5. FARMING AND CULTIVATION PLAN

5. Farming and Cultivation Plan

5. Farming and Cultivation Plan

5.1 Objectives of the Study

The marginal areas have various constraints in raising agricultural production and finally in improving the farming system. The purpose of the study on farming and cultivation is to formulate farming and cultivation plan along with the land use plan described in 4. Soils and land use.

5.2 Farming Systems

1) Improvement of Existing System

In general, there are such existing farming system like rice-based system in the narrow alluvial valleys, corn-based system, and coconut-based system in the marginal areas. These systems have almost mono cropping system on a limited farming scale in unstable and low productivity. Therefore, it is necessary to improve the existing farming system.

a) Rice-based Farming System

Though development of water resources for irrigation is limited in the marginal area, it is necessary to supply irrigation water to paddy rice as well as other diversified crops for an increase of rice production and also for generation of additional income through development of small scaled irrigation system. In the irrigation area of Cluster 2 and 3 areas, the proposed irrigation system will serve for such intensive cropping pattern as double cropping of paddy rice + short term crops like mungbean could be introduced. However, in Cluster 1 areas, where the water resources are quite limited, the irrigation system will serve supplementarily to grow paddy rice during wet season. Due to the limited water resources the irrigation water will be used to grow high value crops like vegetables and garlic during dry season. The proposed cropping patterns in the irrigated rice land for each cluster area in the typical model areas are prepared based on the above said concept(refer to Figure 5.1).

b) Corn-based Farming

Presently mono cropping of corn cultivation prevails in most of the marginal areas, where corn is grown usually in the upland with slope of less than eight percent. However, especially in Cluster 3 areas, corn is planted twice a year in the land with slope of even more than 18 percent, so far as the soils are rather suitable to grow corn. This land results in severe soil erosion and decrease of soil fertility. For an establishment of sustainable agriculture, it is

necessary to employ crop rotation among corn and leguminous crops and also raise soil fertility. Generally the upland soils in the marginal areas have soil fertility problems like phosphorous deficiency and strong acidity. So these kinds of soils have to be improved through staggered application of phosphorous and organic matter with liming for moderately and strongly acid soils. Adequate organic matters have to be applied through full utilization of crop residue, planting of green manure crops, collecting materials in the production forest.

c) Coconut-based Farming

Among the four typical marginal area, coconut-based farming is employed only in Marangog area. This may be attributed mostly by high elevation in Silae area and long dry season in Sappaac area. In Cofcaville area, soil conditions may limit plantation of coconut trees. In Marangog area, coconut trees are grown in very low density, where coconut inter-cropping covers the very limited area.

Leyte area is one of the nutritional deficiency area in term of nitrogen, phosphorous, potassium, chlorine, sulfate and boron, according to the Philippines Recommends for coconut. By planting additional coconut trees, introducing multi-storey cropping, and applying adequate amount of fertilizer, the existing coconut farms have to be developed to have more intensive and productive coconut-based farming system.

2) Introduction of Fruit tree-based Farming System

Since in most of the idle/uncultivated land with slope of 8 to 18 percent the soils are more suitable for fruit trees than field crops, it is proposed to introduce fruit-based farming in these areas. The fruit trees require a long period to be established. So, during establishment of fruit trees, such field crops like corn and beans(mungbean, peanut and others) have to be inter-cropped with the fruit trees. The concept of Sloping Agriculture Land Technology (SALT) will be applied in the fruit tree-based farms to protect the land from soil erosion and to improve soils. The nurse trees like kakawate and also such hedgerows plants as Flemingia(Flemingia macrophylla) and Rensonii (Desmodium rensoni) will be planted as shown in Figure F.2-39, Annex F. These plants will not only improve the soils but also supply the materials of organic matter.

The kinds of fruit trees have to be selected based on crop adaptation to climate and soils as well as marketability. Based on the feasibility study for the typical mode areas, the following fruit trees are selected;

Cluster	Selected Fruit Trees
1	Mango, cashew nut
2	Banana, citrus, rambutan, and jackfruit
3	Jackfruit, durian, marang, rambutan, and lanzoness

The climate of distinct dry season for more than six months in Cluster 1 area are very favorable to produce quality mango. However, in the area which have such unfavorable soil conditions as nutrition deficiency and severe moisture stress, cashew nut is recommendable to introduce. In the area which have shorter dry season period with large amount of rainfall, banana is suited to the land. The saba(cooking) type banana can recover from typhoon damages immediately after typhoon occurrence.

Jack fruit, rambutan, and lanzones are suitable to grow in Cluster 3 area, where it rains almost evenly throughout the year. The durian and marang are suited to the climate in Mindanao.

Among the said fruit trees, the mango grows well in the fertile soils, rich in organic matter. On the other hand, durian prefers fertile loamy soils. It is considered that the infertile and clayey soils may be prevailing in many marginal areas. In these areas, soil improvement will be required prior to planting the seedlings. One of the recommendable procedure to be taken into account is the following soil improvement aside from proper selection of the land.

- Removable of rock outcrop from a circular area, four meter in diameter and 50 cm in depth,
- Culture of the above area by mixing the soils with chemical and organic fertilizer and lime.

3) Introduction of Production/Protection Forest

For the idle/uncultivated land with slope of 18 to 30 percent, it is proposed to plant forest trees. The proper selection on the species for the forest trees .shall be made based on the climate and soil conditions. To select forest trees in the typical model areas, the respective species are referred to the species in the subproject of ADB assisting Forestry Sector Project under DENR. Namely the following species of forest trees are selected by Cluster.

Cluster	Fast Growing Trees	Production Forest	
		Climax Trees	Nurse Trees
1.	Bagras (Eucalyptus deglupta)	MahoganyBagras (Swietenia macrophylla)	Kakawate (Gliricidia sepium)
2.	Gmelina	Mahogany	Gmelina (Gmelina aborea)
3.	Gmelina	Mahogany	Bagalunga (Melia dubia) Bagras

As for fast growing trees, there are other recommended trees like Acacia aulacocarpa and mangium (Acacia mangium) according to DENR Bukidnon Industrial Plantation Project.

The production forest will supply not only timber but also fuel wood and material of organic fertilizers through pruning and thinning of trees.

5.3 Cultivation Plan

1) Farming Practices

The recommendable farming practices by project crop is formulated as shown in Figure F.2-48 to F.2-58, Annex F, which are mostly based on the Philippines Recommend of respective crops, prepared by Philippine Council for Agriculture, Forestry and Natural Resources Research and Development(PCARRD). The recommendable farming practices include recommendable varieties, soil requirement, and fertilizer requirement. The details of farm input requirement per hectare by typical model area are indicated in Table F-27 to F-30, Annex F. The labor and draft power requirement per hectare are estimated for respective crops, based on the farming practices employing animal draft power(refer to F.2-18 to F.2-26, Annex F).

The technology which are developed by DNER shall be applied for product/protection forest, including selection of species, nursery, planting and care of seedlings.

2) Target Yield and Full Development of Production

The target yield of respective crops by typical model area is formulated

based on the various data on the potential yield by land class as shown in Table 5.1. In case of annual crops, it is expected the target yields are attained for five years. However, the target yields of perennial crops and forest trees are expected to attain in the following manner(the target yield of respective crops/trees are indicated in Table F.2-14 to F.2-17, Annex F) ;

Crop/Tree	First Harvest (year after planting)	Full Development/Last Harvest (year after planting)
Fruit Trees		
Banana	second	third
Mango	sixth	16th
Jackfruit	sixth	tenth
Durian	sixth	13 th
Fast growing trees		
Gmelina	seventh	15 th
Nurse trees		
Bagras	sixth	14 th
Bagalunga	seventh	15 th
Kakawate	fourth	
Falucata	seventh	tenth

3) Required Capital for Establishment of Fruit Tree-based Farming System and Production /Protection Forest

According to some subprojects of ADB assisting Forestry Sector Project under DENR, the cost of establishment for production forest is estimated about 25,000 Pesoes/ha. The establishment cost of fruit tree-based farm is much more than that in production forest. However, during the establishment of fruit tree-based farm and production forest almost no income or only limited income will be generated. Therefore, the availability of farm credit for the establishment is prerequisite.

Table 5-1 Target Crop Yield with Project

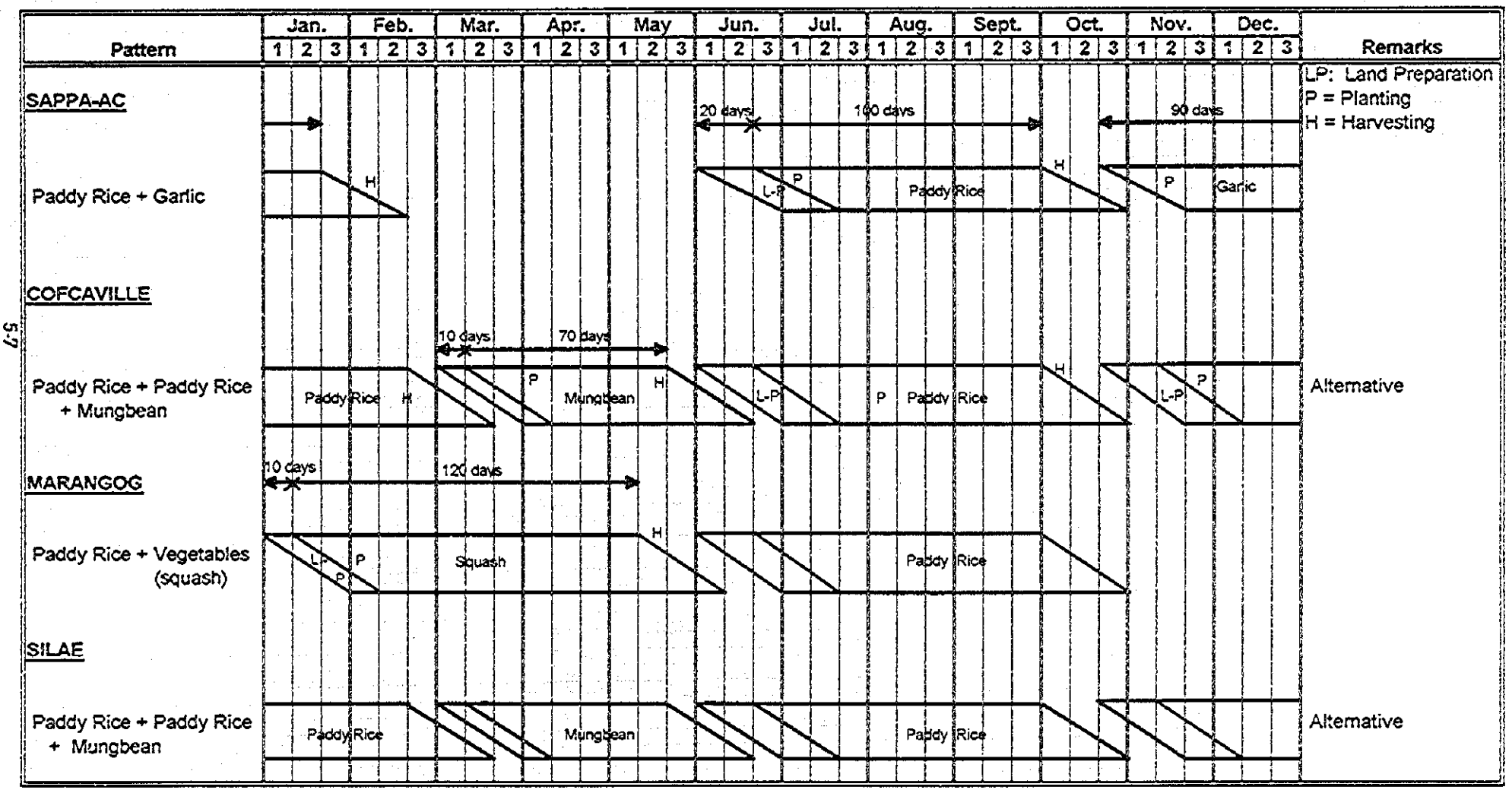
(Unit:ton/ha)

Crop	Estimated Yield by Land Class				ARC							
		Land Class			Sappaac		Cofcaville		Marangog		Silac	
	Potential (100%)	S1 (95%)	S2 (85%)	S3 (75%)	Land Class	Yield	Land Class	Yield	Land Class	Yield	Land Class	Yield
1. Paddy Rice. Irrigated												
- Wet Season	5.2	4.9	4.4	3.9	S2	4.4	S1	4.9	S2	4.4	S1	4.9
- Dry Season	5.8	5.5	4.9	4.3	S2	4.9	S1	5.5	S2	4.9	S1	5.5
2. Paddy Rice. Rainfed	3.7	3.5	3.1	2.8	S2	3.1	S1	3.5	S2	3.1	S1	3.5
3. Corn. White (Open pollinated)	4.0	3.8	3.4	3.0	S3	3.0			S3	3.0		
4. Corn. Yellow (Hybrid)	4.7	4.5	4.0	3.5			S3	3.5			S3	3.5
5. Mungbean	1.2	1.1	1.0	0.9	S3	0.9	S3	0.9	S3	0.9	S3	0.9
6. Peanut	1.2	1.1	1.0	0.9	S3	0.9	S3	0.9	S3	0.9	S3	0.9
7. Sweet Potato	9.0	8.6	7.7	6.8	S3	6.8	S3	6.8	S3	6.8	S3	6.8
8. Cassava	12.8	12.2	10.9	9.6			S3	9.6				
9. Squash	3.8	3.6	3.2	2.9					S2	3.2		
10. Garlic	3.0	2.9	2.6	2.3	S2	2.6						

Note: (1) The source of data on the respective potential yield
Paddy rice. irrigated...Bohol Irrigation Development Project Phase II, JICA. 1985
Paddy rice rainfed...Philippine Integrated Agriculture Infrastructure and Support Services Project. Draft Final Report. ADB. 1996
Corn. White...Gintong Ani Corn Production Program. 9 Basic Steps towards a Bountiful Corn Harvest. DA
85 % of attained yield for IES Cn 1
Corn. Yellow...Gintong Ani Corn Production Program. 9 Basic Steps towards a Bountiful Corn Harvest. DA
85 % of average attained yield for SMC 305 and other four varieties
Peanut...Estimated the attained yield in the recommended component technology program. DA II. 1995)
Sweet Potato....Average of statistical data for Abra. Qurrino. Leyte. and Bukidnon provinces. 1991-1995 in BAS data
Cassava...Investment opportunity of cassava. DA Region X
Squash...Development Project of Viable Agrarian Communities in Southern Plawan. JICA. 1995
Garlic...Ilocos Norte Irrigation Project. JICA. 1980

(2) Land class by study area...Estimated by the soil survey result for most part of land to be caultivated the respective crops.

FIGURE 5-1 PROPOSED CROPPING PATTERN (IRRIGATED AREA)



6. ANIMAL HUSBANDRY AND INLAND FISHERIES

6. GUIDELINE FOR LIVESTOCK PROJECT FORMATION

1) Formulation of the Development Framework

In the formulation of the development program/project, in addition to the consideration for the measures to be taken, in order to attain the project target, alternative field survey should be carried out in a way to consolidate opinions among the regional department of agriculture officials and also non-government organization, if necessary.

2) Status of Project/Program on the Regional Economy, Goals and Objectives

The goals of the planned livestock and poultry development project are to meet the projected demand and farmer's needs for livestock products through;

- Maximum use of domestic resources
- Minimum dependence of (import) inputs
- Erecting employment and improving farm income via greater and more intensive participation of small holders.

3) Socio-Economic Framework and Beneficiaries

In the formulation of the program/project, fostering of small farmers should be planned.

4) Evaluation of the Background

Evaluation on livestock and poultry sector in the country and the Region should be undertaken, and following analyses should also be made;

- Role,
- Function,
- National performance,
- Efficiency,
- Review the present livestock position in the country and the region and its profitability (consult with Regional Department of Agriculture's livestock officers and veterinarians),
- Evaluate existing management levels for livestock and poultry production and distribution,
- Major constraints.

5) Focus of the Program/Project

- Focus of livestock and poultry development on rural segments of the population - particularly, those households below the poverty line,
- Focusing domestic market and diversify people's diet.

6) Identification of the Program/Project

- Identify limiting factors and remedial measures focusing particularly on feed and fodder availability and the place of livestock with the farming systems on the basis of recent statistics and field observation.
- Identify investment and input requirement.
- Identify how new technologies can be introduced and existing bottlenecks overcome.

7) Determination of the Development Areas

Development zoning should be determined according to the regional plan or intensive development areas. This development zoning should be determined through discussion with regional department of agriculture officials, taking into consideration macro-economic factors.

8) Preparation of the Development Strategies

In the formulation of the development strategy, planning flexibility shall be required.

9) More emphasis to intensification instead of unlimited extensive increase of different animals, many areas may be technically suitable for livestock development, careful studying is required of the financial and economic viability of investment into animal production.

10) Justification may depend on in direct benefit such as crop residue utilization, soil fertilization and employment.

Figure 6-1 indicates the relationship among these components.

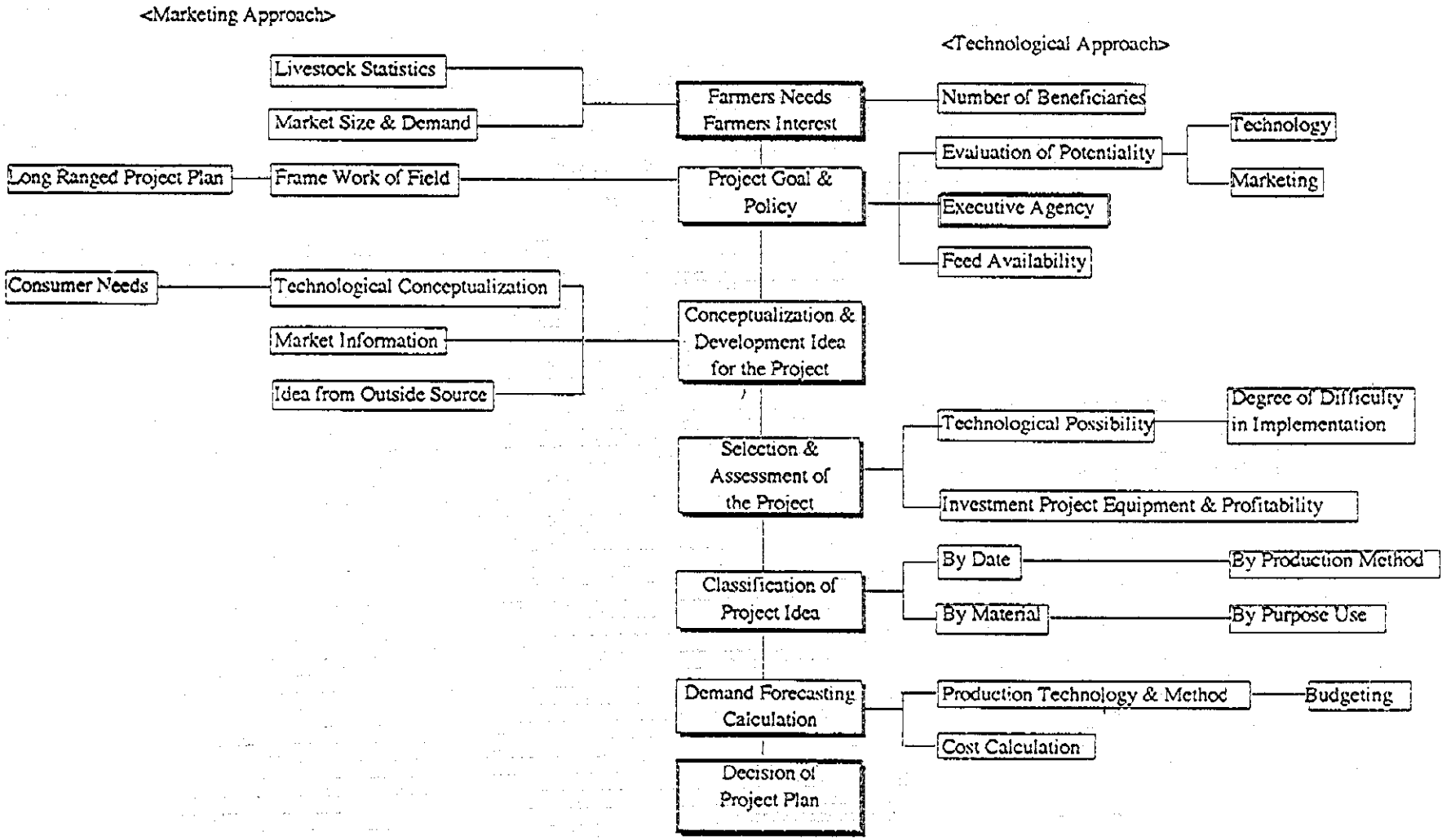


FIGURE 6-1 GUIDELINE FOR LIVESTOCK PROJECT FORMATION

7. POST-HARVEST AND RURAL AGRO-INDUSTRY PLAN

7. Post-Harvest and Rural Agro-Industry

7. Post-Harvest and Rural Agro-Industry

7.1 Post-Harvest Development

Post-harvest development is aiming at shortening of working hours, lightening of heavy works, reduction of post-harvesting losses and upgrading of crops quality. If the plan for post-harvest development is designed for these purposes, designers or beneficiaries should understand that the hardware such as equipment and facilities is needed for the development and those equipment and facilities require investment costs, operation and maintenance costs as well as installation and storage places. Therefore, if the benefits from the development could be higher than the total costs of depreciation of investment and operation & maintenance, such development plan should be promoted.

