CHAPTER 4
FOREST MANAGEMENT PLAN FOR PILOT AREAS

CHAPTER 4 FOREST MANAGEMENT PLAN FOR PILOT AREAS

4.1 General Conditions of Pilot Areas

(1) Land Use and Vegetation

The area by land use and vegetation category in the Pilot Areas is shown in Table 4-1-1. The area was measured using the land use and vegetation maps (scale: 1/10,000) of the Pilot Areas which was prepared under the Study using aerial photographs taken from January to March, 1997 and in May, 1997 and which showed the state of land use and vegetation prior to the major forest fire in May, 1998.

(2) Forest Resources

1) Estimation of Growing Stock

The volume of each sub-compartment was calculated using the stand volume table based on the aerial photographs which was prepared under the Study and the totalised figures are shown in Table 4-1-2 (see Forest Inventory Books for details of this growing stock estimation process).

Table 4-1-2 Growing Stock by Comunidad (Pine, Pine-Quercus and Quercus Forests)

(Unit: m^3)

Type of Wood	S.M. Las Nieves	S.M. Totomoxtla	S.M. Buenavista	S.J. Teponaxtla	Total
Commercial Timber Production Forests					
- Pine	29,370	20,320	250,620	231,340	531,650
- Others (Broad-Leaved Species)	46,070	37,730	167,490	120,590	371,880
Sub-Total	75,440	58,050	418,110	351,930	903,530
Forests Other Than Commercial Timber Production Forests					
- Pine	5,230	37,800	116,620	234,000	393,650
- Others (Broad-Leaved Species)	17,180	58,760	141,480	194,790	412,210
Sub-Total	22,410	96,560	258,100	428,790	805,860
Total	97,850	154,610	676,210	780,720	1,709,390

* The data here indicates the state of forest resources prior to the forest fire in May, 1998.

Table 4-1-1 Area by Land Use and Vegetation Type

Land Use and Vegetation Type	Symbol	S.M. Las Nieves		S.M. Totomoxtla		S.M. Buenavista		S.J. Teponaxtla		Entire Pilot Areas	
		Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
<Forest Zone>											
Pine Forest	P	39.75	5.1			537.75	9.8	566.67	5.3	1,144.17	6.2
Pine-Quercus Mixed Forest	PQ	445.25	56.6	1,274.00	83.7	3,548.50	64.5	4,446.38	41.3	9,714.13	52.3
Quercus Forest	Q	110.50	14.1	65.25	4.3	185.25	3.4	890.67	8.3	1,251.67	6.7
Selva Baja (Low Broad-Leaved Forest)	Sb					652.25	11.9	896.88	8.3	1,549.13	8.3
Mountain Mesofilo Forest	Me	120.00	15.3	69.25	4.5	318.00	5.8	3,154.06	29.3	3,661.31	19.7
Secondary Forest in Mountain Mesofilo Forest Area	Bs							196.02	1.8	196.02	1.1
Sub-Total		715.50	91.0	1,408.50	92.5	5,241.75	95.3	10,150.68	94.3	17,516.43	94.3
<Non-Forest Zone>											
Agricultural Land	Ag	53.75	6.8	96.25	6.3	156.75	2.9	428.19	4.0	734.94	4.0
Abandoned Agricultural Land (inc. Fallow Land)	Ag (a)	3.00	0.4			33.75	0.6	85.65	0.8	122.40	0.7
Grazing Land	Pz										
Shrub Land	Ab	4.00	0.5			47.25	0.9	63.40	0.6	114.65	0.6
Highland Grassland	Ch	5.25	0.7	5.25	0.3					10.50	0.1
Denuded Site	D			8.25	0.5					8.25	
Residential Area	Hu	4.50	0.6	4.75	0.3	20.00	0.4	40.74	0.4	69.99	0.4
Sub-Total		70.50	9.0	114.50	7.5	257.75	4.7	617.98	5.7	1,060.73	5.7
Total		786.00	100.0	1,523.00	100.0	5,499.50	100.0	10,768.66	100.0	18,577.16	100.0

2) Estimation of Annual Increment of Pine in Existing Stands

As the present stand composition varies from one comunidad to another, the annual increment of pine in commercial timber production forests was estimated for each comunidad. This estimation was conducted by multiplying the volume by the DBH class of existing stands, established for each comunidad by the plot survey, by the annual rate of increment. The estimation results are shown in Table 4-1-3.

Table 4-1-3 Pine Increment of Commercial Timber Production Forests

Item	S.M. Las Nieves	S.M. Totomoxtla	S.M. Buenavista	S.J. Teponaxtla
Average Growing Stock (m^3/ha)	79.40	68.73	197.21	243.05
Increment (m^3/ha)	5.07	5.70	10.5	10.6

* The data here was calculated prior to the forest fire in May, 1998.

(3) Soil

1) Types and Characteristics of Soil

The soil distributed in the Pilot Areas is largely classified into four soil groups, i.e. Leptosols, Luvisols, Cambisols and Podzols, which in turn are divided into sub-groups based on specific characteristics. The characteristics of each soil type are described below.

a. Leptosols (LP)

Leptosols are a type of soil of which the thickness is less than 30 cm because of the presence of a continual hard rock or consolidated layer or soil characterised by the dominance of gravel (the ratio of fine soil upto 75 cm below the surface is less than 20%). In the Study Area, the Eutric Leptosols described below are observed at steep cliffs, narrow ridges and small mountain summits.

a) Eutric Leptosols (LPe)

Eutric Leptosols are a type of Leptosols and are characterised by the absence of a continual hard rock or consolidated layer within 10 cm of the surface, absence of a dark A horizon and high level of base saturation. The Eutric Leptosols found in the Study Area are the remains of sheet erosion and the thickness is restricted to less than 30 cm by the bedrock which is cracked but not weathered. Eutric Leptosols have an extremely rich presence of gravel. The bedrock is not

particularly compact and tree roots are sometimes found to have invaded the bedrock through cracks.

b. Luvisols (LV)

Luvisols are one of the soil groups characterised by the presence of a B horizon with illuvial clay. Luvisols are mainly found in semi-tropical zones or temperature zones and are best developed under a moist climate with a distinctive dry season. Soil with illuvial clay in the B horizon can be said to be fairly old, well-developed soil. Luvisols have a particularly high level of base saturation and a high cation exchange capacity. Relatively speaking, Luvisols are not exhausted and are a young soil group among soil groups with a B horizon with illuvial clay. In the Study Area, Chromic Luvisols and Vertic Luvisols are mainly found in gently sloping piedmont areas and at hillsides.

a) Chromic Luvisols (LVx)

Chromic Luvisols are a type of luvisols with the B horizon showing a strong brownish-reddish colour and lacking properties other than hydromorphic and vertic (shrinkage during the dry season and expansion in the wet season) properties. The Chromic Luvisols observed in the Study Area have a thin sandy loam to loam A horizon and a sandy clay loam to clay B horizon. The illuvial horizon of clay tends to be found 20 - 50 cm below the surface. The typical profile of Chromic Luvisols shows this illuvial horizon of clay in red. The soil layer is relatively thick and often extends over 70 cm before the C horizon is reached. Because of the high compactness of the entire profile and the presence of an illuvial horizon of clay, development of the plant root system may well be restricted to a shallow area. The Ao horizon tends to be thin.

b) Vertic Luvisols (LVv)

Vertic Luvisols are a type of Luvisols and are characterised by a high degree of swelling as the water content significantly changes from one season to another. The Vertic Luvisols observed in the Study Area clearly have a higher clay content than Chromic Luvisols. Vertic Luvisols have a clayey loam A horizon and a clay B horizon and minute cracks can be seen throughout the profile from the surface upto a depth of some 80 cm. Humus has invaded these cracks. An illuvial horizon of clay is found between 20 cm and 50 cm below the surface and an accumulation of lime powder is sometimes found some 80 cm below the surface.

c. Cambisols (CM)

Cambisols lack the real characteristics shown by other soil groups and can be said to be a transitional soil in the process of development to various types of soil. In the Study Area, Chromic Cambisols and Eutric Cambisols are mainly found in sloping mountain areas.

a) Chromic Cambisols (CMx)

Chromic Cambisols lack such properties as hydromorphic and vertic properties, the presence of a large quantity of carbonates and a B horizon with a low cation exchange capacity, etc. but have a B horizon showing a high level of base saturation and a strong brownish-reddish colour. The Chromic Cambisols found in the Study Area generally have a thin sandy loam or loam A horizon which quickly shifts to a loam or clayey loan B horizon. Although the profile appears firm and compact when dry, it is believed to swell in moist weather. There are many pores and the water permeability is good. The soil layer thickness ranges from some 30 cm to more than 100 cm. The thickness of the Ao horizon considerably varies depending on the vegetation. It is relatively thin in broad-leaved forests but a thick Ao horizon covers the ground surface like a carpet in Pine or Pine-Quercus forests. The decomposition of organic matters in these forests is mainly conducted by fungi and, therefore, the supply of organic matters to inorganic soil is extremely slow.

b) Eutric Cambisols (CMe)

Eutric Cambisols are the same as Chromic Cambisols except that a B horizon showing a strong brownish-reddish colour is lacking. The Eutric Cambisols observed in the Study Area have the same description as Chromic Cambisols in a) above except that the B horizon has a light brown-yellowish orange colour. As Eutric Cambisols only appear locally in the Study Area, they are included in Chromic Cambisols on the soil maps.

d. Podzols (PZ)

Podzols are a soil type with an eluvial horizon and an illuvial horizon and are observed in parts of mist forests at a high elevation. As a result of the excessive supply of water by rain and mist, clay and other minute minerals, organic matters and free iron oxide, etc. are washed away from the top layer or layers near the top layer to form a brownish-grey eluvial horizon which is often observed some 10 - 20 cm below the top layer and which is rich in quartz, sand and gravel. Haplic Podzols

with a clear eluvial horizon, Cambic Podzols without a clear eluvial horizon and illuvial horizon and hydrmorphic Gleyic Podzols are observed in the Study Area. Stagni-haplic Podzols which are strongly affected by surface water are also observed in flat areas. As these different types of Podzols are distributed in a mosaic manner, they are simply shown as Podzols on the soil map.

2) Soil Distribution

In the Study Area, Chromic Luvisols (LVx) are distributed in low elevation areas with a clear dry season while Chromic Cambisols (CMx) and Eutric Cambisols (CMe) are distributed in high elevation and moist areas to the east. An elevation of 1,800 - 2,000 m acts as the boundary between Luvisols and Cambisols. Podzols (PZ) are distributed in flat to gently sloping areas at a higher elevation in the mist forest zone. Typical Chromic Luvisols are found in river terrace areas along the Rio Grande. At areas at a higher elevation above the Rio Grande, the soil gradually shows the characteristics of Cambisols. Vertic Luvisols (LVv) are distributed at hillsides with round, wide ridges facing the Rio Grande in the southwestern part of Teponaxtla. While the distribution of Eutric Leptosols is affected by both the topographical and geological conditions, the meteorological conditions do not appear to affect their distribution.

3) Land Use Based on Soil Type

In general, the soil depth and capacity for a plant to extend its root system are very important growth factors as good growth cannot be anticipated without a suitable depth and capacity. Sufficient air permeability and adequate water retentivity are also required. In addition, the conditions of nutrients and level of soil acidity are important factors for the growth of agricultural products together with work efficiency determined by the inclination and gravel content, etc. Each type of local soil is examined below from the viewpoint of these necessities.

a. Eutric Leptosols (LPe)

Leptosols are a type of soil with no use value for either forestry or agriculture. They are often located at places with steep topography where planting is difficult.

b. Chromic Luvisols (LVx)

The well developed clay illuvial B horizon prevents the penetration of plant roots, movement of soil water and dispersion of air in the soil. Consequently, the agricultural productivity is slightly low and the growth of agricultural products, particularly those with a low tolerance to adverse land conditions, is poor. In the

case of trees, growth at certain stages is believed to be restrained. Nevertheless, the overall growth of trees is not significantly affected and planting or natural regeneration is feasible to create a forest. In regard to Luvisols, the loss of vegetation may result in surface erosion which in turn may lead to outcropping of the consolidated clay layer. At present, agricultural land in the Study Area spreads over an area of Luvisols. The contour planting of herbaceous plants (such as true grasses) which are capable of soil retention using their root system, the erection of soil retaining fencing and terracing are useful ways of preventing surface erosion.

c. Vertic Luvisols (LVv)

As in the case of Chromic Luvisols, humus can deeply penetrate the cracks and the soil itself is believed to be fairly softened with moisture. The presence of fine roots through the soil structure is assumed to indicate that Vertic Luvisols have better productivity than Chromic Luvisols.

d. Chromic Cambisols (CMx) and Eutric Cambisols (CMe)

Cambisols are suitable for both forestry and agriculture provided that no specific restrictive factor exists. In particular, the Cambisols distributed in the elevation zone of between 2,000 m and 2,400 m are soft and capable of swelling with good air and water permeability. It also has an adequate thickness and, therefore, its productivity is considered to be high. In the Study Area, however, this type of soil faces such restrictive factors in terms of work efficiency as steep slopes and an abundance of gravel and is, therefore, suitable for forestry purposes but not for agricultural purposes. Given the presence of a thick Ao horizon above this soil in the Study Area, the removal of the Ao horizon is necessary for the regeneration of pine trees.

e. Podzols (PZ)

The areas in which podzols are distributed are not particularly suitable for agriculture due to the short sunshine hours and low temperature. From the viewpoint of forestry, the creation of a forest is possible by means of planting or natural regeneration although tree growth could be restrained due to seasonal excessive water in the soil. In the mist forest zone, the extremely high level of rainfall means that the felling of trees has adverse effects in terms of soil and water conservation. The clearance of forests in this zone will result in the discharge of water currently consumed by trees, possibly leading to surface erosion as well as torrent devastation.

(4) Forest Management Tasks

The problems and future tasks of forest management which have been identified by the Study are outlined below.

Forests in and around the Pilot Areas have been subject to felling since the 1960's while opening new forest roads. Felling has been conducted in the form of the selective felling of fine trees and no regeneration work has been conducted after felling. Although seed pine trees have not been felled, the remaining pine trees other than fine trees and encino trees have effectively prevented the regeneration of second generation pine trees. If appropriate regeneration work had been conducted at these felling sites in the 1960's, some 30 year old pine trees would be observed at these sites today. However, this is hardly the case. The reality suggests that the sustainability of forest resources was not considered when felling was conducted in the past and this lack of foresight is tantamount to the loss of forest resources which could have been reared in the 30 year period.

The vigorous regeneration of pine is observed at some former forest fire sites but the lack of any tending means the emergence of over-crowded stands with small diameter pine trees.

Only S.J. Teponaxtla has a small area of untouched forests, illustrating the fact that forests in comunidades near Route 175 have been subject to felling in the past. Accordingly, the period of non-tending is longer in the case of forests subject to earlier felling and these forests are not within the proper operation cycle of pine forests.

This situation suggests that any delay of forest management accelerates the succession to forests with few regenerated pine trees and many encino trees. Unless this situation is soon rectified, it will become difficult to foster desirable forests which will be assets (income sources) to support the development of comunidades. The following operations designed to change existing forests to excellent pine forests are urgently required.

1) Change of the existing stands which are mixed with many encino trees to stands with a higher ratio of pine trees.

2) Urgent thinning of very dense stands.

While the above forestry activities do not constitute satisfactory forest management, they are essential steps before proceeding to the next steps. As these activities do not involve

felling to produce income, their implementation is a future task to be examined in terms of both the funding and technical aspects.

1) Funding Aspect

All comunidades have expressed a hope of developing excellent forests but have also indicated the limitations of *tequio* [1] to meet the necessary development expenses. The administration provides a subsidy for this purpose but the subsidy is likely to prove insufficient to meet all expenses.

2) Technical Aspect

Local people have hardly any proper knowledge of forest operations or forestry in general. This is assumed to be one reason for the historical degradation of forests. If local people had more knowledge of forestry, it would have been possible for them to check the work of the Director Tecnico (supervising forestry engineer) and to ask him to explain the principles of forest operations. Moreover, they would have been able to conduct some kind of regeneration work instead of leaving forests untouched after felling. Forests are the common assets of a comunidad and the local people owning these forests must correctly understand the conditions of these assets based on a minimum knowledge of forestry to take the initiative in regard to forest management.

While these two aspects must be addressed in the future, it is important to proceed with thinning and stand improvement work as much as possible, using *tequio* and/or the assistance of the administration. Thinning and stand improvement work could generate income which can then be used to fund such work on a greater scale.

As far as the technical aspect is concerned, it will initially be necessary to request the assistance of the administration for the provision of technical guidance on forestry activities. In the long run, however, it may be necessary for comunidades to foster their own engineers to conduct sustainable operations from a long-term perspective.

