlings for highland will continue in the existing nursery. For water source, water from the upstream spring will be used.

Facilities:

For the management of nursery, the facilities such as office, workers' mess house, material storage, garage, store of seeds, working shed, store of potting soils and compost hut will be constructed in both nursery as shown on the following Table 6-11.

In Same Nursery, deep wells will be provided and pipeline for watering and water tank will be installed.

In Mwembe Nursery, piping from the upstream water spring will be laid and water tank and pipeline for watering will be installed.

Access road from public road will be established in the respective nurseries.

Table 6-11 Related Facilities

Facilities	Same Nursery	Mwembe Nursery
Office	80 m^2	40 m^2
Worker's mess house	50 m^2	30 m^2
Material storage	40 m^2	40 m^2
Garage	50 m^2	40 m^2
Store of Seeds	40 m^2	—
Working shed	200 m^2	100 m^2
Compost hut	40 m^2	20 m^2
Store of potting soils	150 m^2	100 m^2
Irrigating pipeline	200 m (Deep well)	5,000 m (Pipe line)
Earth fill dam	300 m^2 (only 1 place)	—
Water tank	30 m^3 (10 $m^3 \times 3$)	10 m^3 (Only 1 tank)
Pipeline for watering	1,200 m	600 m
Access road	740 m	300 m
Accomodation	— Shared with the management centre	30 m^2
Pumping facility	1 set	1 set
Guards' house	20 m^2	15 m^2

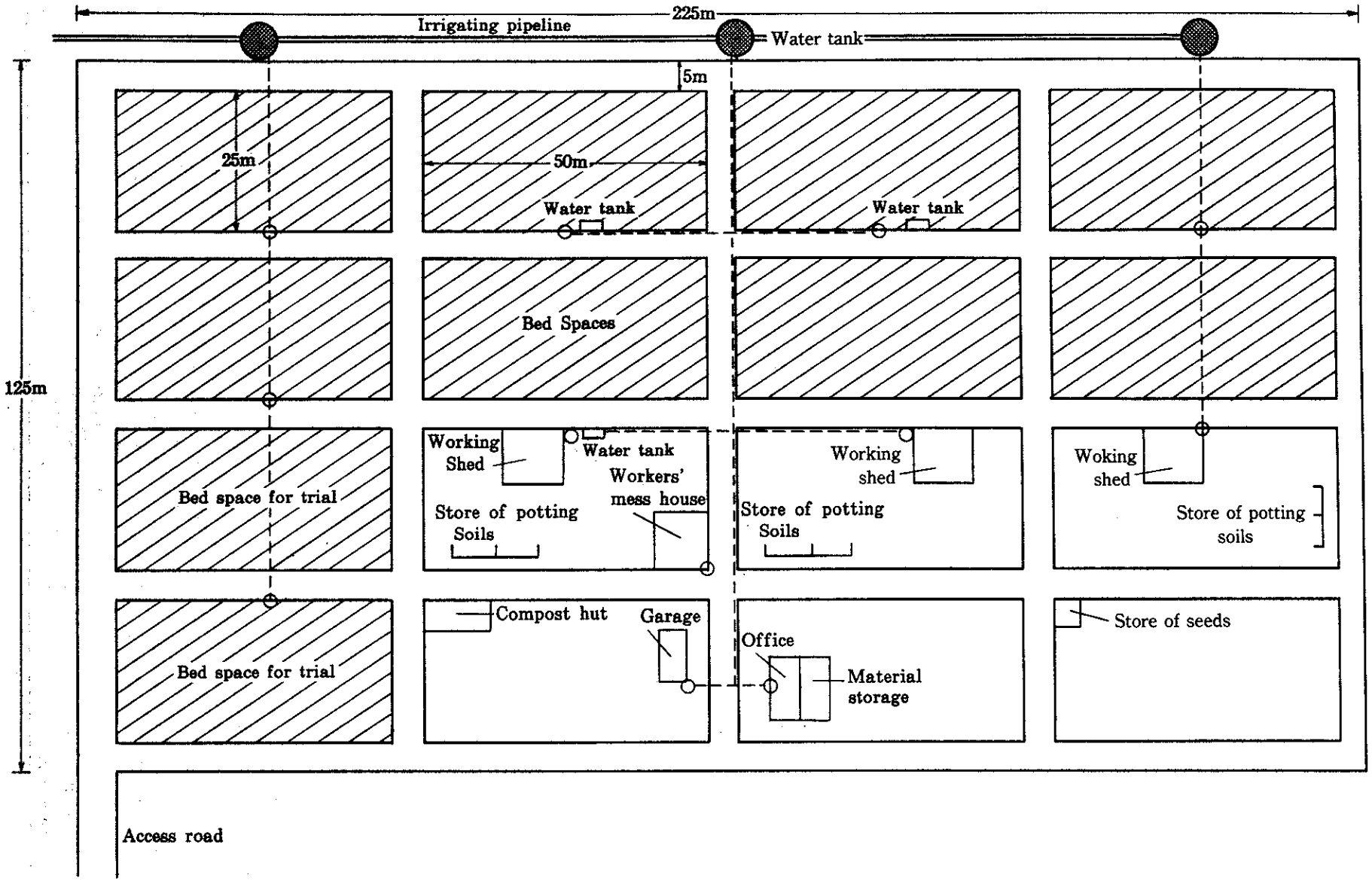


Fig. 6-3 Layout of Same Nursery (1 : 1,000)

