JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
DEPARTMENT OF AGRARIAN REFORM (DAR)

THE FEASIBILITY STUDY
ON
DEVELOPMENT OF AGRARIAN REFORM COMMUNITIES
IN
MARGINAL AREAS
IN
THE REPUBLIC OF THE PHILIPPINES

GUIDELINES

JULY, 1997

SANYU CONSULTANTS INC.
PACIFIC CONSULTANTS INTERNATIONAL

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PREFACE

In pursuance of the objectives of the Implementing Arrangement (IA) for the Feasibility Study on Development of Agrarian reform Communities in Marginal Area, agreed upon between JICA and DAR on November 1995, JICA Study Team prepared this guideline at the termination of the Phase-I and Phase-II works.

The guideline aims to be applicable for the formulation of other agrarian reform community development plans in the nationwide, of which areas will be categorized into three clusters, although these clusters might be altered depending on the prevailing situation of the marginal areas.

The guideline consists of following 14 subjects;

- Classification of Marginal Area
- Participatory Approach for Developing Marginal Area
- Institutional and Social Capability Building-Up
- Soil and Land-Use
- Farming and Cultivation Plan
- Animal Husbandry and Inland Fisheries
- Post-Harvest and Agro-Industry Plan
- Agricultural Supporting Plan
- Irrigation and Drainage Plan
- Farmers' Organization Plan
- Environmental Conservation Plan
- Design of Major Facilities and Cost Estimate
- Project Implementation Plan
- Project Evaluation

CONTENTS

1. CLASSIFICATION OF MARGINAL AREA

1. Classification of Marginal Areas

1. Classification of Marginal Areas

1.1 Objectives of the Study

In order to formulate the project plan for the marginal areas existing in the whole country, these areas should be classified into similar groups, for which independent project plan will be proposed based on the prepared guideline.

Subsequent deals with the procedure of the classification of marginal areas.

1.2 Classification of Marginal Areas

Classification of the marginal areas into similar groups should be undertaken taking into consideration the development pattern and methods, social capacity such as establishment conditions of communities (barangay and sitio), area custom and practices, marketing systems, topography, natural conditions, etc.

These classification analyses would be made in the following two cases;

- Classification by prevailing present conditions in the area, and
- Classification by project development plan for each areas,

1.2.1 Classification by Prevailing Present Conditions in the Area

1) Related Elements for Classifying the Marginal Areas

In classifying the marginal areas based on the prevailing present conditions in the area, four major subjects such as I) poverty conditions, ii) living conditions, iii) production conditions, and development potentials, would be taken into consideration, which are furthermore subdivided into smaller elements as shown bellow;

<u>Poverty Conditions</u>

- Annual income per household
- Employment rate for agricultural sector
- Employment rate for non-agricultural sector

Living Conditions

- Natural condition
- Accessibility to the areas
- Rural and social infrastructures
- Environment

Production Conditions

- Farming conditions
- Agricultural infrastructures

Development Potentials

- Land Resources
- Water resources
- Human resources
- Institutional capability in development

Table 1-1 indicates sample tabulation of the related elements considered into classification of marginal areas, which involves in 12 Model Areas in JICA study.

2) Ranking of Related Elements

The tabulated elements mentioned above will be evaluated on the basis of the following ranking indices;

Rank-3 : Best or highest in positive factor and/or least or lowest in negative factor of evaluation indices,
Rank-2 : Medium in both positive and/or negative factors, and
Rank-1 : Worst or lowest in positive factor and/or most or highest in negative factor.

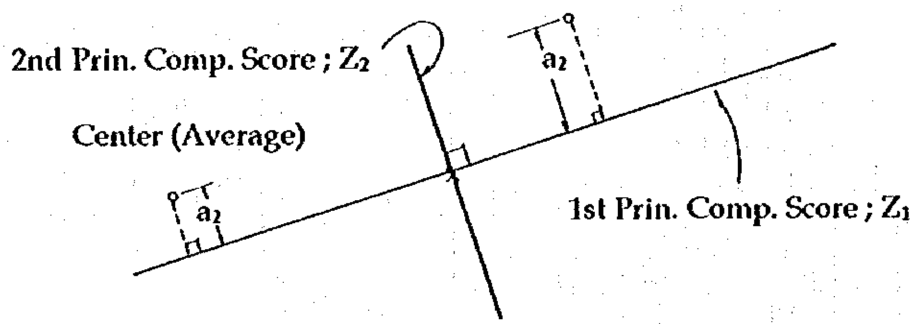
Table 1-2 shows the evaluation criteria for each element, and Table 1-3 shows a sample tabulation of evaluated elements in each area.

The classification of analyses would be made based on these evaluated data, applying the following two statistical methods, that is, one will be Principal Component Analysis and the other will be Cluster Analysis.

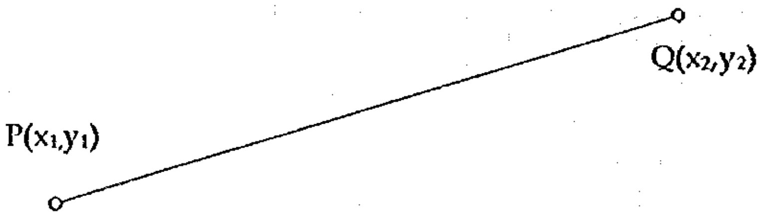
3) Principal Component and Cluster Analyses

The Principal Component Method is the mathematical transformation of the original data for various elements falling under each of the four major subjects mentioned in the above. In its essence, Principal Component Method searches for the linear combination which would best represent the interrelation between and among the indicators of each major subjects. In the Principal Component analyses, principal component score will be expressed by the following equation; $Z_1 = (A_{11}X_1 + A_{12}X_2 + ... + A_{1P}X_p)$, where Z_1 is first principal component score, A_{11} is the element (coefficient) of the characteristic vector, and X_{1P} is the linear compound.

The line Z_1 is a linear line passing through an average point of X. The line must have the smallest values(amount), in calculating $a_1 + a_2 + ... + a_n$. These a_1 and a_n are vertical lines which connect any points and Z_1. Draw a vertical line that passes through an average point X to the line Z_1. This linear line become line Z_2, as shown below. This linear compound of Z_2 is the second principal component score. In order to analyze the principal component score, two ways exist, that is, Eigenvector method and Principal Component Load method.



On the other hand, the Cluster Analysis would be applied using different combination of the subjects on the basis of the transformed data. By the method of iteration, objective marginal areas would be grouped based on the means of the transformed values of the subject to be considered. The process of clustering were continued until a convergence is found among the cases. To put it concretely, the scale to be used for clustering the group is scored distance and correlation coefficient among the cases. The scale of scored distance is used for Sample Cluster method, while the correlation coefficient is used for Variable Cluster method. The scored distance between the cases are estimated by the equation of $d = \sqrt{(X_2 - X_1)^2 + (y_2 - Y_1)^2}$ in the case of a quadratic equation.



Each cluster has a center (a mean squared distance of 0). So, the basis for grouping within the same cluster is the distance of each sample case from the cluster center. The computer gives the distance of each sample case from the cluster center for every variable combination.

Figure 1-1 indicates the flow-chart by means of Principal Component and Cluster analyses for the classification of marginal areas. These analyses would be made applying computer. The detailed explanations of the Principal Component and Cluster Methods are referred to the attached paper.

The Principal Component and Cluster analyses mentioned in the above would be made for a few cases of alternatives considering number of principal components and number of cluster. In case of 12 Marginal Areas, two cases of alternative plan were studied. Furthermore, two alternative studies in the Case-2 were made, that is, Case 2-1 with three cluster and Case-2-2 with four cluster, respectively. The study results are given in Figure 6.3-1. As is observed in the figure, the differences between Case 2-1 and Case 2-2 are clustering of Abiera Estate. In the former case (Case-2-1), Abiera Estate will be involved in Cluster-3, however in the case of latter case (Case-2-2), Abiera Estate will be independent cluster (Cluster-4).

As a most adequate number of cluster for classifying 12 Model Areas, Case 2-1 with three cluster will be selected considering the characteristics of Abiera Estate such as locality of it.

Alternative Cases for Principal Component and Cluster Analyses

Items	Case 1	Case-2	
		Case 2-1	Case 2-2
- Principal Component Analysis			
Analysis Method	Eigenvector	Eigenvector	Eigenvector
No. of Principal Components	3	4	4
- Cluster Analysis			
Analysis Method	Sample Cluster	Sample Cluster	Sample Cluster
No. of Cluster	4	3	4

The results of Principal Component and Cluster Analyses are shown in Figure 1-2. The similar samples (ARC) are grouped by dotted line.

As is seen in Figure 1-1, Case 2 with four principal component presents slightly higher cumulative percentage of variance in the case of 2nd principal component, compared with that of Case 1. Therefore, the number of principal components will be decided at four (in general, the number of principal components will be decided expecting that the cumulative percentage of variance should be more than 60 percent).

Figure 1-3 indicates the dendrogram of the Cluster analysis. Following table indicates the results of classification for 12 Model Areas as a sample.

Classification of Model Areas by Prevailing Present Elements

12 Model Areas	Principal Component and Cluster Analyses		
	Cluster-1	Cluster-2	Cluster-3
Sappaac ARC (Reg.-CAR)	O		
Talugtog ARC (Reg.-1)		O	
Cofcaville ARC (Reg.-2)		O	
Montilla ARC (Reg.-3)	O		
Maulawin ARC (Reg.-4)	O		
Pag-asa ARC (Reg.-5)		O	
Abiera Estate (Reg.-6)			O
San Vicente ARC (Reg.-7)			O
Marangog ARC (Reg.-8)			O
Silae ARC (Reg.-10)			O
Kipalili ARC (Reg.-11)			O
Mat-i ARC (Reg.-13)			O

Through the study results mentioned in the above, 12 Model Areas were classified into tree clusters applying the Principal Components and Cluster Analyses on the basis of prevailing present conditions. Figure 1-3 indicates the dendrogram of the Cluster Analysis.

However, the selection of Typical Model Areas for the whole Study Areas will be undertaken taking into account the results obtained through the study by means of development plan to be described hereinafter.

1.2.2 Classification by Project Development Plan

The project components of the marginal land could be considered as show below;

- Improvement and enhancement plans for institutional capacity in the rural areas,
- Land-use and soil conservation plans
- Farm management and Agricultural supporting service plans
- Water resource development plan
- Agriculture infrastructure plan
- Rural infrastructure plan
- Rural agro-industry plan
- Environmental conservation and rural health improvement plans

Of these components mentioned above, since all project components except for land-use and environmental conservation plans (presented by ratio of cultivation and cultivable areas), water resource plan (type of water resources facilities and irrigation methods), and agricultural farm management plan (introduced crops, cropping pattern, etc.) are considered to be essential and prerequisite components for whole the marginal areas, the classification of marginal areas by means of project development plan will be made depending on following three main project components.

Through the study on marginal area classification, the areas would be classified into following four types of development plans;

- Dev. Type-I : High ratio of cultivation/cultivable area + Irrigated agriculture + Main crop(paddy rice)
- Dev. Type-II : High ratio of cultivation/cultivable area + Rainfed agriculture + Main crop(Paddy rice)
- Dev. Type-III : High ratio of cultivable/cultivation area + Rainfed agriculture + Main crop(Upland crop)
- Dev. Type-IV : Low ratio of cultivable/cultivation area + Rainfed agriculture + Main crop(Upland crop)

Following table presents the classification results of 12 Model Areas by means of project development type.

Classification of Model Areas by Project Development Type

12 Model Areas	Classification of Develop. Plan
Sappaac ARC (Reg.-CAR)	I, II
Talugtog ARC (Reg.-1)	I
Cofcaville ARC (Reg.-2)	III
Montilla ARC (Reg.-3)	III
Maulawin ARC (Reg.-4)	III
Pag-asa ARC (Reg.-5)	III
Abiera Estate (Reg.-6)	IV
San Vicente ARC (Reg.-7)	III
Marangog ARC (Reg.-8)	IV
Silae ARC (Reg.-10)	IV
Kipalili ARC (Reg.-11)	IV
Mat-i ARC (Reg.-13)	IV

Through the study results by both cases of classification by means of prevailing present condition of the areas and type of project development plan, relations of the classification between both cases are identified as shown below , that is, the Cluster-1 has Development Type-I, II and III, the Cluster-2 has Development Type-I and III, and the Cluster-3 has Development Type-III and IV, respectively, as shown below;

Classification of 12 Model Areas

12 Model Areas	Principal Component and Cluster Analyses			Type of Develop. Plan
	Cluster-1	Cluster-2	Cluster-3	
Sappaac ARC (Reg.-CAR)	O			I, II
Talugtog ARC (Reg.-1)		O		I
Cofcaville ARC (Reg.-2)		O		III
Montilla ARC (Reg.-3)	O			III
Maulawin ARC (Reg.-4)	O			III
Pag-asa ARC (Reg.-5)		O		III
Abiera Estate (Reg.-6)			O	IV
San Vicente ARC (Reg.-7)			O	III
Marangog ARC (Reg.-8)			O	IV
Silae ARC (Reg.-10)			O	IV
Kipalili ARC (Reg.-11)			O	IV
Mat-i ARC (Reg.-13)			O	IV

The salient characteristics and similar features of the classified clusters and development types should be presented as the study results.

Table 1-1 Subject to be Considered in Determining Classification of Model Areas

Items	CAR Sappa-ac	Reg-1 Talugtog	Reg-2 Cofcaville	Reg-3 Montilla	Reg-4 Maulawin	Reg-5 Pag-asa	Reg-6 Abierra	Reg-7 San Vicente	Reg-8 Marangog	Reg-10 Silae	Reg-11 Kipalili	Reg-13 Mat-i
I. Poverty Conditions												
1. Rural Economy												
1.1 Annual Income per Household ('000 Peso)	35.1	54.2	31.4	105.4	28.4	24.8	8.5	22.9	13.3	24.6	13.7	22.2
1.2 Employment Rate for Agricultural Sector (%)	78.1	68.4	80.4	63.4	77.1	70.5	74.8	73.7	72.9	94.6	71.6	83.9
1.3 Employment Rate for Non-Agricultural Sector (%)	21.9	31.6	19.6	36.6	22.9	29.5	25.2	26.3	27.1	5.4	28.4	16.1
II. Living Conditions												
1. Natural Conditions												
1.1 Climate Type	I	I	III	I	IV	II	III	IV	IV	III	II	IV
1.2 Frequency of Typhoon Occurrence (time/annum)	21	21	23	22	34	36	27	26	34	3	3	23
2. Agricultural Infrastructure												
2.1 Accessibility to Marginal Areas in Wet Season	Not Difficult	Not Difficult	Difficult	Not Difficult	Not Difficult	Difficult	Difficult	Not Difficult	Difficult	Not Difficult	Not Difficult	No Road
3. Rural and Social Infrastructure												
3.1 Village Water Supply (Place)	8	Many	29	5	13	2	4	-	1	-	2	-
3.2 Presence of Complete Elementary Education	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
3.3 Rural Health Services	100	25	100	88	75	50	100	63	25	50	38	88
3.4 Rural Electrification	Supplied	Supplied	Supplied	None	Supplied	Supplied *	None	None	None	None	Supplied	None
4. Environment												
4.1 Land-Sliding and Soil Erosion	High	High	Very High	Moderate	High	High	High	Very High	High	Very High	Very High	Very High
4.2 Water Quality for Village Water Supply	Moderate	Good	Poor	Poor	Moderate	Poor	Very Poor	Poor	Moderate	Poor	Poor	Poor
4.3 Reforestation Needs	Moderate	Moderate	Very High	Moderate	Very High	High	High	Very High	High	Very High	Very High	High
III. Production Conditions												
1. Farming Conditions												
1.1 Cultivated Area per Farm Household (ha.)	1.2	0.9	2.2	1.0	1.0	0.8	1.1	0.4	2.5	2.0	2.1	4.7
1.2 Distributed Area per Farm Household (ha.)	1.7	1.0	2.7	1.7	2.2	6.2	2.9	2.8	2.7	3.3	2.9	5.5
1.3 Cropping Intensity (Distributed Area = 100%)	41.6	60.5	86.4	72.2	66.4	46.3	41.5	49.3	58.5	79.3	28.1	37
1.4 Corn Yield per Hectare (ton/ha)	1.5	1.5	2.2	0.6	0.1	-	-	1.2	0.4	1.6	0.5	-
1.5 Paddy Yield per Hectare	1.2	1.0	2.2	-	1.1	1.5	1.0	1.4	0.5	1.3	2.9	-
2. Agricultural Infrastructure												
2.1 Irrigation Areas	Small	1.5	21.5	-	-	35.0	-	Small	-	-	15.0	-
2.2 Farm Roads	L = 5.0	L = 1.0	L = 4.0	L = 5.0	L = 6.5	L = 5.0	L = 5.0	L = 2.0	L = 14.0	L = 4.0	L = 16.5	-
2.3 Post Harvest Facilities	1 Rice Thresher	1 MPP	1 MPP									
	(Private)	Many Rice Thresher	1 Corn Sheller	1 Tractor	-	1 MPP	1 Tractor	-	1 MPP	-	1 Rice Mill	
		1 Rice Mill	(Private)	(Private)			(Private)				(Private)	
		1 Kuliglig		1 Warehouse			1 Warehouse				1 Rice Thresher	
		1 Reaper (Private)									(Private)	

Items	CAR Sappa-ac	Reg-1 Talugtog	Reg-2 Cofcaville	Reg-3 Montilla	Reg-4 Maulawin	Reg-5 Pag-asa	Reg-6 Abierra	Reg-7 San Vicente	Reg-8 Marangog	Reg-10 Silae	Reg-11 Kipalili	Reg-13 Mat-i
IV. Development Potential												
1. Land Resources												
1.1 Slope of Topography (Area Ratio less than 18%)	70.9	76.6	68.4	94.6	70.1	81.2	23.5	84.9	46.3	55.3	37.8	29.6
1.2 Soil Fertility	Moderate	Moderate	Low to	Low to	Moderate	Low to	Low	Moderate	Moderate	Moderate	Low to	Moderate
			Moderate	Moderate		Moderate			Partially to Stony		Moderate	Partially
1.3 Stoniness and Gravel (% of respondents)	44	14	12	32	2	56	40	52	60	24	44	72
2. Water Resources												
2.1 Available Soil Moisture (mm) and Effective Month	986 (6-10)	844 (6-10)	820 (5-11)	637 (6-10)	946 (6-1)	871 (6-1)	388 (6-12)	101 (10-12)	550 (6-2)	463 (6-11)	106 (5-10)	1,405 (6-4)
2.2 Available Surface Water	1 creek	-	3 creeks	2 creeks	1 creek	1 creek	1 creek	1 creek	1 creek	1 creek	2 creeks	2 creeks
2.3 Available Sub-Surface Water	2 springs	many wells	34 wells	3 springs	-	1 spring	-	-	1 spring	-	-	-
3. Human Resources												
3.1 Present Labor Force per Hectare	0.46	0.98	0.30	1.44	0.54	0.67	0.71	0.45	0.59	0.88	0.69	0.90
3.2 Completion Rate of Elementary Education for Available Labor Force	14.5	11.7	11.7	5.1	15.8	10.6	6.8	5.9	9.8	8.0	7.1	11.1
3.3 Woman in Development	42.2	42.8	36.9	66.6	32.0	38.7	36.5	58.2	38.0	51.5	61.0	59.2
4. Institutional Capacity in Development												
4.1 Ratio of ARBs Participating in Multi-Purpose Cooperative Organization (%)	60	40	40	40	40	50	40	60	30	70	80	40
4.2 Presence of NGO Activities in Development												
- Within the Study Area	no	no	yes	no	no	yes	yes	yes	no	no	no	yes
- Outside the Study Area but within Province	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

• Electricity - Supplied but due to typhoon Rosing on Nov. 1995 electricity is still not available.