(5) Result of Rapid Rural Appraisal

When the Rapid Rural Appraisal (RRA) was conducted, the study team tried to enhance the understanding of people who are engaged in forest and forest management. Through the study, the following social and economical factors concerning the planning and implementation of forest management plan, are pointed out.

---

[1] Compulsory labour imposed on male Mexicans of 16 years of age or more. The main requirement is participation in the work to construct living infrastructure for comunidades.

As the forest management plan aims at carrying out good forest management and at improving the living standards of the people, it is necessary to define the benefits and beneficiaries of the plan. Here, two benefits should be highlighted. The first one is related to the adequate land categorization and map of forest management in the plan. By utilizing the land categorization and map, people will be able to understand the characteristics of their land and forest, and also able to plan the community land use which reflect and maximize such public functions of forest as soil and headwaters conservation and provider for firewood. The second benefit is related to forestry activities, and this benefits can be divided into two types: the first benefit is to provide direct benefit such as job opportunities; and the indirect benefits such as improvement of the basic infrastructure financed by the cash comes from the sales of their forest resources.

The beneficiaries are also not uniform, as many groups have different relationships with forest. The major groups in the community are; 1.emigrants who work outside of the community; 2.women; and 3.male farmers. In the study area, there are some communities in which more than a half of the male population emigrates. Most emigrants are single men. They stay in community for short period. However, they eventually return to assume the leadership role in the community. In many communities, this group intends to introduce new ideas. Women group is the biggest group which takes up 60% of the inhabitants. In all communities, women are engaged only in reproductive activities such as child raising and house work. Even though the actual situations of women are similar in many communities, their attitudes vary. In some communities, women want to participate in non-reproductive activities, and in others, they are not interested in expanding their activities. 25-50% of adults are male farmers. This group plays a big roles in productive activities and management of the community. Besides these three groups, there are small groups which consist of school teachers, medical staff, and traditional curers.

Here, the papers focuses on the relation between the people and benefits derived from forest management plan. The RRA study team consisted of local inhabitants and specialists who come from outside community. Through the study, the team gathered information concerning socio-economic condition of the community. At the end of the study, the inhabitants members drew a map of future community land use. Even before RRA study started, the inhabitants of the communities participated in discussion with the forester during the forest management and inventory. Thus it was easy for the inhabitants to draw a map which reflect the actual land use. The map of the forest management in the plan is drown on the basis of this map and as the results of technical research. Once forest management map is prepared, it is very important for the people to compare it with their own map and discuss the differences between the two. This is particularly important for

the implementation of the plan and educational effects. The plan will not be implemented efficiently without people's understanding. And the comparison of the two maps will provide a good opportunity to make them understand their own forest. As there are some youth who show strong interest in their forest, they may take a leading part in the study meeting, using these map.

With regard to the benefits from the forestry activities. The emigrant group as well as others groups show strong interest in "direct benefit", meaning, job opportunity. In all communities, the people mentioned that they could engage in forestry activities for 5-6 months a year. Talking about "indirect benefit", in all communities the cash income from the sale of their forest resources has been utilized for construction of the basic infrastructure such as the roads, school or water pipes. But there is a bias among in the people who know about this benefit. For example, women hardly know about the use of cash income. To distribute equally the benefit from the forest resources, it is important to take into account opinions of different groups, because forest is common resources of the community members. Also, all groups should be informed about the indirect benefit of forest resources.

About mentioned benefits from forest are obtainable only when the community has forest to take advantage of. But in those communities in the target areas, due to the inadequate cutting in the past, the actual forests seem to be out of the proper forest management cycle. And there are no forest areas for commercial use. This situation is especially critical in the communities close to the 175 Highway. These communities, which do not have trees to cut, can not obtain any benefits for the moment. Nevertheless these communities should invest human and economic resources to generate forest, so that the people will receive benefit by putting back the forest into the proper forest cycle. The SEMARNAP and SEDESOR are now providing technical assistance and subsidies related to forestry activities. But the implementation depends on people's voluntary labor, *tequio*. In the RRA study, local inhabitants pointed out the need of thinning or other activities to improve the stand of forest. The also claim that they are motivated to participate in *tequio*. It is very important to keep their motivation to ensure the continuation of *tequio* for the long term forest management by tequio.

Now, how could it be possible to motivate people? First, to form a committee which understands the situation of actual forest situation and takes responsibility for informing people on the date of thinning and other forestry activities. The team sees that other committees in the communities work relatively well. Therefore, once the committee is organized with the approval of people, there is a good chance that it will function well.

Also the people, who have learned from their own experience, show a strong willingness to participate in the forest activities. Considering how other committees work, the roles of forest committee should be; accumulation of knowledge and information related to forest; provision of information to the people and motivation; advice to forest management body. To accumulate the knowledge in the forest committee, the committee should consists of the members from the youth group (emigrants), male farmer group, and women group. Youth group will lead the community in the future, therefore their participation is essential. But since the mobility of this group is very high, it is wise to include male farmers who have low mobility and women who always stay in the communities. Depending on the situation, the forest management body might take this responsibility. The same consideration can be applied to the selection of members of forest management body. To fulfill their responsibilities, the members should acquire the minimal knowledge on forest. Also some measures to enhance their knowledge should be considered.

Secondly, it is necessary to create a certain social environment within the community and around the community, for the committee to fulfill its functions. The group actually engages in forest activities is the male farmer group whose major interest is improvement of agriculture products. They do not have an incentive to participate in *tequio* to improve their forest. Thus, it is important to inform them the benefits of forest and also the numbers of tequio in order to form a consensus. Discussion among the community on the map of community land use, which was prepared by the RRA inhabitants member, and on the forestry management map. is the first step to grasp their forest situation. To motivate them, at least some measures to resolve the present firewood problem should be included in the plan. It is also recommendable to take in account of improvement of agriculture.

Rising awareness of the group, although it does not have any direct relation to the forestry activities, is also important. For example; providing environment education to the student about their forest; uses "day of tree" as an opportunity to reaffirm the roles of forest in construction of basic infrastructure, among men and women. Since women's group has given the access to information and decision making, it is important to start generating the kind of attitudes within the community in which women's opinions are heard. Also, since women group is the biggest in community, they should be consulted when the community starts receiving benefits from their forest.

To create better relationships with other communities, it is important to cooperate with nearby communities with similar socioeconomic and forest situation. Also, there is a regional organization called The Natural Resources Committee of Sierra Norte. The forest committee or management body should discuss with the nearby communities, and use this

regional organization to obtain some governmental assistance. By exchanging information, the people not only acquire knowledge but also are stimulated to maintain their forest activities. And in the future, when they have trees to cut, it will be important for them to work together, so that they will not be exploited by the timber dealer.

4.2 Common Plan for All Comunidades

(1) Basic Principles for Formulation of Forest Management Plan

Forests in the Pilot Areas are closely linked to local life in many ways. Local people obtain such daily necessities as water, firewood and foodstuffs from forests. At the time of felling, they obtain employment by participating in felling. The income from felling is used to improve the living infrastructure of comunidades through the construction of schools, churches, roads and water supply facilities, etc. Moreover, forests protect the living environment for local people by means of performing national land conservation, soil conservation, water yield and nature conservation functions.

Forests in the Pilot Areas have, in fact, been subject to the selective felling of fine trees since the 1960's but regeneration and tending after felling have been neglected. As a result, the present forests show the following negative conditions.

- The invasion of many encino trees has prevented the regeneration and growth of pine trees.
- Even if pine trees have regenerated, the very dense stands have resulted in the poor diameter growth as well as poor form of these trees.

Meanwhile, firewood resources near settlements have declined in terms of both quantity and quality because of excessive collection.

As described above, the composition of forests in the Pilot Areas does not allow rational forestry production in a sustainable manner and is far from ideal. Rectification of this situation will become increasingly difficult with the passing of time. It is, therefore, necessary to urgently conduct forestry operations to improve the existing forests to forests which can be efficiently used, which have a higher value and which allow sustainable forest management.

Given the above-mentioned situation, the present forest management plan is formulated taking the following issues into consideration.

- Forests should be categorised based on their expected functions and operation and management principles and standards should be determined accordingly.

- The plan period should be 10 years with priority given to urgently required forestry operations (thinning and stand improvement, etc.) while having a long-term perspective.

- The plan must take the intentions of local people regarding land and forest use based on the specific socioeconomic conditions of each comunidad into full consideration.

- The plan contents should be as simple as possible for easy understanding by local people.

(2) Basic Concept of Land Use

The actual land use in the Pilot Areas can be classified into three types, i.e. areas, depending on the elevation as shown in Fig. 4-2-1.

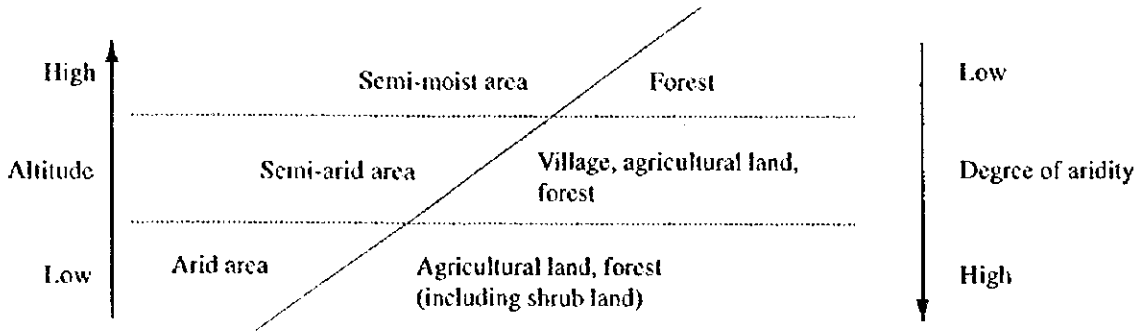

Fig. 4-2-1 Land Use in Pilot Areas

The semi-moist area with a high elevation is mainly covered by forests where commercial forestry production can be anticipated. However, this area cannot be said to be suitable for agriculture because of the climatic, topographical and soil conditions.

The semi-arid area with a medium elevation is currently used for settlement sites, farmland and forests. Farmland is mainly developed around settlements but the generally gravelly soil together with the steeply sloping land makes it difficult to improve the labour productivity above the present level. Land which is suitable for agriculture has already been cultivated, leaving little room for further extension. As the stand growth of forests is inferior to that in the semi-moist area, forests in this area are unsuitable for commercial forest management. Local forests are currently used for the collection of timber and firewood for own use.

The arid area with a low elevation is used as farmland or forest. The degree of aridity increases at a lower elevation, making the land unsuitable for agriculture. However, lower land may be used as farmland if an irrigation system is introduced. The growth and quality of the stands is inferior to those in the semi-arid area and these stands are not even suitable for the collection of timber for own use and other types of use.

When looking at the existing land use from the socioeconomic point of view, farmland is important as a source of basic foodstuffs for local people who want to extend their farmland to meet the rising food demand due to the increasing population. While one option is to convert forests for this purpose, the available forest land is not necessarily suitable for agriculture. Moreover, forests are important to economically and environmentally support local life and local people are reluctant to randomly convert forest land to farmland. As described earlier, there is no free scope for the extension of farmland because of the local natural conditions. Consequently, the need for increased agricultural production must be met by improved productivity through the application of better farming techniques as listed below.

- Development of an irrigation system
- Active use of compost
- Application of leaves (collected from forest land) to farmland
- Introduction of hedge plants (leguminous plants or fruit trees) along farmland boundaries
- Introduction of soil retaining fences along contour lines or the planting of herbaceous plants which are capable of retaining the soil

Based on the above observation of the land conditions, a significant change of the present land use appears difficult. Accordingly, what is important in the case of forests is improvement of the forest functions by means of appropriate forestry operations while improving farming techniques to improve the agricultural productivity.

(3) Concept of Forest Use

Forests in the Pilot Areas are required to perform different functions depending on their natural conditions in regard to the topography, soil and vegetation, etc. and socioeconomic conditions. In places, some of these functions operate side by side. The basic principle of forest use, however, is the classification of the subject area into production areas where production activities mainly involving forest products can be conducted and conservation

areas where protection and conservation forests are the priority. Each forest is then categorised based on its priority function, following the formulation of appropriate forestry operation standards for each category to improve the performance of such priority function. The desirable forest use by area is described below taking the forest categories into consideration.

Many forests in the semi-moist area are pine or pine-quercus forests where such useful species as *Pinus patula* , *Pinus montezumae* and *Pinus ayacauite* account for a large proportion of the standing trees. As the soil and climatic conditions are suitable for pine growth, these forests can be actively used for the production of commercial timber. In parts of this area, however, mesofilo forests with mainly broad-leaved trees are observed and these are characterised by diverse flora and fauna and a complicated ecosystem. Moreover, these forests perform the function of water yield and special forest products, including medicinal herbs, are collected. While some comunidades would like to develop these forests, such development should only be considered after proper studies as rapid development could destroy the balance of the ecosystem, possibly resulting in the loss of the present functions.

Some forest in the semi-arid area have been subject to felling in the past but commercial forest management is not feasible for most forests because of inferior stand growth compared to those in the semi-moist area. Accordingly, the use of these forests is restricted to the collection of wood materials for own use except for a limited number of excellent stand. In the long-term, however, their commercial use will be feasible provided that trees reaching a usable diameter are found in a sufficient number of groups. While firewood is collected from forests in this area, forests providing firewood near settlements are declining in number or deteriorating in some comunidades and the creation of firewood producing forests is an important task for these comunidades.

Forests in the arid area are hardly used at present, The growth of timber trees is exceptionally slow and their poor quality makes them unsuitable for forestry use. Selva Baja forests should be areas in which an increase of vegetation is left to nature.

Further care is required to maintain forest functions from the following viewpoints.

- The agricultural and drinking water supply sources of comunidades are situated above settlements. While headwater forests are supposed to be conserved, their boundaries are not clearly determined. Such boundaries must be determined to protect water sources.

- Forests located along both banks of a river channel must be conserved to protect the river system.

- Forests with a risk of soil loss and forests where soil restoration is a priority because of loss of the top soil should be conserved.

- Some forests have been conserved because of local customs, etc. associated with comunidades and efforts should be made to conserve these forests.

Such minor forest products as mushrooms and medicinal herbs are currently collected in some forests, albeit in small quantities. These products are collected for own consumption and there is no immediate scope for more active production on a larger scale.

(4) Forest Division

As a forest may spread over a vast area with varying geographical conditions and physiognomy, its division into sections of an adequate size is necessary for rational forest management. Forest compartments and sub-compartments are, therefore, introduced to be shown on the relevant maps.

- Compartment: fixed division to pinpoint the location of a forest to facilitate the planning and implementation of forestry activities. Such natural features as ridge lines, streams, etc. and permanent roads, etc. form a compartment's boundries.

- Sub-Compartment: sub-division of a compartment to identify the subject area of the same forestry activities and determined based on the species, forest age and work method, etc. in a flexible manner.

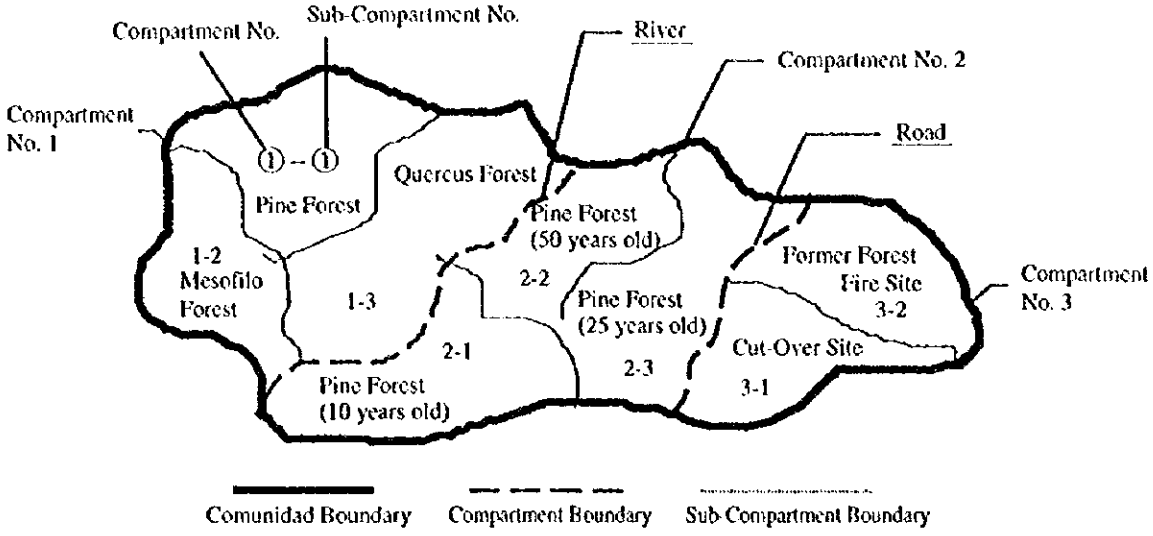

Fig. 4-2-2 Example of Forest Division

(5) Forest Categories

Forests in the Pilot Areas are categorised as shown in Table 4-2-1 based on the concept of forest use described in (3) above.

