2.2 Preparation of Topographical Maps

(1) Topographical Maps of Study Area

1) Map Preparation Method

Topographical maps of the Study Area were prepared in the following manner for use as the base maps for the land use and vegetation maps (scale: 1/25,000) of the Study Area. The same topographical maps were also used as the base maps for the soil maps (scale: 1/25,000) of the Pilot Areas.

Firstly, the existing topographical maps (scale: 1/50,000) prepared by the INEGI from 1984 to 1987 were twice enlarged and contour lines, rivers and ground objects, etc. were transcribed on the enlarged maps. Roads and settlements were corrected using the photographs taken this time. Editing and drawing were then conducted to complete the process. The total coverage of the topographical maps was originally some 160,000 ha as agreed in the S/W but was increased to some 190,000 ha to include additional areas as explained earlier to match the coverage of the land use and vegetation maps.

2) Boundaries of Topographical Maps

The boundaries of the new topographical maps were decided as shown in Fig. 2-2-1 to maintain compatibility with the INEGI's existing topographical maps (scale: 1/50,000).

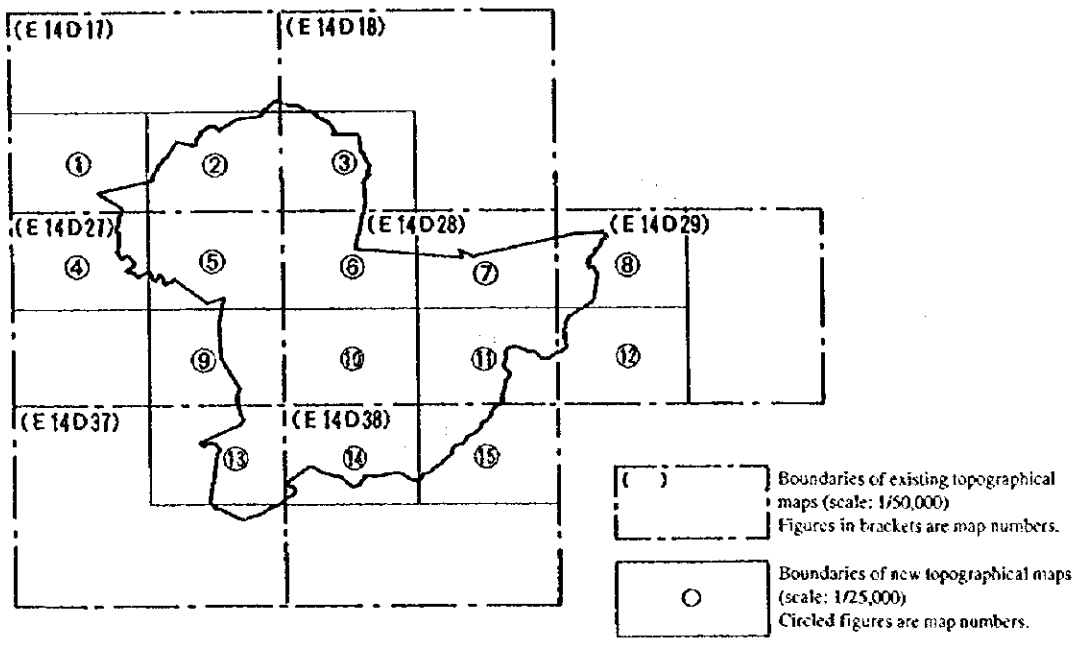

Fig. 2-2-1 Boundaries of Topographical Maps

(2) Topographical Maps of Pilot Areas

The SIGSA which conducted the aerial photography in Phase I was subcontracted to conduct the following ground surveying and plotting work in the comunidades of some 20,000 ha in the Pilot Areas to prepare the topographical maps (scale: 1/10,000).

1) Ground Surveying

Ground surveying was conducted for the photo-orientation which was necessary for the plotting of the topographical maps (scale: 1/10,000). As no existing control points existed in the subject areas, three existing control points in neighbouring areas were used as orientation points to establish two secondary control points in the subject areas and observation was conducted at a total of 40 points. Meanwhile, five bench marks along the neighbouring national road were incorporated in the observation network as part of the levelling work to determine the elevation and the elevation of each point was calculated using the network average calculation technique. All of the observation points were pricked on the aerial photographs (scale: 1/25,000).

2) Plotting

a. Aerial Triangulation

Aerial triangulation was carried out using 118 aerial photographs. A total of 575 photo-orientation points of 91 models were observed by the WILD AVIOLYT AC-1 analytical plotter and the 3-D coordinate values of each point were calculated by block adjustment computation using the bundle method.

b. Plotting

Plotting was conducted using the WILD B-8 plotter based on the observed topographical features and ground objects shown on the aerial photographs. The observation data underwent the analogue-to-digital conversion process by the encoder installed to the plotter to become basic data for digital mapping via computer. The entire mapping information was modified and edited by computer and additional entries, such as place names, were made. This information was output onto the Polyester base by the plotter with the map sheet layout shown in Fig. 2-2-2 to produce base topographical maps.

Scale of Output Maps	:	1/10,000
Contour Interval	:	20 m
Map Size	:	internal dimensions: 100 cm wide, 80 cm high (eight map sheets)

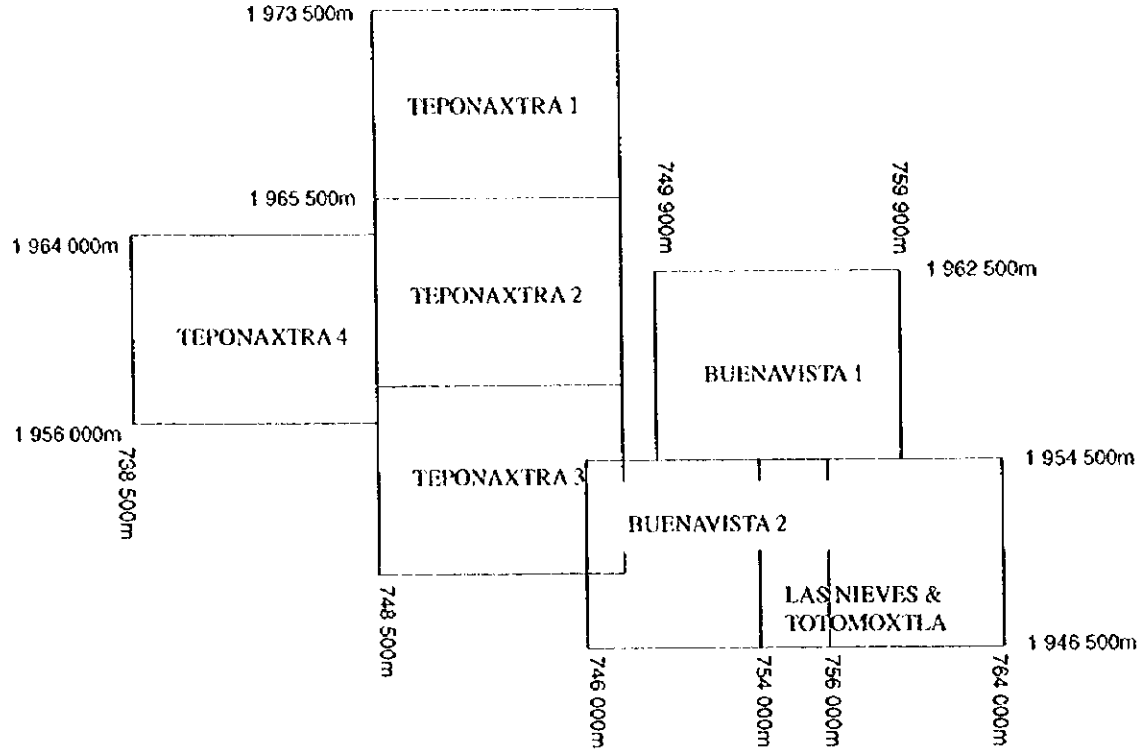

Fig. 2-2-2 Map Sheet Layout

CHAPTER 3

SUSTAINABLE FORESTRY DEVELOPMENT PLAN

(MASTER PLAN)

CHAPTER 3 SUSTAINABLE FORESTRY DEVELOPMENT PLAN (MASTER PLAN)

3.1 Characteristics of Sustainable Forestry Development Plan

The Study Area is located in the Sierra Juarez area in the northern part of Oaxaca State and many local comunidades have forest resources with high productivity, producing high quality pine. As forest resources are practically the only natural resources of significance in this steep mountain area, the appropriate management of forest resources to promote local forestry is particularly important to ensure the prosperous development of local comunidades.

In general, there are three basic tasks as described below when attempting to develop rural or mountain villages.

(1) Development of social infrastructure to consolidate the conditions for permanent living;

(2) Increase of income and improvement of employment opportunities;

(3) Securing the commitment of local people to the development of their locality;

The promotion of forestry through the active utilisation of the forest resources owned by comunidades can contribute to these three tasks in the following manner.

(1) Development of village infrastructure by means of investing the income from forest management

(2) Increased income and employment opportunities by means of participating in forest production activities

(3) Establishment of the commitment of local people by means of demonstrating their ability to act with a sense of purpose through the active participation in forest management and forest production activities and also the formation of an internal development force through such activities

The actual state of forest utilisation in these comunidades varies from one comunidad to another depending on the site conditions and contents of forest resources while the level of infrastructure development also varies depending on the intensity of forest utilisation. In the case of those comunidades which are richly endowed with commercial pine forest resources

and which enjoy good road access to a nearby national road, active forestry practices generate a good profit which is invested in infrastructure development. Meanwhile, there are comunidades where the forest management system is immature and/or local roads are only partly well developed despite rich pine resources. In these comunidades, the full utilisation of the resources tends to be difficult with the resulting slow development of social infrastructure. Nevertheless, it cannot be denied that they have development potential with enhanced forestry activities. As these comunidades can facilitate the development process through the promotion of forestry, they can be considered areas subject to the active promotion of forestry.

Under these circumstances, the objectives of the planned sustainable forestry development plan are the development of forestry in mountain villages by means of effectively utilising the forest resources of comunidades in a sustainable manner and also the improvement of the standard of living of local people by means of ensuring the public benefit functions of forests. In this plan, desirable measures are suggested in line with the natural, socioeconomic and cultural conditions of the Study Area.

There is no single prescription which can be applied to all comunidades regarding how local forestry should be developed as the conditions surrounding each comunidad differ in terms of the availability of forests suitable for commercial production, the availability of forests for timber and firewood for self-consumption and the extent of existing forestry activities. Accordingly, the plan suggests the desirable direction for the efforts of each comunidad to develop forestry in view of the site conditions, forest resources and forest production activities of each comunidad while adopting the basic principle of introducing forest management designed to maintain the public benefit and economic functions of forests in a sustainable manner. It is hoped that the plan puts forward a model which can be applied by the administration to other comunidades with similar circumstances both inside and outside the Study Area as a forestry extension model and which provides comunidades with a desirable direction for forest management.

3.2 General Conditions of Study Area

(1) Natural Conditions

1) Area by Land Use and Vegetation Type

The area by land use and vegetation type in the Study Area is shown in Table 3-2-1. The area figures in this table were measured on the land use and vegetation maps (scale: 1/25,000) which were prepared under the present Study using the types listed in Table 3-2-2. The said land use and vegetation maps were, however, prepared based on the interpretation results of the aerial photographs taken in January through March

and May, 1997 and, therefore, does not reflect the consequences of a large forest fire which occurred in May, 1998.

Table 3-2-1 Area by Land Use and Vegetation Type

Type	Symbol	Area (ha)	Ratio (%)
< Forest Zone >			
Pine Forests [1]		9,295	4.8
- Closed Forests	P(c)	5,007	2.6
- Scattered Forests	P(a)	791	0.4
- Young Forests	P(j)	3,497	1.8
Pine-Quercus Mixed Forests [2]		76,544	39.8
- Closed Forests	PQ(c)	73,400	38.2
- Scattered Forests	PQ(a)	3,144	1.6
Quercus Forests	Q	10,076	5.2
Selva Baja (Low Broad-Leaved Forests)	Sb	13,776	7.1
Mountain Mesofilo Forests	Me	40,643	21.1
Secondary Forests in Mountain Mesofilo Forest Area	Bs	9,726	5.0
Sub-Total (Forest Zone)		160,060	83.0
< Non-Forest Zone >			
Agricultural Land	Ag	14,767	7.7
Abandoned Agricultural Land (Including Fallow Land)	Ag(a)	5,163	2.7
Grazing Land	Pz	274	0.1
Shrub Land	Ab	4,073	2.1
Highland Grassland	Ch	935	0.5
Rivers	R	551	0.3
Denuded Sites	D	19	0.0
Residential Sites	Hu	640	0.3
Sub-Total (Non-Forest Zone)		26,422	13.7
Not Interpreted Zone Due to Cloud Cover		5,300	2.8
Unphotographed Zone		1,029	0.5
Sub-Total (Not Interpreted Area)		6,329	3.3
Total		192,811	100.0

Notes:
1. The area and ratio figures for pine forests are the totals of closed, scattered and young forests.
2. The area and ratio figures for pine-Quercus mixed forests are the totals of closed and scattered forests.

Table 3-2-2 Land Use and Vegetation Types

Type	Symbol	Description
< Forest Zone >		
Pine Forest		The mix ratio of pine is approximately 75% or more
- Closed Forest	P(c)	Pine forest with a crown density of 40% or more
- Scattered Forest	P(a)	Pine forest with a crown density of less than 40%
- Young Forest	P(j)	Uniform regeneration or artificial planting of pine at former cut-over site, site damaged by forest fire, site sustaining disease or pest damage and/or former agricultural site; the tree height is roughly 10 m or less
Pine-Quercus Mixed Forest		The mix ratio of both pine and quercus is approximately 25% or more
- Closed Forest	PQ(c)	Pine-Quercus forest with a crown density of 40% or more
- Scattered Forest	PQ(a)	Pine-Quercus forest with a crown density of less than 40%
Quercus Forest	Q	The mix ratio of quercus is approximately 75% or more
Selva Baja (Low Broad-Leaved Forest)	Sb	Low broad-leaved forest mainly growing in arid area along the Rio Grande; many species are deciduous
Mountain Mesofilo Forest	Me	Mist forest influenced by mist and rain clouds formed near the ridgeline by moist air from the Gulf of Mexico; some tropical moist forests (selva alta mediana) with a different composition of species are observed at highland at a lower elevation
Secondary Forest in Mountain Mesofilo Forest Area	Bs	Secondary forest regenerated at former agricultural sites or other sites in the mountain mesofilo forest area
< Non-Forest Zone)		
Agricultural Land	Ag	Agricultural land of frijol (beans) maize and potatoes, etc, including orchards
Abandoned Agricultural land (Including Fallow Land)	Ag(a)	Fallow land and abandoned agricultural land with the possibility of re-cultivation
Grazing Land	Pz	Grassland used for grazing
Shrub Land	Ab	Areas of former agricultural land where shrubs and vegetation of shrub type had grown
Highland Grassland	Ch	Site with grass and/or shrubs, mainly distributed near mountain summits with a high elevation
River	R	Such rivers as the Rio Grande, including bare sandy land, etc. which is inundated during the rainy season
Denuded Site	D	Denuded site without vegetation cover
Residential Area	Hu	Residential area (including sawmill sites, etc.)

2) Characteristics of Land Use and Vegetation

The distribution of vegetation in the Study Area well reflects such natural environment factors as temperature, rainfall, soil and topography and, therefore, vegetation can be regarded as an index of the natural environment. Meanwhile, the long history of local

people means that forests have been significantly affected by conversion to farmland, etc., burning and forest fires, etc. In recent years, industrial felling has been taking place in many areas, leaving natural vegetation unaffected by human activities to a minimum. As the natural conditions in the Study Area affecting plant growth distinctively change due to elevation and topography, clearly determining the vegetation distribution, the remaining and regenerated vegetation can be used as a clear index to judge the conditions of the natural environment.