Table 1-2 Ranking Evaluation Criteria for Elements in Determining Classification of Model Areas

Items	Good (Ranging-3)	Moderate (Ranking-2)	Poor (Ranking-1)
I. Poverty Conditions			
1. Rural Economy			
1.1 Annual Income per Household (peso)	< P 20,000	P 20,000 - 30,000	> P 30,000
1.2 Employment Rate for Agricultural Sector (%)	> 80 %	79 - 70 %	< 69 %
1.3 Employment Rate for Non-Agricultural Sector (%)	> 30 %	20 - 29 %	< 20 %
II. Living Conditions			
1. Natural Conditions			
1.1 Climate Type	Type-II and IV considering continuous and long natural growing season	Type-I considering abundant rainfall during the wet season	Type-III considering relatively scarce rainfall during the wet season
1.2 Frequency of Typhoon Occurrence (time/annum)	Less than 10 times a year	Between 10 - 30 tims a year	More than 30 times a year
2 Agricultural Infrastructure			
2.1 Accessibility to Marginal Areas in Wet Season	Easy or possible access from nain road	Oiddicult access	Very difficult or absence of access road
3 Rural and Social Infrastructure			
3.1 Rural Water Supply (Place)	Sufficiently suplied under fair conditions with Level-I or Level-II	Presemce of supply systems, but under poor conditionds	Absence of supply systems or just taking water from sources directly
3.2 Presence of Complete Elementary Education	Yes	With facilities, but not complate elementary education	None
3.3 Rural Health Services	Availability of a number of health facilities and services, > 65 %	Presence of moderate number of health facilities and services, 65 - 34 %	Absebce or minimal presence of health services and facilities, < 33 %
3.4 Rural Electrification	Energized	No energized due to damage by thphoon	No energized
4. Environment			
4.1 Land-Sliding and Soil Erosion	Moderate	High	Very High
4.2 Water Quality for Rural Water Supply	Good/Moderate	Poor	Very Poor
4.3 Reforestation Needs	Moderate	High	Very High
III. Production Conditions			
1. Farming Conditions			
1.1 Cultivated Area per Farm Household (ha)	> 3.0 ha	3.0 - 1.5 ha	< 1.5 ha
1.2 Distributed Area per Farm Household (ha)	> 3.0 ha	3.0 - 1.5 ha	< 1.5 ha
1.3 Cropping Intensity (Present Cultivable Area = 100%)	> 80 %	80 - 40 %	< 40 %
1.4 Corn Yield per Hectare (ton/ha) or Paddy Yield per Hectare	> 2.0 ton/ha	2.0 - 1.0 ton/ha	< 1.0 ton/ha
2 Agricultural Infrastructure			
2.1 Irrigation Areas	Presence of irrigation in wet and dry seasons	Presence of irrigation in wet season only	Absence of irrigation
2.2 Farm Road	Presence of farm roads with fair conditions	Presence of farm roads with poor conditions	Absence of farm roads
2.3 Post Harvest Facilities	Presence of post-harvest facilities more than tree items	Presence of post-harvest facilities less than tree items,	Absence of post-harvest facilities
IV. Development Potential			
1. Land Resources			
1.1 Slope of Topography (Area Ratio less than 18 %)	> 70 %	70 -35 %	< 35 %
1.2 Soil Fertility	Moderate	Moderate to Low	Low
1.3 Stoniness and Gravel (% of respondents)	< 33 %	33 - 66 %	> 66 %
2 Water Resources			
2.1 Available Soil Moisture (mm) and Effective Month	Soil moisture more than 700 mm and its effective period more than 7 months	Soil moisture between 700 - 300 mm and its effective period from 7 to 4 months	Soil moisture below 300 mm and its effective period less than 4 months
2.2 Available Surface Water	Available with fair quantity and easy for utilization	Available with poor quantity or difficult for utilization	Not available
2.3 Available Sub-Surface Water	Available with fair quantity and easy for utilization	Available with poor quantity or difficult for utilization	Not available
3. Human Resources			
3.1 Present Labor Force per Hectare	> 1.0 labor / ha	0.99 - 0.65 labor / ha	< 0.65 labor / ha
3.2 Completion Rate of Elementary Education for Available Labor Force	> 20 %	20 - 10 %	< 10 %
3.3 Woman in Development	100 - 60 %	65 - 34 %	< 33 %
4. Institutional Capacity in Development			
4.1 Ratio of ARBs participating in Multi Purpose Cooperatives	High ARBs participation, > 66 %	Moderate ARBs participation, 65 - 34 %	Low ARBs participation, < 33 %
4.2 Presence of NGOs Activities in Development	With NGOs participation within and outside the Study Area	With NGOs partipation either within or outside the Study Area	No NGOs participation at both within and outside the Study Area

Table 1-3 Ranking Evaluation of Elements in Determining Classification of Model Area

Items	Sappa-ac	Talugtog	Cofcaville	Montilla	Maulawin	Pag-asa	Abierra	San Vicente	Marangog	Silae	Kipalili	Mat-i
I. Poverty Conditions	2.33	3.00	1.67	3.00	2.00	2.00	2.00	2.00	1.67	1.33	1.67	1.33
1. Rural Economy												
1.1 Annual Income per Household (peso)	3	3	2	3	2	2	2	2	1	2	1	2
1.2 Employment Rate for Agricultural Sector (%)	2	3	1	3	2	2	2	2	2	1	2	1
1.3 Employment Rate for Non-Agricultural Sector (%)	2	3	2	3	2	2	2	2	2	1	2	1
II. Living Conditions	2.70	2.20	2.10	2.30	2.50	2.10	1.70	2.00	1.90	2.00	2.00	1.90
1. Natural Conditions												
1.1 Climate Type	2	2	1	2	3	3	1	3	3	1	3	3
1.2 Frequency of Typhoon Occurrence (time/annum)	2	2	2	2	1	1	2	2	1	3	3	2
2. Agricultural Infrastructure												
2.1 Accessibility to Marginal Areas in Wet Season	3	3	2	2	3	2	1	3	1	3	2	1
3. Rural and Social Infrastructure												
3.1 Village Water Supply (Place)	3	2	3	2	3	2	1	1	2	1	2	1
3.2 Presence of Complete Elementary Education	3	1	3	3	3	3	3	2	3	3	3	3
3.3 Rural Health Services	3	1	3	3	3	2	3	2	1	2	2	3
3.4 Rural Electrification	3	3	3	1	3	2	1	3	1	3	1	1
4. Environment												
4.1 Land-Sliding and Soil Erosion	2	2	1	3	2	2	2	1	2	1	1	1
4.2 Water Quality for Village Water Supply	3	3	2	2	3	2	1	2	3	2	2	2
4.3 Reforestation Needs	3	3	1	3	1	2	2	1	2	1	1	2
III. Production Conditions	1.86	2.00	2.43	1.57	1.43	2.00	1.43	1.57	1.57	1.86	1.86	1.57
1. Farming Conditions												
1.1 Cultivated Area per Farm Household (ha.)	1	1	2	1	1	1	1	1	2	2	2	3
1.2 Distributed Area per Farm Household (ha.)	2	1	2	1	2	3	2	2	2	3	2	3
1.3 Cropping Intensity (Present Cultivable Area = 100%)	2	3	3	3	3	2	2	2	2	3	1	1
1.4 Corn Yield per Hectare (ton/ha) or Paddy Yield per Hectare	2	2	3	1	1	2	1	2	1	2	1	1
2. Agricultural Infrastructure												
2.1 Irrigation Areas	2	2	3	1	1	3	1	2	1	1	3	1
2.2 Farm Road	2	2	2	2	1	1	1	1	1	1	2	1
2.3 Post Harvest Facilities	2	3	2	2	1	2	2	1	2	1	2	1

Items	Sappa-ac	Talugtog	Cofcaville	Montilla	Maulawin	Pag-asa	Abierra	San Vicente	Marangog	Silae	Kipalili	Mat-i
IV. Development Potential	1.91	2.09	2.18	2.18	2.00	2.27	1.55	1.91	2.09	2.00	1.91	1.82
1. Land Resources												
1.1 Slope of Topography (Area Ratio less than 18 %)	3	3	2	3	3	3	1	3	2	2	2	1
1.2 Soil Fertility	3	3	2	2	3	2	1	3	3	3	2	3
1.3 Stoniness and Gravel (% of respondents)	2	3	3	3	3	2	2	2	2	3	2	1
2. Water Resources												
2.1 Available Soil Moisture (mm) and Effective Month	2	2	3	2	3	3	2	1	2	2	1	3
2.2 Available Surface Water	1	1	3	1	2	2	2	2	3	2	3	1
2.3 Available Sub-Surface Water	1	2	2	3	1	2	1	1	3	1	1	1
3. Human Resources												
3.1 Present Labor Force per Hectare	1	2	1	3	1	2	2	1	2	2	2	2
3.2 Completion Rate of Elementary Education for Available Labor Force	2	2	2	1	2	2	1	1	1	1	1	2
3.3 Woman in Development	2	2	2	3	1	2	2	2	2	2	2	2
4. Institutional Capacity in Development												
4.1 Ratio of ARBs Participating in Multi-Purpose Cooperatives (%)	2	1	1	1	1	2	1	2	1	2	3	1
4.2 Presence of NGOs Activities in Development	2	2	3	2	2	3	2	3	2	2	2	3

FIGURE 1-1 FLOW-CHART OF PRINCIPAL COMPONENT AND CLUSTER ANALYSES

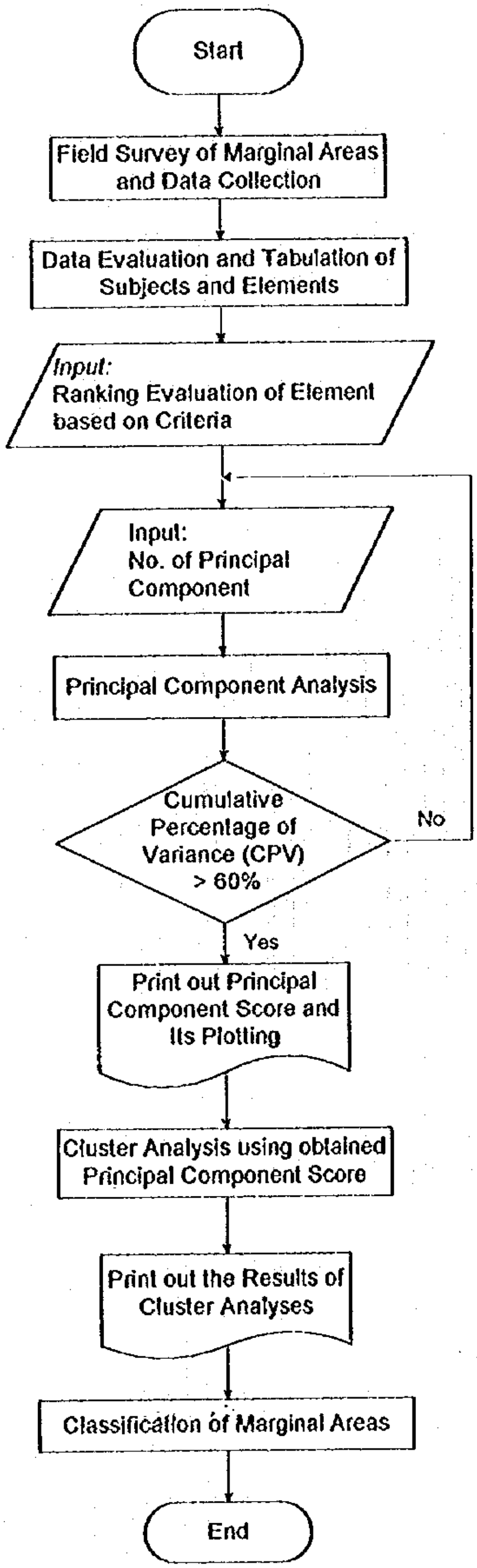
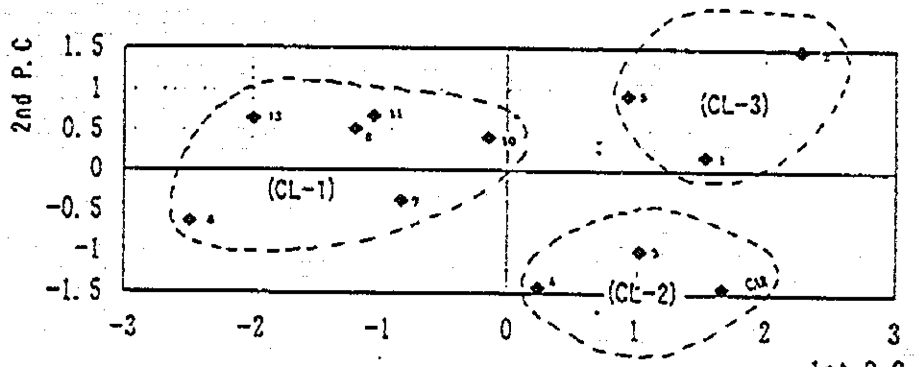


FIGURE 1-2 RESULTS OF PRINCIPAL COMPONENT AND CLUSTER ANALYSIS

Case 2-1

Principal Component Score

	1st P.C	2ns P.C	3rd P.C	4th P.C
1	1.668302	-1.43207	-0.32146	0.809759
2	1.535616	0.181003	-0.40982	-0.31609
3	2.275465	1.484004	-0.71601	0.006198
4	1.031718	-0.98248	0.18419	-0.84633
5	0.242908	-1.43178	1.041286	0.11111
6	0.942994	0.936072	0.560269	-0.10688
7	-2.48829	-0.63409	-1.49098	-0.15171
8	-0.83358	-0.37679	-0.19833	-0.18295
9	-1.19025	0.517802	1.059571	-0.18169
10	-0.14689	0.409588	-0.24323	0.09404
11	-1.04698	0.681267	0.251903	0.907959
12	-1.99102	0.647464	0.282596	-0.14342



P.C : Principal Component

Cumulative Percentage of Variance (CPV)

PC	CR	PTV	CPV
1	2.337893	58.44734	58.44734
2	0.912778	22.81945	81.26679
3	0.527601	13.19003	94.45682
4	0.221727	5.54318	100.00000

PC : Principal Component

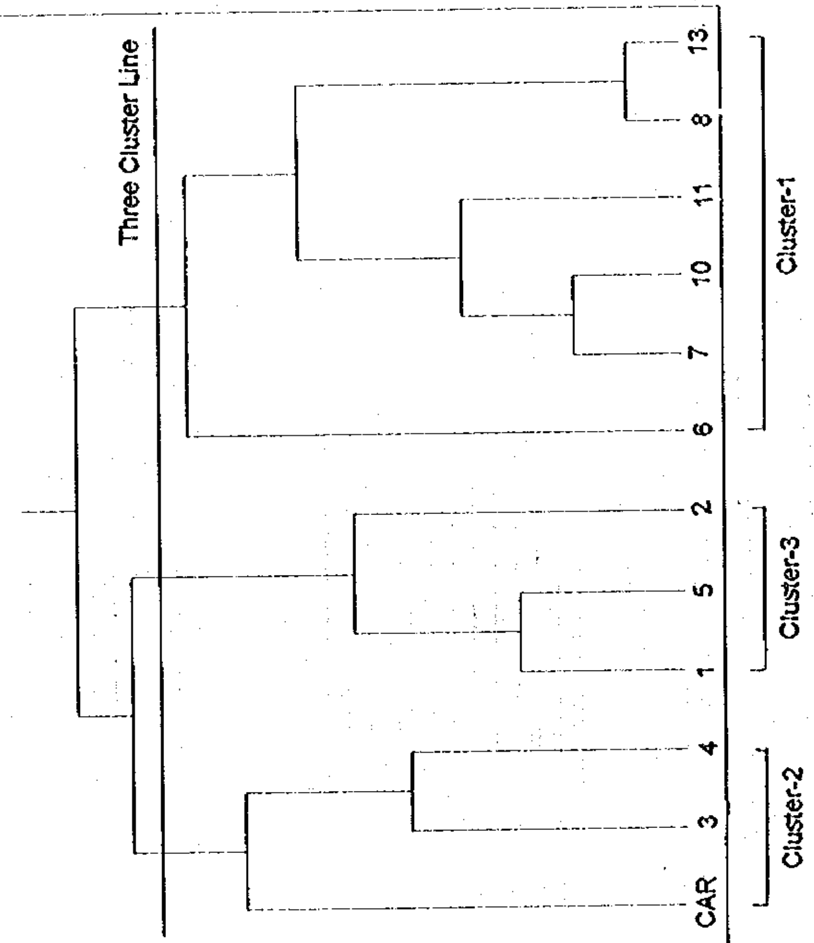
CR : Characteristic Root

PTV : Percentage of Total Variance

Model Area by Clustering

CLUSTER		
Cluster 1	Cluster 2	Cluster 3
6	CAR	1
7	3	2
8	4	5
10		
11		
13		

FIGURE 1-3 DENDROGRAM OF THE CLUSTER ANALYSIS



Principal Component Analysis

Source: "Multivariate Statistical Methods (Third Edition)", published by McGRAW-HILL International Editions

CHAPTER 8

THE STRUCTURE OF MULTIVARIATE OBSERVATIONS: I. PRINCIPAL COMPONENTS

8.1 INTRODUCTION

Earlier we discussed the use of partial, multiple, and canonical correlation for analyzing the dependence structure of a multinormal population. The proper use of those methods required that certain roles be assigned to some of the responses. For a partial correlation analysis it is necessary to decide which variables are to be correlated and which of the remaining responses must be held constant. Multiple correlation demands that one response be dependent upon some or all of the remaining variates. Similarly, for a canonical-correlation analysis the responses must be collected into two or more sets. All these choices depend upon the nature of the responses and other information external to the mere values of their correlations. The conclusions we may draw about the dependence structure will in turn depend upon those choices. Furthermore, if the analyses are repeated for different choices of the dependent or constant variates, the successive findings will hardly be independent or contain mutually exclusive bits of information about the structure.

It would seem clear that a new class of techniques will be required for picking apart the dependence structure when the responses are symmetric in nature or no *a priori* patterns of causality are available. Those methods fall under the general heading of *factor analysis*, for by them one attempts to descry those hidden factors which have generated the dependence or variation in the responses. That is, the observable, or *manifest*, variates are represented as functions of a smaller number of *latent* factor variates. The mathematical form of the functions must be one which will generate the covariances or correlations among the responses. If that form is simple, and if the latent variates are few in number, a more parsimonious description of the dependence structure can be obtained. Now for simplicity linear functions are difficult to surpass, and in the two principal techniques of the sequel we shall always think of the responses and their observations as linear compounds of the latent variates. The analysis of the dependence structure amounts to the statistical estimation of the coefficients of the functions.

We shall begin our study by developing in this chapter the Hotelling principal-component technique. That methodology originated with K. Pearson (1901) as a means of fitting planes by orthogonal least squares, but was later proposed by Hotelling (1933, 1936a) for the particular purpose of analyzing correlation structures. We shall initially define the principal components of a multivariate sample statistically and algebraically and then in terms of the geometry of the scatter swarm of the observations. Some numerical methods for extracting components will be treated, and the problem of interpreting component coefficients will be illustrated by some examples from biology and cognitive psychology, and by some special patterned correlation matrices. Some results of Anderson and Lawley on the sampling properties of principal components will be discussed and illustrated in the last section.

8.2 THE PRINCIPAL COMPONENTS OF MULTIVARIATE OBSERVATIONS

Suppose that the random variables $X_1, \ldots, X_p$ of interest have a certain multivariate distribution with mean vector μ and covariance matrix Σ. We assume, of course, that the elements of μ and Σ are finite. The rank of Σ is $r \leq p$, and the q largest characteristic roots

$$\lambda_1 > \cdots > \lambda_q$$

of Σ are all distinct. For the present we shall not require a multinormal distribution of the X_i.

From this population a sample of N independent observation vectors has been drawn. The observations can be written as the usual $N \times p$ data matrix

$$\mathbf{X} = \begin{bmatrix} x_{11} & \cdots & x_{1p} \\ \cdots & \cdots & \cdots \\ x_{N1} & \cdots & x_{Np} \end{bmatrix} \tag{1}$$

Here a cautionary note on the ranks of Σ and $\mathbf{X}$ is in order. Mathematically, those matrices need not be of full rank p, nor need Σ contain more than one distinct characteristic root. However, the exigency of simplicity in our description of the latent structure of the X_i calls for a data matrix of full rank. We do not wish to confound the problem by including as responses total scores, weighted averages suggested by earlier studies, or other linear compounds which will reduce the rank of $\mathbf{X}$ and obscure whatever latent structure may be present.

The estimator of Σ will be the usual sample covariance matrix $\mathbf{S}$ defined by (9) of Sec. 3.5. The information we shall need for our principal-component analysis will be contained in $\mathbf{S}$. However, it will be necessary to make a choice of measures of dependence: should we work with the variances and covariances of the observations, and carry out our analyses in the original units of the responses, or would a more accurate picture of the dependence pattern be obtained if each x_{ij} were transformed to a standard score

$$z_{ij} = \frac{x_{ij} - \bar{x}_j}{s_j} \tag{2}$$

and the correlation matrix employed? The components obtained from $\mathbf{S}$ and $\mathbf{R}$ are in general not the same, nor is it possible to pass from one solution to the other by a simple scaling of the coefficients. Most applications of the technique have involved the correlation matrix, as if in keeping with the usage established by factor analysts. If the responses are in widely different units (age in years, weight in kilograms, and biochemical excretions in a variety of units, to cite one plausible case), linear compounds of the original quantities would have little meaning and the standardized variates and correlation matrix should be employed. Conversely, if the responses are reasonably commensurable, the covariance form has a greater statistical appeal, for, as we shall presently see, the ith principal component is that linear compound of the responses which explains the ith largest portion of the total response variance, and maximization of such total variance of standard scores has a rather artificial quality (Anderson, 1963a, p. 139). Furthermore, as Anderson has shown, the sampling theory of components extracted from correlation matrices is exceedingly more complex than that of covariance-matrix components.

The first principal component of the observations $\mathbf{X}$ is that linear compound

$$\begin{aligned} Y_1 &= a_{11}X_1 + \cdots + a_{p1}X_p \\ &= \mathbf{a}_1'\mathbf{x} \end{aligned} \tag{3}$$

of the responses whose sample variance

$$\begin{aligned} s_{Y_1}^2 &= \sum_{i=1}^{p}\sum_{j=1}^{p} a_{i1}a_{j1}s_{ij} \\ &= \mathbf{a}_1'\mathbf{S}\mathbf{a}_1 \end{aligned} \tag{4}$$

is greatest for all coefficient vectors normalized so that $\mathbf{a}_1'\mathbf{a}_1 = 1$. To determine the coefficients we introduce the normalization constraint by means of the Lagrange multiplier l_1 and differentiate with respect to $\mathbf{a}_1$:

$$\begin{aligned} \frac{\partial}{\partial \mathbf{a}_1}[s_{Y_1}^2 + l_1(1 - \mathbf{a}_1'\mathbf{a}_1)] &= \frac{\partial}{\partial \mathbf{a}_1}[\mathbf{a}_1'\mathbf{S}\mathbf{a}_1 + l_1(1 - \mathbf{a}_1'\mathbf{a}_1)] \\ &= 2(\mathbf{S} - l_1\mathbf{I})\mathbf{a}_1 \end{aligned} \tag{5}$$

The coefficients must satisfy the p simultaneous linear equations

$$(\mathbf{S} - l_1\mathbf{I})\mathbf{a}_1 = \mathbf{0} \tag{6}$$

If the solution to these equations is to be other than the null vector, the value of l_1 must be chosen so that

$$|\mathbf{S} - l_1\mathbf{I}| = 0 \tag{7}$$

l_1 is thus a characteristic root of the covariance matrix, and $\mathbf{a}_1$ is its associated characteristic vector. To determine which of the p roots should be used, premultiply the system of equations (6) by $\mathbf{a}_1'$. Since $\mathbf{a}_1'\mathbf{a}_1 = 1$, it follows that

$$\begin{aligned} l_1 &= \mathbf{a}_1'\mathbf{S}\mathbf{a}_1 \\ &= s_{Y_1}^2 \end{aligned} \tag{8}$$

But the coefficient vector was chosen to maximize this variance, and l_1 must be the *greatest* characteristic root of $\mathbf{S}$. Let us summarize these results in this form:

Definition 8.1. *The first principal component of the complex of sample values of the responses $X_1, \ldots, X_p$ is the linear compound*

$$Y_1 = a_{11}X_1 + \cdots + a_{p1}X_p \tag{9}$$

whose coefficients a_{i1} are the elements of the characteristic vector associated with the greatest characteristic root l_1 of the sample covariance matrix of the responses. The a_{i1} are unique up to multiplication by a scale factor, and if they are scaled so that $\mathbf{a}_1'\mathbf{a}_1 = 1$, the characteristic root l_1 is interpretable as the sample variance of Y_1.

