PD-AAI-865 ISN2 155 3860474001601

ALTERNATIVE ENERGY RESOURCE DEVELOPMENT PROJECT

Consultant Report

on

Research Program for Woody Biomass Production

Submitted to

USAID

by

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16 October 1981

FINAL DRAFT

CURRENCY EQUIVALENTS

Rs 1 = $0.11
$ 1 = Rs 9

ABBREVIATIONS AND ACRONYMS

ha - Hectare

FAO - Food and Agricultural Organization of the United Nations
FRI - Forest Research Institute at Dehra Dun
GOI - Government of India
MKU - Madurai-Kamaraj University at Madurai
NBRI - National Botanical Research Institute at Lucknow
NCA - National Commission on Agricultural
NCL - National Chemical Laboratory at Pune
USAID- United States Agency for International Development

DEFINITIONS

agronomic practice - treatments applied to woody biomass plantations including timing, rates and types of irrigation, fertilization, and harvest

biomass plantation - an artificial forest of woody trees and/or shrubs and crops established by man from seed, seedlings or cuttings

collaborate - to work jointly with others

cooperate - to work with others for common benefit

coordinate - to act together in a smooth conserted way

firewood - woody plants used as a commercial or non-commercial energy source

fuelwood - see firewood

fuelwood plantation- see biomass plantation

social forestry - programs encompassing farm forestry, extension, recreational forestry and community forestry as defined by the FAO and, in some cases, waste land reforestation efforts as a part of soil and water conservation projects

woody biomass plantation - see biomass plantation

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1.0 SUMMARY AND RECOMMENDATIONS

1.1 Summary

This report focuses on a single, narrowly defined aspect of India's complex alternative renewable sources of energy program: the Production of Woody Biomass. Although the non-commercial sector is emphasized, the program results are applicable to both the commercial and non-commerical sectors. The justification for this focus is provided by Flanigan (1) and its high likelihood of success within a 3 to 5 year period reinforces the strategy.

An intensive, seven-point, practically-oriented research program on woody biomass production is suggested. This program could be implemented in conjunction with on-going biomass research programs in the Biomass Centres at Lucknow and Madurai. However, the programs success depends on the Biomass Centres coordinating and collaborating with each other, the Forest Research Institute, state social forestry programs, agricultural universities, and other selected research laboratories. The state social forestry programs critically need the research results that will be produced and will likely be the most effective mechanism for placing them into practice.

A plan for implementing the research program on woody biomass production is proposed. It requires the development of multidisciplinary research teams that apply systems approaches to the solution of woody biomass production problems. A key feature of the plan is the participation of a U.S. biomass production specialist throughout its life to provide technical expertise, to provide a mechanism to insure cooperation between the various organizations doing biomass research, and to provide continuity

between USAID energy and social forestry programs. The plan identifies project coordination, institutional strengthening, and research components and suggests funding levels. In addition, a proposed time-sequence for the research activities and anticipated research program outputs are included with the plan.

A list of the organizations that were visited and consulted is presented in Appendix F.

1.2 Recommendations

- Provide supplemental funding for the Government of India's research program on woody biomass production
- Allocate $336,600 for project coordination and institutional strengthening
- Allocate $754,800 to the National Botanical Research Institute to complement their on-going research program in biomass production
- Allocate $601,600 to Madurai-Kamaraj University to assist in initiating their proposed research program in woody biomass production
- Emphasize growth regulation and economic and social assessment projects at Madurai-Kamaraj University
- Formulate multidisciplinary research teams that can apply a systems approach to the solution of woody biomass production problems
- Contract a U.S. biomass production specialist to provide research coordination for the woody biomass production program and to maintain continuity between the USAID energy and social forestry programs
- Formally involve the Forest Research Institute, state social forestry programs, agricultural universities, and appropriate national research laboratories with the Biomass Centres in collaborative activities

2.0 INTRODUCTION

The role of alternative renewable sources of energy in relaxing India's dependence on oil as its price rose became an important issue in the mid 1970's. This topic is throughly discussed in a paper reporting on a United Nations Conference in Nairobi on New and Renewable Sources of Energy (9), in an overview of energy problems, policies and programs in India by Ichord (5), and most recently in a report by Flanigan emphasizing energy use in India's non-commercial sector (1). India's Sixth Five Year Plan especially recognizes the need to develop new and renewable sources of energy and sets forth a program to deal with the problem (4). As a result of that planning effort, the problem is being attack from many different directions described in the Department of Science and Technology's recently prepared state of the art report on the production and availability of biomass (2).