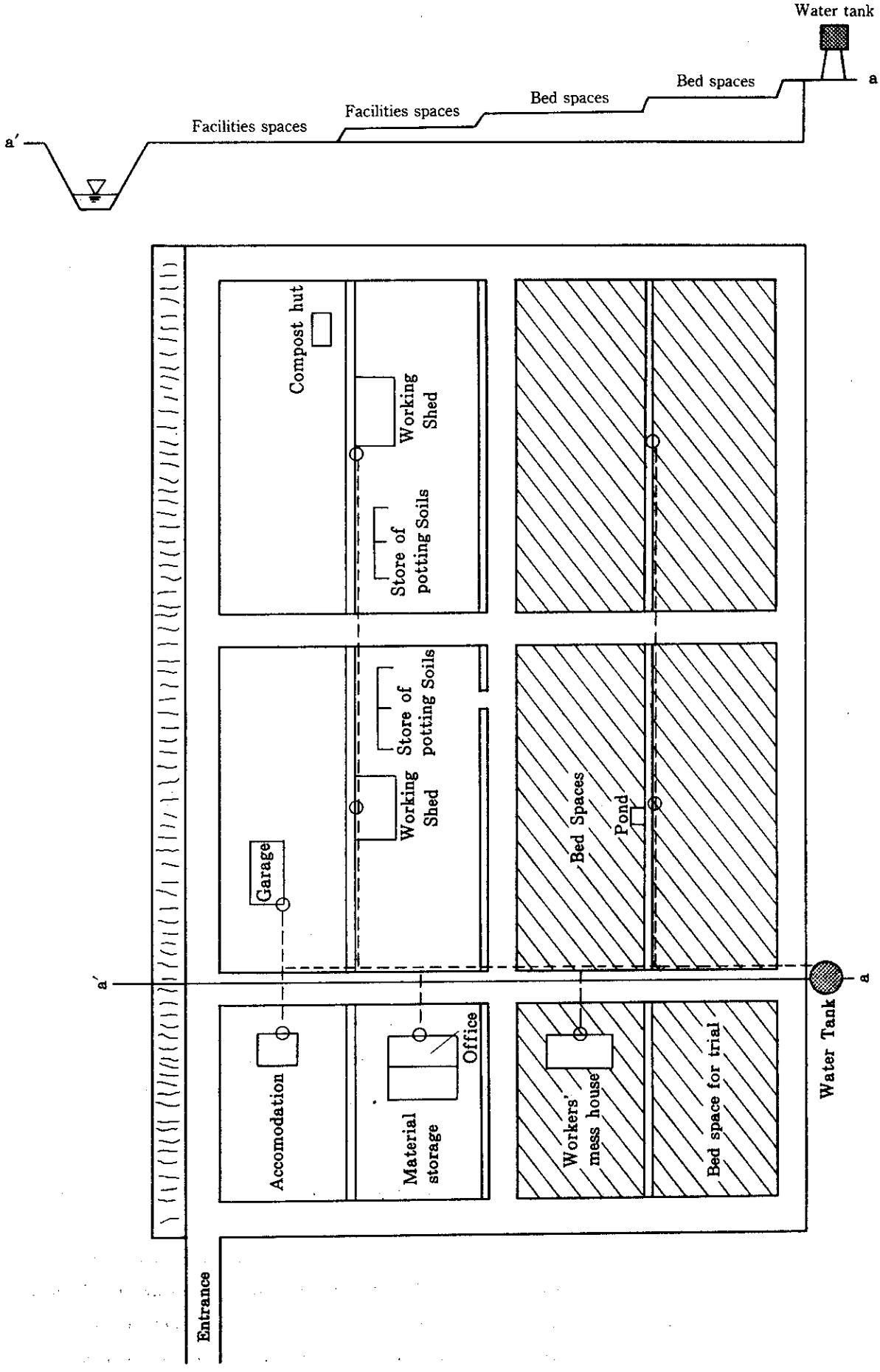


Fig. 6-4 Layout of Mwembe Nursery (1 : 1,000)

Table 6-12 Outline of Vehicles and Equipments for Nursery Management Plan

	Equipment	Brief specification	Quantity	Remarks
Vehicles and heavy machines	Farm tractor	68 PS	2	S 1 M 1
	Disc harrow		2	S 1 M 1
	Micro bus	Seating 26 persons	1	S 1
	Light goods vehicles	Pick up type, Loading 2t	2	S 1 M 1
	Motorcycle	90 cc	2	S 1 M 1
	Bicycle	—	4	S 2 M 2
	Belt conveyor	Length of belt is 10 m, With the engine	2	S 1 M 1
Equipments	Engine sprayer	0.25 HP	2	S 1 M 1
	Hand sprayer	Shoulder type	5	S 3 M 2
	Pumping equipment		2	S 1 M 1
	Tree carrying containers	0.5m × 1.0m × 0.5m	600 containers	S 400 M 200
	Shading materials	—	6,000 m^2	S 4000 M 2000
	Meteorological instrument	Thermometer, hygrometer, rain gauge, anemometer, sunshine recorder, etc.	2 sets	S 1 M 1
	Seed storage container	—	2	S 1 M 1
	Drying oven	—	2	S 1 M 1
	Seedling test utensil	—	1 set	S 1

S ; Same Nursery, M ; Mwembe Nursery

6.4.8 Forest Protection Plan

In the forest protection management in the model study area, countermeasures against grazing in the forest, forest fire, overcutting, etc. are important, and the success in afforestation and management depends upon the quality of these countermeasures.

① Countermeasure against forest grazing

In the model study area, the forest protection countermeasure against grazing in the forest is important. Overgrazing state beyond the forest carrying capacity is widely found in this area.

As the forest grazing contermeasures,

a. Forbidding grazing in important forests (conserved forest and forests during regeneration)

Grazing in conserved forests compacts the soil by tread pressure, promoted turning the earth surface into bare land and reduce infiltration rate into the soil, resulting in deteriorated function of the conserved forest, which function is for catchment and prevention of soil from flowing out. Also, grazing and especially grazing

of goats that browse on leaves is a formidable enemy for forest during regeneration period. If grazing is not thoroughly forbidden during regeneration, there will be no hope of success in the afforestation.

b. Guidance in proper grazing on general forest lands

Grazing in forest after regeneration will be permitted within proper limit is observed. Since, however, if overgrazing tends to occur, guidance should be given for proper grazing by watching out grazing trend. Since the introduction of fodder tree and grass into forests is important to increase the capacity, guidance should be given to the inhabitants accordingly.

Although this should be considered as the present countermeasure, however the comprehensive plan of agriculture, forestry and livestock raising is required in order to properly maintain the forest and savanna on the semi-arid zone in future. It is indispensable to establish proper grazing system such as control of the number of livestock to meet the grazing capacity of the sami-arid zone and the rotational grazing.

② Countermeasure against forest fire

The countermeasure against forest fire is important for forests since the management period is long. The causes for forest fire, are burning for the shifting cultivation and grazing, and an accidental fire from charcoal making on forest land, etc. When any afforestation project starts, outbreak of fire is expected.

As the countermeasures against forest fire,

a. Burning for land preparations and grazing is forbidden in the forest management area. Firing in preparation of lands should be made as few as possible. For this purpose, thorough education for preventing forest fire should be given to the inhabitants and the forestry interest.

b. Firebreaks will be established in order to prevent the spread of a fire from outside. The firebreaks are classified into three: firebreak (width 5 to 10 m) for fuelwood production forest boundary and forest reserve boundary, firebreak (width 20 m including roadbed) along the forest road and firebreak (width 12 m including roadbed) along the spur road, and will be located in order, in accordance with the progress of the afforestation. For the firebreak, it is necessary to make weeding.

c. Construction of watch towers and patrol in order to detect fire early. Since early detection of forest fire should be very important for forest fire extinguishing, supervision should be performed mainly during the peak period for forest fire occurrence (dry season). Especially places which is far from the villages, supervision should be performed using watching towers at two places. The patrol will be performed on foot or by vehicle through the firebreaks which are boundary with outside.

(3) Countermeasures against damage by disease and insects

Outbreak of disease and insect damage is common in an extensive phenome-

non in forests. For the prevention of the breeding and extermination, it is important to first diversify the risks and make efforts to prevent. The use of foreign tree species of which we have trifle afforestation experience and yet in small amount for afforestation causes serious damage once such damage by disease and insects breaks out. It is important to use not only foreign tree species but also many local species which are ecologically suitable and resistant to disease as much as possible.

Though the afforestation species which are to be used in this forest management plan is rarely damaged by disease and insects whice are especially risky, it is essential to detect early and prevent and exterminate early by paying attention to any occurrence of damage by disease and insects at all times.

For wild animals, there are a kind of small deer called "dig-dig" (*Rhynohotragus kirki*) which browse on leaves. Since damage of this type is likely to occur frequently as the plantation increases, it is necessary to study the countermeasures.

6.4.9 Forest Road Plan

Since there are trunk road (Moshi to Dar es Salaam), regional road (Same to Mwembe) and district road (Same to Ruvu Mferejini) as main roads in this area, it is comparatively easy to reach the subject lands in this Plan. These existing roads will be used and in addtion, the following forest roads and spur roads will be planned for forest management.

Table 6-13 Standards of Forest Road and Spur Road

Road type	Effective width	Shoulder width	Ditch width	Firebreak width	Whole way width
Forest Road	5 m	1.5m× 2	1 m× 2	5 m× 2	20 m
Spur Road	4 m	1 m× 2	1 m× 2	2 m× 2	12 m

The forest roads and spur roads will be provided in accordance with the forest management plan. In the expected plantation, both forest roads and spur roads will be such wide as to allow trucks to pass since a heavy load of personnel and seedlings and heavy machinery will be tranported. The forest road density is about 50 m per ha (including spur roads) in the man-made forest area.

In this area, the topography is almost flat, there are a lot of sandy soil and the road surface is not likely to be muddy. Since hardly rocky, it is easy to construct these roads using bulldozers. Since, however, there is concentrated rainfall during rainy season even in a semi-arid area and erosion occurs even on moderate slope because of concentrated flow water, it is necessary to provide gutters and transversal trenches in order to protect the road surface and road sides.

Also in order for both forest roads and spur roads to have a function of fire prevention as well, firebreaks will be provided on both sides. In the farmland windbreaks, forest roads and spur roads will be provided.