But what is the utility of this artificial variate constructed from the original responses? In the extreme case of $\mathbf{X}$ of rank one the first principal component would explain all the variation in the multivariate system. In the more usual case of the data matrix of full rank the importance and usefulness of the component would be measured by the proportion of the total variance attributable to it. If 87 percent of the variation in a system of six responses could be accounted for by a simple weighted average of the response values, it would appear that almost all the variation could be expressed along a single continuum rather than in six-dimensional space. Not only would this appeal to our sense of parsimony, but the coefficients of the six responses would indicate the relative importance of each original variate in the new derived component.

The second principal component is that linear compound

$$Y_2 = a_{12}X_1 + \cdots + a_{p2}X_p \tag{10}$$

whose coefficients have been chosen, subject to the constraints

$$\mathbf{a}_2'\mathbf{a}_2 = 1 \qquad \mathbf{a}_1'\mathbf{a}_2 = 0 \tag{11}$$

so that the variance of Y_2 is a maximum. The first constraint is merely a scaling to assure the uniqueness of the coefficients, while the second requires that $\mathbf{a}_1$ and $\mathbf{a}_2$ be orthogonal. The immediate consequence of the orthogonality is that the variances of the successive components sum to the total variance of the responses. The geometric implications will become clear in the next section. The coefficients of the second component are found by introducing the constraints (11) by the Lagrange multipliers l_2 and μ and differentiating with respect to $\mathbf{a}_2$:

$$\frac{\partial}{\partial \mathbf{a}_2}[\mathbf{a}_2'\mathbf{S}\mathbf{a}_2 + l_2(1 - \mathbf{a}_2'\mathbf{a}_2) + \mu\mathbf{a}_1'\mathbf{a}_2] = 2(\mathbf{S} - l_2\mathbf{I})\mathbf{a}_2 + \mu\mathbf{a}_1 \tag{12}$$

If the right-hand side is set equal to 0 and premultiplied by $\mathbf{a}_1'$, it follows from the normalization and orthogonality conditions that

$$2\mathbf{a}_1'\mathbf{S}\mathbf{a}_2 + \mu = 0 \tag{13}$$

Similar premultiplication of the equations (6) by $\mathbf{a}_2'$ implies that

$$\mathbf{a}_1'\mathbf{S}\mathbf{a}_2 = 0 \tag{14}$$

and hence $\mu = 0$. The second vector must satisfy

$$(\mathbf{S} - l_2\mathbf{I})\mathbf{a}_2 = \mathbf{0} \tag{15}$$

and it follows that the coefficients of the second component are thus the elements of the characteristic vector corresponding to the second greatest characteristic root. The remaining principal components are found in their turn from the other characteristic vectors. Let us summarize the process in this formal definition:

Definition 8.2. The jth principal component of the sample of p-variate observations is the linear compound

$$Y_j = a_{1j}X_1 + \cdots + a_{pj}X_p \tag{16}$$

whose coefficients are the elements of the characteristic vector of the sample covariance matrix **S** *corresponding to the jth largest characteristic root l_j. If $l_i \neq l_j$, the coefficients of the ith and jth components are necessarily orthogonal; if $l_i = l_j$, the elements can be chosen to be orthogonal, although an infinity of such orthogonal vectors exists. The sample variance of the jth component is l_j, and the total system variance is thus*

$$l_1 + \cdots + l_p = \operatorname{tr} \mathbf{S} \tag{17}$$

The importance of the jth component in a more parsimonious description of the system is measured by

$$\frac{l_j}{\operatorname{tr} \mathbf{S}} \tag{18}$$

The algebraic sign and magnitude of a_{ij} indicate the direction and importance of the contribution of the ith response to the jth component. A more precise and widely used statistical interpretation is also available. The sample covariances of the responses with the jth component are given by the column vector

$$\mathbf{S}\mathbf{a}_j \tag{19}$$

By the definition $(\mathbf{S} - l_j\mathbf{I})\mathbf{a}_j = \mathbf{0}$ of $\mathbf{a}_j$,

$$\mathbf{S}\mathbf{a}_j = l_j\mathbf{a}_j \tag{20}$$

and the covariance of the ith response with Y_j is merely l_ja_{ij}. If we divide by the component and response standard deviations, it follows that

$$\frac{a_{ij}\sqrt{l_j}}{s_i} \tag{21}$$

is the product-moment correlation of the ith response and the jth component. If the components have been extracted from the correlation matrix, the correlations of the responses with the jth component are given by the vector $\sqrt{l_j}\,\mathbf{a}_j$. In presenting components in the sequel we shall usually adopt that form of weight.

The vectors $\sqrt{l_j}\,\mathbf{a}_j$ bear an important relation to the correlation or covariance matrix from which they were extracted. The diagonalization theorem stated in Sec. 2.10 implies that every real symmetric matrix **S** can be written as

$$\mathbf{S} = \mathbf{P}\mathbf{D}(l_i)\mathbf{P}'$$

where **P** is an orthogonal matrix and $\mathbf{D}(l_i)$ is the diagonal matrix of the characteristic roots of **S**. If we take as columns of **P** the characteristic vectors of **S**, it follows that

$$\mathbf{S} = \mathbf{P}\mathbf{D}(\sqrt{l_i})\mathbf{D}(\sqrt{l_i})\mathbf{P}' \tag{22}$$

Let

$$\mathbf{L} = \mathbf{P}D(\sqrt{l_i})$$

Then the columns of $\mathbf{L}$ *reproduce* $\mathbf{S}$ by the relation

$$\begin{aligned}\mathbf{S} &= l_1\mathbf{a}_1\mathbf{a}_1' + \cdots + l_r\mathbf{a}_r\mathbf{a}_r' \\ &= \mathbf{L}\mathbf{L}'\end{aligned} \tag{23}$$

The rank r of $\mathbf{S}$ may be less than p. As successive components are extracted from $\mathbf{S}$, the matrices $l_i\mathbf{a}_i\mathbf{a}_i'$ can be formed and their running sum compared with $\mathbf{S}$ to determine how well that matrix is being generated by a smaller number of variates.

By the relation (23) principal-component analysis is equivalent to a factorization of $\mathbf{S}$ into the product of a matrix $\mathbf{L}$ and its transpose. As we shall see in the next chapter, this is also the purpose of factor analysis wherein "factorization" of a matrix has precisely that algebraic meaning. *However*, in component analysis this factorization is unique up to the coefficient signs, for the component coefficients have been chosen to partition the total variance orthogonally into successively smaller portions, and if the portions are distinct, only one set of coefficient vectors will accomplish this purpose. This uniqueness of component coefficients is frequently overlooked by some investigators, who subject every component matrix to a series of postmultiplications by orthogonal matrices to see which transformed set of weights has the simplest subject-matter interpretation. While the ability of the vectors to generate the original matrix $\mathbf{S}$ is unimpaired, their components no longer have the maximum-variance property.

If the components have been extracted from the correlation matrix rather than $\mathbf{S}$, the sum of the characteristic roots will be

$$\operatorname{tr}\mathbf{R} = p \tag{24}$$

and the proportion of the total "variance" in the scatter of dimensionless standard scores attributable to the jth component will be l_j/p. The sum of the squared correlations $a_{ij}\sqrt{l_j}$ of the responses on that component will of course be the component variance l_j.

If the first r components explain a large amount of the total sample variance, they may be evaluated for each subject or sampling unit and used in later analyses in place of the original responses. For components extracted from the covariance matrix the component scores of the ith subject are

$$y_{i1} = \mathbf{a}_1'(\mathbf{x}_i - \bar{\mathbf{x}}), \ldots, y_{ir} = \mathbf{a}_r'(\mathbf{x}_i - \bar{\mathbf{x}}) \tag{25}$$

where $\mathbf{x}_i$ is the ith observation vector and $\bar{\mathbf{x}}$ is the sample mean vector. The scores can be written as the $N \times r$ matrix

$$\mathbf{Y} = \left(\mathbf{I} - \frac{1}{N}\mathbf{E}\right)\mathbf{X}\mathbf{A} \tag{26}$$

where $\mathbf{X}$ is the data matrix (1), $\mathbf{E}$ is the $N \times N$ matrix of ones in every position, and $\mathbf{A}$ is the $p \times r$ matrix whose columns are the first r characteristic vectors. Had the $\mathbf{a}_i$ been extracted from the correlation matrix, the scores would be computed from the standardized observations. Thus, the component values of the ith subject would be

$$y_{i1} = \mathbf{a}_1'\mathbf{z}_i, \ldots, y_{ir} = \mathbf{a}_r'\mathbf{z}_i \tag{27}$$

where $\mathbf{z}_i$ is the vector of standard scores with jth element given by equation (2).

If the ith and jth principal components correspond to distinct characteristic roots, their sample values will be uncorrelated. We may verify this by premultiplying the matrix equation (20) by the ith characteristic vector:

$$\mathbf{a}_i'\mathbf{S}\mathbf{a}_j = l_j\mathbf{a}_i'\mathbf{a}_j \tag{28}$$

But the left-hand side is merely the sample covariance of the component values $y_{hi} = \mathbf{a}_i'\mathbf{x}_h$, $y_{hj} = \mathbf{a}_j'\mathbf{x}_h$, and if $l_i \neq l_j$, it follows from the orthogonality of the vectors that

$$\mathbf{a}_i'\mathbf{S}\mathbf{a}_j = 0$$

We have stated that one important use of the principal-component technique is that of summarizing most of the variation in a multivariate system in fewer variables. Unless the system is of less than full rank, some variance will always be unexplained if fewer than p components are taken to describe the system. How, then, should one decide that the first m components provide a parsimonious, yet fairly adequate, description of the complex, given that they account for K percent of the total variance? In practice one usually knows from earlier studies, the subject-matter nature of the data, or even the pattern of the covariances in $\mathbf{S}$ that a certain minimum number of components with large and distinct variances should be extracted. Beyond that number components might be computed until some arbitrarily large proportion (perhaps 75 percent or more) of the variances has been explained. It has been the author's experience that if that proportion cannot be explained by the first four or five components, it is usually fruitless to persist in extracting vectors, for even if the later characteristic roots are sufficiently distinct to allow easy computation of the components, the interpretation of the components may be difficult if not impossible. Frequently it is better to summarize the complex in terms of the first components with large and markedly distinct variances and include as highly specific and unique variates those responses which are generally independent in the system. Such unique responses would probably be represented by high loadings in the later components but only in the presence of considerable "noise" from the other unrelated variates. Anderson (1963a) has developed tests of

TABLE 8.2
Correlations of carapace dimensions and components

	Component		
Dimension	1	2	3
Length	1.00	−0.07	−0.02
Width	0.99	0.16	−0.03
Height	0.98	0.03	0.20

a test of the uniqueness of variances of these components in Sec. 8.6. The component correlation coefficients are given in Table 8.2. Component 1 appears to be almost equally correlated with the three dimensions. Components 2 and 3 are correlated with the width and height dimensions, but then only to a negligible degree.

Computation of the characteristic roots and vectors. We shall assume in this chapter that a subroutine or program is available for extracting all of the characteristic roots and vectors of square symmetric matrices of reasonable dimensions. BMDP Program P4M (BMDP, 1985) will give the principal components of covariance or correlation matrices in loading, or variable and component correlation, form. The components are computed as the initial stage of the *factor analyses* we shall describe in the next chapter. Similarly, the SAS (1979) statistical package will give the principal components of a data set as an option in the PROC FACTOR procedure. In both systems the principal component method is the "default" option when no method of factor extraction is specified. The programming language APL2 (Gilman and Rose, 1984) contains a primitive function which, when applied to a square matrix, produces a new matrix whose first row contains the characteristic roots of the original matrix, and whose successive rows are the characteristic vectors corresponding to the roots. STSC (1985) APL PLUS contains functions for extracting characteristic roots and vectors ("eigenvalues" and "eigenvectors" in its usage) from square matrices. Such interactive statistical packages as the STSC STATGRAPHICS™ (1985, Chap. 25) and Minitab (Ryan *et al.*, 1980) contain procedures for extracting the principal components of covariance and correlation matrices.

Various texts describing numerical methods for computing characteristic roots and vectors were referenced at the end of Sec. 2.10. We shall only mention an iterative scheme proposed by Hotelling (1936a) which can be implemented very well with a language such as APL, and which will usually serve admirably when a formal package or program is not available. Select an initial vector $\mathbf{a}_0$, for example, $\mathbf{a}_0' = [1, \ldots, 1]$,

hypotheses and confidence intervals for determining whether the remaining component variances are identical, and we shall discuss this approach at length in Sec. 8.6.

McCabe (1984) has summarized some optimal properties of principal components, and has proposed an alternative notion of "principal variables" for explaining variation in a multivariate sample. The principal variables avoid the complications of interpreting components that are linear compounds of the observed variables.

Example 8.1. Before turning to the geometric interpretation of principal components and a computing algorithm let us fix the ideas of this section with an example from biometry. Jolicoeur and Mosimann (1960) have investigated the principal components of carapace length, width, and height of painted turtles in an effort to give meanings to the concepts of "size" and "shape." The covariance matrix of the lengths, widths, and heights in millimeters of the carapaces of 24 female turtles was

$$S = \begin{bmatrix} 451.39 & 271.17 & 168.70 \\ & 171.73 & 103.29 \\ & & 66.65 \end{bmatrix}$$

The coefficients and variances of the three components extracted from this matrix are summarized in Table 8.1.

The first principal component accounts for nearly all the variance in the three dimensions. It is the new weighted mean of the carapace measurements

$$Y_1 = 0.81(\text{length}) + 0.50(\text{width}) + 0.31(\text{height})$$

The size of the turtle shells could be characterized by this single variable with little loss of information. Had the dimensions been expressed in logarithms of units, Y_1 would indeed be the logarithm of the volume of a box whose sides were powers of the actual carapace dimensions. Jolicoeur and Mosimann call the second and third components measures of carapace "shape," for they appear to be comparisons of length versus width and height, and height versus length and width, respectively. We shall consider

TABLE 8.1
Carapace component coefficients

	Component		
Dimension	1	2	3
Length	0.8126	−0.5454	−0.2054
Width	0.4955	0.8321	−0.2491
Height	0.3068	0.1006	0.9465
Variance	680.40	6.50	2.86
Percentage of total variance	98.64	0.94	0.41

compute the sequence of column vectors

$$\mathbf{a}^{(1)} = \mathbf{S}\mathbf{a}_0$$
$$\mathbf{a}^{(2)} = \mathbf{S}^2\mathbf{a}_0 \tag{29}$$
$$\mathbf{a}^{(3)} = \mathbf{S}^4\mathbf{a}_0$$
$$\mathbf{a}^{(4)} = \mathbf{S}^8\mathbf{a}_0$$
$$\vdots$$

and normalize each $\mathbf{a}^{(i)}$ to unit length. The sequence of normalized vectors should converge to the vector $\mathbf{a}_1$ corresponding to the largest characteristic root, which can be computed as

$$l_1 = \mathbf{a}_1'\mathbf{S}\mathbf{a}_1 \tag{30}$$

by expression (8), Sec. 8.2. If the initial vector $\mathbf{a}_0$ is not too dissimilar from $\mathbf{a}_1$, convergence should occur in three or four iterations. If the covariances of S have mixed signs, or if the variances are of different magnitudes, the signs and sizes of the elements of $\mathbf{a}_0$ should be changed to reflect the likely pattern of the components in $\mathbf{a}_1$. The second characteristic vector and root can be found by applying the iterative process to the "deflated" matrix

$$\mathbf{S} - l_1\mathbf{a}_1\mathbf{a}_1' \tag{31}$$

where of course $\mathbf{a}_1'\mathbf{a}_1 = 1$.

Example 8.2. We shall extract the first principal component from the matrix S in Example 8.1 by the powering algorithm. The initial vector is $\mathbf{a}_0' = [1,1,1]$. The normalized vectors from the first through fourth iterations are shown in the table:

	Iteration			
Variable	**1**	**2**	**3**	**4**
Length	0.8111267612	0.8126297093	0.8126427616	0.8126427627
Width	0.4970820251	0.4955115187	0.4954946280	0.4954946263
Height	0.3081928578	0.3067593362	0.3067520428	0.3067520425

The vectors converged to four-place accuracy in only two iterations.

9.10 CLUSTERING SAMPLING UNITS

In our treatment of multivariate data we have always assumed that the sample came from a homogeneous population with a single mathematical form and set of parameters. If the distribution was not multinormal we tacitly assumed a smooth and unimodal density function. Often the data belie those assumptions: the observation vectors may clump together in clusters, or contain gaps that appear to indicate that the source may be a mixture of several displaced distributions. A number of methods and algorithms have been proposed for grouping multivariate data into clusters of sampling units. The methods are exploratory and descriptive, and their statistical properties do not appear to have been developed. The clusters they suggest are highly dependent on the sampling variation and measurement error in the observations: Small perturbations in the data might lead to very different clusters. The choice of the number of clusters may not follow from the algorithm, but may have to be made subjectively. For those reasons cluster analysis is not a rigorous and sharp statistical tool, and should be applied with care and with the assistance of any other information about the sampling units.

The clustering process begins with measures of the distances of the observation vectors from one another. Several measures are available, but we shall use simple euclidean distance in most cases. Usually the observations are transformed to standard scores to eliminate the effects of different units or variability, although that may not be necessary if the variables are commensurable, as in the case of subtest scores from a standardized psychological test. In our usual notation let x_{ij} be the observed value of the jth response variable for the ith sampling unit, where $i = 1, \ldots, N$, and $j = 1, \ldots, p$. The corresponding standard score is

$$z_{ij} = (x_{ij} - \bar{x}_j)/s_j \qquad (1)$$

where $\bar{x}_j$ and s_j are the respective mean and standard deviation of $x_{ij}, \ldots, x_{Nj}$. The euclidean distance of the standardized observations $[z_{i1}, \ldots, z_{ip}]$ and $[z_{h1}, \ldots, z_{hp}]$ is

$$d_{ih} = \left[\sum_{j=1}^{p} (z_{ij} - z_{hj})^2\right]^{1/2} \qquad (2)$$

The distances may be summarized in the $N \times N$ symmetric matrix

$$\mathbf{D} = \begin{bmatrix} 0 & d_{12} & \cdots & d_{1N} \\ d_{12} & 0 & \cdots & d_{2N} \\ \cdots & \cdots & \cdots & \cdots \\ d_{1N} & d_{2N} & \cdots & 0 \end{bmatrix} \qquad (3)$$

We might form clusters in a rudimentary way by scanning the matrix for smallest distances and grouping the observations into clusters on that basis. However, more formal rules are available, and we shall begin by describing the *single-linkage* algorithm, which combines the original N single-point clusters hierarchically into one cluster of N points.

We start the process by pairing the two observations with smallest distance. For the second cluster we form a new matrix of distances by eliminating the rows and columns in D corresponding to the observations in the first cluster, and by adding a row and column of distances for the new cluster. The distances in the latter column for the cluster containing observations g and h are found from the rule

$$d_{(gh),i} = \min(d_{ig}, d_{ih}) \qquad i \neq g, h \qquad (4)$$

The second cluster consists of the two variables (including the new cluster variable just added) with minimum distance. Next we form an $(N-2) \times (N-2)$ matrix of distances, and locate its minimum value to find the third cluster. The algorithm continues in this manner until all observations have been grouped into a hierarchy of clusters. The hierarchy can be represented by a plot called a *dendrogram*. We shall describe the dendrogram in a forthcoming example.

We shall illustrate single-linkage clustering with the senile-factor subjects' WAIS subtest scores in the first data set of Appendix B. The euclidean distances (rounded to two places) of the standardized scores

TABLE 9.5
Distances of the WAIS subtest standardized scores

Subject	1	2	3	4	5	6	7	8	9	10	11	12
1	0	2.35	2.21	1.74	3.39	3.16	1.15	2.40	0.92	1.83	2.32	2.14
2		0	2.61	3.50	2.01	1.93	2.84	2.19	2.08	1.18	3.29	3.96
3			0	2.88	3.12	2.82	2.24	3.10	1.72	2.32	1.60	3.04
4				0	4.93	4.64	1.60	4.10	2.23	3.40	1.85	1.46
5					0	0.55	4.00	1.87	3.01	1.62	4.45	5.21
6						0	3.84	2.02	2.86	1.53	4.14	5.03
7							0	2.90	0.99	2.48	2.00	1.22
8								0	2.07	1.20	4.15	4.08
9									0	1.54	2.19	2.20
10										0	3.29	3.69
11											0	2.20
12												0

are shown in Table 9.5. The minimum distance occurs between subjects 5 and 6, so the first cluster will consist of those subjects. The second matrix of distances is formed by dropping the fifth and sixth rows of D, and adding a row and column with the distances of the remaining subjects from the cluster (5,6). Those distances are found from the rule

$$d_{1,(5,6)} = \min(d_{15}, d_{16}) = \min(3.39, 3.16) = 3.16$$
$$(5) \qquad \vdots \qquad \vdots \qquad \vdots \qquad \vdots$$
$$d_{12,(5,6)} = \min(d_{5,12}, d_{6,12}) = \min(5.21, 5.03) = 5.03$$

The minimum distance in the second matrix is $d_{19} = 0.92$. Subjects 1 and 9 are assigned to the second cluster. Next we form a third distance matrix: for it we note that

$$(6) \qquad d_{(5,6),(1,9)} = \min(d_{1,(5,6)}, d_{9,(5,6)}) = \min(3.16, 2.86) = 2.86$$

We continue in that way until the twelve subjects form a single cluster. The successive clusters found by the single-linkage algorithm and the distances to the last subject are shown in the following table.