Table 4-2-1 Forest Categories and Descriptions

Category			Description
Production Area	Timber Production Forest	Commercial	Pine or pine-Quercus forest with many pine trees and favourable growth conditions where the active production of timber is feasible.
		Non-Commercial	Pine or pine-Quercus forest of which the growth conditions are inferior to those of a commercial timber production forest; mainly used for the collection of timber for own use (commercial use may be feasible when standing trees covering a certain area reach a certain diameter)
	Firewood Production Forest		Quercus or pine-Quercus forest with a high mix ratio of Encino and other broad-leaved trees; located near a comunidad and firewood is produced.
Protection Area	Nature Conservation Forest		Mesofilo forest or forest with a high elevation; once destroyed, its restoration is extremely difficult.
	Headwater Conservation Forest		Forest of which the primary function is the protection of water sources or water quality (forest located upstream of an intake for domestic water; forest to protect a river system).
	Soil Conservation Forest		Forest to prevent soil loss on a steep slope with thin top soil; forest to restore soil because of the loss of top soil on a steep slope.
	Other Conservation Forests		Selva Baja where the preservation or natural increase of vegetation is desirable because of little vegetation caused by adverse climatic and soil conditions; forest requiring conservation because of its association with local customs, etc.
Restoration Area			Abandoned agricultural land, shrub land, former forest fire site, etc. for future forest development for timber production, environmental conservation and other purposes.

(6) Desirable Forest Composition and Structure, etc. of Categorised Forests

The desirable forest composition and structure, etc. of the forests categorised in (5) are described in Table 4-2-2.

Table 4-2-2 Desirable Forest Composition and Structure, etc. of Categorised Forests

Category			Composition and Structure, etc.
Production Area	Timber Production Forest	Commercial	1) Even-aged forest mainly consisting of pine trees 2) Suitable soil for forest growth 3) Adequate density with favourable growth 4) High value trees due to excellent form 5) Sustained yield feasible (Note)
		Non-Commercial	1) Mainly consisting of pine trees 2) Adequate density maintained
	Firewood Production Forest		1) Many suitable species (Encino) for firewood 2) Production of firewood with short felling period and easy natural regeneration by seeding or sprouting 3) Near a settlement for easy collection of firewood
Protection Area	Nature Conservation Forest		1) Consisting of diverse species 2) Uneven-aged forest with multi-story structure 3) Presence of diverse ecosystem with rich wildlife 4) Increased vegetation and successful soil conservation at forests with high elevation
	Headwater Conservation Forest		1) Uneven-aged forest with multi-story structure 2) Adequate density with rich undergrowth 3) Vigorous growth of stands and high water retention capacity due to well-developed root system
	Soil Conservation Forest		1) Consisting of diverse species 2) Uneven-aged forest with multi-story structure 3) Well-developed root system of stands 4) Adequate density with rich undergrowth 5) Increased vegetation and successful soil conservation at steeply sloping land
	Other Conservation Forests		1) Increased vegetation and successful soil conservation
Restoration Area			1) Maximum performance of expected forest function(s)

Note: A sustained yield is only possible with an approximately equal area of stands of each age which provide a harvesting volume equivalent to the annual increment. This situation is described as the normal state. For example, assuming an area of commercial timber production forests of 300 ha and a rotation age of 60 years, if a stand of each age has an area of 5 ha (300 ÷ 60) with growing stock corresponding to the stand age, 5 ha of the stand reaching the felling season can be felled to produce a yield equivalent to the annual increment, ensuring a sustained yield.

(7) Principles of Forestry Operations by Forest Category

The actual conditions of forests subject to forest management vary from one forest to another. Therefore, the manner of forestry operations and forest management should ideally be determined for each stand. In reality, however, it is both very difficult and complicated to establish a detailed forestry operation method for each stand. Here, the

forestry operation principles are determined for each forest category so that actual forestry operations in the Pilot Areas can be conducted based on such principles.

1) Production Areas

a. Timber Production Forests

In regard to timber production forests, two types of production groups, i.e. commercial timber production forests and non-commercial timber production forests, are established.

< Commercial Timber Production Forests >

In general, the ideal operation in commercial timber production forests is clear felling leaving seed trees as described in (8)-1) and the basic issues regarding this method are described below. However, the present state of local forests makes it difficult to sustain a constant yield and forestry operations must centre on the thinning and stand improvement described in (8)-2) for some time.

– Target Diameter Class for Production

The target diameter for production is determined based on various factors, including the purpose of use of the produced timber, average increment and economic profitability. Based on the findings of the forest inventory and the need to consider these factors, approximately 40 - 50 cm appears a suitable target diameter class for production in the Pilot Areas.

– Rotation Age

The rotation age is the standard for the felling age for the actual felling of a stand and is identical to the stand age when the stand in question reaches its target diameter class for production. When the target diameter class for production is 40 - 50 cm, a suitable rotation age is roughly 60 years. The rotation age may be 70 - 80 years if the production of large diameter timber is aimed at.

– Sustained Yield and Yield Regulation

To ensure a sustained yield, the ideal method is to make the stand area corresponding to each forest age almost identical in order to level the yield each year, i.e. normal state. In this case, the annual increment equals the planned annual yield and yield regulation should be conducted based on this principle. In reality, however, there are not many stands for regeneration felling except in S.J.

Teponaxtla and succeeding stands are not in place. Under these circumstances, the urgent commencement with thinning and stand improvement is necessary to make forests achieve the normal state. To do this, felling until such time when the stand area subject to regeneration felling reaches a certain size will mainly consist of felling designed to achieve stand improvement. The yield regulation level cannot, therefore, be determined based on the increment in the usual manner for a long period of time. In the case of S.J. Teponaxtla, application of the following equation appears possible because of the existence of a fairly large number of stand where regeneration felling can be conducted. The yield is, therefore, controlled for S.J. Teponaxtla based on the annual increment of such stands.

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

Where,

E: annual allowable felling volume

Ip: current annual increment

Vp: current growing stock

T: rotation age

Points to Note Regarding Felling

Special attention must be paid to the following points in relation to felling.

- The felling of an extensive area could radically change the natural environment which in turn could cause soil erosion coupled with the loss of vegetation. The maximum felling area size should be limited to 5 ha and the felling areas should be separated from one another. Depending on the land condition, felling at the extent of one felling block will be desirable. Felling at separate sites should also be considered even if felling is conducted during the same year.

- Forests located in 25 m wide belts along a river channel with constantly flowing water or 10 m wide belts along a river channel with intermittently flowing water should be preserved in view of river protection.

- When a road crosses a stream, necessary side drains and cross drains should be installed for road protection. Water from road drainage channels should be drained onto stable ridges for safe draining.

< Non-Commercial Timber Production Forests >

Compared to commercial timber production forests, the tree growth is slower and the quality of non-commercial timber production forests is not necessarily good and aggressive forestry operations should not be introduced in these forests. At present, hardly any existing stands are suitable for regeneration felling and, in principle, tree growth should be left in the hands of nature. However, the selective felling of trees to produce timber for own use should be permitted as long as it does not considerably change the forest physiognomy. As the scale of timber production for own use is very limited, the principle of yield regulation does not apply. In the long run, when a sizable number of trees in a group reach the usable diameter class, felling can be conducted using a similar method to that for commercial timber production forests.

b. Firewood Production Forests

As the main objective of firewood production forests is, by definition, the production of firewood, quercus or pine-quercus forests near settlements constitute such forests. In some comunidades, local people currently have to walk quite a long distance from their homes to collect firewood, making the creation of firewood production forests an important task.

As a first step, quercus and pine-quercus forests near settlements are designated firewood production forests to secure a production volume which meets the firewood demand of comunidades and to ensure convenient firewood collection for local people. In the case of pine-quercus firewood production forests with a high pine tree mix ratio, pine trees should be selectively felled and pine seedlings naturally regenerated by seeding should be removed to foster the generation and growth of seedlings of encino and other species in order to increase the ratio of encino trees in these forests.

Felling to obtain firewood should generally be conducted with standing trees with a DBH of 20 cm or more. Assuming that the growing stock and stand volume growth rate of a firewood production forest are 70 m^3/ha and 7% respectively with a safety margin based on the forest inventory findings, the annual increment per ha of a firewood production forest is 4.9 m^3 (roughly equivalent to 24 encino trees with a DBH of 20 m and a tree height of 15 m). Firewood collection should be conducted using this figure as a yardstick. Regeneration will be attempted by means of natural regeneration by seeding or sprouting. If the demand cannot be met during the fostering period of a firewood production forest, the encino to be felled under the

stand improvement of a commercial timber production forest will be used to supplement for the shortfall.

2) Protection Areas

In principle, forests in protection areas are not subject to felling.

– Nature Conservation Forests

In principle, felling is prohibited and nature is left to take its course.

– Headwater Conservation Forests

In principle, felling is prohibited but may be permitted to improve the water yield function as long as it does not considerably change the forest physiognomy.

– Soil Conservation Forests

In principle, felling is prohibited and planting is conducted if necessary.

– Other Conservation Forests

In principle, felling is prohibited.

3) Restoration Areas

In principle, felling is prohibited until the forests have been restored. Once restored, appropriate operations for each forest category will be conducted.

(8) Forestry Operation Model for Commercial Timber Production Forests and Changing Method for Existing Stands

1) Forestry Operation Model for Commercial Timber Production Forests

As forests in the Pilot Areas enjoy excellent natural regeneration, clear felling leaving seed trees which is less expensive than planting should be adopted as the forest operation model for commercial timber production forests. This operation model intends that seed trees be left to achieve natural regeneration by seeding and to ensure the excellent growth of naturally regenerated trees by tending work consisting of weeding, improvement felling and selective felling, etc. The standard practices of this model are described below.

a. Regeneration Felling

Regeneration felling not only aims at using the felled trees for timber but also at ensuring the regeneration of the next pine forest in the following manner.

< Felling Method >

Seed trees are left at a density of 10 - 16 trees/ha, i.e. a seed tree distance of 25 - 30 m) and all other trees (including encino and other broad-leaved trees) are felled. Too many seed trees or left-over encino and other broad-leaved trees may have adverse impacts on the growth of regenerated pine trees and may inflict considerable damage on regenerated pine trees when seed trees are felled (first selective felling). Pine trees with a good quality stem are left as seed trees.

< Supplementary Regeneration Work >

– Clearance of Limbs and Tops Left on Forest Land

The limbs and tops left on forest land after felling and logging on forest land should be piled up to provide clear regeneration sites.

– Ground Clearing

The ground surface of local pine or pine-quercus forests is covered by a deposited layer of leaves. Unless this layer is removed, the fallen seeds will not survive even if they germinate. Clearing of the ground surface is, therefore, necessary to expose the surface soil. It is unnecessary to clear the entire forest bed and the line clearing of areas where the ground surface is not exposed by yarding should prove sufficient as a supplementary measure. Burning instead of ground clearing is more effective but is, in principle, not opted for because of the risk of forest fires.

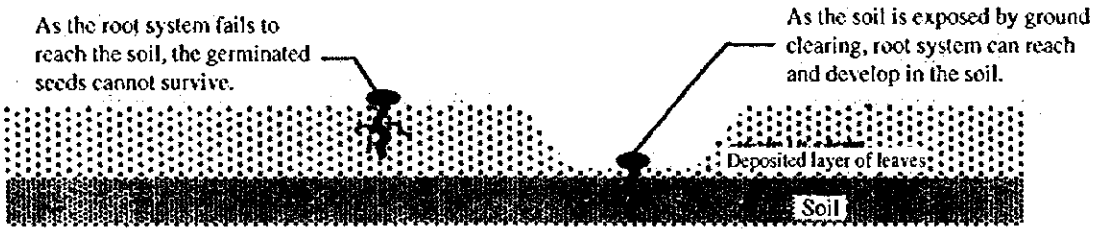

Fig. 4-2-3 Effects of Ground Clearing

b. Completion of Regeneration

The yardstick to determine the completion of regeneration is the observation of regenerated trees throughout the intended regeneration area with a minimum density of approximately 1,250 trees per ha (12 - 13 trees in an area of 10 m × 10 m). If this yardstick is not achieved, ground clearing should again be conducted at those sites where the number of regenerated trees is insufficient to facilitate the regeneration process. If this does not achieve the intended effect, planting should be conducted.

c. Weeding

Weeding aims at the removal of weeds, etc. which compete with the regenerated trees and should be conducted based on the observed situation of competition. If the regenerated trees are more dominant than competing weeds and trees, weeding is unnecessary.

d. Improvement Felling

If species other than pine are found to be obstructing the growth of the regenerated trees 5 - 10 years after the completion of regeneration, these species should be removed together with damaged or low quality regenerated trees. If the regenerated trees are found to be too dense, those with a relatively small diameter among healthy trees should also be removed to achieve a remaining tree density of some 800 - 1,000 trees/ha (8 - 10 trees in an area of 10 m × 10 m). This work can easily be conducted using a hatchet. The important point is the timing as delayed improvement felling results in a lower work efficiency due to the fact that trees of a larger diameter must be felled and adverse impacts on the growth of the regenerated trees.

e. First Thinning

When a stand is closed (15 - 25 years after the completion of regeneration), the first thinning should be conducted to regulate the density of the standing trees, i.e. to reduce the competition between timber trees and to stimulate their growth. The priority order to select the trees subject to thinning is as follows.

- Species other than pine
- Damaged or poor quality pine trees
- Healthy pine trees with a relatively small diameter (leaving small diameter trees with vigorous growth)

The thinning intensity is determined in view of achieving a remaining tree density of approximately 400 - 600 trees per ha (4 - 6 trees in an area of 10 m × 10 m). Seed trees may be felled at this time. However, they may also be left until the next thinning or regeneration felling if they show a prospect of further growth, if the production of large diameter timber is aimed at or if there is a risk of their felling causing much damage to the regenerated trees.

f. Second Thinning

When a stand which has undergone the first thinning is closed (30 - 40 years after the completion of regeneration), the second thinning should be conducted for the same purposes as the first thinning. The priority order to select the trees subject to thinning is the same as that for the first thinning and the thinning intensity is determined to achieve a remaining tree density of approximately 200 - 300 trees per ha (2 - 3 trees in an area of 10 m × 10 m).

g. Regeneration Felling

After stage f. described above, the stand returns to the stage of reaching its designated rotation age.

The stages involved in the forestry activity cycle described above are summarised in Table 4-2-3 and Fig. 4-2-4.

Table 4-2-3 Operation Model for Clear Felling Leaving Seed Trees (Draft)

Stand Age	Type of Operation	Stand Density (trees/ha)	Average Value for Single Tree			Volume (m^3/ha)	No. of Trees Subject to Improvement Felling/Thinning (per ha)	Subject Volume of Thinning (m^3/ha)
			Diameter (cm)	Height (m)	Volume (m^3)			
1	Completion of Regeneration	1,250						
7	Improvement Felling	1,250						
	After Above	900						
20	First Thinning	900	16.8	12.0	0.0824	74	400	22
20	After Above	500				52	(44.4)	(30.0)
25		500	22.3	16.4	0.2186	109		
30		500	25.2	19.0	0.3400	170		
35	Second Felling	500	28.0	21.1	0.4797	240	250	72
35	After Above	250				168	(50.0)	(30.0)
40		250	33.3	24.7	0.8241	206		
45		250	35.2	26.3	1.0003	250		
50		250	37.0	28.0	1.2030	301		
55		250	38.6	29.0	1.3653	341		
60	Regeneration Felling	250	40.0	30.0	1.5298	382		

Note: Tim series changes of the tree diameter and height are calculated based on data obtained by the increment survey, taking the effects of weeding, improvement felling and thinning into consideration.