The guideline for the development plan should be drawn up in the following five stages such as a) survey in and around the study area, b) planning of development c) confirmation of plan, d) implementation and e) monitoring and evaluation.

Contents of Guideline

1) Survey in and around the Study Area

a) Selection and Determination of Agricultural Crops

Select the possible agricultural crops to be developed depending on the following items;

(1) Yield Survey
Yield is preferred to the normal high or higher land yield.

(2) Production Volume and Quality:
Production volume is higher than the supposed performance of equipment and facilities. It is preferable that the quality is good or better than the normal quality.

(3) Composition of Field
Field of proposed crops is located near the collecting point and wide enough.

(4) Infrastructure of the Area and Vicinity
Road should be so good, that jeepney or truck may be passed. Electricity is not necessary for some equipment and facilities i.e. equipment without motor.

(5) Contents of Other Development Plan Concerned
Farming technology development may effect the yield.

(6) Present and Development Conditions in the Area and Vicinity
Especially, irrigation and farming development will increase the yield and production. Its contents should be obtained.

(7) Kinds, Performances and Prices of Equipment and Facilities
Supposed equipment and facilities should be selected according to the distribution conditions in and around the area. Their performances and prices should be obtained.

b) Present Post-Harvest Conditions of Selected Crops

(1) Manner of Post-Harvest
Survey of present post-harvesting conditions such as manual or mechanical. In marginal area, manual post-harvest is popular.

(2) Working Hours
Whether working hours are long or not compared with the normal.

(3) Weight of Works
Whether works are heavy or not, especially, during the planting and harvesting seasons.

(4) Harvesting Loss
How many are the harvesting losses? Usually, post-harvesting losses are very high in the marginal area for lack of post-harvest facilities. It is said that the post-harvesting losses are approximately 10-23%.

(5) Crop Quality
How is the quality of crops? Crop quality is very low in the marginal area for lack of quality control equipment and lack of instructions and training from the Government. Quality standards of rice and corn can be referred to the NFA standards.

(6) Marketing Conditions
Are there many marketing places in and around the area? Marginal area is normally far from the marketing places.

(7) Farmers' Skills and Intention
Does a farmer have enough skills or not? Usually, the farmer is conducting the traditional farming.

(8) Investment Capability

Does a farmer have enough capital for investment or not? Usually, the farmer has not enough capital. Loan from the bank burdens the farmer with high interest, worry of many application forms and mortgage. Government support should be necessary for this matter.

(9) Assistance Agency

In marginal area, any periodical training and instruction from the Government is not carried out. Government should support at least at the first stage of the development.

2) Plan Formulation

(a) Concept Determination about Basic Development

(1) Comprehension of Problems, Constraints and Potential

According to the above mentioned survey, conduct the data analysis and comprehension of problems, constraints and potential.

(2) Selection of Kinds, Performances of Equipment and Facilities

To solve the problems and constraints, set up the criteria for selecting the equipment and facilities. Select them according to the criteria and kinds, performances and prices of the equipment and facilities. The weight of profits and deficits from the introduction of the equipment and facilities should be considered.

(3) Selection of Their Installation and Storage Places

Select the installation places taking into consideration the good access and land ownership. Public land is preferable because the equipment and facilities will be used for all beneficiaries in the area.

(4) Planning of Management Manner

Prepare the manner of management. Who will manage the equipment and facilities? It is recommendable that Project Management Office should be established for that works.

(5) Planning of Operation and Maintenance Manner

Draw up the manner of Operation and Maintenance. Who will conduct it? It is effective that the farmers' cooperative will take care of the simple or small implemented equipment and facilities.

b) Formulation of Basic Development Plan

(1) Calculation of Basic Project Investment and Benefits

Low investment cost and high return are preferable.

(2) Execution of Case Study
Find out the low, middle and high returns. By the first investment, the middle or low returns might be expected.

(3) Planning of Basic Implementation Manner
Form the implementation manner. Newly established PMO should be conducted the planning.

3) Confirmation of Plan

a) Examination of Basic Development Plan

It is necessary that the farmers' cooperatives, FO, LGU, NGO and other personnel concerned participate the following activities.

- Confirmation of Beneficiaries' Intentions and Skills
- Confirmation of Management Manner
- Confirmation of Operation and Maintenance Manner
- Confirmation of Installation and Storage Places

b) Formulation of Development Plan

- Calculation of Break-Even Point
  It is preferable that the break-even point is higher than the banking interest.

- Determination of Implementation Manner
  Newly established Coordinating Committee should draw a conclusion.

4) Implementation of Development Project
Newly established PMO will be in charge under the supervision of Coordinating Committee.

5) Monitoring and Evaluation
Provincial DAR will conduct the monitoring and evaluation periodically with coordination of the PMO. These monitoring and evaluation should be utilized for the next development planning for other similar marginal areas.

Flow Chart of this guideline is referred to Figure K7-1.

7.2 Rural Agro-Industry Development

Rural agro-industry development is aiming at the emergency food storage, obtaining of high return and increasing of livelihood. If the plan for agro-industry development is designed for these purposes, designers, or beneficiaries should understand that the equipment and facilities are essential for the development, and those equipment and facilities require investment cost, operation and maintenance cost as well as installation and storage places. Therefore, if the benefits from the development could be higher than the total cost of depreciation of investment and operation & maintenance, such development plan should be promoted.

The guideline for the development plan should be drawn up in the following five stages i.e. a) survey in and around the study area, b) planning of development c) confirmation of plan, d) implementation and e) monitoring and evaluation.

Contents of Guideline

1) Survey in and around the Study Area

a) Selection and Determination of Agricultural Crops

Select the possible agricultural crops to be developed depending on the following items:

(1) Yield Survey
It is preferred to the higher crop yield than the others.

(2) Production Volume and Quality
Production volume is higher than the supposed performance of equipment and facilities and production in other areas. It is preferable that the quality is good or better than the normal quality.

(3) Composition of Field
Field of proposed crops should be located near the collecting point and wide enough.

(4) Infrastructure of the Area and Vicinity
Road should be better, so that truck can be passed. Electricity is necessary for some equipment and facilities and operation convenience.

(5) Contents of Other Development Plan Concerned
Farming technology development may effect the yield. Production volume and yield from the development should be obtained.

(6) Present and Development Conditions in the Area and Vicinity
Especially, irrigation and farming development will increase the yield and production. Its contents should be obtained.

(7) Kinds, Performances and Prices of Equipment and Facilities
Supposed equipment and facilities should be selected according to the distribution conditions in and around the area and marketing conditions. Their performances and prices should be obtained.

b) Present Agro-Industry Conditions of Selected Crops

(1) Manner of Agro-Industry
Survey of present agro-industy conditions such as the marketing condition and users' skills to be taken into consideration. In marginal area, agro-industry is not popular.

(2) Crop Quality, Market Needs
How is the quality of crops? Crop quality is very low in the marginal area for lack of quality control equipment and lack of instructions and training from the Government. Quality standards of rice and corn can be referred to the NFA standards. Collect the data of consumers' intention and needs.

(3) Marketing Conditions
Are there many marketing places in and around the area? The marginal area is normally far from the marketing places. Survey whether marketing price information system is there or not? The manager should know the daily marketing prices for obtaining the higher selling prices. Institutional support is necessary for this matter.

(4) Farmers' Skills and Intention
Does a farmer have enough skills or not? Usually, the farmer has not enough skills for making the good quality produce and selling to the market. It is necessary for the Government support and instruction.

(5) Investment Capability
Does a farmer have enough capital for investment or not? Usually, the farmer has not enough capital. Loan from the bank burdens the farmer with high interest, worry of many application forms and mortgage. Government support should be necessary for this matter.

(6) Assistance Agency

In marginal area, any periodical training and instruction from the Government is not carried out. Government should support at least at the first stage of their development.

2) Plan Formulation

a) Concept Determination about Basic Development

(1) Comprehension of Problems, Constraints and Potential
According to the above survey, conduct the data analysis and comprehension of problems, constraints and potential.

(2) Selection of Kinds, Performances of Equipment and Facilities
To solve the problems and constraints, set up the criteria for selecting the equipment and facilities. Select them according to the criteria as well as kinds, performances and prices of the equipment and facilities. The weight of profits and deficits from the introduction of the equipment and facilities should be concerned.

(3) Selection of Their Installation and Storage Places
Select the installation places taking into consideration the good access and land ownership. Public land is preferable because the equipment and facilities will be used for all beneficiaries in the area.

(4) Planning of Management Manner
Prepare the manner of management. Who will manage the equipment and facilities? It is recommendable that Project Management Office (PMO) should be established for that works.

(5) Planning of Operation and Maintenance Manner
Draw up the manner of Operation and Maintenance. Who will conduct it? It is effective that the PMO will take care of them. However, small and simple equipment may be maintained by the cooperative or beneficiaries.

b) Formulation of Basic Development Plan

(1) Calculation of Basic Project Investment and Benefits
Low investment cost and high return should be necessary.

(2) Execution of Case Study
Find out the low, middle and high returns. By the first investment, the middle or low returns might be expected. Reasonable plan should be drawn up taking into consideration the benefits and deficits from the introduction of the facilities.

(3) Planning of Basic Implementation Manner
Form the implementation manner. Newly established PMO should be conducted the planning.

3) Confirmation of Plan

a) Examination of Basic Development Plan

It is necessary that the farmers' cooperatives, FO, LGU, NGO and other personnel concerned participate the following activities.

- Confirmation of Beneficiaries' Intentions and Skills
- Confirmation of Management Manner
- Confirmation of Operation and Maintenance Manner
- Confirmation of Installation and Storage Places
-

b) Formulation of Development Plan

- Calculation of Break-Even Point
  It is essential that the break-even point is higher than the banking interest.
- Determination of Implementation Manner
  Newly established Coordinating Committee should draw a conclusion.

4) Implementation of Development Project
Newly established PMO should be in charge under the supervision of Coordinating Committee.

5) Monitoring and Evaluation
Provincial DAR should conduct the monitoring and evaluation periodically with coordination of the PMO. These monitoring and evaluation should be utilized for the next development planning for other similar marginal areas.

Flow Chart of this guideline is referred to Figure K7-2.

FIGURE 7-1 FLOW CHART FOR GUIDELINE OF POST-HARVEST DEVELOPMENT PLAN

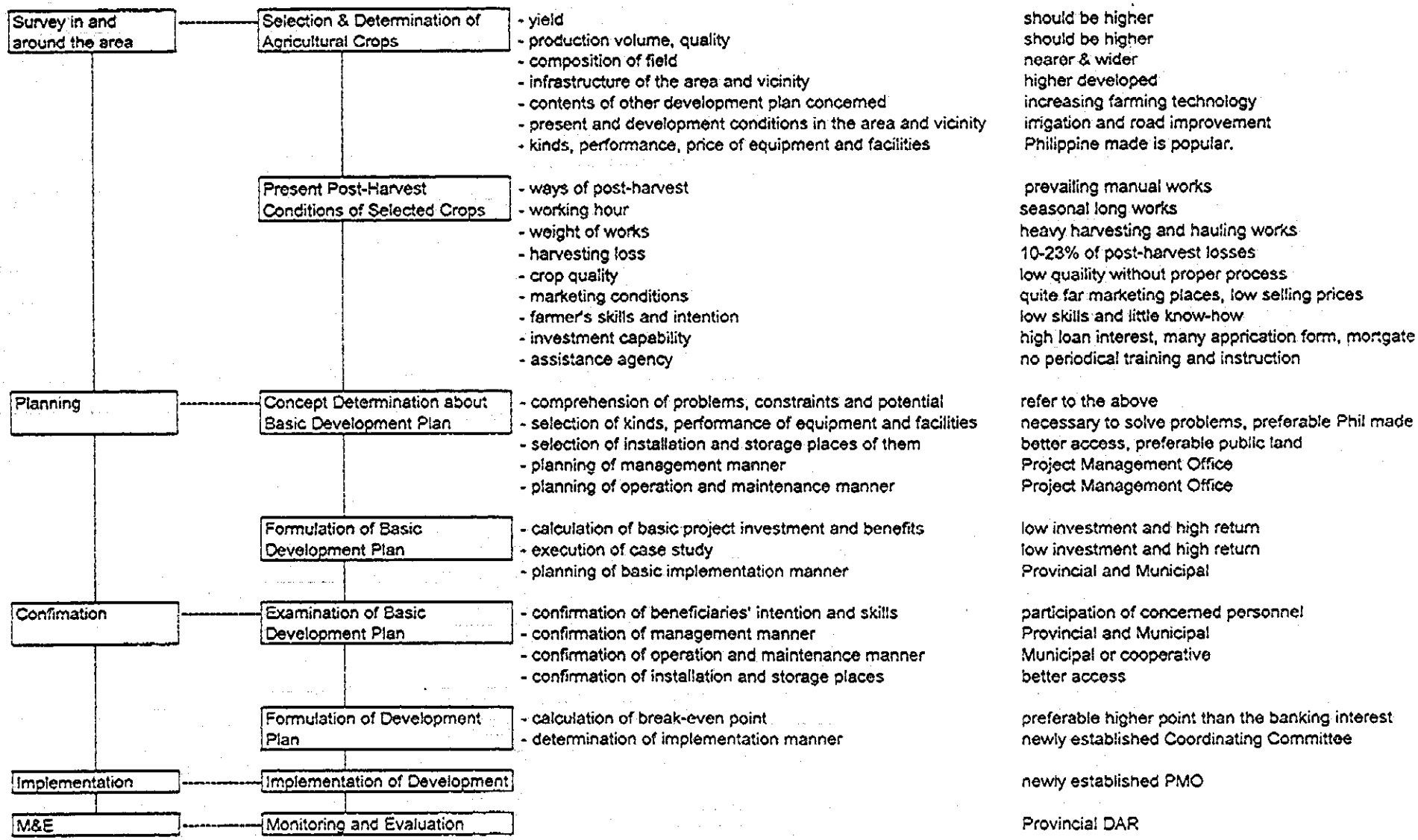
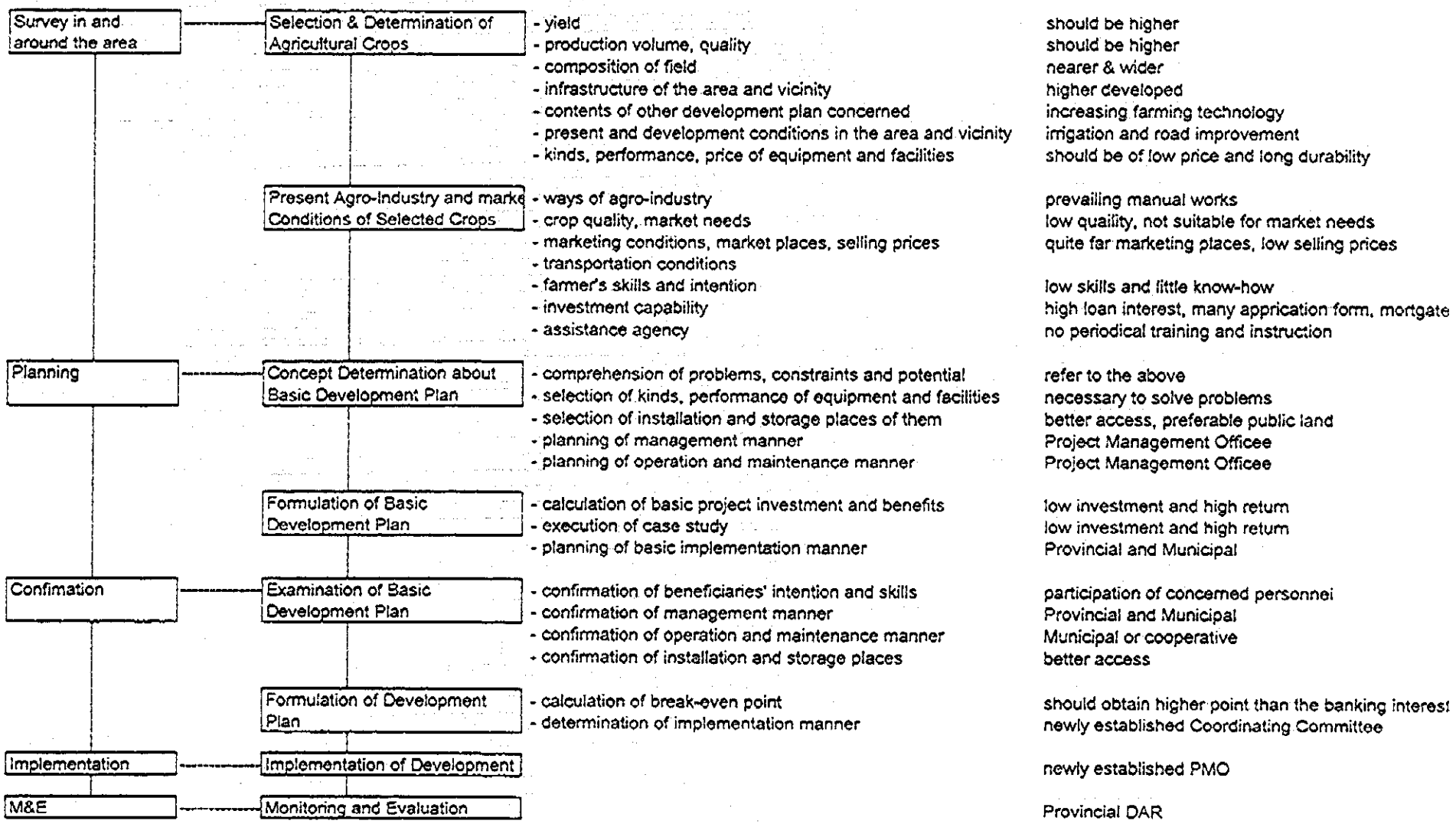


FIGURE 7-2 FLOW CHART FOR GUIDELINE OF AGRO-INDUSTRY DEVELOPMENT PLAN



8. AGRICULTURAL SUPPORTING PLAN

8. Agricultural Supporting Plan

8. Agricultural Supporting Plan

The process of making an agricultural institutional supporting plan for the development of agrarian reform communities in marginal areas is as follows.

1) Making a List of Support Service Agencies

A list of support agencies for the various fields is made by filling up of the following table;

Items to be supported	Support Agencies
- Production technology	NGs, LGUs, NGOs
- Extension and training	ditto
- Production materials	ditto
Seeds and seedlings	ditto
Livestock	ditto
Fry and fingerling	ditto
Fertilizer & agricultural chemicals	ditto
- Farming funds	ditto
- Marketing	ditto
- Farmers organization	ditto

2) Execution of Memorandum of Agreement

In order to form an institutional supporting system among the different government agencies and non-government organizations, DAR executes a Memorandum of Agreement between DAR and the executives of support agencies.