As a typical example of the vegetation distribution in the Study Area, Fig. 3-2-1 is a schematic drawing of the elevation, topography and vegetation distribution along the line linking San Miguel Maninaltepec, San Martin Buenavista, Cerro San Martin and Cerro Hueso.

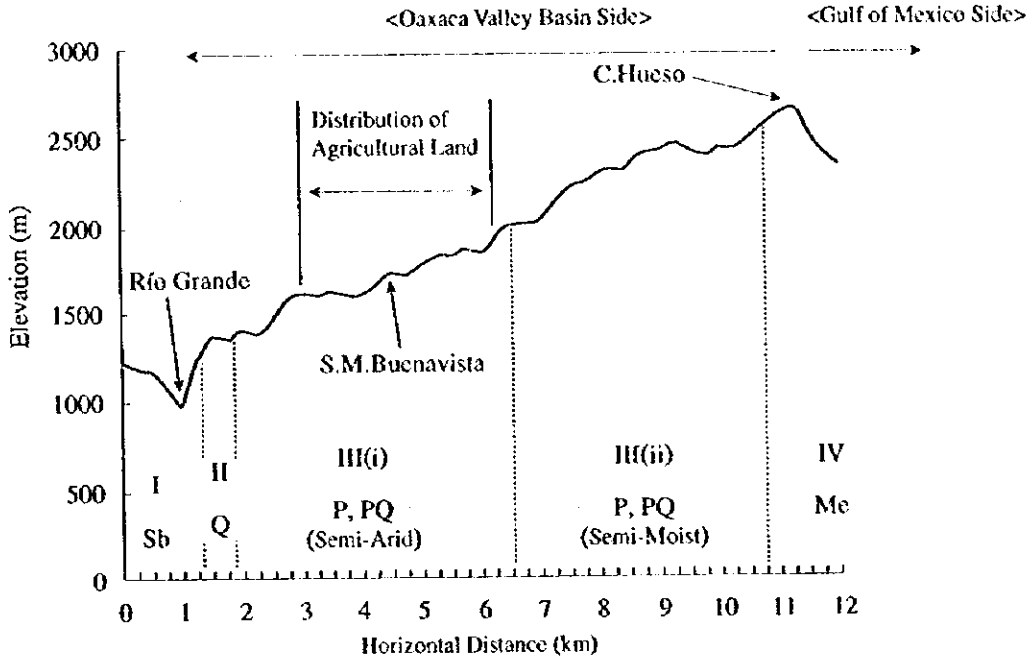

Fig. 3-2-1 Schematic Drawing of Elevation and Vegetation Distribution in Study Area

Although the vegetation distribution shown in the schematic drawing may slightly change due to such factors as the elevation of the ridgeline, geographical location and slope bearing, etc., the following basic characteristics appear to be generally applicable to the entire Study Area because of the little influence of moist air from the Gulf of Mexico on the southern side of the ridgeline (Oaxaca Valley Basin side), running from C. Manta to Dos Escaleras, C. Hueso, C. Zacate, C. Pelon and Mirador.

- Areas at a lower elevation (areas with a relatively low elevation of approximately 800 - 1,000 m along the Rio Grande in the Study Area) tend to be characterised by a high temperature, dry weather and a thin layer of poor soil.

- As the elevation increases and become moist the soil conditions improve.

- Because of these meteorological and soil conditions, the vegetation of low elevation areas along the Rio Grande is often dominated by low pine and *quercus* trees as well as shrubs. Forests with a low density also exist.

- Many high and dense forests exist in high elevation areas, showing rich vegetation and abundant organic matters in the soil.

- Mountain mesofilo forests are distributed on the Gulf of Mexico side. Tropical moist forests are observed in low elevation areas.

(2) Social Conditions

There are 25 comunidades and 2 ejidos with 23,000 inhabitants in the study area. In the Oaxaca state, the percentage of indigenous people is as high as 99.8%, the traditional autonomy systems are still preserved. There are great ethnic diversities; the biggest ethnic groups are Zapoteco, Chinanteco and Cuicateco. In spite of this ethnic diversity, there is no big conflict among them.

The Population of comunidades and ejidos, ranges from 74 to 2,479. Nearly 69% of communidades' and ejidos' population are under 1,000. Thus it can be said that the population of each is relatively small. The area of these communidades and ejidos are also small, more than a half of them being less then 5,000 ha.

Table 3-2-3 Population, Area and Percentage of Indigenous People in the Study Area (by comunidad and Municipio)

Municipio	Cominidad or Ejido	Population (1990)		Area (ha)	Percentage of indigenous people
Abejones	Abejones	(3,000)	1,402	6,546	100.0
S.J. Atepec	San Juan Atepec	(4,000)	1,841	13,183	100.0
S.J. Quiotepec	San Juan Quiotepec		1,822	3,608	100.0
	San Miguel Maninaltepec	(650)	399	13,743	
	Santa María Las Nieves		141	930	
	Santa María Totomoxtla	(315)	187	1,088	
	Santiago Cuasimulco		74	1,795	
S.M. Aloapan	San Miguel Aloapan	(2,100)	2,479	13,518	100.0
S.P. Macuiltianguis	San Pablo Macuiltianguis	(2,000)	678	9,703	99.4
	San Juan Luvina		804	4,224	
S.P. Yolox	San Francisco la Reforma		386	1,929	100.0
	San Martín Buenavista	(1,000)	440	5,358	
	San Pedro Yolox	(1,550)	1,777	8,178	
	(E) Nuevo Rosario Temextitlan		169	1,231	
S. Comaltepec	Santiago Comaltepec		1,685	18,366	100.0
	Soledad Tectitlan	(565)	276	519	
S.J. Tepeuxila	San Juan Tepeuxila		575	6,442	100.0
	San Andres Pápalo	(550)	445	1,897	
	San Juan Teponaxtla	(940)	783	10,716	
	San Pedro Coyaltepec		618	1,747	
	San Sebastian Tlacolula		597	3,210	
S.P. Sochiapan	San Pedro Sochiapan		1,459	2,796	99.0
	(E) San Jose Retumbadero		123	1,886	
	San Juan Zapotitlan		1,020	3,630	
	San Juan Zautla		856	1,681	
	Santiago Quetzalapan		373	2,947	
Santa María Pápalo	Santa María Pápalo	(2,000)	1,801	5,838	100.0

Note: The data in ( ) are based on the study conducted form January to March 1997.
Source: INEGI,1996 "OAXACA Datos por Ejido y Communidad Agraria"

Table 3-2-4 shows major social indicators in the study area. These indicators are better than those of the Oaxaca state. But the indictors by sex reveal that most of the women's indicators are lower than those of the state level.

Table 3-2-4 Major Social Indicators in the Study Area (1990. by *Municipio*)

Region		Number of household	Illiteracy rate			Percentage of student who enter secondary school	Percentage of households which have sewage system	Percentage of households which have electricity	Percentage of households which have water supply	Level of marginality
			Total	Male	Female					
Total of OAXACA		4.9	76.8	83.2	70.9	67.7	11.0	65.7	36.4	
Ixtlán	Abejones	5.8	68.3	84.8	51.6	62.2	0.7	97.3	1.9	3
	San Juan Atepec	3.7	79.5	85.7	74.0	55.0	21.3	87.7	91.3	3
	San Juan Quiotepec	5.6	58.5	72.1	46.9	71.6	38.9	61.7	36.3	3
Cuicatlán	San Juan Tepeuxila	4.2	86.2	91.4	80.6	73.8	1.3	58.5	32.2	3
	San Miguel Aloapan	5.4	74.3	87.0	61.8	76.7	20.9	93.4	59.0	4
	San Pablo Macuiltianguis	4.4	80.8	87.4	74.6	57.4	34.7	70.4	36.1	2
	San Pedro Sochiapam	6.4	62.0	71.6	53.3	85.4	11.8	2.4	38.4	3
	San Pedro Yolox	5.8	67.1	80.5	54.3	70.3	9.3	73.2	21.7	3
	Santa María Pápalo	4.9	75.4	83.4	66.9	89.5	0.3	59.3	10.9	3
	Santiago Comaltepec	4.8	80.2	89.4	71.8	46.2	47.8	83.3	63.3	3

Note : 1.illiteracy rate, percentage of student who enter secondary school are percentages among the population over 15 years old.
2.level of marginality is based on the level of social services they receive: 1 sufficient; 2 average; 3 not sufficient; 4 insufficient
Source: INEGI,1996"OAXACA Datos por Ejidos y Communidades Agraria"
INI,1993" Indicadores Socioeconomicas de los pueblos Indigenas de Mexico,1990"

(3) Economic Conditions

To understand the economic situation of the study area, it is necesarry to divide the area into three parts; the northern part known as Cuacatlan, where fruits and coffee are produced; the southern part where there are abundant forest resources; and the middle part where there are limited farm land and forest resources. The latter two are included in Ixtlan.

Table 3-2-5 shows the land use by each region. It indicates that Canada region, which includes Cuicatlan, has many farm land and that Shierra Jarez region, which includes Ixtlan, has many forest land. As for types of products, Cuicatlan produces more cash-crop such as coffee than Ixtlan, where mainly non-cash crop such as corn are cultivated.

Table 3-2-5 Land Use by Region (1995)

	Farm land	Pasture	Forest	Other	Total
Total of OAXACA	1,103,284 (11.6)	2,344,514 (24.6)	3,895,257 (40.8)	2,193,345 (23.0)	9,536,400 (100.0)
For region					
MIXTECA	144,727 (7.4)	357,210 (18.2)	763,746 (39.0)	692,579 (35.4)	1,958,262 (100.0)
VALLES CENTRALES	183,954 (11.3)	270,198 (16.7)	1,089,035 (67.1)	80,172 (4.9)	1,623,359 (100.0)
COSTA	240,223 (19.2)	275,139 (22.0)	180,949 (14.5)	553,868 (44.3)	1,250,179 (100.0)
ISTMO	252,265 (10.2)	780,537 (31.5)	815,594 (33.0)	626,319 (25.3)	2,474,715 (100.0)
SIERRA JUAREZ	64,710 (6.9)	253,691 (27.1)	615,537 (65.9)	858 (0.1)	934,796 (100.0)
CAÑADA	79,940 (18.7)	6,000 (1.4)	163,885 (38.4)	177,449 (41.5)	427,274 (100.0)
TUXTEPEC	137,465 (15.8)	401,739 (46.3)	266,511 (30.7)	62,100 (7.2)	867,815 (100.0)

Note: The numbers in ( ) are the percentages
Souce: INEGI,1996" Anuario Estadistico del Estado de OAXACA 1996"

In the study area, the access to highway and qualityof forest resource, which has economic value (here in after refer to as economic forest resource), are the biggest factors which affect the economic situation of each Municipio. The national highway pass through the south-east part of the study area, comunidades nearby the highway are economically very active.

Two benefits derive from the economic forest resources. One is the job opportunity, provided from forestry productive activities. Another is the improvement of basic infrastructure in the community, by using the money which comes from the sales of forest resources. Interviews indicated that not only the quantity of forest resources but also the way in which they utilize it, strongly influenced the economy and the level of infrastructure in the community. Furthermore, those communities which have economic forest resources, have forest management body which subscribes for social security and provide pensions to the members. The possession of economic forest resource influences not only the actual life but also their future security. Economic impact on the communities, with forest resource, on the nearby communities seems to be limited.

Besides the economic forest resources, the money send from the emigrants who work in the United States of America is another important resource of income for the people in the study area. In 12 communities, the emigration rate ranges from 5 to 65%. In general, the emigration rate is very high, as in 9 communities, the rate was more than 30%. The emigration rate is relatively low in the northern part, and high in the middle-southern part.

There are positive economic impact of the money send from emigrant to the comunidad and to the household, when it is used properly.

3.3 Basic Concept of Land Use and Forest Use

(1) Concept of Land Use

Land use is restricted by many factors, including such natural factors as topography, soil, climate and river systems and such socioeconomic factors as legal regulations, land ownership, industrial activities, population, transport and lifestyle. Ideally, the optimal land use should be determined based on a comprehensive judgement of these factors in order to ensure the maximum benefits for the local community. In reality, however, as land use is not necessarily determined in a planned manner, the state of existing land use does not necessarily show the rational combination of various land use categories. In addition, it is not always possible to change the state of existing land use to a more rational pattern. Taking these general points into consideration, the land use in the Study Area is discussed below from the viewpoint of the local natural and socioeconomic factors.

1) Land Use Based on Natural Factors

Land is used as a means of production for agriculture and forestry. As the level of production is largely determined by various site conditions, judgement of the site suitability for specific land use commands paramount importance. Accordingly, it is essential to judge the level of land productivity from the viewpoint of natural factors with a view to applying the judgement result to land use. The common method of judging land use suitability based on the natural conditions takes such factors as workability in relation to labour input (ease of cultivation in the case of agricultural use, ease of tending in the case of forestry use and ease of management in the case of grassland use) and growth potential (ease of growth) of plants into consideration. In other words, land use suitability is judged in a comprehensive manner using such natural factors as inclination, soil and elevation, etc. as factors restricting the workability and growth potential.

At present the dominant form of land use in the Study Area is forest and agricultural land can be observed around settlements in each comunidad. The elevation falls in the range of between approximately 500 m and 3,000 m and this elevational difference of some 2,500 m produces steeply sloping land. In terms of the soil, gravelly soil is widely distributed. These conditions significantly restrict local land use for agriculture. As a reduction of the workload or an improvement of productivity is difficult, intensive land use cannot be hoped for.

The present agricultural land around settlements is located on relatively gentle slopes which are still generally steep for farming purposes. The further development of agricultural land can only take place at steeper slopes and could lead to serious soil erosion. From the viewpoint of soil conservation, use of the present forest areas for forestry purposes is highly desirable.

The mountain mesofilo forests and tropical moist forests in the northeastern part of the Study Area are also located on steeply sloping land. The remaining broad-leaved forests in this part of the Study Area not only play an important role as soil conservation forests and headwater forests but also provide habitat for many rare fauna and flora, creating a complex ecosystem where various animal and plant species interact with one another. These forests are important in terms of ecology as well as the preservation of genes and, once destroyed through development, their restoration is difficult. Therefore, the present state of forests should be preserved while restricting their conversion to farmland. Farmland which has already been developed and then abandoned should be restored to forest land by means of planting and other methods.

Selva Baja forests are characterised by not only steep slopes but also by dry weather. Some soil erosion can already be observed. Given the difficulty of restoring vegetation by artificial means, these forests should be conserved without any human interference in anticipation of an increase of vegetation through natural recovery.

To summarise, the desirable direction for land use in the Study Area is the preservation of forests except at those sites which have already been developed as settlement or farmland.

2) Land Use Based on Socioeconomic and Cultural Factors

When looking at the land use policy from the legal point of view, the current emphasis of the Government of Mexico on environmental protection is evident in Article 59 of the Agricultural Land Law which effectively prohibits the conversion of forest land to agricultural land by means of invalidating any allocation of forests for agricultural purposes. Although Article 19 of the Forest Law stipulates that alteration of the land use designation of forest land may be exceptionally permitted, such alteration is conditional in that no adverse impacts result in terms of such forest-related functions as the preservation of biological diversity, prevention of soil erosion, preservation of water quality and water yield. In short, no alteration is feasible unless a high degree of public benefit can be expected of the alteration.

