PDWAL946

MEMORANDUM

TO : Mr. Fred Scheick, DAA/Asia DATE: October 22,1981

FROM : S&T and ASIA/TR Technical Review Team: P. Weatherly, S&T/EY PW.
G. Wahlgren, USDA/Forest Service GW
K. McNamara, ASIA/TR/EFE KM (in draft)

SUBJECT: Report on technical issues for Dendro-Thermal/Livelihood Development Fund PID and Project Paper

Attached is the final draft of the report of the S&T-ASIA/TR Technical Review Team sent to the Philippines to determine the technical issues that must be addressed by AID in a consideration of the dendro-thermal component of the Livelihood Development Project. Before we left the Philippines a preliminary draft of this report was submitted to Mr. Bruce Gair, the leader of the combined technical and social review teams.

This report represents the consensus views of representatives of the technical offices of the Asia Bureau and the Science and Technology Bureau that are concerned with energy projects. These views are based on a brief, but intense round of field trips, on a close review of relevant documents, and on detailed conversations with foresters, Philippine government officials, AID officers, and others. The views presented in this report were refined in discussions among the three members of the S&T-ASIA/TR technical team. Effort was made to draw conclusions and make recommendations soley from a consideration of technical questions.

The major conclusion of this report is that the Dendro-Thermal Project is technically feasible; however, project success will probably not be achieved unless the Philippine National Electrification Administration (NEA) augments its technical staff. This staff improvement is necessary if NEA is to have the capacity to manage the technical aspects crucial to the program. Unlike NEA's experience implementing rural electrification, establishing a dendro-thermal power generation program is without precedent. Such an innovative program requires technical management by full-time staff made up of the best trained and most experienced persons available. The other donor agencies (Sweden, Asian Development Bank) and private enterprise (PICOP) contacted by the technical team concur in the primacy of this recommendation.

Attachment: S&T/-ASIA/TR Technical Team Report

CC: DAA/S&T, Mr. C. Farrar
ASIA/PD: Rvan Raalte, DTiedt, JNussbaum
ASIA/TR: GHickey, JStanley, RIchord
ASIA/PTB: DChandler, CPenndorf
S&T/FNR: DDeeley, MBenge, MKux

REPORT ON TECHNICAL CONCERNS RAISED BY THE DENDRO-THERMAL COMPONENT of the PHILIPPINE LIVELIHOOD DEVELOPMENT PROJECT

I. Introduction

A presidential decree on 8 October 1979 directed the National Electrification Administration (NEA) to assist the country's electric cooperatives in developing renewable energy sources for power generation.

In response to this directive, the NEA launched a number of programs, including the Dendro-Thermal Program. The overall objective is to develop 70 power plant projects with a total generating capacity of 200 MW. To support the fuel requirements of these power plants, NEA is establishing 70,000 hectares of tree farms. This means that at each of the 70 power plant sites approximately 1,000 hectares will be planted with rapidly growing woody species capable of sustaining a frequent cutting cycle.

Each of the 70 project sites will be associated with an existing Electric Cooperative. The 1,000 hectare planting will be divided into 100 hectare "modules," each of which is managed by a "farmer's association" composed of ten local farming families. Each association is responsible for planting, weeding, protecting, and harvesting their 100 hectares of trees, so far primarily Ipil-Ipil (*Leucaena leucocephala*) trees.

II. Purpose and Scope of S&T-ASIA/TR Technical Review Team

The review team is charged with the following tasks: one, scoping the technical inputs which must be assembled for project success and which must be dealt with in the project paper; and two, make suggestions as to individuals and institutions capable of assisting in the preparation of the project paper.

III. Sources Investigated

Three categories of sources were investigated during the review team's Washington preparation and Philippine visit. One, documents relevant to current activities in the biomass energy sector of the Philippines were reviewed. Two, officials of the Government of the Philippines and non-governmental agencies were interviewed Three, existing biomass plantations were visited. A summary report of site visits to biomass plantations is given in Table I. Documents reviewed and persons interviewed are listed in Table II and Table III respectively.

IV. General Evaluation of Technical Support and Specific Recommendations

A. NEA technical support program. NEA's Dendro-Thermal Development Office (DTDO), since its inception one year ago, has addressed the need for technical input to ensure long term success of quick rotation energy plantations with the following measures:

1. Setting out requirements for technical field staff in the NEA Guidelines for Dendro-Thermal Projects. These guidelines call for one forester and two agronomists to be employed full-time at each 1000 hectare site.