This report focuses on a single, narrowly defined, aspect of India's complex alternative renewable sources of energy program: the Production of Woody Biomass. Although the emphasis is on the non-commercial sector, the program results are applicable to both the commercial and non-commercial sectors. This is illustrated by the fact that methodologies developed in this program are applicable to the production of woody biomass for India's pulp and paper industries, construction industries, commercial bio-energy conversion facilities and the like.

3.0 WOODY BIOMASS PRODUCTION: IT'S IMPORTANCE

Although 75 million ha of land or 23% of India's area is classified as forest, only 40-50% of this area is actually under adequate tree cover and an estimated 20 million ha is serously affected by erosion. Thus, no more than 12% of India's land area is forested, as against a target of 33% recommended in the National Forest Policy of 1952 (10).

Forestry is an old and well-established activity in India. In 1865 the first Indian Forestry Act was passed to regulate exploitation of forests. The importance of improving the productivity of Indian forests was not generally recognized, however, until the early 1970's when the National Commission on Agriculture (NCA) extensively reviewed India's forestry prospects and policies. The NCA report recommended that India's strategy for forestry development focus on a "production forestry" to supply the growing needs of the domestic wood products industry and "social forestry" to supply fuelwood, fodder, small timber and other forest products to the rural population (10).

The Sixth Five Year Plan (4) states that

> the main objectives of the forestry programme ... will be the conservation of existing forests and the launching of country-wide afforestation and social forestry programmes....In conformity with this objective the major area of thrust will be the promotion of a people's forestry movement.

Currently, social forestry[1] programs exist or are being established in all of the major Indian states.

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1 The term social forestry is being applied to programs encompassing farm forestry, extension, recreational forestry and community forestry as defined by the FAO and, in some cases, soil and water conservation as a part of waste land reforestation efforts are also included.

Given the strong dependence of the rural population on non-commercial fuels, particularly firewood, and the high probability that this demand will continue, the central question becomes: what is required to make supplies more nearly equal to demand? In addition to the Sixth Five Year Plan, this question is addressed in the report from the working group on Science and Technology on energy policy (3). This focused concern has been assimilated by Flanigan into a suggested strategy that will support India's comprehensive effort in renewable energy and provide wise use of USAID funds (1). The strategies topics in descending priority are:

1. reforestation (social forestry and energy plantations)
2. producer gas pump sets
3. plantation harvest planning
4. other conversion processes

Although India has a significant infrastructure for the management, research and development of her biomass resources, the Department of Science and Technology established two specialized centers with a view to promote time-targeted and result-oriented development work and accelerate demonstration projects in the area of biomass research (9). One center was established at the National Botanical Research Institute (NBRI) in Lucknow and the other at Madurai-Kamaraj University (MKU) in Madurai. The complete objectives and functions of these two centers are included in Appendices A and C. The objectives of these research centers can be summarized as (7):

- Assess the potentials of plant species for biomass production
- Standardize agricultural techniques for energy plantations
- Study photosynthesis of selected species in relation to plant productivity, nutrient cycling, and nitrogen economy

- Survey the land and water potential of an area and formulate programs for the utilization of municipal and agricultural wastes for energy conversion
- Concentrate on terrestrial and aquatic energy crops
- Undertake feasibility studies on more efficient uses of biomass for obtaining maximum energy and develop appropriate technologies for energy crops, i.e. production systems, harvesting, pretreatment, and different conversion processes

The Sixth Five Year Plan provides the Department of Science and Technology an appropriation of Rs. 50 Crores over the next 5-years for biomass research[2]. To date Rs. 25 Lakhs have been allocated to each institution (7). Additional programs in the Sixth Five Year Plan which support and complement the Biomass Centres include the establishment of a Forest Survey of India to provide reliable information on existing and potential forest resources; establishment of an autonomous Institute of Forest Management; expanded forestry research programs at the Dehra Dun Forest Research Institute (FRI), at institutes under the Indian Council of Agricultural Research, and at State Forest Departments and agricultural universities; and establishment of a Division of Forestry Extension at FRI.