In regard to the relationship between people living in local comunidades and forests, people are aware of the value of forests as important sources of firewood to sustain their lives and as effective economic resources which contribute to improvement of the social infrastructure. Accordingly, they are trying to conserve forests by means of prohibiting the free felling of pine by comuneros. They also prohibit felling in those forests which provide a source of water supply to a settlement or which are particularly important in terms of beautiful scenery as part of their overall efforts to preserve the environmental conservation function of forests. In some cases, the spiritual value of forests as sacred sites is upheld. This culture of carefully treating forests appears to have been formed on the basis of the consciousness of solidarity among local people which has been fostered through joint forest management and also on the basis of the fact that forests support local life by providing timber, firewood, medicinal herbs and other useful products. In short, comunidades appear to be fully aware of the various useful values of forests and have a strong awareness of the need to conserve and hand over forests to subsequent generations as essential resources which sustain local life.

Given the facts that the conversion of forest land to other land use purposes is strictly controlled by law and that comunidades treat forests very carefully as described above, the appropriate management of forests with a view to preserving existing forests and ensuring the economic, environmental and/or spiritual values of forests sought by local people should prove highly beneficial from the socioeconomic and cultural viewpoints.

(2) Concept of Forest Use

For comunidades, forests have the economic function of producing timber and other products. The active use of forests as production areas is, therefore, required from the viewpoint of the constant supply of essential forest products for society and the promotion of local communities through such supply of forest products. At the same time, forests should be protected and conserved to preserve their public benefit functions to maintain their status as the basis for local life. These two functions are not in competition but should be constantly harmonised to ensure their coexistence.

Nevertheless, there is a limit to the maximisation of the simultaneous performance of all of the functions of forests. The classification of forests into functional categories is important with a view to developing forests in line with the priority functions of individual forests. To be more precise, forest land should be classified largely as production areas where the production of forest products is emphasised and conservation areas where

protection/conservation is a priority. Forests should then be categorised based on the perceived priority functions, followed by the formulation of appropriate forest management standards for each category to enable appropriate forest management. Production activities may take place even in conservation areas with the imposition of restrictions. Similarly, forests in production areas are expected to perform public benefit functions to a certain degree and it is necessary to implement forest management designed to foster healthy forests to conduct forest production activities while preserving these public benefit functions.

In the case of those forests which cannot perform their expected functions due to the loss of forest vegetation, the option of restoring forests by means of establishing special restoration areas to foster forests must be considered.

1) Required Forest Functions and Forest Categories

Forest use is closely related to the socioeconomy of each comunidad and also to the lives of local people. Some forests are used for timber production while others are used to protect water sources, making the handling of these forests with special care desirable from the viewpoint of water resources conservation. Other forests may require special handling to avoid any worsening of the soil conditions. In short, some forests require special management practices because of their specific conditions. Any attempt at the functional categorisation of forests must be based on a proper understanding of the actual conditions and restrictions, if any, regarding the subject forests. From this point of view, forests in the Study Area appear to be associated with various functions or requirements as listed below.

- Forests to produce commercial timber
- Forests to produce timber for home use
- Forests to produce firewood
- Forests for headwater conservation
- Forests for river system protection
- Forests requiring soil conservation or soil restoration
- Forests requiring conservation of the biological diversity as restoration is difficult once destroyed
- Forests to be protected on religious or customary grounds in comunidades
- Forests requiring restoration due to declined soil productivity caused by the loss of forest vegetation

• Forests requiring the preservation or enhancement of vegetation

While forests may be used to perform a single function, they are used to perform multiple functions in many cases.

2) Forest Categorisation

Given the actual state of local forests in the Study Area, the following categorisation can be made based on the priority functions.

Table 3-3-1 Forest Categorisation

Area	Forest Category	Description
Production Area	Timber Production Forest	< Commercial Timber Production Forest > - Forest where commercial timber can be actively produced < Non-Commercial Timber Production Forest > - Forest where commercial timber cannot be actively produced but timber for home use can be produced
	Firewood Production Forest	- Forest where firewood production can be conducted
Conservation Area	Nature Preservation Forest	- Forest where the very existence of the forest or nature requires preservation
	Headwater Conservation Forest	- Forest which is required for water source and river system conservation
	Soil Conservation Forest	- Forest where there is a need to prevent soil erosion or loss
	Other Conservation Forests	- Forests with less vegetation than usual due to climatic and other reasons, requiring preservation or enhancement of the present forest vegetation
Restoration Area		- Forest requiring restoration as the loss of forest vegetation has reduced the soil productivity; this type of forest should be classified as either a production or conservation area in the long-term

3.4 Current State of Forest Resources and Direction for Future Development

(1) Current State of Forest Resources

The current state of resources by forest type found in the Study Area is described below.

1) Pine Forest (P) and Pine-Quercus Forest (PQ)

Pine is used to produce timber and has the highest commercial value among forest resources in the Study Area. Various species of pine grow in the Study Area,

reflecting the topographical, climatic, soil and other conditions of specific sites and the site conditions determine the use value of these forests. The *Quercus* spp. growing in pine-quercus forests is used as firewood for home consumption by local people. The areas in which pine and pine-quercus forests grow in the Study Area are largely classified into the following two types with different use values.

a. Semi-Arid Pine and Pine-Quercus Forests

In general, these forests are located above selva baja and quercus forests and pines which had adapted to a dry climate grow in these forests. The general height of pine trees of 20 m or less is not high and the diameter growth is slow. Many stands are unsuitable for commercial timber production because of bending and other qualitative problems. The stand density is not particularly high and the stand composition is rather simple. Most settlements in the Study Area are situated in these areas, resulting in a prominence of agricultural land and former agricultural land. As local agriculture mainly aims at the production of crops, etc. for self-consumption, there are no large-scale forest clearings. As a result, the forests are relatively well preserved.

b. Semi-Moist Pine and Pine-Quercus Forests

In general, these forests are situated above semi-arid pine and pine-quercus forests. The reasonable level of moisture and good soil conditions mean that pine trees grow to a height of some 25 - 35 m and their good quality makes them suitable for timber production. As a result, these are the only forests subject to commercial use in the Study Area. Almost all forests of this type in the Study Area experienced felling activities in the some 20 year period between 1960 and 1980. Although selective felling was conducted at that time, many stands are characterised by the poor growth of succeeding pine trees due to inadequate tending works and other reasons in the post-regeneration period. At many such stands, old trees which were left as seed trees form the upper-story while *Quercus* spp. and other broad-leaved trees and shrubs tend to form the under-story due to the poor regeneration of pine. Despite this, the high productivity potential means that high quality stands with high growing stock can be created with appropriate forest management.

2) Quercus Forests (Q)

Quercus forests generally form the upper part of selva baja and there are many secondary forests regenerated at former agricultural land in pine-quercus Forest areas or stands which have been invaded by quercus because of the poor regeneration of

pine trees after felling. In general, the height of the trees is low and the stand composition is simple. Quercus is used as firewood for home consumption by local people. After felling to obtain firewood, it regenerates by sprouting or natural seeding in most cases. The stand density can be very high.

3) Selva Baja Forests (Sb)

These are low broad-leaved forests which grow in a dry climate and are mixed with thorny species and cacti. In many places, the soil conditions are poor and trees which can be used as forest resources seldom grow. Forest trees with a height of 4 m to 8 m are scattered and shrubs and herbs form the undergrowth. The stand density is low and the stand composition is simple. In short, these are forests with poor forest floor vegetation and low productivity.

4) Mountain Mesofilo Forests (Mc)

These are mist forests formed under the influence of moist air from the Gulf of Mexico. The soil is deep with rich organic matters. This type of forest in the Study Area is often marked by a tree height of approximately 25 m. There is a rich mixture of species which are mostly broad-leaved species with some *P. chiapensis* and other needle-leaved species. While such useful species as *Cedrela* spp. grow, they are sometimes used to produce timber for home use because of the scattering of trees and difficult access caused by the steep inclination.

Mountain mesofilo forests enjoy biological diversity and are important habitats for rare flora and fauna. Their location in areas with high rainfall and their excellent headwater conservation function supported by favourable vegetation as well as soil conditions mean that they play an important role in the conservation of water resources.

There is much agricultural land currently in use and shrub land or secondary forests regenerated after the abandonment of cultivation within Mountain Mesofilo Forests in the Study Area.

5) Tropical Moist Forests (Sam)

Although Tropical Moist Forests are similar to mountain mesofilo forests, they are generally located in areas at a lower elevation than mountain mesofilo forests. Some Tropical Moist Forests have a higher tree height and slightly different composition to

mountain mesofilo forests. The current conditions of forest resources and land use are believed to be similar to those of mountain mesofilo forests.

(2) Areas in Each Forest Category

1) Land Use and Vegetation Conditions by Forest Category

The general conditions of land use and vegetation and the natural conditions of each forest category discussed in 3-3-(2) are summarised in Table 3-4-1 taking the current conditions of forest resources and land use into consideration.

2) Areas in Each Forest Category

Based on the natural conditions and current conditions of land use in each forest category in the Study Area, the following areas can be identified.

a. Production Area

(a) Timber Production Forests

i. Commercial Timber Production Forests

These are highly productive pine or pine-quercus forests with the production of timber being the main purpose of use. In general, the semi-moist pine and pine-quercus forests distributed in the elevation range of between approximately 2,000 m and 3,000 m on the south side of the ridgeline (Oaxaca Valley Basin side) running from C. Manta to C. Hueso, C. Zacate, C. Pelon and Mirador are classified as commercial timber production forests.

ii. Non-Commercial Timber Production Forests

Among pine and pine-quercus forests, those which cannot be actively used to produce timber due to low productivity but which can tolerate the collection of timber for home use are classified as non-commercial timber production forests. Semi-arid pine and pine-quercus forests located in the elevation range of between 1,500 m and 2,500 m generally fall in this category. (In the case of forest categorisation for each comunidad, the current state of forest resources and the supply-demand situation of both timber and firewood in each comunidad must be taken into consideration.)

(b) Firewood Production Forests

Among pine-quercus forests where encino (*Quercus* spp.) suitable for use as firewood is dominant and quercus forests, some are designated for firewood

production in view of the site conditions, including access from a nearby settlement and land use conditions. In areas to the south of the ridgeline referred to earlier (Oaxaca Basin side), parts of the semi-arid pine-quercus Forests distributed in the elevation range of between 1,500 m and 2,500 m and quercus forests located below approximately 1,500 m fall in this category. In areas where there is a encino firewood shortage, however, pine trees which are unsuitable for timber production and broad-leaved trees other than encino may be used for firewood.

b. Conservation Area

(a) Nature Preservation Forests

These are forests where the continual preservation of nature in the future is important for various reasons, including (i) preservation of a precious ecosystem which maintains a primeval or similar state, (ii) protection of the habitat of rare fauna and flora, (iii) conservation of genetic resources and (iv) protection of a forest which is considered to be very important by local people from the viewpoint of culture, custom, religion and the protection of nature or which is designated a protected area by law or regulation. Conservation areas in the Study Area cover those well maintained sites in mountain mesofilo forests and Tropical Moist Forests, both of which are mainly distributed in the area from the aforementioned ridgeline to the north (Gulf of Mexico side). In addition, part of the western section of the Study Area is planned to be included in the Tehuacán-Cuicatlán Nature Reserve for which proceedings to designate the area as a protected area are currently in progress. Some sites in the Study Area are considered important by local people for reasons of culture, custom, religion and/or the protection of nature. Special attention should be paid to these sites in the formulation of a forest management plan for each comunidad.

(b) Headwater Conservation Forests

These are forests which have the function of conserving essential water resources for the lives of local people. They are located upstream of the water intake points of settlements. (In general, headwater areas lie in moist areas with a high elevation and are often found in semi-moist pine forest and pine-quercus forest areas or mountain mesofilo forest areas.)

(c) Soil Conservation Forests

These are forests which are characterised by a high degree of soil erosion or landslide hazard and a steep inclination of approximately 100% or more.

(d) Other Conservation Forests

These are forests where conservation of the existing environment is desirable because of (i) the difficulty of regenerating vegetation once it has been lost due to unfavourable soil and other site conditions and (ii) the lack of sufficient soil productivity to enable productive activities, etc. These forests are mainly found in Selva Baja areas along the Rio Grande.

c. Restoration Areas

The current state of these areas is abandoned (former) agricultural land, shrub land or former forest fire sites, etc. and where afforestation efforts will be made in the future for timber production, environmental conservation and other purposes.

Table 3-4-1 Natural Conditions and Current Land Use and Vegetation Conditions by Each Forest Category

Forest Category		Main Land Use and Vegetation in Study Area						Remarks
		Forest					Non-Forest	
		Sb	Q	Semi-Arid P, PQ	Semi-Moist P, PQ	Me, Sam	Ag(a), Ab, etc.	
<Production Area>								
Timber Production Forest	Commercial Timber Production Forest				O			
	Non-Commercial Timber Production Forest			O				
Firewood Production Forest			O	O				
<Conservation Area>								
Nature Preservation Forest						O		Mainly Me and Sam; any areas designated by law are classified in this category regardless of land use and vegetation types
Headwater Conservation Forest					O	O		Mainly semi-moist P and PQ, Me and Sam; all land use and vegetation types fall in this category if the headwater conservation function is required
Soil Conservation Forest		O	O	O	O	O		Areas with a strong soil conservation requirement regardless of land use and vegetation types
Other Conservation Forests		O						
<Restoration Area>							O	Area requiring forest restoration regardless of land use and vegetation; former agricultural land and former forest fire sites, etc. fall in this category in the Study Area

(3) Principles of Forest Management by Forest Category

1) Desirable State by Forest Category

The desirable state by forest category is described in Table 3-4-2.

Table 3-4-2 Desirable State by Forest Category

Area	Forest Category		Desirable State
Production Area	Timber Production Forest	Commercial Timber Production Forest	Forest with suitable forest soil for timber tree growth, adequate density, good quality and many useful species and enjoying a high increment level
		Non-Commercial Timber Production Forest	Forest mainly consisting of pine with an adequate density
	Firewood Production Forest		Forest consisting of many species which are suitable for use as firewood
Conservation Area	Nature Preservation Forest		Forest to preserve biological diversity and existing vegetation
	Headwater Conservation Forest		Forest characterised by soil with a well-developed aggregated structure and many coarse pores, a well-developed root system, good growing undergrowth and a high level of crown closure
	Soil Conservation Forest		Forest characterised by good growing undergrowth due to a deep and spreading root system and adequate sunlight
	Other Conservation Forests		Forests with more vegetation than the present state
Restoration Area			Forest which can fully perform the special function(s) expected of it

2) Principles of Forest Management by Forest Category

Given the varying conditions of each forest, a concrete forest management method should ideally be determined by each stand. Here, the basic forest management approach is determined for each forest category to standardise forest management. The principles of forest management, featuring mainly felling and regeneration, to make forests attain the desirable state described in Table 3-4-2 are shown in Table 3-4-3.