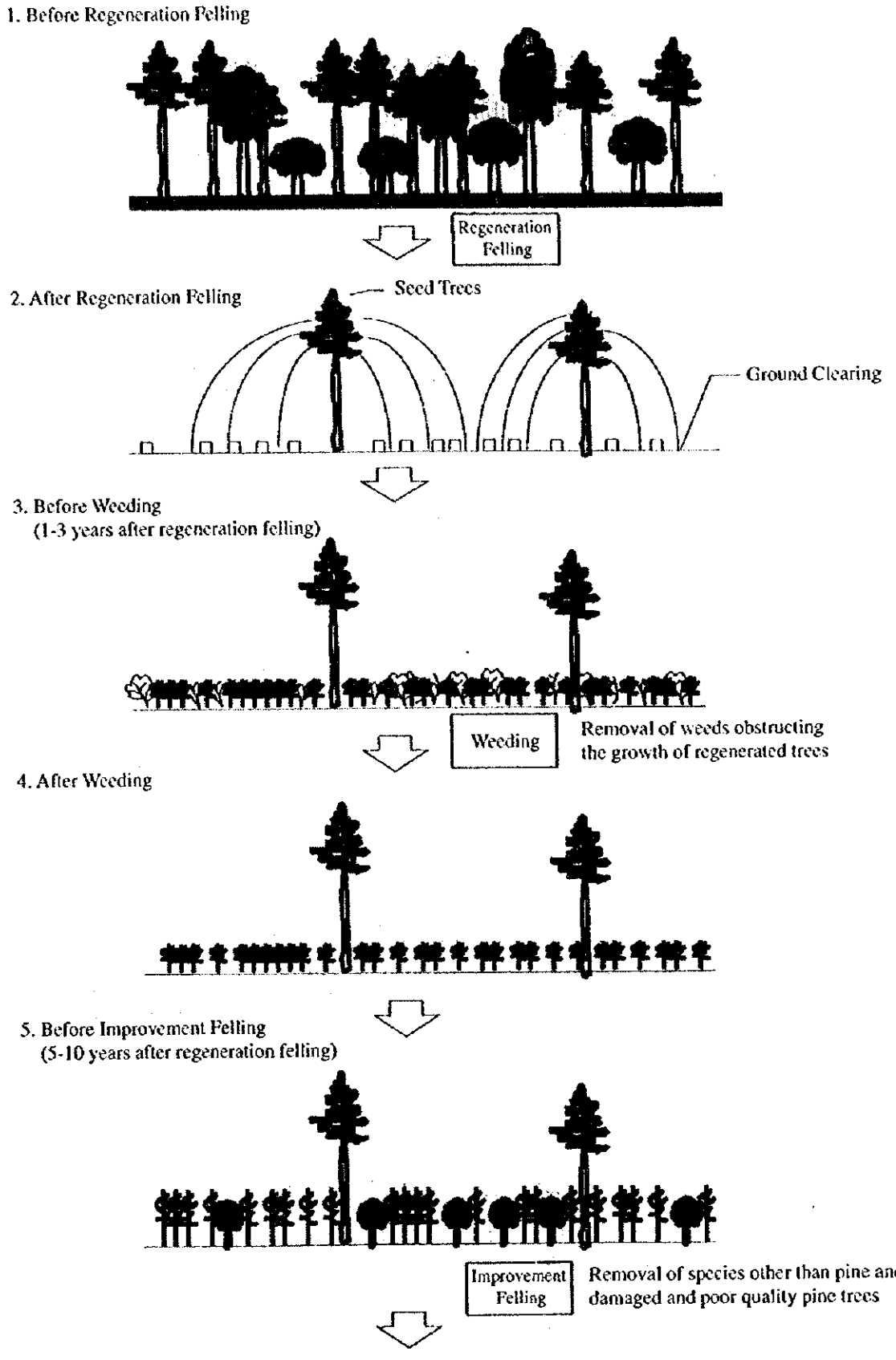

Fig. 4-2-4 Operation Model for Commercial Timber Production Forest (1)

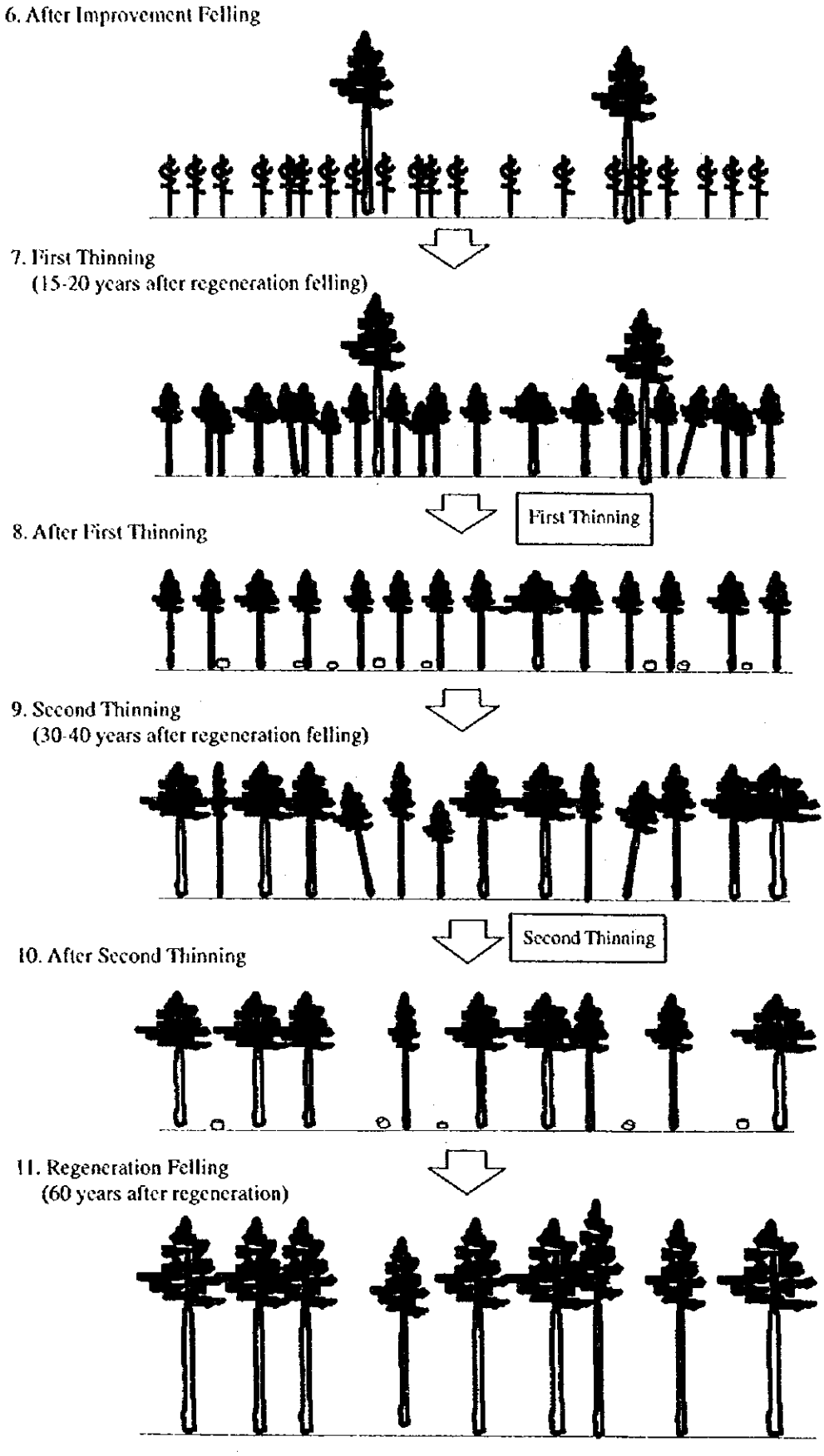

Fig. 4-2-4 Operation Model for Commercial Timber Production Forest (2)

2) Existing Stands Operations

As a result of the absence of careful forestry operations regarding regeneration and tending after felling, many local stands require the following improvement work. Consequently, priority will be to implement forestry operations designed to lead existing stands to one of the stage of the above operation model.

a. Thinning

At those stands where the density of standing pine trees is particularly high or where the healthy growth of pine trees is hampered by a high mix ratio of encino (including other broad-leaved trees; the same definition applies hereinafter), thinning and the selective felling of encino should be urgently conducted to stimulate the growth of the remaining pine trees. The selection of the trees to be felled should follow the priority order for the selection of trees subject to thinning under the above operation model. The felling intensity should aim at achieving a distance between the remaining trees of approximately one-fourth of the height of the remaining trees. If a subject stand is found to be excessively dense, single thinning to achieve this target may make the post-thinning stand liable to wind damage because of the poor shape of the timber trees. In this case, thinning should be conducted in several steps at a lower intensity.

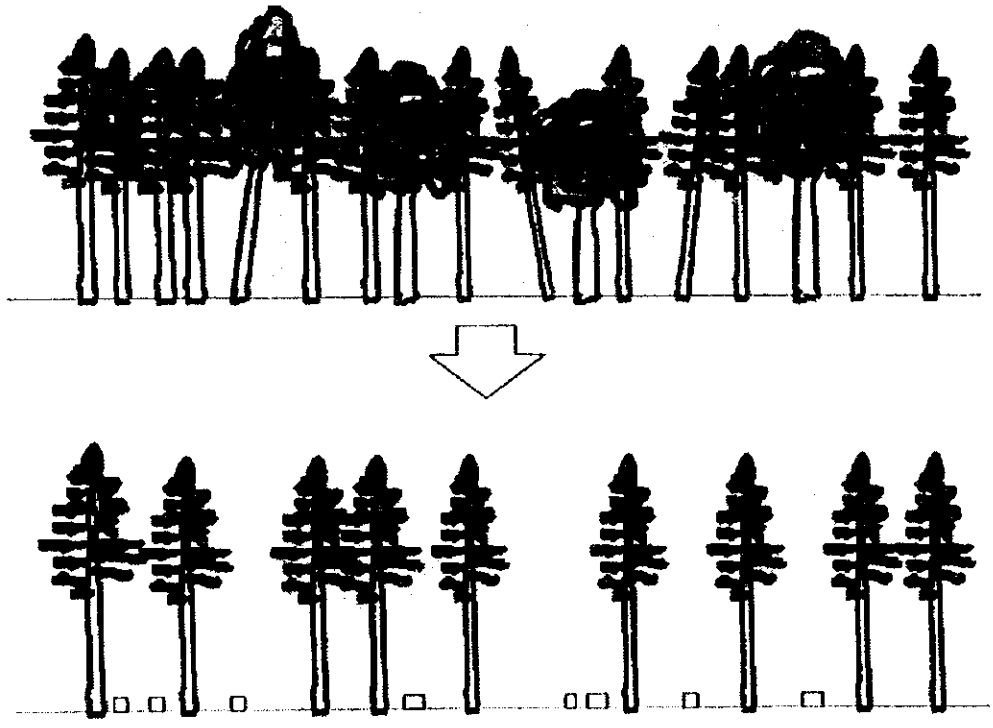

Fig. 4-2-5 Pine Forest with High Standing Tree Density and Pine-Quercus Forest with High Mix Ratio of Encino

b. Stand Improvement

Stand improvement should be conducted in the following manner at those stands where the regeneration of pine trees is poor because the upper-story is dominated by pine trees and/or encino left over from previous felling. A fairly large number of encino trees is expected to be felled during this stand improvement work. Subsequent forestry operations may be difficult to properly conduct if felled encino are scattered in the forest. Felled encino should be used as firewood for own consumption as much as possible from the viewpoint of the effective utilisation of forest resources. The firewood production forests of many comunidades will be in the process of fostering for some time and the utilisation of encino from the stands subject to improvement will be necessary so that firewood production forests remain untouched.

< Stand Improvement Work Type 1 >

If the regeneration of pine is poor throughout the stand, work similar to the regeneration felling of the operation model for commercial timber production forests should be conducted, leaving 10 - 16 seed trees per ha and felling all other standing trees (including encino and other broad-leaved trees). When this work has been conducted, upper-story pine trees should firstly be felled and transported, followed by the felling of encino in view of better work efficiency. The remaining limbs and tops, etc. on the forest land should then be cleared to secure ground which is suitable for regeneration which will be cleared to ensure the regeneration of pine. Thereafter, the operation model described in 1) above will apply.

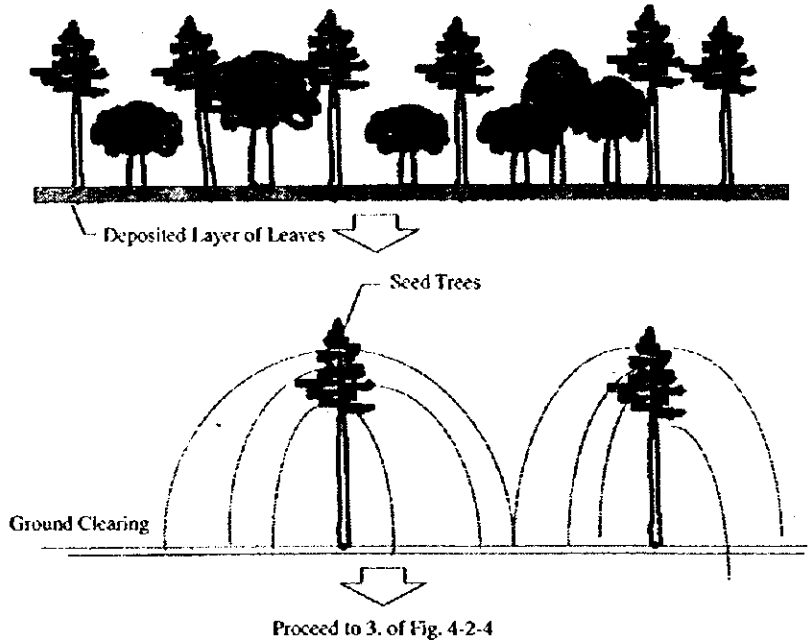

Fig. 4-2-6 Stand Improvement Work Type 1

< Stand Improvement Work Type 2 >

In regard to those areas where pine trees with a positive growth prospect do not exist, those areas with little regeneration of pine trees due to the dominance of pine and encino in the upper-story will be subject to spot clear felling with a radius of 25 - 50 m to encourage regeneration from the side. The regeneration and tending in these areas will follow the operation model described in 1) earlier.

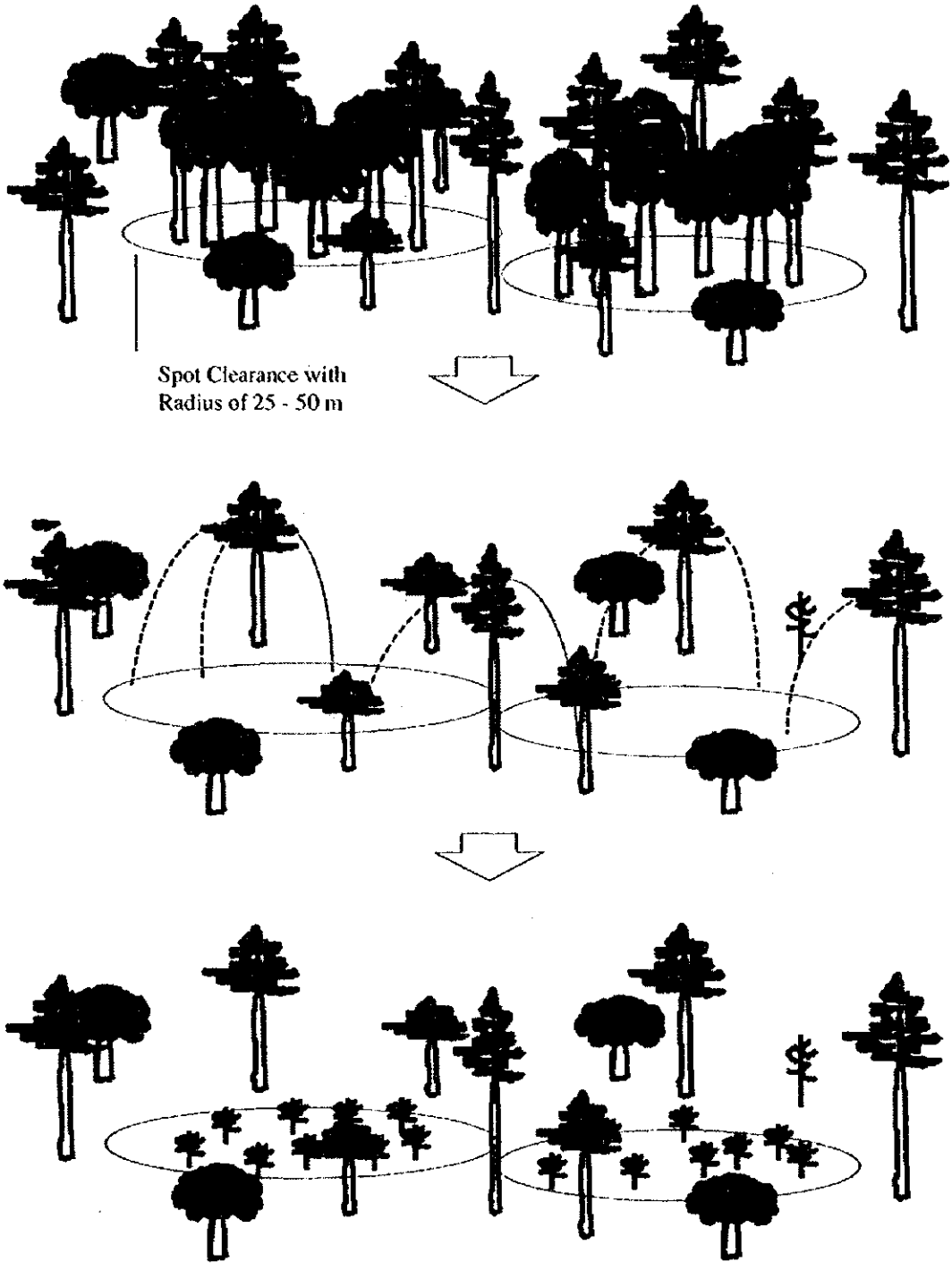

Fig. 4-2-7 Stand Improvement Work Type 2

(9) Felling and Transportation

1) Work Method

Felling and transportation will follow the standard method employed in the Sierra Juarez area.

a. Felling

- For felling and bucking, each team will consist of a chainsaw man and 1 - 2 assistants.
- The trees to be felled will be marked by the supervising engineer during his yield survey and only marked trees will be felled.
- When felling and bucking are conducted slightly earlier than yarding, the work efficiency will be improved together with improved work safety.
- When the stand density is high, felling tends to produced lodged trees. To avoid the occurrence of lodged trees, the falling direction should be properly determined and a wedge should be used as well as an under-cut and back-up to ensure that the trees fall in the proper direction.
- Care should be taken to avoid an unreasonably high felling height.

b. Bucking

- After trimming by a hatchet or chainsaw, the felled trees will be bucked.
- Efforts should be made to produce as many 2.62 m long logs as possible.

c. Yarding

- Above Road Level (Manual)
  - Each work team will consist of 2 - 3 workers.
  - The logs will be taken to a road using gancho or runners.
- Below Road Level (Yarding Crane)
  - Each work team will consist of a yarding crane operator and 2 - 3 choker men.
  - After choking, the logs will be lifted to the road level (the yarding of tree length logs, if possible, will result in a higher efficiency).