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2 Discussions held with Mr. M. Dayal, Energy Advisor, Department of Science and Technology, September 1981.

4.0 WOODY BIOMASS PRODUCTION: A RESEARCH PROGRAM

To assist social forestry and rural energy programs in meeting their fuelwood production goals an intensive research program on woody biomass production is critically needed. The program would consist of at least seven components:

Assessment of Existing Fuelwood Plantation Information

Implementation of Woody Biomass Plantation Field Trials

Identification of Plantation Establishment Relationships

Implementation of Seed Procurement and Maintainence Procedures

Identification of Continuous Cropping Nutrient Cycle Relationships

Identification of Potential Insect and Disease Impacts

Implementation of Economic and Social Assessments

4.1 Assessment of Existing Fuelwood Plantation Information

During the past decade numerous national, state and private organizations have established biomass plantations. In contrast to the annual harvest of agricultural crops, biomass plantation crops are harvested once each 3 to 15 year period. Thus, plantations established in the past provide production information today. Therefore, India's research program in biomass production could produce intermediate results in a very short period of time by evaluating existing biomass plantation information. This component:

- identifies and compiles published information on biomass plantations in India and the surrounding region
- summarizes and reports the range of species and agronomic practices associated with established biomass plantations

- Estimates and reports the biomass production rates by species and agronomic practices associated with established biomass plantations

4.2 Implementation of Woody Biomass Plantation Field Trials

The complete range of species and agronomic practices that are needed will not be satisfactorily evaluated in Component 4.1. Component 4.2 completes the set of biomass production functions needed to realistically assess biomass production potentials and their limitations in India. This component:

- evaluates the performance of selected woody plant species
- estimates production rates of plant biomass under a variety of agronomic practices
- evaluates the impact of interplanting woody plants, grasses and/or agricultural crops on biomass production
- relates biomass production to soil, climatic, intercrop, and agronomic practices
- estimates the energy production of the biomass plantation and relates it to the energy input

4.3 Identification of Plantation Establishment Relationships

Biomass production is directly affected by the survival rate of plants in the plantation and the period of time until they are harvested. The biological condition of plants when they are placed in the ground and their subsequent care directly impacts these two production factors. This component:

- determines the minimal and optimal characteristics of plants to insure high survival and rapid initial growth
- determines the optimum time for planting
- determines the minimal and optimal rates and timing of irrigation during the initial year of the plantation

- determines the minimal and optimal rates, timing, and types of fertilization during the initial year of the plantation

4.4 Implementation of Seed Procurement and Maintainence Procedures

Greater biomass production can be obtained by selecting, storing, and propagating seed for use in biomass plantations from plants that genetically appear to have more rapid growth, have greater rates of survival, and are less susceptible to insect and disease problems. This component:

- identifies and develops genetic selection criteria
- develops seed collection procedures
- identifies and develops seed storage methodologies
- develops plant propagation methologies and procedures

4.5 Identification of Continuous Cropping Nutrient Cycle Relationships

A program to evaluate the nutrient replacement needs in biomass plantations is critical if the productive of the plantations over time is to be sustained. This component:

- determines the minimal and optimal rates, timing, and type of fertilization to maintain long-term soil productivity
- evaluates the use of selectively interplanting plant species to biological maintain or supplement fertilization in biomass plantations

4.6 Identification of Potential Insect and Disease Impacts

Excessive mortality resulting from animals, insects or diseases will greatly reduce the productive of biomass plantations. This component:

- identifies potential animal, insect and disease problems in biomass plantations

- relates identified animal, insect and disease problems to species, soils, climatic, intercrop, and agronomic practices and factors
- formulates an integrated pest management research program for biomass plantations

4.7 Implementation of Economic and Social Assessments

The economics of biomass plantations must be known if they are to be successfully integrated into rural environments. In addition, the impact of biomass plantations on a village's consumption habits, goals, and value systems need to be understood. This component:

- determines energy consumption patterns in rural areas
- develops supply/demand relationships for alternative sources of energy in rural areas
- undertakes an investment analyses of biomass plantations

5.0 CURRENT RESEARCH ACTIVITY IN WOODY BIOMASS PRODUCTION

The Indian Forest Service's, Forest Research Institute (FRI) at Dehra Dun is the oldest program in India directly focused at woody biomass production research. It was established in 1878. Today, in addition to FRI, almost every state forestry department has a research station addressing woody biomass production problems. The advent of the social forestry programs broadened these research programs from their original focus on commercial forest tree species to include woody plants for fuelwood plantations. Their biomass research programs concentrate on species selection and plantation production studies and would be classified as very applied research based on the objectives and methodologies employed.

Agricultural Universities, given the recent emphasis on social forestry, have begun to focus limited research efforts at the production of woody plants for fuelwood and fodder use. Today approximately 4 of the 22 agricultural colleges have incorporated forestry into their programs[3]. Their research programs concentrate on studies that identify production resulting from combinations of woody plant species and agricultural crops grown together on a unit of land. The research would be generally classified as applied based on the objectives and methodologies employed.

Biomass plantations have been also established by other research organizations throughout India such as Jyoti Solar Energy Institute at Baroda, Gujarat Energy Development Agency at Gandhinagar, and Biocentre at Ahmedabad. These efforts have generally emphasized biomass production

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3 Discussions held with Dr. S. Kondas, Conservator of Forests, Trichy, September 1981

with the focus of the research on conversion of the biomass to energy.

The creation and subsequent funding, in 1981, of the two biomass centers at Lucknow and Madurai represents the latest thrust by the Government of India (GOI) to continue the development of alternative sources of energy programs emphasizing biomass. The centers have developed the following research objectives:

National Botanical Research Institute

1. To assess biomass production potential of plant species of proven adaptability to soil alkalinity and also of other species which may qualify as promising candidates; identification and multiplication of elite clones;

2. To identify and standardise agro-techniques including cropping patterns, rotation lengths, fertilizer responses, etc., to secure maximal biomass yield;

3. To undertake studies of nutrient cycling of selected species and nitrogen economy of selected legumes;

4. To assess the biomass production potential of selected crop plants and conversion of their biomass into alcohol;

5. To determine the economics of short-rotation biomass plantations;

6. To disseminate knowledge concerning management of firewood plantations in rural areas.

Madurai-Kamaraj University

1. Broaden the resource base for biomass through proper assessment and survey of the land and water potential,

2. To formulate a critical assessment of the available municipal wastes and agricultural and forest wastes for energy conversions,

3. To concentrate on energy crops, both terrestrial and aquatic so as to meet the most immediate demands of the rural population for their domestic and farm use,

4. Assessment of the present end uses of the biomass and to undertake feasibility studies on more efficient uses of the same for obtaining maximum energy,

5. Undertake studies on the appropriate technology which include energy crop, production systems, harvesting and collecting transportation, pre-treatment and conversion technology,

6. Area and need based determination of end product for energy use, such as direct heat, steam, electricity, alcohol or gases or co-generations.

The portion of these two programs oriented towards biomass production is substantially less applied in it approach than programs undertaken by the forestry organizations and the agricultural universities. Dr. D. J. Durzan (7) also noted the "heavier than expected orientation of the biomass centers on basic research." Of the two centers, NBRI has substantially greater experience in coordinating the transfer of existing technology directly to users.

6.0 COORDINATING RESEARCH ACTIVITY IN WOODY BIOMASS PRODUCTION

The extensive and varied research efforts in woody biomass production need coordination and focus. The biomass research effort in India contains a mixture of forest, agricultural and biological scientists with varied field and laboratory expertise and with methodological approaches to research ranging from very applied to basic. However, neither the Biomass Centres nor the other organizations have effectively combined these characteristics to form a comprehensive research team. To date only informal self-evaluations have been undertaken to analyze strengths and weaknesses, assess needs, and coordinate activities. Significant gains in technology needed to sucessfully produce biomass plantations on marginal and submarginal lands in India can be expected in a 3 to 5 year time-frame if comprehensive research teams are used to address the problems in a systems analysis fashion.