Cluster	Subject numbers	Distance
1	(5,6)	0.55
2	(1,9)	0.92
3	(1,7,9)	0.99
4	(2,10)	1.18
5	(2,8,10)	1.20
6	(1,7,9,12)	1.22
7	(1,4,7,9,12)	1.46
8	(2,5,6,8,10)	1.53
9	(1,2,4–10,12)	1.54
10	(3,11)	1.60
11	(1–12)	1.72

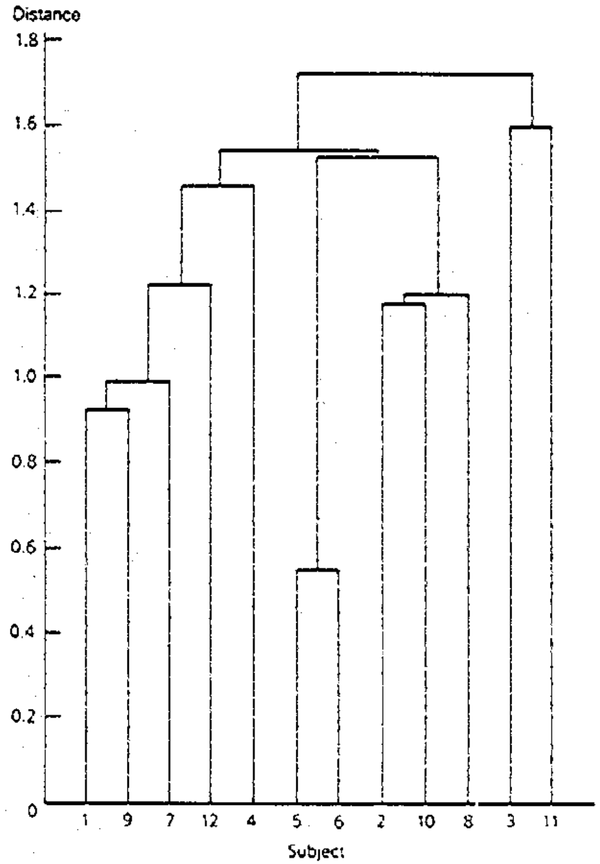


FIGURE 9.3
Dendrogram of the senile-factor subjects.

The clusters are also illustrated in the dendrogram of Fig. 9.3. The dendrogram is formed by plotting the minimum distances for each cluster in a tree configuration leading to the single cluster of all N observations. The observations should be ordered so that the branches or "teeth" of the dendrogram stand alone without crossing. The dendrogram suggests that the sample may contain four sets of subjects:

(7) $\qquad$ (5,6) $\qquad$ (1,4,7,9,12) $\qquad$ (2,8,10) $\qquad$ (3,11)

Sampling units can be clustered by the single-linkage criterion through the BMDP Program P2M (BMDP, Sec. 17.2, 1985). The program allows for four distance measures: euclidean, pth powers of absolute differences, and for categorical data, chi-squared and phi-squared statistics. Clusters are formed in stepwise fashion by the single-linkage algorithm, the kth nearest-neighbor algorithm, or the difference between cluster mean vectors. The output includes a dendrogram, a matrix showing distances by the degree of typographic shading, a histogram of the distances, and a matrix of the initial distances between each of the initial N sampling units.

K-means clustering is another method of grouping sampling units which has been implemented in program PKM of the BMDP series (BMDP, Sec. 17.3, 1985). The procedure is due to MacQueen (1967), and consists of comparing the distances of each observation from the mean vectors of each of k proposed clusters in the sample of N observations. The observation is assigned to the cluster with nearest mean vector. The distances are recomputed, and reassignments are made as necessary. This process continues until all observations are in clusters with minimum distances to their mean vectors. If the responses are incommensurable the data should be transformed to standard scores before clustering. Distance measures may be euclidean, or of the general quadratic kind

(8) $$d^2(\mathbf{x}_i, \mathbf{x}_j) = (\mathbf{x}_i - \mathbf{x}_j)'\mathbf{A}^{-1}(\mathbf{x}_i - \mathbf{x}_j)$$

which includes the Mahalanobis-Hotelling squared distance when $\mathbf{A}$ is a covariance matrix.

The euclidean distances of the observation vectors from the centroids of the four clusters (7) given by the single-linkage clustering method are shown in Table 9.6. The original observations rather than standard scores were used in the analysis. The subjects appear to be in the correct clusters, for all of the distances to the centroids of the other clusters are larger. However, application of the K-means rule to some

TABLE 9.6
Distances of observations from cluster mean vectors

		Cluster			
Cluster	Subject	1	2	3	4
1	1	3.63	7.97	7.41	11.79
	4	4.31	8.16	12.91	17.09
	7	1.73	7.04	9.96	14.49
	9	3.95	6.60	6.65	10.91
	12	4.86	9.03	14.52	19.00
2	3	7.89	2.74	9.96	11.58
	11	6.71	2.74	13.16	15.94
3	2	11.08	11.51	3.86	6.40
	8	10.98	13.17	3.90	7.07
	10	9.43	10.56	1.11	5.48
4	5	14.87	14.23	5.56	1.00
	6	14.13	13.13	5.56	1.00

other similar clusters also led to minimum distances for the cluster members. At least for the present senile-factor data set the K-means method does not appear to yield a unique set of four clusters.

Our attempts at clustering the twelve senile-factor subjects have suggested that the data should be studied for possible clusters by *ad hoc* and less formal methods than the two algorithms we have used. Let us begin by calculating the sum of the four scores for each subject, and ordering the sums from largest to least:

Subject	12	4	11	7	1	9	3	10	2	8	6	5
Total score	46	43	39	37	32	30	29	19	18	17	10	8

We note that the sum of the scores is close to the first principal component of the senile-factor WAIS scores given in Example 8.6. If we examine the sums visually for clusters we might conclude that these four are present:

(9) (4,7,11,12) (1,3,9) (2,8,10) (5,6)

These groups are similar to the clusters (7) found by the single-linkage method. The clustering appears to be justified by the K-means rule, in that the observations of the clusters are closest in the euclidean distance sense to the cluster mean vectors. By transforming the four-dimensional observations to single scores we have made the possible clusters more apparent, and by aggregation, we have reduced the amount of variation in the observations. Cluster analysis might well be preceded by data reduction through principal components or such meaningful functions of the responses as sums and differences.

A number of other clustering measures were applied to the senile-factor data, and often gave results inconsistent with the cluster sets (7) and (9). Since those solutions each contained the observations 1, 3, 4, 7, 9, 11, 12 in the union of two of the clusters we attempted to cluster those sampling units into two subsets on the basis of the distances between the subset mean vectors. The first distance measure chosen was the two-sample T^2 variant of the general distance (8), with the covariance matrix estimated from the pooled within-clusters sums of squares and products matrices. However, the small sample sizes and degrees of freedom (4,2) for each T^2 led to very insensitive distance measures that were greatly affected by the large variation in the elements of the sample covariance matrix. For example, the largest T^2 had the value 299 for the mean vectors of the subsets (3,11) and (1,4,7,9,12), whereas the univariate t for the mean total WAIS scores of those subsets was only 0.62. The inflated T^2 appeared to be due to a nearly singular covariance matrix rather than the separation of the mean vectors. Euclidean distances were calculated between the mean vectors of the subsets, and modified for sample sizes by the factor $[N_iN_j/(N_i + N_j)]^{1/2}$. The largest distances were not associated with the partitioning in (9) based on the response totals. We can only conclude that the more apparent clustering in (9) does not extend to a clustering based on the individual WAIS subtests.

Clustering methods have been treated in the books by Everitt (1974) and Hartigan (1975). Procedures for clustering response variables as well as sampling units have been described with examples of their computer output in the *BMDP Manual* (BMDP, 1985). An overview of cluster analysis, its connections with discrimination, and in particular, a description of available clustering software, have been given by the Panel on Discriminant Analysis, Classification, and Clustering (Gnanadesikan, 1988).

2. PARTICIPATORY APPROACH FOR DEVELOPING MARGINAL AREA

2. Participatory Approach for the Development of Marginal Areas

2. Participatory Approach for the Development of Marginal Areas

The Participatory Approach (PA) would start at the beneficiary level where at the initial stage, problems, needs and interest are identified, prioritized and consolidated. During this period, recommendations and strategies for countering the identified needs and problems are discussed by the beneficiary themselves. Then whatever is identified, discussed and recommended is put into an action plan which the beneficiary can use for the development of their community. The plan is then presented to concerned agencies and to other institutions at the local or provincial or regional or central level, for appropriate action, depending on the magnitude of the proposed action plan.

This exercise/activity shall be undertaken initially with the assistance and supervision of the concerned Community Development Worker, for this Project, by the DAR Development Facilitator and/or NGO worker (if available in the Area).

For the participatory approach, the following activities shall be undertaken in all phases of the development process:

2.1 Barangay Consultations

- Need analysis of the community through participatory discussion

  This activity shall be undertaken through public meetings, small discussion groups, home visits, interviews, etc. The needs and problems of the community shall be identified, listed and discussed and through consensus, the needs and problems shall be prioritized and action plan developed. This activity maybe undertaken more than once as the need arises.

- Presentation of the development plan which was elicited from the community in a formal assembly followed by in-formal discussion to identify gaps, other solutions/recommendations and to determine willingness of the community to provide counterpart contributions.

- Formalization of community participation and commitment. This participation will form as their equity or share in terms of labor (voluntary or reduced labor cost), participation in meetings, discussions or training; right-of-way for road or irrigation facilities/canals, provision of lot for multipurpose center or solar pavements or nursery, use of farm area for demonstration purposes, etc.

- Presentation of the plan to concerned agencies and/or institutions from the local to the central level if necessary for implementation.

2.2 Local Government and Local Agency Level Consultations

Participatory Approach shall also include the involvement of all units/groups in the development of the community and this includes the outer community such as, the local government unit, other concerned agencies, NGOs, the business group, etc.

- Involvement of the LGU, the other government agencies and institutions concerned in the preparation of the plan, in terms of assistance to but not limited to the following: provision of data and information required; assistance in the undertaking of surveys, interviews; field work reconnaissance; discussions on their plans, programs, activities, problems and constraints in the development and implementation of projects, etc. in Sappaac. During this stage, the support and commitment of all concerned will have to be initially solicited.

- Presentation of the development plan by DAR to the LGU, agencies concerned in a formal assembly to initiate mutual consultation or dialogue among them towards consolidation of the identified proposed program or project. During this formal meeting/presentation, the DAR will also solicit and confirm their participation in terms of what facilities, resources, manpower, support and time can be provided for the development of the ARC area. The output of this local level consultation are: (i) awareness of all agencies concerned on the plans and development proposed for the area; (ii) agreement of the proposed plan and inclusion into their own plans and programs; (iii) endorsement of the program/project through the Sanggunian (iv) initial commitment and agreement forged for the support to be provided for the ARC area; (iv) assignment of personnel for the Local Technical Working Group (LTWG) to be proposed an, (v) allocation and inclusion of budget for the committed counterpart support.

- After the formal assembly, series of discussions will have to be undertaken between and among agencies initiated and coordinated by DAR provincial office for the formalization of agreements and/or contracts, hence, the completion of Memorandum of Agreements, budget preparations, sanggunian resolutions, endorsement, and the like.

2.3 Collection of Primary and Secondary Data

Participatory Approach also entails collection of primary data which involves conduct of sample surveys, interviews, discussions and mutual interaction with the community. Standard information sheet using structured questionnaires will be use for the resources inventory of the area, socio-economic-agro survey of sample farmers, assessment of existing local community system, organizations/associations, LGU, other agencies' and NGOs.

1) Resources Inventory Survey

This a key informant interview and secondary data compilation with a pre-determined survey questionnaire. The purpose of the resources inventory survey is to determine the level of facilities and utilities available within and in the immediate surrounding area in order to assess the needs of the community and to be used as a reference point for assessing and determining the plans and programs to be recommended for the project area. This will be counterchecked with the identified and prioritized needs of the community (based on the interviews, meetings and discussions with the community). The survey shall be conducted with local government units (provincial, municipal, barangay level) government agencies/offices at the local level, non-government organizations, etc. to provide information on the concerned barangay or municipality. In formation to be collected will include (but not limited to) the following:

- General information, such as, land area, population, income and labor force;
- Information on land and farming such as, land use and area, land tenure status, crop area and production, livestock and poultry, inland fish culture and other farming activities;
- Water sources/ condition including domestic/drinking supply, surface and groundwater irrigation;
- Agricultural support services/facilities covering agricultural extension and technology, seeds/seedling supply, post harvest facilities, agro-processing facilities;
- Electricity/power, communication, postal and telecommunication facilities;
- Road and transportation facilities/utilities;
- Health facilities/services (number of facilities, personnel, causes and rates of morbidity and mortality, nutritional levels and programs, family planning and immunization programs);
- Education services/facilities, participation rates, dropout rates;
- Non-agricultural and industry establishments (number and type);
- Welfare services/conditions for women and children;
- Non-government organizations (number, type of services/facilities);

- Agricultural cooperatives/associations, irrigators association and other people's organizations (number, type, services, etc.);
- Marketing, such as destination and pricing of major products, pricing, support facilities, etc.

2) Socio-Agro-Economic Survey

The purpose of the survey is to determine the present existing situation of farmers in the community, to establish the level of certain socio- agro-economic factors within the Project Area, and shall provide information to be used in the planning and formulation of development plans and as reference point in the monitoring and evaluation exercise to be undertaken as part of project or post-project activities. The output of the survey shall be used by all sectors and experts of the Study . Information to be collected shall include but not limited to the following:

- Demographic characteristics (age, sex, marital status, employment)
- Labor profile
- Land tenure status including area tilled
- Landholding (area and yield of various crops grown, including idle lands, etc.)
- Agricultural systems and practices (cultivation practices for various crops including input, timing, patters, etc.)
- Preferences with regards to crops and livestock
- Sources, frequency, nature of extension services and advice
- Credit (source and repayment conditions)
- Market (where produce are sold, transport cost, who purchases it, etc.)
- - Post harvest facilities
- Transport frequency in the barangay and nature of transport
- Social services
- Cooperatives and other organizations
- Income (farm and off-farm and expenditure patterns)

- Peace and order condition
- Problems and needs
- Development perceptions

3) Assessment of Local Community System including, Organizations and /or Associations

The purpose of the activity is to assess and evaluate the local community system as one of the fundamental elements of people-based development in terms of individual and group effort in collective and cooperative forms of action, local characteristic's particular conditions resulting from people's experiences and capability within that context. It shall focus on the involvement of the people on community development activities. It shall identify community problems, local resource potential's and process of participation among different organizations present in the area. For this assessment level, not only the formal activities but also the informal or indigenous capability, activities and practices shall be considered.

To be able to grasp the function or development potentials in the area, the assessment activity shall include preliminary surveys and consultations to involve local communities, such as but not limited to the identified local officials (barangay officials, officers of organizations/associations) informal leaders and selected barangay residents (selected at random). Other activities shall include discussions and mutual interaction with officers and members of the community and organizations including attendance to some on-going group meetings and discussions at the time of the assessment survey. The basic idea here is to determine exactly what they do, how they do things, who participates and it what manners, how do they form collection action and decision making.

For the beneficiary organization/associations, the assessment study shall focus on the different aspects of the organization/association, such as, history, leadership, process of decision making, membership participation, systems and procedures, projects/programs implemented, etc. Information shall be elicited from the officers and members of the organizations, the officers of the barangay and some members of the community to get their own idea on how they do things. Information to be collected shall include but not limited to the following:

<u>Community Level Assessment</u>

- Explore mutual assistance activities or collective activities they have within the community (formal, traditional, indigenous ways of doing things) and based on their experiences what is their participation or involvement;
- Elicit their own idea on how they will participate in the planning and formulation of development plan for their community;

- Solicit information on what they consider as common resources of the community and for them to identify the benefits they derive from these resources, how resources are utilized, managed and shared, contribution and participation of the people in the community on the management system and procedures of these resources, etc.

- Identify roles and responsibilities played by the community members: who are the initiators of collection action and mutual help activities, who are active and passive participants, etc.,

- Identify the process and pattern of decision making in the community

- Identify the needs and problems and how they propose to solve these problems

<u>Organizations and/or Associations</u>

- How they evolved as an organization (on their own or through outside initiative);

- Membership of the organization (farmers, women, youth or a combination, etc.);

- Who are the initiators, those actively involved in the organization's activities, the passive members; explore why they are such;

- What are the collective activities of the organization, the mutual assistance or support activities;

- What are the regular activities participated by the members, how are task distributed;

- What are the individual/group benefits; how can they attain this;

- How is the decision making process within the organization;

- What are the systems and procedures to manage the organization;

- Who are responsible for the systems and procedures; how do they implement these systems and procedures;

- Training activities they acquired to develop themselves: what type, did they learn, did they apply in their daily activities; of no, why not;

- Training needs assessment to determine gaps in extension of services;

- Performance level of the organization in terms of: work done, involvement of members, income generating activities, present resources, etc.

4) Assessment of LGUs, Other Agencies' and NGOs.

The objectives of the assessment survey shall be to evaluate and assess the capacity of DAR, LGU and other support agencies concerned, to assist and implement in the development efforts and to identify the support agencies' participation in all phases of the planning and implementation of the project, their role, their involvement, plans and programs for the area, etc. It is also necessary to determine the mechanisms and channels for which the resources and services of the LGUs, other agencies and NGOs are delivered to the beneficiaries of projects. Information to be collected shall include but not limited to the following:

- Present activity, on-going projects, plans and programs of the agency in the area;
- Mechanism and channel of delivery network of coordination, services and resources to intended beneficiaries;
- Manpower complement, availability of expertise, training acquired and required;
- Equipment and transport needed to implement projects;
- Constraints and problems of the support agency to implement the project component proposed for the marginal area;
- Recommendations of the support agency to solve problems and constraint to implement programs and projects;
- Support/assistance needed by the support agency to implement proposed projects.

3. INSTITUTIONAL AND SOCIAL CAPABILITY BUILDING-UP

3. Institutional and Social Capacity Building Plan

3. Institutional and Social Capability Building Plan

3.1 Social Preparation of the Community

There is a need to undertake intensive social preparation in the community to prepare them to manage their own organization and eventually their resources. The people in the community should be adequately trained to understand the nature of rural associations and their roles in them. Social preparation through community organization and training will help improve the management capabilities of associations and organizations. Through proper education and training, members of the organization may understand the principles of cooperativism as a way of life and better understanding of their roles and responsibilities to the organization and the community. Earlier training conducted in the ARC area were inadequate and therefore more social preparation will solved the problems being faced by the organization.

The basis for the formulation of the social preparation plan shall be the assessment surveys/studies on the community, the organization/associations, the DAR at the provincial and local level and the LGU.

The following activities should be undertaken for the social preparation of the community. and Figure 3-1 shows the implementation plan of social preparation and institutional strengthening works;

1) Community Capability Building-Up

Since the level of social preparation of the local communities, particularly the organizations/associations in the marginal areas are still at the low level stage, there is a need to build-up and strengthen community capability in terms of attaining self-sufficiency and management or their own resources.

The DAR therefore, together with the NGO, LGU and other agencies and institutions concerned should provide the sustained support to attain social preparation of the community in terms of providing the necessary training, supervision and materials needed until such time that the community becomes self-reliant.

The initial step to be undertaken as the basis for the following aspect is the contracting of NGO by DAR to undertake the social preparation and community development activities. The first task of the NGO community development worker is to undertake a need assessment of the community and to validate the institutional capacity of the existing organizations within the Project Area through participatory approach. The next step is to make an inventory of existing resources (in terms of people, services and resources available), formal and indigenous technology, practices, beliefs, values within the community. Also to be considered is the identification of available outside community resources and technology applicable to community needs. Based on the findings, a program of implementation for the social preparation aspect of the beneficiary shall be undertaken.

Specifically, the social preparation shall include but not limited to the following:

- Need analysis of the community through participatory approach

- Strengthening of the people's organization/association in the Project Area through value formation, that is, by slowly eradicating negative traditional values towards work and life, some examples of which are the need to pay debts, "Bahala Na" system attitude, luck, destiny, the importance of group work and cooperativism, social hygiene and sanitation, etc. through education, seminars, cross visits, etc.

- Involving the farmer members in group/community activities through the initiation of low-level and costless projects (at the first stage) such as community sanitation, beautification, health related activities, waste recycling for bio-fertilizer production, etc.

- Initiation of low-financed projects with assistance from outside community (ex. backyard vegetable farming, planting of herbal garden, poultry and pig raising, community mobilization, for example through assistance in the repair or maintenance of water system in the community, road clearing and cleaning, repair of day care center or barangay center, etc.)

- Trust and confidence building among members of the organization and within the community. This aspect is very important for any organization to succeed especially in cooperative organizations where material investment are involved. This can be undertaken by providing venue for building trust through initiation of low or medium financed projects with a larger portion of the fund coming from organization through group trading business (as buy and sell of crops/products, consumer store, fund drives for capital mobilization) or group buying of farm inputs, seeds, others, acquisition of income generating equipment or machinery or working animals. The farmers could be encouraged to form into small work groups with responsibilities given to as many persons as possible not only to one or two persons. Responsibilities should be rotated and every member should be given the chance to participate in all aspects of the activity. This would help develop trust and confidence among members.

- Development of reliance among members of the community and organization through savings mobilization (self-reliance in capitalization), regular training (which could develop local leaders, managers, local trainers for transfer of technology) through initiation of costless, low-level to medium or high level projects, etc., networking with GOs, NGOs, private/business groups for relevant assistance and other support services.

- Development of leaders and improvement of leadership pattern by eradicating traditional leadership pattern vested on formal authorities, by initiating consultation and decision-making by majority, formation of functional work committees or small working groups to assist each other through labor exchange, development of local trainers to transfer technology, identification and involvement of indigenous leaders and farmers with special skills and technology in the initiation and implementation of projects.

- Provision of technical and farm management skills necessary to the farmers, specifically related to the proposed development plan, such as, but not limited to the following: soil conservation-based farming systems, land use, soil survey, soil and crop management, SALT technology (A-frame, preparation of contour lines, contour ditches, silt trap, drainage canal, etc.), mechanisms for the availment of credit and related facilities, production and marketing plan to improve the potentials of farm produce, etc.

- Provision of technical and other skills to the other sectors of the community, such as, the women, youth and the elderly, such as income generating skills (handicraft, fruits and crop preservation, etc.), informal health activities, population and education, health and material care, etc.

