association with the development of educational facilities in Jatinagor, extensive housing development is in progress in Rancaekek. The Perumnas Housing Development Project is already underway to provide 500 ha of residential land. These 2 areas constitute the main development areas features in the Urban Development Strategy for the Bandung Metroplitan Area. Areas in which industrial and educational facilities are currently located and where housing development is in progress are all situated outside the Planning Area.

The decline of the agricultural sector in the Study Area in terms of employment is also confirmed by a recent report. The report of the sampling survey (342 households) on the social and economic conditions in the Study Area conducted by the SBRLKT Citarum (hereinafter referred to as the SBRLKT Report) states that employment in the agricultural sector declined from 42.43% of all employment in 1985 to 39.10% in 1991.

The population of the Study Area shows a generally increasing trend with the working population of the industrial sector growing at the expense of the agricultural population. This trend is caused by the following characteristics of the Study Area.

- Proximity to Bandung city which is an expanding economic zone
- Inclusion of paddy field areas in the Bandung basin where industrial parks and housing estates are being developed
- Inclusion of the Jatinagor area in the Bandung District where the large development of educational facilities is in progress.

The population pressure, defined by Otto Soemarwoto, is reportedly 1.66 as of 1991 in the Study Area, far exceeding the general tolerance limit of 1.00. The farming of dry crop fields in the Planning Area is mainly conducted manually.

The details of local agriculture and forestry, which are subject to this project directly, are discussed in 3.5 Local Agriculture and 3.6 Forestry in Study Area.

3.2.2 Land Use and Water Use

(1) Land Use

Land use in the Study Area is characterised by high proportions of paddy fields, mixed gardens and dry crop fields. In the Bandung District in particular,

paddy fields account for almost 40% of the total land. In contrast, the combined figure for mixed gardens and dry crop fields is larger than that for paddy fields in the Sumedang District. Year-to-year changes of land use in the Bandung District, however, showed a slight decline of paddy fields to around the 40% level in the period between 1985 and 1990. A similar decline of the forest area was also observed in the same period to around the 12% level. In comparison, the land use ratio of dry crop fields increased from some 22% in 1985 to 31% in 1990. The shrinkage of paddy fields and the expansion of dry crop fields has led to increased sediment runoff in the upper reaches of Citarik river, increasing the necessity and urgency of the Project's implementation.

Table 3-9 shows the scale of local land ownership cited from the SBRLKT Report. The division of 0.10 - 0.50 ha accounts for 70% of the total. Given the fact that the overwhelming majority of the subject persons of the Project are small landowners, an organized approach involving local communities should prove more effective than other methods to prevent soil erosion.

In general, most farming households in the Study Area own only a small area of land and farmers are inclined to give their highest priority to making as much profit as possible. Consequently, the general interest in the types of land use which are preferred from the viewpoint of soil and water conservation is weak. The questionnaire survey found that especially tenant farmers, whose lands belong to the absentee landlords, showed less interest in soil and water conservation.

With regard to existing farming customs related to soil conservation, there is a tendency for traditional farming, such as home gardens and mixed gardens on sloping land, using the ecosystem's material cycle to be replaced by farming using energy supplied from outside the cycle (dry crop farming).

There is a traditional custom of mutual help (Goton Royon) which is organized on a village basis in terms of farming, public civil engineering work and disaster prevention/rehabilitation work.

The agricultural land use is discussed into details in 3.5 Local Agriculture and 3.6 Forestry in Study Area.

Table 3-9 Land Ownership in Upper Reaches of Citarik River

Owned Area (ha)	Number of Owners	Ratio (%)
No Ownership	7,110	6.04
0.10 - 0.25	52,253	44.38
0.26 - 0.50	33,061	28.07
0.51 - 1.00	15,720	13.35
1.01 - 2.00	6,703	5.69
2.01 <	2,537	2.15

Source: SBRLKT Report

(2) Water Use

According to the results of a survey conducted by the Ministry of Public Works on the water supply and demand situation around Bandung, water resources in the Study Area are utilised to a full 100%. Irrigation is the main type of water use in the Study Area and changes in the irrigated area are shown in Table 3-10.

Table 3-10 Irrigated Area in Sub-Watersheds in Study Area

Sub-Watershed	Technically Irrigated Area (ha)			Desa Irrigated
	Previous	1990	Reduction (%)	Area (ha)
Cipamokolan	138	0	100	876
Cikeruh	3,620	2,338	35	1,000
Citarik	1,276	1,188	7	6,456

Source: Department of Public Works, "West Java Provincial Water Sources Master Plan for Water Supply", 1990

Notes
- Technically Irrigated Area: systematically managed by the Cabang Dinas, Ministry of Public Works.
- Desa Irrigated Area: no systematic management is provided.

The technically irrigated area showed a declined in all 3 sub-watersheds, presumably because of the progress of urbanisation and industrialisation around Bandung. In particular, irrigated fields ceased to exist in the Cipamokolan sub-watershed in 1990 as the area was the most subject to strong pressure by urbanisation because of its inclusion in the sprawling Bandung area. The following characteristics of water use in the Study Area can be pointed out.

① Springs are the main source of drinking water. Water from wells and reservoirs is also used in areas lying between the midslope and foot of sloping land.

② Rivers are the main source of agricultural water. Wells and reservoirs are also used in areas lying between the midslope and foot of sloping land. Industrial water mainly consists of groundwater.

③ Quiet water areas such as reservoirs are sometimes used for the culture of fish.

④ A domestic water shortage sometimes occurs during the dry season in areas lying between the midslope and foot of sloping land and water is supplied from reservoirs under the control of the Ministry of Public Works.

(3) Spatial Plan at Provincial, Municipal and District Levels

The future land use in the Study Area has been planned by the provincial, municipal and district BAPPEDAs (planning bureaus) as follows.

① The land use plan of the BAPPEDA of West Java Province has the following components which relate to the Project.

- Conversion of land use near Bukit Jarian (total area: approximately 400 ha)
- Functional improvement of protection zones designed to prevent flooding

The land conversion format at Bukit Jarian is for the Perum Perhutani to purchase village land currently used as dry crop fields for conversion to conservation zones.

The functional improvement of protection zones is one of the declared measures under the Second 25-Year Long-Term National Development Plan for 1994 - 2020 (KEPPRES No. 32) which stipulates land use policies for protection zones. The Presidential Special Budget Execution Authority (SATDAL), which consists of many government ministries and agencies with the Population and Environmental Bureau acting as the secretariat, has been

established within the West Java provincial government to conduct a wide range of environmental improvement activities using the INPRES budget, including regreening and the promotion of bamboo craftwork. These activities are specially designed to improve the social and educational environments for low income families and these objectives are compatible with those of the Project.

② The BAPPEDA of the Bandung municipal government has prepared a master plan called "Rencana Umum Tata Ruang Kota, Kotamadya Daerah Tingkat II Bandung (Revisi Rencana Induk Kota Bandung 2005)" (Bandung Municipal Development Plan - Revised Bandung Municipal Development Plan to 2005), the contents of which are related to the Project. This master plan envisages the conservational land use of upper slope sections to the northeast of Bandung. The Study Area overlaps with this conservation area and the objectives of the Project are identical to those of the master plan.

③ The BAPPEDA of the Bandung district government is also preparing a local development plan which is similar to the master plan of the Bandung municipal government. The planning contents include conservation areas (Tanah Konservasi) and a road network. No discrepancy between the district plan and the Project was found at the meeting between the Study Team members and district officials.

④ The BAPPEDA of the Sumedang district government is also preparing a local development plan and is actually implementing the Rencana Umum Tata Ruang Kota Perguruan Tinggi Jatinagor (Jatinagor Education City Development Plan) which envisages the development of Jatinagor as a concentrated area of educational organizations through a 20 year period commencing in 1987.

3.3 Soil Erosion

3.3.1 Soil Erosion Test

Soil erosion test equipment was installed to determine the prevailing tendency of soil erosion in the Planning Area. The annual rainfall, elevation and slope gradient of the established experimental plots are 2,000 - 2,200mm, 850 - 1,050m and 25 - 38% respectively while the soil type is the Cambisols Complex III for all plots. Each

plot was rectangular and was 4m in width and 22m in slope length (resulting in a plot area of 88m^2). A plot was established for each of 4 different land use categories, i.e. dry crop field, bare land, bamboo forest and forest. The sediment runoff volumes (dry weight) of these plots were observed for the 6 month period between November, 1992 and April, 1993 (see Supporting Report A4 for detailed data).

The volume of soil erosion per ha for the above 6 month period was highest for the bare land plot (640.6 tons/ha), followed by the dry crop field plot (200.1 tons/ha), the bamboo forest plot (1.9 tons/ha) and the forest plot (0.04 tons/ha). The indexed soil erosion, using the volume of soil erosion of the bare land plot as 1, was 0.31 for the dry crop field plot, 0.003 for the bamboo forest plot and 0.00006 for the forest plot. Although the bamboo forest plot and the forest plot have slightly higher annual rainfall and are steeper than the other 2 plots, they showed much less soil erosion. In particular, the forest plot showed an extremely low degree of soil erosion despite its steep slope gradient of 38%, indicating that a forest with well developed undergrowth is very effective in preventing soil erosion. The estimated annual volume of soil erosion per ha for each plot based on the USLE method is the largest for the bare land plot with 728.3 tons/ha/year, followed by 405.8 tons/ha/year for the dry crop field plot, 11.5 tons/ha/year for the bamboo forest plot and 1.4 tons/ha/year for the forest plot, showing similarities to the actual observation results in terms of dimension order. Nevertheless, the applicability of the estimated volumes using the USLE method to the Study Area in general cannot be upheld due to the lack of sufficient data covering a long period of time and a large number of plots. Consequently, it has been decided to use the estimated soil erosion volumes of the USLE method as relative values for the present study purposes.

3.3.2 Survey on Sedimentation at Check Dams

The current conditions of the sedimentation volume and catchment area of the existing 28 check dams in the Planning Area were surveyed to clarify the actual soil discharge to torrents in the Planning Area (see Supporting Report A5 for detailed data). The annual sedimentation volume per ha of the catchment area ranged from 1.8 to 112.5 m^3/ha/year based on the average annual sedimentation volume at each check dam and the weighted average, taking the size of the catchment area into consideration, was 16.9 m^3/ha/year. The multiple regression analysis to clarify the possible relation between the annual sedimentation volume per ha of the catchment area and the conditions of the catchment area established the following equation, showing a certain relation between the annual sedimentation volume on the one

hand and the density of the main torrent, the number of valleys and the forest coverage on the other hand.

$$\log Y = 0.76864 \log X_1 + 0.71269 \log X_2 - 0.0079 X_3 - 0.12098$$

where

Y : annual sedimentation volume per ha of catchment area (m^3/ha/year)

X_1 : density of main torrent (m/ha): total length of longest torrent in catchment area per unit catchment area size (estimated from topographical map with a scale of 1/10,000)

X_2 : number of branching valleys in catchment area per unit catchment area size (estimated from topographical map with a scale of 1/10,000)

X_3 : forest coverage (%): forest coverage in catchment area per unit catchment area size (estimated using 2cm meshes on land use and vegetation map with a scale of 1/10,000)

Multiple Correlation Coefficient : 0.73

Range of Applicable Catchment Area Size: 10 - 250 ha

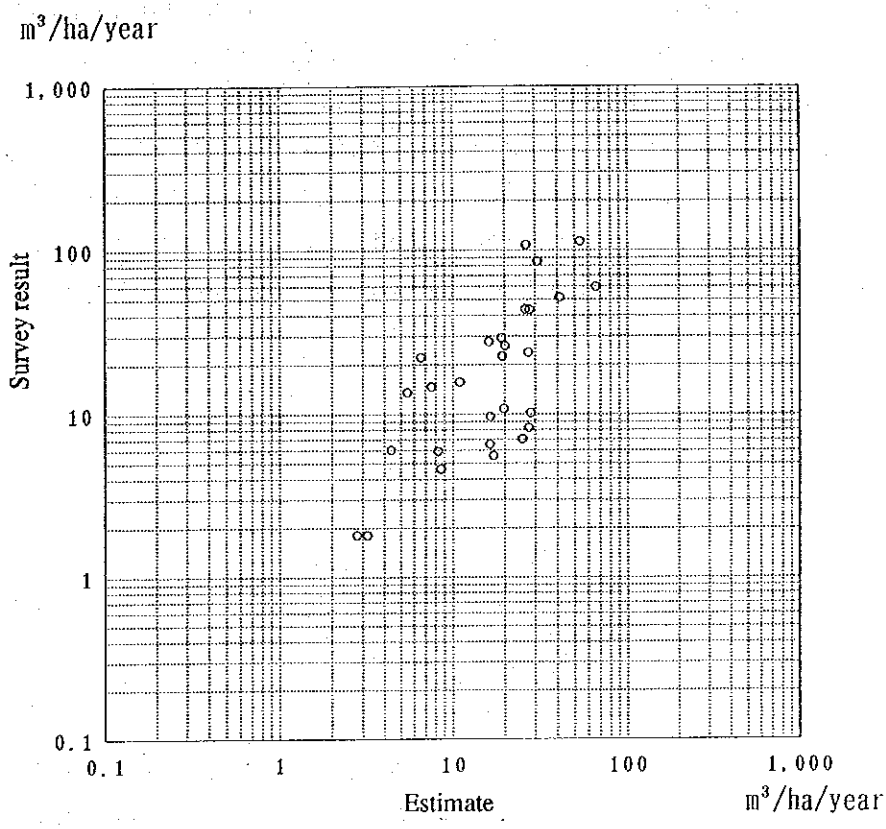


Fig. 3-2 Correlation Between Survey Result and Estimate of Annual Sedimentation Volume/ha in Catchment Area

3.3.3 Estimate of Soil Erosion Volume Using USLE Method

The surface soil erosion volume in the Study Area was estimated using the USLE (Universal Soil Loss Equation) method (see Supporting Report A6 for details). Prior to the analysis, the Study Area was squared (200m x 200m equivalent to 2cm squares on the topographical map with a scale of 1/10,000) and the soil erosion volume was estimated for each square (4 ha). The estimated results are given in Table 3-11. The annual soil erosion volume per unit area in the Study Area is 203 tons/ha/year and the total annual soil erosion volume is 10,180,000 tons/year.

3.4 Current Conditions of Torrents

3.4.1 Characteristics of Sub-Watersheds

The results of the survey on the characteristics of the 12 sub-watersheds which constitute the Planning Area are given in Table 3-12. The average area of these sub-watersheds is 2,800 ha and Sub-Watershed No. 4 and Sub-Watershed No. 12 are the largest and smallest with 6,213 ha and 526 ha respectively (Table 1-2). The length of the main torrent in each sub-watershed is rather long with 19,100m for Sub-Watershed No. 4 and 17,700m for Sub-Watershed No. 6. Sub-Watershed No. 12 has the shortest main torrent length of 4,800m. The difference in the relative elevation of the main torrent within the sub-watershed is large in the case of Sub-Watershed Nos. 10, 11 and 4 at 1,210m, 1,050m and 1,035m respectively. However, the figure is small for Sub-Watershed Nos. 12 (265m), 8 (450m) and 7 (470m). The gradient of the main torrent of is large at 10% for both Sub-Watershed No. 3 and No. 10 but is small for Sub-Watershed No. 6 at 4% as well as Nos. 4, 7 and 8 at 5%.

Table 3-11 Soil Erosion Volume by Sub-Watershed

Sub-Watershed No.	Annual Soil Erosion Volume per ha (tons/ha/year)	Annual Soil Erosion Volume (tons/year)
1	310.0	691,995
2	172.4	604,736
3	224.8	552,214
4	210.8	1,301,056
5	619.7	1,814,512
6	223.9	922,516
7	191.6	530,248
8	253.2	650,110
9	456.3	1,003,841
10	390.6	962,414
11	374.9	526,324
12	910.5	480,767
13	9.9	55,388
14	5.3	27,592
15	9.3	56,081
Study Area	202.8 (average)	10,179,794

In terms of the elongation ratio (ratio of the diameter of a circle with the same area as a particular watershed to the length of the main stream in the same river system), Sub-Watershed Nos. 3 and 5 show relatively large values of 0.79 and 0.78 respectively, indicating a radial pattern of torrent distribution. Conversely, the elongation ratio of 0.54 of Sub-Watershed No. 11 is small, indicating a plume-like pattern of torrent distribution.

Sub-Watershed Nos. 4 and 6 have a long aggregate valley length of 147,400m and 105,400m respectively while Sub-Watershed Nos. 12, 11 and 5 have a short aggregate valley length of 15,400m, 33,600m and 36,800m respectively.

The valley density is high in the case of Sub-Watershed Nos. 1 (30.2 m/ha), 12 (29.3 m/ha), 2 (26.4 m/ha) and 6 (25.7 m/ha) while it is low in the case of Sub-Watershed Nos. 5 (12.7 m/ha), 7 (17.0 m/ha) and 8 (19.2 m/ha).

Table 3-12 Current Conditions of Sub-Watersheds in Project Area

Sub-Watershed No.	Sub-Districts (Kecamatan) Located in Sub-Watershed	Area (ha)	Main Torrent				Elongation Ratio	Aggregate Valley Length	Valley Density (m/ha)
			Name	Length (m)	Difference in Relative Elevation (m)	Gradient (%)			
1	Cimenyan, Cicadas, Arcamanik	2,255	Cisaranten	9,400	835	9	0.57	68,200	30.2
2	Cilengkrang, Ujung Berung, Cibiru, Cimenyan	3,524	Cipanjalu	1,100	850	8	0.61	93,000	26.4
3	Cileunyi, Cikeruh, Cibiru	2,443	-	7,100	735	10	0.79	53,600	21.9
4	Tanjungsari, Cikeruh	6,213	Cikeruh	19,100	1,035	5	0.47	147,400	23.7
5	Cimanggung, Tanjungsari	2,909	-	7,800	630	8	0.78	36,800	12.7
6	Cimanggung, Cicalengka	4,097	Citarik	17,700	760	4	0.41	105,400	25.7
7	Cicalengka	2,758	Cibodas	9,800	470	5	0.60	47,000	17.0
8	Cicalengka, Cikancung	2,590	Cijalupang	9,400	450	5	0.61	49,600	19.2
9	Cicalengka, Cikancung	2,226	Cibingkur	7,600	660	9	0.70	44,800	20.1
10	Paseh, Cikancung	2,466	Ciunggala	12,400	1,210	10	0.45	61,200	24.8
11	Paseh	1,381	-	11,600	1,050	9	0.36	33,600	24.3
12	Cikancung	526	Cilutung	4,800	265	6	0.54	15,400	29.3

3.4.2 State of Torrent Devastation

A survey was conducted on major torrents in the Planning Area to determine the state of devastation (see Supporting Report A8).

Cisaranten river in Sub-Watershed No. 1 mainly flows through dry crop fields and paddy fields except at the upper part of the mountain slope. Bank erosion is observed in some parts and a high level of boulder and gravel deposits is seen just below quarries. The river water is a yellowish brown colour. The river flows through forests at the upper part of the mountain slope where no bank erosion is observed and where the river water is transparent.