NBRI and the Conservator of Forests, Research and Development Circle, U.P. have teamed together informally to address a Biomass Centre research problem focused at biomass production. This action suggests comprehensive research teams can be formed to systematically address woody biomass production problems at both Biomass Centres.

A successful biomass production program must formally coordinate the applied field experience of forest research scientists with the laboratory expertise of biological research scientists. The forest scientists are well trained in basic ecological principles, are familar with plant species and their requirements, and are experienced in installing and conducting field experiments. They have very limited laboratory training or experience. The biological scientists, however,

are well trained in basic biological and plant sciences, are familar with factors and mechanisms affecting plant growth, and are experienced in conducting laboratory experiments. They have limited training and experience in forestry and in the identification and structuring of research problems so the end result of the research can be directly and practically applied to the production of woody biomass in plantations.

Not only will the merger of these scientific expertises result in quick solutions to biomass production problems, it will broaden the perspective and future development of each group of scientists. Thus, in general, strengthening biological research in India.

7.0 WOODY BIOMASS PRODUCTION: A RESEARCH PLAN FOR USAID

This report proposes that USAID's strategy be directed at providing the needed research for Flanigan's (1) first priority: reforestation. This can be accomplished by implementing a program directed at Woody Biomass Production similar to the one outlined in Section 4.0 and cooperatively supported by the Government of India, Department of Science and Technology and USAID.

This program should be implemented through the Biomass Centres at Lucknow and Madurai. The GOI and USAID need to emphasize the coordination of Biomass Centre projects with FRI, state social forestry departments and agricultural universities in addition to on-going programs at other institutions; specifically tissue cultural work at the National Chemical Laboratory (NCL), Pune.

This section suggests USAID support in terms of the overall woody biomass production research program and in terms of each Biomass Centre. In each case, the support is related to the research program outlined in Section 4.0.

7.1 Project Coordination and Institutional Strengthening

As discussed in Section 6.0, the success of the USAID program depends on the biomass production research efforts in India being focused and coordinated. This requires the development of comprehensive research teams that apply a systems approach to the solution of woody biomass production problems.

It is suggested that USAID contract a biomass production specialist to work with the Biomass Centres, forestry organizations and agricultural

universities in coordinating the activities of the research program. This would provide the research institutions needed assistance in

1. focusing their programs,
2. applying systems approaches to problem solving, and
3. modeling biomass production systems.

It would also insure USAID of needed coordination between research institutions and provide a continuing evaluation of the program.

It is suggested that program focus and coordination be initiated with a biomass plantation assessment tour. The tour should include:

1. the biomass production specialist,
2. two scientists from NBRI (Dr. S. D. Khanduja- Program Coordinator, Mr. P. N. Misra),
3. two scientists from MKU (Dr. A. Gnanam- Program Coordinator, Forest Silviculturist to be hired),
4. one agronomist from the Agricultural University at Madurai,
5. Conservator of Forests, Research and Development Circle, U.P. (Mr. A. N. Chaturvedi), and
6. one forest silviculturist from FRI (Mr. S. P. Singh).

Upon completion of the tour the group could prepare a study plan to guide the initial direction of the research program in woody biomass production. The study plan would identify critical soil types, woody plant species, intercrop plant species, spacings, and agronomic practices that should be scientifically evaluated. The plan would serve as the focual point for the two Biomass Centres biomass production research programs.

In addition to the plan, the tour would expose foresters, agriculturists, and biologists to each others problems, identify areas in critical need

of coordination and collaboration, and formally initiate a dialogue between the research institutions associated with woody biomass production.

The biomass production specialist would continue as the laison person for the life of the project, cooperating with NBRI (Dr. S. D. Khanduja) and MKU (Dr. A Gnanam) in the coordination of the complete GOI/USAID woody biomass production program.

7.2 National Botanical Research Institute - Lucknow

NBRI had a program directed at the use of biomass as an alternative energy source in 1980 when they received their Biomass Centre designation. Since then they have increased the scope of their activity and have initiated parts of the program they proposed in their Biomass Centre proposal (Appendix A).