Table 3-4-3 Principles of Forest Management by Forest Category

Area	Forest Category		Principles of Forest Management
Production Area	Timber Production Forest	Commercial Timber Production Forest	Clear cutting leaving seed trees for natural regeneration is basically employed for Pine and Pine-Quercus Forests. If necessary, regeneration assistance work, weeding, improvement felling and/or thinning are conducted. Seed trees are felled at the time of the first thinning but this may be postponed until the second thinning or later depending on the situation. As some stands can be improved to achieve higher productivity, these are classified as improvement stands with a view to conducting improvement work. Useful Quercus Forests are subject to selective felling and natural regeneration.
		Non-Commercial Timber Production Forest	In principle, such forests are left to natural transition although selective felling is allowed to obtain timber for home use. In the long run, when the tree size reaches a usable DBH class with a sufficient number of trees, forest management similar to that for commercial timber production forests can be employed.
	Firewood Production Forest		In principle, selective felling with regeneration by sprouting or natural seeding is employed.
Conservation Area	In principle, no timber production takes place in this area but the following principles apply to felling to maintain local life.		
	Nature Preservation Forest		Minor selective felling with natural regeneration is permitted to obtain the minimum quantity of timber for home use and firewood required by local people
	Headwater Conservation Forest		Felling on a minor scale by means of the selective felling or clear cutting of a small area is permitted. The method of regeneration is natural regeneration.
	Soil Conservation Forest		In principle, only minor selective cutting is permitted and felling is prohibited in areas with a large inclination and exposed ground.
	Other Conservation Forests		Minor selective felling is permitted to enable the minimum level of forest use by local people.
Restoration Area			Forest restoration is attempted by means of either natural or artificial regeneration. Weeding, improvement felling and thinning are conducted if necessary.

(4) Forest Management

1) Felling

As felling is important work to determine the direction of forest management, the subject sites, quantity and felling method must be carefully determined based on a proper analysis and understanding of the conditions of existing stands and a practical idea regarding the desirable state of succeeding stands, including the method of regeneration after felling.

In the case of commercial timber production forests, the target diameter class for production and the rotation age must be determined in accordance with the production target. The standard felling volume must also be determined with the ceiling being the expected level of increment. The annual felling volume must be decided within the limit of this standard felling volume. If felling takes place in a conservation area, the scale must be within the limit of not disrupting the target function of the specified forest category.

a. Production Area

(a) Timber Production Forests

i. Commercial Timber Production Forests

As the production of timber is a long-term commitment, the felling volume must be determined to ensure the sustainability of resources, making the establishment of a reasonable production target essential. The principal felling method is clear cutting with the preservation of seed trees to ensure the regeneration of pine.

< Target Diameter Class for Production and Rotation Age >

The target diameter class for production is determined from the viewpoints of the perceived use of pine timber (which is the target product of forest management), average increment and economic profitability, etc. The rotation age provides the standard by which the felling age is determined for actual felling in the subject stands and coincides with the stand age, i.e. the time when the target diameter class for production is reached. In general, the target diameter class for production and the rotation age for pine are approximately 40 - 50 cm and 60 years respectively.

< Standard Felling Volume >

The standard felling volume is determined at a level which does not disrupt sustained harvesting and which ensures a stable supply of timber, taking the trends of timber supply and other relevant factors into consideration. The upper limit is the perceived increment of trees in the subject timber production forests during the forest plan period. If a stand has many trees which have reached the final age, the following formula is applied.

$$E = \frac{Ip}{2} + \frac{Vp}{T}$$

Where,

E: annual allowable felling volume

Ip: current annual increment

Vp: current growing stock

T: rotation age

In the case of a stand which has undergone extensive felling, there are not enough trees of which the felling can be compensated by the annual increment and the above formula cannot be applied. Instead, the viable use is restricted to the use of wood produced by tending work, such as thinning and stand improvement.

< Felling Method: Clear Cutting with Preservation of Seed Trees >

Trees of an excellent quality are left uncut for use as seed trees. The number of such seed trees is approximately 10 - 16/ha (at 20 - 30 m intervals) and the actual selection is determined on the basis of the topography, inclination, bearing and state of regeneration of the subject stand. To ensure the regeneration of the succeeding pine stand, species other than the target species are cleared as long as the healthy growth of the stand is not hampered by such clearance. An upper limit is introduced for the size of one felling block (approximately 5 ha) so that there is no continuity between felling blocks. Depending on the land condition, felling at the extent of one felling block will be desirable.

< Felling Sites and Felling Volume per Site >

The felling sites and felling volume per site must be decided to ensure felling in a planned manner. Even in the case of a timber production forest, arbitrary felling to meet a qualitative ceiling, which is determined based on the available resources, is not sufficient. Felling must be conducted in an orderly manner with proper planning which takes the protection of the newly regenerated stand, the water yield function of the stand in a given watershed and other relevant factors into proper consideration.

ii. Non-Commercial Timber Production Forests

In principle, the natural growth of trees is hoped for and selective felling to produce timber for home use is permitted if necessary as long as it does not drastically change the forest physiognomy. Since the growth of this stand is

slow it can not be treated as commercial timber production forest. In the long run, after sufficient progress is being made, in case trees which have reached the usable diameter class are collectively available in number, felling become possible under forest management similar to that for commercial timber production forests.

(b) Firewood Production Forests

As encino vigorously regenerates by means of both natural seeding and sprouting, stands which have reached a certain diameter class (DBH of approximately 20 cm or more) can be subject to felling. While the annual felling volume is determined based on the principles described for timber production forests, felling in each stand is possible within a limit not exceeding the annual growth rate of each stand. Selective felling which does not drastically alter the forest physiognomy is preferable to clear cutting. For the sustainable and orderly management of firewood resources, systematic determination of the subject stands to felling and regeneration for each year is desirable instead of subjecting all available stands to felling.

b. Conservation Areas

If there is no usable forest, felling may be permitted based on the criteria described below.

(a) Nature Preservation Forests

In addition to the collection of dead trees and dead branches, etc., a minimum level of selective felling may be permitted to produce timber for home use and firewood required to sustain the lives of local people. Any legal restriction regarding nature reserves, etc. must be observed.

(b) Headwater Conservation Forests

The clear cutting of a small area or selective cutting is permitted as long as such work neither jeopardises the function of headwater conservation nor drastically changes the forest physiognomy.

(c) Soil Conservation Forests

Selective felling on a minor scale is permitted within the limit of not hampering the soil conservation function.

(d) Other Conservation Forests

These are forests where the enhancement of vegetation must be given top priority. In principle, they should not be subject to felling although the minimum level of selective felling is permitted to produce timber for home use and firewood required to sustain the lives of local people.

c. Restoration Areas

These are areas in which forest restoration is given top priority and felling is, in principle, prohibited until the completion of the restoration process. Thereafter, however, forestry work can commence in accordance with the objective of each forest category.

2) Regeneration and Tending

a. Natural Regeneration

In general, pine enjoys excellent natural regeneration. This is because of such characteristics of pine as (i) little suppression of seedling growth because pine can grow in stands with low soil productivity and low forest floor vegetation and (ii) quicker growth speed of the seedlings after germination than other species.

Natural regeneration is opted for in the case of the Study Area at almost all pine forest land to make the best use of these favourable characteristics. Natural regeneration also appears to be technically and economically the most appropriate method.

As natural regeneration relies on favourable natural conditions, there is no guarantee that the required number of seedlings will be in place two or three years after felling when the regeneration process is completed. In addition, the distribution of the regenerated seedlings may be irregular. From the viewpoint of efficient timber production, some 1,250 regenerated seedlings per ha (12 - 13 seedlings in an area of 10 m by 10 m) at uniform intervals is desirable to secure the optimal distance between trees in order to achieve the maximum yield through favourable trunk growth.

When undergrowth and/or leaves, etc. cover the ground, forest floor clearance is required as supplementary regeneration work to allow the easy bedding of seeds falling from seed trees for assured regeneration.

This ground clearance generally consists of the clearing of limbs and tops, clearance of the ground vegetation and raking of the ground surface, etc. This work may be conducted depending on the conditions of the forest floor before or after regeneration felling. It is also conducted if the number of regenerated trees is found to be insufficient. Estimation of the growth prospect of seeds through observation is desirable which should be conducted prior to ground clearance work so that such a prospect reflects on the planning and implementation of regeneration work.

b. Artificial Regeneration

Artificial regeneration is a more reliable means of regeneration and is applied to those sites where sufficient natural regeneration is unlikely to take place. It has a much higher cost than natural regeneration as it requires ground preparation, planting and other work and the nursing of seedlings.

The natural regeneration of pine in the Study Area generally appears to be favourable. However, artificial regeneration must be opted for in the case of (i) the absence of seed trees of the target species for regeneration, (ii) an intended change of the forest management type to one of higher productivity, (iii) natural regeneration being considered difficult and (iv) intended forest restoration at a treeless site, such as abandoned farmland. The principle of the right tree on the right site is basically adopted in the selection of the planting species and pine appears to be the most suitable species for timber production forests in the Study Area. Even so, particular attention must be paid to the fact that the suitable species differs according to the environmental conditions, including elevation. The standard planting density is 2,000 - 2,500 trees/ha.

c. Weeding and Improvement Felling

If the target trees for regeneration are found to be competing with other trees, such trees are cleared to facilitate the growth of the regenerated trees. Improvement felling is conducted for the same purpose if trees other than the target species have begun to compete with the target species a few years after weeding. Improvement felling of the target species is conducted prior to thinning to foster high quality and healthy stands if the number of the target species is excessive and results in competition.

3) Thinning

Thinning is a type of felling which is conducted prior to regeneration felling and does not involve regeneration. It is conducted at those stands requiring density adjustment.

Thinning must be conducted to ensure the fostering of a healthy stand and the production of good quality timber based on a clear understanding of the growing stock of the subject stand, character and diameter class of the trees and other relevant aspects. The trees subject to thinning are selected in accordance with the following priority order.

- Damaged trees
- Medium diameter trees of poor character and lower-story trees, both of which are hampering the growth of seedlings/young trees
- Species other than the target species which are in competition with upper-story trees
- Poor quality trees in upper story
- Seed trees left behind after regeneration felling
- Healthy trees

Assuming a rotation age of 60 years, the general appropriate timing for thinning is when the subject stand is closed (15 - 25 years after the completion of regeneration) for the first thinning and when the subject stand is again closed after the first thinning (30 - 40 years after the completion of initial regeneration) for the second thinning. If the subject stand is excessively dense, it may be necessary to repeat minor thinning several times.

The thinning intensity is generally upto some 30% of the stand volume as the top priority is maintenance of the health of the stand. Another yardstick is to make the interval of the remaining standing trees after thinning approximately 1/3 - 1/4 of the tree height in the case of a common pine stand.

4) Stand Improvement

There appears to be many stands at present where encino and other species which are not the target species for regeneration have regenerated due to a small number of succeeding pine trees after regeneration felling (either selective felling or clear felling) caused by poor regeneration. Most encino trees have no suitable use other than as firewood for home consumption in local comunidades. No tangible demand for firewood other than for home consumption appears to currently exist. Accordingly, the improvement of timber production forests with a high Quercus mix ratio to those with a high pine mix ratio by means of removing encino trees so that forest land can

be more intensively used with increased pine growth stock should prove advantageous.

In those comunidades which are already engaged in active forestry production, the fostering of high quality stands by means of stand improvement should be considered from the viewpoint of further facilitating forest production activities. Such efforts should commence wherever possible, giving priority to forests characterised by favourable site conditions and vigorous tree growth.

This improvement work does not immediately benefit comunidades and demands the input of substantial labour which may prove a major obstacle. One feasible method of conducting this work is to carry it out in such a manner as part of the joint work for firewood collection to provide local people with an incentive. This should enable the effective use of the available resources. In the case of a comunidad having surplus labour, the idea of labour storage may become relevant whereby current surplus labour is input with its achievements stored in the form of forest to secure a high production level in the future.

This stand improvement can be achieved by the following methods.

a. Pine-Quercus Forests

The improvement felling or thinning of encino trees which hamper the growth of pine is conducted to facilitate pine growth. If the removal of encino trees leaves a large empty site, such supplementary regeneration work as raking of the ground is conducted to encourage the regeneration of pine. Planting is an alternative.

b. Quercus Forests

The clear felling or group felling of encino trees is conducted, followed by the planting of pine trees. If there are many pine stands nearby which provide a good prospect of regeneration by natural seeding from the side, such regeneration by natural seeding can be relied upon. In the case of clear felling, temporary agroforestry is an alternative with the cultivation of maize and frijol (bean), etc. for a certain period after felling, followed by the planting of pine.

3.5 Forest Management

The basic idea of forest management is to deal with forests by the formulation of a forest management plan which incorporates the method, scale and subject sites, etc. of the forest

operation for each forest category while taking the sustainable use of forests and desirable direction for forest management into consideration in view of the full performance of the functions required of each forest category.

The actual ways of utilizing forests and proceeding with forest production activities differ depending on (i) the site conditions of the forests possessed by a comunidad and details of the available forest resources in terms of species, age composition and scale, etc. and (ii) the intentions and experience of the comunidad regarding forest resources control, forest management and overall use of the land in its possession. The tasks faced by fore-running comunidades which are already engaged in active forest management cannot be the same as those faced by comunidades planning to organize and commence such work. Discrepancies also exist between comunidades where lives are largely dependent on profits obtained from forest production activities or where such activities are expected to provide the basis for life and comunidades which do not rely on forestry. What is required is the development and management of forests in accordance with the specific conditions or realities of each comunidad. A forest management plan can be both practical and effective by means of carefully considering these conditions and the background of the comunidad.

Forest management is a question of how the forests owned by comunidades should be utilized and is directly related to improving the local standard of living as well as local development. The direction of forest utilization and the desirable state of forests to be developed must, therefore, be determined with the consent of local people and a forest management plan must be formulated with a view to implementing concrete actions to achieve such a desirable direction of forest management, etc.

The issues related to forest management in the Study Area are discussed below from the viewpoint of forestry development which is the main purpose of the present Study.

(1) Forest Management Plan Period

As the successful rearing of forests takes an extremely long time, forest management must be conducted with a much longer plan period than in the case of other types of industrial management. While the plan period for forest management is generally 5 - 10 years, a longer plan period necessarily increases the level of uncertainty of the various factors involved, making it necessary for the plan period to allow realistic analysis of the plan's feasibility. In other words, the current conditions of resources, site conditions and socioeconomic conditions of the forests subject to planning must be taken into consideration when determining the plan period. Needless to say, forest management should not be considered completed after a certain period of time and sustainable

management and the creation of better performing forests should be aimed at. In this sense, the plan period must take forest utilization beyond the plan period into consideration and should allow room for revision based on a longer prospect if necessary. It may also be necessary to review the plan at regular intervals depending on changes of the socioeconomic situation, actual state of forest growth and/or other relevant factors.

(2) Forest Division

When a subject forest covers an extensive area, it is usually divided into areas of an appropriate size which enables adequate management. In general, a forest is divided into compartments which in turn are divided into sub-compartments.

Compartments are introduced on the basis of a certain criterion in terms of the land size when the original forest area is too large for the efficient planning and implementation of forest management. The purpose of dividing a forest into compartments is to precisely locate each compartment to assist the planning and implementation of forest management. As a compartment is a basic fixed unit for long-term forest management, its boundaries usually consist of such natural boundaries as a clear ridgeline or river channel and artificial boundaries, including roads.

A sub-compartment is a further division of a compartment based on a different forest operation method, species and forest age, etc. and is established to indicate an area under the same type of forest operation. Unlike compartments, the boundaries of sub-compartments can be altered to reflect a change of the forest operation method and/or results of forestry activities. Therefore, their boundaries must be reviewed every time a new plan is formulated.

(3) Management in Production Areas

As described so far, what is generally common to all comunidades in the Study Area is significantly differing forest vegetation from one comunidad to another which reflects the different environmental conditions determined by an elevational difference of from some 3,000 m in the highlands to some 1,000 m near the Rio Grande. Such changing conditions largely determine the method of forest management. Areas with a high elevation enjoy high forest productivity and the best forest resources and are, therefore, suitable for commercial timber production. The forest productivity declines in mid-slope semi-arid areas and the character of the trees for commercial timber production is poorer. Nevertheless, it is still possible to produce timber and firewood for home use and settlements and agricultural land are mainly observed in these areas. Below these areas, it becomes increasingly difficult to conduct either agriculture or forest and no forest in the category of a production

area exists. Under these circumstances, the principal method of forest management is determined by the intended forest utilization by individual comunidades, i.e. either commercial production or non-commercial production (for own use).