The ultimate objective of the social preparation is the implementation of the proposed community framework plan with the active participation of the members of the community. Outside support and assistance from DAR, LGU, DA and other government services will be provided initially with the eventual turnover after the beneficiaries have become self-sufficient and capable to successfully sustain projects with very minimal support and intervention.

2) Formation of Local Technical Working Group (refer to Figure 3-2)

a) Composition:

DAR MARO as chairman
Local government unit at the municipal level
Municipal Agricultural Office (MAO)
Community Environment Natural Resources Office (CENRO)
State University in the province
Municipal Health Office (MOH)
Municipal Social Welfare and Development(MSWD)
Department of Trade and Industry (DTI)
Department of Science and Technology(DOST)
Land Bank of the Philippines (LBP)
Research Outreach Stations (ROS)
Non-Government Organizations (NGO)

b) Objectives:

Assist in the social preparation of the organizations /associations in the community prior to implementation of the infrastructure projects in terms of training, extension services and the like and act as permanent representative of the agency/group in all aspect of the project

c) Activities:

(I) prepare work place for the ARC area in terms of activities to be undertaken, implementation schedule and cost estimates based on the proposed development plan; (ii) function as the agency/institution representative in all activities to be undertaken in the community in coordination with the Development Facilitator and the NGO community organizer assigned in the area; (iii) provide technical assistance, training and/or extension activities as need arises; (iv) document all activities undertaken in the area for monitoring and evaluation purposes, to determine the progress of activity, to assess the impact of the activity on the community and would serve as a basis for future work in other areas; and (v) assist in the implementation of the programs conceived for the Project Area.

3) Deployment of NGO

An NGO shall be tapped and deployed in the ARC site to undertake the social preparation of the community in general and the cooperatives and associations in particular. The criteria for the selection of NGO shall be finalized by DAR at the provincial level with the assistance of the DAR Regional Office.

a) Objectives of NGO Deployment

- Involve the community in all stages of project development and management,
- Strengthen community organizations so as to become viable and sustainable community organizations to develop and manage community resources and projects,
- Generate community knowledge and skills on project management,
- Promote cooperation and collective participation in the community, and
- Promote cooperation and support between local community and the LGU.

b) General Criteria to be Considered for the Selection of NGO

- NGOs orientation towards grassroots community development,
- Substantial experience in the field of participatory approach in community and institutional organizing and development work,
- Knowledge and capability to undertake training on agricultural development, cooperative development, primary health care, and others,
- Have commitment, integrity and reliability, and
- Familiarity of the NGO in the area.

c) Activities of the NGO

- Through participatory approach and assessment survey, gather sufficient information on the level of community participation and involvement in collective activity so that the management strategies for social preparation shall be in accordance with the current situation of the Project Area,

- Based on the generated information, develop the plan of approach for the social preparation component,

- Undertake organization and capability building activities specifically but not limited to: (I) value formation on-self-help, self-responsibility, solidarity, cooperation, etc.; (ii) leadership training; (iii) organization management; (iv) project planning and management; (v) financial management; (vi) others, as identified and needed,

- Conduct community planning workshops, assemblies, meetings, seminars, social development and technical training, consultation with communities,

- Assist the community in the preparation of the comprehensive development plan, and

- Record and monitor all activities (methodology, progress, failures, potentials, obstacles encountered) undertaken for future reference and use by other communities.

4) Training and Seminars

Though the training programs and technology transfer to be conducted are basically packages of information and skills, the characteristics of the training activities must be two-way affair where the trainees (community) participate in knowledge sharing and generation. Thus, in the process of technology and skill transfer, the trainer shall incorporate and put into practical use the know-how generated from the participants. The training activity must therefore have flexibility, must be experimental and must consider improvisation. Education and training will be provided by the following:

- Training of the community on value formation, leadership, organization, project planning, financial management, etc., - DAR, NGO, LGUs,

- Technical skills on farm management - DA, LGU through the PAO and/or MAO, NGO, ROS, BS, successful private establishments, etc.,

- Technical skills on agro-forestry -DENR-PENRO/CENRO, successful private establishments, etc.

- Technical skills on income generating activities - LGUs, DTI, DOST,, MSWD, FIDA, PCA, NGO, etc.

Pre-membership and value formation training should be given to all prospective members in the community. Value formation and others mentioned beforehand shall be provided to the people in the community through the existing organizations and/or associations. Other training shall be provided after determining the needs of the community by the NGO Community Development Worker with the assistance of the LTWG which shall focus on but not limited to the following depending on the development type. For all marginal area communities, the following type of skills and education awareness are proposed to be undertaken.

- Value formation particularly on self-reliance through collective efforts
- Training on leadership and managerial skills
- Skills on networking and diplomacy for market sourcing, credit accessing for internal and external resource mobilization
- Skills on communication and negotiation where the participants will learn how to deal with the government and about who or what agency to talk to about specific issue
- Project proposal making for farming and community projects
- Training and exposure to health, sanitation, livelihood, responsible parenthood, specially for women
- Farm management technology, integrated pest management, crops and cropping system
- Land use plan at plot level through participation of the beneficiary
- Soil survey to provide adequate information on land use and soil improvement
- Investment plan and implementation on land development and soil improvement
- Resource mobilization to increase capital built-up to expand activity for organizations/associations and to generate income generating activities (for the community in general).

Based on the identified Development Type for marginal areas, the following specific education and training shall be provided:

Development Type-I

- Farm management technology appropriate for irrigated and rainfed paddy, vegetables, rootcrops
- Plant propagation for vegetable, banana, mango, bagras, mahogany
- Fruit and other crop processing (mango, banana, sweet potato) and other livelihood and income generating skills (duck raising, fresh water fish raising), etc.
- Simple SALT technology using contour farming in the 3-15 m land elevations

Development Type-II

- Farm management technology appropriate for rainfed paddy and corn
- Plant propagation for vegetable, rootcrops, banana, gmelina, mahogany
- Fruit and other crop processing (mango, banana, sweet potato) and other livelihood and income generating skills, etc.
- Agro-forestry schemes (gmelina, mahogany)
- Simple SALT technology using contour farming in the 3-15 m land elevations

Development Type-III

- Farm management technology appropriate for rainfed paddy, corn, vegetable and tree crop like banana, mango
- Plant propagation for banana, mango, gmelina, mahogany
- Fruit and other crop processing (banana, corn, rootcrops like sweet potato and cassava) and other livelihood and income generating skills, etc.
- Agro-forestry schemes (gmelina, mahogany)
- Simple SALT technology using contour farming in the 3-15 m land

elevations

Development Type-IV

- Farm management technology appropriate for upland paddy, corn, vegetable , rootcrops and tree crop like coconut, banana, jackfruit, durian
- Plant propagation for coconut, banana, vegetable, beans, gmelina, mahogany
- Fruit and other crop processing (coconut, corn, banana, peanut, abaca, durian, rootcrops like sweet potato) and other livelihood and income generating skills, etc.
- SALT technology
- Environment conservation measures such as soil erosion and watershed management.

Training and seminar should be backed-up by on-site training and cross farm visits and by information education campaign through public forum, distribution of information materials and radio broadcast (if available) to instill awareness.

3.2 Institution and Support Group Strengthening

1) Strengthening of the DAR Field Offices

- Provision of additional and necessary skills to keep up with the task of assistance in the development of the area. Specialized training should also be provided such as, upland development technology, farm management, etc., and these specialized training can be provided by existing agencies and institutions within the Project Area.
- Training and seminar should be backed-up by on site visits of successful on-going projects of similar nature implemented by government, NGOs, private and business groups.
- Transportation and office support, such as, motorcycle, computer equipment, visual aids, typewriters, others.

2) Institutional Strengthening of the LGUs

Provision of necessary skills and competence to assist in some aspect of the strengthening of local communities/organizations and to help support project implementation. Specifically, the NG will need to provide the following:

- Training on value/moral development for participatory coordination among concerned agencies
- Provide services to LGU, specifically assistance to planning, budgeting, project monitoring and implementation
- Provide technical support, e.g., project development, contracting and procurement
- Provide incentives to which the LGUs can improve their ability to raise revenues locally
- Help provide access to credit for the LGUs machinery and equipment build-up

Based on the above-mentioned participatory approach and social and institutional capability plan, the development scenario expected of the rural community are measured by the indicators showin in Table 3-1.

Table 3-1 Measuring Indicator for Community Development

Indicators	Year 4 (After Social Preparation)	Year 6 (Community Development Program: NGO phase-out)
1. Status of Organization	Organization units/ committees are functional; cooperative activity has expanded to include activities other than consumer services and re-lending schemes	Self-reliant organizations with multi-purpose functions (retailing of basic household needs; provision of credit; rental and sale of farm input, seeds, implements, post harvest facilities; marketing services to rice, corn, vegetable, fruit farmers; small scale-processing of farm products; alternative livelihood activities bakery products, hollow-block making)
2. Member Participation in Group/Community Activities	Participation has expanded to community mobilization and self-help activities	Full and active participation in organizations and in the solution of community problems and needs.
3. Attitude of the Community	Gradual break from negative traditional values (luck, destiny, faith)	Positive attitude towards work and life (enthusiasm for work, attitude towards new and innovative ideas, payment of debt, etc)
4. Trust and Confidence	Members of the PO have grasp the importance of group work and endeavor; the importance of a PO and how members depend on one another for the success of the PO; there is less or minimum internal conflict within the PO or the community	There is full understanding and commitment to PO goals and objectives; there is cooperation and harmony though at times conflict cannot be avoided, there is distribution of functions and responsibilities

5. Leadership Pattern	Planning and decision-making by majority; existence of functional working committees	Planning and decision-making by majority; existence of functional working committee ; emergence of new & indegenous leaders, local trainers.
6. Initiation of Organizational Projects	Initiation of low-financed projects with assistance from outside communities	Initiation of medium and high financed projects with minimum or no assistance from outside resources; networking with GOs, NGOs, private groups for relevant assistance and other support services
7. Financial Status of Organizations	Medium level of financial viability	Self-reliance in capitalization hence can engaged in multiple income generating activities
8. Viability of PO or Community to Sustain Project Activity	Some viability; capable to sustain successfully small scale projects	Economically viable; capable of loan repayment; capable to sustain medium and big-scale projects
9. Organizational Stability	Organizationally stable but still needs guidance	Very stable; has already established political presence as already recognized by the LGU and others; may have representations in LGU and other entities.
10. Technical and Farm Management Skills of Members	Medium technical and farm management skills through training	Functional farm-management and technical skill

FIGURE 3-1 IMPLEMENTATION PLAN OF SOCIAL PREPARATION AND INSTITUTIONAL STRENGTHENING

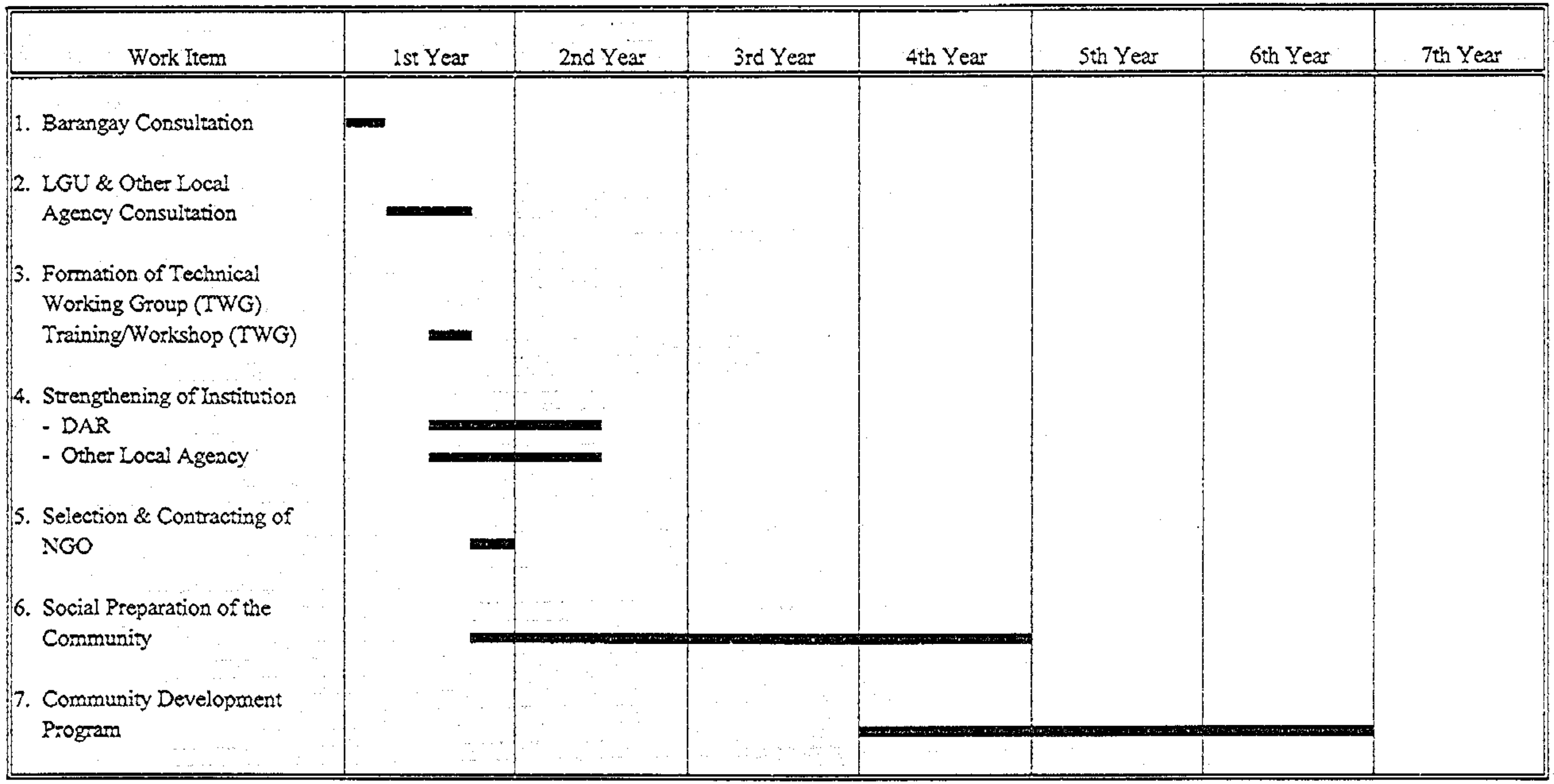
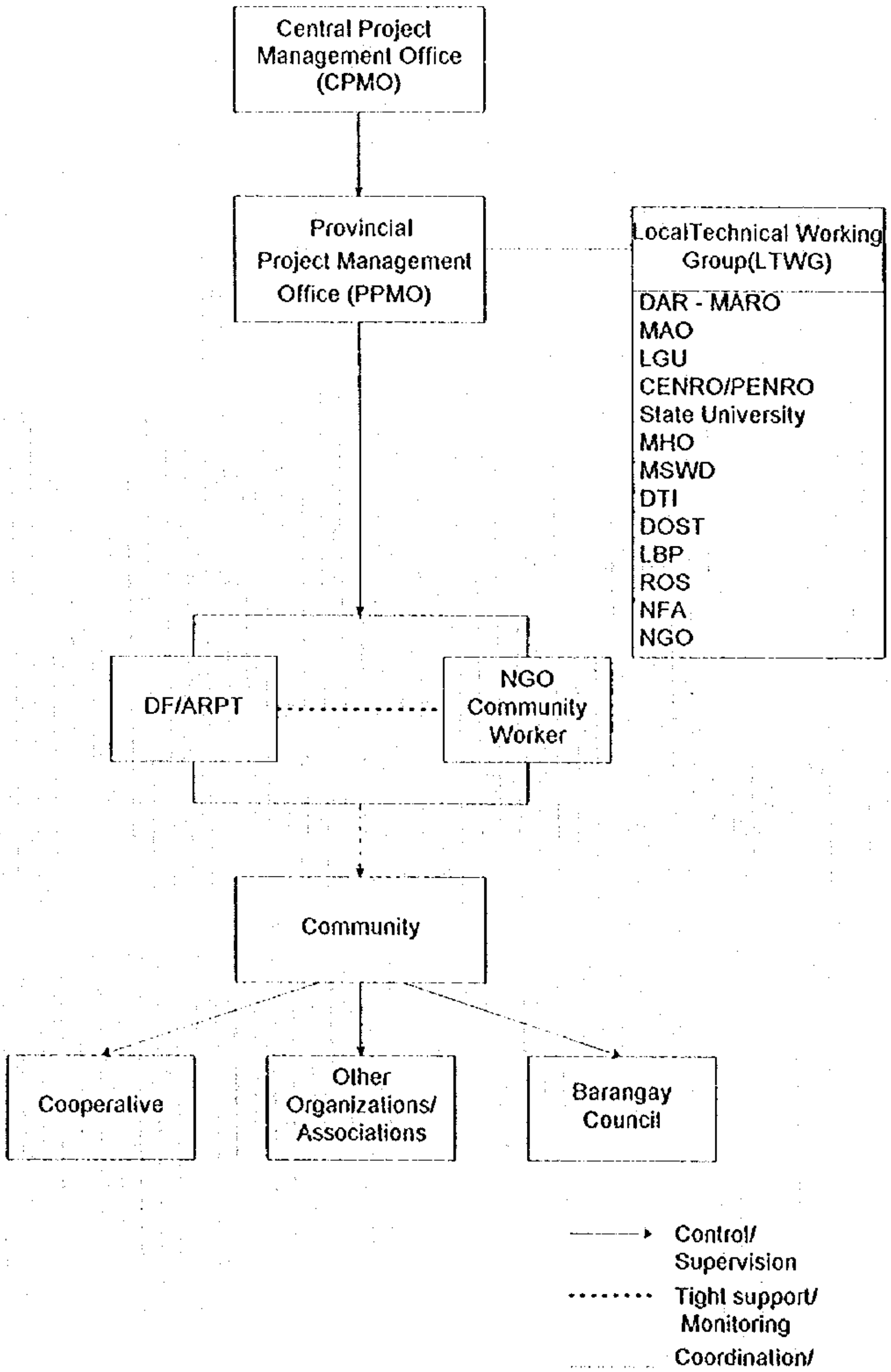


FIGURE 3-2 INSTITUTIONAL MECHANISM FOR SOCIAL PREPARATION



4. SOIL AND LAND-USE

4. Soil and Land Use

4. Soils and Land Use

4.1 Objectives of the Study

Not only such infrastructure development on farm to market roads, irrigation and drainage, but also development in such other necessary project components as soil conservation, soil management including remedy of soil acidity and zinc deficiency in soil, land use plan shall be included.

The purpose of study on land use plan is to formulate land use for the economic evaluation of development options in the feasibility study. The investigation of soil and land during this feasibility study shall confine largely to those properties which determine development and operating costs. Although further detailed land use plan will be required to formulate at the project development stage for the proper implementation of the project, this guideline dose not cover these detailed land use plan study.

Three clusters are identified for twelve model areas during the Phase-I study. The typical model areas fall on the three cluster as follows:

Cluster	Typical Model Area
1	Sappaac
2	Cofcaville
3	Marangog, Silae

The Cluster-1 and-2 areas have distinct wet and dry season with long dry season period, where there are a large area of the land with slope of 8 to 30 percent in the idle/uncultivated land. However, the Cluster-2 area are hit by typhoon very often and the amount of yearly rainfall is as high as more than 2,400 mm. The Cluster-3 areas have rainfall almost throughout the year. On the other hand there are very limited area with slope of 8 to 30 percent.

4.2 Flows of Formulation on Land Use Plan

The flow of the formulation on land use plan is indicated in Figure 4-1, where topographic map with the scale of 1 : 4,000 have to be prepared. Slope unit map is identified from the topographic map. Then a soil survey is carried out to provide information on soil characteristics and crop suitability maps for the respective crops to be introduced in the project area. Based on the slope unit map and crop suitability map for paddy rice, field crops and fruit trees, agricultural land use is formulated.

On the other hand, irrigation plan will be formulated based on the above said agricultural land use and available water resources. The irrigation plan is incorporated in formulation of land use plan. In the land use plan, for the area where crop production is not suitable but forest tree planting is suitable, the forest tree planting shall be included for the sake of not only income generation but also soil and water conservation.

The soil survey which is conducted in the feasibility study is based on the rather qualitative analysis on land and soils due to the limited site intensity of soil observation. For the proper implementation of the project, the survey on land development and management at plot level have to be conducted based on the further detailed soil survey.

4.3 Method of Formulation of Land Use Plan

1) Classification of Land by Slope Unit

According to topographic maps, the following four kinds of slope units are identified on the maps.

- Land with slope of less than 8 percent
- Land with slope of 8 to 18 percent
- Land with slope of 18 to 30 percent
- Land with slope of more than 30 percent

The area by slope in each model area is tabulated in Table 4-1.

2) Soil Survey and Land Classification

To assess the land suitability of soils for various land use, a soil survey was carried out during the Phase II field survey. In the soil survey, soil characteristics for sample soils shall be observed, such as soil depth(surface and top soil), soil texture and content of gravel, presence of rock outcrop, soil color, depth of dark A horizon, depth of soil layer of glei soils(rice land), presence of gravel and rock outcrops, vegetation and present land use. At the time of site observation, soil samples for surface and subsoil layers will be taken for the following chemical analysis.

- pH
- NH4-N and NO3-N content(mg/100g)
- Available phosphate content(mg/100g)
- K20(mg/100g)
- CaO content(mg/100g)
- MgO content(mg/10g)
- Fe content(ppm), and
- NaCl(%)

Based on the above survey, the following maps were prepared with scale of 1/10,000.

- Present land use
- Maps for major survey items(soil depth, content of gravel and presence of rock outcrop, pH, NH4-N, NO3-N, available phosphate, potassium)
- Land suitability map for paddy rice, field crops and tree crops

The standard which was applied in preparing the above said land suitability map is indicated in Table 4-3. This standard is based on the crop suitability rating criteria which is developed Agricultural Land Management Evaluation Division (ALMED), Bureau of Soils and Water Management (BSWM).

3) Land Use of Existing Cultivated Land

Generally the land use of existing land will be same as that in presently cultivated land. However, some cultivated land having different land use may be utilized more intensively. For instance, there are some cases that certain kind of the cultivated land will be converted to other kinds of crop land through land development under irrigation and drainage schemes, as seen in the land use plan in Silae area. In the Silae area, about 20 ha of upland will be converted to rice land. This rice land will be irrigated by small water impounding reservoir.