NBRI has an excellent record of implementing practices and programs associated with their research projects. They successfully use the Banthra Research Station in this capacity. Past projects have resulted in successes in medicinal plants, non-traditional agricultural crops, and aquatic programs to name a few. A further example of their desire to implement research is illustrated in their Annual Report. It lists scientific publications directed at professional and subprofessional cliental which are written in both english and hindi as well as a broad array of workshops and seminars. Their Economic Botany Information Service and Library is excellent both from the standpoint of staff as well as from the number and thoroughness of the tasks they undertake.

Although the NBRI scientists have excellent credentials and have a history of conducting field experiments at Banthra Research Station, they are inexperienced in the area of woody biomass production; both in terms of awareness of problems as well as methodologies to address the problems. They recognize this deficiency and have initiated cooperation with knowledgable woody biomass researchers. Thus, their desire to remedy this deficiency is apparent.

The following subsections of this report present, in a summarized form, suggested projects for involving NBRI in a woody biomass production research program as outlined in Section 4.0. Complementary preproposals have been submitted by NBRI scientists and are included in Appendix B.

7.2.1 Existing Plantation Assessments: Research Emphasis

- Continue and strengthen on-going projects tabulating bibliographies on biomass production
- Participate in reviewing and assessing existing biomass production programs throughout India
- Provide leadership in collaboration with the biomass production specialist for the overall biomass research program

Principal Investigator- Dr. S. D. Khanduja
Mr. B. R. Juneja

Strengths- Excellent facilities
Strongest Biomass Centre biomass research program

Deficiencies- Need assistance in providing focus to the woody biomass production program
Need assistance in quantification of research results

Coordination- Agricultural universities

Collaboration- MKU, FRI, State Social Forestry Programs

U.S. Assistance- Biomass Production Specialist
Information Scientist

7.2.2 Field Trial Implementation: Research Emphasis

- Continue and expand studies evaluating the performance of selected plant species
- Increase project emphasis on studies focused at production rates under various agronomic practices
- Initiate a project to evaluate the impact of interplanting woody plants, grasses and/or agricultural crops in biomass plantations
- Initiate a project relating biomass production to soil, climatic, intercrop, and agronomic practices
- Determine energy budgets associated with biomass plantations

Principal Investigator- Mr. P. N. Misra

Strengths- Banthra Research Station
Have on-going projects for several species
Have field trial experience
Collaboration with State Social Forestry Programs

Deficiencies- Need to increase the scope of the on-going projects
Need assistance in quantification of research results
Need to replicate studies in the laboratory and the field

Coordination- MKU, FRI, Agricultural universities

Collaboration- State Social Forestry Programs

U.S. Assistance- Biomass Production Specialist

7.2.3 Plantation Establishment Relationships: Research Emphasis

- Initiate a project to determine the minimal and optimal characteristics of plants to insure high survival and rapid initial growth
- Initiate a project to determine the optimum time for planting
- Initiate a project to determine the minimal and optimal rates, timing, and types of irrigation and fertilization during the initial year of the biomass plantation and relate these practices to plant survival

Principal Investigator- Mr. P. N. Misra

Strengths- Banthra Research Station
Excellent laboratory facilities

Deficiencies- Not an on-going research project
Need assistance in quantification of research results

Coordination- MKU, FRI

Collaboration- State Social Forestry Programs

U.S. Assistance- Reforestation Specialist

7.2.4 Seed Procurement and Maintainence: Research Emphasis

- Initiate a project to select woody biomass plants with genetically desirable characteristics
- Initiate a project to develop seed collection criteria
- Initiate a project to identify seed storage methodologies
- Develop mass seedling propagation methodologies

Principal Investigator- Dr. P. D. Dogra
Dr. M. N. Gupta
Dr. H. C. Chaturvedi

Strengths- Excellently trained scientists
Experienced researchers

Deficiencies- Lack experience in specific woody plant species

Coordination- FRI, State Social Forestry Programs, Indo-Danish Forest Tree Seed Collection Program