These conditions are schematically shown in Fig. 3-5-1. In the figure, 0 to V indicate different stages of forest utilization. At Stage I, forests are mainly utilized as a direct means of supporting local lives. At high stages, the intensity of commercial production gradually increases to Stage V where no more production for own use is conducted. Stage II through Stage IV are intermediate stages with a different degree of emphasis on the two elements.

Even in the case of forests classified in the production area category, the direction of forest management is determined based on the relative degree of emphasis on own utilization or commercial utilization. This reflects the choice of either seeking profits to develop social infrastructure if possible or emphasising the securing of the maximum area of forests for own utilization. Forest management is conducted in accordance with the choice made.

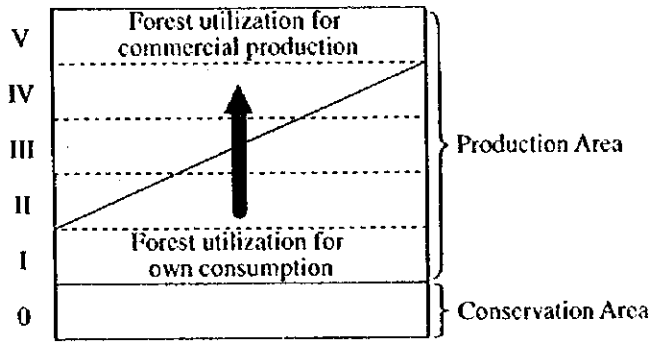

Fig. 3-5-1 Stages of Forest Utilization

(4) Management of Timber Production Forests (Commercial Timber Production)

When considering the best way to manage timber production forests to achieve the best economic profits for comunidades, fore-running comunidades are required to aim at achieving a more mature style of management which is characterised by intensive forestry work and the improved productivity of forestry activities, etc. in order to achieve further improvement in the form of a continual increase of profits and increased productivity, etc. Even though it is difficult to determine the appropriate intensity level, attention must at least be paid to achieving (i) an increase of the production volume per unit area by means of stand improvement designed to increase the mix ratio of pine, (ii) the production of good quality, large diameter timber through active thinning and/or (iii) the improvement of

the operational organization to enhance the operation rate of yarding cranes and other machinery which demand large investment.

Moreover, while timber production forests are classified into those for commercial production and those for non-commercial production, i.e. for own utilization, depending on the productivity level described in (3) above, different styles of forest management must be employed for these two types of timber production forests to ensure the stable management of forestry activities.

In the case of late starting comunidades, it is difficult for them to immediately catch up with the level of forest production activities of fore-running comunidades. Their main tasks are, therefore, to determine the direction for forest improvement based on the present state of forest resources and to identify feasible forest production activities at present in order to consolidate the necessary foundations for forest management with a view to developing forestry activities in the future along the desirable path. The most practical way is to commence with modest production activities with the purpose of gradually proceeding to more active management through the accumulation of profits. Some comunidades are considered to be late starters simply because of the small scale of a timber production forest. It may be possible to use this small scale as a managerial advantage to quickly respond to market requirements. One option is to aim at creating forests with high productivity per unit area in the future based on the idea of labour storage (for example, unemployed labour from farming sector during the rainy season) described earlier even though this will not have any quick, short-term economic effects.

The exchange of information on the technical as well as operational aspects of forest management between comunidades is recommenced with a view to enhancing the quality of management. The exchange of information will increase the knowledge of all participants and will have significant effects on overall local development, not confined to the forestry sector.

(5) Operation System

Felling and the other principal operational components of forest production do not appear to adopt uniform standards. As individual comunidades assign personnel to their own operation groups, this operational set-up is liable to problems regarding operational efficiency and labour safety.

A thorough review of the operational components is highly desirable to make workers fully understand operational standards and arrangements in order to improve productivity

as well as labour safety. The provision of appropriate education and training for workers must also be considered with a view to improving their skills.

(6) Production Equipment

The level of production equipment owned varies from one comunidad to another. It is essential for all comunidades to arrange such equipment (by means of new procurement, disposal and/or renewal) in view of its compatibility with the scale of activities, efficient use and future operation prospects, etc. to improve both the productivity and profitability of forest production activities. As expensive machinery in particularly greatly affects the production cost, its efficient use must be achieved through a thorough analysis of its operational status. Improvement of the operation rate by means of borrowing machinery from a comunidad with surplus machinery and/or establishing a joint procurement and management system provided that the necessary agreement can be reached between comunidades may prove to be very efficient.

(7) Forest Roads

1) Basic Concept of Forest Roads

Forest roads are essential for the efficient development of forest management and the proper maintenance of forests. They also play an important role in improving the living environment for comunidades. Improvement and promotion of forest roads therefore are important.

The general picture of forest roads in the Study Area is that ordinary roads link comunidades to national roads and either forest roads or spur roads are in place in forests which have undergone felling in the past. While some ordinary roads are well maintained in some comunidades, many require repair. In the case of forest roads and spur roads, maintenance is not conducted once felling and logging have been completed.

The basic concept of forest roads in the Study Area is that ordinary roads will be used as local trunk roads and will be properly maintained, including levelling of uneven surfaces and the repair of side ditches to provide adequate drainage, while ensuring smooth and safe vehicle traffic. Forest roads and spur roads extending to and in forests will be developed in time for planned felling. Priority will be given to the improvement or repair of existing roads. In the case of roads to be newly constructed, the construction cost, expected profits from forestry activities, forest management

requirements, necessity from the viewpoint of local lives and likely impacts on the environment must be properly examined.

2) Repair of Forest Roads

Existing forest roads suffer from various types of deterioration as listed below.

- Uneven surface or rills
- Muddy surface due to poor drainage
- Scoured or buried side ditches
- Conspicuous growth of shrubs or large plants on the shoulders
- Cracks on the valley side of the sub-base

Such deterioration can be improved by the following methods.

- Levelling of the uneven surface by a bulldozer or other machinery and the removal of grass and shrubs (manual work in the case of it being on a small scale)
- Excavation of buried side ditches
- Introduction of a drainage system at sites likely to become muddy
- Repair of shoulders and cracked sections by means of cutting the slope and/or re-banking with net or gabion works being applied at the tip of the cracked section to secure the road bed

These improvement works should be systematically conducted by deciding the priority order of the subject roads while taking their relative urgency in terms of the felling plan and forest fire prevention and relevant issues from the viewpoint of forest management into consideration. Ordinary roads in particular are life-lines for local life and the state of these roads considerably affects the timber transportation cost to Oaxaca in the case of comunidades lying deep inland, making their constant maintenance essential to keep them in good condition. The constant repair of minor defects should prove cost effective in the long run as costly major repairs can be avoided.

(8) Forest Protection

1) Prevention of Forest Fires

a. Control of Burning

Local people are strongly aware that forest fires can destroy forest resources, which are common assets, and the importance of forest fire prevention is well understood. Nevertheless, forest fires constantly occur in the Study Area and are mainly caused by the accidental spread of fire due to burning for agricultural and stock raising purposes. A major forest fire which destroyed forest areas around S.M. Buenavista in May, 1998 is a case in point (originating from agricultural burning). Mexico's official standards (NOM-EM-003) stipulate how fires in forests and at farmland and grazing land should be handled but are not well understood by local people. It is desirable for the SEMARNAP, SEDAF and other administrative organizations to improve awareness of the need for fire prevention among local people through the provision of guidance for local people and promotion of the necessary understanding in comunidades, including the introduction of rules on the compulsory notification of the timing and place of burning by local people to the local authority.

b. Fire-Fighting System in Comunidades

In comunidades with a forest production unit (unidad de produccion forestal), the community council (comisariado comuna) and the forest production unit have jointly established a fire-fighting system. In those comunidades without a forest production unit, the community council plays a central role in forest fire prevention and forest fire-fighting even through no official organization is assigned to these tasks. In either case, an efficiently functioning fire-fighting system is necessary to minimise the damage of forest fires. Early fire-fighting prior to the spread of a fire is preferable and a quick response by the nearest comunidad to a fire is essential to minimise fire damage.

What are required to prevent or minimise fire damage are (i) a surveillance system during high fire hazard periods, (ii) a fire spotting and reporting system (to the comunidad in which the fire occurs, neighbouring comunidades and SEMARNAP forest guards, etc.), (iii) provision of fire-fighting equipment, (iv) clarification of role of each party in fire-fighting activities (for example, relating to the introduction of fire-fighting teams, the respective role of each team and fire-fighting command system) and (v) a thorough understanding on the part of comuneros of the above systems, etc. and field exercises to ensure the proper functioning of such systems, etc. In addition to the establishment of an effective fire-fighting system,

administrative guidance by the SEMARNAP and SEDAF and cooperation between the administration and comunidades are also very important.

2) Prevention of Diseases and Pests

The most damage to trees by either disease or pest in the Study Area is caused by the decorticator or bark remover (*Dendroctonus* spp.) to pine forests. Decorticator initially arrives at a pine stand from outside the stand. When it successfully settles and damages a small number of pine trees, it uses such trees as propagation sources. The damage gradually spreads to neighbouring trees and can be very extensive. The detection of damaged trees at the initial stage of invasion and suitable treatment are crucial. There are various methods of preventing pest damage, including the spraying of damaged trees with insecticide, the felling and burning of damaged trees and the logging of damaged trees outside the area after felling. At present, the most effective and economical method is to fell and peel damaged trees at the initial stage of damage, followed by burning of the peeled bark and logging of the peeled logs outside the area. If the damage is detected sufficiently early, the damaged trees can be used to produce pulp.

As it is reported that forests liable to damage by decorticator are those which have previously suffered a forest fire or those with low soil productivity, the priority monitoring of these forests should lead to the early detection of damage.

(9) Forest Management Organization

Forest management which is based on certain principles and which has continuity under some kind of management system is essential for the joint management of forests by comunidades as the fostering and management of forests is a long-term commitment. Given the different forest resources available to individual comunidades and the different functions required of forests by each comunidad, forest management must be appropriate vis-a-vis the forest realities.

Comunidades which are actively engaged in forest management have already established forest production units to conduct forest management under a specific system. It appears important for these comunidades to establish a system capable of providing stable management from a long-term perspective so that more active forest management can be conducted. The present management system, however, is not necessarily stable as the persons assigned to forest management are frequently changed.

At present, following a resolution passed by a general meeting of the comunidad, persons responsible for forest management are appointed. Those responsible for the technical aspects of forest management are qualified technicians who are invited from outside the comunidad. The former change at the end of their term while the latter also face a risk of change due to them being outsiders. This prospect of changing personnel may well become a factor in the implementation of forest management based on a long-term perspective. The problem regarding the former is unavoidable because of the inherent system of comunidades. As the appointment of outside technicians may result in permanent dependence on outsiders, it may be a good idea to try to foster technicians within comunidades. Such local technicians could work as assistants to those responsible for forest management and may be able to compensate for the weak points of management staff. In the case of those comunidades which enjoy profitable forestry activities, these could bear the cost of technical education/training to make insiders obtain the necessary qualifications in exchange for the obligatory commitment of newly qualified technicians to the forest management of their own comunidads.

In the case of those late starting comunidades which are currently planning more active forest management, the first target should be the establishment of the system possessed by fore-running comunidades with a view to gradually developing the system based on their real strength. An important option is the establishment of a forest comunidad union (unión de comunidades forestal), such as the UZACHI or IXETO if comunidades with a similar situation can reach an agreement.

For those comunidades which have no forest resources subject to active forestry activities or those which can only anticipate intermittent forest management due to the small forest size, it is practically impossible to opt for one of the two organizational arrangements described above. The most realistic choice for these comunidades is for the council of the comunidad or a similar organization to play a central role in forest management.

Forest management should not be a matter of interest for only those responsible for it but must be conducted to serve the interests of all local people. Accordingly, it is essential that the forest management system of a comunidad incorporate a system to allow the participation of all local inhabitants (both man and woman) in an appropriate manner.

(10) Individual Plans Related to Forest Production

Forest production activities are currently dominated by felling. The basis of forest management is the development of a system whereby forest resources can be sustained and improved on a permanent basis. Efforts must be made to plan the sites, method and work

volume, etc. for such individual work as planting, tending, seedling production, forest road construction/repair and so on based on a relevant forest management plan prior to the implementation of work each year.

(11) Recording of Forestry Operation

Recording of the forestry activities conducted each year not only provides basic data for subsequent activities but is also necessary to establish a clear understanding of the state of forests. The existence of such records contributes to the continuity of activities even if the persons responsible for forest management change. An operation register should be prepared for each stand (sub-compartment) to record details of felling, regeneration and tending work and the observation results on damage, species, character and growth situation, etc. If sufficient labour and time are available, another book should be prepared to record and compare the progress of each year's individual plans so that the analysis results can be used to improve subsequent plans.

One idea may be for fore-running comunidades to conduct a production cost analysis based on operation records and other data to identify problems with a view to improving the efficiency of forest management activities. In this case, any decision to reduce the number of workers for the purpose of cost reduction should not be taken without extremely careful consideration as forest production activities are an important source of local employment opportunities.

3.6 Promotion of Forestry and Forest Products Industry

(1) Basic Concept of Promoting Forestry and Forest Products Industry

Not all comunidades in the Study Area are on the same socioeconomic level. Their differences can mainly be attributed to the amount of profits from forestry activities as they are largely dependent on such profits for the development of all types of infrastructure. In the case of comunidades of vigorous forestry activities, the profits even benefit individual households, illustrating the importance of promoting forestry and the forest products industry to improve the lives of local people. As forestry profits mainly come from the production of commercial timber, the development of forestry to produce commercial timber should be the main direction for the promotion of forestry and the forest products industry. However, a single target level for the promotion of forestry and the forest products industry should not be introduced as the conditions of each comunidad differ.

For those comunidades with excellent pine forests which can be used for commercial purposes, the main tasks are improvement of the productivity of pine forests and to aim at

establishing forest management practices designed to increase profits. Conversely, those comunidades without many such excellent pine forests have no choice but to conduct commercially-oriented forestry activities on a smaller scale. It may be an idea for these comunidades to aim at achieving intensive management, making the best use of small-scale operation.

In addition, forest management to secure the supply of timber and firewood for home use to maintain the daily lives of local people is essential for all comunidades regardless of the existing level of excellent pine forests.

The use of forests depends on the site conditions and available resources of the forests owned by individual comunidades and also on the particular intentions of each comunidad. The Study Area is geographically divided below based on the current level of forestry activities of comunidades and the endowment level of pine resources and possible measures to promote forestry and the forest products industry in line with the actual conditions of each area are examined.

(2) Geographical Division Based on Level of Forestry Activities in Study Area

The Study Area can be divided into the following geographical areas based on the SEMARNAP classification of comunidades, in turn based on the situation of forestry activities, and on the pine resources of individual comunidades.

1) Southern Area

There are many excellent pine forests which are suitable for commercial use. This area is characterised by vigorous forestry activities by comunidades which take advantage of these forests to produce rough and sawn pine timber. Forestry activities should be further promoted.

2) Northern Area

Although there are many excellent pine forests suitable for commercial use, these forests have so far been used for the collection of firewood for own use. The level of forestry activities is not particularly high despite the sale of standing trees and the production of logs. Given the high production potential, forestry should be promoted.