2. Conducting a series of five day technical courses designed by the staff of the Forest Research Institute (FORI) research program on Non-Conventional Energy Sources to teach field extension workers the biomass energy plantation technical skills that have to be transferred to farmers. For example the August 9-14, 1981, workshop attended by 30 electric cooperative participants and 23 NEA participants covered seed technology, soil conservation, cultivation of Ipil-Ipil, nursery establishment, pest and diseases, timber management, harvesting, and yield research.

B. Specific technical recommendations. Although tree planting is proceeding at an impressively rapid rate (approximately 12,000 hectare of the proposed 70,000 hectare were planted in 1980-1981), the technical team feels that so far NEA technical staff development, at both central and field levels, does not match the anticipated planting schedule. As a result of its review, the technical team has developed three recommendations for strengthening project technical management. These recommendations are discussed below together with suggestions as to how the USAID project might play a constructive role:

1. The National Electrification Administration (NEA) should augment the technical capacity of its central office (see Diagram I) to assist project planning, implementaion, and monitoring. This augmentation is necessary to provide technical services to all levels of project development: NEA, Coops, and farmers association. For these technical services to be effective, NEA technical staff should be concentrated in one location or office in the DTDO. The AID technical team has refered to this office as a "technical support service" although its exact location within DTDO is not as important as its capacity to provide these services to all levels of NEA.

a. NEA. A strong technical support service is needed to provide policy level input to managers and decision makers concerning the following programmatic questions:

(1) A technical support service could analyse the producton of feedstock, including evaluation of the range of alternative energy plantation mangement practices, such as seeding versus planting, spacing, thinning, harvesting, and nutrient balance. The information provided to policymakers would be continuously updated as a result of field monitoring of biomass growth and yield by species, site, and management practice.

(2) A technical support service could evaluate technical and economic questions on the conversion of feedstock to charcoal, electricity, and producer gas. It could provide updated

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information on the alternative technologies and processes. This unit will review the economics of feedstock preparation alternatives, standardization of plant capacity, and central versus more dispersed locations.

(3) A technical support service could provide guidance on priority locations for power plants by considering existing and projected grid patterns and potential sources of raw materials (including standing growing stock).

(4) A technical support service could provide projections of manpower requirements and identify training program needs as well as opportunities for coordinated activities with other agencies, particularly the Bureau of Forest Development (BFD).

b. Rural Electrification Cooperatives. The technical service could provide criteria for guidance in project site selection and planning to the Coops:

(1) Recommend species and predict species growth and yield for each candidate site.

(2) Develop practical proposals for the most efficient harvesting, handling, drying, and transport system for each candidate site in consideration of site topography.

(3) Provide technical assistance on the evaluation and design of possible co-generation alternatives at each site.

c. Farmers Associations. A technical support service could act as an action center for problems arising at a particular project site. In this role they would work directly with farmers associations to deal with the following kinds of problems (and any others not yet anticipated):

(1) Failure to meet production goals.

(2) Outbreak of pest problems.

(3) Shortage of certified seed supply.

(4) Fire protection planning.

(5) Information on new species.

(6) Information on innovative techniques for planting, weeding, thinning, harvesting.

2. The NEA should initiate a vigorous progam of applied activities (see diagram) designed to strengthen its energy plantaion projects. This program should bring institutions, both within the Philippines and in the international community, into an ongoing relatonship with the NEA dendro-thermal project. The following kinds of program activities could be started:

a. Linkage with the institutions which are already involved in innovative bio-energy research or who have the capacity to perform applied studies to augment the technical knowledge required for energy plantation development. Among these institutions are the Forest Research Institute, BFD, the College of Forestry, The institute of Human Ecology, private industry, and donor agencies.

b. Information exchange with those individuals and institutions, wherever located, engaged in parallel efforts. This information should be transmitted directly to the coops and the farmers associations through periodic news letters and on site workshops.

c. An aggressive tree improvement program involving species selected, seed procurement and certification, and varietal development.

d. Programs should be developed for training and upgrading of project staff in the range of technical areas necessary for project implementaton.