3) Appointment of Project Officers

DAR plays roles in coordinating the works among the support agencies and facilitates the projects with appointment of each one officer in the head office of DAR, regional DAR, PARO and MARO concerned to the Project Areas.

4) Preparation of Land-Use Plan

Land-use plan is prepared jointly with RIARC, ROS, DENR, MAO and farmers in the Project Area with ROS as the central figure taking into consideration of soil, meteorological condition, irrigation condition, topography and farming conditions of farmers. The preparation of joint work is taken by development facilitator of MARO.

5) Production Technology Support

Production technology support is taken by the agencies of Regional DA including RIARC and ROSs, DENR, MAO. The agencies prepare production plan for the Project Area with the joint work of the agencies and the farmers. The items including in the production plan are; kind of crops / fruit trees / forest trees and their varieties to be introduced, area to be cultivated, cultivation technology to be introduced, amount/number of input materials, expected yield and production, sowing time, transplanting time, harvesting time, cropping system, labor amount required, expected farming income.

Plan of the livestock and fish culture are made with the joint work of RIARC, ROS, PCC, MAO and the farmers. Main items to be included in the plan are kind of livestock / fish to be introduced, breeding technology to be introduced, number of livestock / fish fry to be introduced, input materials, expected production and the economic evaluation.

6) Extension and Training Support

Extension and training support are carried out by DA, PAO and MAO with establishment of techno-demo farms and PAO, MAO, ROSs and ATI with conducting farmers training as mentioned below.

a) Establishment of Techno-Demo Farms

The two techno-demo farms are established in a Project Area by joint work of DA, PAO and MAO as mentioned below.

Cluster	Techno-Demo Farm	Number of Fields	Area Cultivated (ha)	Crops and Trees
I	Advanced lowland farming	1	0.2	Irrigated rice, Rainfed rice, Corn, Garlic,
	Advanced upland farming with SALT	1	3.0	Corn, Peanut, Mungbean, Mango, cashew, Acacia, Madre de cacao, Mahogany
II	Advanced lowland farming	1	0.2	Irrigated rice, Rained rice, Mungbean
	Advanced upland farming with SALT	1	3.0	Corn, Mungbean, peanut, Sweet Potato, Banana, Rambutan, Gemelina, Flemingia, Mahogany

Cluster	Techno-Demo Farm	Number of Fields	Area Cultivated (ha)	Crops and Trees
III	Advanced lowland farming	1	0.2	Irrigated rice, Rainfed rice, Squash, Corn
	Advanced upland farming with SALT	1	3.0	Corn, Peanut, Mungbean, Sweet Potato, Coconut, Banana, Mango, Durian, Abaca, Acacia, Mahogany, Madre de Cacao, Flemingia, Pine

7) Financing Support

CDA and LBP are the support agencies of financing. Cooperative members need to receive training from CDA or LBP in management of cooperative, behavior of cooperative members, grant condition of loan and method of economic diagnosis of own farming etc.

8) Marketing Support

Provincial CDA and DTI support market development technology, such as introduction of buyers, price information, technology for supply of production materials to the members and sale of their products etc.

9) Farmers Organization Support

DTI, CDA and LBP support development and strengthening of cooperative with farmers' training.

10) Production Materials Support

Development facilitator of MARO grasps the necessary amounts of production materials such as seeds, seedlings, livestock, fish fries, fertilizers and agricultural chemicals to be provided by the support agencies after discussion with the farmers, based on the production plan prepared by the joint work of DA, PAO, MAO and farmers, and requests for the agencies the amounts/number of production materials to be provided by each agency.

On the fruit seedlings, the amounts to be provided by each agency should be decided in consideration of their production capacities. The fruit seedlings have to use grafted and virus free seedlings with the best variety in quality so as to survive market competition in future. The price of the

production materials should be production cost price.

In order to enhance an advanced technology, it is proposed that DAR advances farmers the costs of seeds and fertilizers for improved rice and corn cultivation with the condition of deferred payment for the five years of the initial stage of the project.

9. IRRIGATION AND DRAINAGE PLAN

9. Irrigation and Drainage Plan

9. Irrigation and Drainage Plan

9.1 Introduction

The proposed marginal areas in the Philippines are located in the whole country, and present cultivation in these areas has been practiced under the rainfed condition using available rainfall. However, the cultivation types are quite different from the areas depending on the climate conditions classified into four types. For instance, climate type-I has two pronounced seasons, wet and dry seasons, and no rainfall during dry season, while climate type-IV has evenly distributed rainfall throughout the year.

The relation among Cluster identified through classification study of the Model Area, region, and climate types are tabulated as shown below;

Relation among Cluster of Model Areas, region, Climate Type

Cluster	Model Areas	Region	Climate Type	Develop. Type
Cluster-1	Sappaac ARC	CAR	I	I, II
	Montilla ARC	III	I	III
	Maulawin ARC	IV	IV	III
Cluster-2	Talugtog ARC	I	I	I
	Cofcaville ARC	II	III	III
	Pag-asa ARC	V	II	III
Cluster-3	Abiera Estate	VI	III	IV
	San Vicente ARC	VII	IV	III
	Marangog ARC	VIII	IV	IV
	Silae ARC	X	III	IV
	Kipalili ARC	XI	II	IV
	Mat-i ARC	XIII	IV	IV

As is observed in the above table, development type I and II, which have a potential for irrigation plan with adequate water resources such as creek water and spring water, and also located mainly in the northern part of Luzon, are categorized into the limited areas in a part of Cluster-1 and -2.

Under the situations, since it is difficult to describe the guideline on irrigation and drainage fields depending on the classified Cluster and Development Type, the irrigation and drainage guideline given in hereinafter describes in case applicable for Development Type of I and II only.

9.2 Irrigation Plan

The Study Areas of marginal areas are generally located in hilly and undulating topography with scarce water resources for irrigation, so that large scale of irrigation plan could not inevitably be expected in the project. However, supposed small amount of water resources by means of creek water or spring water were available to be used, irrigation plan using those water resources would be formulated considering the low investment costs for the Area.

The subsequent deals with the necessary procedures to make irrigation and drainage plan to the areas.

9.2.1 Calculation of Irrigation Water Requirement

Since the calculation of irrigation water requirement for the specified areas has no relation with the classification of Model Area, general methods for the calculation will be described hereinafter.

1) Proposed Cropping Patter

Proposed cropping pattern is the basic data for the calculation of irrigation water requirement in the area. Therefore, the most suitable cropping pattern to the area , inclusive of alternative cropping patterns should be prepared by agronomy group.

2) Calculation of Reference Crop Evapotranspiration(ETo)

a) Calculation Methods

Reference crop evapotranspiration(ETo), generally recognized as fairly reliable index in calculating consumptive use, can be determined by a number of methods, such as the evaporation measurement with evaporation pan and the application of empirical formula based on the climatological data. Since the ETo values used in NIA, however, has been calculated applying Modified Penman method , same method was followed in the project.

The Modified Penman method is the most complete theoretical approach, showing that consumptive use is inseparably connected to incoming solar energy. The formula representing the ETo is shown below;

$$ETo = C \times [W \times Rn + (1-W) \times f(u) \times (ea-ed)]$$

where;

ETo	=	reference crop evapotranspiration (mm/day)
Rn	=	net radiation in equivalent evaporation (mm/day)
(ea -ed)	=	difference between the saturation vapor pressure at mean air temperature and the mean actual vapor pressure of the air (mbar)
C	=	adjustment factor to compensate for the effect of day and night weather conditions.

b) Necessary Data and Calculation Procedures

As the basic data for calculation of the ETo, following climatological data should be collected on the monthly basis;

- Mean temperature (°C)
- Mean relative humidity (%)
- Wind speed (km/day)
- Dewpoint(°C)
- Cloudiness
- Uday/Unight

Detailed calculation procedures of the ETo is referred to the attached guidebook for the calculation of ETo prepared by NIA. Table 9-1 shows one of the sample in case of Sappaac ARC in the Province of Abra.

3) Calculation of Crop Evapotranspiration (ETcrop)

Crop evapotranspiration (ETcrop), which is equivalent to an actual evapotranspiration of crop, is calculated by multiplying the estimated ETo values by the crop coefficient (kc), which express the relation between reference and actual evapotranspiration during distinct vegetative stage of the crop.

Kc Values of Paddy Rice

The Kc values of paddy rice is assumed to be one(1) throughout growing season.

Kc Values of Upland Crops

Since the Kc values related to the upland crops are generally not available, the values will be estimated on the 10-day basis in accordance with the attached NIA's guidebook. Table 9-2 shows the procedure to obtain the Kc values of mungbean as a sample.

4) Calculation of Irrigation Water Requirement

Two types of irrigation water requirement should be estimated; one will be irrigation water requirement without effective rainfall and the other will be with effective rainfall. The maximum water requirement in case of former one will be used for design of irrigation facilities such as canal and its related structures, while the latter one being equivalent to actual water demand will be used for reservoir operation study mentioned subsequently.

In estimating the irrigation water requirement in the period of 10 day basis, followings are taken into account;

- Effective rainfall
- Reference crop evapotranspiration (ETo)
- Percolation in paddy rice
- Crop coefficient (Kc)
- Crop evapotranspiration (ETcrop)
- Crop water requirement
- Irrigation water requirement
- Diversion water requirement

Effective Rainfall

As a first step of the effective rainfall, design rainfall should be selected based on annual rainfall of at least 20 years data observed at the neighboring observation station. In the project, design rainfall with return period of 1/2 was adopted considering characteristic of marginal areas such as size of area, topography and scarce water resources.

Reference Crop Evapotranspiration (ETo)

Refer to the above mentioned descriptions.

Percolation of Paddy Field

Percolation rate of paddy field is assumed at 1.0 mm/day.

Crop Coefficient (Kc)

Refer to the above mentioned descriptions.

Crop Evapotranspiration (ETcrop)

Crop evapotranspiration could be estimated by multiplying reference crop evapotranspiration by crop coefficient mentioned in the above.

Crop Water Requirement

Crop water requirement could be estimated by adding percolation rates to crop evapotranspiration mentioned in the above.

Irrigation Water Requirement

Irrigation water requirement could be estimated by subtracting effective rainfall from crop water requirement.

Diversion Water Requirement

Diversion water requirement could be estimated by dividing irrigation water requirement by irrigation efficiency. In the project, following irrigation efficiencies were adopted;

These irrigation efficiencies were determined on the basis of "FAO Irrigation and Drainage Paper 24". Especially, conveyance efficiency was decided at 90 percent because irrigation canal will be made by concrete flume.

Irrigation Efficiency

Irrigation Efficiency	Paddy Field	Upland Crops
	(%)	(%)
Application Efficiency	70	60
Conveyance Efficiency	90	90
Operation Efficiency	90	90
Overall Efficiency	56.7	48.6

Table 9-3 and Table 9-4 show the one of the sample of the estimated irrigation water requirement without and with effective rainfall in case of Sappaac ARC in the Province of Abra.

9.2.2 Reservoir Operation Study

In case that small scale reservoirs or tanks are proposed in the irrigation plan, reservoir operation study on 10-day basis should be analyzed in order to decide the most optimum irritable areas in both wet and dry seasons.

Table 9-5 shows one of the sample of reservoir operationstudy in case of Sappaac ARC, and in the analysis followings are taken into account;

- Inflow to reservoir
- Diversion requirement
- Irrigation area
- Irrigation requirement
- Total outflow of water (release water from reservoir and losses)
- Effective storage of reservoir
- Water level of reservoir
- Spillage water from reservoir
- Shortage of water in reservoir

Inflow to Reservoir (Qi)

- Direct Inflow;
  Direct inflow to reservoir from its own catchment area should basically be actual monthly observation data, however, in the marginal areas such data are usually not available, so that direct inflow will be estimated based on the following equation and assumptions;

  Monthly run-off discharge (Qr) = R x A x C
  where;
  R = 10-day basis average rainfall in design year with return period of 1/2-year.
  Two years average data will be used considering the rainfall fluctuation by year.
  A = catchment area (ha)
  C = run-off coefficient, 0.6

- Diverted Flow;
  Since marginal areas are usually in scarce water resources, available water in the vicinity, sometime, diverted to the reservoir area by means of pipeline. These amounts of diverted water should be observed in both wet and dry seasons.

Diversion Requirement

Refer to the above mentioned diversion water requirement with considerations of effective rainfall.

Irrigation Area

Out of the potential cultivation areas, which will be delineated in the land use plan to be analyzed by agronomy group, irrigation areas will be finally decided through trial calculation reservoir operation study on the following assumption and procedures; at first, irrigation area will be assumed, and check the frequency of water shortage. If shortage of water will occur at the frequency more than two times a year, the assumed area should be reduced. In the above trial calculation, the shortage of water less than 15 cu.m/day will be considered to be negligible small.

Irrigation Requirement

Irrigation requirement could be calculated by emulsifying diversion water requirement by irrigation areas to be used for paddy rice and upland crops.

Total Outflow of Water (Qo)

Total outflow of water from reservoir consists of two items, that is, released water for irrigation mentioned above and reservoir losses. The reservoir losses were assumed at 0.5 percent of the reservoir storage capacity in previous 10-day decade.

Effective Storage of Reservoir (Se)

Effective storage capacity of the reservoir is net amount of water to be utilized for irrigation after subtracting dead storage capacity from total storage capacity. These dimension of reservoir should be decided by design group.

Water Level of Reservoir (W-EL)

Water level of reservoir will be converted from the stored water using stage-storage capacity curve. Initial water level of reservoir in the operation study will be normal water level (NWL) at the full storage capacity (S_f) at the beginning of wet season.

Spillage Water from Reservoir (Qs)

Spillage of water from reservoir could be calculated based on the following rule;

- If $(Se_{-1} + Qi - Qo) > S_f$, $Se_{-1} + Qi - Qo - Se$
- If $(Se_{-1} + Qi - Qo) < S_f$, 0

where; Se_{-1} = effective storage capacity of reservoir at 10-day previous decade.

Shortage of Water in Reservoir

Shortage of water in the reservoir could be calculated based on the following rule;

- If $(Se_{-1} + Qi - Qo) > S_f$, $S_f - (Se_{-1} + Qi - Qo)$
- If $(Se_{-1} + Qi - Qo) < S_f$, 0

9.2.3 Water Management Plan

Irrigation water distribution method , in general, should be selected and decided in accordance with available water resources, size of rotation area, cropping pattern, growing stage of crops, crop water requirement, and irrigation facilities on the systems. However, in case of the project of marginal area, rotational irrigation methods should be practiced even though growing stage, due to scare water resources in the Area.

9.3 Drainage Plan

9.3.1 Calculation of Drainage Modules for Paddy Fields

The existing paddy fields located in low-lying area and flat topography are customarily inundated during the wet season, resulting in low agricultural crop production and occurrence of water-born diseases such as diarrhea and malaria in the areas.

In these areas, drainage improvement plan should be formulated in the project.

1) Rainfall Analysis

Prior to the formulation of the drainage plan, design rainfall to analyze the drainage discharge should be determined based on the daily maximum rainfall data observed for at least 20 years at the vicinity of Study Area.

2) Drainage Modulus

The drainage modulus for planning drainage facilities should be decided based on the following assumption that design rainfall would be drained within two days, and drainage modulus could be calculated by the following equation;

$$q = R_{max} \times C / (24 \text{ hr} \times 2 \text{ days})$$

where;

C = run-off coefficient, 0.8

9.3.2 Design Flood Discharge for Planning of Spillway for Small Water Impounding Dam

In case that small water impounding dam would be proposed in the project for the purposes of supplemental irrigation water supply for paddy fields, design flood discharge of the spillway would be calculated through the following procedures;

Design Rainfall

The design daily maximum rainfall would be decided on the basis of rainfall with a return period of 1/50-years. And the selected daily maximum rainfall would be distributed in hourly maximum rainfall using the following equation;

$$R_t = R_{24} \times (1/24)^k$$

where;

R_t = hourly maximum rainfall intensity (mm/hr)

R_{24} = 24 hour rainfall to be distributed (mm/24 hr)

k = 0.5

Design Flood Discharge

The design flood discharge (Q_p) for spillway would be calculated

based on the following equation;

$Q_P = R_t \times C \times A / 360$

where;

Q_P = Design flood discharge (cu.m/sec)

R_t = Design rainfall (mm/hr)

C = peak run-off coefficient , 0.8

A = catchment area, 7.2 ha

Table 9-1 Calculation of Reference Crop Evapotranspiration (ETo) Sappaac Area

Lat. : 17° - 30' Long. : 128° - 38'
Alt. : 220 m

Item	Month											
	June.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
1. Tmeam (°C)	27.9	27.4	26.7	27.2	27.2	27.0	25.9	25.5	26.0	27.6	28.8	28.7
2. RHmean (%)	83	85	87	85	81	79	75	74	75	75	75	78
3. Wind Speed (km/day)	184	189	206	202	86	86	86	86	86	96	86	86
4. Dewpoint (°C)	17	17	17	16	16	15	14	13	13	14	16	16
5. Cloudiness	6	7	7	7	6	5	4	4	4	4	5	6
6. Sun shine hour(hr)												
7. ea (mbar)	35.9	35.8	33.7	35.7	35.7	35.7	31.9	31.8	33.6	35.8	38.0	38.0
8. ed (mbar)	29.8	30.4	29.4	30.4	29.0	28.2	23.9	23.5	25.2	26.9	28.5	29.6
9. (ea - ed) (mbar)	6.1	5.4	4.4	5.4	6.8	7.5	8.0	8.3	8.4	9.0	9.5	8.4
10. f(u)	0.77	0.78	0.83	0.82	0.50	0.50	0.50	0.50	0.50	0.53	0.50	0.50
11. (1-w)	0.23	0.23	0.24	0.24	0.24	0.24	0.25	0.25	0.25	0.23	0.22	0.29
12. (= 9 * 10 * 11) (mm/day)	1.08	0.96	0.87	1.05	0.82	0.90	1.00	1.04	1.05	1.09	1.05	1.22
13. Ra (mm/day)	16.1	16.1	15.8	14.9	13.7	12.1	11.2	11.7	13.1	14.6	15.6	16.1
14. n/N	0.30	0.15	0.15	0.15	0.3	0.45	0.55	0.55	0.55	0.55	0.45	0.3
15. Rs (mm/day)	6.44	5.23	5.14	4.84	5.48	5.75	5.88	6.14	6.88	7.67	7.41	6.44
16. Rns (= 0.75 * Rs) (mm/day)	4.83	3.92	3.86	3.63	4.11	4.31	4.41	4.61	5.16	5.75	5.56	4.83
17. f(T)	16.3	16.2	16.0	16.1	16.1	16.1	15.9	15.8	15.9	16.2	16.5	16.4
18. f(ed)	0.10	0.10	0.10	0.10	0.10	0.11	0.12	0.13	0.12	0.11	0.11	0.10
19. f(n/N)	0.37	0.24	0.24	0.24	0.37	0.51	0.60	0.60	0.60	0.60	0.51	0.37
20. RnI (17 * 18 * 19)	0.60	0.38	0.39	0.38	0.62	0.87	1.19	1.20	1.14	1.09	0.88	0.61
21. Rn (=16 - 20) (mm/day)	4.23	3.54	3.47	3.25	3.49	3.44	3.22	3.41	4.02	4.66	4.68	4.22
22. W * Rn (mm/day)	3.26	2.73	2.64	2.47	2.65	2.61	2.42	2.56	3.02	3.59	3.65	3.00
23. (=12 + 22) (mm/day)	4.33	3.69	3.51	3.52	3.47	3.52	3.42	3.60	4.07	4.68	4.70	4.21
Udat/Unight	1.00	1.00	1.00	1.00	0.85	0.77	0.70	0.68	0.61	0.55	0.79	0.85
Uday (m/sec)	1.1	1.1	1.2	1.2	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.5
24. C	1.02	1.00	1.00	0.99	1.01	1.02	1.02	1.02	1.04	1.05	1.04	1.03
25. ETo (=23 * 24) (mm/day)	4.4	3.7	3.5	3.5	3.5	3.6	3.5	3.7	4.2	4.9	4.9	4.3