Collaboration- MKU, NCL

U.S. Assistance- Tree and Shrub Improvement Specialist

7.2.5 Nutrient Cycle Relationships: Research Emphasis

- Initiate field and laboratory projects to determine the minimal and optimal rates, timing, and type of fertilization to maintain long-term soil productivity in biomass plantations
- Initiate field and laboratory projects to evaluate the use of interplanted plant species to biologically maintain or supplement fertilization in biomass plantations

Principal Investigator- Dr. S. D. Khanduja
Mr. P. N. Misra

Strengths- Excellently trained scientists
Experienced researchers

Deficiencies- Lack specific field experience

Coordination- FRI, State Social Forestry Programs, Agricultural universities

Collaboration- MKU

U.S. Assistance- None

7.2.6 Insect and Disease Impacts: Research Emphasis

- Assess potential animal, insect and disease problems in biomass plantations and relate them to species, soil, climatic, intercrop, and agronomic practices and factors

- Assist in the preparation of guidelines for an Integrated Pest Management research program

Principal Investigator- Forest Entomologist (open position)

Strengths- None

Deficiencies- Not an on-going research project
Lack woody plant insect and disease expertise
Need assistance in qunatification of research results
Need assistance to develop an Integrated Pest Management research program

Coordination- FRI, State Social Forestry Programs

Collaboration- MKU

U.S. Assistance- Forest Insect and Disease Specialist

7.2.7 Economic and Social Assessments: Research Emphasis

- Initiate a project to evaluate biomass plantations using economic investment criteria

Principal Investigator- Resource Economist (open position)

Strengths- None

Deficiencies- Not an on-going research project
Lack economic expertise
Need assistance in undertaking economic assessments

Coordination- FRI, State Social Forestry Programs

Collaboration- MKU

U.S. Assistance- Resource Economist

7.3 Madurai-Kamaraj University - Madurai

MKU had a limited biomass production program prior to their designation as a Biomass Centre. It does not appear that the limited biomass program has perceptively changed since that designation. They are, however, currently beginning to increase the scope of their activity and to initiate parts of the program they proposed in their Biomass Centre research proposal (Appendix C).

MKU's strength lies with its faculty and its educational programs. The fact that it is a university with diciplines in statistics, computer science, mathematics, sociology, economics as well as biological sciences makes it a unique Biomass Centre. USAID should capitalize on this feature.

The faculty's experience in implementing the practical aspects of their scientific endeavors is limited. Although MKU scientists have excellent credentials they are inexperienced in the area of woody biomass production; both in terms of awareness of problems as well as methodologies to address the problems. Although they verbally acknowledge this deficiency, to date they have not formally cooperated with scientists experienced in the field problems associated with woody biomass production. MKU's expertise is training researchers and solving fundemental biological problems.

If MKU's activities are closely coordinated by the U.S. biomass production specialist and if they actively collaborate with state social forestry programs and agricultural universities, MKU could contribute positively to biomass production field projects. Their initial thrust, however, should concentrate on growth regulation projects (see 7.3.3 and 7.3.5) and on economic and social assessments (see 7.3.7).

The following subsections of this report present, in a summarized form, suggested projects for involving MKU in a woody biomass production research program as outlined in Section 4.0. Complementary preproposals have been submitted by MKU scientists and are included in Appendix D.

7.3.1 Existing Plantation Assessments: Research Emphasis

- Participate in reviewing and assessing existing biomass production programs throughout India

Principal Investigator- Forest Silviculturist (currently being recruited)

Strengths- None

Deficiencies- Need assistance in providing focus to the woody biomass production program
Need assistance in quantification of research results

Coordination- Agricultural universities

Collaboration- NBRI, FRI, State Social Forestry Programs

U.S. Assistance- Biomass Production Specialist

7.3.2 Field Trial Implementation: Research Emphasis

- Initiate proposed biomass production studies
- Initiate a project to estimate biomass production rates under various agronomic practices
- Initiate a project to evaluate the impact of interplanting woody plants, grasses and/or agricultural crops in biomass plantations
- Initiate a project relating biomass production to soil, climatic, intercrop, and agronomic practices

- Determine energy budgets associated with biomass plantations

Principal Investigator- Forest Silviculturist (currently being recruited)