Cipanjalu river in Sub-Watershed No. 2 mainly flows through dry crop fields and paddy fields from the midslope downwards. Bank erosion is observed in some parts and the revetment work is breached at several points. The river water is a yellowish brown colour. Above the midslope area, the river flows through forests, quinine estates and dry crop fields and no bank erosion is observed. The river water in these upper reaches is a grey-greenish brown colour and is translucent.

Cikeruh river in Sub-Watershed No. 4 mainly flows through paddy fields from the midslope downwards. Bank erosion is observed in some parts and the river water is a yellowish-brown or grey-greenish brown colour. The upper reaches of the river are in the forest zone where hardly any bank erosion is observed. The river water becomes increasingly transparent deeper into the forest zone. Interviews with local inhabitants at Kp. Sindanglaya in the Tunjungsari Sub-District found that the flood level in 1970 reached as high as 3m, causing damage to housing. Revetment work was subsequently conducted by the Ministry of Public Works.

Citarik river in Sub-Watershed No. 6 mainly flows through paddy fields and dry crop fields. Bank erosion is observed in many places and the river water is a yellowish-brown colour. Interviews at Desa Tegalmanggung in the Cimanggung Sub-District found that the flood water level is 2 - 3m and that gravel, boulders and driftwood is carried by the flood.

Cimulu river, which forms the uppermost reaches of Citarik river, mainly flows through forests and no bank erosion is observed. The river water becomes increasingly transparent deeper into the forest zone.

Ciunggala river in Sub-Watershed No. 10 mainly flows through paddy fields and dry crop fields from the midslope downwards. Bank erosion is observed in some parts and a large number of boulders and gravel have been deposited in some places. The river water is a greyish-green or grey-greenish brown colour. Interviews at Desa Cipaku in the Paseh Sub-District found that the flood water level in 1978 reached as high as 3m, destroying bridges and carrying down boulders, gravel and driftwood. Above the midslope, the river mainly flows through forests and no bank erosion is observed. The river water is transparent.

3.4.3 Sedimentation Volume at Saguling Dam

There are 3 hydroelectric dams in the lower reaches of the Study Area, i.e. Saguling dam, Cirata dam and Jatiluhur dam. Saguling dam is the uppermost located and its catchment area of 2,283 km^2 includes 49,799 ha of the Study Area which is 99% of the entire area of 50,325 ha. The State Electricity Public Corporation (Perusahaan Umum Listrik Negara: PLN) recently completed a survey on the sedimentation volume at Saguling dam. The survey found that the sedimentation volume was relatively steady in the last 4 years between 1988 and 1992 at an annual rate of between 3,160,000 m^3/year and 3,779,000 m^3/year with an average of 3,408,000 m^3/year (Table 3-13). The dam has a capacity of 167,689,000m^3 below the horizontal plane marked by the upper end of the water intake for power generation. As the sedimentation volume as of June, 1992 is 12,878,000m^3, the dam has a remaining capacity of 154,811,000m^3. Assuming an annual sedimentation volume of 3,408,000 m^3/year and that the sedimentation plane is level, Saguling dam has a remaining service life of 45.4 years as of June, 1992.

Assuming an annual soil discharge per ha from the Planning Area of 16.9 m^3/h/year based on the survey results described in 3.3.2, the annual soil discharge to Citarum river from the Planning Area is 555,000 m^3/year as the Planning Area in the Saguling dam catchment area covers 32,862 ha of land. This annual discharge is equivalent to 16% of the annual sedimentation volume at Saguling dam.

Table 3-13 Sedimentation Volume at Saguling Dam

(Unit: m^3)

Observation Period	Sedimentation Volume	Sedimentation Volume Below Horizontal Plane Marked by Upper End of Water Intake	Sedimentation Volume Above Horizontal Plane Marked by Upper End of Water Intake
Feb., 1985 - June, 1988	5,851,305	4,640,502	1,210,803
June, 1988 - June, 1989	3,160,464	976,699	2,183,765
June, 1989 - June, 1990	3,465,934	2,563,936	901,998
June, 1990 - June, 1991	3,228,136	2,431,694	796,442
June, 1991 - June, 1992	3,778,765	2,265,382	1,513,383
June, 1988 - June, 1992	13,633,299	8,237,711	5,395,588
Annual Average	3,408,325		

Source: PLN, Laporan Data Pendukung Monitoring Sedimentasi, 1992
Notes Catchment Area: 2,283 km^2
Dam capacity upto horizontal plane marked by upper end of water intake (EL 616m): 167,689,000m^3

3.5 Local Agriculture

3.5.1 Farmland Ownership

The farmland ownership in the Bandung District is shown in Table 3-14.

Table 3-14 Farmland Ownership in Bandung District

Ownership Status	Number (persons)	Ratio (%)
Landlord (Pemilik Tidak Menggarap)	130,800	23.5
Owner-Farmer (Pemilik Penggarap)	158,754	28.5
Tenant Farmer (Penggarap Penyewa)	122,676	22.0
Farm Labourer (Buruh Tani)	145,167	26.0
Total	557,397	100.0

Source: Kabupaten Bandung Dalam Angka 1990, Kantor Statistik Kab. Bandung

Owner-farmers, mainly cultivating their own lands, account for only 28.5% of the total and half of the people in the agricultural sector are tenant farmers and farm labourers who cultivate the others' lands besides theirs.

The SBRLKT Report (1992) indicates that the ratio of owner-farmers of 48% for paddy fields is relatively higher than the one for dry crop fields of 37%. Tenant farmers and farm labourers maintain their livelihoods through the cultivation of

rented land, labour for wages and/or the Maro system (where the landlord and tenant farmer split the harvest fifty-fifty).

3.5.2 Agricultural Production

(1) Main Crops

The Study Area accounts for only some 10% of the total land area of the Bandung and Sumedang Districts but plays a fairly important role in agricultural production as shown by its relatively high production volume vis-a-vis the overall production volume of these 2 districts. The largest production ratios recorded by the Study Area vis-a-vis the total production of the 2 districts are 28% for cassava in the common crop category, 42% for red beans in the vegetable category, 38% for tobacco in the estate crop category and 35% for papayas in the fruit category. The main common crops are rice, maize and cassava (see Supporting Report A9). In the case of vegetables, part of the Study Area within the Sumedang District produces more than 70% of the total vegetable production volume, excepting chilies, of the Sumedang District. The production of estates in the Study Area is rather small and the only activity of any note is tobacco production in part of the Study Area within the Sumedang District. In contrast, fruit production is fairly active and one-quarter or one-third of the total fruit production of the 2 districts comes from the Study Area.

Comparison between 1985 and 1991 in terms of the unit yield shows a substantial improvement from some 5 tons/ha to 6.5 tons/ha for paddy rice, from some 2.1 tons/ha to 3.0 tons/ha for upland rice and from some 10.2 tons/ha to 13.6 tons/ha for cassava. A similar improvement was also observed for other crops. Nevertheless, the unit yield of agricultural products did not uniformly improve as the unit yield of vegetable products greatly fluctuated.

In short, the Study Area is characterised by rice production, both paddy rice upland rice, which commands the largest cultivation area. Many dry crop fields also exist in the Study Area and vegetables and fruit are actively produced in addition to such common crops as cassava, maize and sweet potatoes.

(2) Cropping Patterns

The types of agricultural land use in the Study Area include irrigated paddy fields, rain-fed paddy fields and dry crop fields and the cropping patterns of these fields are described below.

Paddy fields are located on flat land and, in the case of well-irrigated paddy fields, rice is grown all year round. Paddy rice is generally harvested twice a year, i.e. during the dry season and during the rainy season. Occasionally, however, paddy fields are used as fish culture ponds. In the case of rain-fed paddy fields, rice is planted during the rainy season and maize, pulses, tubers and vegetables are grown during the dry season when these fields are treated as dry crop fields.

Such common crops as upland rice, maize, red beans, groundnuts, soybeans, cassava, sweet potatoes and chilies are grown in dry crop fields by means of inter-cropping or mixed cropping while such vegetables as cabbages and tomatoes are grown by means of single cropping. Most crops are planted during the rainy season although those requiring much less water are planted during the dry season. Cassava, which has a long growth period, is grown regardless of season. In the case of mixed gardens, fruit trees and other useful trees are planted together with crops.

As the ecological water level requirement is fairly high for such vegetables as cabbages and tomatoes, these are commonly planted as secondary crops for paddy fields or in dry crop fields with an excellent water supply and are frequently seen in relatively cool mountain areas. See the Table 3-15 and 3-16 for the cropping patterns by land use type and the annual cultivation schedule for the main crops.

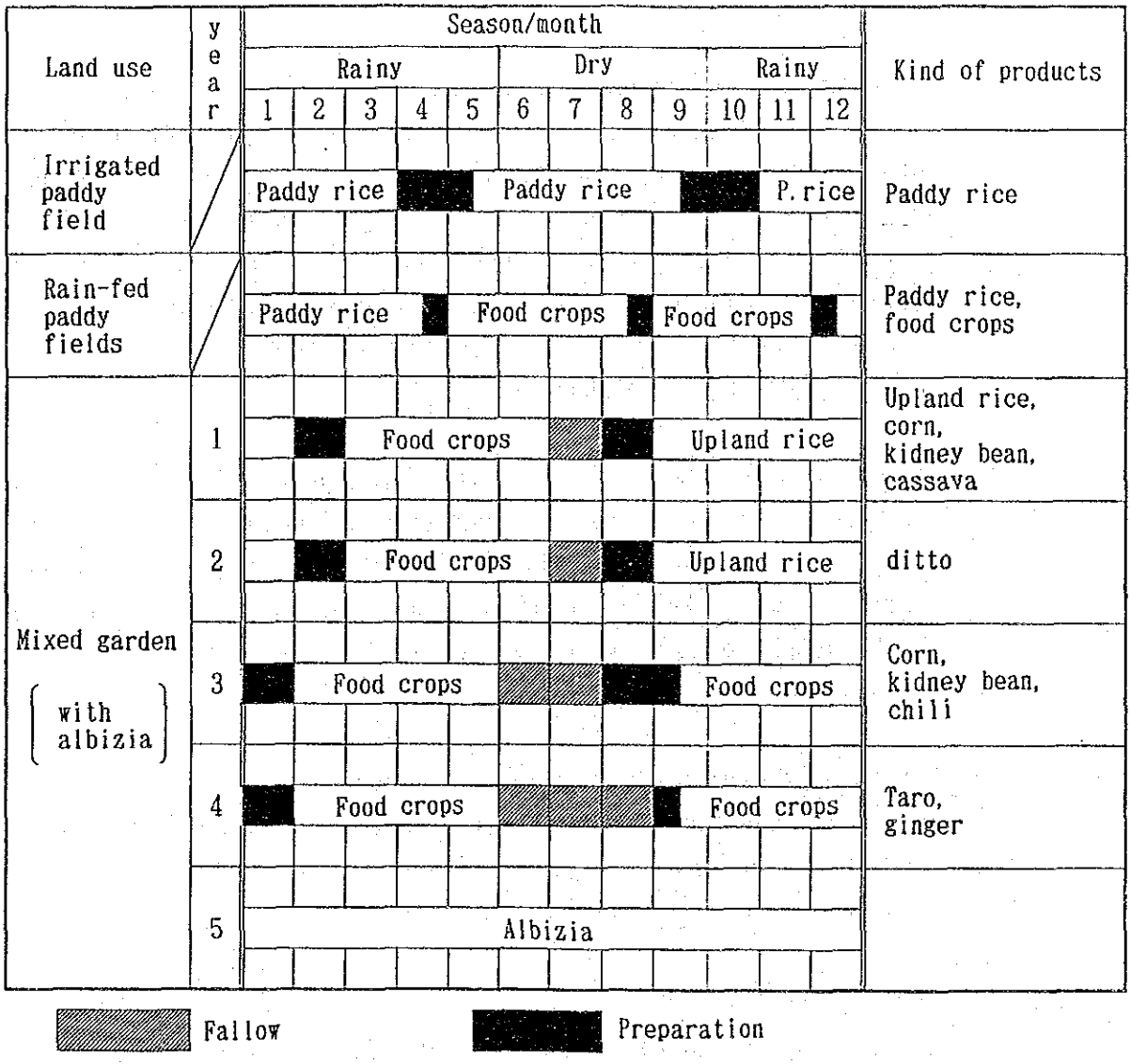
The traditional terraced farming method is employed on sloping land and the area of cultivated land per farming household is rather small. Farming is generally conducted by hand and water buffaloes are sometimes used in the paddy fields. Machinery is rarely used.

(3) Stock Raising

On average, a farming household in the Study Area keeps 2 - 3 sheep and several chickens, mainly for its own consumption. These are mainly fed with grass cut from around paddy fields or bordering areas of dry crop fields, small twigs and the leaves of fruit and other trees and unhulled rice. Excreta is used as an organic fertilizer. Water buffaloes for working purposes and ducks are raised in paddy field areas. In some areas, cows are raised for commercial sale but the management size is as small as around 5 head/household. Other animals

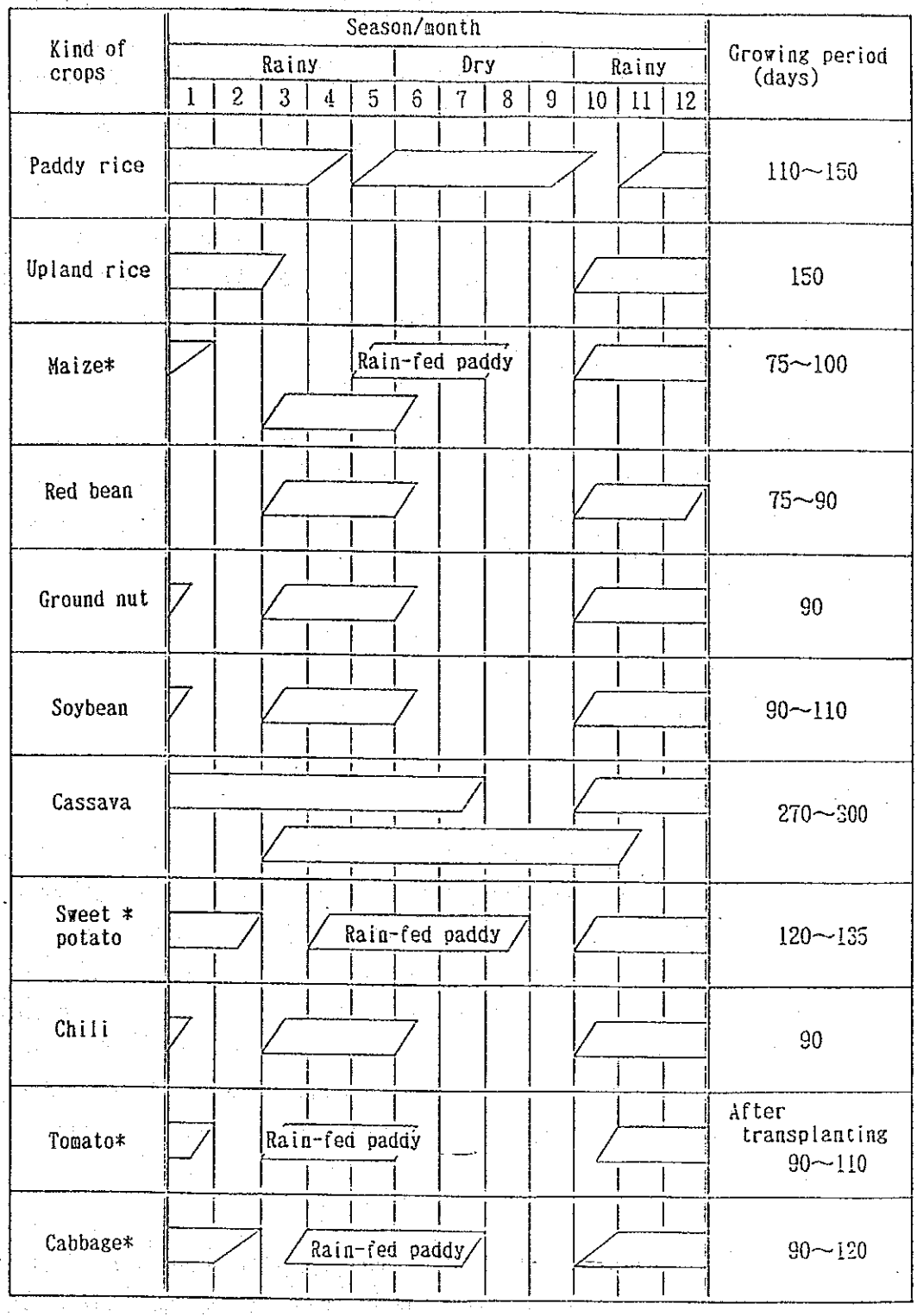
are also raised, including beef cattle, horses, goats and rabbits. These are generally kept in outhouses constructed in the vicinity of the main residence.

Table 3-15 Cropping Pattern by Land Use



Note: Based on the documents obtained from 3 Agricultural Extension Centres in the Study Area (1992).

Table 3-16 Cultivation Calendar of Principal Crops



Note: Based on the documents obtained from 3 Agricultural Extension Centers in the Study Area (1992).
Kinds of crops marked with "*" are temporarily cultivated in the rain-fed paddy field.

(4) Distribution of Agricultural Products

In principle, agricultural products are freely traded and the prices are determined based on the market mechanism. There are slight differences in the distribution systems of basic crops (rice, maize, soybeans and green grams) and secondary crops (those other than basic crops) or estate crops. Basic crops are controlled by the National Food Procurement Agency (Badan Urusan Logistik: BULOG). The main function of the BULOG is to procure and store certain quantities of basic products and to release them onto the market in the case of a crop failure to prevent a sudden, substantial price fluctuation due to imbalanced supply and demand. However, it must be noted that the BULOG only handled some 5% of the total rice production in fiscal 1987/88. Moreover, its presence in the rice market has been declining.

Interviews with local inhabitants revealed that direct trading between growers and brokers accounts for approximately 80% of all trading. The remaining 20% is trading between growers and either the BULOG or village cooperatives (Koperasi Unit Desa: KUD).

Both secondary crops and estate crops are freely traded.

3.5.3 Farm Management

(1) Agricultural Income and Expenditure

It is admittedly very difficult to identify the total income of a farmer, including that generated outside his own farmland. Here, the focus is on the income and expenditure associated with the farmer's own farmland where he works. (Note that the cost of purchasing such farming tools as hoes and sickles, their depreciation cost and the depreciation cost of terracing are not included in expenditure.) Data used for the analysis were mainly obtained through a questionnaire given to farmers and interviews with officials of related organizations (see the Supporting Report A10 for the survey method used.)

1) Income from Crops

In regard to the annual income from crops, 40% of all farming households earn up to 390,000 Rp while another 40% earn between 400,000 Rp and 990,000 Rp with the remaining 20% earning more than 1 million Rp. According to Otto Soemarwoto, the minimum income requirement is

360,000 Rp, implying that nearly half of the farming households in the Study Area are near the poverty level.