4) Alternative Land Use Plan

The average land holding per farm house hold is accounted at 1.77 ha for the twelve model areas. Out of 1.88 ha, the land including the land not available for cultivation covers 1.06 ha(refer to Table 4-2). According to the land use data in the typical four model areas, it is estimated that most of the land not available for cultivation are left as idle/uncultivated land.

Based on the data on area by slope unit and the result of the said soil survey, following five cases of land use patterns are formulated for each typical model area;

Cases of Land Use

Case	Existing Cultivated Land	Idle/Uncultivated Land 8 to 18% Slope	18 to 30% Slope	More than 30% Slope
1	Crop	Retaining of Present Land Use	Retaining of Present Land Use	Retaining of Present Land Use
2	Crop	Crop (Contour Farming)	Retaining of Present Land Use	Retaining of Present Land Use
3	Crop	Crop (Contour Farming)	Production/ Protection Forest	Retaining of Present Land Use
4	Crop	Crop (Contour Farming)	Agroforestry	Retaining of Present Land Use
5	Crop	Crop (Contour Farming)	Agroforesty	Production/ Protection Forest

Note: The details of land use pattern are shown in Figure 4-2 to Figure 4-6.

Among the five cases, Case-1 has the most conservative land limited to the presently cultivated land, while the land use in Case-5 shows the case for full utilization of the land. The land use in Case-3 is the intermediate between Case-1 and Case-5. This Case-3 is concluded as the proper land use in every typical model areas, according to the following reasons;

(i) The land use of Case-1 generate very limited crop benefits. Then, there is a need to utilize the idle/uncultivated land.

(ii) To utilize the idle/uncultivated land, priority shall be given to the land with 8 to 18 percent slope in selection of land than other category.

(iii) Small capital available with the farmers for proper operation and maintenance of the marginal land has to be taken into account.

(iv) From an environmental view point, the land with more than 30 percent slope shall be reserved as much as possible without disturbing the soils.

(v) The land use of Case-3 is justified as the most appropriate land use because of the larger crop benefits it provide with the smaller investment and better land and water conservation to the lower areas. Moreover, forest trees will provide not only timber but also organic matter to improve the soils in the marginal land.

4.4 Formulation of Land Use in Case-3

Including the idle/uncultivated area the land use plan is formulated in the four typical model areas based on the land use pattern of Case-3 in the below. The land use in the existing cultivated land is just the same as that of the presently cultivated land except for the some converted land and irrigation land under land development with project. The crop adaptability is studied in each typical model area based on the crop suitability criteria as shown in Table 4-3.

1) Cluster-1 Area

The Sappaac area belongs to Cluster 1 area, where almost all the land with slope of 8 to 18 percent are suitable to grow various fruit tree crops like mango, guava, cashew nut, banana ,and forest trees according to land suitability map. However, the land are marginally suitable to grow upland crops due to various soil limitations. About 30 percent of the land has shallow soil depth with rock outcrops. Then, 70 percent of the land are allotted to the fruit tree-based farming, and the remaining land to the fast growing forest trees. Furthermore, respectively 60 percent and 10 percent of the land, out of 70 percent of the land will be divided into the fruit tree-base farms for fruit trees including mango, guava, and cashew nut, and to the banana farm(refer to Table 4-5 and Table 4-9.

As for the land with slope of 18 to 30 percent, forest tree will be planted because they have various unfavorable soil conditions like soil depth, soil fertility, and content of gravel. Thus it is proposed that these land will be utilized as production forest. Regarding to this land use, ten percent of the land is allotted to protection forest and fireline to protect the land from severe soil erosion or forest fire.

2) Cluster-2 Area

The Cofcaville area falls on Cluster-2 area. The soil suitability maps prepared during the Phase-II field survey for the Cofcaville area show that the idle/ uncultivated land are much more suitable to grow perennial crops like banana, citrus, coffee and cacao than to grow upland field crops. It is estimated that large area of the toe slope which are transient area from narrow alluvial valley to upland hills are distributed considerably extensively. These land are highly suitable to grow banana. However, there are so considerable land in the idle/ uncultivated land, which have stiff compact clayey. Therefore, it is considered that the root of the fruit trees cannot penetrate due to the stiff compact clay. Considering that, it is formulated for banana to cover 30 percent of the land with slope of 8 to 18 percent, while cassava will be planted in the remaining land(refer to Table 4-6 and Table 4-10.

The land with slope of 18 to 30 percent would be more suitable to grow forest tree than crops, because they have various unfavorable soil conditions like soil depth, soil fertility, and content of gravel to compare with the soils with slope of 8 to 18 percent. Taking just the same land use as that in the Sappaac area, 90 percent and ten percent of the land is respectively covered by the production forest and the protection forest or fire line respectively.

3) Cluster-3 Area

The idle/uncultivated land in the Marangog area have steep and rolling terrain with shallow top soils, content of gravel and rock outcrop. Eventually the land with slope of 8 to 18 percent , about 17 ha(five percent of the gross area) are identified to as the land which have following land use in the proposed land use plan. Namely 90 percent of this category land will be developed as fruit based farms, where the land is more suitable to grow tree crops than upland crops according to the soil suitability maps which are prepared during the survey. The remaining ten percent of the area is covered by the fast growing forest tree, where the land may have less suitability for fruit trees(refer to Table 4-7 and Table 4-11).

90 percent and ten percent of the land are respectively covered by the production forest and the protection forest or fire line just as same to the land use in the other areas.

Presently, coconut land cover about 50 percent of the total cultivated area. Since the cropping intensity of coconut is very low and coconut inter-cropping is employed only small area, it is proposed to introduce intensified coconut-based farming through planting additional coconut and also through establishment of coconut multistory cropping. In the proposed land use plan, this is taken into account.

4) Land Use in Silae Area

The Silae also has a very limited idle/uncultivated land with slope of 8 to 18 percent. That is, there are only ten ha of the land identified as this category land. These land are seen to be highly suitable to introduce fruit tree-farming in the soil suitability map prepared during the Phase II field survey. Then, 90 percent of the land is allotted to the fruit tree-based farming, while the remaining ten percent to the fast growing tree planting area(refer to Table 4-8 and Table 4-12.

The same land use for the land with slope of 18 to 30 percent as that in other areas is formulated in the Silae area, where 90 percent and ten percent of the land are covered by the production forest and the protection forest or fire line respectively.

Table 4-1 Present Land Use by Model Area

(Unit: ha)

Study Area	S<8%	8%<S<8%	18%<S<30%	30%<S	Total Area	Area Ratio less than 18%
1. Sappa-ac ARC, Bangued Abra	98 (26.1)	163 (43.4)	69 (18.5)	45 (12.0)	375 (100)	69
2. Talugtog ARC, San Juan La Union	89 (53.1)	39 (23.4)	20 (12.2)	19 (11.1)	167 (100)	77
3. Cofcaville ARC, Maddela Quirino	133 (27.0)	203 (46.3)	139 (28.3)	15 (3.3)	490 (100)	69
4. Montilla ARC, Tuyo, Balanga Bataan	64 (58.9)	38 (35.7)	5 (4.9)	1 (0.0)	108 (100)	95
5. Maulawin ARC, Calauag Quezon	96 (30.0)	129 (40.0)	62 (19.4)	34 (10.5)	321 (100)	70
6. Pag-asa, Tinambac Camarines Sur	124 (40.2)	126 (41)	23 (7.5)	35 (11.2)	308 (100)	81
7. Abierra Estate, Altavaz Aklan	31 (10.7)	37 (12.8)	37 (12.9)	184 (63.6)	289 (100)	24
8. San Vicente ARC, Trinidad Bohol	166 (36.4)	222 (48.4)	59 (13.1)	9 (2.0)	456 (100)	85
9. Marangog-Leyte ARC, Hilong Leyte	37 (11.1)	116 (35.1)	71 (21.6)	106 (32.2)	330 (100)	46
10. Silae ARC, Malaybalay Bukidnon	43 (26.0)	48 (29.4)	44 (26.8)	29 (17.8)	164 (100)	55
11. Kipalili ARC, Asuncion Davao Del Norte	108 (33.2)	15 (4.6)	13 (4.1)	191 (58.1)	327 (100)	38
12. Mat-i ARC, Surigao City Surigao Del Norte	20 (10.2)	39 (19.4)	54 (26.7)	87 (43.7)	200 (100)	30
Total	910	1,012	528	710	3,160	61

Source: Surveyed by DAR (Conceived Development Plan by LGU and Others).

Table 4-2 Cropping Intensity by Model Area

Model Area	Distributed Area = 100 %			Cultivated Area = 100 %			No. of Farm Households	Farm Size	
	Distributed Area (ha)	Total of Cropped Area (ha)	Intensity (%)	Cultivated Area (ha)	Total of Cropped Area (ha)	Intensity (%)		Distributed Area (ha)	Cultivated Area (ha)
1. Sappa-ac ARC, Bangued Abra	375	151	40.3	129	151	117.1	189	1.98	0.68
2. Talugtog ARC, San Juan La Union	167	101	60.5	95	101	106.3	190	0.88	0.50
3. Cofcavilie, Maddela Quirino	490	379	77.3	218	379	173.9	179	2.74	1.22
4. Montilla ARC, Tuyo Balanga Bataan	108	78	72.2	78	78	100.0	63	1.71	1.24
5. Maulawin ARC, Calauag Quezon	321	212	66.0	154	212	137.7	302	1.06	0.51
6. Pag-asa ARC. Tinambac Camarines Sur	307	203	66.1	186	203	109.1	120	2.56	1.55
7. Abierra Estate, Altavaz Aklan	289	120	41.5	106	120	113.2	114	2.54	0.93
8. San Vicente ARC, Trinidad Bohol	456	225	49.3	177	225	127.1	220	2.07	0.80
9. Marangog-Leyte ARC, Hilongos Leyte	330	214	64.8	172	214	124.4	247	1.34	0.70
10. Silae ARC, Malaybalay Bukidnon	164	150	91.5	75	150	200.0	115	1.43	0.65
11. Kipalili ARC, Asuncion Davao del Norte	327	92	28.1	65	92	141.5	112	2.92	0.58
12. Mat-i ARC, Surigao City Surigao del Norte	200	74	37.0	74	74	100.0	150	1.33	0.49
Average	295	167	57.9	127	167	129.2	167	1.77	0.76

Source: Rural Socio Economic Survey, 1996, JICA.

Table 4-3 Suitability rating Criteria for Selected Uses (1)

Uses	Slope				Inherent Fertility				Surface Impediments (%)			
	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N
Grain Crops												
Paddy rice irrigated	< 3	3-5	5-8	> 8	High	Moderate	Low	-	None	0-5	5-10	> 10
Paddy rice non-irrigated	< 3	3-5	5-8	> 8	High	Moderate	Low	-	None	0-5	5-10	> 10
Corn	< 5	5-8	8-18	> 18	High	Moderate	Low	-	None	1-3	3-5	> 5
Beans												
Mungbean	< 3	5-15	15-20	> 20	High	Moderate	Low	-	None	0-5	5-10	> 10
Peanut	< 3	5-15	15-20	> 20	High	Moderate	Low	-	None	0-5	5-10	> 10
Rootcrops												
Sweet Potato	< 3	3-5	5-8	> 8	High	Moderate	Low	-	None	0-5	5-10	> 10
Cassava	< 3	3-5	5-8	> 8	High	Moderate	Low	-	None	0-5	5-10	> 10
Vegetables												
Squash	< 3	3-5	5-8	> 8	High	Moderate	Low	-	None	1-3	3-5	> 5
Industrial Crops												
Coconut	0-8	8-15	15-30	> 30	High	Moderate	Low	-	None	0-10	< 10	> 10
Fruit Trees												
Lanzones	0-8	8-15	15-30	> 30	High	Moderate	Low	-	None	0-10	< 10	> 10
Banana	0-8	8-15	15-30	> 30	High	Moderate	Low	-	None	1-3	3-5	> 5
Hedgerows Shrubs/Pasture	0-15	15-30	30-50	> 50	High	Moderate	Low	-	None	0-10	< 10	> 10
Forest Tree												
Mahogany	0-15	15-30	30-50	> 50	High	Moderate	Low	-	None	10-30	10-30	> 50

Table 4-3 Suitability rating Criteria for Selected Uses (2)

Uses	Soil Texture				Soil Depth (cm.)				Soil Drainage			
	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N
Grain Crops									SPD-WD			
Paddy rice irrigated	SiL-CL	SL-C	SL-C	S-LS	> 50	40-50	30-40	< 30	PD	SPD-GHD-PD	SPD-HD-PD	
Paddy rice non-irrigated	SiL-CL	SL-C	SL-C	S-LS	> 50	40-50	30-40	< 30	SPD-WD	SPD-GHD-PD	SPD-HD-PD	H_2O Logged
Corn	SiL-CL	SL-C	SL-C	S-LS	> 60	40-60	20-40	< 20				
Beans												
Mungbean	SC-CL	SL-C	SL-C	S-LS	> 50	30-50	15-30	< 15	WD-MWD	SPD	SPD	PD-VPD
Peanut	SC-CL	SL-C	SL-C	S-LS	> 50	30-50	15-30	< 15	WD-MWD	SPD	SPD	PD-VPD
Rootcrops												
Sweet Potato	SC-CL	SL-C	SL-C	S-LS	> 75	50-75	50-20	<20	WD-MWD	SPD	SPD	PD-VPD
Cassava	SC-CL	SL-C	SL-C	S-LS	> 100	75-100	50-75	< 50	WD-MWD	SPD	SPD	PD-VPD
Vegetables												
Squash	SC-CL	SL-C	SL-C	S-LS	> 50	40-50	30-40	< 30	WD-MWD	SPD	PD-VPD	H_2O Logged
Industrial Crops												
Coconut	All except loamy sand and sand			S-LS	150	90-150	40-90	< 40	WD-MWD	WD-MWD	SPD	PD-VPD
Fruit Trees												
Lanzones	All except loamy sa			S-LS	> 100	50-100	30-50	< 30	WD-MWD	WD-MWD	SPD	PD-VPD
Banana	Tolerate a wide ra			S-LS	> 100	70-80	45-70	< 45	WD-MWD	WD-MWD	SPD	PD-VPD
	except sandy anc											
Hedgerows Shrubs/Pasture	All except loamy sand and sand			S-LS	> 50	30-50	30-50	< 30	HD-MWD	WD-MWD	SPD	PD-VPD
Forest Tree												
Mahogany	All textural classes				> 150	100 - 150	50-100	< 50	HD-MHD	HD-MHD	SPD	PD-VPD

Rating:

S1 - Highly suitable
S2 - Moderately suitable
S3 - Marginally suitable
N - Not suitable
NE - Not relevant

VPD - Very Poor Drained
PD - Poorly Drained
SPD - Somewhat Poorly Drained
MWD - Moderately Well Drained
WD - Well Drained

Source: ALMED,BSWM

Table 4-4 Adaptation of Crop s (1)

ARC: Sappaac

Land Category/Crop	Altitude (m)	Temperatur (°C)	Rainfall (mm)	Soil Depth (cm)	Soil Texture	Soil Acidity (pH)	Soil Fertility P_2O_5 (ppm)	Drainage Classes	Slope (%)	Surface Stoniness (%)	Total Suitability
1. Rice Land	180	26.0		>100	Sic-C	6.7-7.2	<5.0	Poor	<8	<0.01	
- Paddy Rice		S2		S1	S1	S2-S3	N	S2	S2	S1	S2
- Garlic		S2		S1	S2	S1	N	S2	S2	S1	S2
2. Upland,Shale Sandston	260	25.4		>50	SL-CL	5.3-6.7	N	Well	8-30	<0.01	
- Corn		S1		S2	S2	S1-S3	N	S1	S2-S3	S1	S2-S3
- Sweet Potato		S2		S2	S1-S2	S2	N	S1	S2-S3	S1	S2-S3
- Mungbean		S1		S2	S1-S2	S1-S3	N	S1	S2-S3	S1	S2-S3
- Peanut		S1		S1	S1-S2	S1-S3	N	S1	S2-S3	S1	S2-S3
- Banana		S1		S2-S3	S1-S2	S1-S2	N	S1	S2-S3	S1	S2-S3
- Mango		S1		S1-S2	S1-S2	S1-S2	N	S1	S1-S2	S1	S1-S2
- Cashewnut		S1		S1-S2	S1-S2	S1-S2	N	S1	S1-S2	S1	S1-S2
- Eucalypts		S1		S1	S1	S1	S1	S1	S1	S1	S1
- Hedgerow plant		S1		S1	S1	S1	S1	S1	S1	S1	S1
3. Upland,Hills on Volcar	260	25.4		>50	CL-C	5.6-6.3	N	Well	8-30	<0.01	
- Corn		S1		S2	S2-S3	S1-S2	N	S1	S2-S3	S1	S2-S3
- Sweet Potato		S2		S2	S1-S3	S1	N	S1	S2-S3	S1	S2-S3
- Mungbean		S1		S2	S2-S3	S1	N	S1	S2-S3	S1	S2-S3
- Peanut		S1		S1	S2-S3	S1-S3	N	S1	S2-S3	S1	S2-S3
- Banana		S1		S1	S2-S3	S1-S3	N	S1	S2-S3	S1	S2-S3
- Mango		S1		S1-S2	S1-S2	S1-S2	N	S1	S1-S2	S1	S1-S2
- Cashewnut		S1		S1-S2	S1-S2	S1-S2	N	S1	S1-S2	S1	S1-S2
- Eucalypts		S1		S1	S1	S1	S1	S1	S1	S1	S1
- Hedgerow plant		S1		S1	S1	S1	S1	S1	S1	S1	S1
4. Upland,Limestone Hill	260	25.4		<50	CL-C	6.5-6.8	N	S1	8-30	>3	
- Corn		S1		S2-S3	S2-S3	S1	N	S1	S2-S3	N	S2-S3
- Sweet Potato		S2		S2-S3	S1-S3	S2	N	S1	S2-S3	N	S2-S3
- Mungbean		S1		S2-S3	S1-S2	S1	N	S1	S2-S3	N	S2-S3
- Peanut		S1		S2-S3	S1-S2	S1	N	S1	S2-S3	N	S2-S3
- Banana		S1		N	S1-S2	S1	N	S1	S2-S3	S3	S2-S3
- Mango		S1		S1-S2	S1-S2	S1-S2	N	S1	S1-S2	S1	S1-S2
- Cashewnut		S1		S1-S2	S1-S2	S1-S2	N	S1	S1-S2	S1	S1-S2
- Eucalypts		S1		S1	S1	S1	S1	S1	S1	S1	S1
- Hedgerow plant		S1		S1	S1	S1	S1	S1	S1	S1	S1

Source: Agroforestry Project Planning and Management,UPLB Agroforestry Program,1994

Table 4-4 Adaptation of Crop s (2)

ARC: Cofcaville

Land Category/Crop	Altitude (m)	Temperature (°C)	Rainfall (mm)	Soil Depth (cm)	Soil Texture	Soil Acidity (pH)	Soil Fertility P2O5 (ppm)	Drainage Classes	Slope (%)	Surface Stoniness (%)	Total Suitability
1. Rice Land	120	26.8		>100	C	6.1-6.5	>25	Poor	<8	<0.01	
- Paddy Rice		S2		S1	S1	S1	S3	S2	S2	S1	S2
- Mungbean		S2		S1	S2-S3	S1	S1	S2	S2	S1	S2
2. Upland, Undulating	160	26.8		>100	SiC-C	4.7-6.1	N	Well	8-30	<0.01	
- Corn		S1		S2	S1-S3	S1-N	N	S1	S2-S3	S1	S2-N
- Sweet Potato		S2		S2	S1-S3	S1-S3	N	S1	S2-S3	S1	S2-S3
- Mungbean		S1		S2	S2-S3	S1-S3	N	S1	S2-S3	S1	S2-S3
- Peanut		S1		S1	S3	S1-N	N	S1	S2-S3	S1	S2-S3
- Banana		S1		S1	S2-S3	S1-S3	N	S1	S2-S3	S1	S2-S3
- Rambutan		S1		S1-S2	S1-S2	S1-S2	N	S1	S1-S2	S1	S1-S2
- Gemelina		S1		S1	S1	S1	S1	S1	S1	S1	S1
- Hedgerow plant		S1		S1	S1	S1	S1	S1	S1	S1	S1
3. Upland, Undulating	140	26.8		>100	CL	6.1-6.4	N	Well	8-30	<0.01	
- Corn		S1		S1	S1	S1	N	S1	S2-S3	S1	S2-S3
- Sweet Potato		S2		S1	S1	S1	N	S1	S2-S3	S1	S2-S3
- Mungbean		S1		S2	S2	S1	N	S1	S2-S3	S1	S2-S3
- Peanut		S1		S1	S3	S1	N	S1	S2-S3	S1	S2-S3
- Banana		S1		S1	S1	S1	N	S1	S2-S3	S1	S1-S3
- Rambutan		S1		S1-S2	S1-S2	S1-S2	N	S1	S1-S2	S1	S1-S2
- Gemelina		S1		S1	S1	S1	S1	S1	S1	S1	S1
- Hedgerow plant		S1		S1	S1	S1	S1	S1	S1	S1	S1
4. Upland, Limestone	260	25.4		<50	CL-C	6.5-6.8	N	S1	8-30	>3	
- Corn		S1		S2-S3	S2-S3	S1	N	S1	S2-S3	N	S2-S3
- Sweet Potato		S2		S2-S3	S1-S3	S2	N	S1	S2-S3	N	S2-S3
- Mungbean		S1		S2-S3	S1-S2	S1	N	S1	S2-S3	N	S2-S3
- Peanut		S1		S2-S3	S1-S2	S1	N	S1	S2-S3	N	S2-S3
- Banana		S1		N	S1-S2	S1	N	S1	S2-S3	S3	S2-S3
- Mango		S1		S1-S2	S1-S2	S1-S2	N	S1	S1-S2	S1	S1-S2
- Cashewnut		S1		S1-S2	S1-S2	S1-S2	N	S1	S1-S2	S1	S1-S2
- Eucalypts		S1		S1	S1	S1	S1	S1	S1	S1	S1
- Hedgerow plant		S1		S1	S1	S1	S1	S1	S1	S1	S1

Source: Agroforestry Project Planning and Management, UPLB Agroforestry Program, 1994.