The annual plan for forest roads and spur roads is as follows:

Table 6-14 Annual Plan for Forest Road and Spur Road

(km)

Road type	Phase I	Phase II	Total
Forest road	15	25	40
Spur road	35	35	70

6.4.10 Related Facilities Plan

In order to implement the forest management plan, the management center will be established and the following facilities will be installed. The center will be located abutting at Same Nursery and its area is about 1.6 ha. The facilities placed in the centre are as follows (Table 6-15):

Table 6-15 Outline of Facilities for the Management Centre

Facility	Area (m^2)	Remarks
Management centre	350	Meeting room, training room, office room, etc.
Garage	150	
Heavy machinery shed	200	
Equipment storage	100	
Material warehouse	100	
Workshop	200	
Fuel house	50	
Accommodation for experts	220	Guest house capacity 8 rooms
Accommodation for counterparts	400	Capacity up to 20 persons
Watch tower	(2 towers)	Iron-made, height 6 m
Guards' house	20	

Fig. 6-5 shows the plan of the management centre and the major equipment related to this forest management plan are listed in Table 6-16.

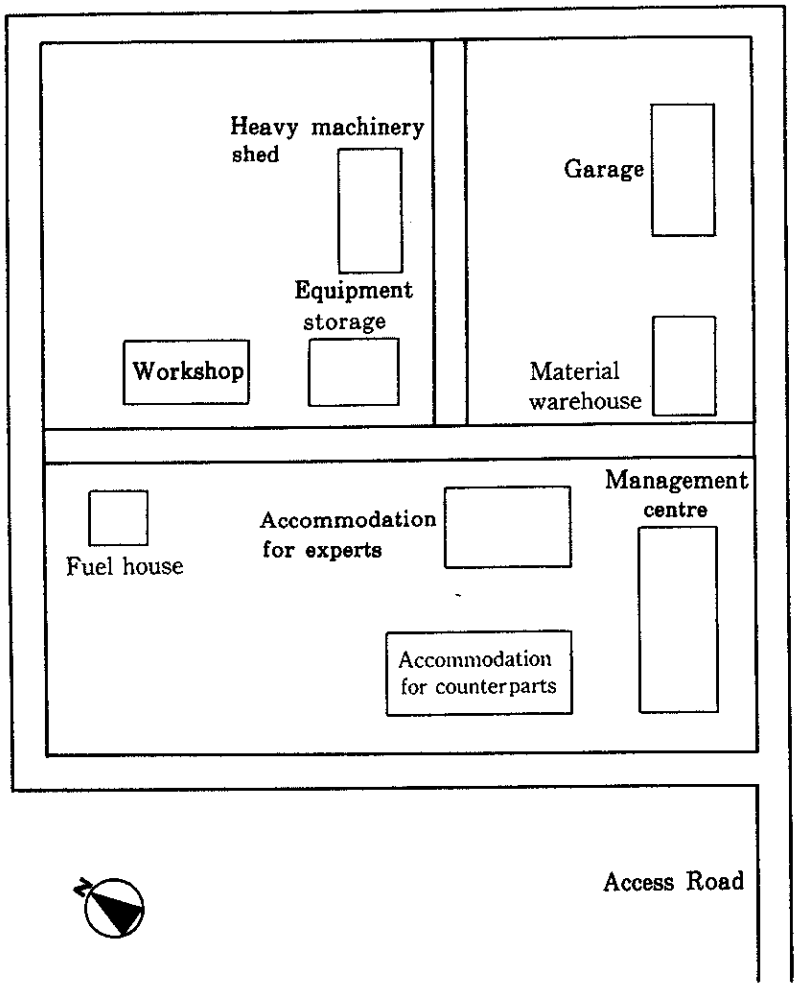


Fig. 6-5 Layout of Management Centre

Table 6-16 Outline of Major Machines for Management Centre

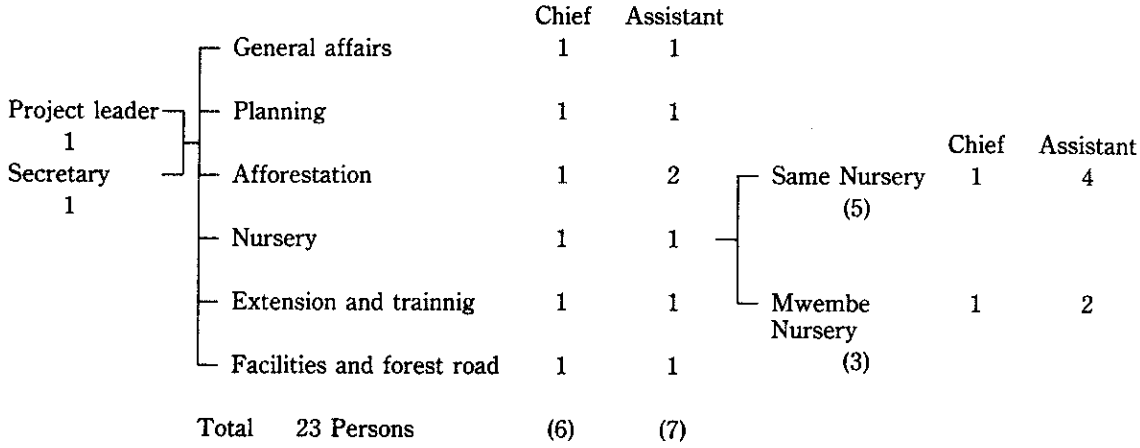
	Machines	Description	Quantity
Vehicles and Heavy machines	Bulldozer	16t	1
	Bulldozer	13t	1
	Bulldozer	6t	1
	Farm tractor	68 PS	1
	Micro bus	Seating 26 persons (3,400 cc)	2
	Dump truck	Loading 6t (Diesel)	1
	Cargo truck	Loading 4t (Diesel)	2
	Truck	Loading 2t (Diesel)	1
	Trailer	Loading 2t	2
	Tank truck	Loading 4t	1
	Disc Harrow	Wheel type	1
	Motor grador	115 PS	1
	Back-hoe	20 HP	1
	Automobile	4,000 cc, Station Wagon, 4WD	4
	Automobile	1,000 cc, 4WD	4
	Motorcycle	125 cc	4
	Bicycle	—	2
Equipments	Engine sprayer	0.25 HP	1
	Earth auger	Earth breaker DA20	10
	Chainsaw	40 cm ; 6, 50 cm ; 1	7
	Bushcutter	38 cc	12
	Radio system	—	1 set
	Walking talkie	—	5
	Binocular	—	3
	Hand pump	Shoulder type, Jet Shooter, 18ℓ	30
	Fire pump	Portable with 50 m hose	3
	Water tank	Collapsible, 5ℓ removable $5m^3$?	5
	Repairing equipment	In the workshop	1 set
	Soil analysis equipment	—	1 set
	Seedling test utensil	—	1 set
	Audio-visual aids	—	1 set
	Office utensil	—	1 set
	Office supplies	—	1 set
	Generator	—	2

6.4.11 Implementation System and Training Program

(1) Implementation system

As already described, important afforestation, watersource conservation and soil conservation enterprises have been organized and controlled as 3 projects in Tanzania. This forest management plan should be also operated as a project by mutual close cooperation of the country, region and district.

The organization and staff required to execute the management plan are considered as follows. (however, operator level is not included)



The implementation of the management plan will call for experienced forestry engineers but it would be difficult to locally recruit qualified personnel in Tanzania. Also, procurement of the facilities, equipment and materials, funds, etc. seems to be difficult through Tanzania's own efforts as mentioned before. Thus, human and financial assistance from foreign countries will be required like other important projects.

(2) Training program

To train those forestry engineers and local inhabitants who have little experience in afforestation of forests in semi-arid zone and extend the technique is very important to succeed in large-size afforestation by developing social forestry in this area. It is essential to study and expand the system for training and extension of afforestation and management techniques in semi-arid zone on the country or region level from now on.

In this forest management plan, technical training will be given to local forestry engineers, workers and inhabitants by the project staff as lecturer through the execution of the project for the time being in order to contribute to accomplishment of the management plan.

For local inhabitants, emphasis is placed on the responsible persons for village administration, persons in charge of afforestation, persons in charge of school afforestation and church afforestation in Same District as well as the model study area. Especially, participation of women will be promoted.