3) Central Area

This area is further divided into areas where excellent pine forests suitable for commercial use have been virtually felled and areas where the collection of firewood

is the only current activity due to the absence of excellent pine forests. In the former, forestry can be promoted due to the high production potential while the promotion of forestry cannot be anticipated in the latter.

4) Mesofilo Forest Area

Pine forests suitable for commercial use are virtually non-existent in this mountain mesofilo forests area and only firewood for own use is collected. This is an area in which the promotion of forestry cannot be anticipated.

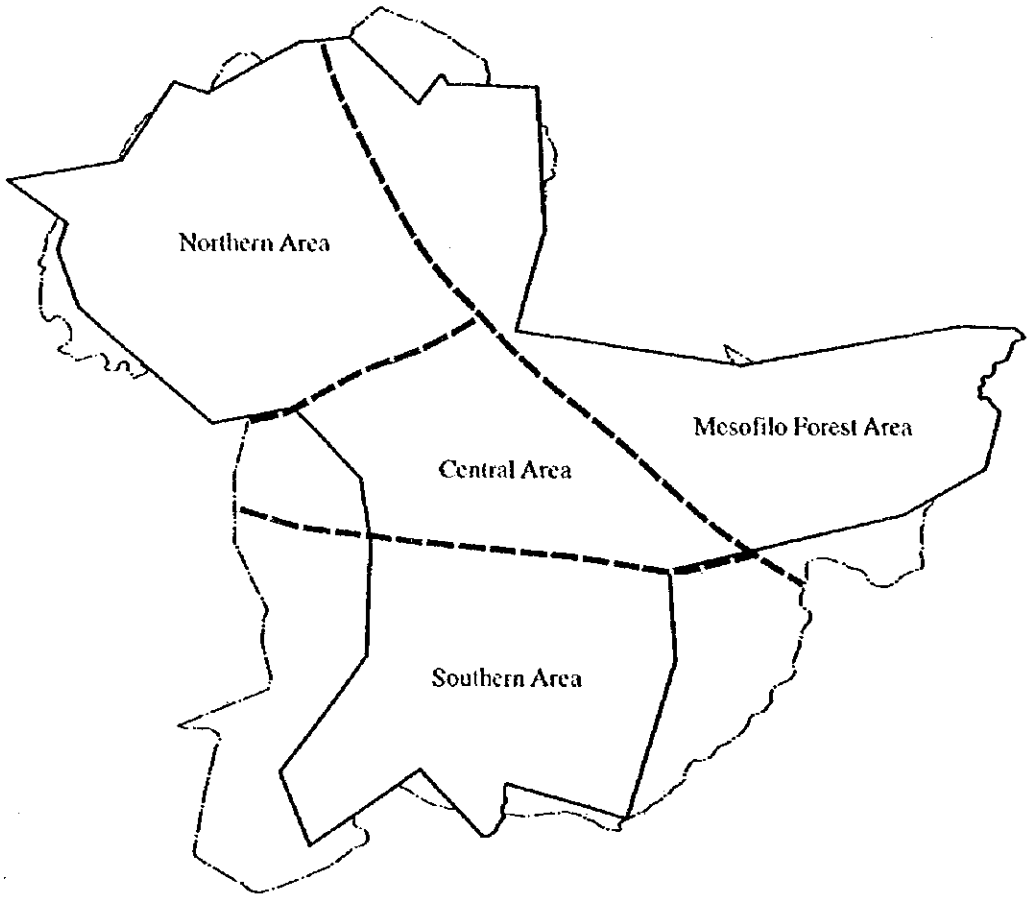

Fig. 3-6-1 Geographical Division of Study Area Based on Situation of Forestry Activities

(3) Tasks for Promotion of Forestry and Forest Products Industry by Geographical Area

1) Southern Area

This area is characterised by the most vigorous commercial forestry in the Study Area. One advantage of conducting forestry activities in this area is the existence of a through national road in areas with an elevation of 2,500 m or higher where there are many excellent pine forests. As a result, access to these forests is easy, providing far

better infrastructure to stimulate forestry activities compared to comunidades which are not served by a national road.

Upto the early 1980's, the selective felling of good quality trees was conducted by concessionaires. In the second half of the 1980's, however, comunidades took over forestry activities. Today, some comunidades are engaged in the production of logs while others have a sawmill or even a simple woodworking plant.

The reality of forestry activities is that the potential productivity of stands is not fully exploited despite rich resources due to the high occupation ratio of encino trees or over-crowded stands, both of which can be attributed to insufficient tending, leaving room for the more effective use of forest resources. Moreover, the annual harvest falls short of the allowable felling volume in many cases, making the consolidation of an effective forest operation control system desirable.

This is a fore-running area in terms of forest management regarding the production of commercial timber and the preferable direction for future development may be further enhancement of the productivity by means of fostering excellent stands to make the area a model for other areas and an increase of the profits by means of intensive forest management.

2) Northern Area

As in the case of the southern area, many excellent pine forests suitable for commercial use exist in places with a high elevation. The level of forestry activities is generally low as there are comunidades which have suspended such activities, comunidades where forestry activities are not a high priority and comunidades where the forest management system is inadequate despite ongoing forestry activities.

Some comunidades have now ceased to conduct forestry activities due to various reasons, including the long distance to the nearest national road in the direction which makes timber transportation more costly than it is for other comunidades and such inappropriate forestry activities as felling, regeneration and tending, etc.

Meanwhile, there are some comunidades which still have excellent pine forests and have only recently started to use pine resources in the form of the sale of standing trees with a view to producing logs in the near future.

Some comunidades enjoy rich forest resources and their forestry activities include sawmill operation. The scale of business operation is still small compared to the volume of forest resources and the management system is not fully established. In addition, the long distance to a paved national road via poor local roads means that most of the profits from forestry are used for road maintenance and cannot be distributed to the development of living and other infrastructure.

As described so far, the northern area has rich pine resources which are suitable for commercial forestry activities and there is large potential for more vigorous forestry activities. At the same time, it faces many pending tasks as listed below.

a. At comunidades with rich pine resources but where forestry activities are not conducted, forest management aimed at producing commercial timber should be introduced.

b. At comunidades hoping to further vitalise their forestry activities, more advanced management should be aimed at.

c. At comunidades where some production activities are conducted with a sawmill but where the operation management system is still immature, the establishment of appropriate operation under a coherent system should be aimed at.

3) Central Area

In this area, fine quality trees in many pine forests have been selectively felling but the past existence of large diameter pine forests illustrates the high production potential. Some comunidades still have pine forests which are suitable for commercial production to a certain extent while others have few such forests. In both cases, however, the level of current forestry activities is low.

In the case of comunidades with pine forests which are suitable for commercial production to a certain extent, the production of logs by these comunidades should prove feasible while consolidating the forest operation system and improving forests by means of thinning and stand improvement work, etc.

The scale of forest management is necessarily small at those comunidades which have few pine forests which are suitable for commercial production. One advantage of small-scale management is that carefully planned intensive activities are possible. For these comunidades, the main task is the establishment of a management base to

develop forestry activities while making the best use of this advantage. Even if an area of pine forest is as small as 300 ha for example, high average growing stock of 200 m^3/ha at the time of reaching the stage of a normal forest will result in total growing stock of 60,000 m^3. Assuming a rotation age of 60 years and an average volume of 400 m^3/ha at the rotation age, a final yield of 2,000 m^3/year can be expected.

The direction for promotion of forestry and the forest products industry is summarized as Table 3-6-1 considering the circumstances.

Table 3-6-1 Direction for Promotion of Forestry and Forest Products Industry

Area	Contents of the Direction
Southern	1) Improved productivity and profits through intensive forestry activities
Northern	2) Commercial forestry activities 3) Forestry activities aimed at producing logs 4) Establishment of a forest operation management system
Central	5) Forestry activities focusing on forest improvement 6) Small-scale and intensive forestry activities

(4) Measures to Promote Forestry and Forest Products Industry

Based on the identified tasks for the promotion of forestry and the forest products industry for each area described above, the key points of the measures designed to promote forestry and the forest products industry by area are examined next for the southern, northern and central areas which can be duly considered forestry promotion areas. Although the ultimate objective is to establish the sustainable production of commercial timber with a perceived better profit earning capacity, the actual measures to be taken differ from one area to another, reflecting differences in terms of the scale of operation and stage of business development.

1) Southern Area

Active thinning and other work must be conducted in this area to increase the occupancy ratio of pine through stand improvement to improve profitability and to foster excellent stands capable of producing large diameter and high quality timber.

Pine forests in this area have a high potential to produce excellent stands through appropriate activities because of the favourable growth conditions.

As improvement of the production efficiency is important to achieve the planned log production volume, it will be necessary to review the log production process to establish a more efficient work system and to improve the machinery operation rate.

In regard to forestry machinery, if the level of investment vis-a-vis the production scale is considered to be excessive, the necessity to keep the present range of machinery must be examined at the time of renewal with a view to the loan of surplus machinery to late starting comunidads. Borrowing from fore-running comunidades should be considered if there is a shortage of machinery.

The possibility of establishing a mechanisation centre or similar under a forest comunidad union (unión de comunidades forestales) of comunidades, such as the UZACHI or IXETO, should be explored in view of the collective management of all machinery to achieve efficient use. While dependent on successful negotiations with a paper mill(s), several comunidades may be able to establish a joint chip plant to produce and sell chip to a paper mill(s) to facilitate the use of thinned wood as well as wood chip produced by sawing activities.

What is commonly important for those comunidades planning to actively proceed with forest management, particularly in such an area where forest management is much advanced, is to obtain as much market information as possible to achieve the profitable sale of logs according to the current practice of negotiated agreements. This information may be obtained by and provided to comunidads by the forest comunidad union described above if such an organization is successfully established.

More advanced forest management than the production of logs will involve sawing activities by comunidades. However, the fact that a sawmill should only be established by a comunidad when investment in sawing equipment can be justified by the profit forecast in view of the production scale and managerial capability of the comunidad must be carefully considered.

In regard to sawmills, sawing techniques, such as the sawing method and sharpening, etc., must be improved to increase the production efficiency, i.e. the sawing yield rate. In some cases, the renewal of equipment should be considered by means of using the internal reserve.

Given the fact that higher quality sawn timber naturally fetches a better price, the careful handling of logs is required in regard to drying, etc. to prevent blue stain.

Sawdust is not currently used. It may be a good idea for the administration to study the production of sawdust compost as a profitable use of sawdust. When such production is believed to be feasible, the technique can be passed to comunidades which in turn can produce and deliver sawdust compost to comuneros to increase the agricultural productivity.

The establishment of firm organizational arrangements to ensure sustainable, stable and efficient forest management in the future is also necessary. To this end, the training of forestry engineers and other personnel from among the members of comunidades should be considered. Active use of the training system under the PROCYMAF which is being implemented with the assistance of the World Bank should be made. One future option is for comunidades to establish a scholarship fund using forestry profits to train forestry engineers so that children of a suitable calibre can use the scholarship to receive a higher education.

2) Northern Area

a. Commercial Forest Management

The forest management target for comunidades with rich forest resources is the production of commercial timber, following the example of fore-running comunidades, to make the best use of the available resources.

One of the main reasons why comunidades fail to implement efficient forest management is the prohibitive cost of formulating a proper forest management plan. Efforts must be made to establish a system whereby the administration provides the necessary assistance in accordance with the Forest Law so that a forest management plan can be properly formulated. The introduction of a forest comunidad union of comunidades which will assign engineers to plan formulation is another possibility.

In regard to forestry activities, as it is difficult to immediately proceed to the stage of log production, it is advisable to commence with the sale of standing trees with a view to gradually consolidating a forest production unit which is capable of producing logs without external assistance.

b. Forest Management Aimed at Log Production

In the case of those comunidades which already sell standing trees, the immediate target is to shift to log production with higher added value because of the good potential of conducting more active forestry activities using the rich pine resources. As the sale of logs requires a strong business management system, the conventional system where comunidad leaders are also responsible for forest management should be revised and a full-time forest production unit should be established to conduct the said management in line with specific principles. The introduction of an independent forest production unit, as in the case of fore-running comunidades, should be considered as such a unit will be able to concentrate on forestry activities, the sale of logs, extension activities aimed at local people and other forestry activities, consolidating the foundations for more advanced forest management.

For the successful transition to a forest management system capable of log production, it may be necessary for local people to participate in the felling and tending work conducted by specialist companies and fore-running comunidads to learn the relevant skills and techniques.

c. Establishment of Forest Management System

In the case of those comunidades which are unable to effectively use the available resources due to an inadequate management system even though they are already engaged in log and timber production, the target is to firmly establish a system whereby forest management is conducted under specific principles to increase the profits. It is essential for the independent forest production unit described earlier to learn appropriate management methods from fore-running comunidades to strengthen their own management system. A future target is the development of a system whereby engineers trained by comunidades can revise and implement forest management plans designed to suit changing needs.

In regard to sawmills, improvement of the sawing method, sharpening and other sawing technologies is very important as described earlier. The assistance of the administration is required to improve the situation where most forestry profits are spent on road maintenance due to the poor road conditions.

3) Central Area

a. Forest Management Centering on Forest Improvement

At those comunidades where some pine forests which are suitable for the production of commercial timber still exist but where excellent pine trees have mainly been felled in the last 30 years, the present forests are characterised by stands where the regeneration of pine is poor due to the dominance of left over pine trees and encino in the upper-story or stands where small diameter pine trees densely grow. The structure of these forests does not allow sustainable forest management. In this case, the main target should be forest improvement focusing on stand improvement work, thinning and other tending work to stimulate pine growth with a view to shifting to a forest structure which is capable of sustainable production in the future.

As in the case of the small-scale intensive forest management described next, the emphasis of forest management on tending in these forests means that local people cannot immediately expect large profits. Given such a prospect, the establishment of a system to maintain interest in and commitment to forest management on the part of local people is crucial.

b. Small-Scale Intensive Forest Management

For those comunidades which have some pine forests which are suitable for the production of commercial timber despite the generally small forest area and pine forest area in particular, the target is to aim at achieving small-scale intensive forest management. One advantage of small-scale forest management is that careful attention to all corners of a forest is possible because of the small size, allowing intensive activities to produce large diameter and high quality timber. However, the existing pine forests have temporarily undergone the selective felling of fine trees in the past and there is no forest with large growing stock and a favourable age class distribution. As a long time is required to develop excellent forests, the immediate work must focus on tending, providing little prospect of high profits. Under these circumstances, it is essential to conduct forestry activities with commitment and patience while securing the consent of local people. Low cost operation is another important consideration.

Small-scale intensive forest management means that the procurement of machinery, etc. to establish a log production system could prove too expensive for comunidades. Consequently, it may be necessary to introduce a system to borrow

machinery from other comunidades for the sale of standing trees or the production of logs to ensure a reasonable profit level.

(5) Required Actions of the Administration

In addition to some of the actions described earlier, the administration can implement other positive actions, including (i) development of the use of small diameter logs and markets for products made out of small diameter logs and the provision of a subsidy for the installation of equipment for the efficient sawing of small diameter logs with a view to encouraging forestry activities, such as thinning, and (ii) research and experiments to develop the use of encino which exists in abundance.

One good idea to assist the balanced development of the Study Area is the construction of a through road which is passable for vehicles between National Route 175 to the east of the Study Area and National Route 131 to the west of the Study Area in the direction of Cuicatlán to consolidate the basic conditions for the development of the central and northern areas of which the development lags behind the southern area. As only a short distance of this road awaits completion, the administration should give it higher priority. In addition to the construction of the remaining section, road improvement work must be conducted at many poorly maintained sections to upgrade them for use by ordinary vehicles.

The assistance measures to be considered by the administration are outlined below.