Data source : PAGASA
Data Station : Mean Temperature : Vigan, Ilocos, (1977 - 1986)
Relative Humidity : Vigan, Ilocos, (1977 - 1986)
Wind Speed : Bagio, La Union, (1977 - 1986)
Dewpoint : Bagio, La union, (1977 - 1986)
Cloudiness : Bagio, La Union, June - Sept. (1977 - 1986), Oct. - May (1977 - 1985)
Uday/unight : Bagio, La Union,

Table 9-2 Determination of Crop Coefficient for Garlic (Sappaac ARC)

Given :

Crop	:	Garlic planted in late of November, growing period of 90 days
Climate conditions		
Wind	:	Light to Moderate (0 - 5 m/sec)
Mid-summer RH	:	> 70 %
Irrigation		
ETo	:	3.5 mm/day
Irrigation Frequency	:	7 days (assumed)

I. Planting date : Late of October

II. Length of growth stages

Initial	:	20 days
Crop development	:	40
Mid-season	:	20
Late-season	:	10

III. Plot period as indicated : refer to below Figure

IV. Kc Value

Kc initial stage : Kc initial = 0.52 (refer to Figure-2)

ETo : 3.5 mm/day

Irrigation frequency = 7 days

Kc mid-season stage : Kc mid-season = 0.95 (refer to Table-13)

Wind = light/moderate

Humidity = high >70 %

Kc late-season stage (end) : Kc end of season = 0.75 (refer to Table-13)

Wind = light/moderate

Humidity = high >70 %

V. Plot Kc value and connect values with straight lines : Kc development stage = 0.35 - 0.95'
Kc late season stage = 0.95 - 0.75

VI. Read Kc value from prepared graph for each selected period at mid-point of 30-days

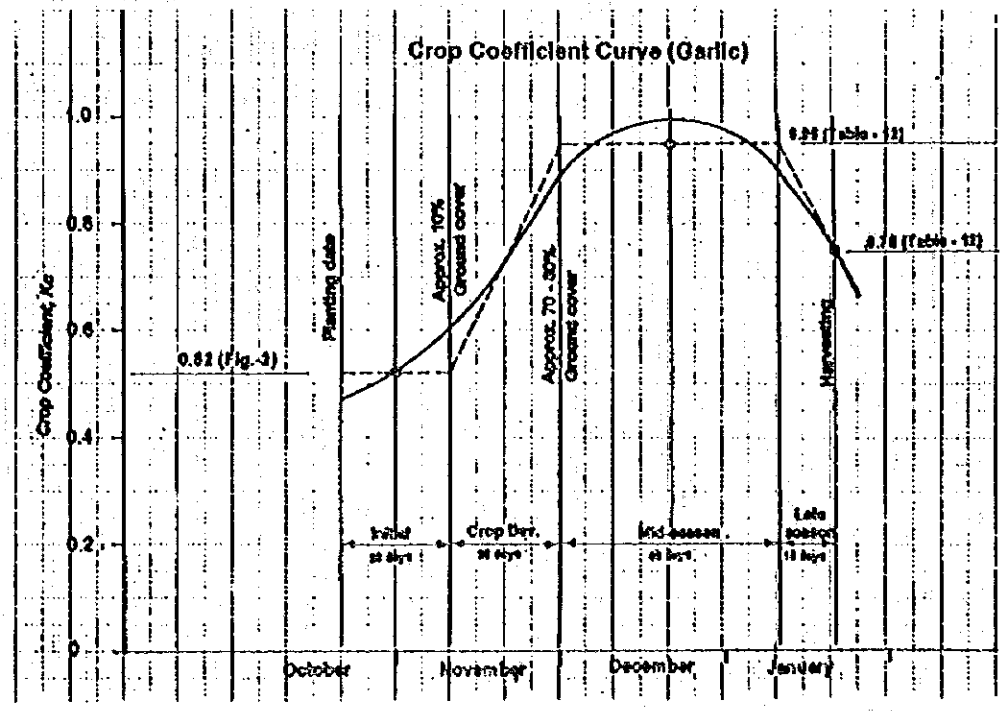


Table 9-3 Estimation of Irrigation Water Requirement Without Effective Rainfall (Sappaac ARC)

Description	January			February			March			April			May			June			July			August			September			October			November			December		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Proposed Cropping Pattern																																				
	Garlic																					Paddy Rice												Garlic		
80 % Rainfall(mm/10-days)	0	0	0	0	0											0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reference Crop Evapotranspiration (mm/10-days)	37.0	37.0	40.7	42.0	42.0											44.0	44.0	48.4	37.0	37.0	40.7	35.0	35.0	38.5	35.0	35.0	35.0	35.0	35.0	38.5	35.0	36.0	36.0	36.0	35.0	38.5
Percolation (mm/10-days)																10.0	10.0	10.0	10.0	10.0	11.0	10.0	10.0	11.0	10.0	10.0	10.0	10.0	10.0							
Crop Coefficient, Paddy Rice (mm/10-days)																1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00							
Upland Crops (mm/10-days)	0.95	0.84	0.75	0.75	0.75																									0.50	0.56	0.66	0.82	0.94	0.99	0.98
Crop Evapotranspiration, Paddy Rice (mm/10-days)																44.0	44.0	48.4	37.0	37.0	40.7	35.0	35.0	38.5	35.0	35.0	35.0	35.0	35.0							
Upland Crop (mm/10-days)	35.2	31.1	30.5	31.5	31.5																									19.3	19.6	23.8	29.5	33.8	34.7	37.7
Crop Water Requirement, Paddy Rice (mm/10-days)																54.0	54.0	58.4	47.0	47.0	51.7	45.0	45.0	49.5	45.0	45.0	45.0	45.0	45.0							
Upland Crops (mm/10-days)	35.2	31.1	30.5	31.5	31.5																									19.3	19.6	23.8	29.5	33.8	34.7	37.7
Irrigation Requirement, Paddy Rice (mm/10-days)																54.0	54.0	58.4	47.0	47.0	51.7	45.0	45.0	49.5	45.0	45.0	45.0	45.0	45.0							
Upland Crops (mm/10-days)	35.2	31.1	30.5	31.5	31.5																									19.3	19.6	23.8	29.5	33.8	34.7	37.7
Diversion Requirement, Paddy Rice (mm/10-days)																95.2	95.2	103	82.9	82.9	91.2	79.4	79.4	87.3	79.4	79.4	79.4	79.4	79.4							
Upland Crop (mm/10-days)	72.4	66.0	62.5	64.5	64.5																									39.7	40.3	48.0	60.7	69.5	71.4	77.6
(lit./sec/ha)	0.84	0.74	0.78	0.38	0.13											0.18	0.55	0.98	0.96	0.96	0.96	0.92	0.92	0.92	0.92	0.92	0.77	0.46	0.15	0.07	0.21	0.43	0.64	0.73	0.75	0.82

Table 9-4 Estimation of Irrigation Water Requirement With Effective Rainfall (Sappaac ARC)

Description	January			February			March			April			May			June			July			August			September			October			November			December		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Proposed Cropping Pattern	Garlic																					Paddy Rice												Garlic		
80 % Rainfall(mm/10-days)	0.2	1.1	0	0	0											387.8	183.4	101	100.1	242	105.8	113.2	12	35.3	181.4	150.5	53.9	38.2	9.1	3.2	2.2	0	0	0	1.4	0
Reference Crop Evapotranspiration (mm/10-days)	37.0	37.0	40.7	42.0	42.0											44.0	44.0	48.4	37.0	37.0	40.7	35.0	35.0	38.5	35.0	35.0	35.0	35.0	35.0	38.5	35.0	36.0	36.0	36.0	35.0	38.5
Percolation (mm/10-days)																10.0	10.0	10.0	10.0	10.0	11.0	10.0	10.0	11.0	10.0	10.0	10.0	10.0	10.0							
Crop Coefficient, Paddy Rice (mm/10-days)																1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00							
Upland Crops (mm/10-days)	0.85	0.84	0.75	0.75	0.75																									0.50	0.56	0.66	0.82	0.94	0.98	0.98
Crop Evapotranspiration, Paddy Rice (mm/10-days)																44.0	44.0	48.4	37.0	37.0	40.7	35.0	35.0	38.5	35.0	35.0	35.0	35.0	35.0							
Upland Crop (mm/10-days)	35.2	31.1	30.5	31.5	31.5																									19.3	19.6	23.8	29.5	33.8	34.7	37.7
Crop Water Requirement, Paddy Rice (mm/10-days)																54.0	54.0	58.4	47.0	47.0	51.7	45.0	45.0	49.5	45.0	45.0	45.0	45.0	45.0							
Upland Crops (mm/10-days)	35.2	31.1	30.5	31.5	31.5																									19.3	19.6	23.8	29.5	33.8	34.7	37.7
Irrigation Requirement, Paddy Rice (mm/10-days)																0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.0	14.2	0.0	0.0	0.0	6.8	35.9							
Upland Crops (mm/10-days)	35.0	30.0	30.5	31.5	31.5																									16.1	17.4	23.8	29.5	33.8	33.3	37.7
Diversion Requirement, Paddy Rice (mm/10-days)																0	0	0	0	0	0	0	58.2	25	0	0	0	12	63.3							
Upland Crop (mm/10-days)	72.0	61.7	62.8	64.8	64.8																									33.1	35.8	49.0	60.7	69.5	68.5	77.6
(lit./sec/ha)	0.83	0.71	0.76	0.38	0.13											0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.26	0.00	0.00	0.00	0.07	0.12	0.06	0.19	0.43	0.64	0.73	0.72	0.82

Table 9-5 Reservoir Operation Study (Sappaac ARC)

Irrigated Area Paddy : 30 ha
Upland : 6 ha (Carlic)

Month	Inflow			Outflow						Effect. Storage	Water Level	Spillage	Shortage
	Direct Inflow (1)	Diverted Flow (2)	Total (3)=(1+2)	Diversion Requirement (4)	Irrigation Area Paddy Rice (5)	Irrigation Area Upland Crop (6)	Irrigation Requiement (7)=(4)*(5+6)	Reservoir Losses (8)	Total (9)=(7)+(8)	(10)=(10)-(3-9)	(11)	(12)	(13)
	(cu.m/day)	(cu.m/day)	(cu.m/day)	(lit./sec/ha)	(ha)	(ha)	(cu.m/day)	(cu.m/day)	(cu.m/day)	(cu.m/day)	(EL-m)	(cu.m/day)	(cu.m/day)
										3,166	223.0		
June-1	2,094	1,642	3,736	0	30		0	16	16	3,166		3,720	0
-2	991	1,642	2,633	0	30		0	16	16	3,166		2,617	0
-3	546	1,642	2,188	0	30		0	16	16	3,166		2,172	0
July-1	540	1,642	2,182	0	30		0	16	16	3,166		2,167	0
-2	1,307	1,642	2,949	0	30		0	16	16	3,166		2,933	0
-3	571	1,642	2,213	0	30		0	16	16	3,166		2,197	0
Aug.-1	612	1,642	2,254	0	30		0	16	16	3,166		2,238	0
-2	65	1,642	1,707	0.67	30		1,737	16	1,752	3,120		0	-46
-3	191	1,642	1,833	0.26	30		674	16	690	3,166		1,097	0
Sept.-1	980	1,642	2,622	0	30		0	16	16	3,166		2,606	0
2	813	1,642	2,455	0	30		0	16	16	3,166		2,439	0
3	291	1,642	1,933	0	30		0	16	16	3,166		1,917	0
Oct.-1	206	1,642	1,848	0.07	30		181	16	197	3,166		1,651	0
-2	49	1,642	1,691	0.12	30		311	16	327	3,166		1,364	0
-3	18	1,642	1,660	0.06		6	31	16	47	3,166		1,613	0
Nov.-1	12	1,239	1,251	0.06		6	31	16	47	3,166		1,204	0
-2	0	836	836	0.09		6	47	16	62	3,166		774	0
-3	0	432	432	0.11		6	57	16	73	3,166		359	0
Dec.-1	0	432	432	0.12		6	62	16	78	3,166		354	0
-2	73	432	505	0.12		6	62	16	78	3,166		427	0
-3	0	432	432	0.14		6	73	16	88	3,166		344	0
Jan.-1	1	432	433	0.83		6	430	16	446	3,153		0	-13
-2	4	432	436	0.71		6	368	16	384	3,166		40	0
-3	17	432	449	0.76		6	394	16	410	3,166		39	0
Feb.-1	0	432	432	0.38		6	197	16	213	3,166		219	0
-2	0	432	432	0.13		6	67	16	83	3,166		349	0
-3	0	432	432				0	16	16	3,166		416	0
Mar.-1	26	432	458				0	16	16	3,166		443	0
-2	0	432	432				0	16	16	3,166		416	0
-3	0	432	432				0	16	16	3,166		416	0
Apr.-1	19	432	451				0	16	16	3,166		435	0
-2	7	432	439				0	16	16	3,166		423	0
-3	16	432	448				0	16	16	3,166		433	0
May-1	0	836	836				0	16	16	3,166		820	0
-2	92	1,239	1,331				0	16	16	3,166		1,316	0
-3	694	1,642	2,336				0	16	16	3,166		2,320	0

GUIDEBOOK FOR THE CALCULATION OF CROP EVAPOTRANSPIRATION(ETcrop) USING MODIFIED PENMAN METHOD

Diversified Crops Irrigation Engineering Project
(Design Section)

NIA-JICA

I. INTRODUCTION

Prediction methods of determining crop water requirements such as Blaney-Criddle, Modified Penman, Pan-Evaporation, etc, are frequently used because accurate field measurements is the most applicable but are hard to obtain. However, to test the accuracy of these methods to the various sets of climatic and agronomic conditions of the Philippines will entail much time, money and effort.

Crop water requirements are affected by climate as well as local conditions such as size of fields, soil condition, soil water availability, irrigation and farming practices, etc, for which local field data are necessary.

The Diversified Crop Irrigation Engineering (DCIE) Project had conducted Consumptive use (Cu) investigations in its Trial Farm at San Rafael, Bulacan adopting the soil moisture depletion method using tensiometers, electric resistance and gravimetric method (soil sampling). Results for various crops, however, are considered limited despite those data gathered from other research stations. Nevertheless, these results could be adopted if processed diversified crop promotion project (DCPP) area shows similar climatic and local conditions with those of the Trial Farm reference data.

In the absence of these results and conditions, the use of other methods of estimating rate of Cu based on available climatic data is recommended. The Modified Penman method which was found to give good results (with minimum possible error) would be suitable.

This guideline (adopting the Modified Penman) was prepared to help NIA irrigation engineers in designing the irrigation requirement of some crops, listed in Table 12, under varying conditions as mentioned above.

II. Procedure of Calculation of Crop Evapotranspiration (ETcrop)

Calculation of crop evapotranspiration (ETcrop) is shown in the following chart;

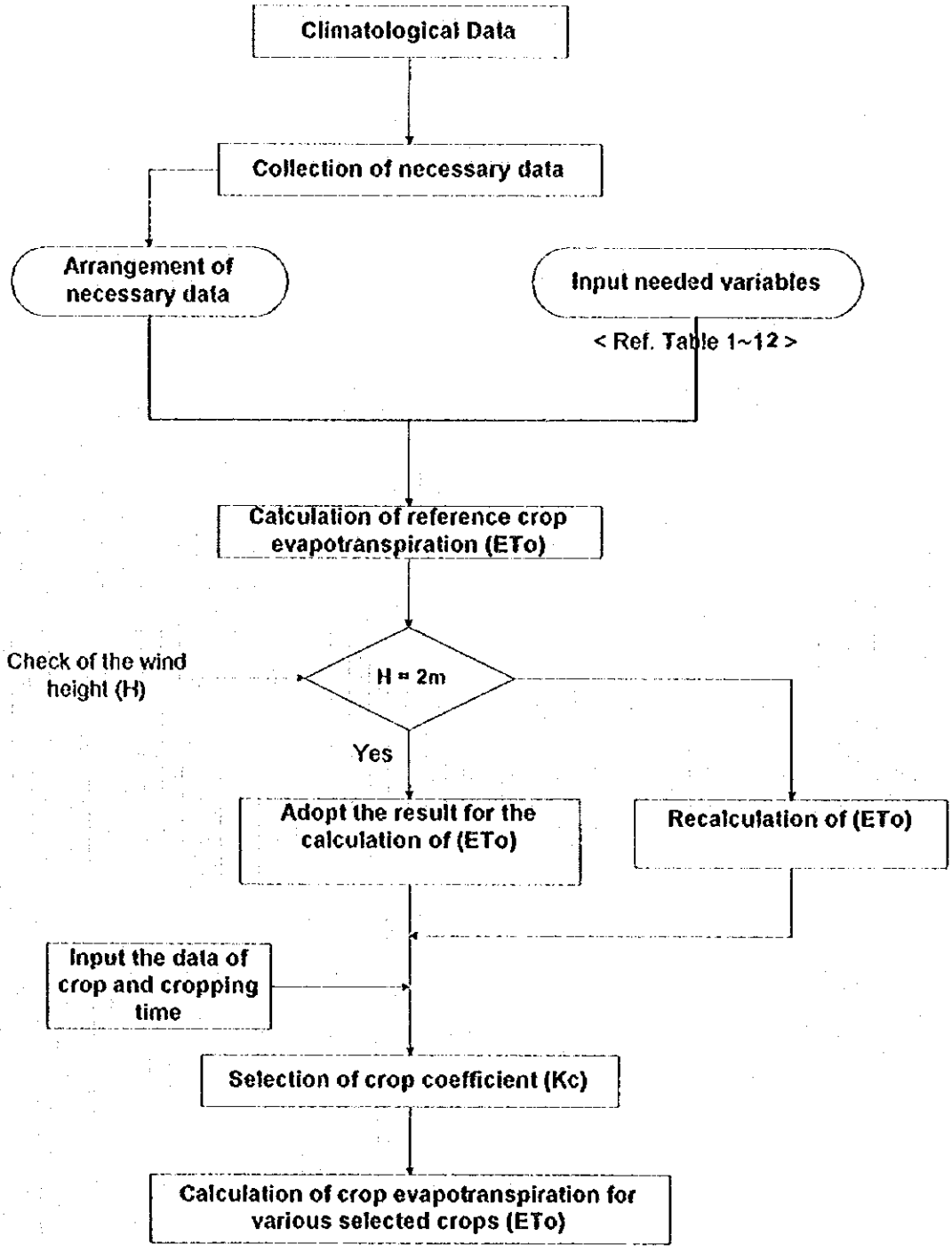


Figure 1. Flow chart for Calculation of ETcrop

III. Collection and Selection of Necessary Data

The reference data for the calculation of ETcrop were gathered and classified into two large-scale type data. Each necessary data may be selected based on the content as follows:

(1) Actual observation data (temperature, dewpoint, relative humidity, cloudiness and wind speed) were gathered from PAGASA and the Asian Compendium of Climatic Statistics.

(2) Analyze the data coefficient/value as given in FAO manual (ID #24).

3.1 Arrangement of the Climatic Data

To compute the ETo, the mean daily climatic data for 10 or 30 periods may be utilized. In this guidebook, the 30 day period is being adopted for the mean daily climatic data because of the arrangement of data gathered (daily records by month and monthly averages).

3.2 Result of Data Arrangement

Not all observation stations have complete or up to date climatic data.

3.3 Selection of the Reference Data

Use the arranged data as reference from the nearest observation station in case there is none within the proposed target area.

3.4 Adoption of the Reference Data

(1) The variations in the data of temperature, relative humidity and dewpoint are much less than wind speed. In addition, the majority of the values are approximations, hence simple mean value can be adopted.

(2) The data of wind speed varies every year from place to place. Therefore, data of dependable level of wind speed that can be expected 7 to 8 out of 10 years).

IV. Calculation of Reference Crop Evapotranspiration(ETo) using the Modified Penman Method

This guidebook does not include the more detailed contents concerning Modified Penman Method (refer to FAO ID Paper #24 for more information).

4.1 The Form of the Equation used in the Modified Penman Method

$$ETo = \underbrace{c \times [W \times Rn}_{\text{radiation term}} + \underbrace{(1-W) \times f(u) \times (ea-ed)]}_{\text{aerodynamic term}}$$

where:

ETo	=	reference crop evapotranpiration (mm/day)
W	=	temperature - related weighting factor
Rn	=	net radiation in equivalent evaporation (mm/day)
f(u)	=	wind = related function
(ae-ed)	=	difference between the saturation vapor pressure at mean air temperature and the mean actual vapor pressure of the air, both in (mbar).
c	=	adjustment factor to compensate for the effect of day and night weather conditions.