3. The technical service could help NEA establish long-range objectives which guarantee a continuous supply of raw material. In determining these objectives, the following issues should be considered:

a. Biomass yield prediction models.

b. Evaluation of plantations nutrient budget (including trace elements).

c. Evaluation of species and site experience.

d. Alternative management systems to succeed Ipil-Ipil monoculture.

e. Energy production economics and the possible need for subsidies.

V. Project Paper Preparation

Although the Dendro-Thermal Project is feasible, there remains concern about the NEA's present capacity to manage the technical aspects of a program as large as is contemplated. The recommendations given above therefore place first emphasis on the need to strengthen the NEA's technical management capacity. Without such an augmented capacity, the NEA will have difficulty addressing the technical concerns that have been identified by this report. Consultation with GOP agencies, other donors, and the private sector confirm the conclusion that NEA's technical staff should be augmented before the project reaches the operational stage. The following are suggestions for preparing the technical sections of the project paper:

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A. Content of Project Paper technical sections. The Dendro-Thermal Project Paper (PP) should present evidence of NEA's recognition of the paramount importance of augmenting the technical capability of its central office staff. As a step toward preparing the PP, the USAID Mission should engage the NEA in a discussion of the staffing and organizational needs of its Dendro-Thermal Project Office. These discussions should emphasize the inter-relationships between the NEA, other government agencies, and the full range of institutional resources potentially available to the project. The resulting description of NEA's central office technical staff and the institutional inter-relatonships should form the core of the technical analysis section of the PP.

The technical analysis of the PP should identify clearly the role of the technical assistance project fund in helping to strengthen the technical capability of the NEA Dendro-Thermal Central Office. The technical assistance fund should strike a balance between developing NEA and supplying technical analyses. In a highly innovative effort like the Dendro-Thermal project even the best state of the art technical analyses are soon outdated and hence of less value to an inexperienced staff incapable of making independent judgements.

B. Suggested scopes of work to address specific technical issues. Issues which require particular attention in the Project Paper include:

1. Choice of alternative harvesting and transport alternatives. A comprehensive study is needed to review state-of-the-art transport and harvesting techniques currently in use in the Philippines for short rotation species. (Private Sector: PICOP, Nassipitt, Canlubang Sugar Estate, Philippine Tobacco Companies); (Research Organizations: FORI, FORPRIDECOM, and BFD). This study should also compare short rotation transport techniques used in Philippines with experience from Brazilian energy plantations and from U.S. *Populus tremuloides* plantations, etc., to identify appropriate new technologies not considered to date.

2. Choice of alternative plantation management models (species, thinning, pruning, spacing, rotation, succession). A study is needed to derive optimum models suited to the range of different (edaphic, topographic, economic) types of energy plantation sites.

3. Design for a field monitoring and evaluation system. A study is needed to identify alternative growth and yield measurement (volumetric and weight) methods currently used for fast rotation species and assess their pros and cons for use in the Philippine Dendro-Thermal Porject. This study should collect available information on moisture content measurement and assess the implications of moisture content for alternative yield models, harvesting, and transport systems.

C. Resources available for project paper preparation. A pool of in-country highly qualified technical expertise is available and could be

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paired with foreign expertise to address the issues listed above for input into the PP and for implementation of the Rural Energy Technical Assistance Project (LD002-8109).

1. Resources suitable for plantation design, management, and monitoring:

In-Country	Foreign
Dr. P. V. Bawagan Forest Product Dev. Specialist Forest Products Research and Industries Dev. Commission (FORPRIDECOM) NSDB, College Laguna 3720, Philippines	U.S. Forest Service Forest Products Lab. Madison, Wisconsin 53701 Contact: John Zerbe
U.S. Forest Service Products Research Lab. Madison, Wisconsin - 2 year training program in harvesting engineering and research	
MADECOR consulting firm team member USAID/Phil. Upland Energy Options Study	
Dr. Mario A. Eusebio Science Research Chief Forest Research Institute College, Laguna 3720 Philippines	Georgia Pacific Weyerhaueser
U.S. Forest Service Products Research Laboratory Madison, Wisconsin - 2 year training program in harvesting engineering research program Dr. Lucrecio L. Rebugio Socio-Economic Forest Researcher College of Forestry Forest Research Institute College, Laguna	
Ph D: Yale School of Forestry MADECOR Consulting firm team member for USAID Phil. Upland Energy Options Study	
MADECOR Consultants	
PICOP	