1) Construction of a through road between National Route 175 to the east of the Study Area and National Route 131 to the west of the Study Area in the Cuicatlán direction and improvement of the roadbed to support general vehicle traffic

2) Maintenance of the roads linking comunidades in remote areas to a national road or the provision of a subsidy for these comunidades to conduct the said road maintenance

3) Provision of technical guidance on the formulation of a forest management plan for comunidades which lack the financial resources for forest management plan formulation

4) Provision of technical guidance on forestry activities for the self supply of forest products which do not require a forest management plan

5) Provision of guidance on the organization of a forest production unit

6) Provision of guidance on the establishment of a forest comunidad union of comunidades

7) Development of the use of small diameter logs and the development of markets for products made out of small diameter logs

8) Provision of a subsidy for the installation of sawing equipment for small diameter logs

9) Development of the use of encino

10) Development of the use of sawdust

(6) Forestry and Forest Product Industry Promotion Measures

These forestry and forest product industry promotion measures are compiled in Table 3-6-2 where important measures and particularly important measures are marked by ○ and ◎ respectively. All of these items and options relate to comunidades outside the Study Area in one way or another and, therefore, should prove useful for the promotion of forestry and the forest products industry throughout Mexico.

Table 3-6-2 Options for Forestry and Forest Products Industry Promotion Measures

	Item	Option	Southern Area	Northern Area			Central Area	
			(1)	(2)	(3)	(4)	(5)	(6)
Commitment by Comunidades	Forest Management Plan	- Learning from fore-running comunidades - Formulation of forest management plan by engineers of forest comunidad union (including revision) - Use of PRODEFOR	◎	○		◎ ○	○	○
	Forest Operation	- Fostering of excellent stands (thinning and stand improvement) - Use of PRODEFOR	◎			○ ○	◎ ○	◎ ○
	Forest Management Body	- Establishment or strengthening of forest production unit		○	◎	◎	○	○
	Machinery	- Establishment of mechanization centre - Improved machinery operation rate	○ ◎			◎		
	Appropriate Sale		○	○	○	○	○	○
	Log Production	- Review of work processes - Learning of log production technology	◎		◎	◎		
	Sawmills	- Improved sawing technology (sawing method and sharpening, etc.) - Use of sawdust	◎ ○			◎ ○		
	Training of Engineers	- Use of PROCYMAF - Training of selected members of comunidades as forest engineers	◎		○	◎ ○	○	○
Commitment by Administration	Ordinary Roads	- Construction of a through road from the east to the west of Study Area - Maintenance of roads linking comunidades to national roads		○	○	◎ ○		
	Forest Management Plan	- Technical guidance		○			○	○
	Forest Operation	- Technical guidance		○	○	○	◎	◎
	Forest Management Body	- Guidance on establishment of forest production unit		○	◎	◎		○
	Machinery	- Subsidy for installation of sawing equipment for small diameter logs	○			○		
	Development of Demand	- Small diameter pine logs - encino - Sawdust (Study of production of sawdust compost)	○ ○ ○	○	○	○ ○ ○		

Notes:
(1) Improved productivity and profits through intensive forest management
(2) Commercial forest management
(3) Forest management aimed at log production
(4) Establishment of forest management system
(5) Forest management centering on forest improvement
(6) Small-scale intensive forest management

3.7 Community Development

(1) Basic Concept of Community Development

Historically, the communities in the target area have tried to improve the standard of living with their own initiative. It is perceived that the communities with active participation of the people tend to be better off than the other communities. In order to play active role in community development, the people have to unite firmly and find the way in which they will not have to depend on the external assistance. They must understand the potential of their natural, human and economic resources and discuss their well-being from the long term perspective. With the active participation of the people, it is possible to improve the feasibility and sustainability of the project, as well as to maximize the impact of the project.

Because the people are the main actors, it is necessary to encourage them to stay or return to the community. To accomplish this, it is important that the communities possess the basic infrastructure which help the people lead a good social and mental life. At the same time, it is indispensable to secure source of income to sustain their lives. Presently, the major sources of income among the people in the target area, are the money send from family members who work in the United States of America. It is dangerous to count only on this, since many are illegal workers who are subject to deportation and do not have any social security. It is desirable to generate their income within the community, using community resources or at least, to generate employment in the nearby communities.

To quire the above mentioned needs, it is important to combine regional community development strategies together with individual community development strategy. By implementing regional strategies, it is possible to deal with problems which each individual community can not solve alone. Also it is important to take in account the combination of two aspects of development: Hardwear development such as construction of basic infrastructure and software development such as human development or creation of network among the communities. In this context, it is indispensable to consider social aspects of development, including gender.

(2) Community Development through Forestry Activities

Forest resources are the only natural resource in the target area. Forestry is very important to develop the communities. The following are some of approaches for community development through forestry, which can be applied to the communities in the target area.

1) Forest Management with Active Participation of the People

The participation of both men and women in forest management, can enhance development potential within the community. Also the forest management may become more elaborated and sustainable. And the Active participation implies that people realize that they are the owner of the forest and take actions with an intention to manage it.

The Participatory Rural Appraisal (PRA) is one of the useful methods to motivate people to commit themselves to forest activities. Through PRA, people will become aware of their own potentials and limitations, and will seek improvement. For example, they will be able to make decision objectively as to how their resources should be used, based on the information on their land , forest and human resources in the community. They will be able to find alternatives which do not cause problems with the social values of the community. Also, to understand the limitation of their capacities help them prepare substantial plan. The exchange of information among the communities is another useful means to motivate the people. By exchanging information, people will be motivated or will able to come up with different options to combat problems. For example, people will be able to learn just by visiting other communities and exchanging their opinions with others who practice adequate thinning and maintain pine forest in a good condition.

2) Improvement of Basic Infrastructure by the Cash Income from the Sales of Forest Resources.

To apply sustainable forest management on forest and to utilize the cash income from the sale of forest resources for construction and improvement of the basic infrastructure is another way to promote development in the community.

In the target area, the sales of forest resources were used for construction and improvement of the basic infrastructure. But in reality, the volume of the forest varies from the community to another. In fact, it is very difficult for the community to construct or to improve it, if they do not have forest resources. If these communities keep depending on the forest resources, the communities with better forest resource will develop faster than the less fortunate communities. The government should understand this possibility and consider to implement some measure to avoid unequal development in the area. For example, the community, with limited forest resource, needs government development assistance which include the construction of access road to national highway as well as construction of basic infrastructure. On the other

hand, the community, which has abundant forest resources, needs the government support to implement project with peoples' initiative.

Those communities which do not have any economic forest resources, at present should dedicate themselves to manage and to create the forest for future use. To achieve this, the people in the community should be highly motivated to maintain their active participation in forestry management.

3) Income Generation through Forestry Activities

To carry out sustainable forestry to create and secure the job opportunities for the people is also important.

Forestry can not itself provide sufficient income which will substitute for the money sent by the emigrants. Thus, it is not very productive to depend on this money. Instead it is wise for the people start thinking about the use of the allowance in the long term perspective.

As forestry activities depend on the resource in the community, its sustainable and maximum use will help to stabilize the people life, and thus provide the basic condition for the people to come up with a long-term plan.

3.8 Gender Consideration

(1) Women in Development (WID) and Gender Consideration

First of all, it should be clear that this report defines WID and Gender consideration as following. WID refers to the women's roles in development, and its purpose is to promote the participation of women in development process, which was not sufficient in the past, in order to improve the efficiency of the development assistance. "Gender consideration" refers to consideration of the situation of women and men in development process in order to reflect WID's idea into the project.

Consideration of gender is also required for project sustainability. Development which aims to act on people's life, will promote changes in their society. But in general, those who are socially disadvantaged, such as women, have not been given any opportunities, information or education due to the unequal social relationship. Thus if the development project, which aims at the improvement of the living condition of the people, does not have any considerations for the social disadvantaged or gender issues, it may fails to improve

the unequal social relationship, or worse, strengthens the existing unequal social relationship.

In case of the forestry project, it is important to consider the following four points gender related issues; equal distribution of benefits from forest activities for women and men, project efficiency, project sustainability, and mitigating of the negative impact.

(2) Situation of Men and Women in Target Area

Gender roles are very stereotypical in the target area. Reproductive activities are carried out by women, and other productive activities and communal activities such as taking decision for the community are carried out by men. All of forestry activities are done by men, as well. The social indicator shows that women have lower education level, higher illiteracy rate and very limit opportunity to go out from the community.

Considering their social values, it is very difficult for the outsider to judge their situation. But in the limited number of interviews, women showed their strong desire to receive higher education, to assure social role in the community, or to know the issue discussed in the community meeting. At least from the women's perspective, there exist some needs to change their actual situation.

(3) Participation of Men and Women in the Forest Activities

This part, first refers the above mentioned four points, and then present some possibilities to solve problem through forest activities.

There are two direct and indirect benefit derived form forest activities. Direct benefits are job opportunity provided by forest activities and direct distribution of the money which comes from the sale of forest resources. The major forest activities, such as logging or transporting the wood to market, are physically difficult for women. Thus, it is difficult for them to get benefit from this type of activities directly. On the other hand, money from the sale of wood seems to benefit all, because it is distributed almost to all households, including female headed household and the aged household. It seems that this benefits equally to all. But there are some case in which the money does not benefits entire family member. When the money was handed over to men, some end up using it to consume alcohol.

Indirect benefit from the forest activities is improvement of basic infrastructure by making use of the money from the sale of wood. This indirect benefit seems to benefits to all. Of course, there exist the possibilities for unequal distribution, because women are excluded

from the community council in which they decide the area of investment. So far, the decision also seems to have reflected the women's needs, such as construction of church, school, and water supply. To enhance more equal distribution of this benefit, it is desirable to ask for equal participation and take into account opinions of both men and women in the community council. Although in reality it seems difficult, participation of minorities should be enhances as well.

With regard to the second, third and fourth points: efficiency; sustainability of project; and negative impact. It is not worthy that all forest activities are carried out exclusively by men. It is should be more efficient and sustainable for the project to open job opportunities for women due to the high emigration rate of men. One of the possible ways for the community member to recognize or change their attitude, is to conduct the participatory rural evaluation. By doing so, the people will be able to recognize the potential and limitation of their human and natural resources, and may seek for change. No negative impact is expected from the implementation of this project.

Finally, it is important to emphasize the need to take into account different perceptions of those who are concerned with the forest management. For instance, men often talk about scarcity of firewood near by the settlement. Many women complain about not having enough activities for social gathering. The forester point out the need to reduce quercus, the trees suitable for firewood, to healthy growth of the pine forest located far from settlement. Taking these three opinions into account, it is not difficult to come up with creative idea such as "cut quercus in the pine forest. With men and women go together with the communal bus. In this way they can get enough firewood, women have chance to talk together, and pine forest will grow healthily".

3.9 Forestry Management Models

The future state of forest management by comunidades in the Study Area is discussed here in line with the management principles described so far. Several methods are introduced to encourage the active promotion of forest management by comunidades with similar conditions in other areas in view of the management of forests in an appropriate manner, reflecting their individual conditions.

Several different forest management models are established depending on the size of commercial timber production forests where forest management is feasible. The distance of forests from markets is also taken into consideration. For each type of model, the size of the profits from forest management is estimated for the first 10 year period and following the

completed forest improvement to a desirable state. Moreover, the size and other factors of commercial timber production forests to make sawmill operation profitable are examined. The sales income from and the production cost of timber are calculated using 1997 data obtained by the project evaluation survey and are compared.

(1) Different Models

Different models are established based on the respective commercial timber production forest areas of 300 ha, 1,000 ha, 2,000 ha and 5,000 ha as shown in Table 3-9-1 and a distance factor of 100 km and 150 km from a market is also considered for each model.

Table 3-9-1 Different Models

Model	A	B	C	D
Area (ha)	1,000	3,000	5,000	15,000
Population (persons)	300	500	500	1,000
Forest Area (ha)	900	2,700	4,500	13,500
- Commercial Timber Production Forests (ha)	300	1,000	2,000	5,000
- Forests Subject to Management (ha)	200	600	1,200	3,000

(2) Operation Principles

The clear felling leaving seed trees model in Table 4-2-3 is adopted as the basic pattern for operations in commercial timber production forests. Assuming that no regeneration activities have taken place after felling in the past, the following types of operations are planned in line with the forest management plan for the Pilot Areas.

1) Types of Operations in Commercial Timber Production Forests

- Regeneration felling (at stands where many excellent pine trees still remain uncut)
- Stand improvement (at stands where the regeneration of pine trees has been hampered by the growth of encino after felling in the past)
- First thinning (subject stands: dense stands with small diameter pine trees)
- Second thinning (subject stands: dense stands with pine trees of some 30 cm in diameter)
- Regeneration work and tending (at stands having undergone regeneration felling or stand improvement)

The principles for each type of operation are described in Table 3-9-2.

Table 3-9-2 Operation Principles

Type of Operation	Principle(s)
Regeneration Felling	Rotation period of 60 years
Stand Improvement	Improvement period of 30 years
First Thinning	To be conducted in 10 years
Second Thinning	To be completed in 10 years
Regeneration Work and Tending	Ground clearance, weeding and improvement felling to be conducted at stands which have undergone regeneration felling or stand improvement

2) Log Production Volume per Ha

The expected log production volume by type of operation is shown in Table 3-9-3.

Table 3-9-3 Log Production Volume per Ha

Type of Forestry Operation	Years After Regeneration	Felling Volume (m^3/ha)	Log Production Yield (%)	Use Rate (%)		Log Volume (m^3/ha)	
				Timber Wood	Pulp Wood	Timber Wood	Pulp Wood
Regeneration Felling	60	380	70	70	30	190	80
Stand Improvement	–	80	70	70	30	40	20
First Thinning	20	20	50	0	100	0	10
Second Thinning	35	70	60	50	50	20	20

(3) Sales Prices and Production Costs of Logs and Timber

1) Sales Prices of Logs and Sawn Timber

The sales prices of logs and sawn timber are shown in Table 3-9-4.

Table 3-9-4 Sales Prices of Logs and Sawn Timber

Item	Price	Remarks
Timber Wood	450 Pesos/m^3	Delivery price to sawmill, milurum (no sorting of grade)
Pulp Wood	290 Pesos/m^3	Delivery price to factory
Sawn Timber	3.4 P Pesos/PT	Delivery Price to sawmill

Note: PT = board feet - 0.00236 m^3

2) Costs

The main cost items, ranging from the yield survey cost to the production cost of logs and sawn timber by comunidades and the cost of transportation to a market are listed below.

- Yield survey : 14 Pesos/m^3
- Regeneration felling : 52 Pesos/m^3
- Stand improvement : 85 Pesos/m^3 (regeneration cutting cost + stand improvement cost)
- Thinning : 83 Pesos/m^3
- Regeneration and tending : 10 Pesos/m^3
- Yarding and transportation (100 km) : 130 Pesos/m^3 [with rented grua (truck equipped with crane) and truck, etc.]
- Yarding and transportation (100 km) : 90 Pesos/m^3 (with comunidad-owned grua and truck, etc.
- Yarding and transportation (150 km) : 170 Pesos/m^3 (with rented grua and truck, etc.)
- Yarding and transportation (150 km) : 130 Pesos/m^3 (with comunidad-owned grua and truck, etc.)
- Forest road maintenance : 50 Pesos/km (assumed forest road length: A = 10 km, B = 40 km, C = 80 km, D = 200 km)
- Sawing : 50 Pesos/m^3 (in logs)
- Forest production unit expenses : 10% of total cost covering yield survey cost upto forest road maintenance cost
- Miscellaneous expenses : as above (procurement cost of tools, etc. is included in miscellaneous expenses)

The above list excludes the construction cost of new forest roads, the construction cost of a sawmill and the procurement cost of machinery and vehicles.

a. Cost for Immediate 10 Years

The average log production cost per m^3 based on the above-listed costs plus the transportation cost is shown in Table 3-9-5. For the first 10 years, the production of sawn timber will not be considered and a grua and truck etc. will be rented. The cost per m^3 will accordingly decline because of the improved operation efficiency with a larger management scale.