Due to the independence of the variables composing the equation, the correct use of units in which variables need to be expressed is important. Use of the correct units are shown in the examples presented.

4.2 Description of Variables and Their Method of Calculation

(a) Vapor Pressure (ea-ed)

Air humidity affects ETo. Humidity is expressed here as saturation vapor pressure deficit (ae-ed): the difference between the mean saturation water vapor pressure (ae) and the mean actual water vapor pressure (ed). Air humidity data are reported as relative humidity [Case-1] and sometimes as dewpoint temperature [Case-2].

Table 1. Saturation Vapor Pressure (ae) as Function of Mean Air Temperature (T)

(Unit ; T: ℃, ea : mbar)

T	15	16	17	18	19	20	21	22	23	24
ae	17.0	18.2	19.4	20.6	22.0	23.4	24.9	26.4	28.1	29.8
T	25	26	27	28	29	30	31	32	33	34
ae	31.7	33.6	35.7	37.8	40.1	42.4	44.9	47.6	50.3	53.2

Examples [A]: For all cases altitude is 0 m.

*Case-1:

Given factor:

Tmean = 25.5 °C, Rhmean = 78%

Calculation:

ae at 25.5°C = 32.7 mbar (from Table 1)

ed = ea x Rhmean/100 = 25.5 mbar

(ae-ed) = 7.2 mbar

*Case-2:

Given factor:

Tmean = 25.5°C, Tdewpoint = 22°C

Calculation:

ea at 25.5 °C = 32.7 mbar (from Table 1)

ed at Tdewpoint = 25.4 mbar

(ea-ed) = 6.3 mbar

b) Wind Function f(u)

The effect of wind on ETo has been studied for different climates and the resulting function is defined as:

$$f(u) = 0.27 \times (1 + U/100)$$

where: U is 24-hr wind run in km/day at 2 m height. This expression is valid when (ea-ed) is expressed in mbar.

Table 2. Values of Wind Function f(u) for Wind Run at 2m Height

unit: km/day

Wind	0	10	20	30	40	50	60	70	80	90
	-	0.30	0.32	0.35	0.38	0.41	0.43	0.46	0.49	0.51
100	0.54	0.57	0.59	0.62	0.65	0.67	0.70	0.73	0.76	0.78
200	0.81	0.84	0.86	0.89	0.92	0.94	0.97	1.00	1.03	1.05
300	1.08	1.11	1.13	1.16	1.19	1.21	1.24	1.27	1.30	1.32
400	1.35	1.38	1.40	1.43	1.46	1.49	1.51	1.54	1.57	1.59
500	1.62	1.65	1.67	1.70	1.73	1.76	1.78	1.81	1.84	1.90
600	1.89	1.92	1.94	1.97	2.00	2.02	2.05	2.08	2.11	2.15
700	1.16	2.19	2.21	2.24	2.27	2.29	2.32	2.35	2.38	2.40
800	2.43	2.46	2.48	2.51	2.54	2.56	2.59	2.62	2.64	2.65
900	2.70									

Where wind data are collected at 2m height, the appropriate corrections for wind measurements taken at different heights are given in Table 3.

Table 3. Corrections for Wind Measurements taken at Different Heights

Measurement height	0.50	1.00	1.50	2.00	3.00	4.00	5.00	6.00	7.00
Correction factor	1.35	1.15	1.06	1.00	0.93	0.88	0.85	0.83	0.82

Example [B]:

Given factor:

Wind speed at 2.0m height is 173 km/day

Calculation:

U above conversion = 173 x 1.00 (from Table 3)
= 173 km/day
f(u) = 0.74 (from Table 2)

c). Weighting Factors (W) and (1-W)

W is a weighting factor for the effect of radiation ETo. And also (1-W) is the weighting factor for the effect of wind and humidity on ETo.

Table 4. Values of Weighting Factor (W) for the Effect of Radiation on ETo at Different Temperatures and Altitudes

Tmean EL (m)	16	18	20	22	24	26	28	30	32	34	36
0	0.64	0.66	0.69	0.71	0.73	0.75	0.77	0.78	0.80	0.82	0.83
500	0.65	0.67	0.70	0.72	0.74	0.76	0.78	0.79	0.81	0.82	0.84
1000	0.66	0.69	0.71	0.73	0.75	0.77	0.79	0.80	0.82	0.83	0.85

Example [C]:

Given Factor:
Altitude 2.0 m, Tmean = 25.5 °C

Calculation:

W = 0.74 (from Table 4)
(1-W) = 0.26

d) Net Radiation (Rn)

(Rn) is the difference between all incoming and outgoing radiation. It can be measured, but such data are seldom available. (Rn) can be calculated from degree of cloud cover (or sunshine hours), temperature and humidity data using the following steps.

(1) The amount of radiation received at the top of the atmosphere (Ra) is dependent on latitude and the time of the year only. Select (Ra) value from Table 5.

(2) Part of (Ra) is absorbed and scattered when passing through the atmosphere. The remainder, including some that is scattered but reaches the earth's surface is identified as solar radiation (Rs). To obtain (Rs) = (0.25 x 0.50 x n/N) x Ra. Cloudiness is expressed in oktas (0 to 8) which must first be converted into equivalent of n/N in Table 7.

(3) To obtain net short-wave radiation (Rns) = (1-@) x Rs. For most crop @ = 0.25

(4) Net longwave radiation (Rnl) can be determined from available (T), (ed) and ratio n/N data

(5) To obtain total net radiation (Rn), the algebraic sum of (Rns) and (Rnl) is calculated. Rnl always constitutes a net loss so, Rn = Rns - Rnl

Table 5. Extra Terrestrial Radiation (Ra) expressed in Equivalent Evaporation for Different Months and Latitudes (Lat.)

Latitude	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
26	9.8	11.5	13.7	15.3	16.4	16.7	16.6	15.7	14.3	12.3	10.3	9.3
24	10.2	11.9	13.9	15.4	16.4	16.6	16.5	15.8	14.5	12.6	10.7	9.7
22	10.7	12.3	14.2	15.5	16.3	16.4	16.4	15.8	14.6	13.0	11.1	10.2
20	11.2	12.7	14.4	15.6	16.3	16.4	16.3	15.9	14.8	13.3	11.6	10.7
18	11.6	13.0	14.6	15.6	16.1	16.1	16.1	15.8	14.9	13.6	12.0	11.1
16	12.0	13.3	14.7	15.6	16.0	15.9	15.9	15.7	15.0	13.9	12.4	11.6
14	12.4	13.6	14.9	15.7	15.8	15.7	15.7	15.7	15.1	14.1	12.8	12.0
12	12.8	13.9	15.1	15.7	15.7	15.5	15.5	15.6	15.2	14.4	13.3	12.5
10	13.2	14.2	15.3	15.7	15.5	15.3	15.3	15.5	15.3	14.7	13.6	12.9
8	13.6	14.5	15.3	15.6	15.3	15.0	15.1	15.4	15.3	14.8	13.9	13.3
6	13.9	14.8	15.4	15.4	15.1	14.7	14.9	15.2	15.3	15.0	14.2	13.7
4	14.3	15.0	15.5	15.5	14.9	14.4	14.6	15.1	15.3	15.1	14.5	14.1
2	14.7	15.3	15.6	15.3	14.6	14.2	14.3	14.9	15.3	15.3	14.8	14.4
0	15.0	15.5	15.7	15.3	14.4	13.9	14.1	14.8	15.3	15.4	15.1	14.8

Table 6. Mean Daily Duration of Maximum Possible Sunshine Hours (N) for Different Months and Latitudes

Latitude	Jan.	Feb.	Mar.	Apr	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
25	10.7	11.3	12.0	12.7	13.3	13.7	13.5	13.0	12.3	11.6	10.9	10.6
20	11.0	11.5	12.0	12.6	13.1	13.3	13.2	12.8	12.3	11.7	11.2	10.9
15	11.3	11.6	12.0	12.5	12.8	13.0	12.9	12.6	12.2	11.8	11.4	11.2
10	11.6	11.8	12.0	12.3	12.6	12.7	12.6	12.4	12.1	11.8	11.6	11.5
5	11.8	11.9	12.0	12.2	12.3	12.4	12.3	12.3	12.1	12.0	11.9	11.8
0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0

Table 7. Effect of n/N and (1-@) (0.25 + 0.50n/N) on Cloudiness Oktas

Cloudiness Oktas	0	1	2	3	4	5	6	7	8
n/N	0.95	0.85	0.75	0.65	0.55	0.45	0.30	0.15	0
(1-@) (0.25+0.5n/N)	0.54	0.51	0.47	0.43	0.39	0.36	0.30	0.24	0.19

Table 8. Effect of Temperature f(T) on Longwave Radiation (Rnl)

T°C	16	18	20	22	24	26	28	30	32	34
$f(T) = TK^4$	13.8	14.2	14.6	15.0	15.4	15.9	16.3	16.7	17.2	17.7

Table 9. Effect of Vapor Pressure f(ed) on Longwave Radiation (Rnl)

ed	16	18	20	22	24	26	28	30	32	34
f (ed)	0.16	0.15	0.14	0.13	0.12	0.12	0.11	0.10	0.09	0.08

Note: f(ed) = 0.34 - 0.044 x SQR(ed)

Table 10. Effect of the Ration of Actual and Max. Bright Sunshine Hours f(n/N) on Longwave Radiation (Rnl)

n/N	0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5
f (n/N)	0.15	0.19	0.24	0.28	0.33	0.37	0.42	0.46	0.51	0.55
n/N	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95	1.0
f (n/N)	0.60	0.64	0.69	0.73	0.78	0.82	0.87	0.91	0.96	1.0

Note: f (n/N) = 0.1 + 0.9 * n/N

Example [D]:

Given Factor:

Cavite, Latitude: 14-30 N, Altitude: 2.0 m, January

Tmean = 25.5 °C, Rhmean = 78%, Cloudiness oktas = 6

Calculation:

Ra =	12.2 mm/day	(from Table 5)
n/N =	0.3	(from Table 7)
Rs =	(0.25 + 0.50 x n/N) x Ra	= 4.88 mm/day
Rns =	(1 - @) x Rs = (1 - 0.25) x 4.88	= 3.66 mm/day
f (T) =	15.8	(from Table 8)
f (ed) =	0.34 - 0.044 x SQR (ed)	= 0.12 (from Table 9)
f (n/N) =	0.37	(from Table 10)
Rn1 =	f (T) x f (ed) x f (n/N)	= 0.70
Rn =	Rns - Rn1 = 3.66 - 0.70	= 2.96 mm/day

e) Adjustment Factor (c)

The Penman equation given assumes the most common conditions where the radiation and maximum relative humidity is medium to high and the moderate daytime wind about double the nightime wind. However, these conditions are not always met, hence, correction to the Penman equation is required. There is a point ratio of daytime and nightime wind speed (basic data were arranged from the Asian Compendium of Climatic Statistics). Table 11 presents the adjustment factor (C) for Rhmax, Rs, Uday, Uday/Unight.

Table 11. Adjustment Factor (c) for the Penman Equation

Uday (m/sec)	Rs (mm/day)									
	3	4	5	6	7	8	9	10	11	12
0	1.02	1.03	1.05	1.06	1.07	1.09	1.10	1.10	1.10	1.10
1	0.96	0.98	0.99	1.01	1.03	1.05	1.07	1.07	1.08	1.08
2	0.91	0.93	0.95	0.97	0.99	1.02	1.04	1.05	1.06	1.07
3	0.85	0.87	0.90	0.92	0.95	0.98	1.01	1.02	1.04	1.05
4	0.81	0.84	0.86	0.89	0.92	0.96	0.99	1.00	1.02	1.03
5	0.76	0.79	0.82	0.85	0.89	0.93	0.97	0.99	1.00	1.02
6	0.72	0.75	0.79	0.82	0.86	0.91	0.95	0.98	0.99	1.00
7	0.69	0.72	0.76	0.79	0.83	0.88	0.92	0.94	0.97	0.99
8	0.65	0.68	0.72	0.75	0.80	0.85	0.90	0.92	0.95	0.97
9	0.62	0.65	0.69	0.72	0.77	0.82	0.87	0.90	0.93	0.96

Note: Rhmax = 90%; Uday/Unight = 1.0

Example [E]:

Given Factor:

Place; Cavite,	Station: No. 20436
Rhmax = 90%	Rs = 4.88 mm/day (January)
U = 173 km/day	Uday/Unight = 1.10

Calculation:

Uday = U x 1000 / (60x60x24) x (Ud/Un) / (1+Ud/Un)
= 173 x 1/86.4 x (1.1/2.1) = 1.10 m
c = 0.99, say c = 1.0

Therefore, ETo = (1.38 + 2.20) x 1.0 = 3.6 mm/day

V. Selection of Crop Coefficient (kc)

The above mentioned method predict the effect of climate on ETo. To account for the effect of the crop characteristics on crop water requirements, (Kc) are presented to relate ETo to ETcrop. Procedures for selection of appropriate kc values are given, which take into account the crop characteristics, time of planting or sowing, and stages of crop development and general climatic conditions.

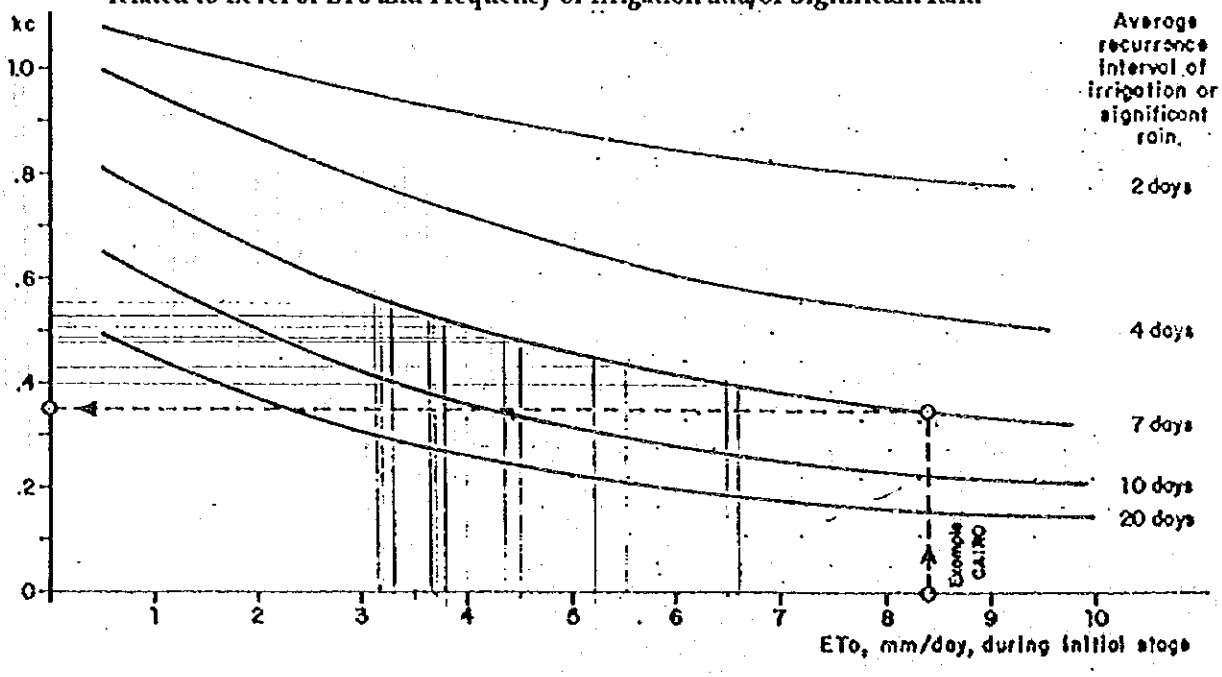
ETcrop = kc x ETo:

(kc) for vegetable crops are presented in Table 12. Crop development period and growing period are given under cropping calendar. The four stages of crop development are:

1) Initial stage
2) Crop development stage
3) Mid-season stage

Late season stage

Figure 2 Average Kc value for Initial Crop Development Stage as related to Level of ETo and Frequency of Irrigation and/or Significant Rain



VI. Calculation of Crop Evapotranspiration (ETcrop)

Example [F]:

Given factor:

Place : Cavite, Station : No. 20436
Crop : Eggplant, Planted : early - December
Total growing season winds are light to moderate (0-5m/sec)
Rhmin is over 70%, ETo initial stage is 3.1 mm/day
Irrigation frequency initial period assumed to be 7 days

Calculation:

(1) Planting data

(2) Length of growth stages
1) Initial : 30 days
2) Crop Development : 45 days
3) Mid-season : 40 days
4) Late-season : 25 days

(3) Plot period as indicated
Kc initial stage : 0.58 (Figure 2)
Kc mid-season stage : 0.95 (Table 15)
Kc late-season stage : 0.80 (Table 15)

(4) Plot Kc value and connect values with straight lines

Kc development stage : 0.58 - 0.95
Kc late-season stage : 0.95 - 0.80

(5) Peak kc value from prepared graph for selected period at mid-point of 30 day period

(6) Determination of the crop evapotranspiration

Item/Mon.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
ETo	3.9	3.8	3.1	3.6	4.4	5.5	5.7	5.1
kc	-	-	0.58	0.64	0.86	0.95	0.89	-
ETcrop	-	-	1.8	2.3	3.8	5.2	5.1	-
			[a]		[b]		[c]	

Note : Etcrop = ETo x kc
[a] : 0.58+(0.95 - 0.58) / 45 x 42 = 0.75 ---- late January
therefore, (0.58 x 10 + (0.58 + 0.75) / 2 x 21) /31 = 0.64
[b] : {(0.95 + 0.75) /2 x 24 + 0.95 x 4} /28 = 0.86
[c] : {0.95 x 5 + (0.95 + 0.8) /2 x 25} /30 = 0.89

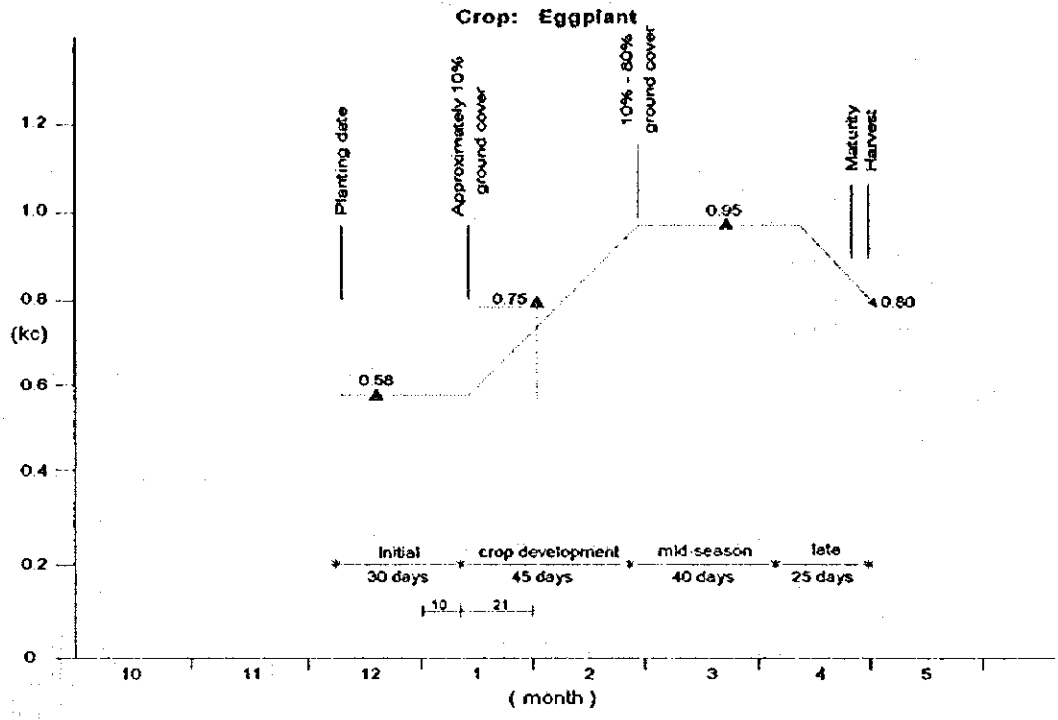


Figure 3: Example of Crop Coefficient Curve

Table 12: Crop Coefficient (kc) for Field and Vegetable Crops for Different Stages of Crop Growth and Prevailing Climatic Conditions

Humidity	RHmin > 70%			
Windo Speed (m/s)	0 - 5		5 - 8	
Crop Name / Crop Stage	3	4	3	4
All field crops (stage: 1 to 2) - Use Figure 3 by interpolation				
Barley	1.05	0.25	1.10	0.25
Bean/s (green)	0.95	0.85	0.95	0.85
Bean/s (dry) Pulse/s	1.05	0.30	1.10	0.30
Carrot/s	1.00	0.70	1.05	0.75
Celery	1.00	0.90	1.05	0.95
Corn (sweet)	1.05	0.95	1.10	1.00
Cron (grain)	1.05	0.55	1.10	0.55
Cotton	1.05	0.65	1.15	0.65
Crucifer/s (cabbage, cauliflower brocolli, brussel sprout)	0.95	0.80	1.00	0.85
Cucumber; Fresh market	0.90	0.70	0.90	0.70
Cucumber; Machine harvest	0.90	0.85	0.90	0.85
Eggplant	0.95	0.80	1.00	0.85
Lettuce	0.95	0.90	0.95	0.90
Melon/s	0.95	0.65	0.95	0.65
Onion (dry)	0.95	0.75	0.95	0.75
Onion (green)	0.95	0.95	0.95	0.95
Peanut/s (Groundnuts)	0.95	0.55	1.00	0.55
Peas	1.05	0.95	1.10	1.00
Pepper/s (fresh)	0.95	0.80	1.00	0.85
Potato	1.05	0.70	1.10	0.70
Radishes	0.80	0.75	0.80	0.75
Sorghum	1.00	0.50	1.05	0.50
Soybeans/s	1.00	0.45	1.05	0.45
Spinach	0.95	0.90	0.95	0.90
Squash	0.90	0.70	0.90	0.70
Sugarbeet	1.05	0.90	1.10	0.95
(No irrigation; last month)		0.60		0.60
Tomato	1.05	0.60	1.10	0.60
Wheat	1.05	0.25	1.10	0.25

Note: FAO manual described the value of kc as defined as 2 types Rhmin > 70%; Rhmin < 20%. Majority of Rhmin is over 70% in this country, therefore, it is only Rhmin > 70% that is applied.