2) Agricultural Production Cost Composition

The average agricultural cost composition greatly varies from crop to crop or from area to area. Broadly speaking, the labour cost accounts for 40 - 50% while seeds, chemical fertilizers and agrochemicals (pesticides) account for approximately 40%. The remainder consists of the land rent and the cost of transporting harvested crops to the market.

3) Cost - Income Comparison

Although the actual figures vary from area to area, the average income from crops per ha in the Study Area is approximately 1.75 million Rp against an average cost of 1.25 million Rp, resulting in a net income of approximately half a million Rp/ha.

Apart from crops, sources of income for farming households in the Study Area include stock raising (mainly sheep and chickens), day labour in Bandung (especially in the dry season), such commercial activities as retailing, manufacturing and the marketing of brooms and handicrafts and land rent. In addition, they may receive payment in kind or production shares in kind. The actual state and composition of income greatly vary from area to area and/or from household to household.

(2) Prices of Agricultural Products

The types of crops grown by local farmers are shown in Table 3-17. The prices listed are retail prices/kg at the market in suburban Bandung (Pasar Induk Gedebage) as of the end of October, 1992. (The price of maize is for grain only while the price of upland rice is the standard price for undried and unhulled rice in the Study Area.) During the interviews, local farmers pointed out several problems associated with the production of vegetables which are believed to be of high commercial value.

① Drastic price fluctuations in the market

② Necessity to engage in relatively large-scale production in order to be able to sell the products in the market

③ High production cost and the time and labour-consuming nature of tending in the case of some vegetables

④ Technical difficulty of growing, necessitating many years of experience

Table 3-17 Types and Retail Prices of Agricultural Products

Product	Number of Growers	Retail price (Rp/kg)
Maize (Jagung)	130 (87%)	375
Red Beans (Kacang Merah)	93 (62%)	775
Upland Rice (Pady Gogo)	79 (53%)	310
Cassava (Ketela Pohon)	75 (50%)	225
Groundnuts (Kacang Tanah)	27 (15%)	1,400
Chilies (I) (Cabe Cengeh)	15 (10%)	1,100
Chilies (II) (Cabe Kriting)	10 (7%)	1,500
Tomatoes (Tomato)	10 (7%)	450
Red Onions (Bawang Merah)	9 (6%)	1,200
A type of Cassava (Ubi Kayu)	8 (5%)	--

Source: Questionnaire survey (multiple reply) conducted on 150 local farmers.

(3) Livestock holding

The most popular livestock in the Study Area are sheep and chickens. In areas with relatively low income from crops, the dependency on stock raising as a source of income is believed to be relatively high. The price of sheep ranges from 100,000 Rp to 150,000 Rp/head for a ram and from 75,000 Rp to 100,000 Rp/head for a ewe although the actual price level is also affected by age. (Lambs are sold for 30,000 - 50,000 Rp/head.) The motivation for raising livestock is not confined to cash income through their sale but also includes the use of excreta as a fertilizer in some cases.

(4) Farming Plan

In general, the farming income in the Study Area is not particularly high as mentioned earlier and the income from crops in particular appears to be rather low. The measures contemplated by farmers to increase their agricultural income are discussed in this section together with their expectations for certain types of assistance.

In terms of finance, farmers are hoping to raise the funds required to cover the procurement cost of agricultural equipment/materials or to start a new business (handicrafts, etc.). With regard to farmland, they are considering enlarging

their farmland by means of a long-term tenancy agreement with large landowners. With regard to agricultural equipment/materials, farmers would like to See consolidation of the retailing network for chemical fertilizers and other items and to obtain sufficient procurement funds. They would also like to Seeprice increases restrained for small orders. The crops that farmers are interested in growing considerably differ from area to area. In general, farmers hope for a high yield, guaranteed variety of the particular cash crop (such as maize) which they are actually growing at present. Nevertheless, they are evidently cautious about introducing new varieties and thorough discussions with farmers appear necessary on the selection of crops to be grown under the Project. Many farmers have a positive attitude to planting such trees as albizia which are supposedly good for soil conservation purposes and this fact should be taken into consideration in any future planning for the Project.

With regard to stock raising, many farmers hope to increase the number of sheep and fowl which they raise.

The lack of funds is a stumbling block to the assistance farmers would like to receive to increase their income. The provision of financial assistance should prove to be a key factor to increasing the income of farmers. In general, most farmers lack sufficient financial management experience (running a bank account and savings) and loan management experience, probably because of the strong tendency to avoid the risks associated with a loan, lack of familiarity with loan procedures and the absence of financial institutions in local areas. The inadequate mortgage capability of farmers is particularly demonstrated by the small number of farmers who have registered their land with the National Land Agency (Badan Pertanahan Nasional: BPN).

The demand for improved transport varies from area to area with a particularly strong demand being expressed in several areas.

3.5.4 Organizations to Assist Agricultural Activities

(1) Farmers' Groups

There is a total of 320 farmers' groups in the Study Area, i.e. 241 in the Bandung District, 43 in Bandung City and 36 in the Semedang District. The main focal points of these groups are diverse, ranging from the production of seedlings, soil and water conservation, stock raising and fish culture to bamboo crafts. Each group consists of

20 - 40 families (households). Some groups have been spontaneously formed over the years while others used the opportunity of participating in a government project as the starting point. In general, a farmers' group is led by a group leader and is engaged in various activities. Most leaders show strong interest in soil and water conservation activities. One of the most representative farmers' groups in the Study Area is at Babakan Peutey which operates very well under a capable leader. The main activities of farmers' groups are the collective purchase of chemical fertilizers and the alleviation of temporary fund shortages during the planting season through the allocation of funds to farmers from a joint saving fund to which regular payments are made by group members. Many members expect their groups to establish nursery beds and to provide marketing information on their products, etc. in the future. Some groups foster the seedlings of albizia and coffee for both in-group allocation and external sale. One group is engaged in the product collection business using a short-term loan provided by the KUD. Most farmers appear to have a positive opinion of the work of farmers' groups in terms of the purchase of such agricultural materials as seeds and chemical fertilizers, coordination of cooperative work and the exchange of useful information.

(2) Village Cooperatives (Koperasi Unit Desa: KUD)

As its name implies, a KUD is an agricultural cooperative established in each village (Desa). The envisaged activities include the purchase and sale of agricultural products, promotion of stock raising, rice milling and food procurement, purchase and sale of production equipment and materials, provision of savings accounts and small loans and transportation.

The aim of these KUDs is to organize farmers through the above activities in order to improve both the agricultural productivity and general living standard of farmers. The findings of the interview survey, however, indicate that the KUD membership ratio among the target farmers in general is not particularly high and that not every village has its own KUD. In fact, the KUDs are not always involved in activities which are designed to assist farmers. For example, while membership in a KUD is a precondition for a farmer to apply for a general-purpose loan under the KUT (Kredi Usahatani) system, this precondition does not exist in the case of the KUK (Kredi Usahatani Konservasi) which is designed to assist dry crop field conservation work.

3.6 Forestry in Study Area

3.6.1 Forests in West Java Province

Forests in West Java Province account for some 22% (1.02 million ha) of the total land area of 4.63 million ha. Although the forest coverage is said to be as high as some 74% in the whole of Indonesia, the coverage of Java island of some 23% is much more modest.

Some 0.81 million ha (80%) of the national forests in West Java Province is managed by the Perum Perhutani Unit III Jawa Barat and the remaining some 0.21 million ha is under the jurisdiction of the Directorate General of Forest Projection and Nature Conservation (Direktorat Jenderal PHPA: PHPA). As described earlier, there is no forest which can be converted to farmland or other land use categories in the province. The Perum Perhutani Unit III has established 14 forest district offices (Kesatuan Pemangkuan Hutan: KPH) which are responsible for the management of the respective national forest zones.

3.6.2 Current Conditions of National Forests

National forests in the Study Area are managed by 3 KPHs. The North Bandung KPH is responsible for the area north of the railway line running east-west through Bandung City and the Bandung District. The South Bandung KPH is responsible for the southern part of these 2 areas. Both KPHs have an office in Bandung City. Forests in the Sumedang District are managed by the Sumedang-based Sumedang KPH. The total national forest area in the Study Area is approximately 9,500 ha, accounting for some 19% of the land area.

The main forestry activities of the above 3 KPHs, including afforestation and harvesting, are described below.

(1) Wood Production

The KPHs supply an annual total of approximately 72,000m^3 of timber as well as 24,000m^3 of stacked firewood (actual volume, 72%) (Table 3-18). By species, while a fairly large supply of teak can be expected from the Sumedang KPH, Pinus merkusii is the most common species.

Table 3-18 Harvesting Plan of Each KPH (1991 - 1995)

(A) Timber

(Unit: m^3)

KPH	Thinning				Thinning				Total
	Teak	Pinus merkusii	Others	Sub-Total	Teak	Pinus merkusii	Others	Sub-Total	
North Bandung	1,577	47,022	–	48,599	7,613	20,312	–	27,925	76,524
South Bandung	–	59,699	23,453	83,152	3,643	10,843	12,292	26,778	109,930
Sumedang	40,894	110,277	-	151,171	12,326	7,605	1,808	21,739	172,910
Total	42,471	216,998	23,453	282,922	23,582	38,760	14,100	76,442	359,364

(B) Firewood

KPH	Final Felling				Thinning				Total
	Teak	Pinus merkusii	Others	Sub-Total	Teak	Pinus merkusii	Others	Sub-Total	
North Bandung	500	14,160	–	14,660	6,883	5,664	–	12,547	27,207
South Bandung	–	17,230	6,662	23,892	3,224	3,140	3,307	9,671	33,563
Sumedang	18,218	26,833	-	45,051	10,598	1,647	558	12,803	57,854
Total	18,718	58,223	6,662	83,603	20,705	10,451	3,865	35,021	118,624

(2) Afforestation

As part of the afforestation work, an annual average of some 690 ha of regular planting with additional planting of some 4,100 ha over a 5 year period is planned for such currently non-productive forest land as unstocked land (Table 3-19).

Table 3-19 Afforestation Plan of Each KPH (1991 - 1995)

(Unit: ha)

KPH	Reforestation			Expansive Afforestation			Total		
	TS	BH	Total	TS	BH	Total	TS	BH	Total
North Bandung	226	350	576	177	55	232	403	405	808
South Bandung	0	1,083	1,083	0	3,527	3,527	0	4,610	4,610
Sumedang	1,809	0	1,809	346	0	346	2,155	0	2,155
Total	2,035	1,433	3,468	523	3,582	4,105	2,558	5,015	7,573

Source: Perum Perhutani Unit III Java Barat

Notes TS: Tumpangsari System (with land preparation for the whole site)
BH: Banjar Harian System (with land preparation only for areas immediately surrounding trees to be planted)

A closer look at the activities of each KPH shows that the North Bandung KPH adopts the Tumpangsari system and the Banjar Harian system on a fifty-fifty basis. In contrast, the South Bandung KPH solely relies on the Banjar Harian system and the Sumedang KPH on the Tumpangsari system.

In addition to the above activities related to national forests, the KPHs are engaged in diverse activities to assist the development of local communities, including the planting of trees in villages located in the vicinity of national forests and the provision of assistance for bee-keeping. One notable activity is the promotion of albizia planting outside national forests as part of the national movement to expand forest functions (Sengonisasi) and the 3 KPHs hope to annual plant trees over an average area of 850 ha.

(3) Forest Products

Apart from timber and firewood, the KPHs envisage the harvesting of such by-products as pine resin, rattan, bamboo and pakis (edible fern) in their respective forest areas.

3.6.3 Current Conditions of Private Forests

The forest management of private land is, in most cases, jointly conducted by small landowners and the subject forests are called Hutan Rakyat (cooperation forests). The DEPHUT encourages planting on private land to facilitate the supply of industrial materials and to promote land rehabilitation programmes. This encouragement has significant meaning in regard to the securing of timber supply.

In general, afforestation work in the Study Area, which requires a much longer time (at least several years) than crop growing to harvest, faces difficulties due to the high population density and distinctively small land ownership of farming households. Nevertheless, progress has been gradually made through the active efforts of the Land Rehabilitation and Soil Conservation Centres (SBRLKTs).

A survey conducted by the SBRLKT Citarum in 1988 found that fast growing species, such as albizia, are the most popular species for the afforestation of cooperation forests. While trees are mainly planted for timber and firewood production, almost all forests are mixed forests with fruit and other useful trees, creating the appearance of multi-storey forests. The planting (regeneration) density ranges from 500 to 2,500 trees/ha depending on the envisaged tree mixture state.

The same survey identified slightly less than 500ha of cooperation forests in the Study Area. At an interview with the Agricultural Extension Centre (BPP) for the present study, however, the existence of some 600ha of cooperation forests was suggested, indicating the steady growth of such forests. Including these cooperation forests, all land owned by individual persons and the land holding/household varies from 0.24 ha to 2.14 ha.

The SBRLKT Citarum estimates that some 200 ha constitutes the minimum forest management size in view of profitability. Given the small land holding in the Study Area, continuous and systematic efforts to spread cooperative practices are required to organize private forest landowners to create cooperation forests of a desirable size.

3.6.4 Nurseries

(1) Production of Seedlings

Seedlings are mainly produced in the Study Area by farmers' groups except those to be planted in national forests. Each sub-district has one or 2 nurseries, the size of which is 0.1 - 0.5 ha each. A relatively large variety of species are grown in these nurseries, including such forestry trees as albizia, maesopsis and caliandra, such fruit trees as coffee, durian and mango and ornamental garden trees. Each nursery grows some several thousand or several tens of thousand seedlings. The fully grown seedlings are distributed to group members free of charge and are planted in private forests or mixed gardens. Some have been sold in neighbouring areas in recent years. The seeds are obtained from private seed orchards or local farmers.

(2) Nursery Techniques

The most popular nursery method is the use of vinyl pots. Fertilizer and pesticide are applied from time to time and irrigation is conducted during the dry season. The seedlings are transplanted 9 - 12 months after seeding when they reach a height of 50 - 100cm although the actual timing of transplantation varies from one species to another. Local nurseries appear to be in possession of good nursery techniques, probably because of the excellent guidance provided by instructors and training courses.

(3) Operation and Management

Many of the present nurseries are located on land borrowed from group members and few nurseries have been established on a permanent basis. Finance for the creation of a nursery and for the production of seedlings generally comes from the farmers' groups' own funds or from a public fund allocated under the INPRES Budget.

3.6.5 Forest Product Processing Facilities

(1) Sawmills

Three sawmills in the Study Area were studied to obtain a clear picture of sawmill operation in the Study Area. Each owner of these 3 sawmills expressed the hope to enlarge operation and to upgrade the product range (for example, to include furniture). The log processing capacity of the sawmills varies. Although the current demand for timber exceeds the supply, business expansion has been hampered by several constraints, i.e. inadequate machinery capacity, lack of skilled workers, problems associated with log supply (for example, supply in small lots from private forests) and difficulty of raising investment capital.

While the surveyed sawmills purchase some logs from Kalimantan and Central Java Provinces, their main logs, such as those of Pinus merkusii and albizia, are supplied from the eastern part of West Java Province. The average wage of the sawmills is said to be 7,000 - 10,000 Rp/day depending on the skill of the workers.

Table 3-20 Activities of Typical Sawmills

Mill	Location (Sub-District)	No. of Workers	Logs Purchased			Log Price (Rp/m^3)	Main Market(s)	Sawing Capacity (m^3/year)
			Species	Ratio (%)	Volume (m^3/year)			
A	Cicalengka	10 - 15	Albizia Pinus merkusii Maesopsis Jack Fruit Others	50 20 20 } 10	1,680	45,000 45,000 42,000 42,000	Majalaya	3,500 1)
B	Cimenyan	10	Teak Rausin Kamper	10 15 75	600	700,000 500,000 300,000	Bandung Jakarta	600
C	Cikeruh	15	Pinus merkusii 2) Albizia Maesopsis Mahogany Others	80 } 20	7,500	76,000 55,000 55,000 97,000 -	Jakarta Bogor Bandung	8,100
D3)	Cikancung	10 households	Bamboo 4)	-	15 trees/day	1,000/tree	Jakarta Tasikmalaya	-

Notes
1) Inclusive of extra capacity under construction.
2) Pinus merkusii is supplied from national forests and the products are exported.
3) The bamboo processing group is included here for reference purposes and is described in 3.6.5 (2).
4) Approximately 8cm in diameter and 6 - 8m in length per tree.

(2) Bamboo Processing

The bamboo processing group, consisting of 10 households as shown in Table 3-20, mainly manufactures centre pieces using traditional looms. Raw bamboo is obtained from neighbouring bamboo forests and is also purchased from areas adjacent to Tanjungsari. This group is capable of manufacturing a minimum of 30 centre pieces/day, earning 150 Rp/piece.

3.7 Road Conditions

3.7.1 General

Trunk roads in the Study Area include provincial roads between Bandung and Sumedang and between Bandung and Garut and district roads between Cicalengka and Majalaya and between Rancaekek and Majalaya. Village roads branch out from these trunk roads, forming a village road network.

Village roads are often constructed to run from urban areas on the piedmont towards mountain ridges because of the locations of villages, the necessity to provide access to national forest project sites and the topographical characteristics of the Study Area. In both suburban and piedmont areas, however, there are many roads which

horizontally traverse the midslope rather than heading for the mountain ridge, providing an excellent means of transportation between villages. There are few roads which run horizontally above the midslope areas which can be used by vehicles due to topographical constraints and agricultural products are often transported on the shoulders across steep slopes.

As many roads run along mountain ridges, their longitudinal gradient is often very steep, hindering traffic in places where the road surface conditions are poor when it rains.

Slope improvement has advanced in the case of roads running through national forests as measures to prevent soil erosion from roads have been implemented. In contrast, such measures have not been introduced for roads running through private land and soil erosion is caused by rain. The implementation of soil conservation measures, including the planting of trees, is necessary for all such land.

The aggregate road length in the Planning Area is 22 km (road density: 2.4 m/ha) for state land and 481 km (road density: 20.5 m/ha) for private land (Table 3-21). The road length is measured on the topographical map. Common roads and tracks correspond to those roads shown by a double line and single line respectively on the map. As some roads on state land are not shown on the topographical map due to their coverage by crowns, the actual aggregate road length may well be much longer than the measured length given in Table 3-21.