It is important that the training period should be such short as to facilitate participation and not long-term.For the engineers and regular operators, training on the spot shoud be centered to improve the techniques and skills (Table 6-17).

Table 6-17 Training Program

Training course / Object	General	Nursery	Afforestation	Machinery and civil engineering	Remarks
Local inhabitants	○	○	○		About 20 persons each course
Lower-grade engineer		○	○	○	3 to 7 days each time
Workers	○	○	○	○	Once or twice for each course

6.5 Establishment and Management Plan of Trial Forests

6.5.1 Objectioves and Contents

The trial afforestation plan was formulated as the first phase of the semi-arid forest management plan for the model study area, as stated previously.

The plan purpose is to develop and improve various forest establishment and management techniques suitable for semi-arid zone of Tanzania through the establishment and management work of trial forest, and to systematize these techniques. For this purpose, a trial forest plan, a nursery practice program, a forest road network plan, a training program and a related facilities plan, etc. described hereunder will be formulated. Even though the forest developed by the implemention of these plans and programs may be small in area, this project will serve as a model for the establishment of forests in semi-arid zone of Same District and promote afforestation in the future and thereby contribute to solving the problem of good supply of fuelwood. It would also be helpful to improve the local natural environment by preventing desertification, conserving lands and protecting villages as well as farming lands. The project is also expected to be developed as a social forestry project and lay the foundation for the development of the area.

These anticipated results would provide a guideline for the solution of problems which not only Tanzania but the whole of Africa are confronted with.

6.5.2 Establishment of Trial Forests

Of the techniques necessary for future forest administration and promotion of social forestry in the semi-arid zone, the following techniques will be developed on a priority basis through the trial forest project proposed hereunder.

- Afforestation techniques in semi-arid zone
- Natural forest working techniques in semi-arid zone
- Selection of tree species suitable for semi-arid zone
- Agro-forestry techniques suitable for semi-arid zone

① Establishment of man-made forests in semi-arid zone

In the light of the unbalanced supply and demand situation in fuelwood in semi-arid zone, the urgent establishment of large scale fuelwood plantations is urgently called for. However, the afforestation technique for semi-arid zone where severe conditions has not been developed adequately. Especially the mechanized afforestation technique and other technical systems adaptable to large scale afforestation have hardly been set up. Therefore, the following two themes will be taken up as the objectives of the technological development for the immediate future.

a. Systematization of large scale afforestation techniques

The study on mechanized afforestation techniques is primary importance. In the afforestation of semi-arid zone, it is necessary to plough and prepare soils adequately to allow increase infiltration rate and the permeability of the soils as much as possible, to contain its evaporation from the ground surface to a minimum in order to store it. In order to accomplish this, various water harvesting methods will be practiced, such as building levees along the contour lines, digging ditches, and digging large planting holes, all of which require a large manpower if this should be done manually in the consolidated soils of a semi-arid zone. The planting time is also limited in semi-arid zone because the rainy season there is short. What is more of cultivating their agricultural crops important is, this planting period overlaps with the farmers' busy season therefore it is often difficult to secure a large amount of manpower during this period. Mechanized afforestation is therefore adopted in many semi-arid zone where large scale afforestation is in progress and is achieving successful results.

For example, the "Méthode steppique", which was developed a long time ago in the semi-arid zone of North Africa and which achieved successful results in afforestation of semi-arid zone in West Africa, is the method of building levees along the contour lines by mechanical tilling and of planting trees on the slope of those levees. Afforestation in Tlaxcala Province in the central mountainous zone of Mexico was done by providing 60 cm wide, 60 cm deep ditches along the contour lines at intervals of every few meters by mechanical tillage and planting trees.

The method adopted in the FAO project at Baringo, Kenya is also to build levees after mechanical tillage and plant trees on a small block as a catchment area. In the afforestation of the devastated grassland in Panta Bangan in the Philippines, too, stripped tilling by machinery is practiced. All of the above are the cases in which rain water is caught, and its percolation into the ground is enhanced by mechanical tillage, so as to improve the planting results remarkably and reduce the cost of afforestation.

If the wage rate is lower and manpower can be easily secured, however, the cost of manual afforestation is lower than the cost of mechanized afforestation.

According to the result of a trial estimate, mechanzied afforestation costs more in the case of this area.

However it is expected to have the social benefit of increasing employment opportunities for local inhabitants. One of the important aspects of social forestry is to let the inhabitants acquire the afforestation technique through employment and promote their self-reliance in afforestation. Accordingly, it would not be better to adopt complete mechanized afforestation right away. But, there is no doubt that mechanized afforestation would become an indispensable technique for afforestation in semi-arid zone in the near future.

In this implementation of the trial afforestation project a technique which combines manual work and mechanizing land preparation will be studied. Specifically, mechanized afforestation will be tried out with main emphasis on stripped tillage with a bulldozer mounted with rippers along contour lines adopted at the afforestation of Panta Bangang in the Philippines with digging planting holes (40 cm in diameter, 50 cm in depth) either by manual work or by a small portable machine.

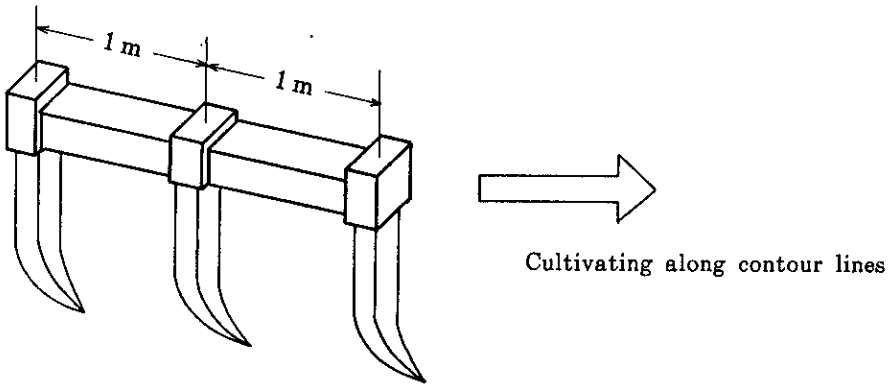


Fig. 6-6 Ripper ; One of the Attachment for Cultivating Machine

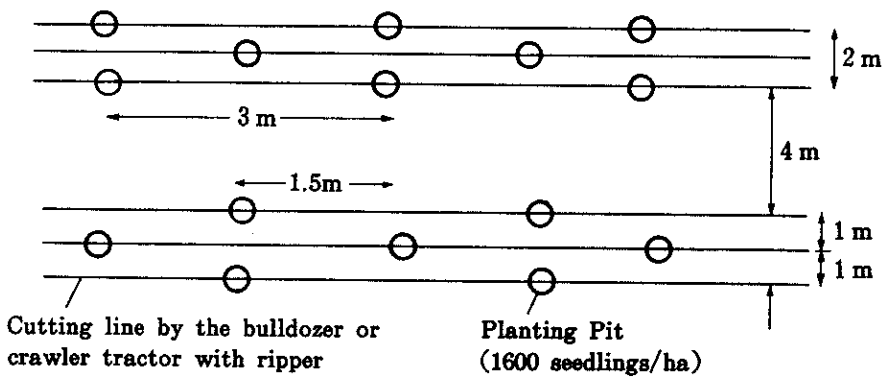


Fig. 6-7 Strip Cultivation and Spacing

Tree species to be adopted for large scale afforestation will be limited only to those which hold high potentiality. 40 ha of land which comprises Class I site and Class II site equally will be afforested by each species. The following seven species for fuelwood are considered to be the likely candidates for this area.