10. FARMERS' ORGANIZATION PLAN

10. Farmers' Organization Plan

The five farmers' Muiti-Purpose Cooperatives being in the four Study Areas can be grouped into three types, based on the development stage of the cooperatives, that is, pre-takeoff stage (Type I), immediately after takeoff stage (Type II) and recovering stage from the failed takeoff (Type III).

The cooperatives of pre-takeoff stage are in the status which has not yet been qualified of application of farming loan from LBP and CDA. The cooperatives of immediately after takeoff stage are in the status which have active farming with farming loan granted from LBP and CDA. However, the cooperatives are in the just repayable conditions of the loan with the risk to become insolvency by the damages of drought and typhoon etc.. The cooperatives of Type III are in the conditions of insolvency of the loan granted from LBP and CDA. The guideline was made with due regard to these types of cooperatives as below;

Type of cooperative	Development order	Activities to be introduced
I, III	1	Upbringing of reliable cooperative
I, II, III	2	Increase in farming income with introduction of improved farming and introduced cash crops. The deferred payment system at after harvesting will be introduced to the seeds and fertilizer for improved farming of rice and corn productions.
I, II, III	3	Introduction of economic activities such as purchase and sale of production materials and products through cooperative and operation/ improvement of consumer store.
I, II, III	4	Accumulation of cooperative capital by recruiting of new members, perfect collection of share capital, thrift and saving of money and group activities.
I, II, III	5	Introduction of farming loan based on the steady plan
I, II, III	6	Fullness of cooperatives' facilities for increased productivity and introduction of new processing business.
I, II, III	7	Development of new market for cash crops and processing goods

11. ENVIRONMENTAL CONSERVATION PLAN

11. Environmental Conservation Plan

11. Environmental Conservation Plan

11.1 Rationale

Ecological balance for sustainable development of the ARCs in the marginal areas is one of the objectives of the CARP. The land awarded to the ARBs must be developed to provide the food, fuel, and cash requirements of the farm households while improving their health and nutrition and living conditions and enhancing the resource base and the environment. Methodology to identify and assess the environmental constraints and opportunities in the ARC and to offer management options to correct the constraints and develop the opportunities in partnership with the beneficiaries is needed in the development of its landscape. This includes the upper watershed and the downstream areas outside the delineated project boundary.

The sustainable development of the landscapes of the ARCs in marginal areas is grouped into four depending on the matrix. The patches and the corridors, the other elements of the landscape, will be developed as well.

In development Type-I, the matrix is the irrigated agriculture with paddy rice as the main crop. In contrast to Development Type-IV, the matrix is the agro-forestry together with forest plantation for fuelwood, lumber, and windbreak. The farm to market roads, foot trails and the vegetation along the creek are some of the corridors. The settlement area, nurseries, demonstration farms and other small ecosystems are the patches. They are interacting with one another. The ARC landscape is also interacting with other landscapes like the urban centers and industrial areas outside the project area. Understanding of the socio-economic background of the ARC including the institutions related to these environmental concerns is important in formulating the priority action plans and strategies for implementation by the ARBs.

This guidelines covers soil erosion, water quality, flora and fauna, and environmental health and education. Other environmental concerns which could occur in the uplands are volcanic activity, earthquake, off-site effects of pollutive industries in the uplands like geothermal development, mining, and mechanized agriculture using aerial spraying with aircraft among others.

Techniques, data requirements, and sources of data for each aspect, and interpretation in relation to the environmental conservation planning and management of the ARCs in the four types of development are discussed.

11.2 Soil Conservation Assessment

Most of the marginal hilly lands of the ARC have slopes of more than 18 percent. Some are former logged over areas. The soils are commonly moderate

to severely eroded due to shifting cultivation together with up and down the slopes cultivation. When the soil becomes unproductive, the area is followed and grasses particularly cogon with talahib will take over and frequently subjected to grassland fire during dry season. Assessment of the degree of soil erosion in each farm lot given to the beneficiaries and displayed on the map with a bigger scale in order to show most of the identifiable land features like lot boundary and areas planted to various crops will be ideal. Understanding the land management practices of the beneficiaries on the marginal land, soil and rainfall distribution patterns, typhoon and flooding hazard, and the awareness of the farmer on the environmental degradation occurring in the farm and his interest to make the land productive are the basic determinants for an effective soil conservation planning.

11.2.1 Objectives

- To understand the simple technique of assessing soil erosion using the secondary and primary data.

- To relate the interpretations to simple bio-engineering techniques of soil conservation-based farming systems in the four development types of the ARCs.

11.2.2 Data Requirements

1) Secondary Data

Since most of the available maps on soil, land use, slope, soil erosion, soil depth and other soil interpretations have a scale of 1:50,000, these serve as preliminary information for field validation. The minimum size delineation of this resource map is so large that variation of an area of 400 ha. will not be sufficiently represented on the map. This area is only 16 sq. cm. of the 1:50, 000 scale map. The Land Resource Evaluation Report of the Province uses land management unit while the Reconnaissance Soil Survey of the Province, phases of the soil series. The latter has a smaller scale. These reports provide information for better understanding of the soil erosion problems of the area before conducting the field survey. Enlarging these maps do not increase the detail of the information provided.

Daily and monthly rainfall and typhoon occurrence for at least ten years shall be collected from the nearest weather station within the same basin of the area. The average monthly rainfall is usually included in the agricultural report of the locality and the province.

Information on the cropping patterns on various slopes, methods of

cultivation practices, and occurrence of grassland fire will give a better idea of the soil resource degradation. Information on the occurrence of strong earthquake in the recent years which may cause damage to infrastructures of the area or serious landslides have to be noted.

2) Annual Soil Erosion Estimation

Soil erosion of an area is the interaction of the soil erodibility, rainfall erosivity, slope and length of the slope, ground cover, and soil conservation practices. Modified universal soil loss equation can be used to quantified the annual soil loss (David, 1987). Soil erodibility (K) is the susceptibility of the soil to erode and this can be approximated using the following equation (David, 1987):

$$K = [(0.043\ pH) + 0.62/OM + 0.008250\ S - 0.0062\ C] \times Si$$

where; OM = organic matter content (%)
S = percent sand
C = clay ratio = % clay / (% sand + % silt)
Si = % silt /100

The soil erodibility of some soils of the Philippines have been determined. This reported values can be used in estimating the soil erosion instead of the above value.

The rainfall erosivity (R) of an area can be determined using the following equation:

$$R = A \times \sum_{1}^{n}(P^m/n)$$

Where;
P = daily rainfall > 2.5 mm from Jan. 1 to Dec. 31 of each year
n = number of year of available data
A = 0.002
m = 2

Bayotlang (1986) reported in his dissertation thesis at U P Los Banos the rainfall erosivity factors of the Philippines which can be used.

Slope and slope length factor is very important in upland management because it is modified when contour hedgerows are established on sloping area. The slope length becomes shorter with the contour hedgerows. The slope and slope length (SL) is determined with the following equation:

Slopes less than or equal to 20 %:

$$SL = L/100\,(1.38 + 0.985\,S + 0.138\,S^2)$$

where

L = length of slope (m)
S = slope (%)

Slopes greater than 20 %:

$$SL = [\,L/22.1\,]^{0.6} \times [\,S/9\,]^{1.4}$$

Table 11-1 shows the crop coefficient for various crop or ground cover in the Philippines (David, 1987). The soil conservation factor (P) without soil conservation practice is 1. Contour strip of annual crops and contour hedge rows have a soil conservation factor of 0.5 and 0.35, respectively.

The estimated annual soil erosion using the Modified universal soil loss equation of David (1987) is;

$$A = (R) \times (K) \times (SL) \times (C) \times (P)$$

where;

A = ton of soil/ ha / yr

This procedure does not estimate the soil loss due to gully erosion and stream bank erosion. About 10 ton/ha/yr is generally considered the critical level for soil erosion. This is about one truck load annually or about 1mm of soil over a hectare of land.

Overlay the land use and slope maps to determine the vegetation cover and the corresponding present soil conservation practice. The average slope for a given slope range is used in computing the SL factor. The estimated values should be compared with any reported values of similar soil and soil management practices.

3) Primary Data Collection

Farmer survey of various farm households representing various farming systems in the ARC should be conducted. The key questions of the survey questionnaire should include the following:

- Occurrence of soil erosion, landslide, flooding, and typhoon hazard in their farms during he last five years

- Reasons for not cultivating the idle lands

- Clearing and cultivation of the stream bank and the sloping area above the flow of the water

- Attendance to training on sloping land agricultural technology (SALT) willingness to practice soil conservation in their farmlots

- Preferred agro-forestry species

- Willingness to learn bamboo shoot production, bamboo furniture making and crafts, production of prime wood in their farmlot, rapid composting, integrated pest management, production of biological pesticides, and production of roofing material using anahaw and bamboo

4) Field Survey on Soil Erosion

The ARB should be informed on the importance of having soil erosion map including the erosion prone areas in their farms so that they would understand the usefulness of the resource map. Interaction of the survey team with the beneficiaries is very important so that they would share their farming systems practices which are very important in evolving recommendation domains. The farmer interview should take note of all the insights and experiences of the farmers in soil conservation.

While the soil survey and interview of the farmers representing various farmlots on different landscape positions of the marginal land are being conducted, independent soil erosion, vegetation, and aquatic resource use survey should be done using the cadastral map with superimposed drainage system as the base map. The location of gullies and the estimated width, depth and length and number of gullies per 50 m strip across the slope in the various farmlots are recorded. Location of bouldery or gravely soil phase and kind of vegetation are delineated on the base map. Presence of soil conservation structures, gullies along the roads creeks and rivers, and areas with landslides or land creep are also delineated on the map. The ARBs must accompany the survey team for they are must familiar where the eroded areas are located. The extent of sedimentation of the waterways is noted.

Schistosimiasis infested areas are also delineated on the map.

If possible the output map should be translated into a simple relief map for the community to fully visualized the environmental dynamics in the

marginal areas

5) Recommended Soil Conservation Practices

The generally recommended soil conservation practices for various parts of the landscape is as follows:

Soil Depth	Slope (%)			
(cm)	<8	8-18	18-30	>30
> 90	C1	C2	AF	F
50-90	C1	C2	AF	F
20-50	C2	C2	AF	F
<20	AF	AF	F	F

C1 = Contour plowing, strip cropping, crop ratation, and contour ditches to dispose the surface runoff in the drainage canal with check dam;

C2 = SALT, use suitable legume as hedgerows, use suitable pasture grass on therisers, and established ditches below the risers to dispose runoff safely with minimum channel erosion;

AF = Agroforestry with contour hedgerows;

F = Forestry species for fuelwood, lumber, raw materials for the cottage industry and/or windbreak

The soil depth, soil erosion, vegetation, and crop and forest tree suitability maps are put together to prepare the proposed land use map. The perennial trees whether fruit or forest trees on the landscape must be maintained and protected for landscape stability.

The good quality species pasture grass are grown on the risers like Napier grass, Guinea grass, or Star grass. This can be planted either by seeding seeds or stem cuttings (Napier grass), root stock (Guinea grass), or by stolons (Star Grass).

For shallow and small gullies, filling the gullies during the construction of the hedgerows should be done. Large gullies should not be used as the drainage canal unless check dams are well established across the channel. The drainage canal should be made on stable ground away from the gullies.

Diversion canal should be constructed above the gully head to change the direction of the run off water into more stable ground with check dams. Trees should not be planted in the gullies below the water level of the flow for it will obstruct the flow and could cause undercutting of the side of the gully. Grasses, branches of trees and rocks in the area are used to make the needed check dams.

The topsoil and the subsoil must not be used as the subgrade during road construction. All the soft spots on the ground of the road alignment must be dug to removed most of the clay soil. Barangay road rehabilitation or opening new farm to market roads must be completed during the dry month to minimize sedimentation of waterways. The spoil must be contained using fill batter with slope of 3H:1V for establishing and maintaining vegetation. As soon as the rain starts, seeding of grasses should be done. The cut-slopes and the fill-slopes should have a slope of 2-3H: 1V. Shrubs and grass should be planted on the slopes. The diversion of the road drainage canal should have stable channel to prevent erosion. Proper maintenance of the drainage channels after a heavy storm is necessary to prevent deterioration of the road.

11.3 Flora

The vegetation on the landscape including its upper watershed is identified and delineated on the map during the survey. The farmer beneficiaries guiding the team would be able to identify the common name of the plant species and the uses other than lumber and fuel wood like herbal medicine for man and animals and tubers, shoots, leaves, flowers, or fruits as food, bio-pesticides and the like. Samples of leaves and flowers of the unidentified plants particularly of significant to the community should be collected for identification by the plant taxonomists in the state universities and colleges in the province. The Manual on the Philippine Flora is most often available in the academic institution. The DENR Manual on Agro-forestry Practices is a simple reference. The present of wild rambutan in the area suggests that this can be the stock for introduction of good quality Maharlika variety of rambutan.

The existence of logging activity should be indirectly gathered. The buyers of the smuggled logs should be traced in a casual conservation. The involvement of the community members in the Social Forestry Program as beneficiaries, participants in SALT, environmental management, nursery management, and forestry project should be noted. The source and use of bamboo, anahaw, rattan, buri, and other secondary forest products in their handicraft making or as forest products sold at the market should be documented.

The preferred agro-forestry species for the rehabilitation of the degraded

upland shall be included in the survey questionnaire. Establishment of fuelwood or forest tree plantation by the ARBs should be documented as a model for other farmers.

In the grassland areas, occurrence of fire in summer should be inquired The extent of community participation in fire control or prevention and the extent of damage should also be noted. The use of cogon and the price per bundle should be inquired. The agroforestry practices to control or prevent grassland fire should be documented. In the crop area including the home garden, the varieties of crops grown by the farmers should be identified.

The home garden should have varieties of crops: vegetables, fruits, medicinal plants, and other ornamentals to provide the most of the daily requirements of the farm households. This would encourage the farmers to keep the pigs, goat, cattle, and/or carabao in the shed so that the animal manure could be utilized for the crops in the home garden. Winged bean, lima bean, ampalaya, patola, and ubi could be trained to climb the big tress as the trellis. Red pepper, native tomato, malunggay, papaya, and other vegetables that have erect canopy architecture could be grown in the fence of the homelots.

The existing native fruits like cashew, tamarinds, duhat, makopa, chisa, passion fruit, anonas, guava, guyabano and mabolo among others that have high market potential should be first promoted. Extra care on the introduction of exotic varieties of crops or plant species to avoid the problems on pest or disease build-up. Processing of the native fruits like tamarind into candy, duhat and bignay into fruit wine, and guava into jelly should be promoted. This is the market incentive for the improvement of the vegetation cover of the marginal areas. Production of food products free from chemical should be the leading edge of the marginal lands.

Production of the plants that have medicinal values for man and animals, bio-pesticide properties like tubli, and can be used as animal feed like pongapong and San Fernando variety of gabi must be promoted. Wild yam or "lami" which is used as survival food during lean months must be grown in the farm. Planting of pegion pea in the upland should be encouraged to increase the supply of plant protein during dry season.

Planning anahow for roofing material, handicrafts, and bag making along the creek must be demonstrated. Production of kaong along the slopes of the creek could be part of the stream corridor rehabilitation together with bamboo production. Assisted regeneration should be used to rehabilitate the remaining patches of remnant forest. Plant-based handicraft and furniture making should promote the production of the raw materials in the ARC. The kakawate hedgerows in the agroforest can be the trellis of the black pepper. Suitability of the new crops to be introduced must be determined to ensure the viability of the crops.

Firebreaks must be established around the agro-forest or forest tree plantation to control the spread of grassland fire during summer.

11.4 Fauna

The wildlife, domesticated animals, birds, insects, amphibians, reptiles, fishes being raised by the farmers and present in the creeks/rivers should be identified including the economical values to the community. Exotic fishes like African catfish should not be introduced into the community. This is the predator of the native species of fishes in the creek or river. Golden snail is another example of introduction of animal without proper understanding of the ecology of the organism. Now it is a pest of the rice.

Integrated pest management, use of bio-pesticides and planting of multi-crops should be encouraged to minimize the build up of pest. Chemical pesticide should be avoided as much as possible. Training on integrated pest management for various crops should be offered for the farmers. This pesticide should not be used for catching the fishes in the river or creek.

The presence of potential source of guano should be noted for community use in their farms like in Sappaac ARC, in Bangued, Abra.

In Development Types III and IV, protection of the habitat of the wildlife is very important for the patches of the forest are the nest or home of these animals.

11.5 Water Quality

The safety of the sources of drinking water of the community is very vital to public health. The recurrence of water borne diseases is an indication of pollution of the drinking water.

11.5.1 Data Requirements

1) Secondary Sources

The data from the Municipal Health Office or from the Barangay Health Station on leading causes of morbidity provide information of the occurrence of water borne diseases like diarrhea, typhoid fever, gastroenteritis, and dysentery, The health records of the Barangay Health Workers and the midwife assigned in the ARC could substantiate the morbidity report in terms of the identity of the affected farm households for follow up interview.

2) **Primary Data.**

Key informant interview of health workers in each sitio or purok on the occurrence of the water borne diseases in relation to the pollution problems of the sources of drinking water should be done. The nature of each sources shall be documented. The changes in water flow, color, odor, taste, effect of flooding on the source, presence of cover and cemented flooring with adequate surface drainage, leak of the distribution lines, and presence of suspended materials like soil particles should be noted.