Table 4-4 Adaptation of Crop s (3)

ARC: Marangog

Land Category/Crop	Altitude (m)	Temperatur (°C)	Rainfall (mm)	Soil Depth (cm)	Soil Texture	Soil Acidity (pH)	Soil Ferti-lity P2O5 (ppm)	Drainage Classes	Slope (%)	Surface Stoniness (%)	Total Suitabi-lity
1. Rice Land	150	26.1		>100	C	6.5-6.8	<5.0	Poor	<8	<0.01	
- Paddy Rice		S2		S1	S1	S1	N	S2	S2	S1	S2
- Squash		S2		S1	S3	S1	N	S2	S2	S1	S3
2. Coconut Land	200	25.5		50-100	C	6.6-7.0	N	Well	8-30	0.1-15.0	
- Coconut		S1		S1	S3	S1	N	S1--S3	S2-S3	S1	S3
3. Upland,Low Limestone H	200	25.5		50-100	C	6.6-7.0	N	Well	8-30	0.1-15.0	
Gently Sloping and Undurating											
- Corn		S1		S1	S3	S1	N	S1--S3	S2-S3	S1	S3
- Sweet Potato		S2		S2	S3	S2	N	S1--S3	S2-S3	S1	S3
- Mungbean		S1		S1	S3	S1	N	S1--S3	S2-S3	S1	S3
- Peanut		S1		S1	S3	S1	N	S1--S3	S2-S3	S1	S3
- Banana		S1		S1-S3	S3	S1-S2	N	S2	S2-S3	S1	S2-S3
- Mango		S1		S1-S2	S1-S2	S1-S2	N	S2	S1-S2	S1	S1-S2
- Abaca		S1		S1-S2	S1-S2	S1-S2	N	S1	S1-S2	S1	S1-S2
- Acacia		S1		S1	S1	S1	S1	S1	S1	S1	S1
- Hedgerow plant		S1		S1	S1	S1	S1	S1	S1	S1	S1
4. Upland,Low Limestone H	200	25.5		>50	C	6.5-6.8	N	Well	8-30	<0.01	
Undurating to Moderately Steep											
- Corn		S1		S2	S3	S1	N	S1	S2-S3	S1	S3
- Sweet Potato		S2		S2	S3	S2	N	S1	S2-S3	S1	S3
- Mungbean		S1		S1	S3	S1	N	S1	S2-S3	S1	S3
- Peanut		S1		S1	S3	S1	N	S1	S2-S3	S1	S3
- Banana		S1		S2-S3	S3	S1-S2	N	S1	S2-S3	S1	S2-S3
- Mango		S1		S1-S2	S1-S2	S1-S2	N	S1	S1-S2	S1	S1-S2
- Abaca		S1		S1-S2	S1-S2	S1-S2	N	S1	S1-S2	S1	S1-S2
- Acacia		S1		S1	S1	S1	S1	S1	S1	S1	S1
- Hedgerow plant		S1		S1	S1	S1	S1	S1	S1	S1	S1

Source: Agroforestry Project Planning and Management, UPLB Agroforestry Program, 1994.

Table 4-4 Adaptation of Crop s (4)

ARC: Silae

Land Category/Crop	Altitude (m)	Temperatur (°C)	Rainfall (mm)	Soil Depth (cm)	Soil Texture	Soil Acidity (pH)	Soil Ferti-lity P2O5 (ppm)	Drainage Classes	Slope (%)	Surface Stoniness (%)	Total Suitabi-lity
1. Rice Land	500	24.1		>100	C	5.0-5.2	>26	Poor	<8	<0.01	
- Paddy Rice		S2		S1	S1	S2	S3	S2	S2	S1	S2
- Mungbean		S2		S1	S2	S1	S3	S2	S2	S1	S2
2. Upland,Undulating	550	23.5		>100	C	5.5-6.2	N	Well	8-30	<0.01	
- Corn		S1		S1	S3	S1-S2	N	S1	S3	S1	S3
- Peanut		S1		S1	S3	S1	N	S1	S2-S3	S1	S3
3. Upland,Gently Slop Undulating Hills	600	22.9		>100	CL	6.1-6.4	N	Well	8-30	<0.01	
- Corn		S1		S1	S3	S1	N	S2	S2-S3	S1	S3
- Mungbean		S1		S2	S3	S1	N	S2	S2-S3	S1	S3
- Peanut		S1		S1	S3	S1	N	S1	S2-S3	S1	S3
- Durian		S1		S1	S1	S1	N	S1	S1-S2	S1	S1-S2
- Acacia		S1		S1	S1	S1	S1	S1	S1	S1	S1
- Hedgerow plant		S1		S1	S1	S1	S1	S1	S1	S1	S1
4. Upland,Undulating and Rolling	600	22.9		>100	SCL-L	5.2--6.4	N	S1	8-30	<0.01	
- Corn		S1		S1	S1-S3	S1-S3	N	S1	S2-S3	N	S1-S3
- Mungbean		S1		S1	S1-S3	S1-S3	N	S1	S2-S3	N	S2-S3
- Durian		S1		S1	S1-S2	S1-S2	N	S1	S1-S2	S1	S1-S2
- Acacia		S1		S1	S1	S1	S1	S1	S1	S1	S1
- Pine		S1		S1	S1	S1	S1	S1	S1	S1	S1
- Hedgerow plant		S1		S1	S1	S1	S1	S1	S1	S1	S1

Source: Agroforestry Project Planning and Management, UPLB Agroforestry Program, 1994.

Table 4-5 Planting Area in Idle/Uncultivated Land, Sappaac ARC (Case 3)

Item	Physical Area (ha)	Cropping Intensity Whole Period (%)	Cropping Intensity Average (%)	Cropping Intensity Rounded (%)	Planting Area (ha)
1. Fruit-based Contour Farming	110				
Fruit Trees	(100%)				
(1) Fruit trees(Mango)	66	1-90	90	90	59
(2) Nurse trees(Kakawate)	(60%)	20-0	20	20	13
(3) Hedgerows plant(Flemingia)		12	12	10	7
(4) Corn, Wet Season		51-3	27	25	17
(5) Beans(Peanut), Wet Season		26-2	14	15	10
(6) Bean(Mungbean), Dry Season		26-2	14	15	10
Subtotal					116
Banana	11				
(1) Nurse tree(Kakawate)	(10%)	10	10	10	1
(2) Banana		90	90	90	10
Subtotal					11
Forest Trees *1	33				
(1) Fast growing tees(Bagras *2)	(30%)	90	90	90	30
Subtotal					157
2. Reforestation *3	69				
(1) Climax trees(Mahogany)		90	90	90	62
(2) Nurse trees(Bagras) *4		*1 90	*1 90	*1 90	62
Subtotal					124
Total	179				281

Note: (1) The crops in the parenthesis show the representative crops.

(2) *1...Out of 33 ha, 3ha (33haX10%) are excluded as the land of fireline

*2...Eucalyptus deglupta

*3...Out of 69 ha, 7ha (10% of 69ha) are excluded as the land of fireline

*4...Intercropped with climax trees

Table 4-6 Planting Area in Idle/Uncultivated Land, Cofcaville ARC (Case 3)

Item	Physical Area (ha)	Cropping Intensity Whole Period (%)	Cropping Intensity Average (%)	Cropping Intensity Rounded (%)	Planting Area (ha)
1. Cassava and Fruit-based Contour Farming	89 (100%)				
Cassava	62 (70%)	100	100	100	62
Banana	27 (30%)				
(1) Nurse tree (Kakawate)		10	10	10	3
(2) Banana		90	90	90	24
Subtotal					27
Total					89
2. Reforestation *1	132				
(1) Climax trees (Mahogany)		90	90	90	119
(2) Nurse trees (Gmelina*2)		*1 90	*1 90	*1 90	119
Subtotal					238
Total	221				327

Note: (1) The crops in the parenthesis show the representative crops.
(2) *1...Out of 132 ha, 13 ha (132hax10%) are excluded for the land of fireline.
*2...Gmelina aborea (intercropped with climax trees)

Table 4-7 Planting Area in Idle/Uncultivated Land, Marangog ARC (Case 3)

Item	Physical Area (ha)	Cropping Intensity Whole Period (%)	Cropping Intensity Average (%)	Cropping Intensity Rounded (%)	Planting Area (ha)
1. Fruit-based Contour Farming	17				
Fruit Trees	(100%)				
(1) Fruit trees (Jackfruit)	15	1-90	90	90	14
(2) Nurse trees (Falcata)	(90%)	20-0	20	20	3
(3) Hedgerows plant (Flemingia)		12	12	10	2
(4) Corn, Wet Season		38-5	22	20	3
(5) Beans (Peanut), Wet Season		38-5	22	20	3
(6) Corn, Dry Season		38-5	22	20	3
(7) Beans (Peanut), Dry Season		38-5	22	20	3
Subtotal					31
Forest Trees	2				
(1) Fast growing trees (Gmelina*1)	(10%)	90	90	90	2
Total					33
2. Reforestation *2	32				
(1) Climax trees (Mahogany)		90	90	90	29
(2) Nurse trees (Bagalunga *3)		*1 90	*1 90	*1 90	29
Subtotal					58
Total	52				90

Note: (1) The crops in the parenthesis show the representative crops.

(2) *1...Gmelina aborea

*2...Out of 32ha, 3ha(32hax10%) are excluded as the land of fire line

*3...Intercropped with climax trees

(3) The fruit-based contour farming is applied for the 17 ha of existing upland.

Table 4-8 Planting Area in Idle/Uncultivated Land, Silac ARC (Case 3)

Item	Physical Area (ha)	Cropping Intensity Whole Period (%)	Cropping Intensity Average (%)	Cropping Intensity Rounded (%)	Planting Area (ha)
1. Fruit-based Contour Farming	10				
Fruit Trees	(100%)				
(1) Fruit trees (Durian)	9	1-90	90	90	8
(2) Nurse trees (Kakawate)	(90%)	20-0	20	20	2
(3) Hedgerows plant (Flemingia)		12	12	10	1
(4) Corn, Wet Season		51-3	27	25	2
(5) Beans (Mungbean), Wet Season		26-2	14	15	1
(6) Corn, Dry Season		51-3	27	25	2
(7) Beans (Peanut), Dry Season		26-2	12	15	1
Subtotal					17
Forest Trees	1				
(1) Fast Growing Tees (Gmelina *1)	(10%)	90	90	90	1
Total					18
2. Reforestration *2	42				
(1) Climax trees (Mahogany)		90	90	90	38
(2) Nurse trees (Bagras *3)		*1 90	*1 90	*1 90	38
Total					76
Grandtotal	52				94

Note: (1) The crops in the parenthesis show the representative crops.
(2) *1...Gmelina aborea
*2...Out of 42ha, 4ha (42hax10%) are exclued as the land of fireline.
*3...Eucalyptus deglupta, intercroppedwi the climax trees.

Table 4-9 Proposed Cropping Area, Sappaac ARC (Case 3)

Kind of Land	Land Area	Cropping Intensity	Crop	Season	Area
	(ha)	(%)			(ha)
1. Rice Land					
- Irrigated	30	100	Paddy Rice	Wet	30
		20	Diversified Crops(Garlic*1)	Dry	6
			Subtotal		36
- Rainfed	58	100	Paddy Rice	Wet	58
		40	Diversified Crops(Corn)	Dry	23
			Subtotal		81
Total	88				117
2. Upland	30				
- Rainfed		30	Corn	Wet	9
		70	Root Crops(Sweet Potato*2)	Wet	21
		40	Mungbean	Dry	12
			Subtotal		42
3. Orchard	8	60	Mango		5
		40	Banana		3
			Subtotal		8
4. 8-18% Slope Land	110	15	Corn	Wet	17
		9	Beans(Peanut)	Wet	10
		9	Beans(Mungbean)	Dry	10
		9	Banana		10
		54	Mango		59
		6	Hedgerow plants(Flemingia)		7
		13	Nurse trees(Kakawate)		14
		27	Forest Trees(Bagras)		30
			Subtotal		157
6. 18-30% Slope Land	60	90	Forest trees(Mahogany)		62
			Forest trees(Bagras)		62
			Subtotal		124
6. More than 30% *3	45				
7. Other Land	32				
Grandtotal	382				448

Overall cropping intensity=448ha/(375ha-45ha-32ha)X100=150.1%

Note: The crops in the parenthesis show the respective representative crops.
*1... including such vegetables as squash, cabbage, and eggplant
*2... including cassava

Source: Study Team

Table 4-10 Proposed Cropping Area, Cofcaville ARC (Case 3)

Kind of Land	Land Area	Cropping Intensity	Crop	Season	Area
	(ha)	(%)			(ha)
1. Rice Land					
- Irrigated	7	86	Paddy Rice	Wet	6
		100	Paddy Rice	Dry	7
		86	Diversified Crops (Mungbean)	Dry	6
			Subtotal		19
- Rainfed	32	100	Paddy Rice	Wet	32
		40	Paddy Rice	Dry	13
			Subtotal		45
Total	39				64
2. Upland	163				
- Rainfed		95	Corn	Wet	155
		5	Root Crops (Sweet Potato*1)	Wet	8
		76	Corn	Dry	124
		10	Beans (Mungbean)	Dry	16
			Subtotal		303
3. Orchard	23	100	Fruit Trees (Banana)		23
4. 8-18% Slope Land	89	70	Cassava		62
		27	Fruit Trees (Banana)		24
		3	Nurse Tree (Kakawate)		3
			Subtotal		89
5. 18-30% Slope Land	132		Forest trees (Mahogany*2)		
		90	Mahogany		119
		90	Gmelina		119
			Subtotal		238
6. Over 30% Slope Land	16				
7. Other Land	28				
Total	490				717

Overall cropping intensity=717/(490ha-16ha-28ha)X100=160.8%

Note: The crops in the parenthesis show the respective representative crops
*1... including gabi and cassava
*2... including narra
*3... including 13ha of land for fireline in 18-30% slope land.

Source: Study Team

Table 4-11 Proposed Cropping Area, Marangog ARC (Case 3)

Kind of Land	Land Area	Cropping Intensity	Crop	Season	Area
	(ha)	(%)			(ha)
1. Rice Land					
- Irrigated	11	100	Paddy Rice	Wet	11
		100	Diversified Crops(Squash*1)	Dry	11
			Subtotal		22
- Rainfed	13	100	Paddy Rice	Wet	13
		60	Paddy Rice	Dry	8
		40	Diversified Crops(Corn)	Dry	5
			Subtotal		26
Total	24				48
2. Upland	16				
- Rainfed		30	Corn	Wet	5
		70	Root Crops(Sweet Potato*2)	Wet	11
		80	Corn	Dry	13
		20	Beans(Peanut)	Dry	3
			Subtotal		32
3. Coconut	86				
		100	Coconut		86
		20	Corn	Wet	17
		20	Beans(Peanut)	Dry	17
		10	Banana		9
		10	Abaca		9
			Sutotal		138
4. Orchard	29	40	Banana		12
		60	Abaca		17
			Subtotal		29
5. 8-18% Slope Land	17	20	Corn	Wet	3
		20	Beans(Mungbean)	Wet	3
		20	Corn	Dry	3
		20	Beans(Peanut)	Dry	3
		80	Fruit trees(Jackfruit)		14
		10	Hedgerow plants(Flemingia)		2
		18	Nurse trees(Falcata)		3
		12	Fast growing tree(Gmelina)		2
			Subtotal		33
6. 18-30% Slope Land	29	100	Climax trees(Mahogany*3)		29
		100	Nurse trees(Bagalunga)		29
			Subtotal		58
7. More than 30% Slope Land	106				
8. Other land	23				
Total	330				338

Overall cropping intensity=338ha/(330ha-106ha-23ha)X100=168.2%

Note: The crops in the parenthesis show the respective representative crops.
*1... including stringbean, tomato, eggplant, etc.
*2... including Gabi, cassava, etc.
*3... including Narra

Source: Study Team

Table 4-12 Proposed Cropping Area, Silae ARC (Case 3)

Kind of Land	Land Area	Cropping Intensity	Crop	Season	Area
	(ha)	(%)			(ha)
1. Rice Land					
- Irrigated	30	100	Paddy Rice	Wet	30
		37	Paddy Rice	Dry	11
		47	Mungbean	Dry	14
			Subtotal		55
2. Upland	45				
- Rainfed		80	Corn	Wet	36
		20	Beans(Mungbean)	Wet	9
		80	Corn	Dry	36
		20	Beans(Peanut)	Dry	9
			Subtotal		90
3. 8-18% Slope Land	10	20	Corn	Wet	2
		5	Beans(Mungbean)	Wet	1
		20	Corn	Dry	2
		5	Beans(Peanut)	Dry	1
		80	Fruit trees(Durian*1)		8
		20	Nurse trees(Kakawate)		2
		10	Hedgerow plants(Flemingia)		1
		10	Fast growing trees(Gemelina)		1
			Subtotal		18
4. 18-30% Slope Land	38	100	Climax trees(Mahogany*2)		38
		100	Nurse trees(Bagras)		38
			Subtotal		76
5. More than 30% Slope Land	29				
6. Other Land	12				
Total	164				239

Oveall cropping intensity=239ha/(164ha-29ha-12ha)X100=194.3%

Note: The crops in the parenthesis show the respective representative crops.
*1... Including marang, lanzones, rambutan, and mango
*2... Including Bagras to be intercropped

Source: Study Team

FIGURE 4-1 PROCESS OF FORMULATION ON LAND USE PLAN FEASIBILITY STUDY (CASE 3)

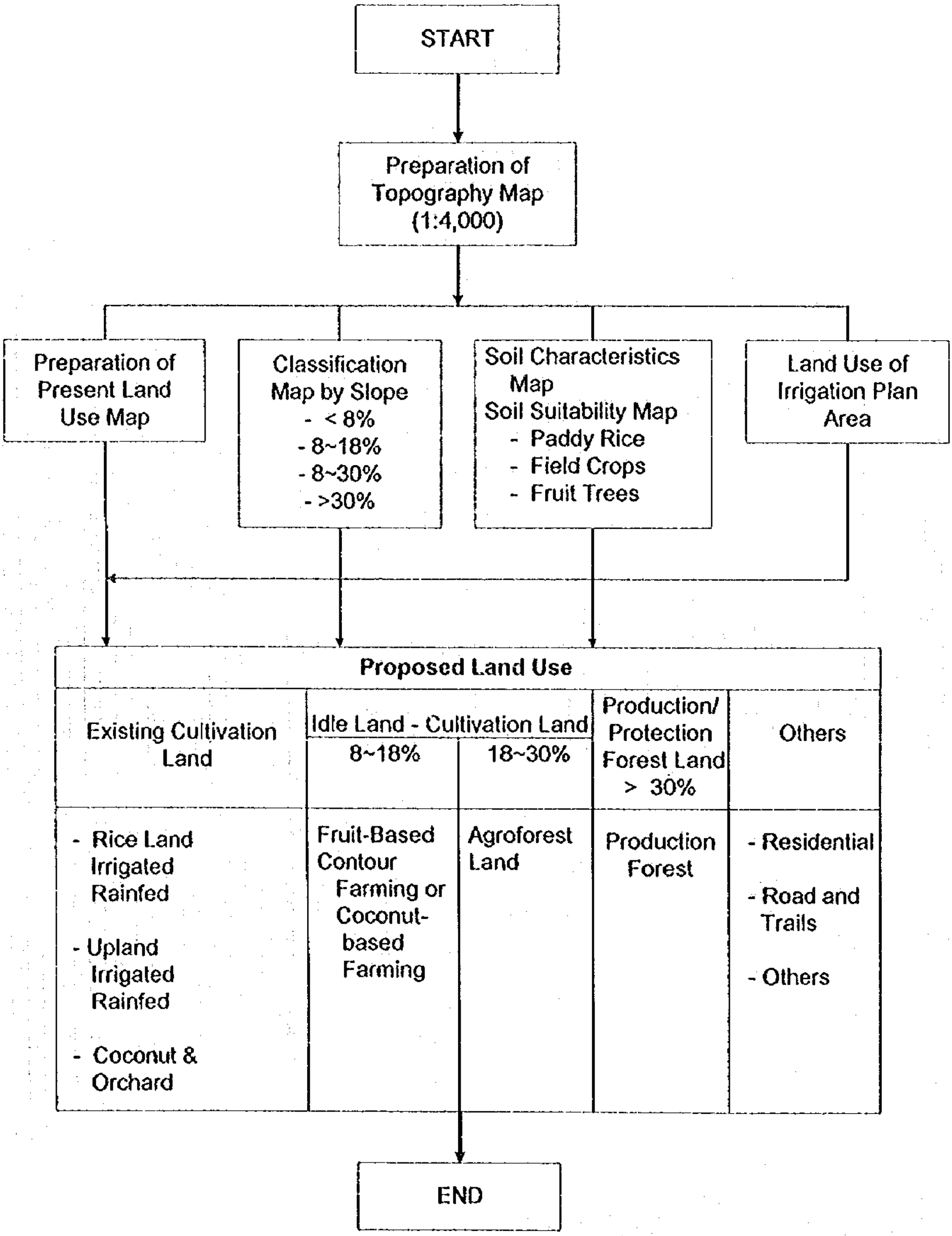
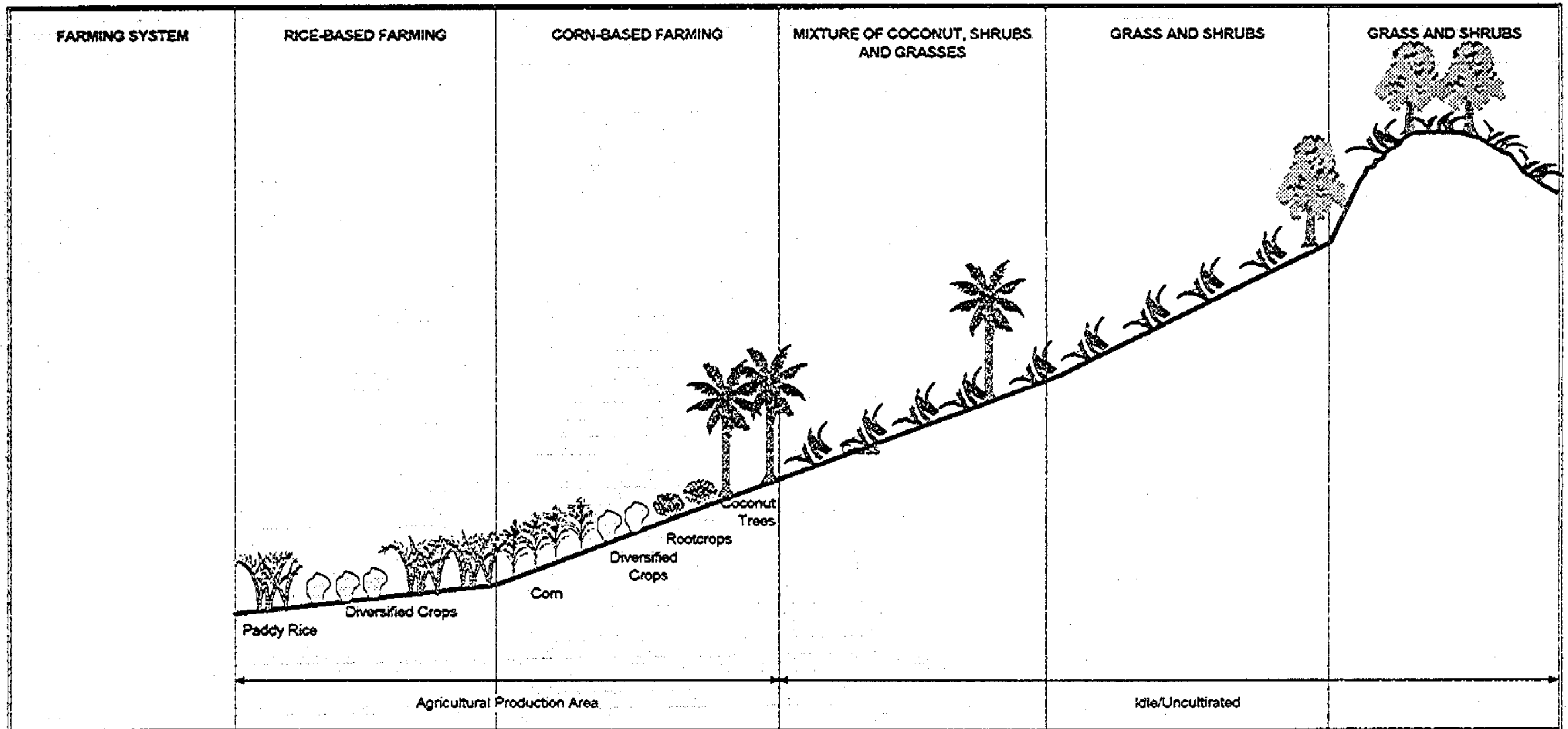