Acacia albida, A. tortilis, Albizia lebbek, Cassia siamea, Eucalyptus camaldulensis, Leucaena leucocephala, and *Syzygium cumini.*

Table 6-18 Annual Program for Experiment of Large Scale Afforestation

(Unit : ha)

Year	1	2	3	4	5	Total
Experiment of large scale afforestation	—	40	80	80	80	280

Note ; 7 tree species will be tested for 40 ha each species and each 40 ha of lands comprises Class I site and Class II site

b. Standardization of semi-arid zone afforestation techniques

Having had only little experience in afforestation, the semi-arid zone afforestation techniques have not been thoroughly established as practically workable techniques in Tanzania yet. Particularly the following major technical items must be reexamined through implementation of this project and must be standardized as the techniques for semi-arid zone of Tanzania, especially this area.

Land preparation technique:

The land preparation method of removing vegetation completely in order to prevent loss of water from the forest land is commonly adopted in afforestation of semi-arid zone. However, in wooded savanna and the like, the method of saving scattered trees (having d.b.h. of 5 cm or more, for example) regardless of their species and planting into them as shelterwood or the method of leaving shelterwood in belt form and preparing the land in line or belt ought to be considered.

Irrigation method:

The methods for water harvesting are also important techniques in land preparation of semi-arid zone. Water harvesting methods such as building of simple levees and digging of ditches must be developed for flat areas in relation to digging of planting holes separately from the water havesting methods for mechanized afforestation.

Further, watering at the beginning of the first dry season after planting is naturally useful greatly for existence and growth of the planting trees. The study of an effective watering method with a small amount of water is an important problem in afforestation in semi-arid zone in future. The following system is considered as one of methods in this area.

Establish a reservoir near the plantation by utilizing a swamp where water remains during rainy season, store rainwater there temporarily during rainy season

and send it to water storage tanks provided at various places in the plantation for storage.

Though it is difficult to store sufficient water throughout the whole dry season, according to this system an effect of extending the rainy season and an effect of preparing against the fluctuation in rainfall can be expected.

In order to use a small amount of water effectively, a method (sub-soil watering) in which a pipe is inserted into the land up to about 30 cm deep to directly water the sub soil should be also studied.

Planting techniques:

While planting spacing of 2.5×2.5 m to 3.0×3.0 m are considered to be normal, the standard spacing for this area must be studied in consideration of the characteristics of species to be planted and the differences in site conditions. Also, while the standard size of planting hole is generally deemed to be 30 to 40 cm in diameter and 40 to 50 cm in depth, the standard size of planting hole for this area must be studied. Also, in relation to the land perparation methods, planting methods for underplanting, line planting and belt planting must also be studied.

In cases where the forest is already devastated and there is no tree which can be left as shelterwood, it should also be necessary to try out the method of planting tree species as shelterwood which are strong against drought and which grow fast even though they may not be useful, and later, if they survive, use them as shelterwood and plant useful tree species.

It is considered important to mulch the bases of planted trees in afforestation of the semi-arid zone in order to retain as much soil moisture as possible around the roots of those trees. A study on mulching techniques and material must be examined.

Regeneration techniques:

When a man-made forest has been established and the time for its rageneration comes, not only the system of regeneration by clear cutting but also by coppicing are important.

Tree species for the production of fuelwood suitable for sprouting regeneration must be selected and its regeneration methods for the same should be studied. In short rotation fuelwood production, the clear cutting system is not necessarily desirable from the viewpoint of conservation of forest land depending on the condition of that forest land. Regeneration by the selective cutting system of the two-storied forest system should therefore be studied, too.

Direct seeding is one of the regeneration techniques. Some successful afforestation cases by this technique were observed with the planting species; *Acacia, Eucalyptus, Azadilachta indica* and *Cassia siamea,* which are adopted in this area. Accordingly the direct seeding should be studied as a cheap alternative of the regeneration techniques though it would have a disadvantage of the irregular stocking.

Nursery Practice Techniques:

The accomplished results of nursery practices in this area have been mostly for raising seedlings for afforestation at high altitudes, and the operating scale of nursery has also been small. When forest development in this area makes great strides in the future, production of some hundred thousand seedlings per nursery will become necessary. For this purpose, techniques for raising seedling on a large scale must be gradually integrated and estblished as a system.

Table 6-19 Annual Program for Standardization Experiment of Afforestation Technique

(Unit : ha)

Year	1	2	3	4	5	Total
Standardization experiment of afforestation technique	—	10	10	10	20	50

Note ; 5 tree species will be tested for 10ha each tree species. Experiment of seedling cultivation will be practiced in each nursery.

The standards for seedlings must be reexamined urgently in the nursery practice. Since planting conditions are unfavorable in semi-arid zones, standards for seedlings that withstand drought ought to be standerdized according to the characteristics of each tree species and the characteristics of each site. In view of the above, seedlings should be sorted into classes by either their basal diameter or the ratio between tree height and basal diameter and their survival and growth should be compared by each class. The pot size is mostly 8-10 cm in diameter and 15-20 cm in length, but it should be reexamined on the standards for seedling classes.

The study of stump is important to reduce the afforestation cost. Since there is an example of having succeeded in planting stumps of genera such as *Acacia, Azadilachta, Cassia, Eucalyptus, Dalbergia* including the desired afforestation tree species in this area, there is a possibility in this area.

As keeping with the diversification of planted tree species, the composition of soils for pot, methods of watering and sun-shading, method of hardening off of seedlings prior to planting-out, etc. must be improved. Particularly in response to the requirements of social forestry, it would be necessary to study the nursery practices method of raising seedlings of fodder trees, soil improving trees and fruit trees, too.

In studying the standardization of afforestation techniques, it is necessary to select one species each from *Acacia* group, *Cassia* group and *Eucalyptus* group and add two species of *Leucaena leucocephala, Azadirachta indica* to them, and specify those five species as standard seedlings and test them one by one.

c. Selection of tree species suitable for semi-arid zone

15 planting species will be presently selected from the proposed afforestation

tree species for semi-arid zone and examined for possibility of planting in the project area. The afforestation work will be manually carried out in accordance with the stadardized silvicultural method.

It is desirable that trial forest should be set up for demonstration and extension purposes at a place suitable and the area allocated for a tree species shall be 4 ha.

Table 6-20 Annual Program for Experiment of Tree Species Selection

Year	1	2	3	4	5	Total
Experiment of tree species selection	—	10	10	20	20	60

Note ; 15 tree species will be tested for 4 ha each species and each 4 ha of lands comprises class I site.

The tree species to be planted are listed in the following Table 6-21, but further examination shall be made on other tree species not contained therein basing upon any additional investigation works.

Table 6-21 List of Tree Species to be Planted

	Species	Uses														Provenance		Seed supply		Coppice potential
		Fodder	Timber	poles	Fuelwood	Cash crop	Fruit	Charcoal	Soil improvement	Land reclamation	Shade for homesteads	Shade for crops or animals	Animal barrier	Ornament	Medicinal	Exotic	Indigenous	Seed from Lushoto silviculture Research	Seed locally collected	
1	Acacia albida	◎	○	○	○		○	○	◎			◎	◎		○		V	V	V	
2	A. nilotica	○			○			○	○			○	○				V		V	
3	A. tortilis	◎	○		◎		◎			○							V		V	
4	Afzelia cuanzensis		◎														V		V	
5	Albizia lebbeck	◎	○		○				◎			◎					V		V	
6	Annona intocarupus				○		◎										V		V	
7	Azadirachta indica		○	○	◎					◎	◎			○	◎	V			V	
8	Carica papaya					○	◎								○		V			
9	Cassia siamea		○	○	◎				○	○				◎	○	V			V	
10	C. spectabilis			○										◎		V			V	V
11	Casuarina cunninghamiana		◎		◎				◎							V			V	V
12	C. equisetifolia		◎	◎	◎			◎	◎	◎				○		V		V	V	
13	Eucalyptus camaldulensis		○	○				○								V		V		
14	E. citriodora		○	○												V		V		V
15	E. tereticornis		○	○												V		V		V
16	E. zanzibar		○	○				○								V		V		V
17	Ficus benjamina										○						V			V
18	Leucaena leucocephala	◎		○	◎				◎	◎						V			V	
19	Mangifera indica				○	◎	◎	○			◎	◎			○	V			V	
20	Parkinsonia aculeata	○			◎			○		◎			◎	○		V			V	
21	Prosopis chilensis	◎		○	○							○					V		V	
22	P. uliflora	◎	○		○				◎								V		V	
23	Psidium guajava	◎			○		◎								○	V			V	
24	Rauvolfia caffra	○		○	○					◎		○			◎		V		V	
25	Syzygium cumini	○			○		◎				◎					V			V	
26	S. jamboe	○			○		○									V			V	
27	Tamarindus indica		○		○	○	◎	○	◎								V		V	

◎ ; Most suitable
○ ; Suitable

Also, 30 ha of seed orchard and arboretum should be afforested in the vicinity of the Same tree nursery in a hurry.