NASSIPITT
Edith Alcantara
Philippine Wood Products. Assoc.
Manila

2. Resources for seed and improved species:

Manila Seedling Bank
Quezon City
Philippines

Dr. Saturnina C. Halos
Chief Science Research
Specialist
Forest Research Institute
College, Laguna

Ph D: University of California,
in plant genetics
Acting Coordinator for Research
Program on Non-Conventional
Energy Sources - FORI

Dr. Manuel Bonita
College of Forestry
Laguna, Philippines

Dr. Revilla
College of Forestry
Laguna, Philippines

U.S. Forest Service
Experiment Station
Honolulu, Hawaii
Craig Whitesell

U.S. For. Ser. Exp. Stat.
Berkeley, California
Bob Callaham

Jim Brewbaker
University of Hawaii
Honolulu, Hawaii

Native Plants, Inc.
Salt Lake City, Utah
Hugh Bollinger
Tree Crops International
Winter, California
Henry Espenshade

3. Resources from AID/Washington: Additional expertise is available from the S&T Office of Energy project, "Bioenergy Systems and Technology." A copy of this PP is attached to this report, and the resources it can provide are listed below:

a. Technical assistance on specific aspects of energy plantation development.

b. Identificaion of expertise and evaluation of proposed souces of technical assistance.

c. Information and linkages to institutions and programs concerned with similar energy plantation work, e.g., the Brazilian Charcoal Program.

d. Preparation and publication of a case study on the NEA Dendro-Thermal Project.

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e. A Workshop in the Philippines for other LDC energy planners contemplating similar programs.

VI. Site Visits

From September 10th until September 13th, inclusive, the team was in the field visiting three dendro-thermal project sites and the seed-production farm of Dr. Figuras. The project sites were in the provinces of Abra, Ilocos Sur, and Pangasinan.

A. Field observations

1. Abra Site - San Juan Dendro-Thermal Project.

Tree planting began in 1980 with direct seeding of 220 hectares. However, only 50 percent of "hills" seeded (three seeds to a hill) produced a sprout. The farmers interviewed (from modules No.9 and No. 4) attributed this high mortality to the late planting date (August 1980), which was during the middle of the rainy season. This year direct seeding was again used on 810 hectares beginning in May and survival looks better. Naked root seedlings were planted to replace the failures from the 1980 seeding. Athough all planting were of *Leucaena* only, the young forester assigned to the Electric Coop was planting other species in small trial plots. All plantings seen at the time of this site visit (September 1981) were showing good growth with very few hills failing to produce at least one seedling.

The preproject vegetative cover of the lands selected for the project site is quite varied. The range is from 100 percent cogon grass (*Imperata cylindrica*) to dense brushwoods. The cogon grass areas appear to be the most difficult for reforestation as they require repeated weedings to allow the Ipil-Ipil seed to sprout and to grow to a height taller than the cogon grass. In some modules, farmers and extra laborers were on the second weeding since the planting in May 1981.

All preexisting woody biomass will be used as feedstock. Some woody stems were seen lying on the ground, indicating the felling and burning by "kaingineros," or shifting cultivators, who were active in the area prior to the start of current tree farming. In each module this downed material is being gathered and piled along with the felling necessary to prepare sites for planting to be used by the dendro-thermal plant. The power plant selected for this location is the French design and will require chipping of all feedstock prior to combustion.

Current practice will affect the design of harvesting systems. The practice of spacing hills on a 1 x 1 meter grid as well as the frequency of double and triple sprouts per hill will produce a relatively dense growth of thin stems. Such a dense planting may require thinning before the first cutting, which is planned for the fourth year. After the first cut, the coppice growth is likely to produce a growth of yet thinner stems. The size range of the stems,

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an important consideration in any transport system to the power plant site, is an especially important specification for the design of the cable system which is required by the steep terrain of many sites.

2. Ilocos Sur site - The Padre Burgos Dendro-Thermal Project.

Tree planting began in 1980 with direct seeding of 100 hectares, followed by an additional 317 hectares direct seeded in 1981. The survival rate was greater than 75%, probably because both seedings were made before the rainy season. Growth is good, particularly in one small valley or draw with good soil where an exceptionally tall stand was noted (6 meters of height growth since planting in 1980).

The preproject vegetative cover ranged from cogon to brush. On those lands previously supporting cogon grass the importance of weeding during the first year of Ipil-Ipil growth was again apparent. There was noticeable better growth on lands that were not previously 100% cogon.