The conditions of the area around the spring sources should be assessed: surface drainage condition, presence of strayed or tethered domesticated animals, land use, plants/ crops grown, washing or bathing near the spring, and drinking area for the carabao or cattle. If possible water sample for coliform determination and chemical analysis should be collected to determine: pH, dissolved oxygen (DO), biological oxygen demand (BOD), phosphorus, nitrate, and heavy metals, and/or pesticides content. The liquid effluent of the pollutive industries like gold mining, geothermal development, or marble quarrying in the nearby communities within the watershed might possibly affect the ground water of the drinking water source. The analysis of the drinking for heavy metals, pesticides, or cyanide would depend on the kind of industries present in the nearby area. Table 11-2 shows the criteria for drinking water of Class AA and Class A. Class AA is a public water supply Class 1 which is intended primarily for waters having watersheds which are uninhabited; otherwise, protected and required only approved disinfection in order to meet the National Standards for Drinking Water (NSDW) of the Philippines. Class A is public water supply Class II with sources that will require complete treatment (coagulation, sedimentation, filtration and disinfection) in order to meet NSDW.

Polluted open shallow wells or artesian wells should be replaced with deeper artesian wells with adequate cemented flooring around the pump and rapid surface drainage to prevent percolation of waste water into the pump. Water from the newly constructed well must be tested to ensure it is safe to drinking.

The area around the spring of the Level II must be acquired by the community through eminent domain and just compensation and to be planted with trees which not suited for lumber or fuelwood like tibig which good for conserving water. Other forest trees can be added. The Sangguniang Barangay must pass a resolution that nobody and even animal be allowed to entered the area to protect the spring from potential pollution.

The distribution lines of the Level II must be properly maintained to prevent pollution. Needed water treatment must be instituted to make the drinking water safe and clean.

11.6 Water Quality of the Domestic Source of Water

The presence of pollutive industries within the watershed or basin of the ARC would require checking the sources of domestic water for washing clothes and bathing particularly the river. This river could be the sink of the toxic waste from the gold mine or from the geothermal plant. This waste might contain mercury, cyanide, arsenic, chromium, cadmium and other heavy metals. Analysis of the water would be necessary particularly if the there are complaints from the community on animal poisoning when it drunk from the river, fish kill occurrence, or skin allergy when some members of the community took a bath in the river. Furthermore, the effluent discharge point at the upstream must be located.

Level I or II must be developed to avoid such pollution problems. However, the fishes and edible aquatic plants like ferns from such polluted waterway are also not safe for human consumption.

11.7 Air Quality

The presence of pollutive industries producing air pollutants like clouds of dust particles from cement plant, H2S and SO2 from geothermal plant, and suspended air particulate and SO2 from the coal power plant in the nearby area which affects the air in the community and public health depending on the prevailing wind direction would require assessment of the air quality. The industry must be required to use clean technology to contain the pollutants and the corresponding just compensation for the ARC.

11.8 Public Health, Nutrition and Environmental Education

11.8.1 Objectives

- To identify environment-related constraints and opportunities in public health and nutrition.
- To identify food production strategies to alleviate 2nd and 3rd malnutrition by improving the diversity of food production system by increasing production of vegetables which require minimal inputs.
- To identify the leading causes of morbidity among children and the whole community and causes of death.
- To determine the period of occurrence of the causes of morbidity and relate this to occurrence of rainy season, flooding, changes in drinking water condition.

- To identify the family planning offered by the Barangay or Municipal Health Unit.

- To assess the population education program of the Barangay health program and the DSWD in the ARC.

- To enhance environmental awareness of the pupils on the development in the

- ARC in marginal area by developing supplementary curricular materials to science and technology, home economics, and social studies.

11.8.2 Data Requirements

Parameter/Criterion	Source of Information
Secondary Data	
Degree of malnutrition among children	Municipal Health Office (MHO)
Per cent of over weight children	MHO
Leading causes of morbidity among children less than 6 yrs old	MHO
Leading causes of morbidity among the population	MHO
Frequency distribution of family planing offered to the community	MHO
Frequency distribution of accepted family planning practices	MHO
Number of children with various types of immunization	MHO
Number of mother with various types of immunization	MHO
Population education offered by the DSWD and number of participants	DSWD
Number of beneficiaries, kinds of food distributed, and frequency and duration of	DSWD

the feeding program for the malnourished children	
Number of households with different types of toilet	DSWD. MHO
Project on herbal medicine and green revolution	BHWs
Construction and distribution of water sealed toilets program on public toilet construction	Sangguniang Barangay
<u>Primary Data</u> Occurrence of Lean Months:	Barangay Health Workers (BHWs)
Composition of food during lean months	BHWs
Source of non-traditional food items during lean month	BHWs
Planting and use of herbal medicine	BHWs
Condition of the barangay health station	BHWs
Inventory of basic health facilities for first aid treatment and paramedical service in the barangay health station	Midwife assigned in the barangay health station
Frequency of medical doctor and nurse visitation to the barangay	BHWs
Occurrence of intestinal worm among the children	Midwife
Deworming program for the children	Midwife
Opportunity for integration of the environmental concerns in the complementary curricular materials of the elementary school	Head Teacher of the Elementary School in the Barangay: DECS District Supervisor

11.8.3 Improvement of the Environment-Related Public Health and Nutrition

Environment-related public health and nutrition is apparently not specifically limited to a particular Development Type. All households must have water sealed toilet. If the area does not have supply of water, Antipolo type would be adequate provided this is enclosed and had good flooring and not affected by surface runoff. Nutrition program through production of vegetables at the home garden throughout the year by planting various vegetables of various maturity must be promoted. Winged bean and lima bean could bear fruit for sometimes. Red pepper particularly the native variety could last for one year. The dry bean of pigeon pea can be stored for a year. The farmlot could be enriched by various kinds of nutritious fruits like avocado, papaya, and other long lasting vegetables like malunggay and katuray. In Development Type I string beans and soybean can be grown on the dike. "Sorjan" method of cropping system could be developed to grow vegetables whole year round.

In Development Types other than Type I where lean month occurs, improving the subsistence level and growing root crops like cassava, gabi, and sweet potato could supply the carbohydrate requirement of the farm household throughout the whole year. The cooking banana could augment this needs. The raising of native chicken could provide the protein requirement. In Development Types I and II, duck raising could add to the protein supply. In Schistosimiasis-free areas the creek and the water impounding dam could be seeded with Tilapia fingerlings to add to the fish supply.

Continuing informal education on primary health care, population education, animal waste management, composting, bio-intensive gardening and processing of the native fruits and vegetables like papaya pickle will improve the health and nutrition of the farm households. The farm household carrying capacity to have a healthy family must be underscored.

The occurrence of malaria is more associated to an environmental patch with poor drainage and thick forest where the Anopheles spp are present. However, the movement of people from the forest area with malaria to any development type with Anopheles spp would spread and colonize any Development Type.

In Malaria infested Development Type, the water impounding dam must not have stagnated water favorable for the habitat of the mosquitoes which transmit malaria. Raising more cattle is necessary so that the malaria-transmitting species (Anopheles spp.) should feed on them instead on human being. All stagnant water around the settlement must be drained. Fumigation of pesticides for the control of this mosquitoes must be done periodically. People must sleep inside the mosquito nets.

In Development Type I or II where mosquito- transmitting Hemorragic fever is commonly reported, patient affected with fever should not take it for granted and they must see the doctor immediately because it is one of the deadly diseases.

In Development Type I Schistosimiasis may be present in large environmental patches. In any Development Types where Schistosimiasis is present in the swampy areas of the creek like in Silae Model ARC, farm households must have toilets and no disposal of human waste (urine or feces) of affected persons into the swampy area with snails which harbored free swimming Miracidium. Quarterly examination of the feces samples of the community is needed for proper medication. People avoid coming to the water with Schistosimiasis for the free swimming Cercariae penetrate the skin. The site of the water impounding dam should be free from snail harboring Meracidium. Chemical control of snails must be instituted.

Continuous population program should emphasize the limitations of the carrying capacity of the marginal areas to support the welfare of population growth and the needs for family planning. The immunization program should be continuous to ensure the children would not be afflicted with dreadful disease which crippled them like polio.

The production and use of herbal medicine should be promoted among the members of the ARC to provide immediate treatment for the sick members of the family before the patient be taken to the nearest hospital.

11.8.4 Environmental Education for the ARC Students

Curricular materials to complement the environmental concepts in science and technology, nutrition, health, and social studies will be developed by the DESC in cooperation with State University/College in the province or with the Institute of Environmental Science and Management of the University of the Philippines Los Baños. This will focus on the ARC in the marginal area for the children of the ARBs to fully appreciate and understand the development activities for the improvement of the ARC. This would influence the attitude of the children towards the rehabilitation, conservation, and protection of the marginal areas of the ARC.

Table 11-1 Crop Coefficient for the Common Cover Conditions of the Philippine Watershed.

Cover Conditions	Crop Coefficient
Annual Crops	
Corn	0.4
Upland Rice	0.15
Peanut and Mungo	0.4
Bananas	0.2
Pineapple	0.35
Diversified Crops	0.3
Grassland	
Imperata grassland, well established and undisturbed, with shrubs	0.007
Imperata, slightly grazed with patches of shrubs	0.15
Shrubs with patches of open, disturbed grassland	0.15
Grassland moderately grazed, burned regularly	0.3
Overgrazed grassland, burned regularly	0.65
Agroforestry	
Fruit trees, less than 3 yrs. without intercrop with ring weeding	0.25
Fruit trees, 3-5 yrs. without intercrop, without ring weeding	0.75
Fruit trees with intercrop or native grass undercover	0.08
Coconut with tree intercrop	0.08
Coconut with annual crops	0.2
Mixed stand of agroforestry species, 5 yrs or more with good ground cover forest	0.08
Forest trees with good ground cover	0.08
Forest trees with good undergrowth	0.2

Source: W. P. David, "Soil Erosion and Land Classification" (Report for World Bank Ffarm Mission), December, 1987 Cited In: The World Bank, 1989. Philippines: Environment and natural Resource M Study Management (A World Bank Country Study).

Table 11-2 DENR Criteria of Drinking Water

Parameter	Unit	Class AA	Class A
Color	PCU	15	50
Temperature (max. rise in deg. Celsius)	degree Celsius rise	--	3
pH		6.5 - 8.5	6.5 - 8.5

Dissolved oxygen (Minimum)	% saturation mg/L	70 5.0	70 5.0

Parameter	Unit	Class AA	Class A
5-day 20 deg. Celsius BOD	mg/L	1	5
Total suspended solids	mg/L	25	50
Total Dissolved Solid	mg/L	500	1000
Oil/Grease (Petroleum ether extract)	mg/L	nil	1
Nitrate as Nitrogen	mg/l	1.0	10
Phosphate as Phosphorus	mg/L	nil	0.1
Phenolic Substances as Phenols	mg/L	nil	0.002
Total Coliforms	Most probable number/100ml	50	1,000
or Fecal Coliforms	Most probable Number/100 ml	20	100
Chloride as Cl	mg/L	250	250
Copper	mg/L	1.0	1.0
Arsenic	mg/L	0.05	0.05
Cyanide	mg/L	0.05	0.05
Lead	mg/L	0.05	0.05
Mercury	mg/L	0.002	0.002

Source: DENR Administrative Order No. 34 Series of 1990

12. DESIGN OF MAJOR FACILITIES AND COST ESTIMATE

12. Design of Major Facilities and Cost Estimate

12. Design of Major Facilities and Cost Estimate

1) Irrigation and Drainage Facilities

- Irrigation system in the marginal areas shall be the gravity system utilizing every available water source efficiently and economically.

- Irrigation facilities shall be simple, easy operation and maintenance, and locally repairable.

- Possible irrigation facilities to be applied in the marginal areas would be the followings:

  - Small water impounding dam (SWID) which collect creek/ river and spring water as well as rain water. Impounding dam site shall be carefully selected in consideration of water shed areas, geological and topographical conditions, and so on. A farm pond can be applied instead of SWID depending on the topographical conditions.

  - Intake weir/diversion dam at small creeks/rivers. Provision of flood protection shall be considered.

  - Tank irrigation system with piped water is applicable to scarce water sources to minimize water losses and also to the sloping hilly lands where a pipe siphon is applied.

  - Spring development for irrigation can be established in connection with the rural water supply plan.

  - Conveyance and distribution canals/pipelines, and turn-out structure shall be adequately provided to the above mentioned irrigation systems.

  - Drainage facilities shall be introduced, particularly in the lowland paddy fields. The existing creeks and rivers in such areas need improvement with realignment or river bank clearing.

  - The design of irrigation and drainage facilities and structures shall be based on the design standards and criteria used by the Bureau of Soils and Water Management (BSWM) and the National Irrigation Administration (NIA).

2) Farm Land Improvement

- Farm would basically remain in the present condition/slope providing counter line farming method for soil erosion protection. Trees/ shrubs/

grasses for planting along contour line shall be provided to farmers through the nursery to be established under agricultural support services.

3) Farm Roads

- Farm roads shall be adequately located and distributed as all-weather road. The road engineering design shall be made on the Design Guidelines, Criteria Standards by DPWH.

- Road alignment shall be determined in consideration of the following conditions, that is, topographical conditions, right-of-way acquisition, flood water level, and maximization of possible number of farm lots to be made accessible.

- Farm roads shall have a one-lane carriage way with a minimum width of 2.5m and a shoulder of 0.5m both sides. Roads surfacing materials shall be gravel for the normal section and concrete for the steep section of over eight percent gradient.

4) Rural Roads

- Rural roads projects for rehabilitation, improvement, upgrading and construction shall follow the Design Guidelines, Criteria and Standards by DPWH.

- Rural roads with function of an access and farm-to-market roads shall be all-weather passable road. A road width shall be 6.0m carriage way and 1.5m shoulder both sides for provincial roads, and 4.0m and 1.0m for barangay roads. Road surfacing materials shall be gravel for the normal section and concrete for the steep section of over eight percent gradient.

- Particularly in the mountainous terrain of the marginal areas, road protection structures, cross drainage facilities and river crossing structures shall be adequately provided taking into considerations of frequent typhoon and heavy rains.

- As to road operation and maintenance, motor pools of LGUs (provincial and municipal government) shall be reinforced if necessary.

5) Rural Water Supply

- An operation level of the rural water supply shall be level-I system as a basic service, and level-II system where water is supplied by gravity pipeline. Water supply with motor pumps would not recommended in the marginal areas considering the operation and maintenance

difficulties, spare parts for repair and frequent power line cut by typhoon or heavy rains.

- Possible rural water supply facilities would be the followings:
  - Deep well as level-I system consisting of a tube well, a hand pump and communal washing basin.
  - Spring development as level-I system consisting of a spring box and communal faucets.
  - Spring development as level-II system consisting of a spring box, pipeline and communal faucets with washing basin.
  - Some other facilities such as chlorinating equipment shall be attached to the above system, if necessary.
- The engineering design of the rural water supply system shall be made based on the Design Guidelines, Criteria and Standards by DPWH.

6) Rural Electrification

- A single phase power line shall be applied to the marginal areas unless electric-driven agricultural machinery are planned. The design of electric power line shall be based on the design standards of each regional electric cooperative.

7) Cost Estimate

- Conditions of cost estimate
  - Construction unit costs shall be determined at current prices of the time of design at a contract basis, and divided into the foreign and local currency portions.
  - Regarding the associated costs, five percent of the construction costs is to be adapted for the pre-engineering costs, and ten percent for the administration costs, while the consulting services costs are to be estimated considering the project features.
  - The costs for land acquisition shall be estimated.
  - Ten percent of the construction costs shall be considered as physical contingency.

- The project costs shall consists of two categories, i.e. construction costs and community development and support service costs.

- The annual operation and maintenance costs which are composed of salaries and wages of operation and maintenance staff, administration and general expenditures, equipment repair costs, fuel and oil costs, and maintenance costs of the facilities shall be estimated at one to three percent of the construction costs.

13. PROJECT IMPLEMENTATION PLAN

13. Project Implementation Plan

13. Project Implementation Plan

1) Project Implementing and Supervising Agencies

- The Project shall be a joint undertaking of the national, the concerned provincial and local governments and the private sector located in the Project Area. As indicated in Figure 13-1, the lead implementing agency for the implementation of the Project is the Department of Agrarian Reform (DAR).

- The implementation of project components will adopt the CARP institutional arrangements where the agencies involved will implement the sub-components according to their competence.

- The existing organizational structure mechanisms for CARP projects already operating in DAR will be adopted for the Project, wherein agencies concerned will mobilize its CARP Implementing Units and tap the other regular units of their respective agencies.

- The highest policy making body for the Project shall be the Executive Coordination Committee (ECC), which shall be organized with DAR Secretary as the chairman. The ECC provides overall policy, direction and support, and shall also undertake linking and networking with other national and international agencies for the resources and technical assistance requirement of the Project. The other members of the ECC shall be the other concerned agencies, such as DA, DENR, NIA, DPWH, etc.

- The ECC shall be supported by a Central Project Management Office (CPMO) composed of a Project Manager and other staff from DAR Central Office. The Project Manager shall be appointed by the Secretary of DAR. The responsibility of the CPMO is the overall supervision and coordination of the Project Areas. It shall also provide support and direction to project implementation and undertake linking and networking at the national level.

- At the provincial level, the Provincial Project Management Office (PPMO) shall be organized composed of DAR (regional, provincial, municipal), LGUs, representatives of other line agencies. The PPMO shall be chaired by the Provincial Agrarian Reform Officer (PARO). The PPMO shall be responsible for the operation and management of the Project. The PPMO shall be supported by technical group/staff composed of the Engineering, O & M, Agricultural and Institutional

Sections. The responsibility of the support staff is to assist the PPMO in the implementation of the Project. The support staff shall be selected from the regular technical staff pool of the regional, provincial, or municipal DAR and other agency offices.

- A Local Technical Working Group (LTWG) at the provincial /municipal level shall be organized. The members of the LTWG shall be composed of the designated senior LGU officials and technical staff of designated line agencies. The LTWG shall assist in the social preparation of the community, provide technical assistance to the PMO, and shall also serve as the project focal persons in their respective municipalities and provinces for coordination mechanisms.

2) Special Consideration

- Implementation mode for facility constructions shall be the contract basis, therefore general contractor(s) are selected preferably through international tendering. On the other hand, the community development and support services shall be implemented mainly by DAR and NGOs which are to be hired on the contract basis under the Project.

- Major preparatory works to be conducted prior to the commencement of the detailed design are as follows:

  - Land acquisition for facilities
  - Topographic survey for major facilities
  - Rout survey for roads, canals and others
  - Geological investigations
  - Institutional capability building-up and social preparation to the beneficiary communities/people concerning the community development/support services, and operation and maintenance of facilities.

- Consulting services shall be required for the detailed design, preparation of the tender documents and supervision of the construction works. Therefore consultant(s) shall be hired preferably through international tendering.

- Land acquisition and compensation to be made prior to the commencement of the detailed design are always key factor for smooth implementation. Intense efforts on land acquisition shall be made by the PPMO.

3) Implementation Schedule

- Implementation schedule for the construction works shall be prepared based on the actual work volume and working conditions.

- As to the social preparation/institutional strengthening and community development, on the other hard, two and three and half years will be required respective works.

Figure 13-2 shows the general implementing schedule for the project.

4) Operation and Maintenance Plan

- Operation and maintenance of the implemented project facilities will be conducted by the Provincial Project Management Office (PPMO) to be newly established. The PPMO will be in charge of planning and management for the implemented project, and the local government units (LGUs) and farmers' organizations/cooperatives to be also established or strengthen shall carry out the actual operation and maintenance works under the jurisdiction of the PPMO. PPMO shall also execute the monitoring and evaluation works as well as operation and maintenance of the implemented project.

- Furthermore, as the supporting agencies for operation and maintenance of the project, Technical Working Group (TWG), which has been organized during the preparation stage prior to the project implementation in order to promote social capability of the beneficiary communities in the Area, will also function as an operation and maintenance organization.

Proposed operation and maintenance organization chart is shown in Figure 13-3.