② Natural Forest Improvement Techniques

Natural forest utilized as production forest are selectively cut down from time to time but many of forests and woodlands need improvement of forest type.

In the trial forest enterprise, an improvement test for natural forests by planting in the forest, etc., will be planned in dry deciduous forest Dd (h_1) and Dd (h_2) with high productivity and relatively good forest type.

Table 6-22 Annual Program for Improvement of Natural Forests

(Unit : ha)

Year	1	2	3	4	5	Total
Experiment of improving	–	–	10	20	20	50

The tree species to be planted shall be preferably selected among the useful trees dominant in the natural forest under study. But, since we have not enough experince in nursery operation of such trees, *Acacia tortilis* or *A. albida* one of the major useful trees in this region shall be planted up to the time when the production of seedlings of many useful trees becomes practicable.

The planting shall be made as groups at the rather scattered places in the forest. The number of planting trees shall be decided in view of the forest type of the planting place but shall not exeeced 800 seedlings per ha.

The planting shall be made manually in the same manner as seen in the afforestation works. Grazing in the newly planted area shall be strictly prohibited for the first 5 years after planting.

In addition to the natural forest improvement as above, natural regeneration investigation area shall preferably be set up in natural forest and savanna to observe the succession when any activities of human and/or animals are excluded and grazing and felling are strictly controlled. Such investigation area shall be decided in consideration of the vegetation and convenient management basing upon the field survey.

③ Establishment of agro-forestry and silvo-pastoral system

The trial forest program sets its objectives at the following items for agro-forestry and silvo-pastoral system which are significantly useful as essential parts of social forestry:

- Establishment of windbreaks
- Establishment of fodder tree forest for demonstration purpose.
- Production and distribution of seedlings for agro-forestry and silvo-pastroral system

The windbreaks shall be also afforested at Unit ① located at the western part of Koko Hill in accordance with the plan written below.

Since the production of firewood and charcoal shall be also carried out at the windbreaks, a larger width of 40 m is decided for effective production and regeneration of them. The windbreaks will constitute 15-row tree line at the spacing of 2.7 m × 2.7 m and be regenerated one-third at a time.

The tree species to be planted shall be *Cassia siamea* and *Eucalyptus camaldulensis*. The rows of the windbreaks will be arranged 200 m by 200 m in square style. (The distance of 200 m is decided by the effective range of the windbreaks

based on the tree height multiplied by 20. Here 10 m is assumed as the tree height.)

Approximately 50 ha of trial forest shall be planted under the following program and the trial forest shall be gradually expanded thereafter.

Table 6-23 Annual Program for Establishment of Windbreaks

(Unit : ha)

Year	1	2	3	4	5	Total
Afforestation area	—	—	15	15	20	50

Establishment of fodder tree forest shall be made at Unit ⑤ (Mwembe settlement) to promote production of fodder as well as production of fuelwood. The fodder tree forest is planned to have approximately 10 ha area and *Leucaena leucocephala* will be the tree species planted. This forest shall have the demonstration purpose and be designed as a model of communnal use.

On top of the several afforestation measures made under this project, any voluntary afforestation efforts among farmers and peasants are strongly desired for effective maintenance of various types of forest, and production and distribution of seedling is also to support farmers and peasants under this program. The seedling production program is established on the basis that 10 pieces of seedling shall be distributed to and utilized by one inhabitant per year.

Although detailed production and distribution programs shall be studied and established for each tree species basing upon thier usage, seedling of following tree species selected basing upon the information obtained by interview on the inhabitants will be produced and distributed for the project period. The selected species include those for fruit tree and for medicinal use.

④ Improvement of conservation forest and forest reserve

It is commonly acknowledged that the forest management in the semi-arid zone indispensably requires maintenance of conservation forest. The strict limitation of grazing and deforestation may lead to the recovery of the forest. In particular, the declined function of conservation of water catchment and prevention of soil erosion usually observed in the conservation forests close to settlements shall be restored in a shorter period of time, and tree planting and civil enginnering works shall be carried out therefore.

For the purpose of soil erosion prevention, tree species having soil improvement effect such as *Acacia tortilis, Acacia nilotica, Leucaena leucocephala* shall be planted. Grooving and/or terrace creation works may be carried out, if necessary, in devastation and denuded area. In view of the demonstration effect of this project to the inhabitants, our efforts shall be managed intensively Koko Hill Forest Reserve (Unit ②) and 10 ha of conservation forests around Mwembe town (Unit ⑤).

For restoration of water conservation ability of the forest, our efforts under this project shall be directed to improvement of 20 ha of forest located at the northern end of Chambogo Forest Reserve which dominates the water resource of Unit ②. Afforestation shall be made in the same manner as aforesaid for the improvement of natural forest.

The importance of the maintenance of land conservation forest at the bank of river shall also be noted as discussed in "Forest Management Plan", and afforestation maintenence work shall be carried out at 10 ha Unit ⑤ presently. The tree species to be planted shall be selected from the local ones.

The preparation of town environment of expanding Same town is also one of the most important issues for the development of the region.

In this plan, planting roadside and in the parks was drawn out. Trees will be planted along roads and part of railways in the Phase I.

For national highways, 2-row tree lines of 5.0 m width shall be planted on both sides of the highways with one tree at the spacing of 5 m × 5 m, while 4-row tree lines of 10 m width with the same spacing shall be planted at the east side of the railways. The tree species to be planted shall be *Cassia siamea, Azadilachta indica, Eucalyptus camaldulensis* and similar species. Any measures shall be adopted for complete prevention of eating damage due to grazing especially for tree lines on the highways.

In addition, production and distribution of seedlings shall be planned for tree planting activeties led by the inhabitants. The target number of seedlings to be distributed shall be 10 pieces per capita per year.

The improvement program of conservation forest and forest reserve shall be as follows for the Project period:

Table 6-24 Annual Program for Improvement of Conservation Forests and Forest Reserves

(ha)

Forest type \ Year	1	2	3	4	5	Total	Remarks
For land conservation *			5	10	15	30	Unit ②, ⑤
For conservation of water catchment			5	10	5	20	Unit ⑥
Planting roadside * *			5	5	10	20	Unit ②
Total			15	25	30	70	

* Forests at the bank of rivers are included.

* * The area of planting roadside is calculated by the planting density.

⑤ Annual program for establishment of trial forest

The afforestation program of trial forest under this project shall be as follows:

Table 6-25 Annual Program for Establishment of Trial Forest

(ha)

Forest type \ Year	1	2	3	4	5	Total
Experiment of large scale afforestation		40	80	80	80	280
Experiment of techniques standardization		10	10	10	20	50
Experiment of tree species selection		10	10	20	20	60
Experiment of natural forest improvement			10	20	20	50
Establishment of windbreaks			15	15	20	50
Establishment of fodder tree forests				5	5	10
Improvement of conservation forest and forest reserves			15	25	30	70
Establishment of seed orchard and arboretum			10	10	10	30
Total		60	150	185	205	600

6.5.3 Nursery Management Plan

In order to supply, as described already, seedling required for the forest management plan in the model study area,it is necessary to newly establish Same Nursery and expand Mwembe Nursery so that both nurseries share the required quantity for production.

The nursey practice plan required for the present trial forest is as follows:

(1) Seedling production plan

The annual program for seedling production to meet the afforestation plan for the trial forest is as shown on the following Table 6-26. The production is shared by Same Nursery and Mwembe Nursery at the rate of 75% and 25% respectively.