Table 3-9-5 Cost per m^3 (for Immediate 10 Years)

(Unit: Pesos)

Item	Model			
	A	B	C	D
Transportation Distance of 100 km	330	310	300	290
Transportation Distance of 150 km	370	350	340	330

b. Cost After Forest Improvement

When forests are improved to their desirable state, the comunidad possess its own grua and truck, etc. to conduct forest management. The expected cost is shown in Table 3-9-6.

Table 3-9-6 Cost per m^3 (after Forest Improvement)

(Unit: Pesos)

Item		Model			
		A	B	C	D
Logs	Transportation Distance of 100 km	240	220	210	200
	Transportation Distance of 150 km	280	260	250	240
Sawn Timber	Transportation Distance of 100 km	290	270	260	250
	Transportation Distance of 150 km	330	310	300	290

(4) Profits in Immediate 10 Years

1) Income

a. Subject Area of Different Operation Types

The assumed subject area of different operation types for each model area is shown in Table 3-9-7.

Table 3-9-7 Subject Area of Different Operation Types

(Unit: ha)

Operation Type	Model			
	A	B	C	D
Total Subject Area of Forestry Operation	200	600	1,200	3,000
- Regeneration Felling	0	100	300	1,000
- Stand Improvement	150	400	700	1,500
- First Thinning	30	50	100	200
- Second Thinning	20	50	100	300

b. Annual Operation Area

The annual operation area, which is determined based on the subject area of different operation types (Table 3-9-7) and activity principles (Table 3-9-2), is shown in Table 3-9-8.

Table 3-9-8 Annual Operation Area

(Unit: ha)

Operation Type	Model			
	A	B	C	D
Regeneration Felling (Regeneration)	0	2	5	17
Stand Improvement	5	13	23	50
First Thinning	3	5	10	20
Second Thinning	2	5	10	30

c. Annual Felling Volume

The annual felling volume, which is determined by the annual operation area (Table 3-9-8) and log production volume per ha (Table 3-9-3), is shown in Table 3-9-9.

Table 3-9-9 Annual Felling Volume

(Unit: m^3)

Operation Type	Model			
	A	B	C	D
Regeneration Felling	0	760	1,900	6,460
Stand Improvement	400	1,040	1,840	4,000
First Thinning	60	100	200	400
Second Thinning	140	350	700	2,100

d. Annual Log Production Volume

The annual log production volume, which is determined by the annual felling volume (Table 3-9-9) and log production volume per ha (Table 3-9-3), is shown in Table 3-9-10)

Table 3-9-10 Annual Log Production Volume

(Unit: m^3)

Type of Product	Model			
	A	B	C	D
Timber Wood	240	1,000	2,070	5,830
Pulp Wood	170	570	1,160	3,160
Total	410	1,570	3,230	8,990

e. Annual Income

The annual income, which is determined by the annual log production volume (Table 3-9-10) and sales price of logs (Table 3-9-4), is shown in Table 3-9-11.

Table 3-9-11 Annual Income

(Unit: Pesos)

Type of Product	Model			
	A	B	C	D
Sale of Logs	157,000	615,000	1,268,000	3,540,000

2) Costs

a. Forest Road Construction Cost

In the case of Model B through Model D, it will be necessary to construct new forest roads to conduct felling in hitherto uncut forests. The required forest road density for efficient forestry operations in Model Areas is approximately 30 m/ha. Based on this road density and the area of uncut forests, the required length of new roads is calculated to be 3 km for Model B, 9 km for Model C and 30 km for Model D, resulting in the annual construction of new roads of 50 m, 150 m and 500 m respectively. Given the unit price of forest road construction of 70,000 Pesos/km, the annual forest road construction cost is shown in Table 3-9-12.

Table 3-9-12 Annual Road Construction Cost

(Unit: Pesos)

Annual Cost	Model			
	A	B	C	D
Forest Road Construction Cost	0	3,500	10,500	35,000

b. Annual Cost

The annual cost, which is determined by the cost per unit volume (m^3) for the immediate 10 years (Table 3-9-5), annual log production volume (Table 3-9-10) and annual forest road construction cost (Table 3-9-12), is shown in Table 3-9-13.

Table 3-9-13 Annual Cost

(Unit: Pesos)

Annual Cost	Model			
	A	B	C	D
Transportation Distance of 100 km	135,000	490,000	980,000	2,642,000
Transportation Distance of 150 km	152,000	553,000	1,109,000	3,002,000

3) Annual Profit

The annual profit, which is the difference between the annual income (Table 3-9-11) and annual cost (Table 3-9-13), is shown in Table 3-9-14.

Table 3-9-14 Annual Profit

(Unit: Pesos)

Annual Profit	Model			
	A	B	C	D
Transportation Distance of 100 km	22,000	125,000	288,000	898,000
Transportation Distance of 150 km	5,000	62,000	159,000	538,000

(5) Future Profits

The forest management plan for the Study Area aims at achieving rational and sustainable forest management. When forestry activities are conducted based on such management principles, both the productivity and profits will ultimately improve by means of intensive forest management. To be more precise, once all commercial timber production forests are

properly improved, the area of stands will become roughly uniform for all ages with the effect of levelling the annual harvest. The profits after forest improvement are estimated below for two cases, i.e. (i) the production and sale of logs by comunidades and (ii) the production and sale of sawn timber by comunidades.

1) Income

a. Annual Log and Sawn Timber Production Volumes

Assuming a rotation period of 60 years, the subject area of annual activities is 1/60 of the total subject area of activities, securing a stable felling volume every year from the first thinning, second thinning and regeneration felling. The annual log production volume, which is calculated based on the log production volume per ha (Table 3-9-3), is shown in Table 3-9-15. The yield of sawn timber from timber wood is assumed to be 40% and is converted to board feet (PT).

Table 3-9-15 Annual Log and Sawn Timber Production Volumes

Item		Model			
		A	B	C	D
Operation Area (ha)		3	10	20	50
Wood (Log) Production Volume	Timber Wood (m^3)	630	2,100	4,200	10,500
	Pulp Wood (m^3)	340	1,100	2,200	5,500
	Total (m^3)	1,000	3,300	6,600	16,000
Sawn Timber Production Volume (PT)		107,000	356,000	712,000	1,780,000

b. Annual Income

Based on the annual log and sawn timber production volumes (Table 3-9-15) and sales prices (Table 3-9-3), the annual income from the production and sale of logs and sawn timber is shown in Table 3-9-16.

Table 3-9-16 Annual Income

(Unit: Pesos)

Item	Model			
	A	B	C	D
Production of Logs	382,000	1,264,000	2,528,000	6,320,000
Production of Sawn Timber	462,000	1,529,000	3,059,000	7,647,000

2) Annual Cost

The annual cost, calculated based on the cost per m^3 (after forest improvement) (Table 3-9-6) and the annual log and sawn timber production volumes (Table 3-9-15), is shown in Table 3-9-17.

Table 3-9-17 Annual Cost

(Unit: Pesos)

Item			Model			
			A	B	C	D
Timber wood + Pulp wood	Production of Logs	100 km	240,000	726,000	1,386,000	3,200,000
		150 km	280,000	858,000	1,650,000	3,840,000
	Production of Sawn Timber	100 km	290,000	891,000	1,716,000	4,000,000
		150 km	330,000	1,023,000	1,980,000	4,640,000

3) Annual Profit

The annual profit, i.e. the difference between the annual income (Table 3-9-16) and annual cost (Table 3-9-17), is shown in Table 3-9-18.

Table 3-9-18 Annual Profit

(Unit: Pesos)

Item			Model			
			A	B	C	D
Amount of profit	Production of Logs	100 km	142,000	538,000	1,142,000	3,120,000
		150 km	102,000	406,000	878,000	2,480,000
	Production of Sawn Timber	100 km	172,000	638,000	1,343,000	3,647,000
		150 km	132,000	506,000	1,079,000	3,007,000

(6) Examination of Sawmill Operation

The feasibility of sawmill construction is examined here based on the estimated profits for the immediate 10 years in view of practicality. The estimated sawmill construction cost is as follows.

Maximum Sawing Capacity (Log Base)

40 m^3/day	:	600,000 Pesos
30 m^3/day	:	500,000 Pesos
20 m^3/day	:	400,000 Pesos
10 m^3/day	:	300,000 Pesos

The administration cost is included in the sawing cost.

In the case of Model A, the annual timber wood production volume in the immediate 10 years after the commencement of forestry management is as small as 240 m^3 and the annual profit is accordingly low at approximately 22,000 Pesos for a transportation distance of 100 km and 5,000 Pesos for a transportation of 150 km. Even if a planned sawmill has a low daily production capacity, the construction cost will be excessive vis-a-vis the profit. When the machinery depreciation cost is included in the cost, the profit is further squeezed to the point that the construction of a sawmill is not economically feasible.

In the case of Model B, the annual timber wood production volume is 1,000 m^3 and the annual profit is 125,000 Pesos for a transportation distance of 100 km and 62,000 Pesos for a transportation distance of 150 km. If the transportation distance is 100 km, the construction of a sawmill may be feasible by saving the profit for several years. However, the machinery operation rate will be extremely low. The construction of a sawmill will be financially difficult if the transportation distance is 150 km. In either case, the construction of a sawmill should only be considered when profit is steadily produced through the production and sale of timber wood under stable forest management.

In the case of Model C, the annual timber wood production volume is 2,070 m^3 and the annual profit is 290,000 Pesos for a transportation distance of 100 km and 160,000 Pesos for a transportation distance of 150 km. The construction of a sawmill is feasible by saving the profit for a few years.

In the case of Model D, the outright construction of a sawmill is feasible.

Under the present circumstances, it is not unreasonable to anticipate an increase of profit by the construction of a sawmill provided that the area of the commercial timber production forests subject to forestry activities is at least 2,000 ha with a reasonable quantity of forest resources already in place.

Even if the profitable operation of a sawmill is feasible, the cost of construction must be deducted from the funds which would otherwise have been invested in improvement of the comunidade's infrastructure. Given the large sawmill construction cost, careful judgement will be required in regard to the urgency of and necessity for the infrastructure development of a comunidad.

(7) Future Prospects

The profit from log or sawn timber production in commercial timber production forests has so far been estimated. According to this estimate, annual profit of some 140,000 Pesos can be expected after forest improvement for small-scale forest management such as Model A provided that the transportation distance to a market is around 100 km. The larger the scale of a commercial timber production forest, the larger the size of the profit. Better profit can be generated by sawn timber production than log production.

Fig. 3-9-1 illustrates future forestry activities after forest improvement under the forest management plan. The state of fore-running comunidades, showing how the promotion of forestry can contribute to the development of comunidades, is shown. Under the forest management plan, the improvement of all forests owned by comunidades is aimed at by classifying forests other than commercial timber production forests into different categories based on their expected function. As shown in Fig. 3-9-1, while forests areas with high productivity are classified in the category of commercial timber production forests, firewood production forests and non-commercial timber production forests near settlements will be able to provide a stable supply of firewood and timber for own use to meet the demands of local people. In conservation areas, forests will be managed in accordance with their respective conservation objectives to perform their expected functions.

The stable as well as sustainable production of timber in commercial timber production forests will produce a profit which can be used to develop various infrastructure for comunidades. Moreover, local people will be able to find employment opportunities in forestry. To summarise, the promotion of forestry will enable local people to envisage a future in which harmonious and stable living conditions are secured.

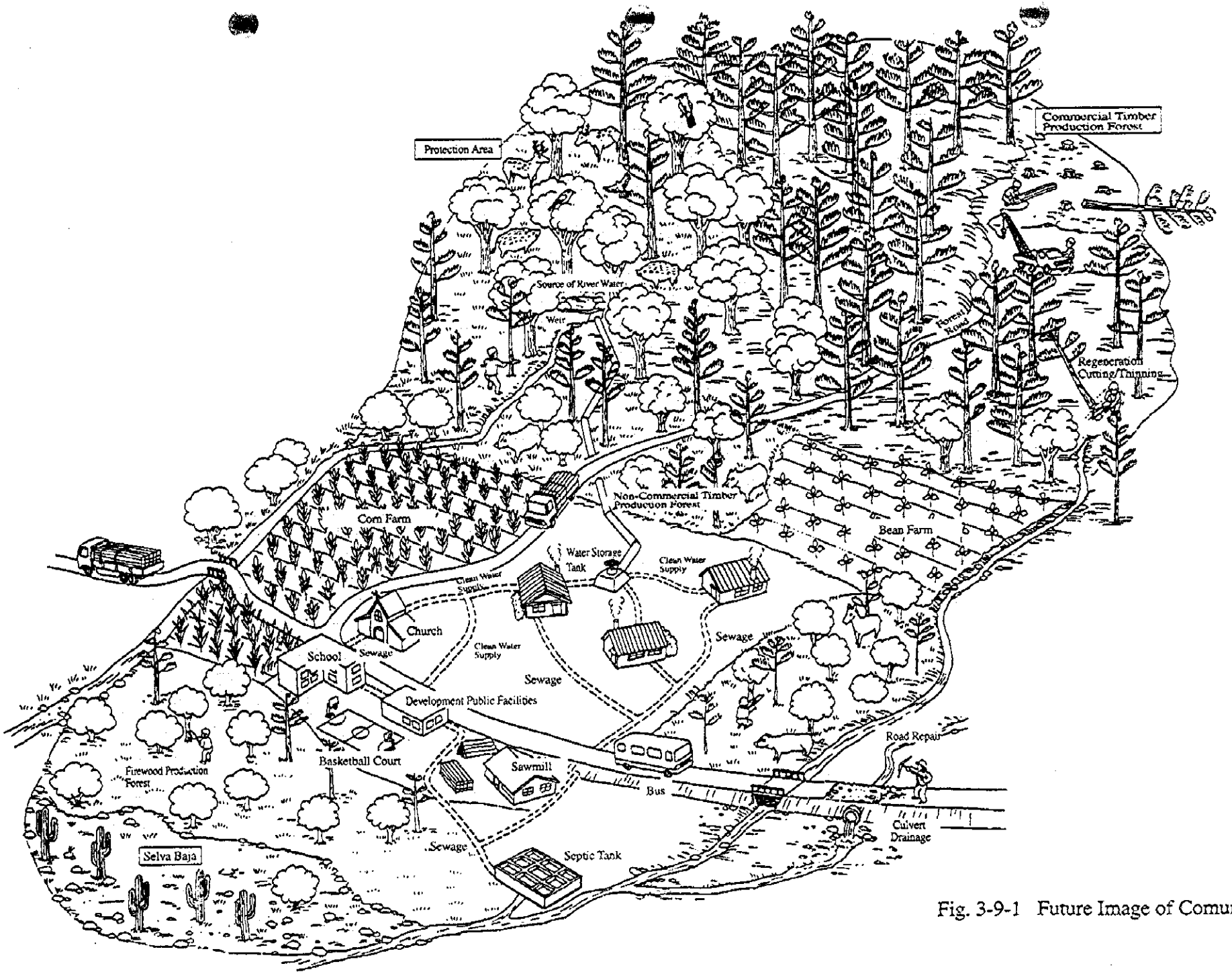

Fig. 3-9-1 Future Image of Comunidad