- The maximum yarding distance will be approximately 350 m.

– The yarded logs should be arranged by type at the road side and the quantity recorded.

d. Loading Onto Truck

– The logs will be loaded onto a truck either manually or by using a yarding crane. In the case of manual loading, two workers can carry a 1.25 m long log. A 2.62 m long log must be leaned against the truck and then pulled up by workers using a rope or gancho.

– Considering the road width and transportation efficiency, the use of a 10 - 12 ton truck for the direct transportation of the logs from the forest road side to a sawmill is desirable. As many local roads and forest roads are in poor condition, regular maintenance will be required. Patrols will be essential, particularly after rain, with a view to conducting drainage and other necessary work to maintain the roads in a passable condition.

2) Work Safety Measures

As felling and transportation involve the hazardous handling of heavy objects on steep slopes, there is always the risk of a fatal accident. In order to ensure work safety, the following measures should be introduced to deal with the risks involved.

– A safety meeting should be held before and after the work to reconfirm the safety measures.

– A site supervisor should always accompany the work teams to provide work instructions to ensure work safety.

– If an accident occurs, its cause(s) should be thoroughly analysed to improve the safety measures to prevent a repetition of the same type of accident.

– Workers should be encouraged to join an accident insurance scheme, etc. to secure their livelihoods following an accident.

– A first aid system should be established to deal with accidents.

The preparation of work standards for felling and transportation with the guidance of the SEMARNAP and SEDAF and their strict enforcement should prove highly effective to achieve work safety.

(10) Forest Protection

1) Forest Fires

Many forest fires have occurred in the Pilot Areas in the past. In fact, a major forest fire broke out during the survey period for the present forest management plan which affected S.M. Totomoxtla, S.M. Las Nieves, S.M. Buenavista and areas outside the Pilot Areas.

S.M. Buenavista in particular suffered devastating damage with some 80% of the forests belonging to this comunidad being lost or partially damaged. As a result, this comunidad lost timber resources which comprised important financing sources for infrastructure development as well as firewood resources required for the daily lives of local people. The turning of forests into bare land means the loss of the water retention, soil conservation and other functions, leading to the emergence of such problems as a shortage of domestic water and massive soil erosion, etc., all of which significantly affect local life.

These results of the forest fire literally show the direct as well as indirect relationship between forest resources and the lives of local people, illustrating the importance of forest fire prevention work by everyone living in a comunidad.

The first principle of forest fire prevention is obviously the eradication of the causes of forest fires. More recent forest fires in the Sierra Juarez area were spread due to burning at newly created farmland. The massive forest fire mentioned earlier also originated from the burning of cultivated land. The most effective forest fire prevention measure is, therefore, to control burning at the time of creating new farmland. The first step should be for each comunidad to prepare rules for burning and to strictly enforce these rules. These rules must specify the following issues.

- Compulsory notification of the date and time of intended burning to the comunidad's executive committee
- Implementation of burning by a well-experienced person
- Compulsory introduction of firebreaks between forests and farmland

- Penal provisions in the case of burning causing a forest fire

In addition, the following measures should be implemented.

- The administration must make local people properly understand the risk of forest fires associated with burning and should demonstrate an appropriate burning method for local people to follow.

- A forest fire information communication system should be established between comunidades together with a system of mutual assistance in the case of a forest fire breaking out.

- Education/training should be provided for administrative staff responsible for forest fire prevention, executive members of comunidades and members of forest committees, etc. to improve their knowledge and skills relating to forest fires.

- The administration should conduct a study on fire-fighting strategies and prepare a practical fire-fighting manual.

- Fire-fighting exercises should be conducted with the participation of administrative staff and local people.

In the case of the occurrence of a forest fire, fire-fighting activities must take the following points into consideration.

- Combustible objects, including standing trees should be removed in all areas in which the forest fire could spread to create firebreaks. In the case of sloping land, as a fire generally spreads upwards, these firebreaks should be created above burning areas.

- As a means of fire suppression, soil can be thrown over a fire using spades and matafuego and tree branches can be used to beat the fire.

- Even if a fire is extinguished on the ground surface, it is still possible for it to smoulder in the ground. Monitoring should continue for at least 24 hours after a fire has been extinguished on the ground surface.

A major forest fire can significantly affect the lives of local people and the following measures should be introduced to minimise its adverse effects.

- The extent of damage by a forest fire (geographical area and level of damage) must be clearly established.

- Damaged trees should be felled or sold or should be used for purposes associated with the daily lives of local people as quickly as possible. Damage by diseases and/or pests can be prevented in this way.

- The impacts of forest fires on local life must be assessed.

- The situation of a damaged area must be properly analysed to determine the specific method of vegetation restoration.

- All hazardous sites in terms of soil erosion must be properly inspected in order to identify the necessary measures to prevent soil erosion.

- All of the above aspects must be analysed to prepare a plan to address fire-damaged areas.

- A special organization to implement the above plan should be established by local people to ensure effective and efficient plan implementation.

- An application to the administration should be made for assistance for plan implementation.

2) Pest Damage

The most common damage observed in the Pilot Areas is that of the decorticator to *Pinus oocarpa* , *Pinus teocote* and other pine species. Damage is likely to occur in areas lacking healthy stands, including former forest fire sites, areas with low soil productivity and very dense stands. If the initial damage is not properly dealt with, the damaged area rapidly spread all around in the form of a concentric circle.

Once pest damage is observed, standing trees in the damaged area should be felled and burned to contain the spread of damage. If the damaged area is near a road, the felling trees may be transported for sale as pulp wood.

As the generally most effective way of controlling pest damage is the disposal of damaged trees at the initial stage of damage, forest patrols should be regularly conducted to detect such damage as early as possible.

(11) Forest Roads and Production Equipment/Tools

1) Forest Roads

Many of the forest roads and spur roads in the Pilot Area are deteriorated and must, therefore, be repaired/upgraded in the manner described below.

< Ordinary Roads >

As ordinary roads play the important role of supporting local life by linking comunidades to the outside world, they must be properly maintained. Repair work, including the levelling of uneven surfaces and the repair of side ditches, must be conducted while ensuring smooth and safe vehicle traffic during the work.

< Forest Roads and Spur Roads >

For the time being, existing roads to the sites of forest production activities will require improvement or repair.

The construction of new roads must be decided based on a thorough examination of their investment effects in view of the future prospects of local forestry.

The state of deterioration of existing roads and concrete maintenance/repair methods are shown in Table 4-2-4.

Table 4-2-4 State of Deterioration of Existing Roads and Repair/Maintenance Methods

State of Deterioration	Repair/Maintenance Method
Uneven surface or rills	Levelling of uneven surface using a spade, hoe, pick and/or bulldozer and repair of side ditches
Muddy surface due to poor drainage	Removal of mud, application of sand and drainage of water
Scoured or buried side ditches	Excavation using a pick or spade
Thick growth of shrubs, etc. on the shoulders	Removal of trees obstructing vehicle traffic using a chainsaw or hatchet
Cracks on valley side of road	Strengthening of the shoulders by banking together with cutting on the mountain side and/or introduction of net fencing or gabions at the tip of cracks

2) Production Equipment/Tools

As the development stage of forest production activities and the scale of current forestry operations vary from one comunidad to another, the required equipment and

tools must be determined for each comunidad, involving the procurement of new equipment/tools, disposal or renewal of existing equipment/tools and/or borrowing of equipment/tools. Either procurement or borrowing must be carefully decided in regard to expensive machinery based on a detailed analysis of the actual use prospects. The minimum equipment and tools required for forest production activities are listed below.

- Felling and transportation: 10 - 12 ton truck, vehicle equipped with yarding crane, gancho, chainsaw and hatchets

- Regeneration and tending: chainsaw, rakes and hatchets

(12) Work Implementation System

1) Forest Management Bodies and Their Activities

a. Forest Management Bodies

The following bodies responsible for forestry activities should be established in addition to the existing bodies in comunidades for efficient forest management by comunidades.

< Forest Production Unit >

The forest production unit will be responsible for the planning and implementation of forestry activities. Full-time officials of this unit will be appointed at a general assembly of local people to implement the assigned work, taking the size of forestry activities into consideration. These full-time officials will cooperate with each other regardless of their main fields of assignment in the planning and implementation of forestry activities. They will also liaise with supervising forestry engineers, local people and members of the comunidad council, forest committee described below and Sierra Norte Natural Resources Committee, etc. to ensure the smooth progress of forestry activities (see Fig. 4-2-8).

In order to ensure the continuity of forestry activities, the officials of the forest production unit should not all be replaced at once.

Note: The Sierra Norte Natural Resources Committee is organized by the SEMARNAP and its members also include representatives of comunidad councils in the Sierra Norte area, forest/forestry-related organizations, SEDAF and other governmental organizations and NGOs. The committee members exchange information on forests and forestry and propose development measures for the area.

Table 4-2-5 Example of Officials of Forest Production Unit and their Assignments

Coordinator	Supreme person responsible for forest production activities. Plans and implements such activities with the assistance of other officials
Secretary	In charge of general administrative affairs, including calculation of the log production volume and preparation of various documents
Treasurer	In charge of recording income and expenditure, management analysis and payment of wages, etc.
Site Supervisor	In charge of actual site work, recording labour input and providing work instructions, etc.

< Forest Committee >

A forest committee should be newly established to (i) improve the awareness of local people of the importance of forests in order to maintain local people's interest in and commitment to forest management and (ii) provide advice and recommendations to the forest production unit. The selection of the committee members from not only comuneros but also from the youth, women's and other groups in a comunidad is desirable. In order for these committee members to fully perform their role, it is necessary for them to improve their basic knowledge of forests and forestry and understanding of the actual conditions of local forests to make accurate judgements.

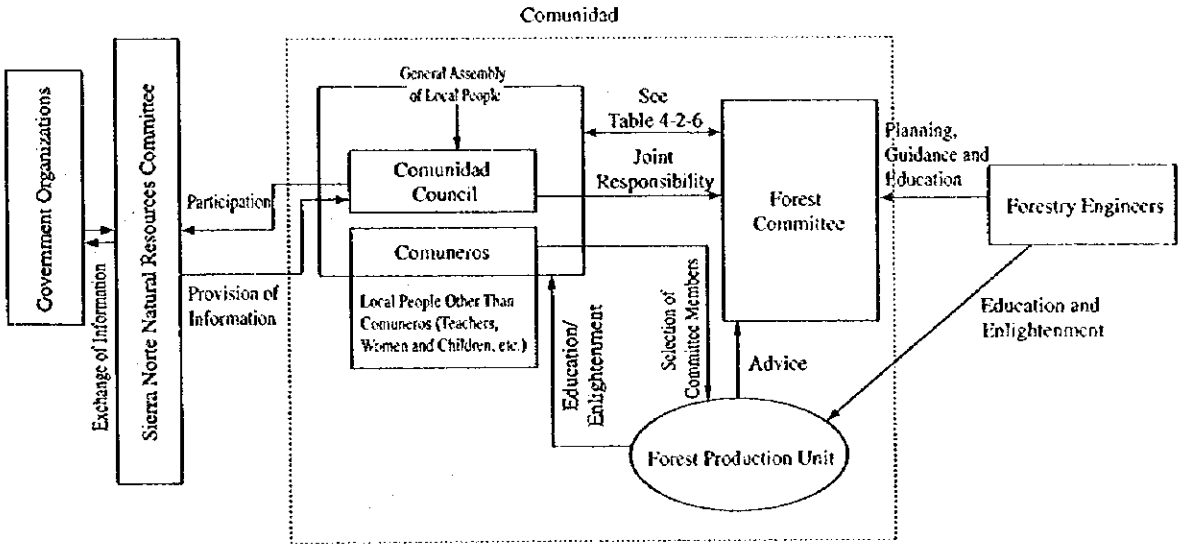

Fig. 4-2-8 Organization of Forest Management

The assumed relationship between the forest production unit and general assembly of local people is shown in Table 4-2-6.

Table 4-2-6 Relationship Between Forest Production Unit and General Assembly of Local People

Business of Forest Production Unit	Role of General Assembly of Local People
- Planning and reporting of forestry activity plan - Agreement and reporting of sales and other contracts - Implementation of forestry activities and reporting - Communication with site supervisor and staff of SEMARNAP and SEDAP	- Selection (comuneros for other than comunidad council), appointment of officials and decision on scope of and wage for each job - Auditing, approval, decision on disposal of profits and approval of officials

b. Preparation of Various Documents

For the smooth implementation of forest management, the forest production unit should prepare a detailed annual forestry activity plan (period, locations, work volume, personnel allocation and income/expenditure forecast, etc.) and should systematically implement the planned forestry activities. When forestry activities have been conducted, the results should be recorded as well as analysed to provide reference materials for subsequent forestry activities. The compilation of the following documents should prove very effective to improve forestry activities in subsequent years.

– Forest activity planning books

– Forest activity plan maps

– Forest activity implementation records

The compilation of these documents is also necessary to ensure the smooth succession of officials.

2) Extension of Forest Education and Improvement of Forestry Techniques

a. Extension of Forest Education and Improvement of Forestry Techniques

Local people lack sufficient knowledge of forests and forestry and, therefore, are not in a position to fully understand the conditions of forests. As a result, forestry activities in the past have been entirely entrusted to buyers or supervising forestry engineers without the active participation of local people. The lack of understanding of the need for regeneration work and tending on the part of local people has led to a lack of adequate forestry operations, resulting in the present situation where the

sustained forest management of local forests is difficult due to the lack of succeeding stands.

It is necessary for local people to improve their basic knowledge of forests and forestry in view of active forest management based on a sound understanding of the current forest conditions. It is, therefore, necessary to provide opportunities for local people to discuss forest conditions and the prospective use of forests to improve their understanding of forests and forestry as part of the overall efforts to develop an environment in which local people actively participate in forest management while maintaining their commitment to and enthusiasm for forestry activities. One way of achieving this goal is to improve the awareness of local people of the importance of forests and forestry through the activities of the Forest Committee described earlier, forest education on Tree Day and the creation of school forests, etc. The active participation of the youth group, which will comprise the mainstay for future forestry activities, and the women's group, which is the largest group in a comunidad, will be particularly important.

Those directly involved in forest management should learn the essential business of the forest production unit through education and guidance provided by supervising forestry engineers and study visits to comunidades where advanced forestry activities, etc. are conducted with a view to improving their technical knowledge of forestry. The introduction of a scholarship designed to foster forestry engineers among members of the local community should also be considered.

b. Role of Supervising Forestry Engineers

In principle, forestry activities must be supervised by forestry engineers who are registered with the national forest register. The scope of work of forestry engineers varies depending on the specific contract and ranges from the forest management plan formulation and forest management to the provision of technical guidance on forestry activities. Given the insufficient knowledge of forest management and forestry techniques on the part of local people at present, forestry engineers are also expected to provide education and guidance for local people in addition to such standard work from the following viewpoints.