(2) Seedling cultivation method and operation schedule

The nursery practice technique for large scale afforestation in the semi-arid zone has, as described above, not been fully established. For this reason, numerous experiment of seedling cultivation are still required. However, this plan adopts the following nursery practice method for the time being.

a. For raising the seedlings, poly-pot seedling is used. The pot is 15 cm in circumference (4.8 cm in diameter) and 15 cm in height, made of black polyethylene.

b. The outline of the growing procedure is as shown Fig. 6-8.

c. Seeds for the planned tree species will be collected locally of from the Silviculture Tree Research Institute (Rushot), sample plantation and part of foreign tree species will be collected from overseas. The provenance of the seeds shall be clearly recorded.

d. For the potting medium, a rate of mountain soil 5; river sand 3; compost (cow manure) 2 is used. For the mountain soil. Surface soil which is rich in humus will be collected and stored after being dried in air. The compost (cow manure) will be completely matured.

Table 6-26 Annual Program for Seedling Production*

Forest \ Year	1	2	3	4	5	Total	Remarks
Experiment of large scale afforestation		77	154	154	154	539	1600 seedlings /ha
Experiment of techniques standardization		19	19	19	38	95	1600 seedlings /ha
Experiment of tree species selection		19	19	38	38	114	1600 seedlings /ha
Experiment of natural forest improving			10	19	19	48	800 seedlings /ha
Improvement of conservation forests and reserve forests			18	30	36	84	1000 seedlings /ha
Establishment of windbreaks			29	29	39	97	1600 seedlings /ha
Establishment of fodder tree forests				9	9	18	1600 seedlings /ha
Establishment of seed orchard and arboretum			12	12	12	36	1600 seedlings /ha
Experiment of seedling cultivation		12	12	12	12	48	
(Sub—total)		(127)	(273)	(322)	(357)	(1079)	
For distribution to inhabitants		185	190	196	202	773	
(Total)		(312)	(463)	(518)	(559)	(1852)	

* The number of seedlings for cultivation increased by 20%

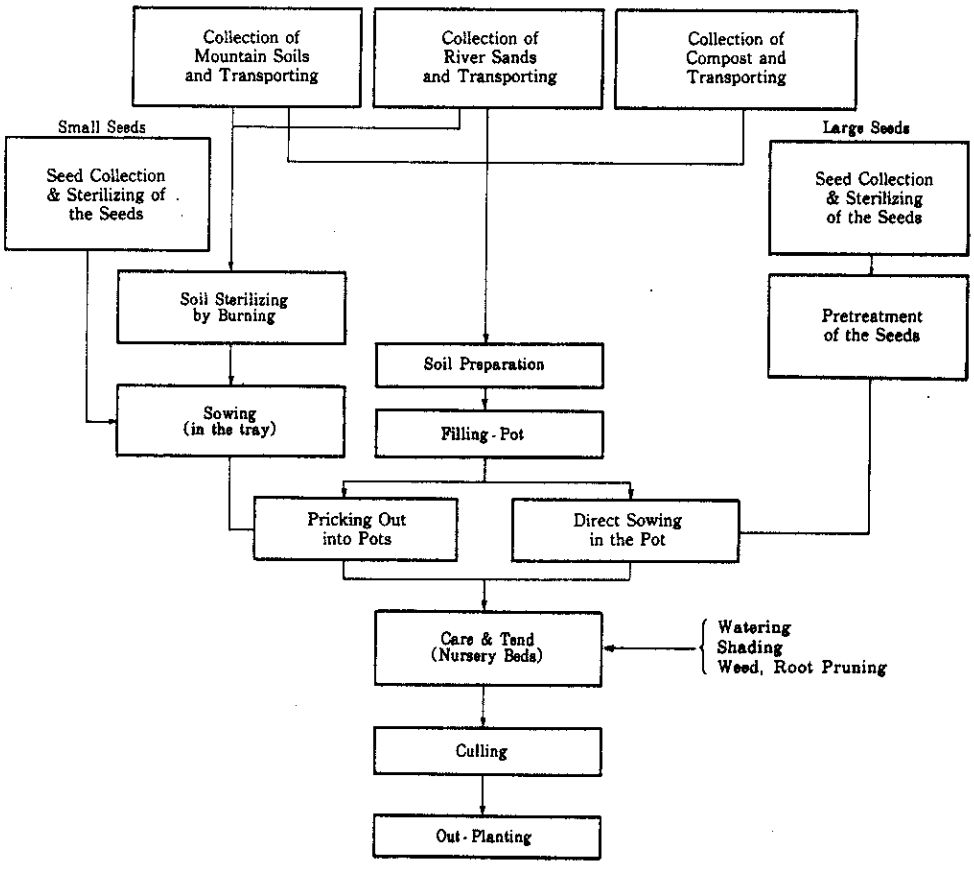


Fig. 6-8 Procedures for Seedling Cultivation

e. For tree species with large-size seeds such as *Acacia* and *Cassia*, direct sowing is performed in the pot. (2 or 3 grains will be rogued after germination). For tree species with small-size seed such as *Eucalyptus*, sowing is performed in a sowing tray and the seedling will be trasplanted into a pot after germination.

f. Watering is perfomed about twice a day (6 mm/day) in dry season as a standard, however should be adjusted according to the season and weather to prevent excessive watering. Especially before the planting season, watering should be reduced to harden-off the seedlings. The seedlings should be shaded from the sunshine for two to three weeks after germination or transplanting. If a direct root from the pot seedling come out of the bottom, the roots will be cut.

g. For a standard for seedling, the length of seedling of 20 to 30 cm is determined as the objective and sound seedling free from damage by disease and insects which is well-balanced between length and diameter of the seedling should be selected for planting.

h. The seedling operation schedule is as follows:

There are two rainy seasons: short rains from the middle of October to December and long rains from March to May in this area. Both planting time and seedling growing period are separated to two seasons according to these rainy seasons, but the main planting season is March to April. Seedling cultivation is also performed in accoudance with it.

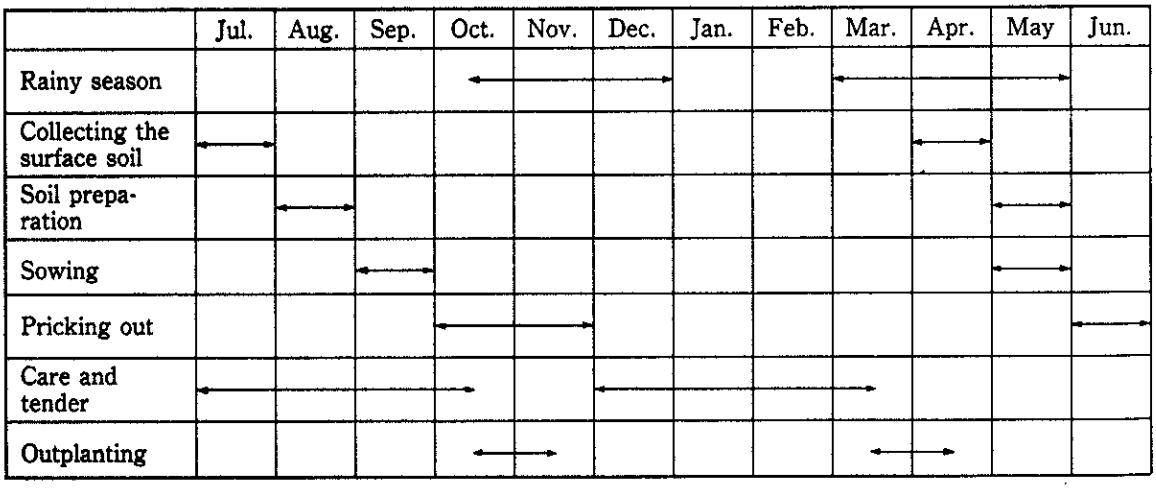


Fig. 6-9 Nursery Operations Schedule

6.5.4 Forest Protection Plan

In the forest protection and management for this area, measures against overgrazing and forest fires are the most important. These basic requirements have already been studied in the forest management plan and will be implemented through establishment of trial forests.