FIGURE 13-1 PROPOSED ORGANIZATION CHART FOR PROJECT IMPREMENTATION

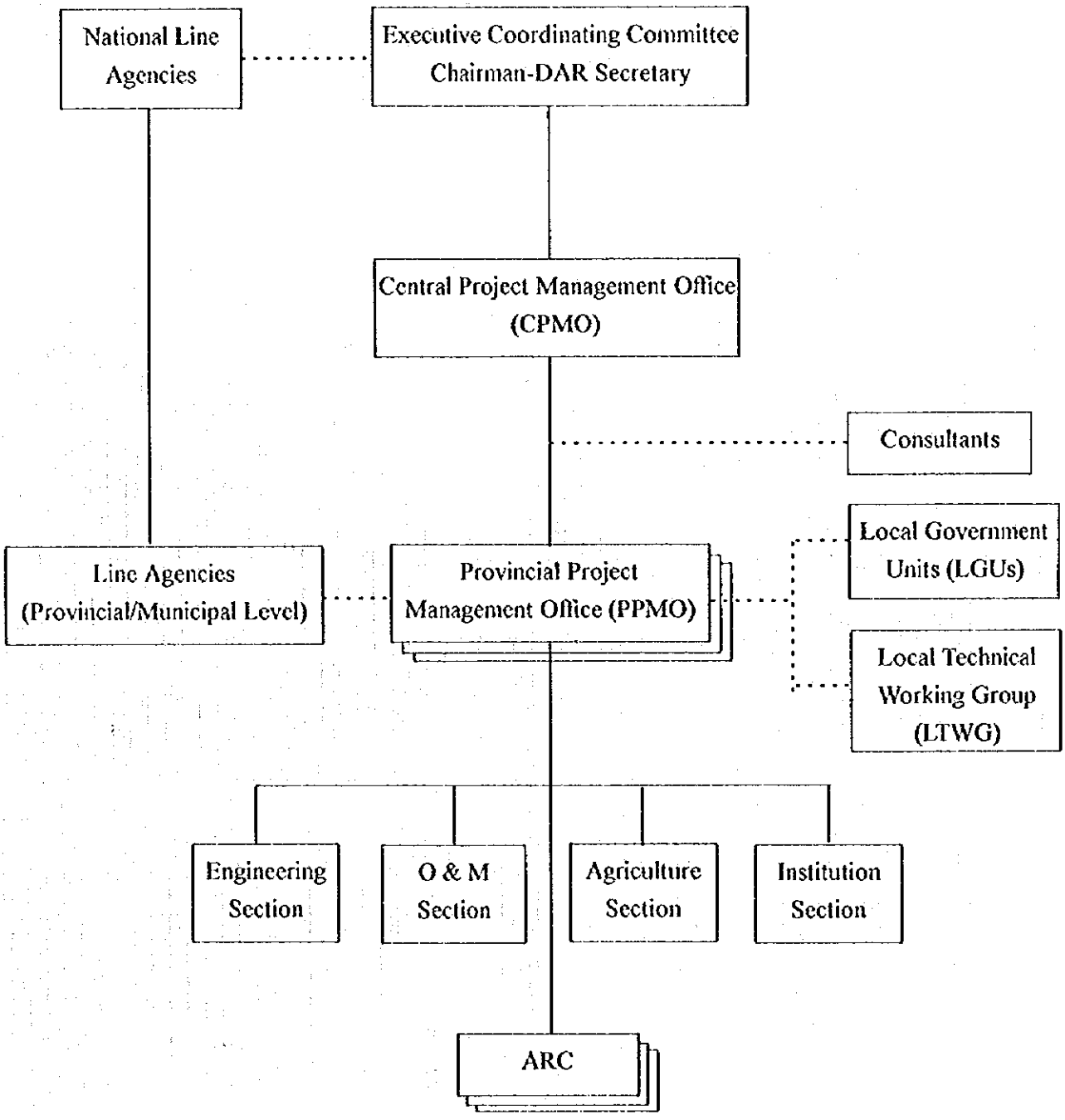


FIGURE 13-2 IMPLEMENTATION SCHEDULE FOR THE PROJECT

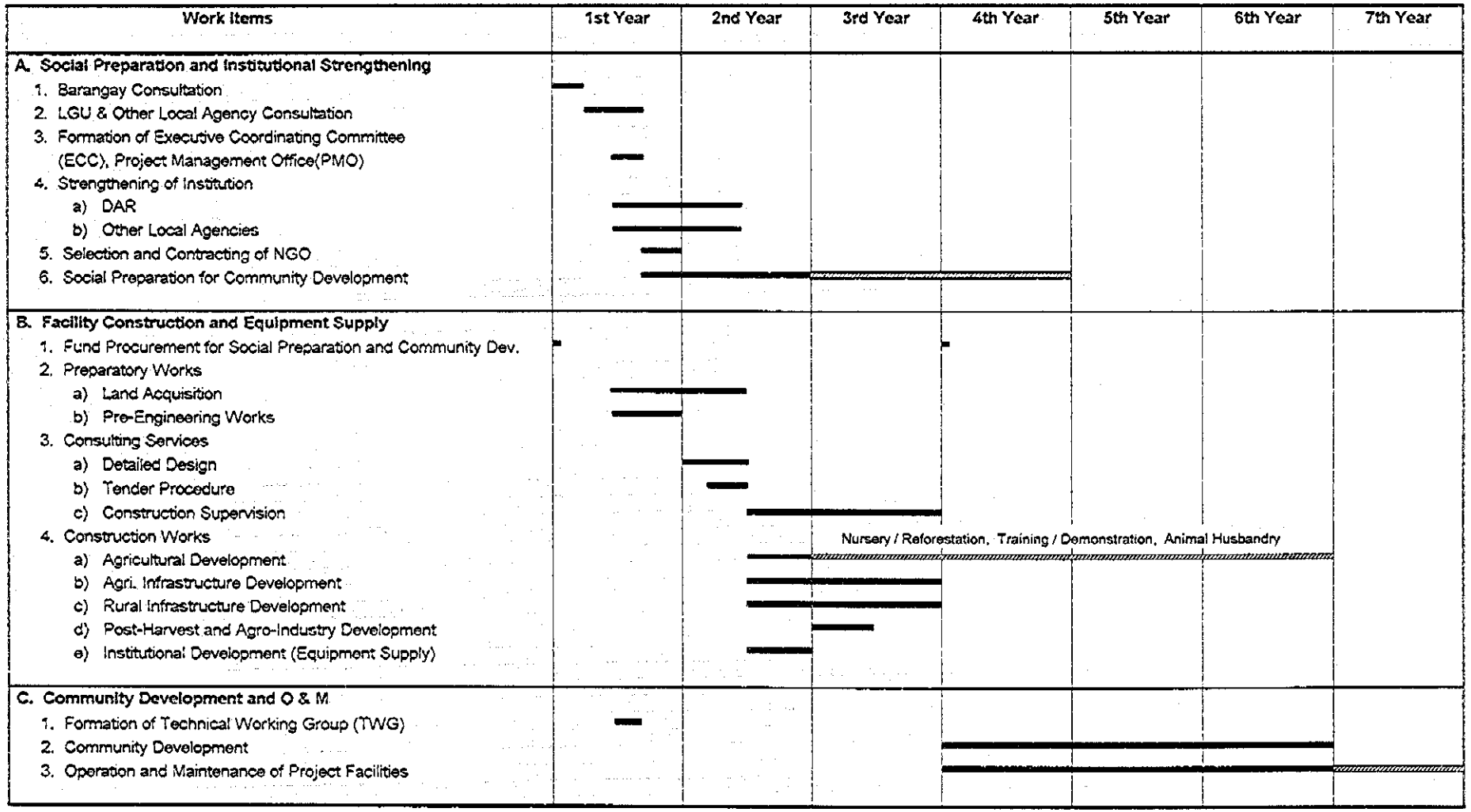
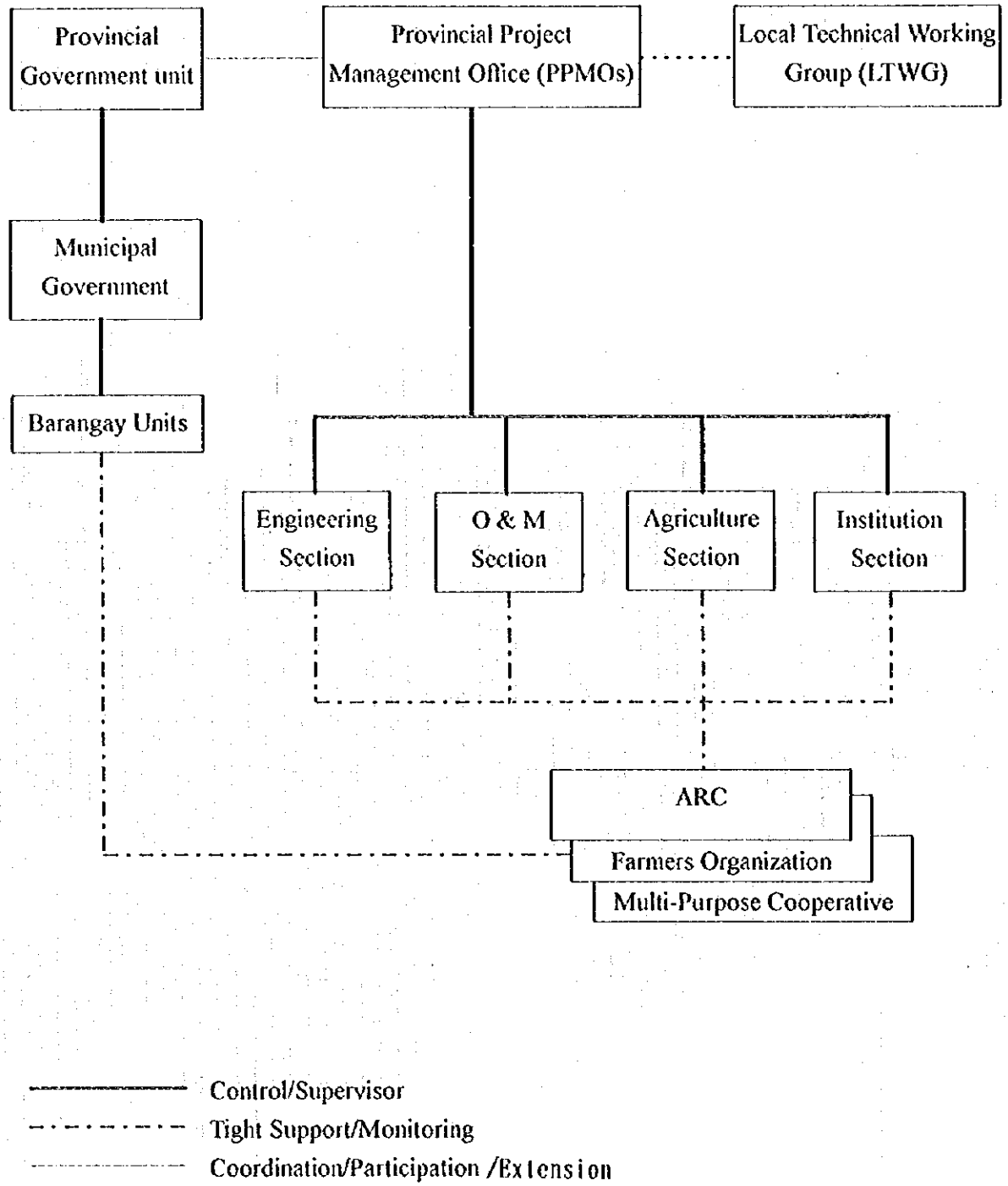


FIGURE 13-3 PROPOSED ORGANIZATION CHART FOR O & M



14. PROJECT EVALUATION

14. Project Evaluation

14. Project Evaluation

14.1 Introduction

To avoid confusion between the term Project Evaluation as it is used here and that used together with Project Monitoring e.g. Project Monitoring and Evaluation (M&E or M and E), the term Project Evaluation used here means the same as the term Project Analysis used by the World Bank and other international financing organisations.

14.2 Steps in Conducting Project Evaluation:

1) Identification of Cost and Benefit Components

In the case of this project on Development of Agrarian Reform Communities in the Marginal Areas (DARCMA), the planned development and costs are: Agricultural development, agricultural infrastructure development, rural infrastructure development; post-harvest and rural industry development; and institutional development. In addition to these development costs which will be disbursed in different portion within the first six years of the project, there will be also the operation and maintenance (O&M) costs to be equally disbursed every year.

What needs to be figured out in the course of Project Analysis/Evaluation is whether all the expected incremental benefits from such development can cover the project development costs within the project life measured in terms of its Benefit-Cost (BC) Ratio, Net Present Worth (NPW) and Internal Rate of Return (IRR).

The Incremental Benefits are what expected to be the Net Benefit or Net Production Value (NPV) created by the project (generally known as the With-Project case) less what expected to be the NPV Without the Project . This is different from comparing between "Before" and "After" the project in that the two events " With" and "Without" are expected to occur at the same time during the project life, and not one after the other. The NPV without-the project is what already will be obtained even without the project, or the Production Foregone from launching the project. This Production Foregone is supposed to represent the cost of land use in the project.

The Project Life is based on the life of the most durable capital item to be invested in the project or how long it will last. In the case of this DARCMA project, there are several capital items of long life. Examples are the rural roads, the irrigation structures, the post-harvest and agro-industry machinery. With the use of the Present Value technique in evaluating the Rate of Return of the

project, and despite the fact that some capital items invested in the project may last longer, the longest project life is normally not taken beyond 25 years. The reason is that the present value of anything beyond that will be very small. An example on this is that at the discount rate of 12 percent, the Present Value of what comes after the Year-25 will only worth about 0.004 its nominal value.

The Rate of Return mentioned above is the Sum of all Present Values of the Benefit Stream less those of the Cost Stream during the Project Life. These can easily be calculated using the IRR function available in Lotus 123 or Excel package of the Window computer program.

From the above development costs, the major benefits expected are incremental production and income from agriculture (crops and livestock) and other benefits including those from Tilapia culture and the imputed values of labor saved from rural roads, rural water supply, and post-harvest/rural industry.

2) Assessment of Project Benefits

With all possible forms of benefits in mind, the next step is to work out in more details the specific types of production to be introduced in the project areas such that the planned benefits can be realised. In agriculture, the crops and livestock which are both technically and economically feasible are to be identified. The technical feasibility of the crops to be introduced is normally based on technical factors like land topography, soil structure and fertility, amount of rainfall, other available sources of water, temperature during different months of the year, and so on.

For economic feasibility, the costs and income of each enterprise and other associated factors like the availability and prices of inputs (seeds/seedlings, fertilisers, insecticides, and others), as well as market and prices of outputs will be needed. Information and data on all these, will have to be collected from all sources, be it primary or secondary, depending on available time and resources. Social factors like the preferences of the farmers in the areas to produce certain farm production may need to be considered.

Based on the above, the crop/livestock specialists and the economists will have to jointly work together in selecting the enterprises that are both technically and economically feasible.

As in the case of this DARCMA project, a total of 31 types of farm production are identified for all the four marginal areas. These include 13 field crops, nine fruit crops, seven forest crops, and two livestock enterprises. Examples are paddy, corn, peanut, mungbean, cassava, garlic, sweet potato and

squash for field crops; abaca, banana, coconut, mango, jackfruit, rambutan, cashew nut and durain for fruit crops; and kakawate, bagras, begalunga, falcata, flemingia, gemilina and mahogany for forest crops; and carabao and poultry for animal production.

In case of the benefits from agricultural development, the kinds of crop and livestock production as well as fish farming are to be identified. Information and data on input requirements, and yield per unit of production (e.g. per hectare, or per unit of animal raised like 2 bulls and 15 cows; poultry unit of 100 hens, etc.) need to be collected. In addition other factors that may be used to indicate the production potential of each crop/animal enterprise also need to be collected and used in selecting them. These include technical data like land topography, altitude, slope, soil structure and fertility, temperature, availability of water, etc. as well as other socio-economic data like the preference of the farmers in the area to grow them, their marketability and so on.

3) Assessments of Project Benefits on Alternative Land Use

Having identified the agricultural enterprises of high potential in the area, the next step is to lay out the plan of production in terms of the size (hectares, units) of each enterprise expected to be produced by the farmers during the project period. At this stage, several alternative production plans or what are called Pattern Farm Plans can be worked out from which final selection is made after other related considerations(mainly economic and environment) have been made. Tables O.2-1 to O.2-84 in the Annex to this report may be referred to in arriving at the economic feasibility of each enterprise included in the analysis of this project.

For the DARCMA project, five different Pattern Farm Plans have been developed out of the Base-Case. Case-1 takes out all the contour farming from the production plan, while Case-5 represents full development of the Project Area. The remaining Case 2-4 are somewhere in between the two extreme Case 1 and 5 in order their intensiveness. Finally, based on all angles of consideration, Case-3 has been selected to represent the most optimal case for Project Analysis.

4) Assessments of Production Costs

With firm ideas about the farm enterprises to be selected, data on farm prices of inputs and outputs will need to be collected from which the costs and value of production will be preliminary assessed to come up with the financial and economic viability of each individual enterprise. This helps judge which enterprise may continue to be included in the farm plan or replaced. All will be reassessed when put together in the Pattern Farm Plans of each project area by

when the related project development costs and other related benefits will also be included in the analysis.

5) Financial and Economic Analysis

On the input and output prices to be used in the analysis, the first rule is that each has to be at the Point of First Sale or Farmgate Prices in case of output. For Financial Analysis or the analysis in real money terms and in terms of individual participant in the project, or in this case the target beneficiaries, market prices at farm gate will be used. For Economic Analysis which will indicate the returns to the entire economy of the country, shadow prices are to replace the market prices in the analysis. The reason is that market prices do not normally reflect the real opportunity costs/return of any inputs and outputs. Take for example output prices may be too low because of the tax imposed upon them to protect the consumers.

The procedures generally used by project analysis is to cover the related world and local market prices into shadow prices. For all foreign costs, either the official exchange rate (OER) or the shadow exchange rate (SER) is used. Where OER is used on foreign costs, a;; local costs will be converted to shadow prices through the application of the standard conversion factor (SCF). Where the shadow exchange rate (SER) is used, all costs will remain at their market prices except the value of unskilled labor which will be discounted by the shadow wage rate.

As to the procedures adopted and suggested by NEDA, all economic prices will be based on SER of 1.2 that of OER and SER of 60 percent that of the market wage of unskilled labor.

On the other hand, input prices may be too low due to the subsidy given to the producers. Since these taxes will go from one party to the other party in the same economy with no net gain to it, the standard procedure in arriving at Economic Prices is to deduct tax from, and add subsidies to the market prices. Tables 7.5-1 and 7.5-2 to 10.5-1 and 10.5-2 in the Annex to this Report may be referred to as the Financial Prices and Economic Prices of Produce and Inputs used in the analysis of this project.

6) Incremental Net Benefits and Internal Rate of Return

Having obtained all the financial and economic prices of related inputs and outputs of the project, they will be applied to all inputs and outputs of both the "Without" and "With" project cases. The difference between the two is the Incremental Net Benefit, or Cash Flow to which Discount Factor (DF) will be

applied to obtained NPW and from which IRR can be calculated. To obtain the BC-Ratio, NPV of both the Benefit and Cost Streams are to be calculated.

The Financial Internal Rate of Return (FIRR) is the IRR obtained from the analysis with benefit and cost streams at market prices and transfer payments left untouched. The Economic Internal Rate of Return (EIRR) is that obtained from benefit and cost streams with Shadow Prices without transfer payments. Tables 7.5-3 and 7.5-4 to 10.5-3 and 10.5-4 in this report may be referred to as how the FIRR and EIRR of the four TMAs are derived.

7) Sensitivity Analysis

Finally, to cope with the unforeseen variations in production, prices of both inputs and outputs, wrong estimation of the data used in the analysis and so on that would have profound effect on the costs and benefits of the project, sensitivity tests or analysis to come up with the resulting IRR due to such variations are needed. Switching Values or the largest percentage decrease in project benefit and increase in the project costs that still keep the FIRR or EIRR at the acceptable range may also be derived. Tables 7.5-5, 8.5-5, 9.5-5 and 10.5-5 may be referred to as the results of Sensitivity Analysis of this project.

8) Applied Computer Program for Analysis

In working on all above, the suggested computer programs are those of spread sheet package like Lotus 123 and Excel. The copy and paste commands of the said package are powerful and can help facilitate the modelling of various Pattern Farm Plans or other forms of Production Plans. Their functions on NPV and IRR are also readily available.