Table 3-21 Aggregate Road Length

(Unit: m)

Sub-	State Land		Private Land		Total	
Watershed	Common Road	Track	Common Road	Track	Common Road	Track
1	2,700	7,360	24,200	23,600	26,900	30,960
2	370	4,470	25,960	44,660	26,330	49,130
3	-	-	30,160	24,820	30,160	24,820
4	1,610	2,260	42,140	34,960	43,750	37,220
5	-	1,180	14,140	35,710	14,140	36,890
6	-	1,810	2,500	32,790	2,500	34,600
7	-	-	6,880	19,120	6,880	19,120
8	500	180	18,680	13,540	19,180	13,720
9	-	-	27,810	12,650	27,810	12,650
10	-	-	13,250	13,120	13,250	13,120
11	110	-	12,320	14,650	12,430	14,650
12	-	-	1,080	470	1,080	470
Total	5,290	17,260	219,120	270,090	224,410	287,350

Notes 1) All figures are relevant for the Planning Area only.
2) Total area of state land: 9,520 ha
Total area of private land: 23,828 ha
3) Road density: state land: 2.4 m/ha private land: 20.5 m/ha

3.7.2 Conditions of Roads on Private Land

Provincial and district roads in the Study Area appear to be in generally good condition in terms of paving, slope protection and the provision of gutters. The conditions of village roads, which have the longest aggregate length among the different types of roads, are described below.

(1) Road Surface Conditions

Village roads are often paved with asphalt in those sections near inhabited areas but increasingly become gravel or even earth roads near mountains. The asphalt sections are generally well maintained near towns and major villages where the traffic is busy. Crushed stones are usually used for gravel roads and the traffic is as smooth as that of asphalt roads in well maintained sections. However, scouring is observed at sections which are poorly maintained. The rolling of uneven road surfaces was formerly conducted manually but road rollers or similar machinery are used today.

While earth roads serve well during the dry season, they tend to become muddy and difficult to use when it rains. The steep sloping sections of both gravel and earth roads are now in need of repair of the asphalt or stone paving.

(2) Slope and Gutter Conditions

As many roads run along the ridgeline, large cut faces are seldom observed except in parts of national forests. Such soil retaining works as the revegetation of slopes are almost non-existent.

While some gutters in villages are manually dug, most are created by natural scouring. In places, scouring has progressed to the extent that the introduction of proper gutters and/or falling works is required for soil conservation purposes.

The shoulders are very narrow and the roads almost border farmland. Although it is often difficult to find space for a tree planting zone, as much planting as possible is deemed necessary to protect the roads from erosion.

The provincial, district, village and settlement authorities and the Perum Perhutani are separately responsible for road management. The Goton-Royon

(traditional mutual help system) is responsible for road maintenance in some villages and settlements.

3.8 Realities of Social Forestry

3.8.1 Development of Forests

The types of social forestry mainly designed for timber production and forest rehabilitation are discussed in this section.

(1) Forests for Timber Production

Cooperation forests (Hutan Rakyat) in the Study Area have been developed by local inhabitants and are mainly managed for timber production as already described in 3.4.

In general, forests for timber production are mainly scattered on steep slopes near ridges and usually have a size of several ha. The planting distance is mainly 2m by 3m or 2m by 5m and food crops are often planted between the trees in the first 2 - 3 year period based on the Tumpangsari system. The most popular planting species are albizia, maesopsis, mahogany and surian, all of which suit the local natural conditions (rainfall, temperature, soil and elevation). Farmers appear to prefer albizia because of its fast growing nature and easy care. The tending of planted trees usually includes weeding and pruning. Albizia is only found on low land in the Study Area because of its weakness vis-a-vis the low temperatures associated with high elevations. The felling period is 3 to 5 years for albizia and maesopsis and 8 to 15 years for mahogany and surian. All these species are used to produce construction timber, furniture and industrial materials.

Farmers believe that the benefits of forests for timber production are soil and water conservation, improved soil fertility, increased income and the production of construction timber for their own use. They also express a desire to continue planting trees and to spread the conceived benefits to farmers in neighbouring areas.

The Tumpangsari system is also adopted in national forests and, in the Study Area, is observed in those forests managed by the Sumedang KPH. This

system is highly praised by local inhabitants as it requires no weeding while increasing the income of those farmers who lack sufficient farming land.

(2) Forests for Firewood Production

In the Study Area, firewood is generally collected from farmland in the vicinity of the main dwelling and, consequently, few forests for firewood production exist. According to the local interview survey results, the firewood supply is generally adequate and only some farmers in the Cimanggung and Cikeruh Sub-Districts have experienced a shortage. The species planted to produce firewood is caliandra. The planting distance is 4m by 4m and the felling period is 3 years. It is regenerated with 12 sprouts in one root. Felling is conducted in August (dry season).

In addition to providing firewood for both industrial and domestic use, forests for firewood production also serve for soil conservation purposes. While it is certainly hoped that the practice of creating such forests will spread throughout the Study Area, the implementation of large-scale development is difficult due to the shortage of suitable land.

(3) Revegetation of School Campuses

In the Cikeruh Sub-District where many educational institutions are located, revegetation efforts are in progress on campuses for soil conservation and environmental improvement purposes. These efforts are not designed to produce timber. Revegetation is also conducted at the training farms used for part of the outdoor teaching, including commemorative planting during the guidance period for new students, the mixed planting of fruit and timber trees on training farms and the planting of albizia using the Tumpangsari method. The seedlings used for these purposes are grown by the students. Attempts are also made to construct terraces, check dams and gully plugs to teach the students actual soil conservation measures.

3.8.2 Agroforestry

The types of agroforestry to guarantee the continuous production of forests, as well as agricultural products and animal feed, etc., are described in this section.

(1) Mixed Gardens (Kebun Campuran)

Mixed gardens are found on midslopes throughout the Study Area and are generally terraced in the traditional manner.

As in the case of dry crop fields, food crops are planted as inter-crops or mixed crops together with several species of fruit and/or timber trees. At the initial stage of tree growth, photophilous crops are selected. As the crown closes, crops which are tolerant of shade are introduced. Such pasture plants as setria are grown as animal feed at the edges of the terraces. Timber trees currently planted in mixed gardens in the Study Area are albizia, maesopsis, mahogany and surian and such fruit trees as avocado, jack fruit, guava and petai are also planted. The planting distance is generally 5m by 5m, 10m by 5m or 8m by 8m and the planting season lasts from November to January (rainy season). Planting holes are 30cm in diameter with a depth of 30cm and urea, triple superphosphate and farmyard manure are used as fertilizers.

According to farmers, the benefits of mixed gardens range from such soil conservation effects as reduced soil erosion and increased soil fertility to the adequate production of agricultural products for domestic consumption. In general, mixed gardens in which many crops are grown in a small plot are time and labour consuming. Nevertheless, they are preferred from the management point of view as they disperse the risks associated with natural disasters and price fluctuations. In general, farmers would like to See the introduction of soil conservation measures for improved productivity and soil conservation and would like to start growing such products as chilies, soybeans, citrus fruits, gnemon trees and star-fruits. At the same time, they point out such problems as a lack of finance, price fluctuations and the need to find the optimal combination of crops and trees to achieve the maximum harvest.

(2) Home Gardens (Pekarangan)

A home garden, which is one of the traditional forms of agroforestry in Indonesia, is established on and around the house premises. In the Study Area as in any other area in Indonesia, a home garden skilfully uses the available space in 3 dimensions and can contain, food, medicinal, seasoning, recreation and fibre crops/plants, trees for construction timber, feed and firewood, vegetables, fruits and flowers. The benefits of domestic gardens are said to be purification of the air around the house, increased home income, soil

conservation and the preservation of soil fertility. Farmers express a hope to maintain their home gardens and to introduce additional trees. The findings of the relevant survey indicate a need to attempt fish culturing and/or stock raising in home gardens to raise the local living standard although such attempts would be subject to land availability.

(3) Grazing Forests

As already described, stock raising in the Study Area involves only 2 - 3 sheep and several chickens per household. The meadow grass around paddy fields and terraced dry crop fields is mainly used as feed although some fruit and other trees in mixed gardens are also used to provide additional feed. In the Cilengkrang and Cibiru Sub-Districts, elephant grass and king grass are planted between the trees as feed for cattle. The tree planting distance is 6m by 6m while the planting distance of these grasses is 30cm by 30cm. The grass is reaped every 45 days.

The planting of timber and fruit trees in pastureland results in not only increased income and improved soil erosion prevention but also has a shading effect vis-a-vis grass and preserves soil fertility, making the creation of grazing forests in areas earmarked for cattle raising highly desirable.

3.8.3 Other Agricultural Activities

Apart from those discussed in 3.8.1 and 3.8.2, there are other agricultural activities related to social forestry in the Study Area as described below.

(1) Apiculture

Apiculture is conducted in mountain areas in the Cimanggung and Cileunyi Sub-Districts. Bees are kept in the traditional way in that a bee hive, which is either a box shape made of wood or a cylinder shape made of palm branches, is hung in the attic, under the eaves or placed on a tree branch. Each household has one or 2 bee hives, totalling some 30 to 40 bee hives/village. The bees are the native species and one bee hive produces some 2kg of honey/month. Most of the honey is consumed within the village. Trees providing honey and pollen are caliandra, albizia, Pinus merkusii, coffee, avocado, palm, citrus and maize, etc., and are planted around the houses.

Farmers point out that the benefits of apiculture include an improved diet, increased income and soil conservation through the planting of trees for bees. They would like to increase honey production, to introduce new techniques and to develop new markets.

(2) Sericulture

Sericulture in the Study Area is only observed in areas located on the eastern edge of the Cicalengka Sub-District. Although it is located outside the Study Area, a private company in the Garut District is conducting sericulture and is equipped with nurseries, a mulberry plantation and rearing rooms. The mulberry plantation is divided into 3 sections and each section is harvested in one month. Three different mulberry species are planted in each section with a planting distance of 1m by 1m and different mulberry leaves are fed in accordance with the juvenile stages of the silkworms. Management work at the mulberry plantation mainly consists of ridging, fertilizer application, chemical spraying, weeding and irrigation.

The benefits of sericulture include a supplementary income for farmers and sericulture contributes to soil conservation through the planting of mulberry trees to feed the silkworms. Relatively large land and cooperative work are required to introduce sericulture, making proper guidance on the technical and other preconditions for sericulture essential for farmers.

(3) Pisciculture

A number of fish ponds of different shapes and sizes are seen in places of abundant water supply in the Study Area. Small ponds are generally found in the domestic gardens of farmers and provide a source of protein, a place of relaxation and a pleasing environment. Well-irrigated paddy fields are sometimes temporarily converted to fish ponds.

Fish ponds are simply dug and water is supplied from rivers or natural ponds through bamboo pipes or other means. Such native species as ikan mas, nilemu and mujairu are bred in the traditional manner using mixed feed consisting of rice bran and fish meal prepared by the farmers. Albizia, coconut palm, banana, setaria and lemon grass, etc. are planted around the fish ponds to provide shade and to prevent damage by wind but there is still much scope for improvement. In the future, farmers hope to enlarge and improve the ponds, to supply their

own fry and to establish good forests for the proper management of fish ponds and water conservation.

3.9 Spread of Soil and Water Conservation Measures

3.9.1 Enlightenment and Guidance

(1) Organizations

Activities to spread soil and water conservation measures in the Study Area are conducted by the Agricultural Extension Centres at Cicalengka, Tanjungsari and Cilengkrang, all of which are controlled by the Bandung Branch of the SBRLKT Citarum. A senior regreening extension worker is stationed at each of these centres to supervise the work of field regreening extension workers. The main role of this senior regreening extension worker is the preparation of a plan to spread soil and water conservation measures in each locality, coordination between the centre and local inhabitants and the education/training of field regreening extension workers. Field regreening extension workers are stationed in villages (Desas) to transfer soil conservation techniques through direct contact with farmers.

The number of regreening extension workers in the Study Area is currently 11 at the Cicalengka Centre, 11 at the Tanjungsari Centre and 10 at the Cilengkrang Centre (the Ujungberung Centre was merged with the Cilengkrang Centre some time ago), totalling 32.

(2) Activities

The following activities are implemented by the regreening extension workers of the Agricultural Extension Centres.

1) Activities to improve the knowledge of farmers of the technical aspects of the land rehabilitation and soil conservation project (RLKT)
2) Activities to help farmers understand their role in the implementation of the RLKT and to provide technical guidance
3) Activities to help farmers understand the necessity and expected role of agroforestry
4) Production and supply of seedlings
5) Activities to develop villages

The targets of these activities are achieved through meetings with farmers and the active use of demonstration plots. Meetings with farmers are held 4 - 5 times/month and guidance is provided via the village chiefs and leaders of farmers' groups on soil and water conservation methods, the establishment of nurseries and other problems raised by farmers. According to the regreening extension workers, farmers in the Study Area understand the purposes and methods of the RLKT and the attendance of farmers at the demonstration plots is quite favourable. Remaining tasks are to achieve the active participation of women and unorganized farmers.

According to officials of the Cicalengka Centre, while the farmers' level of understanding of the RLKT is quite high and is accompanied by a good learning performance of the relevant techniques, the level of learning accomplishment vis-a-vis vegetation conservation techniques is rather inferior to that of conservation techniques in the civil engineering field, including terracing and the construction of check dams.

As the leaders of farmers' groups have a better understanding of the various techniques than ordinary farmers, the further teaching and training of these leaders should prove very beneficial to accelerate the adoption of soil and water conservation measures by ordinary farmers. In short, the preparation of measures to accelerate the revegetation of the Study Area is necessary. These measures include a good understanding of tree characteristics and the multiple use of land. With regard to the farmer response to new agricultural products, they tend to quickly master the cultivation techniques for medicinal herbs, groundnuts and vegetables but are slow to adopt new techniques for growing coffee and tea, etc., possibly because of their strong tendency to rely on traditional techniques. Given the fact that the learning speed of new techniques by farmers depends on the type of crop, it is necessary to provide guidance which takes the idea of the right crop for the right land and the intentions of farmers into consideration when introducing new crops following the implementation of agroforestry or the development of terraced fields. According to officials of the SBRLKT Citarum, the present number of regreening extension workers is inadequate to provide efficient guidance for all villages, suggesting a need to further educate and train such workers.

While the activities of the regreening extension workers are assisted by the use of facilities and equipment, etc., it is also true to say that the inadequate means of transportation and educational facilities has made enlightenment and

guidance activities partly redundant. From the perspective of farmers, the use of teaching materials by regreening extension workers is highly desirable to convey new knowledge on soil and water conservation measures.

3.9.2 Education and Training

(1) Current Conditions of Education and Training

The education and training of farmers in the Study Area for the purpose of promoting soil and water conservation measures are mainly conducted through seminars and visits to demonstration plots at the Agricultural Development Centres. However, these efforts are still deemed inadequate in view of the strong requirement for the education and training of local inhabitants on the importance of soil conservation and local development. In the case of regreening extension workers, these all undergo education and training on afforestation and revegetation techniques and methods to spread such techniques among farmers at the forestry training centres at Bogor and Kadipaten, etc. as well as at the Agricultural Extension Centres. They would like to receive advanced education and training in the future on general issues relating to agriculture and forestry and on various ways to solve problems in these fields.

(2) Training Centres

At present, there are no training centres in the Study Area. The nearest centres which provide education and training for extension workers, farmers and village leaders are located in Kadipaten, Cimanuk and Wonogiri. Training is provided by these centres on the following issues.

① Measures and techniques relating to soil conservation

② Techniques relating to afforestation and revegetation

③ Techniques relating to forest survey and land survey

While training was once dominated by classroom teaching, field training is increasingly gaining in importance. An agroforestry demonstration centre, arboretum and terraced field have been constructed around the lecture building at the Cimanuk Training Centre, emphasising field work. Following the introduction of new techniques and improved training methods, etc., the number of specialists who have been recruited as new lecturers has been increasing.

Some 400 - 500 farmers/year undergo training. Most of the training courses are as short as 5 - 10 days to avoid interfering with farming work. The attendance of farmers at the training courses are arranged by the extension works of the SBRLKTs. All expenses, including the transport and accommodation costs, are paid by the central government.

If the attendants successfully finish the courses, the certificates are awarded for propaganda to other farmers.

3.9.3 Demonstration Plots

The demonstration plots, which are designed to improve soil and water conservation measures and to increase the yield of agricultural products in local areas through the demonstration of measures to achieve such targets, are attracting much attention on the part of the local inhabitants.

24 demonstration plots have been established in the Study Area with the INPRES budget since 1981 and have been very much participated in by local farmers. In general, each plot consists of some 10ha. With the participation of some 20 farming households, vegetative measures using trees and crops and such civil engineering measures as the construction of terraces and waterways have been experimented to achieve the above-mentioned targets. As part of the vegetative measures, the use of fertilizers and pesticides has been added to the simple planting of trees and crops to increase the yield. The actual species planted are albizia, jack fruit and avocado, etc., all of which enhance soil and water conservation as well as having good income prospects. The agricultural crops are commonly upland rice, maize and cassava, etc. although tobacco and soybeans have also been introduced in some plots.

The project period is usually 3 years and the first year is used for land preparation, followed by 2 years of pilot management and maintenance. Civil engineering measures and vegetative measures are mainly employed in the dry season and the rainy season respectively by farmers' groups. While farmers generally show strong interest in the demonstration plots, the actual level of their participation significantly varies depending on the state of land ownership and the dominant type of farming in each locality. The existing demonstration plots have assisted farmers to experience the positive effects of the demonstrated measures in terms of reducing the soil loss and increasing the yield. They have also stimulated the interest of visiting farmers from neighbouring areas in adopting similar measures in their own villages.

The demonstration plots are not without problems. In the technical field, these include ① felling of the planted trees by farmers following a reduced crop yield due to the deprivation of sunlight by the trees and ② difficulties in selecting suitable crop varieties and obtaining a supply of seeds. Problems associated with plot management include ① insufficient information on market trends, ② inadequate project period to fully materialise the demonstration effects and to master both management and maintenance skills and ③ inadequate means of plot access and inadequate provision of information boards.

CHAPTER 4 BASIC PROJECT CONCEPTS

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4.1 Principles of Upland Plantation and Land Development Project

(1) The active implementation of soil conservation measures in the Planning Area is strongly required, not only to maintain or even increase agricultural production by means of preventing sediment discharge from dry crop fields and other types of agricultural land located in the sloping uplands of the Study Area but also to reduce sedimentation at the Saguling dam in the lower reaches. Although the prevention of as much sediment discharge as possible in the Study Area is desirable, realistic targets should be adopted for the Project based on a balanced assessment of the relationship between the expected sediment discharge reduction volume and the cost of achieving such reduction and the possible impact of the soil conservation measures to be introduced on agricultural production.

(2) In planning soil conservation measures, targets should be determined in terms of the actual soil erosion volume. A realistic target must be introduced for each zoning category employed by the DEPHUT for the purpose of national land conservation while taking the social and economic conditions and the opinions/preferences of the farmers in each locality into consideration.

In particular, such vegetative measures as forest development and agroforestry and civil engineering measures, including terracing, should be actively introduced for dry crop fields which suffer from serious soil erosion. Moreover, check dams and gulley plugs should be constructed at sites of devastation along torrents to protect the torrents. Forests specially designed to control erosion should also be created for the same purpose.

When implementing these measures, the participation of local inhabitants should be actively encouraged through the adoption of social forestry, including the planting of multi-purpose species, to achieve not only soil erosion prevention but also increased income as well as local development. The adoption of social forestry is justified on the grounds of the reality of land use and land ownership in the Planning Area.