3. Bolinao Site.

Tree planting began in 1980 with direct seeding of approximately 300 hectates. Survival at 90% was the best of the three sites. An additional 610 hectares were planted in 1981 and already show good height growth. The excellent survival of all plantings is indicated by the 2, 3, and sometimes 4 stems noted for each hill. There are several stands that will definitely require thinning before the proposed harvest in four years.

B. Tentative findings on tree plantations

Only Leucaena trees have been planted to date. Although successful, continued reliance on only one species is not prudent; consideration should be given to the inclusion of other fuelwood species as a precautionary measure against as yet unknown pest, disease, and other problems. .

The farmers who are planting the trees are the key element. Their continuous involvment in planting and weeding is absolutely essential to project success. Immediate consideration should also be directed to practical experiments in thinning the dense 1 x 1 meter spacing plantations. Answers from monitoring of such experiments will be needed to demonstrate the most practical (and economical) spacing that will provide the maximum yield per hectare.

Immediate consideration should be given to planning the appropriate felling, yarding and hauling system suited to these plantaions. Saws, axes and carabaos will probably suffice for the area harvests by the farmers but the transportation system to the power plant will need to be more sophisticated to support the large tonnage required daily by the thermal power plant. The necessity of drying the feedstock, especially during the wet season, should be addressed early.

The success of the project to date is apparent; however, the difficult decision making periods are still ahead. With less than four years to the first cutting many decisions will need to be made soon. A large, well-trained staff of experts will be required by NEA to make these decisions and to incorporate changes into ongoing projects.

C. Visit to Dr. Figueras and his farm at Sto. Domingo, Ilocos Sur

Dr. Figueras, a medical doctor, also has a serious interest in growing Ipil-Ipil trees for seeds and for trying experimental land use concepts on privately owned land.

Unfortunately, we did not see Dr. Figuras Ipil-Ipil seed orchard which we understand has provided most of the seed for the Livelihood Project. We did however see his appraoch to restoring poorly managed private land. On his 200 hectare holding, he has worked out a unique arrangement with landless farmers. The farmers are provided seed (either rice or corn) to plant their crops. In addition, they are also provided Ipil-Ipil seeds. The arrangement is that the farmers plant the rice or corn along with Ipil-Ipil seeds (1 x 1 meter spacing). If 85 percent survival is achieved in the Ipil-Ipil plantation then the entire harvest of rice or corn belongs to the farmer. If survival is less than 85 percent then a share of the rice or corn is given to Dr. Figueras. Each year the farmers repeat the operaton but always at different locations. With this approach it will be just a few years before Dr. Figueras will have all 200 hectares of his land planted in productive Ipil-Ipil forests. This approach for restoring unproductive private lands is being tried on a larger scale by the NEA.

D. Visit to Iloilo (Island of Panay)

This field trip was to observe the operation of charcoal fed gasifiers to supplement diesel fuel in diesel irrigation pumps. Among the sites visited by the technical team, this site was exceptional because of the warm response of the local people to USAID assistance.

The Farm System Development Corporation (FSDC) was organized in response to a Presidential order to assist rice farmers in establishing irrigation systems. The FSDC through the establishment of farmer-run Irrigation Service Associations (ISA's) has been successful in implementing diesel operated irrigation pumping systems. FSDC through its ISA's has installed 1000 such irrigation systems. Since the rapid increases of oil prices, the FSDC has broadened its program to convert diesel engines to burn fuel supplied by a gasifier. FSDC is under the able leadership of Teodoro C. Rey, Jr., who accompanied us during the field trip. Under his leadership the number of ISA's have grown to 1700 and now include some 83,000 members.

Gasification in simple terms is the thermal conversion of biomass materials to combustible gases which can be used for heat and power. Gasification is a proven technology and has immediate application for both diesel and internal combustion engines. The gasifier units selected by FSDC consist of a reactor (containing charcoal or wood chips) and a gas cleaner and cooler. The "scrubbed" and cooled gases are fed through the diesel engine's air intake where it is mixed with a variable percentage of diesel oil.

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We visited two locations in which irrigation pumping systems powered by diesel engines were fueled by a 50-50 mixture of diesel fuel and producer gas. The feedstock for the gasifiers is charcoal which is produced from local tree plantations cultivated by the ISA which is operating the gasifier. The FSDC, recognizing the merits of gasifiers, has organized a Gasifier and Equipment Manufacturing Corp (GEMCOR) to build the all of the gasifiers used in this program.