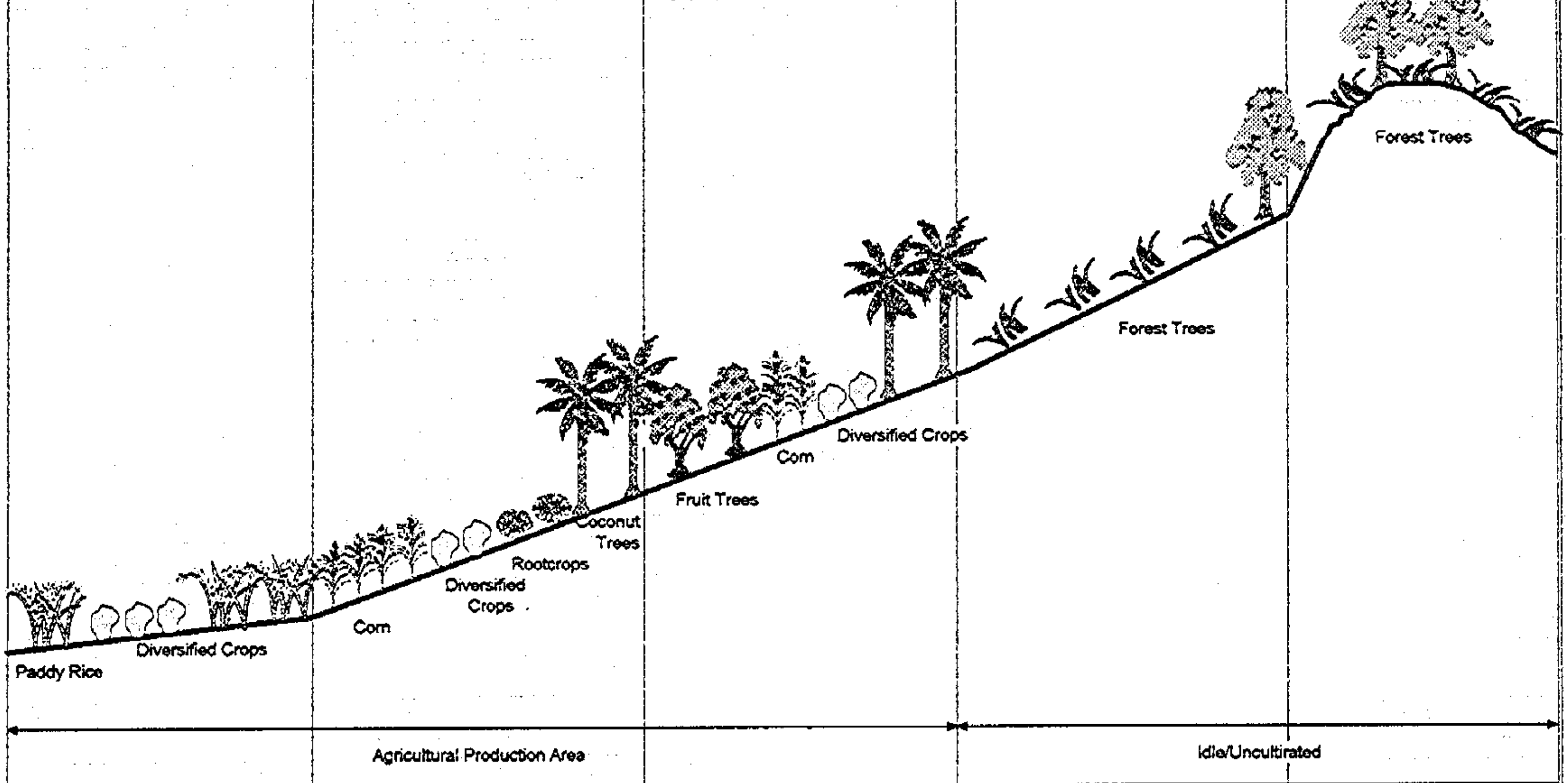
FIGURE 4-2 PROPOSED LAND USE PATTERN (CASE 1)



Predominant Slope (%)	0-3	3-8	8-18	18-30	> 30
Present Crops / Trees	Paddy Rice Corn Root Crops	Corn Rootcrops Coconut Trees	Coconut Trees Shrubs/Cogon Grass	Shrubs/Cogon Grass Coconut Trees	Shrubs/Cogon Grass Kaingin Forest Trees

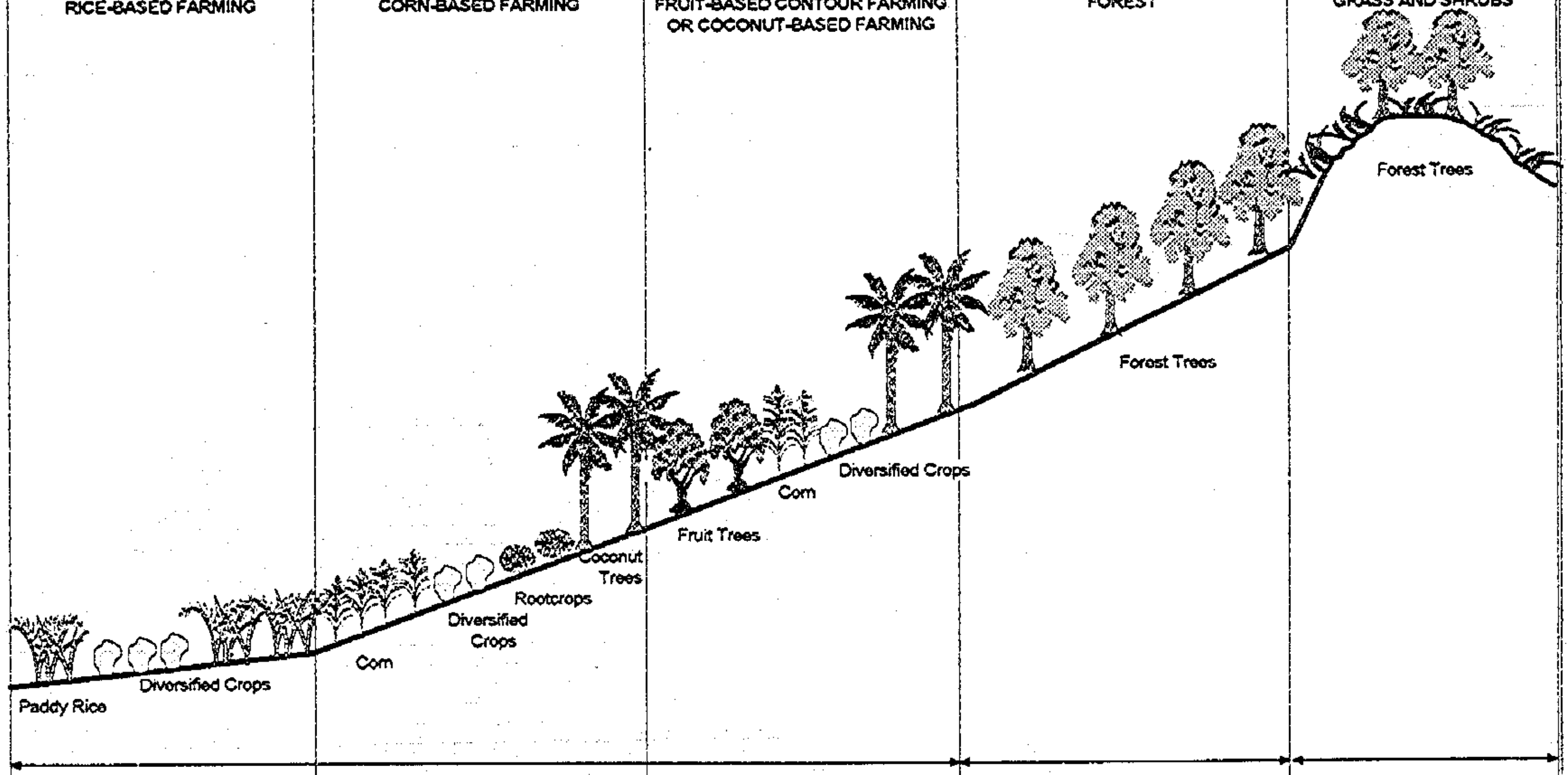
FIGURE 4-3 PROPOSED LAND USE PATTERN (CASE 2)

FARMING SYSTEM	RICE-BASED FARMING	CORN-BASED FARMING	FRUIT-BASED CONTOUR FARMING OR COCONUT-BASED FARMING	FOREST	GRASS AND SHRUBS



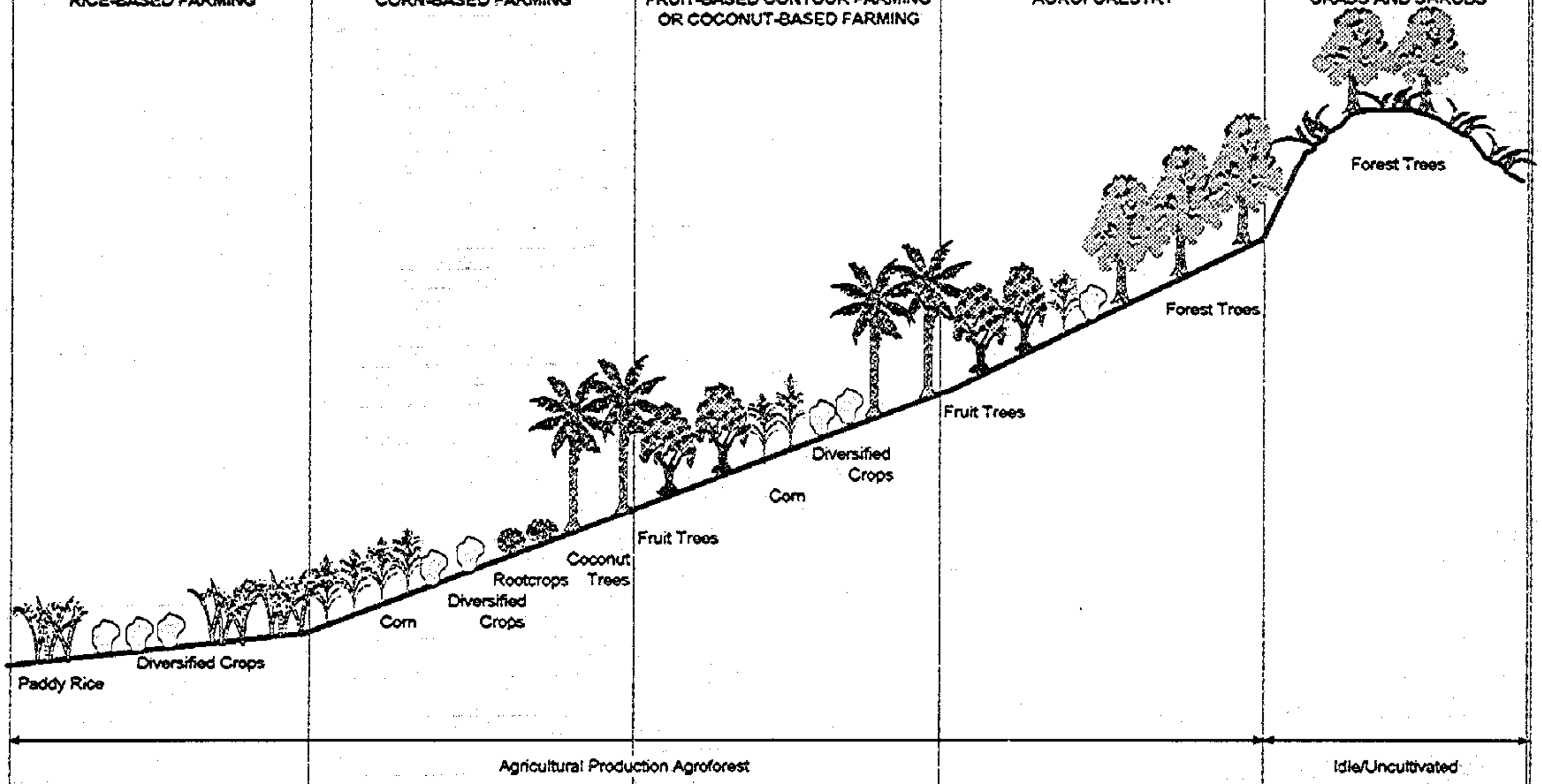
Predominant Slope (%)	0-3	3-8	8-18	18-30	> 30
Proposed Crops / Trees	Paddy Rice Diversified Crops	Com Beans Root Crops Coconut Trees	Coconut Trees Fruit Trees Diversified Crops Hedge Row Shrubs	Shrubs/Cogon Grass Coconut Trees	Forest Trees
Present Crops / Trees	Paddy Rice Com Root Crops	Com Rootcrops Coconut Trees	Coconut Trees Shrubs/Cogon Grass	Shrubs/Cogon Grass Coconut Trees	Shrubs/Cogon Grass Kaingin Forest Trees

FIGURE 4-4 PROPOSED LAND USE PATTERN (CASE 3)



FARMING SYSTEM	RICE-BASED FARMING	CORN-BASED FARMING	FRUIT-BASED CONTOUR FARMING OR COCONUT-BASED FARMING	FOREST	GRASS AND SHRUBS
	Agricultural Production Area			Production/Protection/Forest	Idle/Uncultirated
Predominant Slope (%)	0-3	3-8	8-18	18-30	> 30
Proposed Crops / Trees	Paddy Rice Diversified Crops	Corn Beans Root Crops Coconut Trees	Coconut Trees Fruit Trees Diversified Crops Hedge Row Shrubs	Forest Trees Coconut Trees Fruit Trees	Forest Trees
Present Crops / Trees	Paddy Rice Corn Root Crops	Corn Rootcrops Coconut Trees	Coconut Trees Shrubs/Cogon Grass	Shrubs/Cogon Grass Coconut Trees	Shrubs/Cogon Grass Kaingin Forest Trees

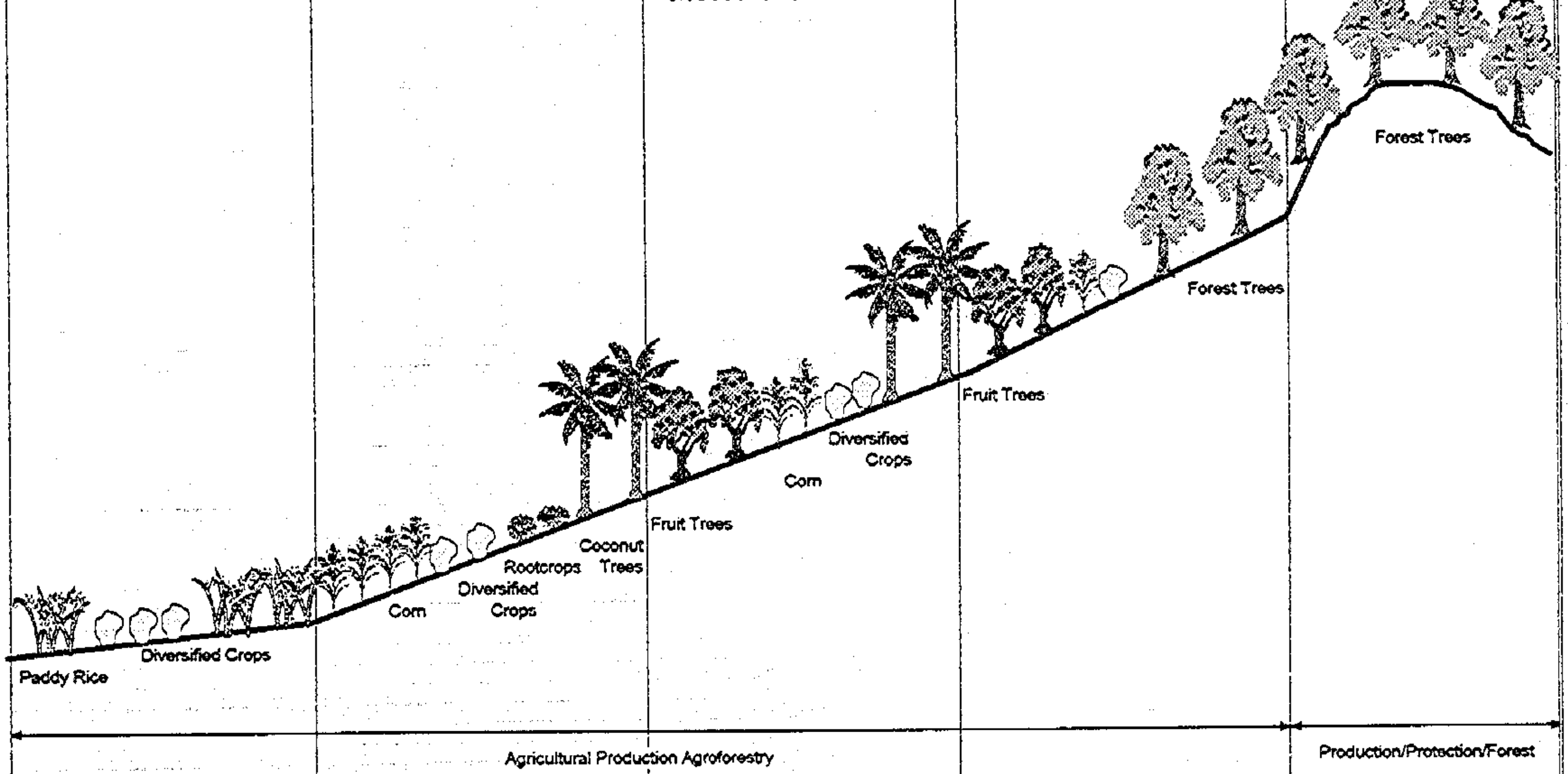
FIGURE 4-5 PROPOSED LAND USE PATTERN (CASE 4)



FARMING SYSTEM	RICE-BASED FARMING	CORN-BASED FARMING	FRUIT-BASED CONTOUR FARMING OR COCONUT-BASED FARMING	AGROFORESTRY	GRASS AND SHRUBS
Predominant Slope (%)	0-3	3-8	8-18	18-30	> 30
Proposed Crops / Trees	Paddy Rice Diversified Crops	Corn Beans Root Crops Coconut Trees	Coconut Trees Fruit Trees Diversified Crops Hedge Row Shrubs	Forest Trees Coconut Trees Fruit Trees	Forest Trees
Present Crops / Trees	Paddy Rice Corn Root Crops	Corn Root Crops Coconut Trees	Coconut Trees Shrubs/Cogon Grass	Shrubs/Cogon Grass Coconut Trees	Shrubs/Cogon Grass Kaingin Forest Trees

FIGURE 4-6 PROPOSED LAND USE PATTERN (CASE 5)

FARMING SYSTEM	RICE-BASED FARMING	CORN-BASED FARMING	FRUIT-BASED CONTOUR FARMING OR COCONUT-BASED FARMING	AGROFORESTRY	FOREST



Predominant Slope (%)	0-3	3-8	8-18	18-30	> 30
Proposed Crops / Trees	Paddy Rice Diversified Crops	Corn Beans Root Crops Coconut Trees	Coconut Trees Fruit Trees Diversified Crops Hedge Row Shrubs	Forest Trees Coconut Trees Fruit Trees	Forest Trees
Present Crops / Trees	Paddy Rice Corn Root Crops	Corn Root Crops Coconut Trees	Coconut Trees Shrubs/Cogon Grass	Shrubs/Cogon Grass Coconut Trees	Shrubs/Cogon Grass Kaingin Forest Trees