- To provide guidance and education for local people in regard to basic knowledge of forests and forestry, bearing in mind the creation of better forests for comunidades

– To hold as many meetings and on-site training courses on the management of forestry activities as possible to educate local people on forest management and forestry techniques in a simple manner for easy understanding of these subjects by local people

– To fully explain the principles and methods of plan formulation and the selection of trees subject to felling to local people

3) Necessity for Tequio (cooperative work)

The existing forests in the Pilot Areas include many forests where thinning or stand improvement work is urgently required without the immediate prospect of a financial return for investment. The shortage of stands which are ready for regeneration felling means that it will be difficult to obtain sufficient income to fund such forestry operations for some time. Consequently, such work must largely rely on tequio. For the smooth progress of tequio, the implementation of the following measures will be necessary as incentives for local people to participate in tequio.

– Transportation of the timber produced by stand improvement work but which is unsaleable for commercial purposes, i.e. only as timber or firewood for own use, to settlements by truck for use by households participating in tequio

– Use of the government subsidy available for thinning and stand improvement work to pay people participating in tequio in cash

– Establishment of targets with the participation of local people (both men and women) for the spending of future income from felling

Moreover, local people must understand the significance of participating in tequio to conduct thinning and stand improvement. This understanding may be obtained by establishing a forest committee with a view to enlightening local people of the contribution made by income from felling in the past to improving the living infrastructure of comunidades.

4) Subsidy Schemes of Administration

There is a limit to the use of the economic resources currently available in a comunidad and to the reliance on tequio to promote forest production activities in a comunidad and, therefore, the active use of the subsidy schemes of the administration shown below is essential.

Subsidy Scheme	Funding Source	Granting Body	Target Recipient(s)	Purpose
PRODEFOR	SEMARNAP SEDAF	SEMARNAP SEDAF	Comunidades Ejido Small Forest Owners	Implementation of forest improvement work, such as tending; subsidy for forest management plan formulation, etc.
PROCYMAF	World Bank	SEMARNAP	Comunidades Ejido	Education and training on forestry operations
Empleo Tomporal (Temporary Employment)	SEDAF	SEDAF	Comunidades Ejido	Financial aid for forest tending and disease/pest control, etc.

Source: SEMARNAP, SEDAF

(13) Environmental Impacts Assessment

1) Assessment Method

It was decided to conduct an environmental impacts assessment in accordance with the four official criteria (NOM-059, 060, 061 and 062) regarding natural resources, introduced by Mexico's Environmental Agency. These criteria, however, only list the assessment items and do not elaborate on the concrete assessment method. As the format of JICA's Guidelines for Environmental Consideration in Development Studies (Forestry) incorporates all of the items listed by the above-mentioned official criteria, this format was used to assess the possible environmental impacts. A list detailing rare flora and fauna is included in this report to meet the official criteria.

Firstly, flora and fauna growing in or inhabiting the Pilot Areas and neighbouring areas were surveyed and the environmental characteristics were established by means of a field survey and aerial photograph interpretation to identify the environmental factors to be affected in order to determine the issues to be considered from the viewpoint of environmental conservation. Secondly, field scoping was conducted in the light of the contents of the forest management plan to be described later, followed by a detailed assessment of possible environmental impacts.

Field reconnaissance and interviews with officials of environment-related organizations as well as local people were also conducted to determine the flora and fauna growing in or inhabiting the Pilot Areas and neighbouring areas. Basic information was obtained from an existing document (Geografia Oaxaca).

2) Environmental Characteristics of Pilot Areas

a. Characteristics of Social Environment

The characteristics of the social environment in the Pilot Areas are basically; (i) all of S.M. Las Nieves, S.M. Totomoxtla, S.M. Buenavista and S.J. Teponaxtla show a social structure based on the local community called a comunidad, (ii) traditional ethnic groups dominate the local population and (iii) neither special sources of cash income nor industries worthy of note exist except for forest resources. While it is true to say that each comunidad differs from others in minor respects, these three characteristics apply to all comunidades from the macroscopic point of view.

On the other hand, under the traditional land ownership system dated back to before agrarian reform, the fair distribution of income and fair development of the living infrastructure are in place and few conflicts appear to exist between local people. On the other hand, the conservative and inefficient forest management over many years has resulted in a shortage of both skills and funds to conduct rational forest management.

b. Characteristics of Natural Environment

The Pilot Areas are located on the right bank of the Rio Grande and in the western Sierra Juarez Mountain Range. This western Sierra Juarez Mountain Range is carved by tributaries of the Rio Grande and appears like a comb or the skeleton of a fish and sub-ridges which stretch southwest to south from the main ridge of Sierra Juarez are lined in parallel towards the Rio Grande. In general, the topography is very steep and the sub-ridges leading to the Rio Grande in particular are characterised by steep cliffs. The elevation is generally between 1,000 m and 2,900 m and comunidades are located in the elevation range of between 1,500 m and 2,000 m, spreading in the areas from the sub-ridges to the mid-slope.

The elevation difference of some 1,900 m over a horizontal distance of some 10 km and the strong impacts of the Caribbean sea air mass on the eastern part of the Pilot Areas means large differences in the microclimate ranging from arid areas to mist forest areas. Arid areas are observed at low elevation sites along the Rio Grande and the mean rainfall in the dry season (November - April) is less than 100 mm. The rainfall level increases in accordance with the increasing elevation towards the northeast from the Rio Grande and the mean rainfall in the period from November to April exceeds 300mm in some places. The mean maximum and minimum

temperatures in the period from November to January are 15℃ - 27℃ and 6℃ - 12℃ respectively and low elevation areas along the Rio Grande are the hottest areas.

From the geological point of view, the Pilot Areas are widely covered by metamorphic rocks although sandstone, conglomerate, limestone and mudstone, etc. are observed along the Rio Grande. In arid areas at a low elevation, illuvial clay is observed but the clay content is generally low with a high presence of sand or fine gravel. Many types of soil are expansive. There are few landslide sites and little devastated land in the Pilot Areas except at roadside slopes despite the steep topography. This ground stability is assumed to be attributable to the excellent water permeability of the local mountain land from the geological and pedological points of view.

The local vegetation consists of arid shrub forests, pine forests, quercus forests, pine-quercus forests and mountain mesofilo forests. Pinus spp. and quercus spp. are the dominant species, forming a rather simple stand structure. Large diameter trees are sparse and there are many very dense stands with a small to medium size diameter. The regeneration of pine seedlings is poor in many stands, presumably because of (i) the obstruction of germination by the well-developed layer of leaves and hypha under the wet climate and (ii) the shortage of light for pine, which is a light demanding plant, because of crown closure. A rich distribution of fauna is observed which reflects the diverse environment, ranging from those species preferring a dry area to those preferring moist and dense forests. The main species of flora and fauna found in the Pilot Areas and their status vis-a-vis CITES and NOM-59 are shown in Table 4-2-7. The species in the CITES and NOM-59 lists are mainly found in tropical forests, mountain mesofilo forests and at dry rocky land.

The newly established Tehuacan-Cuicatlan Ecological Conservation zone is located on the left bank of the Rio Grande and does not include the Pilot Areas.

Table 4-2-7 Main Flora and Fauna in Pilot Areas and their Status Vis-a-Vis CITES and NOM-59

CITES:	I= Listed in Annex I II=Listed in Annex II	NOM-59:	P=Endangered Species A=Threatened Species R=Rare Species Pr=Species in Need of Special Protection

a. Flora

Family	Species	CITES	NOM-59
Araliaceae	Oreopanax horridus		
Betulaceae	Alnus arguta		
Bromeliaceae	Tillandsia usneoides		
Bromeliaceae	Tillandsia grandis		
Burseraceae	Bursera bipinnata		
Cactaceae	Nopalxochia ackemannii	II	
Chenopodiaceae	Atriplex canescens		
Compositae	Cirsium ehrenbergii		
Cupressaceae	Juniperus flaccida		
Cyatheaceae	Alsophila salvinii	II	
Ericaceae	Arbutus xalapensis		
Fagaceae	Quercus aff. crassifolia		
Fagaceae	Quercus candicans		
Fagaceae	Quercus castanea		
Fagaceae	Quercus crasifolia		
Fagaceae	Quercus frufuracea		
Fagaceae	Quercus frutex		
Fagaceae	Quercus laurina		
Fagaceae	Quercus peduncularis		
Fagaceae	Quercus polymorpha		
Hamamelidaceae	Liquidambar styraciflua		
Labiatae	Poliomintha marifolia		
Labiatea	Salvia lavanduloides		
Lauraceae	Litsea glaucescens		P
Lauraceae	Persea sp.		
Liliaceae	Smilax spinosa		
Meltastomataceae	Melastoma sp.		
Oleaceae	Fraxinus sp.		
Onagraceae	Fuchsia microphylla		
Orchidaceae	Encyclia vitellina	II	Pr
Orchidaceae	Lemboglossum cordatum	II	A
Orchidaceae	Maxillaria meleagris	II	
Orchidaceae	Oncidium ornithorrynchum	II	
Palmae	Collinia (Chamaedorea) sp.		
Pinaceae	Pinus ayacahuite		
Pinaceae	Pinus chiapensis		Pr
Pinaceae	Pinus michoacana		
Pinaceae	Pinus montezumae		
Pinaceae	Pinus oaxacana		
Pinaceae	Pinus oocarpa		

Pinaceae	Pinus patula		
Pinaceae	Pinus pseudostrobus		
Pinaceae	Pinus rudis		
Pinaceae	Pinus teocote		
Podocarpaceae	Podocarpus reiche		
Rosaceae	Crataegus pubescens		
Rosaceae	Cydonia oblonga		
Rosaceae	Prunus aff. Brachybotrya		
Rosaceae	Rubus pumilus		
Salicaceae	Salix paradoxa		
Solanaceae	Solanum nigrum		
Sterculiaceae	Chiranthodendron pentadactylon		A
Violaceae	Viola painteri		

b. Fauna

	Family	Species	CITES	NOM-59
Mammalia	Canidae	Canis latrans		
	Canidae	Canis lupus	II	P
	Canidae	Urocyon cinereoargenteus		
	Cebidae	Ateles geoffroyi		P
	Cervidae	Odcoileus virginianus		
	Dasyposidae	Dasypus novemcintus		
	Didelphidae	Chironectes minimus		P
	Didelphidae	Didelphis virginiana		
	Erethizontidae	Coendou mexicanus		A
	Felidae	Flis concolor	I	
	Felidae	Felis pardalis	I	P
	Felidae	Felis yagouaroundi	I	A
	Felidae	Felis wiedii	I	P
	Felidae	Panthera onca	I	P
	Heteromyidae	Liomys spp.		
	Leporidae	Sylvilagus sp.		
	Muridae	Mus spp.		
	Muridae	Neothoma spp.		
	Muridae	Peromyscus mamiculatus		
	Mustelidae	Mephitis macroura		
	Phyllostomidae	Artibeus sp.		
	Procyonidae	Bassariscus astutus		
	Procyonidae	Nasua narica		
	Procyonidae	Procyon lotor		
	Soricidae	Cryptotis goldmanii		
	Sciuridae	Sciurus spp.		
	Tayassuidae	Tayassu pecari	II	
	Vespertilionodae	Lasiurus sp.		
	Vespertilionodae	Leptonycteris samborni		A
Aves	Accipitrhidae	Buteo albicaudatus	II	Pr
	Accipitrhidae	Buteo jamaicensis	II	Pr
	Accipitrhidae	Buteo magnirostris	II	Pr
	Accipitrhidae	Buteo niditus	II	Pr
	Accipitrhidae	Hypomorphus urubitinga	II	
	Accipitrhidae	Rosthramus sociabilis	II	A
	Apodidae	Apodidae sp.		

	Caprimulgidae	Caprimulgus sp.		
	Columbidae	Columba sp.		
	Columbidae	Columbina passerina		
	Columbidae	Columbina tlalpacoti		
	Columbidae	Geotrygon albifacies		R
	Corvidae	Corvus imparatus mexicanus		
	Cotingidae	Cotinga amabilis		A
	Cotingidae	Crax rubra		A
	Cotingidae	Ortalis vetula		
	Cotingidae	Penelope purpurascens		Pr
	Dendrocolaptidae	Dendrocolaptidae sp.		
	Falconidae	Micrastur ruficollis	II	R
	Falconidae	Polyborus cheryway	II	
	Hirundinidae	Hirundinidae sp.		
	Icteridae	Icterus graduacauda		A
	Mimidae	Mimidae sp.		
	Paridae	Parus sp.		
	Parulidae	Parulidae sp.		
	Phasianidae	Colinus virginianus		
	Picidae	Veniliornis fumigatus		R
	Ploceidae	Passer domesticus		
	Porioptidae	Porioptidae sp.		
	Psittacidae	Ara militaris	I	P
	Ramphastidae	Aulacorynchus prasinus		Pr
	Strigidae	Aegolius acadicus	II	
	Strigidae	Bubo virginianus	II	A
	Strigidae	Ciccaba virgata	II	A
	Strigidae	Glaucidium brasilianum	II	A
	Strigidae	Lophostrix cristata	II	
	Strigidae	Otus trichopsis	II	
	Tinamidae	Crypturellus cinnamomeus		R
	Tinamidae	Tinamus major		
	Trochilidae	Cynanthus sordidus	II	
	Trochilidae	Florisuga mellivora	II	R
	Troglodytidae	Troglodytidae sp.		
	Trogonidae	Pharomachrus mocinno	I	P
	Turdidae	Myadestes obscurus		
	Turdidae	Ridgwayia pinicola		R
	Tyrannidae	Tyrannidae sp.		
	Tytonidae	Tyto alba	II	
	Vireonidae	Vireo sp.		
Reptilia	Colubridae	Elaphe sp.		
	Elapidae	Micrurus elegans		R
	Iguanidae	Iguana iguana	II	Pr
	Scincidae	Eumeces copei		R
	Scincidae	Scincella sp.		
	Viperidae	Crotalus basiliscus		Pr
	Viperidae	Crotalus basiliscus oaxacus		Pr
Amphibia	Bufonidae	Bufo sp.		
	Hylidae	Hyla plicata		A
	Plethodontidae	Plethodontidae sp.		

c. Issues to be Considered

The primary issue to be considered in the formulation of a forest management plan for the Pilot Areas is the conservation of the habitat of local flora and fauna which are very diverse and which include many endangered species, rare species and endemic species. For conservation of the ecosystem, it is important to protect not only these special species but also common species. Accordingly, mist forests and arid areas where many notable plant and animal species are observed should be conserved as much as possible. Given the fact that some species seasonally migrate between arid areas and mist forests, large-scale felling should be avoided in the pine-quercus forests laying between these two areas. It is also desirable for felling blocks not to be continuous to one another.

From the viewpoint of preventing surface erosion, forestry operations designed not to disrupt the forest floor are generally desirable. However, because of the excellent water permeability of mountain land in the Pilot Areas, there appears to be little likelihood of surface erosion. In fact, active clearance to facilitate the regeneration of pine seedlings to promote the normal regeneration process is required for environmental conservation.

3) Implementation of Field Scoping

During the process of formulating the forest management plan to be described later, field scoping was conducted to avoid adverse impacts on the environment by forestry activities, taking the characteristics of the local social and natural environments and the planned contents of forestry activities into consideration. The anticipated activities under each forest management plan and subject species of utilisation are shown in Table 4-2-8 and Table 4-2-9 respectively while the scoping results are shown in Table 4-2-10 and Table 4-2-11.

Table 4-2-8 Forestry Activities Under Each Forest Management Plan

Sub-Plan	Description of Activity
Forest Categorisation	- The Pilot Areas will be classified as timber production areas and conservation areas. Forests will then be categorised based on their site conditions and expected function(s) to form the basis for specific activities.
Felling Plan	- The felling volume will be determined so as not to exceed the increment level in order to ensure sustained production. - The felling method will be clear felling leaving seed trees in the case of commercial timber production forests and large-scale felling over a wide area should be avoided. Selective felling will be employed in the case of non-commercial timber production forests and firewood production forests. - In principle, felling will be prohibited in conservation areas although selective felling may be permitted in some cases.
Regeneration Plan	- Natural regeneration will mainly be employed. - The removal of ground cover, including clearing, will be actively conducted at the time of felling to facilitate natural regeneration.
Forest Road Plan	- Existing forest roads will be improved/rehabilitated for continued use. - Particular attention will be paid to drainage channels during rehabilitation work.
Forest Protection Plan	- Forest fire prevention and fighting system will be established. - Swift pest control measures will be implemented.
Management Plan	- A new body will be created in those comunidades where a forest production unit currently does not exist. - The existing forest production unit in some comunidades will be further strengthened.

Table 4-2-9 Subject Species for Utilisation Under Forest Management Plan

Pinus ayacahuite	Pinus patula
Pinus michoacana	Pinus pseudostrobus
Pinus montezumae	Pinus rudis
Pinus oaxacana	Pinus teocote
Pinus oocarpa	Quercus spp.