The gasifiers we saw in operation were of an excellent design that was both efficient and effective. This design is capable of burning up to 85% producer gas, and the ISA visited is experimenting with a range of fuel ratios. Although the ratio being used at the time of the visit was only 50%, the ISA still estimates a net saving in overall fuel costs of thirty percent.

The use of gasifiers to supplement fuel for diesel run irrigation systems is implementable and economically feasible. As a second market GEMCOR has identified gasoline marine engine (there are approximately 150,000 fishing boats powered by gasoline engines in the Philippines).

In the opinion of the technical team the use of wood fed gasifiers for supplying diesel run irrigation pumps should be given a high priority because: (1) gasification is a proven tecnology, (2) gasifiers can be manufactured in the Philippines, (3) there is a clear market, and (4) the introduction of gasifiers can be managed through a network of existing Irrigation Service Associations (ISA).

Table I

DATA ON THREE DENDRO-THERMAL PROJECT SITES

Name of Farmer's Association	Padre Burgos ECO-BLISS Farmers Association	San Juan ECO-BLISS Farmers Association	Cape Bolinao ECO-BLISS Farmers Association
No. of Associations	10	10	10
No. of Beneficiaries	106	180	100
Date of Incorporation	August 1980	August 1980	Sept. 1980
No. of Coop. Modules	1	1	1
Average area per module	110 Has.	100 Has.	100 Has.
No. of Hectares planted in 1980	10 (70% Surv)	220 (50% Surv)	300 (90% Surv)
No. of Hectares planted in 1981	317	810	610
Method of Planting	Direct Seeding	Direct Seeding	Direct Seeding
Crops Interplanted	Rice & Corn	Rice & Corn	Rice & Corn
Cash released to Coop.	₱ 889,000	₱1,900,000	₱2,500,000

SUMMARY

Expected No. of Sites	70
Anticpated Electricity (Total)	200 MW
No. Sites Developed	31
Total Areas for Planting on 31 sites	33,100 Has.
Planted Areas (1981)	6,550 Has.
Total Cash Released to Coops.	₱25,400,000

General Observations (Visits to Above 3 Sites)

- Excellent survival from direct seeding. The poor survival rate at San Juan was due to late seeding. Usual practice is 1x1 meter spacing with 3 seeds per "hill".
- Ring fertilization with high P content was used at time of seeding.
- Very rapid height growth with 4 meters a good average height after 1 years growth. Some 1 year plantings observed at San Juan were 6 meters in height
- Only Ipil-Ipil was planted at sites.
- Influence of forester and agronomist at each Coop. was extremely beneficial to observed favorable results.

TABLE II - DOCUMENTS REVIEWED

- Philippines Appraisal of the Smallholder Tree Farming and Forestry Project - World Bank Report No. 1696a-PH, November 4, 1977.

- Appraisal of a loan to the Republic of the Philippines - World Bank Report No. 424a-PH, May 5, 1974.

- Appraisal Report Philippines Watershed Management and Erosion Control Project - World Bank Report No. 2920-PH, June 10, 1980.

- Bureauof Forest Development Special Order No. 450. Creating an Upland Development Working Group in the Bureau of Forest Development, October 15, 1980 (xerox).

- Ford Foundation Memorandum - Upland Management in the Philippines: The Status of New Initiatives, Christopher Gibbs to John Cool, October 7, 1980.

- Feasibility study for an Industrial Tree Plantation and wood-fired Power Plant of the Canlugang Sugar Estate Consultancy Group (Dr. Pancracio V. Bawagan, Dr. Manuel L. Bonita - College of Laguna, Philippines, February 1978.