(3) As the existing nurseries are incapable of producing a sufficient number of seedlings for the envisaged forest development, agroforestry and roadside planting, new nurseries should be established to ensure a smooth supply of

seedlings. In view of the required transportation time for seedlings and the managerial requirement of a nursery, the establishment of a number of small nurseries throughout the Planning Area is preferable so that local farmers will find it easy to work at these nurseries.

Examination of the necessity to establish wood processing facilities as part of the infrastructure improvement finds that the inclusion of such facilities in the Project is unnecessary. The reasons for this decision are that the existing wood processing facilities are not fully operating due to difficulties in securing a sufficient volume of logs and that the owners of these facilities intend to expand their operation to meet the increasing demand provided that the preconditions of such expansion, i.e. sufficient finance and log supply, are met.

(4) Road conditions in the Study Area are generally rather poor, causing problems in the transportation of agricultural products and sediment discharge. The active improvement of road conditions is necessary by means of paving, slope protection and the construction of gutters, etc. Work roads will be constructed under the Project where necessary to assist the construction of check dams and demonstration plots. In addition, new roads will be constructed in mountainous areas where the transport network is poor to facilitate the transportation of goods and exchanges between villages in order to improve the lives of local inhabitants.

(5) Unfortunately, the need to implement soil and water conservation measures in the Study Area is not yet fully understood by local inhabitants, presumably because of the lack of sufficient funds to implement such measures, shortage of extension workers, shortage of equipment and materials to improve the level of understanding and lack of clear incentives for farmers to adopt such measures.

In view of these circumstances, the Project will assist the recruitment of new extension workers and the provision of the necessary equipment and materials. The Project also envisages the construction of a training centre and demonstration plots to upgrade the abilities of extension workers and the implementation of more aggressive measures to both enlighten and train farmers.

(6) Given the facts that most land in the Planning Area is privately owned and that most local inhabitants are engaged in agriculture, it is essential to enlist the cooperation and understanding of local inhabitants for the smooth implementation of the Project. The role of local inhabitants will become increasingly more important at the management and operation stages of the Project following the

completion of construction work. Consequently, the participation of farmers should be emphasised at the project implementation stage.

Coordination between administrative organizations should be properly planned as part of the project implementation system as the Project involves not only one municipal and 2 district authorities but also the main local offices of the DEPHUT and other departments. At the project implementation stage, the technical and management staff of the Project Office will conduct the necessary coordination and supervision of all the components of the Project. In this context, the plan will be formulated to harmonize with the spatial plans prepared by Planning Boards at the levels of Province, Municipality and District.

(7) From the viewpoint of environmental conservation, the Project will emphasise the implementation of soil conservation measures to achieve a favourable environmental outcome. The measures envisaged include the conversion of dry crop fields where soil conservation measures are not currently implemented to agroforestry fields and civil engineering measures to prevent sediment discharge.

From the local socioeconomic point of view, the Project should prove highly beneficial for local communities in terms of an increased yield of agricultural products and new employment opportunities created by the Project.

(8) For this plan, financial and economic analysis will be conducted in order to examine whether or not the project is feasible.

4.2 Farmland and Forest Land Conservation Measures

(1) Examination of Concrete Conservation Measures

The Project aims at achieving local development by means of preventing soil loss and promoting agriculture and forestry. It is important for these 2 targets to be well balanced in order to prepare the optimal project contents.

Two plans were introduced to examine the actual farmland and forest land conservation measures to be adopted to particularly emphasise one of the above-mentioned 2 targets. Plan 4 focuses on erosion control through the conversion of land to forests with the subject land being not only bare land and grassland but also those dry crop fields and mixed gardens, etc. with a high risk of soil erosion. In contrast, Plan 1 focuses on the implementation of soil conservation measures for farmland only to maintain the existing farmland size, particularly dry crop

fields, while keeping the conversion of farmland to such non-farmland as forests to a minimum. Between these 2 plans are Plan 2 and Plan 3, both of which involve the development of new forests and the introduction of agroforestry in different degrees depending on the actual risk of soil erosion and the existing land use.

Table 4-1 shows the changes in land use, volume of controlled soil loss and project cost (unit price as of 1992 x project scale), estimated based on the different compositions of the conservation measures of these 4 plans. The matrix of soil conservation measures for each plan is given in Table 4-2.

Plan 1 has the problem of not sufficiently preventing soil loss while Plan 4 has the problem of disrupting the agricultural activities of local farmers. Plan 2 and Plan 3 appear to present the most balanced alternatives to achieve the 2 objectives of the Project, i.e. the prevention of soil loss and local development. Comparison of Plan 2 and Plan 3 shows that the project cost estimate of Plan 3 is higher than that of Plan 2 and that the soil loss prevention cost per one ton of soil of Plan 3 is slightly lower than that of Plan 2.

Given the seriousness of the current soil erosion in the Planning Area, the employment of Plan 3, of which the soil loss control performance is superior to that of Plan 2 by 13 points, is deemed appropriate. Based on the above consideration, it has been decided to adopt the contents of Plan 3 for the Project.

Table 4-1 Examination of Different Plans for Farmland Conservation

Table Indexes for deciding the criteria of the Farm/Forest Lands Conservation Plan

CALCULATING CONDITION	BEFORE PLAN		AFTER PLAN 1		AFTER PLAN 2		AFTER PLAN 3		AFTER PLAN 4	
	AREA(ha)	RATE(%)	AREA(ha)	RATE(%)	AREA(ha)	RATE(%)	AREA(ha)	RATE(%)	AREA(ha)	RATE(%)
<<LAND USE INDEXES>>										
Dry crop field with terraces	1,120	2.2	5,004	10.0	9,796	19.5	6,124	12.2	80	0.2
Dry crop field without terraces	11,108	22.1	7,224	14.4	2,432	4.8	1,704	3.4		
Mixed garden closed with CD >70 %	524	1.0	800	1.6	800	1.6	3,572	7.1	3,284	6.5
Mixed garden closed with CD 21-70 %	760	1.5	760	1.5	760	1.5	528	1.1		
Shrub (Belukar)	1,260	2.5	372	0.7						
Grass land	320	0.6								
Quarry	64	0.1								
Forest	7,808	15.6	8,804	17.5	9,176	18.3	11,036	22.0	19,600	39.0
TOTAL	22,964	45.7	22,964	45.7	22,964	45.7	22,964	45.7	22,964	45.7
STUDY AREA	50,204	100.0								
<<OTHER INDEXES>>	SOIL LOSS(t/y)	SLCR(%)	SOIL LOSS(t/y)	SLCR(%)	SOIL LOSS(t/y)	SLCR(%)	SOIL LOSS(t/y)	SLCR(%)	SOIL LOSS(t/y)	SLCR(%)
SOIL LOSS ESTIMATION	10,040,733	-	5,203,459	48	3,230,094	68	1,931,866	81	1,334,078	87
CONTROLLED SOIL LOSS(t/y)	-	-	4,837,274	-	6,810,639	-	8,108,867	-	8,706,655	-
TOTAL COST ESTIMATION(million Rp)	-	-	10,826	-	24,059	-	28,463	-	11,358	-
COST FOR ONE TON CONSERVATION(Rp)	-	-	2,238	-	3,532	-	3,510	-	1,305	-

Note : SLCR : Soil Loss Control Rate (%)

Table 4-2 Matrix of Conservation Measures for Each Alternative Plan

Alternative Plan 1									
	Cultivation Zone			Buffer Zone			Protection Zone		
Soil Erosion Risk	1	2/3	4/5	1	2/3	4/5	1	2/3	4/5
Dry Crop Field (with Terraces)	0	0	0	0	0	0	0	0	0
Dry Crop Field (without Terraces)	0	0	0	0	0	1/2	0	0	1/2
Mixed Garden (≧ 71%)	0	0	0	0	0	0	0	0	0
Mixed Garden (21 - 70%)	0	0	0	0	0	0	0	0	0
Shrub	0	0	5	0	0	5	0	5	5
Grassland	3	3	3	3	3	3	5	5	5
Quarry	0	0	5	0	5	5	0	5	5

Alternative Plan 2									
	Cultivation Zone			Buffer Zone			Protection Zone		
Soil Erosion Risk	1	2/3	4/5	1	2/3	4/5	1	2/3	4/5
Dry Crop Field (with Terraces)	0	0	1/2	0	0	1/2	1/2	1/2	1/2
Dry Crop Field (without Terraces)	0	0	1/2	0	1/2	1/2	1/2	1/2	1/2
Mixed Garden (≧ 71%)	0	0	0	0	0	0	0	0	0
Mixed Garden (21 - 70%)	0	0	0	0	0	0	0	0	0
Shrub	5	5	5	5	5	5	5	5	5
Grassland	3	3	3	3	3	5	5	5	5
Quarry	5	5	5	5	5	5	5	5	5

Alternative Plan 3									
	Cultivation Zone			Buffer Zone			Protection Zone		
Soil Erosion Risk	1	2/3	4/5	1	2/3	4/5	1	2/3	4/5
Dry Crop Field (with Terraces)	1/2	1/2	1/2	1/2	1/2	3	1	3	5
Dry Crop Field (without Terraces)	1/2	1/2	1/2	1/2	1/2	3	1	3	5
Mixed Garden (≧ 71%)	0	0	0	0	0	0	0	0	6
Mixed Garden (21 - 70%)	0	0	0	0	0	4	0	4	7
Shrub	5	5	5	5	5	5	5	5	5
Grassland	3	3	3	5	5	5	5	5	5
Quarry	5	5	5	5	5	5	5	5	5

Alternative Plan 4									
	Cultivation Zone			Buffer Zone			Protection Zone		
Soil Erosion Risk	1	2/3	4/5	1	2/3	4/5	1	2/3	4/5
Dry Crop Field (with Terraces)	1/2	3	5	3	5	5	5	5	5
Dry Crop Field (without Terraces)	1/2	3	5	3	5	5	5	5	5
Mixed Garden (≧ 71%)	0	0	6	0	6	6	6	6	6
Mixed Garden (21 - 70%)	0	4	7	4	7	7	7	7	7
Shrub	5	5	5	5	5	5	5	5	5
Grassland	3	5	5	5	5	5	5	5	5
Quarry	5	5	5	5	5	5	5	5	5

Note: Figures in the matrix correspond to the following code numbers for vegetative measures.

Vegetative Measure	Code Number
Preservation of Current Conditions	0
Improved Dry Field Type 1	1
Improved Dry Field Type 2	2
Agroforestry Type 1	3
Agroforestry Type 2	4
Forest Development Type 1	5
Forest Development Type 2	6
Forest Development Type 3	7

(2) Matrix of Conservation Measures

The matrix of conservation measures based on Plan 3 is shown in Table 4-3 to indicate appropriate measures for the different land use zones in use in Indonesia for national land conservation purposes. The selection of such measures is based on the degree of erosion risk, present land use and socioeconomic conditions, etc. The zoning criteria, soil erosion risk ranking and land use/vegetation categories subject to soil conservation measures are given in the Supporting Report B1. The conservation measures to be introduced for each zone are described below.

Table 4-3 Matrix of Conservation Measures

Zoning / Soil Erosion Hazard Ranking	Protection Zone						Buffer Zone						Cultivation Zone					
	Rank 1		Rank 2 & 3		Rank 4 & 5		Rank 1		Rank 2 & 3		Rank 4 & 5		Rank 1		Rank 2 & 3		Rank 4 & 5	
Current Land Use/Vegetation Categ. / Measures	Vegetation	Civil Works	Vegetation	Civil Works	Vegetation	Civil Works	Vegetation	Civil Works	Vegetation	Civil Works	Vegetation	Civil Works	Vegetation	Civil Works	Vegetation	Civil Works	Vegetation	Civil Works
Dry Crop Field (with terraces)	Improvement 1	-	Agro 1	-	Forest 1	-	Improvement 1	-	Improvement 1	-	Agro 1	-	Improvement 1	-	Improvement 1	-	Improvement 1	-
Dry Crop Field (without terraces)	Improvement 1	Terrace 1	Agro 1	Terrace 1 & 2	Forest 1	-	Improvement 1	Terrace 1	Improvement 1	Terrace 1	Agro 1	Terrace 1 & 2	Improvement 2	-	Improvement 1	Terrace 1	Improvement 1	Terrace 1
Mixed Garden (CD: ≥71%)	Status quo		Status quo		Forest 2	-	Status quo		Status quo		Status quo		Status quo		Status quo		Status quo	
Mixed garden (CD: 21~70%)	Status quo		Agro 2	-	Forest 3	-	Status quo		Status quo		Agro 2	-	Status quo		Status quo		Status quo	
Shrub	Forest 1	-	Forest 1	-	Forest 1	-	Forest 1	-	Forest 1	-	Forest 1	-	Forest 1	-	Forest 1	-	Forest 1	-
Grassland	Forest 1	-	Forest 1	-	Forest 1	-	Forest 1	-	Forest 1	-	Forest 1	-	Agro 1	-	Agro 1	-	Agro 1	-
Quarry	Forest 1	-	Forest 1	-	Forest 1	-	Forest 1	-	Forest 1	-	Forest 1	-	Forest 1	-	Forest 1	-	Forest 1	-

Note:
Vegetative measures includes the following:
Improvement 1: field farming improvement making use of terraces
Improvement 2: field farming improvement without making use of terraces
Agro 1: conversion of land use through the introduction of agroforestry
Agro 2: improvement with planting
Forest 1: uniform afforestation
Forest 2: upgrading planting lightly
Forest 3: upgrading planting heavily

Civil work will be selected according to the type of terraces. The type of terraces differs depending on the land slope.
Terrace 1: when the slope is 10 - 30%, bench terraces will be established
Terrace 2: when the slope is more than 30%, small dike terraces will be established

1) Protection Zone

This zone is designated for the protection of natural resources and soil, etc. and, therefore, any type of land use which may accelerate soil erosion must be avoided. Many forests in the Planning Area which are managed by the Perum Perhutani Unit III belong to this zone. As types of land use resulting in much soil erosion, such as dry crop fields, are actually observed in this zone, such conservation measures as forest development will be introduced.

The subject land for conversion to forests includes dry crop fields and mixed gardens with a soil erosion risk of Rank 4 or higher and all shrub, grassland and quarries. In the case of land with a soil erosion risk of Rank 3 or lower, either agroforestry or an agricultural method with a high degree of soil conservation (hereinafter referred to as improved dry field farming) will be introduced as shown in Table 4-2.

2) Buffer Zone

This zone has the mixed characteristics of a protection zone and a cultivation zone and is designed to ease the expansion of land use which has a high risk of soil erosion. The conservation measures to be introduced will be designed to be in harmony with the purposes of the present land use. The subject land includes all dry crop fields with a soil erosion risk of Rank 4 or higher and mixed gardens of less than 70% in crown density for agroforestry and dry crop fields with a soil erosion risk of Rank 3 or lower for improved dry field farming. Shrub, grassland and quarries will be subject to forest development.

3) Cultivation Zone

For land classified as a cultivation zone, agricultural and other types of land use should be actively sought as this zone has low soil erosion potential. As the zone in the Planning Area is characterised by a high level of economic activities (agricultural and industrial), the introduction of soil conservation measures should be carefully planned so as not to interfere with existing activities. Soil conservation measures will be implemented as long as they do not contradict the purposes of existing land use. In the case of dry crop fields, improved dry field farming will be introduced in general to achieve a high degree of soil conservation. The status quo will be maintained in the case of mixed gardens while shrub and quarries will be subject to forest development. Agroforestry will be introduced for grassland to facilitate the agricultural use of such land. Terraces will be established for dry crop fields

and mixed gardens. Bench terraces will be used for a slope gradient of more than 10% but less than 30% while small dike terraces will be used for a slope gradient of more than 30%.

4.3 Sediment Control on Torrents and Banks

The estimated annual sedimentation volume in the catchment area is 16.9 m^3/ha/year based on the recorded sedimentation volume at 28 check dams in the Planning Area as already described in 3.3.2. The following plan to control soil erosion at torrents has been prepared using this figure.

The soil loss prevention target is to contain soil erosion below the allowable level. As 0.55mm of soil is annually created (5.5 m^3/ha/year) in the humid tropical zone (Wood, S.R. and Dent, F.J., 1983, Lecs. A Land Evaluation Computer System Methodology), containment of the soil loss below this level should preserve land productivity. Therefore, 5.5 m^3/ha/year is adopted as the allowable soil loss volume. The Project is expected to reduce the soil erosion volume to a level below this allowable volume. Any surplus sediment discharge during the project implementation period above the allowable volume will be deposited in torrents and measures to prevent bank erosion will be simultaneously implemented.

The DEPHUT calculates the sediment discharge volume by multiplying the soil erosion volume given by the USLE method by the SDR (sediment delivery ratio) value reflecting the size of the catchment area. The study on the annual sedimentation volume at each of the 28 check dams in the Planning Area and the soil erosion volume in the catchment area of each dam, calculated using the USLE method, found a positive correlation between the 2 values. However, the correlation coefficient was too small to be relied upon to assume the actual sediment discharge volume. Consequently, the estimate of the current sediment discharge volume of each catchment area for the present study was based on the findings of the survey on the sedimentation volume at the check dams.

4.4 Incentives for Farmer Participation and Support Activities

As already stated in the previous section, the active participation of farmers is the key to the successful development of the Project. It must be noted here that there is a strong hope among farmers for financial assistance as most of the respondents of the questionnaire pointed out the difficulty of increasing their agricultural income due to the inadequacy of investment funds. Consequently, farmer participation in the Project

can be reasonably stimulated by the construction of new terraces or the repair of old terraces, the provision of subsidies to purchase chemical fertilizers, high yield varieties and agricultural tools and machinery and/or the provision of assistance in kind rather than cash. In order to maintain the long-term effects of a short-term project, the project must present the attractive prospect of agriculture being a profitable business for farmers. Many of the questionnaire respondents actually noted several ways of improving their income and areas in which they would like to see assistance forthcoming. These are improved farming techniques, cultivation of cash crops, introduction of high yield as well as certified varieties and improved accessibility. All of these should be materialised hand in hand with support in terms of farming techniques and marketing, such as the improved quality, quantity and price of agricultural products and strengthening of the negotiating power in post-harvest marketing.

Provided that farmers' groups are established, support for farmers is classified into 2 categories, i.e. technical support for soil and water conservation and agricultural production and management support for marketing and the joint purchase of equipment, etc. The actual support services for farmers will be materialised through the mobilisation of regreening extension workers and agricultural extension workers, recruitment of specialist consultants (particularly in the fields of marketing, finance and equipment procurement), cooperation with related organizations, provision of training courses, preparation of brochures and the introduction of a reward system vis-a-vis farmers and extension workers. These support services should be periodically reviewed in view of their updating and improvement. In particular, extension activities should be strengthened as these activities constitute the direct, grass-root efforts of the government, necessitating extensive training and guidance (both technical and management support activities) for extension workers at the initial stage of project implementation. Furthermore, due consideration should be given to the necessity to increase the number of extension workers (especially senior extension workers), to prolong the assignment period of each extension worker (to facilitate communication with farmers) and to adopt measures to secure capable extension workers.