Table 4-2-10 Matrix for Field Scoping

Environmental Factor (Titles) (Sub-titles) (Items)	Degree of Environmental Impact on Development Activity (I): Forest Categorisation	Felling Plan	Regeneration Plan	Forest Road Plan	Forest Protection Plan	Management Plan	Remarks
1. Social Life							
(1) Daily Life							
1. Systematic Resettlement							
2. Compulsory Resettlement							
3. Change of Lifestyle						+	Improved living infrastructure of comunidad
4. Conflicts Among People						△	Division of work
5. Ethnic Groups/Nomads, etc.						+	Improved living infrastructure of comunidad
(2) Demographic Problems							
1. Population Increase							
2. Rapid Change of Demographic Structure							
(3) Economic Activities of Local Inhabitants							
1. Transfer of Economic Activity Base	△					△	Change of land use, etc.
2. Conversion of Economic Activities - Unemployment		+	+	+	+	+	Increase of employment opportunities
3. Widening Income Gap						+	Fair distribution of income
(4) Systems/Customs							
1. Readjustment of Common Rights to Forest Use	△					△	Land use restrictions, etc.
2. Change of Social Structure Through Grouping, etc.						+	Improved organization
3. Reform of Existing Systems and Customs						+	As above
2. Health and Hygiene							
1. Increased Use of Agrochemicals							Irrelevant
2. Outbreak of Local Diseases						+	Improved living environment
3. Spread of Infectious Diseases						+	Improved living environment
4. Accumulation of Residual Toxicity (Agrochemicals)							Irrelevant
5. Increased Household and Human Waste							
3. Historical Remains, Cultural Heritage and Beautiful Landscape, etc.							
1. Damage/Destruction of Historical Remains, etc.							Irrelevant
2. Loss of Rare Landscape							Irrelevant
3. Impact on Underground Resources							Irrelevant
4. Rare Wildlife Habitat							
1. Vegetational Change		△		○	+		
2. Impact on Rare Species and Endemic Wildlife		◎		○	+		
3. Decline of Biological Diversity		○		○	+		
4. Invasion by and Propagation of Harmful Creatures				△			
5. Disappearance of Swamps/Peat Moor							
6. Degradation of Natural Forest			+		+		
7. Destruction of Mangrove Forests							
8. Destruction of Coral Reef							

◎: Major negative impact ○: Intermediate negative impact △: Minor negative impact +: Positive impact No score: Irrelevant

Environmental Factor	Degree of Environmental Impact on Development Activity (I)						Remarks
(Titles) (Sub-titles) (Items)	Forest Categorisation	Felling Plan	Regeneration Plan	Forest Road Plan	Forest Protection Plan	Management Plan	
5. Soil and Land							
(1) Soil							
1. Soil Erosion	+	△	+	○	+		Positive effect of forest restoration
2. Increased Base Content of Soil							
3. Decline of Soil Fertility		△	+		+		As above
4. Soil Contamination							
5. Increase of Soil Acidity							
(2) Land							
1. Land Devastation (including Desertification)	+		+		+		Positive effect of forest restoration
2. Emergence of Devastated Land		○	+	△	+		As above
3. Decline of Wind Breaking and Fire Prevention Functions	+	○	+		+		As above
4. Subsidence							
6. Hydrology and Water Quality, etc.							
(1) Hydrology							
1. Change of Flow Regime of Surface Water		△	+	△	+		Positive effect of forest restoration
2. Change of Flow Regime and Groundwater Table		△	+		+		As above
3. Occurrence of Drought or Flood		△	+		+		As above
4. Sedimentation		△	+	△	+		As above
5. Lowering of River Bed							
6. Impact on Shipping							
(2) Water Quality/Water Temperature							
1. Water Pollution/Decline of Water Quality		△		△			Positive effect of forest restoration
2. Eutrophication							
3. Invasion of Salt Water							
4. Change of Water Temperature		△					
(3) Atmosphere							
1. Atmospheric Pollution							Positive effect of forest restoration
2. CO_2 Generation							As above
3. Microclimatic Change		△					As above
4. Noise		△		△			As above
7. Sustainability of Forest Resources and Functions							
1. Discontinued Sustainability of Raw Resources	+	△	+	△	+	+	Implementation of Forest Management Plan
2. Discontinued Sustainability of Environmental Conservation Functions	+	△	+	△	+	+	As above

◎: Major negative impact ○: Intermediate negative impact △: Minor negative impact +: Positive impact No score: Irrelevant

Table 4-2-11 Check List for Field Scoping

Environmental Factor (Titles) (Sub-titles) (Items)	Degree of Environmental Impact (Shown by ○) A	B	C	D	P	Judgement Result
1. Social Life						
(1) Daily Life						
1. Systematic Resettlement			○			Irrelevant
2. Compulsory Resettlement			○			Irrelevant
3. Change of Lifestyle					○	Improved living infrastructure
4. Conflicts Among People			○			Fair distribution and division of work
5. Minority Groups and Nomads, etc.					○	Improved living infrastructure
(2) Demographic Problems						
1. Population Increase			○			Irrelevant
2. Rapid Change of Demographic Structure			○			Irrelevant
(3) Economic Activities of Local Inhabitants						
1. Transfer of Economic Activity Base			○			No major change
2. Conversion of Economic Activities-Unemployment					○	Increase of employment opportunities
3. Widening Income Gap			○			Sharing or fair distribution of income
(4) Systems/Customs						
1. Readjustment of Common Rights to Forest Use			○			No major change
2. Change of Social Structure through Grouping, etc.					○	Improved organization
3. Reform of Existing Systems and Customs					○	Improvement and strengthening of existing systems and customs
2. Health and Hygiene						
1. Increased Use of Agrochemicals			○			Irrelevant
2. Outbreak of Local Diseases					○	Improved living infrastructure
3. Spread of Infectious Diseases					○	Improved living infrastructure
4. Accumulation of Residual Toxicity (Agrochemicals)			○			Irrelevant
5. Increased Household and Human Waste			○			No major change
3. Historical Remains, Cultural Heritage and Beautiful Landscape, etc.						
1. Damage/Destruction of Historical Remains, etc.			○			Irrelevant
2. Loss of Rare Landscape			○			Irrelevant
3. Impact on Underground Resources			○			Irrelevant
4. Rare Wildlife Habitat						
1. Vegetational Change			○			Small change due to natural regeneration
2. Impact on Rare Species and Endemic Wildlife			○			Establishment of conservation areas; felling of small areas
3. Decline of Biological Diversity			○			Small change due to natural regeneration; establishment of conservation areas; felling of small areas
4. Invasion by and Propagation of Harmful Creatures			○			No change
5. Disappearance of Swamps and Peat Moor			○			Irrelevant
6. Degradation of Natural Forests					○	Establishment of conservation forests; stand improvement
7. Destruction of Mangrove Forests			○			Irrelevant
8. Destruction of Coral Reef			○			Irrelevant

Note) Degree of Environmental Impact
A: serious negative impact
B: presumably serious negative impact
C: no serious impact
D: unknown
P: positive impact

Environmental Factor	Degree of Environmental Impact (Shown by ○)					Judgement Result
(Titles) (Sub-titles) (Items)	A	B	C	D	P	
5. Soil and Land						
(1) Soil						
1. Soil Erosion			○			Excellent water permeability
2. Increased Base Content of Soil			○			Irrelevant
3. Decline of Soil Fertility					○	Control of excessive felling; prevention of forest fires
4. Soil Contamination			○			Irrelevant
5. Increase of Soil Acidity			○			Irrelevant
(2) Land						
1. Land Devastation (including Desertification)					○	Control of excessive felling; prevention of forest fires
2. Emergence of Devastated Land			○			Excellent water permeability
3. Decline of Wind Breaking and Fire Prevention Functions					○	Strengthened functions through stand improvement
4. Subsidence			○			Irrelevant
6. Hydrology and Water Quality, etc.						
(1) Hydrology						
1. Change of Flow Regime of Surface Water			○			Establishment of conservation areas; felling of small areas
2. Change of Flow Regime and Groundwater Table			○			Irrelevant
3. Occurrence of Drought or Flood			○			Establishment of conservation areas; felling of small areas
4. Sedimentation			○			Establishment of conservation areas; felling of small areas
5. Lowering of River Bed			○			Irrelevant
6. Impact on Slipping			○			Irrelevant
(2) Water Quality/Water Temperature						
1. Water Pollution/Decline of Water Quality			○			Establishment of conservation areas; felling of small areas
2. Eutrophication			○			Irrelevant
3. Invasion of Salt Water			○			Irrelevant
4. Change of Water Temperature			○			Establishment of conservation areas; felling of small areas
(3) Atmosphere						
1. Atmospheric Pollution			○			Irrelevant
2. CO_2 Generation			○			Irrelevant
3. Microclimatic Change			○			Establishment of conservation areas; felling of small areas
4. Noise			○			Small-scale activities
7. Sustainability of Forest Resources and Functions						
1. Discontinued Sustainability of Raw Resources					○	Implementation of forest management plan
2. Discontinued sustainability of Environmental Conservation Functions					○	As above

Note) Degree of Environmental Impact
A: serious negative impact
B: presumably serious negative impact
C: no serious impact
D: unknown
P: positive impact

4) Environmental Impacts Assessment

An environmental impacts assessment was conducted as described below based on the field scoping results.

The forest management plan in question intends the implementation of urgently required forestry operations for the purpose of consolidating the perceived functions of individual forests for their sustained use under a long-term perspective while taking the intentions of local people fully into consideration. These forestry operations will not involve major changes of the land's character and the use of natural forces will be attempted to create healthy and highly productive forests through felling, regeneration and other work.

The plan incorporates all of the above-mentioned issues to be considered and its implementation will not have any serious negative impacts on the environment. In fact, positive impacts are anticipated in the case of most environmental factors as shown in Table 4-2-12.

Table 4-2-12 Overall Assessment Results

Environmental Factor	Assessment Result	Basis for Judgement and Necessary Future Considerations
Social Life	C or P	The forest management plan in question is designed to improve the technical and managerial aspects of the present forestry practices while taking environmental conservation and the sustainability of resources into consideration. A precondition is the preservation of comunidades which are responsible for joint land ownership, division of work and fair distribution of income, etc. Consequently, no new development in terms of the scale or content is planned. Neither does it intend to change existing systems or customs. No element of the plan will affect the local demographic conditions or economic activities and it is highly unlikely that the plan will result in any new conflicts among local people. Instead, the plan is expected to have such positive impacts as improved awareness on the part of local people in regard to ways of improving their lives, improved lifestyle, improvement of existing systems, etc., improvement and strengthening of the forest management organization, stable forestry income in the future and development of living infrastructure based on increased income, etc. by means of introducing rational and logical forest management and organization methods.
Health and Hygiene	C or P	Improvement of the hygiene conditions and hygiene awareness is anticipated as a result of the improved lifestyle and development of living infrastructure.
Historical Remains, Cultural Heritage and Beautiful Landscape, etc.	C	As no historical remains or cultural heritage or particularly beautiful landscape exist in the Pilot Areas, the forest management plan does not affect these factors. The progress of forest conservation and natural regeneration will, in fact, preserve the common landscape. The planned clear felling is of a temporary nature and no problems are anticipated with the appropriate implementation of the regeneration plan.

Rare Wildlife/ Habitat	C or P	The forest management plan does not intend the use of rare species. Both mountain mesofilo forests where many rare flora and fauna are found and selva baja forests with a somewhat special environment will be conserved as nature preservation forests together with rocky sites. Consequently, no significant impacts on rare species and on their habitat or the ecosystem are anticipated. In general, any destruction of forests and the ecosystem in warm and moist areas is temporary unless the clear felling of a large area and major change of the land use or the forced planting of exotic species is conducted. The original forest land and ecosystem will recover within several years and there is little risk that biological diversity will be lost. Animals will take temporary refuge in neighbouring areas while plants will survive in the felling blocks in the form of seeds or live roots. The temporary destruction will be followed by the invasion or regeneration of plants from the surrounding sites. Even if the forest land is not fully restored, animals will start to invade. In the case of selective felling or clear felling of small areas, the impacts are believed to be insignificant. In the case of certain animals, empty space is essential to form hunting grounds. The present plan basically intends to facilitate regeneration and stand improvement to create better forests and does not involve the construction of many new forest roads. Given these facts, the impacts of the plan on wildlife and the ecosystem will be very small. In fact, more positive impacts are anticipated through the introduction of conservation areas, prevention of forest fires and facilitation of natural regeneration. When clear felling leaving seed trees is opted for, it will be essential to ensure that felling blocks are not continuous to ensure continuous forests. To this effect, the felling of large areas must be avoided and felling at the block next to a felling block should only be conducted after the neighbouring felling block has been restored.
Soil and Land	C or P	In general, the introduction of measures to minimise disturbance of the ground surface due to felling and transportation is required to prevent erosion. However, given the excellent water permeability of the Pilot Areas from the geological and pedological points of view, disturbance of the ground surface at the time of felling and transportation is unlikely to result in erosion. In fact, active exposure of the ground surface by clearing, etc. to facilitate natural regeneration may well have positive effects which overshadow the possible adverse effects of an exposed ground surface. In addition, the establishment of soil conservation forests and the implementation of a forest fire prevention plan will have positive effects.
Hydrology and Water Quality, etc.	C or P	As the Pilot Areas enjoy excellent water permeability, any adverse impacts due to felling are unlikely to occur. The establishment of headwater conservation forests and other protected areas is instead expected to have positive effects.
Sustainability of Forest Resources and Functions	P	At present, the sustainability of forest resources and functions cannot be maintained in the Pilot Areas. However, all of the components of the forest management plan will contribute to achieving such sustainability in the future.

Note) Assessment Categories
- A: serious negative impact
- B: presumably serious negative impact
- C: no serious impact
- D: unknown
- P: positive impact

5) Environmental Consideration

The subject sites of forestry operations under the forest management plan will be mainly pine forests and pine-quercus forests located in areas between the mist forest zone and arid shrub land zone. As far as these pine and pine-quercus forests are concerned, their flora is simple and few rare species or endemic species are observed. However, the biological diversity in these areas has been maintained as the integral diversity of both mist forest and arid zones and it is undesirable to bring this continuity to an end. It is, therefore, preferable for actual forestry operations to avoid the clear felling of large areas or continuous felling blocks.

When conducting road rehabilitation work, special care must be taken in regard to the slope gradient and stability of banking as excessive cutting or banking could induce disasters. Further care is required to conserve those forests located upstream of a water intake as the simple water supply systems of local comunidades use nearby streams as supply sources.

(14) Evaluation of Forest Management Plan

1) Financial Analysis

a. Preconditions for Financial Analysis

The following preconditions have been set for the financial analysis:

(a) While the final cutting age of trees in commercial production forests is estimated at 60 years, a period of the financial analysis is set for 90 years starting from the preparation time of Year 0 to Year 90. Due to analytical difficulties in forecasting prices, prices have been fixed over this period in real terms. This ninety-year period could be too long for the analysis to make use of fixed prices in real terms. It should be understood that results of the analysis are valid only when the preconditions stated here are applied to the analysis.

(b) The analysis is based on prices prevailing in 1997. These prices are obtained during field surveys in Oaxaca: the first survey was in November, 1997 and the second in June, 1998.

(c) Mexico experienced a hyper inflation during 1995 and 1996. However, as seen from the following statistics, the producer price index dropped to the 10 %-level in 1997. In 1998, the inflation rate maintains a decreasing tendency. Based on these statistical data, the expected rate of inflation is estimated at 15 % per annum.

Table 4-2-13 Consumer Price Index and Producer Price Index

(1990=100)

Price Index	1991	1992	1993	1994	1995	1996	1997	Apr.1998
Consumer Price Index (CPI)	22.7	15.5	9.8	7.0	35.0	34.4	20.6	17.5
Producer Price Index (PPI)	19.1	12.0	6.6	6.4	41.5	34.4	16.0	13.2

Source) Banco de Mexico: The Mexican Economy 1998, June 1998.
Note) A moving average of the previous 12 months. The PPI in 1997 shows an average of the previous 12 months in December, 1997.

b. With Project Case

In a With Project case, the financial analysis has been conducted from a viewpoint of a forest production unit which has been (or is expected to be) established in respective comunidades. The analysis postulates management of production forests for commercial purposes. Under the project, the log production will be planned in case of S.M. Las Nieves and S.M. Totomoxtla while both the log production and timber processing are assumed in S.J. Teponaxtla.

(a) Log Production and Sales

In production forests, cutting is planned in accordance with actual conditions of forest stands, respectively, in uncut forest areas for the regeneration cutting, in areas for the forest stand improvement, and in areas for the thinning. With regard to forest stands after the regeneration cutting, Table 4-2-14 below shows the timing of respective forest activities, tree volumes to be cut, yield ratios of the log production, and utilization ratios of logs either for timber woods or pulp woods. These factors are assumed to be same among the comunidades under the project. With respect to the forest management plan for thinning areas, tree volumes to be cut will vary depending on the comunidades but the timing of forest activities, yield ratios of the log production, and utilization ratios of logs are expected to be same among the respective comunidades as shown in Table 4-2-15.