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TABLE III- PERSONS INTERVIEWED

Oscar Gendarano, Forester
Barin Ganguli, Forester
ADB, Manila

Anthony M. Schwarzwalder, Director
AID, Manila

Dr. Pancracio Bawagan
Forest Products Research & Industries
Development (FORPRIDECOM)
Laguna

Dr. Mario A. Eusebio
Science Research hief
Forest Research Institute
Laguna

Dr. Percy Sajise
Institute of Human Ecology
Laguna

Gen. Pedro Dumol
NEA

Abelardo Dumol
Staff NEA, FSDC

Mandala Agriculture Development
Corporation

Dr. Cortez, Director
Bureau of Forest Development (BFD)

Dr. Vicente C. Magno
Chief, Forestry Extension & Education
Division
Bureau of Forest Development

Dr. Vetrusio
Chief, Division of Utilizatio
Forest Research Institute
College of Forestry
Laguna

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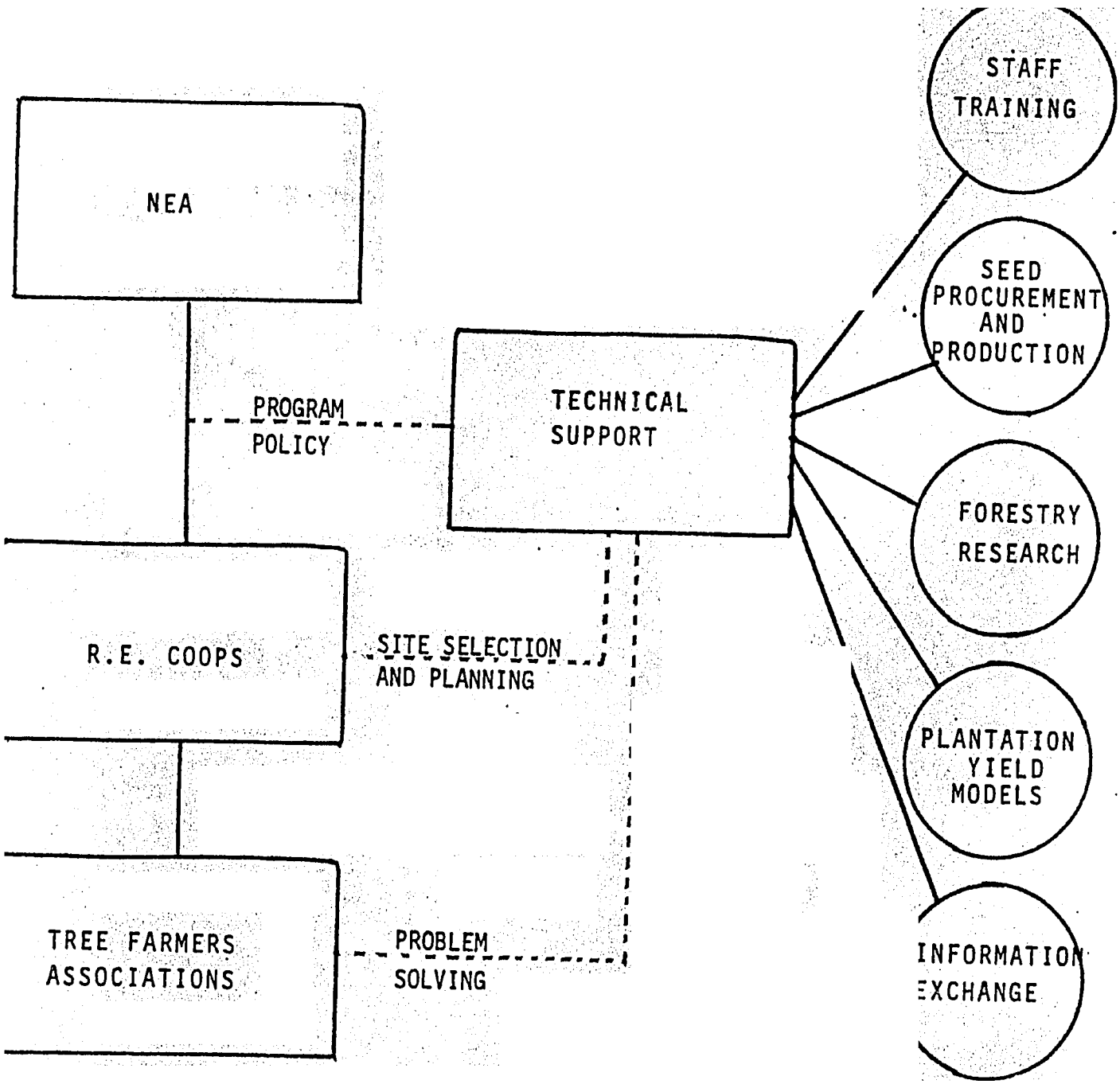
ENERGY PLANTATION TECHNICAL MANAGEMENT SYSTEM



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