4.5 Implementation System and Schedule

(1) Project Implementation System

It is essential to secure the cooperation and understanding of local farmers for the successful implementation of the Project as most of the Planning Area is privately owned and also as most farmers in the Planning Area rely on agriculture as the

main source of income. As farmers will increasingly play a central role at the management and maintenance stage of the Project, the project implementation system should incorporate incentives to stimulate farmer participation, to strengthen extension activities and to ensure continuous maintenance work.

In addition to active farmer participation in the Project, good coordination between the local offices of government organizations related to the Project is also a key to the Project's success. It is important for the Project to be implemented in a well balanced manner over the entire Planning Area covering as much as 33,000 ha, taking the actual conditions of each sub-watershed into consideration. People with sufficient knowledge and experience of planning and implementing such a large project, including the procurement of the necessary equipment and materials and relevant financial management, are not readily available. Consequently, the appointment of foreign consultants is included in the project planning to ensure efficiency in the above-mentioned fields. Local consultants with professional knowledge and skills in terms of design work and supervising will also be needed to assist the technical staff at the Project Office.

(2) Project Implementation Schedule

As mentioned earlier, the Project is deemed to be very urgent, requiring implementation and completion as soon as possible. In view of the envisaged scale of the Project, implementation system and conditions and activities of farmers' groups, a project period of 7 years has been adopted. The planned scope of the project-related work will be less intensive or extensive in the first half of the project period and will gradually increase in intensity halfway through the period. The reasons behind this heavier work volume in the second part of the project period are (i) the organization of farmers into groups with their full consent will be a time-consuming process and (ii) project implementation skills can be expected to gradually improve only over a number of years.

4.6 Project Evaluation

(1) Financial Analysis

The purpose of the financial analysis is to study financial feasibility of the project.

The following are three perspectives which we take when we conduct financial analysis for the project. Each of the perspective is shown in Fig. 4-1.

1) Analysis from a Total Investment View Point (Total Investment Analysis)

To provide a framework of the financial analysis from a total investment view point, it is assumed that the project is implemented by one entity which consists of relevant governmental agencies and farmers. The analysis is made on this entity by taking into account total receipts and expenditures from the entity. However, the setting-up of such an entity is just for the purpose of the analysis and does not make a premise for the results of the analysis. Firstly, per ha incremental net present value is calculated for each of planned changes in cropping patterns. Per ha net present values are, then, multiplied with a size of areas(ha) for respective changes in cropping patterns. This leads to the total net benefits from changes in cropping patterns in the total project areas. In addition to this, costs and benefits from other project components such as construction of roads are added for total investment analysis.

2) Analysis from a Farmer's View Point

While the analysis from a total investment view point as in the above 1) puts its focus on financial feasibility of the project as a whole, the analysis from a farmer's view point looks at the expected project impact on individual farmers, especially how the project contributes to the increase in their living standard. However, it is difficult to generalize the farming practice in the project area because the farming pattern and farming size vary in the area. Furthermore, since prices used for the analysis are fixed throughout the project life, it cannot be denied that the analysis is rather static. Therefore, the results of this analysis should be reviewed, taking into consideration these limitation of the analysis.

The following farming pattern is analyzed in this analysis as a general pattern of farming practice in the project area. Firstly, per ha incremental net present value is calculated for each of planned changes in cropping patterns. Then, weighted average of per ha incremental net cash flows are obtained in accordance with the planned areas for cropping pattern changes in 1994. As the weighted average of incremental net cash flow is thus per ha base flow, the farming size is scaled down to 0.2 ha and so is the net cash flow. The analysis from a farmer's view point is made on the weighted average of expected net cash flow from 0.2 of farming land to study how much the farmer improve their living standard. This is done how much the farmer can

spare for their livelihood from the incremental net cash flow without damaging the feasibility of the project.

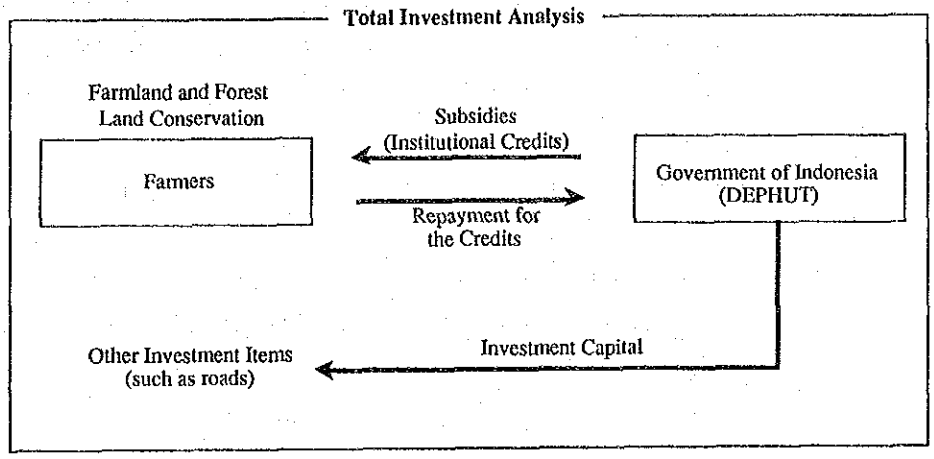

Fig. 4-1 Approach Flow of Financial Analysis

3) Analysis from a Government View Point

The government involvement in the project is to establish and improve public infrastructure such as roads, and to provide farmers with subsidies and/or institutional credits in order for them to change existing cropping patterns.

When the government promotes changes in cropping patterns by providing subsidies, there will be no direct financial benefits to the government. Therefore, the financial analysis is not conducted in this case.

When institutional credits are extended to encourage change in cropping pattern, there will be direct financial benefits in the form of interest receipt. However, based on the study, it is deemed difficult to promote cropping pattern changes for soil conservation through provision of credits because the project needs to cover the entire project area. Among the reasons for difficulties are small scale farming, less experience of farming by getting credits, shortage of collateral for credits, etc. For these reasons, the financial analysis from a view point of the government is not done in the case of institutional credits as well.

(2) Economic Analysis

The purpose of the economic analysis is to study whether or not a project is feasible for the country. Thus, the analysis is made from a point of view of the whole of the nation. Economic prices derived from market prices are used for the analysis. Taxes and subsidies are treated as items to be transferred among concerned parties. Materials used in the project are classified into either tradable goods or non-tradable goods and the adjustment for foreign exchange premium is made on tradable goods.

In addition to the benefits expected from farming practice(partly benefits from fish farming and animal husbandry), off-farm benefits are also taken into account for the economic analysis as positive economic externalities.

4.7 Environmental Care

As the first steps of environmental care, scoping will be conducted as part of the Study. The envisaged Project can be described as being an environmental conservation project to alleviate the serious adverse impacts of such existing types of land development as dry crop fields which cause soil erosion. Consequently, it is reasonably judged that the Project will not have any significnatly negative impact on the environment.

Indonesia's Government Regulations No. 29 (1986) spell out the types of projects which must follow the environmental assessment procedure (hereinafter referred to as the AMDAL). As the present Project consists of conservation measures to be introduced vis-a-vis "land use causing soil erosion", it appears to be outside the scope of the AMDAL. Given this judgement, it has been decided to prepare an environmental care plan so that environmental impact assessment of limited subjects can be conducted to further emphasise the environmental care taken by the Project as an environmental conservation project.

CHAPTER 5 WORK PLAN

CHAPTER 5 WORK PLAN

5.1 Farmland and Forest Land Conservation Plan

In this chapter, the work plan is described to indicate the scope and actual components of the civil engineering and vegetative measures which will be introduced in accordance with the conservation policies described earlier at farmland and forest land where serious soil erosion is taking place.

5.1.1 Establishment of Terraces

Terraces will be established depending on the land conditions and soil erosion rank to prevent soil erosion at dry crop fields. The following work types which have been firmly established in the Planning Area will be introduced.

(1) Bench Terraces

In accordance with the conservation policies, bench terraces (teras bangku) will be introduced at dry crop fields with a slope gradient of between 10 and 30%. These bench terraces will be accompanied by waterway works (saluran pembuangan air) for surface drainage. The planned area for bench terracing is 5,448 ha.

(2) Small Dike Terraces

Small dike terraces (teras gulud) will be introduced at dry crop fields with a slope gradient of between 30 - 40% as suggested by the conservation policies. The planned area for small dike terracing is 2,320 ha.

Figs. 5-1, 5-2 and 5-3 show the standard cross-section of a bench terrace, small dike terrace and waterway works while Table 5-1 shows the planned area for each type of work by sub-watershed.

Table 5-1 Planned Area of Terracing by Sub-Watershed

(Unit: ha)

Sub-Watershed Code Number	1	2	3	4	5	6	7	8	9	10	11	12	Total
Bench Terraces	344	524	460	504	800	676	292	508	780	244	128	188	5,448
Small Dike Terraces	212	188	112	160	236	324	240	220	308	104	96	120	2,320

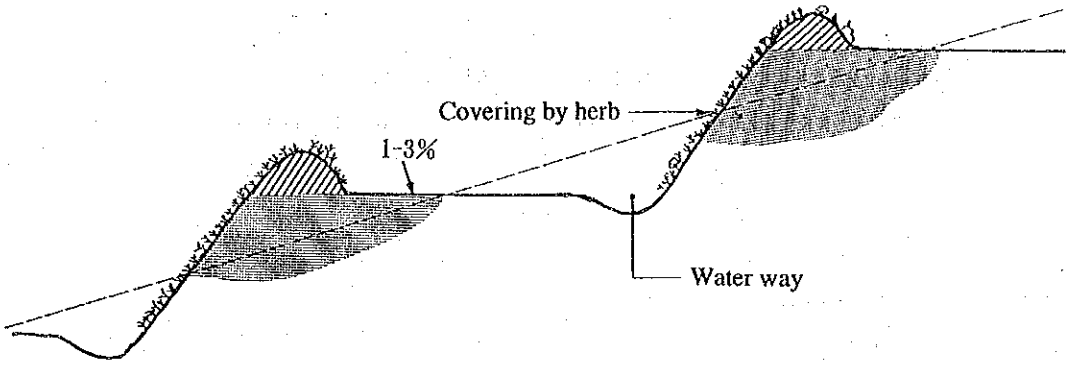

Fig. 5-1 Bench Terrace

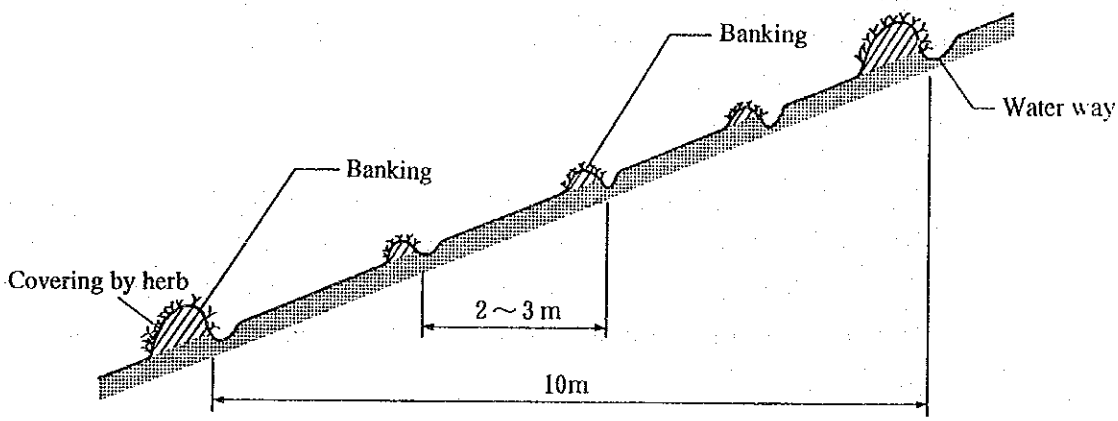

Fig. 5-2 Small Dike Terrace

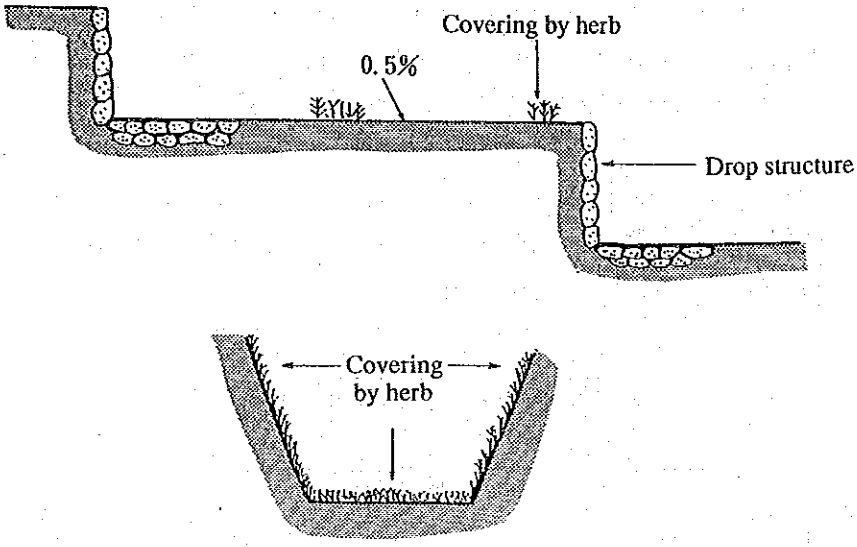

Fig. 5-3 Waterway Works

5.1.2 Forest Development

The main purposes of forest development are to plant new trees to prevent soil erosion at farmland and forest land with a high erosion risk and to increase the production of timber and firewood to achieve a stable life for local inhabitants. Therefore, it is important to make local inhabitants understand the fact that the planting of trees is necessary for not only increased income but also for the conservation of farmland and forest land.

In the case of national forests, the Tumpangsari system is used with a planting distance of 3m by 2m. A wider planting distance will be adopted for the Project to increase the cash income from agricultural products. The planting of coffee, jack fruit and avocado trees in forests at certain proportions will be considered to maintain the household economy of farmers through the annual cash income to be realised from these trees.

(1) Forest Development: Type 1 Forest (Uniform Afforestation)

Uniform afforestation will be introduced at land which is currently used as dry crop fields, shrub, grassland or quarries and which are designated to become Type 1 forests in the conservation measure matrix.

1) Selection of Species

Suitable species are albizia and others for short rotation and surian and others for medium or long rotation. The selected species are listed in Supporting Report C1.

2) Planting Method

The contour planting method with a planting distance of 5m by 2m will be employed (1,000 trees/ha). Because of the adoption of the Tumpangsari system, the intercropping of agricultural products will be conducted for 2 - 3 years after planting in accordance with the planting process explained in 5.1.3 - Agroforestry.

3) Tending Method

- Weeding will be unnecessary because of the adoption of the Tumpangsari system.

- Thinning and pruning will be conducted as required.

The agricultural products will be managed in accordance with the process described in 5.1.3 - Agroforestry.

4) Harvesting

Short rotation species will be harvested in 5 years while medium or long rotation species will be harvested between 8 and 15 years.

(2) Forest Development: Type 2 Forest (Upgrading by Light Planting)

The light planting of trees will be conducted to convert those mixed gardens which have a crown density of 71% or more into forests and which are designated to become Type 2 forests in the conservation measure matrix. The tree species and tending method will be the same as those for Type 1 forests although 200 trees/ha will be planted to achieve the target planting density of a

Type 1 forest (initial planting density: 1,000 trees/ha, density of fully grown trees: 500 trees/ha).

(3) Forest Development: Type 3 Forest (Upgrading by Heavy Planting)

The current mixed gardens which have a crown density of 21 - 70% will be upgraded by heavy planting to Type 3 forests as designated in the conservation measure matrix. The tree species and tending method will be the same as those for Type 1 forests and 300 - 800 trees/ha will be planted to achieve the target planting density of a Type 1 forest (initial planting density: 1,000 trees/ha, density of fully grown trees: 500 trees/ha).

The planned area for forest development by sub-watershed is shown in Table 5-2 while an example of the planting scheme is shown in Fig. 5-4.

Table 5-2 Planned Area for Forest Development by Work Type Sub-Watershed

(Unit: ha)

Sub-Watershed Code Number/ Forest Develop-ment Type	1	2	3	4	5	6	7	8	9	10	11	12	Total
Type 1 Forest	204	104	36	424	300	336	264	332	316	512	156	120	3,104
Type 2 Forest	0	8	0	8	0	0	0	0	0	0	8	0	24
Type 3 Forest	16	0	20	16	12	12	8	4	0	12	0	0	100
Total	220	112	56	448	312	348	272	336	316	524	164	120	3,228

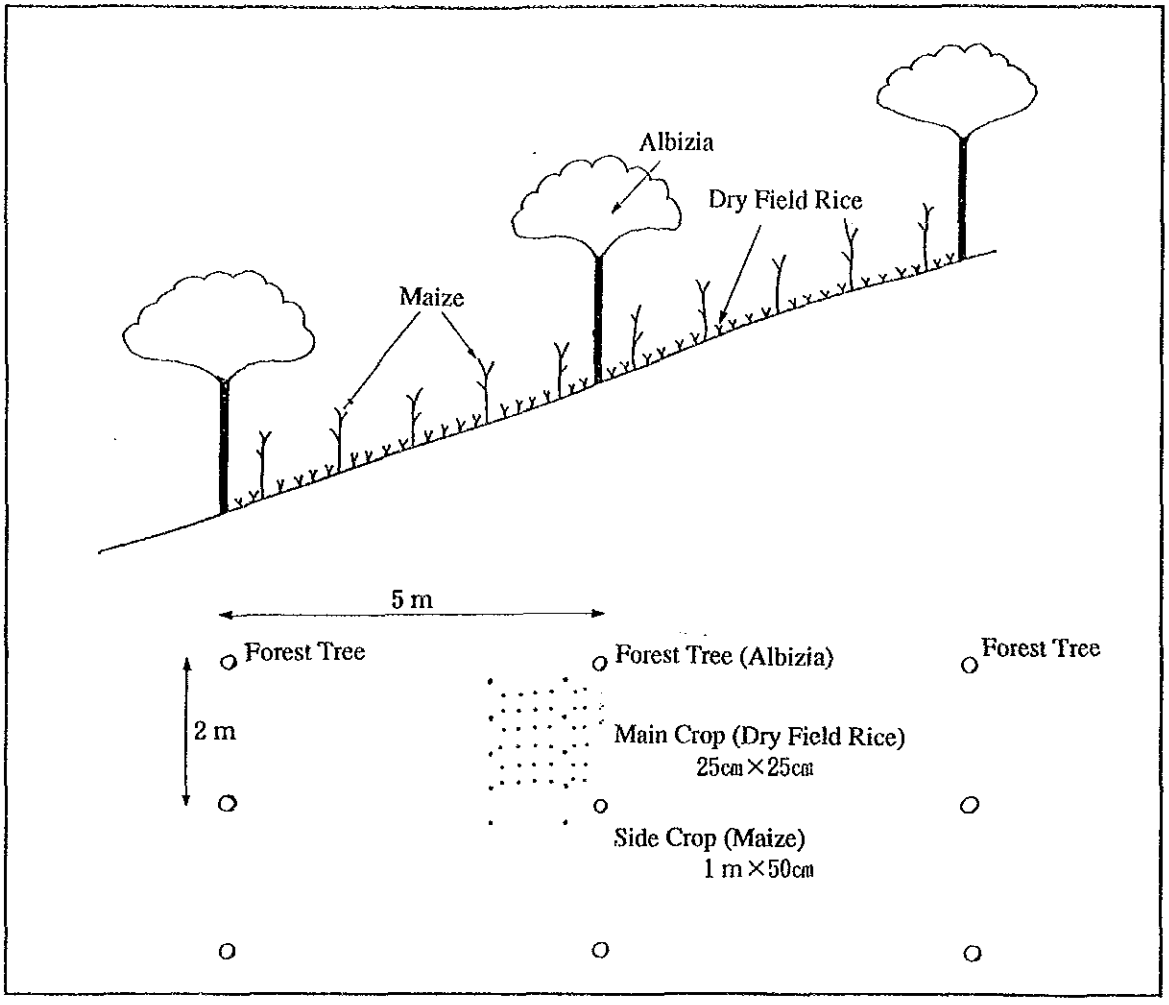

Fig. 5-4 Example of Planting Plan for Forest Development
(Based on Tumpangsari System)

5.1.3 Introduction of Agroforestry

The introduction of agroforestry aims at improving soil conservation as well as local life through lasting production in the form of mixed gardens and others where trees and crops are planted side by side for continual benefits from both.