Table 4-2-14 Forest Management Activities in Areas for Regeneration Cutting

Forest Management Activities	Year of Activities (Note1)	Volumes to be cut (m^3/ha)	Yield Ratios of Log Production (%)	Utilization Ratio (%)	
				Timber Wood	Pulp Wood
First Thinning	20	20	50	0	100
Second Thinning	35	70	60	50	50
Regeneration Cutting	60	380	70	70	30

Note 1: Years of activities indicate a number of years which have passed since the year of the regeneration cutting.

Table 4-2-15 Forest Management Activities in Areas for Thinnig

Forest Management Activities	Year of Activities (Note2)	Volumes to be cut (m^3/ha)	Yield Ratios of Log Production (%)	Utilization Ratio (%)	
				Timber Wood	Pulp Wood
Thinning equivalent to the second one	15	being different depending on communities	60	50	50
Regeneration Cutting	15		70	70	30

Note 2: The year of activities for the thinning equivalent to the second one indicates a number of years which have passed since the year of the thinning equivalent to the first one. The year of the regeneration cutting shows a number of years which have passed since the year of activities for the thinning equivalent to the second one.

i. Regeneration Cutting in Uncut Areas

The regeneration cutting in uncut areas will be planned in 60-year rotation in case of S.J. Teponaxtla. A volume of the log production at the time of the regeneration cutting is shown in the forest management plan in S.J. Teponaxtla. The timing of forest management activities, volumes to be cut and other specific figures are similar to the ones shown in Table 4-2-14 above.

ii. Regeneration Cutting in Areas for the Forest Stand Improvement

The forest stand improvement is planned over a 25-year period in S.J. Teponaxtla and over a 30-year period in both S.M. Las Nieves and S.M. Totomoxtla in their respective areas for the forest stand improvement.

Furthermore, the log production will be simultaneously conducted in areas for the forest stand improvement. The volume of the log production is shown in respective forest management plans in comunidades. The timing of following forest management activities and corresponding annual volumes of the log production are shown in Table 4-2-14 above.

The regeneration cutting will commence in the 61st year after the forest stand improvement is conducted. Since the final cutting age of trees is 60 years, the annual area for the subsequent regeneration cutting will be obtained by dividing the total area for the forest stand improvement with 60 years.

iii. Thinning

In the area for the thinning, the thinning will be conducted over a period of 10 years. The timing of forest management activities, yield ratios of the log production, utilization ratios are as shown in Table 4-2-15 above. The regeneration cutting in thinning areas is planned in the 15th year after the thinning equivalent to the second one is completed. The annual area of the subsequent regeneration cutting will be calculated by dividing the total thinning area with 60 years.

(b) Log Production Cost

i. Cost of Yield Survey

The yield survey aims to select trees to be cut, determines forest conditions after completion of the regeneration cutting and subsequent forest management activities. The survey will then estimate benefits from the cutting. Costs of the yield survey are calculated from a standing stem volume of trees (RTA) and are converted into a unit cost in the log volume. For the analysis, 14 pesos per cubic meter in the log volume will be used for a unit cost of the yield survey.

ii. Cost of Regeneration Cutting and Thinning

The felling and logging are conducted in a course of actions by a team of crews. It is estimated that a team produces an average of 5 m^3 per day in the log volume. The payment to crews is based on the work progress. In comunidades such as fore-running comunidades where the log production is already in practice, a unit cost is determined for each of the production process. Referring to prevailing costs in these comunidades, unit costs as in

the following table have been used for the analysis. With these unit costs being applied, the production cost of logs is calculated at 43 pesos per cubic meter. This unit production cost, however, cover just labor costs. With regard to the labor cost of a chainsaw operator, the unit cost will include a rental fee of a chainsaw as well as fuel expenses. The number of man-days required for the production of one cubic meter of logs are calculated at 0.68 man-days as seen from the table. However, in case of the thinning, due to the low operational efficiency, it is estimated that a number of man-days required for the log production is 60 % larger than those required for the regeneration cutting.

Table 4-2-16 Felling and Transportation Processes

Activities		Type of Crews	Volume of Work in a Day	Required Man-Day per Cubic Meter	Unit Cost per Cubic Meter
Cutting, Processing, Limbing and Bucking		Chainsaw Operator (One person) Labor (One person)	$10m^3$	0.10 0.10	
		Sub-Total		0.20	18
Yarding	Above forest Road	Labors (3 persons)	$7m^3$	0.43	18
	Below Forest Road	Grua Operator (One person) Labor (3 persons)	$25m^3$	0.04 0.12	20
	Average of quantities required for operation above and below forest road			0.30	19
Loading to Trucks	With Grua	Grua Operator (One person) Labor (3 persons)	$25m^3$	0.04 0.12	5
	Without Grua	Labor (4 persons)	$20m^3$	0.20	7
	Average of quantities required for operation above and below forest road			0.18	6
Total				0.68	43

In addition to labor costs required for the log production, twenty percent of the total labor costs are included to cover direct costs such as fuel costs of a Grua.

iii. Cost of Transportation

In case of timber woods, it is assumed that the woods are transported to sawmills in Oaxaca In case of pulp woods, the woods are to be transported to a paper factory in Tuxtepec. It is a widely observed practice in the project

area to calculate the costs based on one cubic meter in log volume to be transported, and the costs will include a rental fee of a truck, a labor cost of a driver, and a fuel cost. In reality, there will be various ways in which transportation is done, for example, by a comunidad's own truck (owned either collectively by a comunidad or privately by a comunidad member, or owned by a neighboring comunidad), by a freighter, or by a buyer of logs. A unit cost of the transportation is also affected by comunidad's abilities to negotiate. However, although there are some differences, the transportation costs from a comunidad to Oaxaca are generally known with a certain range of differences. The financial analysis is based on those found to be appropriate among the transportation fees collected during the field survey.

iv. Cost of Forest Stand Improvement

It is estimated that the forest stand improvement requires 40 man-days per hectare consisting of 12 man-days of chainsaw operators and 28 man-days of labors. A number of labor man-days required for the forest stand improvement is calculated by multiplying the area for the forest stand improvement with 40 man-days. The forest stand improvement is planned over a period of 25 to 30 years and a total number of annual labor man-days required are calculated for each year.

For implementation of the forest stand improvement, two cases will be considered: the first case where the implementation is done by a forest production unit on a fee basis and the second case where the implementation is done by Tequio. In the first case where the work is done on a payment basis, a daily labor cost of general labors is estimated at 30 pesos while that of a chainsaw operator is at 150 pesos. The labor cost for a chainsaw operator includes a rental fee of a chainsaw and a fuel cost. In the second case where the work is done by Tequio, a chainsaw operator is to be paid 120 pesos per day.

v. Costs of Regeneration and Tending

Regeneration and tending activities mean the ground clearance, weeding, and cleaning cutting. It is estimated that the ground clearance requires 3 man-days per hectare. The total number of man-days required for the ground clearance per year is calculated by multiplying with 3 man-days the annual size of areas in hectare where the regeneration cutting is conducted. The weeding is also planned after the regeneration cutting is completed. The weeding is carried

out over 3 years, including the year when the regeneration cutting is conducted. A volume of the work required for the weeding is estimated at 5 man-days and a half of the area where the regeneration cutting is done will be planned for the weeding. The cleaning cutting is scheduled in the 7th year after completion of the regeneration cutting. A required work volume of the cleaning cutting is estimated at 5 man-days per hectare and, as is the case with the weeding, a half of the area for the regeneration cutting is subject to the cleaning cutting. A daily labor cost of 30 pesos is applied for the first case of the analysis and in the second case, the analysis is extended for the case where the regeneration and tending are done with Tequio.

vi. Costs of Equipment, Machinery, and Tools

The purchase of equipment, machinery, and tools is planned, including spare ones. Taking into account the existing possession of equipment, machinery and tools at respective comunidades, procurement of new goods is planned. It is common to see that ownership of chainsaws belongs to individuals and a unit payment for cutting, processing, limbing and bucking in the log production process often include a rental charge of a chainsaw and fuel expenses. Therefore, the analysis does not assume ownership of chainsaws by a forest production unit. It is assumed that an economic duration period of pickeroons ranges from 4 to 5 years and after these years have passed, the analysis expects replacement of the same number of pickeroons. Both hatchets and rakes are planned to be replaced every year. In case of a Grua, it is planned to rent it in S.M. Las Nieves and S.M. Totomoxtla. In Teponaxtla, however, the analysis considers a case where the forest production unit owns and replaces it when it reaches a final age of its physical life.

Table 4-2-17 Cost of Equipment and Tools

Type of Equipment and Tools	Unit Cost (Peso)	Depreciation Period (Year)
Pickeroon	200	4-5
Rake	75	1-2
Hatchet	30	1-2
Grua	320,000	20

vii. Construction and Rehabilitation Costs of Forest Roads

It is estimated that construction of forest roads will cost 70,000 pesos per kilometer in 1997 price. For rehabilitation of forest roads, two percents of the construction cost will be used for each kilometer of roads to be rehabilitated under the analysis.

(c) Sales of Timber Wood, Pulp Wood, and Processed Wood

It is assumed that all timber wood will be sold at a sawmill in Oaxaca. A sales price of "Milrum" comprising of first- and second-class timber woods is estimated at 450 pesos per cubic meter at a sawmill. On the other hand, all pulp woods will be sold at a paper factory in Tuxtepec. A sales price of pulp woods at the factory is estimated at 290 pesos per cubic meter. A sales price of processed woods is estimated at 3.4 pesos per PT at a factory in Oaxaca, including a value added tax.

(d) Operating Expense of a Forest Production Unit

i. Personnel Cost

A forest production unit is consisted of four to five members and their daily wages range from 30 pesos to 45 pesos, depending on comunidades. Daily wages will be paid based on the number of days for which the log production and timber processing are carried out.

ii. Direct Cost

A direct cost is estimated at fifty percent of the above total personnel cost required for the operation of a forest production unit. The direct cost covers operation and maintenance costs of 3 ton trucks owned by comunidades, marketing costs, costs of clerical works, telecommunication costs, contribution to comunidades, and contingencies. Part of the direct cost required to run a forest production unit will start incurring in the preparation year of Year 0 in the analysis.

iii. Working Capital of a Forest Production Unit

The following conditions are used for the analysis: account receivables which account for 25 % of a monthly average of sales; account payables for 5 % of a monthly average of operating expenses; and cash for 50 % of a monthly average of operating expenses.

(e) Benefits from Firewood Production Forest

Benefits from firewood production forests are not taken into account in the analysis because a forest production unit does not sell firewood.

(f) Taxes

An income tax is not levied on a forest production unit which does the log production so long as benefits are used for public service works in a comunidad. The financial analysis assumes that the benefits are used for public service works and therefore, does not take into account an income tax on a forest production unit. As a rate of value added taxes on logs is set at 0 %, value added taxes on logs are not included in the analysis either. However, 15 % of value added taxes will be levied on processed wood and this will be taken into account in the analysis. A land tax is also levied but the land tax has to be paid regardless of implementation of the project. Therefore, a land tax payment is not included in the analysis.

c. Without Project Case

A Without Project case postulates sales of standing trees. The sales of standing trees are planned over a period of 60 years. An annual cutting volume of standing trees will be same over 60 years. In addition, after completion of sales of standing trees, no salable timber forest resources are expected to grow within a time framework of the financial analysis. Sales prices of standing trees for respective comunidades are estimated by deducting all required expenses from a sales price of logs in Oaxaca.

d. Financial Discount Rate

A nominal financial discount rate is calculated based on interest rates on term deposits and possible lending interest rates to comunidades. In terms of lending in the forest sector, interest rates on policy-based credits by FIRA (Fideicomisos Institudios en Relacion a Agricultura) could be referred. FIRA sets its lending interest rate, which is thought to be applicable to comunidades in the project area, at an interest rate level of short-term treasury bills: an average interest rate of 28 days-CETES in the previous month. For example, a CETES rate in November, 1997 was 20.16% per annum. However, FIRA's lending volume in the forest sector in the state of Oaxaca shows a decreasing tendency in the recent years and this implies limited accessibility of comunidades to FIRA's funds. On the other hand, commercial banks quote their lending interests based on CETES rates and/or inter-bank interest rates (either TIIP or TIIE) and, although depending on

creditworthiness of borrowers, it is estimated that their lending interest rate may be around 28 % per annum for a short-term loan and lending interest rate to comunidades may be, with a higher risk premium being incorporated, around 34 % per annum. While an average cost of term deposits for banks (CPP) is about 18% per annum, an opportunity cost of capital for a project to be implemented in a comunidad will be estimated at 20 % per annum (4.3 % per annum in a real term) after taking a weighted average of the lending interest rate from banks and the average cost of term deposits for banks with weights being put at 10 % for the funds from banks and 90 % for the funds from comunidades. Considering that the payment under the project will be partly made against labor works by comuneros, a higher weight is placed on the funds from comunidades. However, in case of S.J. Teponaxtla, since borrowings from financial institutions may be required for investment in a sawmill, the financial discount rate is estimated at 26 % (9.7 % in a real term).

2) Economic Analysis

a. Methodology

The economic analysis has been conducted on each of the comumidades. The preconditions set for the analysis are similar to those for the financial analysis. These conditions are such as a period for the analysis, a base year, an inflation rate, scenarios of the With Project case and Without Project case. However, in case of the economic analysis, financial prices are converted into economic prices taking into consideration taxes, etc. The following formula has been used to convert financial prices into economic prices:

$$\text{Benefit or Cost per Unit} = \frac{\varepsilon s Ps - \eta d (Qd/Qs) Pd}{\varepsilon s - \eta d (Qd/Qs)}$$

ε s: Price elasticity of supply

η d: Price elasticity of demand

Ps: Supply price

Pd: Demand price

Qs: Supply from all others excluding the project

Qd: Total demand

The economic analysis seeks an incremental difference of net present values calculated from expected net cash flows under the two scenarios: With Project and Without Project cases.

b. Conversion Factors

Conversion factors from financial prices to economic prices are calculated in order to adjust prices of equipment, machinery, and tools in terms of excessive profits and taxes, and further in order to consider a foreign exchange premium for tradable components of these goods. A conversion factor is expressed in a ratio of an economic price over a financial price. The following table shows a list of conversion factors for equipment, machinery and tools.

Table 4-2-18 Conversion Factors

Items	Conversion Factor
Chainsaw	0.91
Pickeroon · Hatchet · Rake	0.91
Grua	0.81
Equipment at Sawmill	0.80
Tractor	0.88
Rent of a Tractor	0.86
Petroleum	0.78

Because a value added tax is not levied on logs and the future supply of logs from the comunidades is not expected to influence the total supply of logs in the market, no price adjustment has been made on prices of logs.

c. Foreign Exchange Premium

An average monthly exchange rate in November, 1997 is 8.3 pesos against US dollar. The economic cost of foreign exchanges is calculated based on a weighted average of two types of costs: one is due to an incremental increase in exports and the other is a decrease in consumers' benefits due to decline of import demands. Considering the elasticity of exports and imports with respect to foreign exchange rates as well as import taxes and customs duties, the foreign exchange premium is estimated at 5 %.

d. Opportunity Cost of Labor

Comuneros who are engaged in the log production and processed wood production are regarded as unskilled workers and, unlike skilled workers, their scarcity is not taken into account. In consideration of opportunity costs of labors for the log and processed wood production, the following prevailing wage levels are referred: a daily allowance, in a range from 20 pesos to 40 pesos, to another comunero acting in place of a comunero who cannot participate in obligatory community works (Tequio); a daily wage for agricultural works at other farms in a range from 20 pesos to 40 pesos per day; and a daily wage earned in Oaxaca by a comunidad member in a range from 25 pesos to 50 pesos when s/he works away from comunidades. Based on the above wage information, a daily wage of 30 pesos is used for the economic analysis. This level is similar to the one used in the financial analysis.

e. Economic Opportunity Cost of Capital

An economic opportunity cost of capital is calculated in consideration of saver's time preference for consumption (a deposit interest rate) on the supply side and expected rates of returns from investment on the demand side. In case of expected rates of returns from investment, growth rates of sector-wise GDP are used as the alternatives. Calculation of an economic opportunity cost of capital, i.e. an economic discount rate, is based on decrease in demand on other investment due to implementation of the project and postponement of consumption due to additional savings. Taking into account a withholding tax rate on deposits and corporate income tax rates, the economic opportunity cost of capital is estimated at 23 % in nominal terms. This discount rate is used to calculate an economic net present value of the project.

f. Benefits from Firewood

It is envisaged that thanks to the project, stable supplies of firewood are expected in the future (With Project case). On the other hand, if the project is not implemented, forests are expected to be full of firewood forests. Considering consequences of both the With Project case and Without Project case, benefits from firewood from the project implementation will be netted out. Accordingly, the economic analysis does not take into account benefits from firewood.