Measures against forest fires consist mainly of constructing firebreaks. These firebreaks comprise fire belts (5 to 10 m in width) to be provided as boundaried in fuelwood production forests and forest reserves, forest road firebreaks (20 m in width, including road bed) and spur road firebreaks (12 m in width, including road bed). These firebreaks will be built with progress in afforestation. Road firebreaks will be built under the forest road plan to be described later. Boundary firebreaks will be built preferentially on crop land and woodland boundaries, and along main roads under the following implementation plan. Erection of watch towers will be planned for early discovering of outbreak of forest fires.

Table 6-27 Annual Plan for Construction of Firebreaks

Year	1	2	3	4	5	Total
Firebreaks* (km)	10	15	15	10	10	60
Watch towers (place)	1	1				2

*Boundary firebreaks only

Important measures against forest fires also include increased patrolling, education of residents in prevention of forest fires and provision of fire fighting equipment.

Measures against excess grazing mainly consists of restrcition of grazing in conservation forests and forests in regeneration period, and both surveillance and guidance on grazing such as instruction on proper grazing in ordinary woodland.

For this prupose, efforts should be made to obtain understanding and cooperation from local residents, particularly grazing farmers when trial forests are developed.

Disease control is another important task. In a vast expanse of forest both diversification and prevention of risks are important. For this reason, it is desirable that diverse tree species, particularly indigenous species, should be planted.

6.5.5 Forest Road Plan

Forest roads and spur roads are indispensable to forest management. Road construction using bulldozers, etc. is easy in this area because the terrain is flat, the soil is abundant in sandy loam with little likelihood of becoming muddy, and rock is also scarce. Under the foresty management plan, the density of forest roads has been set to 50 to 60 m/ha.

As per their specifications already mentioned, forest roads and spur roads are designed to have a total width of 20 m and 12 m, respectively, to concurrentry serve

as fire belts.

Although the annual precipitation in semi-arid zone is limited to less than 600 mm, there are heavy rainfalls in the rainy season. Thus, heavy soil erosion is observed in topography where rain water concentrates. Therefore, road sections in such areas will be provided with side gutters, as well as transversal gutters, to prevent concentration of rain water.

Forest roads and spur roads will be constructed with progress in afforestation and woodland improvement projects under the forest management plan. The annual implementation plan for this road construction is as follows:

Table 6-28 Annual Plan for Construction of Forest and Spur Roads

Year	1	2	3	4	5	Total
Forest roads (km)	3	4	4	2	2	15
Spur roads (km)		10	10	8	7	35

6.5.6 Related Facilities Plan

Various facilities including the management center and major pieces of equipment such as vehicles have already been planned under the semi-arid zone forest management plan. These facilities and machines are required to start the plan for establishment of trial forests. Consequently, they must be provided along with facilities and machines involved in nursery in the initial year of the trial forest establishment plan as one of the pre-conditions for successful implementation of this plan. The preparatory period for provision of these facilities and machines is very short. It is anticipated that the preparations may take time depending on particular local situation. This point should be fully taken into consideration when decision is made on the plan for provision of facilities and equipment.

6.6 Preparation of Maps for the Semi-arid Forest Management Plan

Total 11 sheets of the project map were produced on a scale of 1 : 5,000 to show both the semi-arid forest management plan for establishment and management plan for trial forest about 20,000 ha of the model study area as described in the preceeding paragraphs.

The reduced scale copies of these map sheets are attached to this report as an appendix. These management maps show:

1. Classification of management units
2. Suitable site for social forestry by each management units
3. Various programs to be undertaken under management plan for trial forest as the Phase I (5 years) of the forest management plan. The programs include establishment of trial forest, nurseries, and forest roads, and construction of management center.

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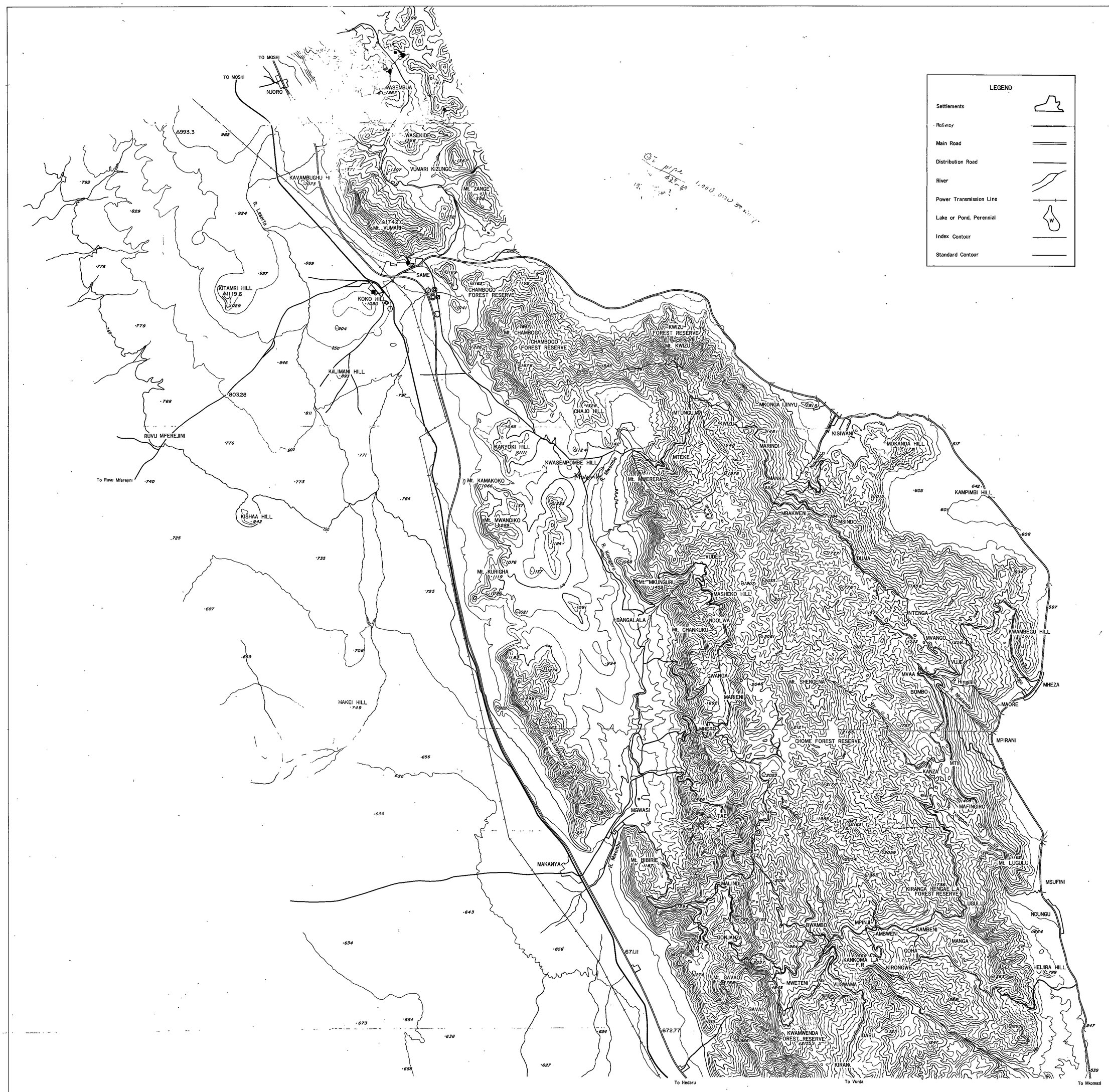
Map for the Semi-arid Forest
Management Plan (1:20,000)
Map of the Study Area (1:100,000)

THE STUDY OF THE DEVELOPMENT SURVEY FOR EXPANDED AFFORESTATION WORK IN SAME DISTRICT OF KILIMANJARO REGION, THE UNITED REPUBLIC OF TANZANIA



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