Agroforestry can take the form of not only mixed gardens but also home gardens, grazing forests, apiculture, sericulture and fish culture. Refer to the section on settlement environment conservation for further details of home gardens. Grazing forests are essential in areas where the dairy industry is promoted. Agriculture and sericulture can be planned in conjunction with the use of demonstration plots and/or check dams. No new development, however, is planned in these fields under the Project. The present state of land ownership in the Planning Area appears unsuitable for the promotion of such collective work as apiculture. No concrete work volume has been planned in advance for the various types of agroforestry as each sub-watershed has different agroforestry needs.

(1) Type 1 Agroforestry

In the case of dry crop fields and grassland which are designated to become Type 1 agroforestry areas in the conservation measure matrix, a combination of trees and crops will be introduced as a new system of land use. The target crown density of mixed gardens after the employment of agroforestry is 71% or more.

1) Selection of Species

The selection of the species to be used for agroforestry will be made on the basis of their use. Appropriate species include albizia as a fast growing tree, jack fruit, avocado, gnemon tree, petai, banana and papaya as fruit trees. Nitrogen-fixing trees are also useful to preserve soil productivity. As damage to plants due to low temperatures is a possibility in the Planning Area because of the high elevation, proper care should be taken in the selection of species.

2) Planting Method

a) With regard to the optimum combination of trees and crops, such main crops as upland rice, red beans, groundnuts and soybeans and such sub-crops as maize and chilies will be planted between the trees and between the rows of trees. The selection criteria for crops are the same as those used for the improvement of dry crop fields. Shade-tolerant crops, such as ginger, will be selected with the crown density is high. A combination of spar trees, such as Gliricidia maculata and pepper, will produce a favourable result. (In the case of grazing forests, such forage crops as elephant grass and king grass will be planted between the trees.)

b) The approximate planting distance is 5m by 5m for timber and fruit trees, 25cm by 25cm for main crops and 1m by 50cm for sub-crops.

c) The trees will be planted between November and January (rainy season). Each planting hole will be approximately 30cm in diameter and 30cm in depth. The planting method and fertilizer application for crops will be the same as those for the improvement of dry crop fields.

3) Tending Method

The tree tending method will be the same as that adopted for forest development. The spraying of pesticides and weeding will be conducted as required for crops. Because of the need for environmental care, pesticides with a low residual toxicity will be selected instead of organo-chloride-based pesticides. Due attention will also be paid to the spraying density.

4) Harvesting

The standard harvesting period for timber trees will be 5 years.

(2) Type 2 Agroforestry

Mixed gardens which have a current crown density of 21 - 70% will be upgraded to Type 2 agroforestry areas through the planting of fruit trees and shade trees. The target crown density by such planting is 71% or more. While the selection of species and the tending method will be the same as those for Type 1 agroforestry, 150 trees/ha will be planted to achieve the target planting density of 400 trees/ha.

The planned area for agroforestry by development method and sub-watershed is shown in Table 5-3 while an example of the planting scheme is shown in Fig. 5-5.

Table 5-3 Planned Area for Agroforestry by Work Type and Sub-Watershed

(Unit: ha)

Sub-Watershed Code No./Type of Work		1	2	3	4	5	6	7	8	9	10	11	12	Total
Type 1 Agro-forestry	Without Terraces	28	32	188	72	8	4	16	4	24	4	0	0	380
	Bench Terraces	0	0	0	52	40	32	20	20	4	56	12	4	240
	Small Dike Terraces	212	188	112	160	236	324	240	220	308	104	96	120	2,320
	Sub-Total	240	220	300	284	284	360	276	244	336	164	108	124	2,940
Type 2 Agroforestry		20	16	16	20	8	12	8	0	8	0	24	0	132
Total		260	236	316	304	292	372	284	244	344	164	132	124	3,072

Note: In the case of Type 1 agroforestry, the subject area is sub-divided by the civil engineering work to be conducted at the same time.

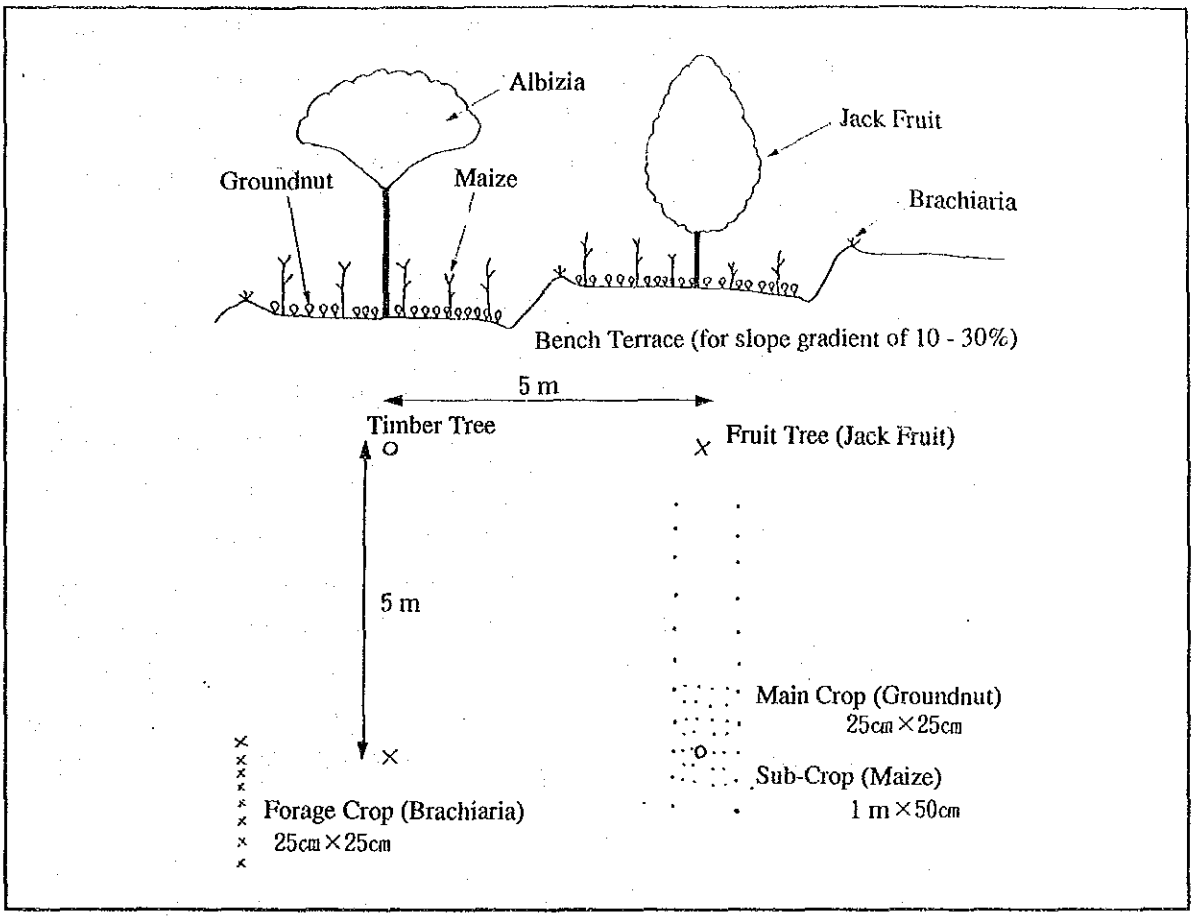

Fig. 5-5 Example of Planting Scheme for Agroforestry

5.1.4 Improvement of Dry Fields

Dry crop fields, including newly terraced fields, will be upgraded to ensure dry farming with a high soil conservation performance by means of the appropriate selection of species and improved planting methods.

(1) Type 1 Improved Dry Field

Improvement work will be conducted for the existing terraced and newly terraced dry crop fields.

1) With regard to the selection of crops, the cultivation of crops for own consumption will be encouraged in addition to the cultivation of cash crops. A planting area of 0.3 ha is required to meet the estimated annual own consumption volume of rice (upland rice which is the main staple

crop) of 1,200 kg (unhulled) of a family of five. Pulse is suitable as a dry season crop. In areas with an excellent water supply, the planting of vegetables requiring plenty of water, such as tomatoes and cabbages, will be encouraged during the dry season by means of irrigation between ridges. The introduction of high yield varieties will also be considered to improve productivity.

2) Intercropping and mixed cropping are appropriate planting methods for soil conservation and to disperse the risks. The actual combination of crops are the same as those for agroforestry. Cyclical planting, i.e. starting with cereals, progressing to pulse crops and further to tubers before returning to cereals, will be employed to avoid a decline of the yield due to the repeated cultivation of the same crops. Fertilizers will be urea, triple superphosphate (TSP), potassium chloride (KCl), hydrated lime and/or barnyard manure. The ratio of phosphate fertilizer will be relatively high along with organic fertilizer because of the predominance of volcanic soil in the Planning Area. The standard application mix of chemical fertilizers will be 150 kg of urea, 100 kg of TSP and 50 kg of KCl for common crops.

   The multiple application of rice straw and agricultural product residue will be effective for monoculture on terraced dry crop fields to prevent soil loss and to maintain soil moisture during the dry period.

3) Trees will be planted along the edges of dry crop fields and on steep slopes to protect such fields. In the case of newly established terraces, such forage crops as brachiaria and setaria and such trees as caliandra and coffee will be planted along the edges of fields and on banked sections to reinforce the terraces.

(2) Type 2 Improved Dry Field

Dry crop fields where the construction of terraces is not planned will also be improved.

1) Although the crops to be planted will be the same as those for Type 1 improved dry fields, the planting of such tuberous root crops as cassava will be refrained from to assist soil conservation.

2) The planting method will be the same as that for terraced fields (Type 1 improved dry fields). The crops will be planted in strips along the contour lines. The contour planting of such forage crops as elephant grass and brachiaria will be conducted between the strips of crops to ensure soil conservation.

3) The planting of trees will follow the practices employed for terraced fields (Type 1 improved dry fields) while the selection of species will adopt the same principles used for agroforestry.

The planned area for improved dry fields by work type and by sub-watershed is shown in Table 5-4.

Table 5-4 Planned Area for Improved Dry Fields by Work Type and Sub-Watershed

(Unit: ha)

Sub-Watershed Code No./Type of Work		1	2	3	4	5	6	7	8	9	10	11	12	Total
Type 1	Existing Terraces	156	48	44	252	92	32	48	204	12	24	4	0	916
	New Bench Terraces	344	524	460	452	760	644	272	488	776	188	116	184	5,208
	Sub-Total	500	572	504	704	852	676	320	692	788	212	120	184	6,124
Type 2 (No Terrace)		32	84	384	188	288	36	160	240	108	88	60	36	1,704
Total		532	656	888	892	1,140	712	480	932	896	300	180	220	7,828

The selection of possible trees and crops will be conducted as follows.

1) Selection Criteria and Method

a) Interviews with the SBRLKT Citarum and Dinas Pertanian Tanaman Pangan Kabupaten Bandung were held in 1993 to establish the suitable natural conditions (rainfall, temperature, elevation and soil type), economic conditions (demand, marketability, transportation and suitability for intensive work) and other conditions (resistance to shade and also to disease and pests) for the following trees and crops.

- Trees and crops suitable for the Planning Area which has a Type B climate, volcanis soil type and elevation type(s) defined by Schmit and Ferguson as referred to by "Pedoman Agroforestry Dalam Perhutanan Social, Perum Perhutani, 1990".

- Trees and crops suitable for the Planning Area which belongs to the agricultural climatic zone C2 as defined by "Oldeman, L. R.: An Agro-Climatic Map of Java, Contr. Centre. Res. Inst. Agric. Bogor, No. 17, 1975".

Further interviews were held at the 3 BPPs located in the Study Area. Based on a general evaluation of the tree and crop suitability in the Planning Area, the tree and crop species suitable for the vegetative measures to be introduced under the farmland and forest land conservation plan were selected. Efforts were made in the final selection to make the species meet the requirements of local inhabitants, taking the findings of the social forestry survey and opinion survey (questionnaire survey) into consideration. The suitability of the trees and crops to be planted in the Planning Area is detailed in Supporting Report C1.

2) Points to Note in Selection Process

As the Planning Area is located near urban areas which provide markets for all kinds of agricultural crops, the scope of selection is quite wide. While the feasibility of the successful cultivation of the new crops, including pepper, is fairly high, trial cultivation in home gardens and/or demonstration plots is necessary. When attempting to grow exported crops, their characteristics as commodity crops must be properly studied in advance to minimise the inherent risks. Careful attention should also be paid to the selection of citrus fruits, petai and soybeans, etc. in view of the prospect of crop damage by disease and/or pests depending on the local conditions.

5.1.5 Conservation of Environment of Settlements

The total area of settlements, including housing sites and home garden sites, in the Planning Area is 2,340 ha, accounting for 7.0% of the total Planning Area. As these sites have an average annual soil erosion volume of 382.5 tons/ha, they constitute a critical source of sediment discharge and it is said that the amount of discharge cannot be ignored. Reduction of the sediment discharge at these sites is, therefore, important in order to adequately conserve the environment. The following measures will be introduced with the cooperation of local inhabitants.

(1) Construction of Absorption Wells

The functions of the absorption wells will be to reduce the surface runoff and to increase the groundwater supply capacity.

The absorption wells to be constructed under the Project will have a cylindrical shape and will be 1m in diameter and 3m in depth. The total number of planned absorption wells is 1,760 based on 15 wells/ha (approximately one well/household). These will be distributed in settlements where the houses are located next to each other. The planned number of wells for each sub-watershed is shown in Table 5-5.

Table 5-5 Planned Number of Absorption Wells by Sub-Watershed

(Unit: sets)

Sub-Watershed Code No.	1	2	3	4	5	6	7	8	9	10	11	12	Total
No. of Absorption Wells	90	350	260	340	110	70	140	120	100	90	80	10	1,760

(2) Planting of Trees

Fruit trees, such as jack fruit, will be planted in home gardens. The planned planting quantity by sub-watershed is shown in Table 5-6.

Table 5-6 Planned Planting Quantity for Home Gardens by Sub-Watershed

(Unit: trees)

Sub-Watershed Code No.	1	2	3	4	5	6	7	8	9	10	11	12	Total
Planned Quantity	2,480	9,200	7,040	9,120	2,880	1,840	3,680	3,120	2,640	2,480	2,160	160	46,800

Note: The number of trees to be planted was calculated based on a planting density of 100 trees/ha to cover 20% of the settlement area.

(3) Hedges

Hedges consisting of such short trees as Gliricidia maculata and caliandra will be created around housing areas. The planned planting quantity by sub-watershed is shown in Table 5-7.

Table 5-7 Planned Planting Quantity to Create Hedges by Sub-Watershed

(Unit: trees)

Sub-Watershed Code No.	1	2	3	4	5	6	7	8	9	10	11	12	Total
Planned Quantity	12,400	46,000	35,200	45,600	14,400	9,200	18,400	15,600	13,200	12,400	10.800	800	234,000

Notes: Trees for the hedges will be planted 1m apart in a straight line for 1% of the settlement area.

Fig. 5-6 shows a typical example of the components of a farmland and forest land conservation plan.

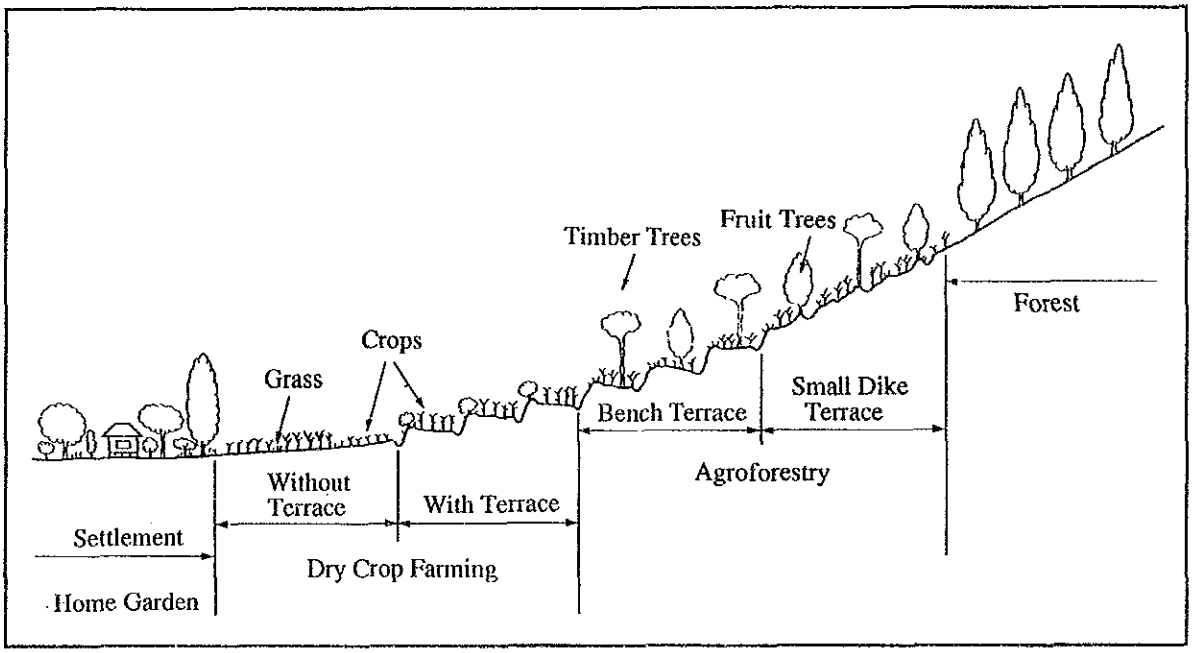

Fig. 5-6 Illustration of Typical Farmland and Forest Land Conservation Plan

5.1.6 Estimation of Soil Loss After Project Completion Using USLE Method

The expected land use changes resulting from the Project are shown in Table 5-8. The main changes will be a decline of areas occupied by dry crop fields without terraces and mixed gardens with a low crown density and an increase of areas occupied by terraced dry crop fields, mixed gardens with a high crown density and forests.

Table 5-8 Changes in Land Use after the Project

Land Use		Before Project		After Project	
		Area (ha)	Ratio (%)	Area (ha)	Ratio (%)
Dry Crop Field (with Terrace)		1,120	2.2	6,160	12.3
Dry Crop Field (without Terrace)		11,108	22.1	1,668	3.3
Mixed Garden	Crown Density ≧ 71%	524	1.0	3,572	7.1
	Crown Density 21 - 70%	760	1.5	528	1.1
Shrub		1,260	2.5	0	0.0
Grassland		320	0.6	0	0.0
Quarry		64	0.1	0	0.0
Forest		7,808	15.6	11,036	22.0

Note: The land use ratio indicates the percentage of land use type in question in the total area of the Study Area.

The change of forest between before and after the project, accounting for 3,228 ha, consists of state land of 1,548 ha and private land of 1,680 ha.

The possible soil loss volume following the completion of the Project, under which forest development, the introduction of agroforestry and the construction of terraces, etc. has been conducted, was estimated using the USLE method and the estimation results are given in Table 5-9. The annual soil loss/ha in the Planning Area will be 58 tons/ha/year while the total soil loss in the Planning Area will be some 1,900,000 tons/year. Compared to the corresponding figures prior to the implementation of the Project, the annual soil loss in the Planning Area will be reduced by 81%.

Table 5-9 Estimated Soil Loss after the Project (USLE Method)

Sub-Watershed Code No.	Before Project		After Project		Soil Loss Control Rate (%)
	Annual Soil Loss/Unit Area (tons/ha/year)	Annual Soil Loss (tons/year)	Annual Soil Loss/Unit Area (tons/ha/year)	Annual Soil Loss (tons/year)	
1	310.0	691,995	81.3	181,454	74
2	172.4	604,736	62.8	220,348	64
3	224.8	552,214	81.4	200,009	64
4	210.8	1,301,056	70.1	432,355	67
5	619.7	1,814,512	87.0	254,610	86
6	223.9	922,516	32.8	135,090	85
7	191.6	530,248	31.3	86,609	84
8	253.2	650,110	41.3	106,177	84
9	456.3	1,003,841	41.9	92,179	91
10	390.6	962,414	42.7	105,145	89
11	374.9	526,324	68.2	95,684	82
12	910.5	480,767	42.1	22,206	95
Planning Area Total	301.1	10,040,733	57.9	1,931,866	81

Note: Soil Loss Control Rate = (soil loss before the Project - soil loss after the Project) ÷ soil loss before the Project x 100

5.2 Torrent and Bank Conservation Plan

Control of the sediment discharge at torrents aims at containing the sediment discharge from farmland and forest land to torrents to 5.5 m^3/ha/year or less by means of implementing the Project as already described in Chapter 4. The sediment discharge to torrents in the Planning Area after the Project was calculated to examine the feasibility of this target.

The equation below was established by the study on the correlation between the annual sedimentation volume and annual soil loss in the catchment areas. The soil loss was estimated using the USLE method for 13 check dams (with catchment areas ranging from 51 ha to 253 ha) out of the existing 28 check dams in the Planning Area based on a catchment size area of more than 50 ha.

$Y = 0.0259435 X + 244.98$

Y : sedimentation volume at check dam (m^3/year)

X : annual soil loss in catchment area by USLE method (tons/year)

Correlation coefficient : 0.41

The annual soil loss/ha in the Planning Area, estimated using the USLE method, will be 57.9 tons/ha/year with the implementation of the farmland and forest land conservation plan (see 5.1.6). Assuming that the catchment area of a check dam is 150 ha, the expected annual sedimentation volume at the dam will be 470 m^3/year, i.e. 3.1 m^3/ha/year.

The annual sediment discharge following the completion of the Project was estimated using the proportional relation between the annual sediment discharge and the annual soil loss per ha based on the USLE method. Using the survey results on sedimentation at check dams described in 3.3.2 and assuming an annual sediment discharge from the Planning Area of 16.9 m^3/ha and a soil loss based on the USLE method of 301.1 tons/ha/year before the Project and 57.9 tons/ha/year after the Project, the annual soil loss after the Project is 3.2 m^3/ha/year provided that the said proportional relation stays the same. This result suggests that the proposed requirement of containing the sediment discharge below the level of 5.5 m^3/ha/year will be met.

The annual sediment discharge following the completion of the Project was estimated next. The Project includes vegetative measures and civil engineering measures for soil conservation which will be implemented in a 5 year period with a quantitative distribution of work of 10% in the first year, 20% in the second year, 25% in the third and fourth years and 20% in the fifth year. As the soil loss prevention effect of vegetative measures will increase in accordance with tree growth, it is assumed that the full potential of vegetative measures to prevent soil loss will materialise and be maintained in the fifth year onwards. Table 5-10 shows the soil loss prevention effects of both the vegetative measures and civil engineering measures in the Planning Area, calculated using the USLE method. Seventy-five percent of the soil loss prevention will be brought about by the vegetative measures while the remaining 25% will result from the civil engineering measures. Table 5-11 indicates the year-by-year soil loss prevention effect of the Project and the increased soil loss prevention effect following the completion of the Project is expected to follow the curve shown in Fig. 5-7.

Consequently, the sediment discharge from the Planning Area will decrease as shown in Table 5-12 and Fig. 5-8 and the surplus sediment discharge above the allowable volume will be 1,463,000 m^3 (based on a sediment discharge of 16.9 m^3/ha/year before the Project, a sedimentation discharge of 3.2 m^3/ha/year with the full materialisation of the soil loss prevention effects after the Project and an allowable sediment discharge of 5.5 m^3/ha/year). The torrent and bank conservation plan should, therefore, be designed to allow sedimentation of the above soil volume in torrents.

Table 5-10 Soil Loss Prevention Effect of Conservation Measures in Planning Area

	Soil Loss Before Project (tons/year)	Soil Loss After Project (tons/year)	Prevented Soil Loss (tons/year)	Prevention Effect Ratio (%)
Civil Engineering Measures				
- Terracing	2,189,108	174,380	2,014,728	24.7
Sub-Total	2,189,108	174,380	2,014,728	24.7
Vegetative Measures				
Type 1 Agroforestry	2,734,957	90,236	2,644,721	32.5
Type 2 Agroforestry	92,403	18,481	73,922	0.9
Type 1 Forest Development	3,286,071	30,026	3,256,045	40.0
Type 2 Forest Development	5,637	141	5,496	0.1
Type 3 Forest Development	149,064	745	148,319	1.8
Sub-Total	6,268,132	139,629	6,128,503	75.3
Total	8,457,240	314,009	8,143,231	100.0

Note: The soil conservation effect of crop changes following dry crop field improvement is not accounted for.

Table 5-11 Annual Achievements of Soil Loss Prevention Measures Under the Project

(Unit: %)

Year Elapsed / Project Year		1	2	3	4	5	6	7	8	9	10
1	Work Volume: 10%										
	Civil. Eng. Measures	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
	Vegetative Measures		1.5	3	4.5	6	7.5	7.5	7.5	7.5	7.5
2	Work Volume: 20%										
	Civil Eng. Measures		5	5	5	5	5	5	5	5	5
	Vegetative Measures			3	6	9	12	15	15	15	15
3	Work Volume: 25%										
	Civil Eng. Measures			6.25	6.25	6.25	6.25	6.25	6.25	6.25	6.25
	Vegetative Measures				3.75	7.5	11.25	15	18.75	18.75	18.75
4	Work Volume: 25%										
	Civil Eng. Measures				6.25	6.25	6.25	6.25	6.25	6.25	6.25
	Vegetative Measures					3.75	7.5	11.25	15	18.75	18.75
5	Work Volume: 20%										
	Civil Eng. Measures					5	5	5	5	5	5
	Vegetative Measures						3	6	9	12	15
Total	Work Volume: 100%										
	Civil Eng. Measures	2.5	7.5	13.75	20	25	25	25	25	25	25
	Vegetative Measures	0	1.5	6	14.25	26.25	41.25	54.75	65.25	72	75
	Total	2.5	9	19.75	34.25	51.25	66.25	79.75	90.25	97	100

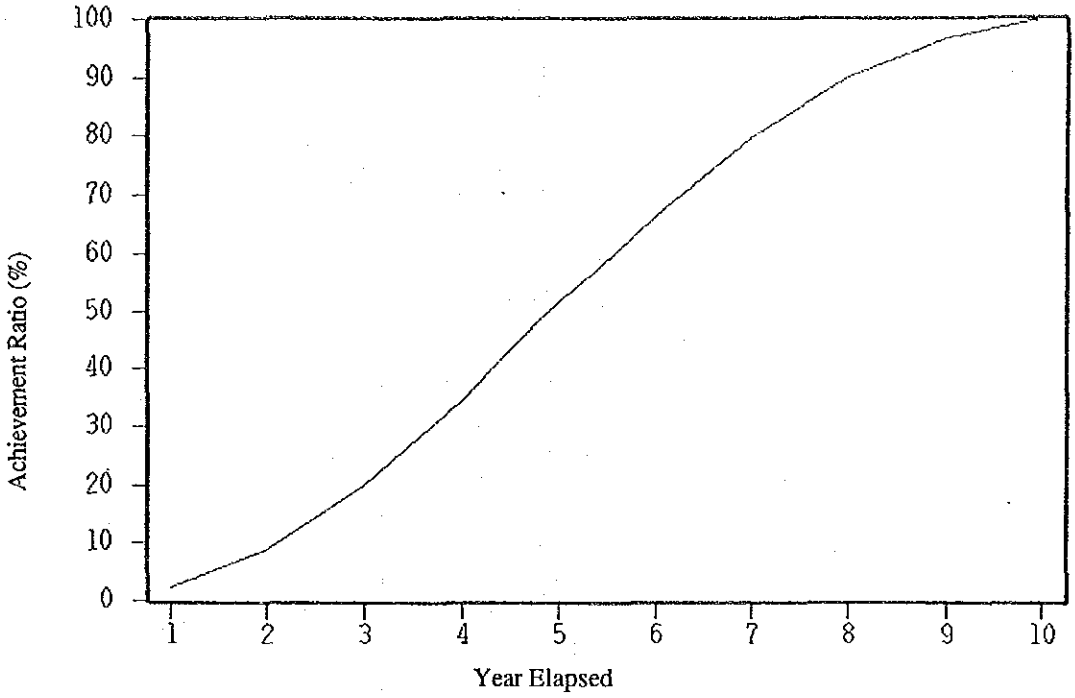

Fig. 5-7 Estimated Soil Loss Prevention Achievement Ratio With Progress of Project Implementation

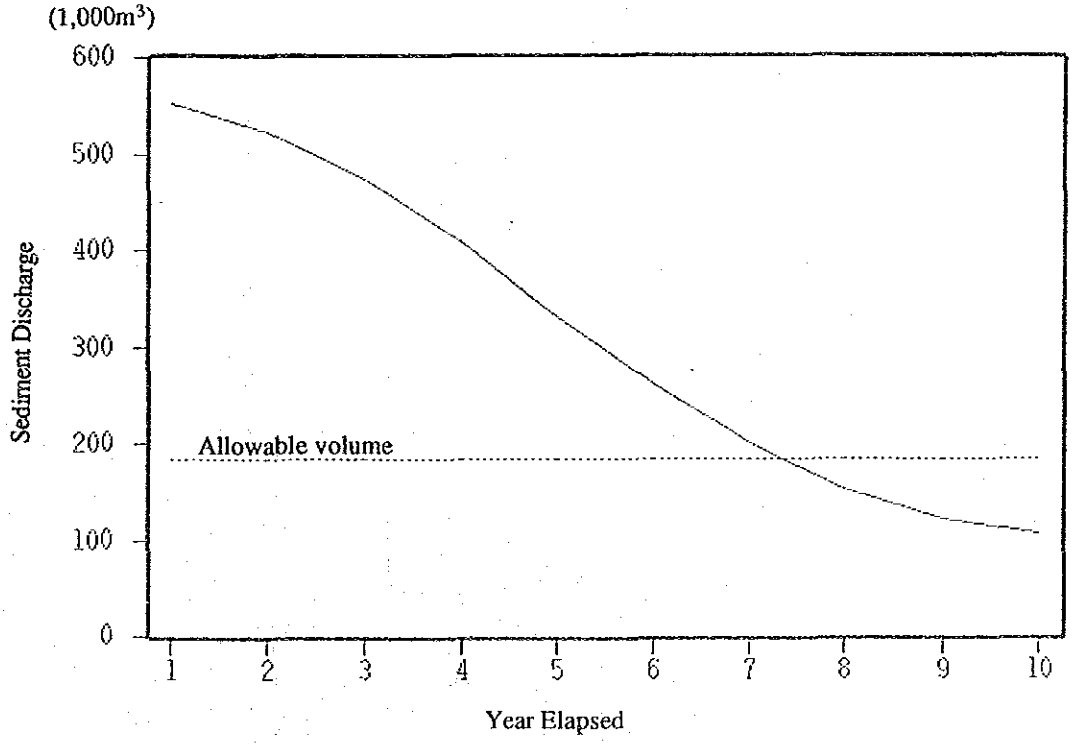

Fig. 5-8 Estimated Sediment Discharge From Planning Area With Project Implementation

Table 5-12 Estimate Sediment Discharge From Planning Area With Project Implementation

Year Elapsed	1	2	3	4	5	6	7	8	9	10
Achievement Ratio of Expected Project Effects	2.5	9	19.75	34.25	51.25	66.25	79.75	90.25	97	100
Sediment Discharge (m^3/year)	552,822	523,090	473,918	407,592	329,832	261,219	199,468	151,440	120,564	106,842
Allowable Volume (m^3/year)	183,634	183,634	183,634	183,634	183,634	183,634	183,634	183,634	183,634	183,634
Surplus Sediment Discharge (m^3/year)	369,188	339,456	290,284	223,958	146,198	77,585	15,834	–32,194	–63,070	–76,792
Accumulated Volume (m^3/year)	369,188	708,644	998,927	1,222,886	1,369,083	1,446,669	1,462,503			

Notes
Subject Area: 33,388 ha
Sediment Discharge Before Project: 16.9 m^3/ha/year
Sediment Discharge After Achievement of Soil Loss Prevention Potential of Project: 3.2 m^3/ha/year
Allowable Soil Loss Volume: 5.5 m^3/ha/year

5.2.1 Torrent Conservation

A total of 70 check dams (dam pengendali) will be constructed to control the soil discharge of some 1,463,000m^3/year. These dams will be core-type earth dams with an effective height of 6m, a sedimentation capacity of 19,000m^3 and a standard catchment area of some 150 ha. In addition, 139 small check dams (dam penahan) will be constructed using steel wire cages with an effective height of 3.5m, a sedimentation capacity of 900m^3 and a standard catchment area of some 50 ha. Furthermore, 2,080 gully plugs with an effective height of 1.5m using steel wire cages will be introduced at a standard distance of 10 - 20m. The planned number by sub-watershed is given in Table 5-13.

Table 5-13 Planned Number of Check Dams, Small Check Dams and Gully Plugs by Sub-Watershed

Sub-Watershed Code Number	1	2	3	4	5	6	7	8	9	10	11	12	Total
Check Dams	5	7	5	13	6	9	6	5	5	5	3	1	70
Small Check Dams	9	15	10	26	12	17	12	11	9	10	6	2	139
Gully Plugs	140	220	150	390	180	260	170	160	140	150	90	30	2,080

5.2.2 Bank Conservation

(1) Revetment Works

Revetment works will be introduced at banks suffering from heavy erosion to prevent the collapse and lateral erosion of such banks. Based on the findings of the field survey, 20% of the total valley length in the Planning Area will be subject to bank conservation measures and 5% will be protected by revetment works. Gabion works will be used and the planned total length is 16,000m as shown in Table 5-14.

Table 5-14 Planned Revetment Works by Sub-Watershed

(Unit: m)

Sub-Watershed Code Number	1	2	3	4	5	6	7	8	9	10	11	12	Total
Length of Revetment Works	1,400	2,000	1,200	3,000	800	2,200	1,000	1,000	1,000	1,200	800	400	16,000

(2) Planting on Banks

Trees will be planted on banks to stabilise bank slopes and to prevent the sediment inflow from farmland to torrents. Caliandra will be planted in 2 rows in a zigzag pattern. A 50m wide green belt will be created with trees and fruit trees above these rows. The species planned for this belt include such trees as albizia, maesopsis and Cinnamomum burmanni and such fruit trees as avocado, citrus fruit and jack fruit, etc. The planting density will be 1,650 trees/ha for sites with trees only and 400 trees/ha and 100 fruit trees/ha for mixed sites. Line planting and green belts will be introduced on both banks for 30% of the total valley length subject to bank conservation. The actual figures are 92 km for line planting and 460 ha for green belts. The planned volume of bank conservation work by sub-watershed is given in Table 5-15.

Table 5-15 Planned Volume of Bank Conservation Work by Sub-Watershed

Sub-Watershed Code Number	1	2	3	4	5	6	7	8	9	10	11	12	Total
Line Planting (km)	8	12	6	18	4	12	6	6	6	8	4	2	92
Green Belt (ha)	40	60	30	90	20	60	30	30	30	40	20	10	460

5.3 Effects of Project on Sedimentation Volume at Saguling Dam

The possible effects of the Project on sedimentation at Saguling dam were roughly estimated assuming the Project's commencement in 1994.

With the implementation of the Project, the annual soil discharge from the Planning Area to Citarum river is expected to decrease from the present 16.9 m^3/ha to 5.5 m^3/ha or less. As the catchment area of Citarum river includes 32,862 ha of the Planning Area, the soil discharge from this 32,862 ha will decrease from 555,000 m^3/year to 181,000 m^3/year or less. Assuming that the entire volume of discharged soil is sedimented at Saguling dam, the sedimentation volume at the dam will decrease from the current level of 3,408,000 m^3/year to 3,034,000 m^3/year or less.

As the remaining sedimentation capacity of the dam upto the upper end of the water intake for power generation is 154,811,000m^3 as of June, 1992 (hereinafter referred to as the remaining capacity), the remaining capacity will decrease to 147,995,000m^3 in June, 1994. Assuming that the sedimentation plane is level, Saguling dam will have a remaining service life of 43.4 years in June, 1994. If the Project commences in