Strengths- Field laboratories
Initiated projects for several species

Deficiencies- Lack experienced expertise
Need to increase the scope of the on-going project
Need assistance in quantification of research results
Need to replicate studies in the laboratory and in the field

Coordination- NBRI, FRI

Collaboration- Agricultural universities, State Social Forestry Programs

U.S. Assistance- Biomass Production Specialist

7.3.3 Plantation Establishment Relationships: Research Emphasis

- Initiate a project to determine the minimal and optimal characteristics of plants to insure high survival and rapid initial growth
- Initiate a project to determine the optimum time for planting
- Initiate a project to determine the minimal and optimal rates, timing, and types of irrigation and fertilization during the initial year of the biomass plantation and relate these practices to plant survival

Principal Investigator- Dr. A. Gnanam

Strengths- Excellently trained scientists
Experienced researchers

Deficiencies- On-going research projects are not oriented at these problems
Need assistance in quantification of research results

Coordination- NBRI, FRI

Collaboration- State Social Forestry Programs

U.S. Assistance- Reforestation Specialist

7.3.4 Seed Procurement and Maintainence: Research Emphasis

- Initiate a project to select woody biomass plants with geneticially desirable characteristics
- Initiate a project to develop seed collection criteria

Principal Investigator- Forest Silviculturist (currently being recruited)

Strengths- None

Deficiencies- Not an on-going research project
Lack woody plant genetics expertise

Coordination- FRI, State Social Forestry Programs, Indo-Danish Forest Tree Seed Collection Program

Collaboration- NBRI

U.S. Assistance- Tree and Shrub Improvement Specialist

7.3.5 Nutrient Cycle Relationships: Research Emphasis

- Initiate field and laboratory projects to determine the minimal and optimal rates, timing, and type of fertilization to maintain long-term soil productivity in biomass plantations
- Initiate field and laboratory projects to evaluate the use of interplanted plant species to biologically maintain or supplement fertilization in biomass plantations

Principal Investigator- Dr. A. Gnanam

Strengths- Excellently trained scientists
Experienced researchers

Deficiencies- Lack field experience

Coordination- FRI, State Social Forestry Programs, Agricultural universities

Collaboration- NBRI

U.S. Assistance- None

7.3.6 Insect and Disease Impacts: Research Emphasis

- Assess potential animal, insect and disease problems in biomass plantations and relate them to species, soil, climatic, intercrop, and agronomic practices and factors

Principal Investigator- Forest Silviculturist (currently being recruited)

Strengths- None

Deficiencies- Not an on-going research project
Lack woody plant insect and disease expertise
Need assistance in quantification of research results

Coordination- FRI, State Social Forestry Programs

Collaboration- NBRI

U.S. Assistance- Forest Insect and Disease Specialist

7.3.7 Economic and Social Assessments: Research Emphasis

- Initiate a project to determine energy consumption patterns in rural areas
- Initiate a project to develop supply/demand relationships for alternative sources of energy in rural areas
- Initiate a project to undertake investment analyses of biomass plantations

Principal Investigator- Dr. John D. K. Sundarsingh
Dr. (Mrs.) L. Thara Bhai

Strengths- Excellently trained scientists
Experienced researchers

Deficiencies- Not an on-going research project

Coordination- FRI, State Social Forestry Programs

Collaboration- NBRI

U.S. Assistance- Resource Economist
Rural Sociologist

8.0 PROGRAM IMPLEMENTATION AND CONTROL

Figure 1 illustrates the beginning and ending points of projects and periods of participation by U.S. specialists for the suggested research program in woody biomass production. The participation of a biomass production specialist throughout the program provides the technical expertise required for Components 4.1 and 4.2 and will also provide the mechanism to ensure cooperation between forestry organizations, agricultural universities, national research laboratories, and the Biomass Centres. It is also suggested that this specialist continue to monitor biomass production programs associated with the Biomass Centers after the completion of the GOI/USAID program. Approximately three months of support is suggested during a 2-year period following this project and the expenditure has been included in the budget. This would provide continuity between this program and continuing USAID supported social forestry programs dependent on the outputs.

In Section 9, USAID salary monies provided the GOI for new scientist positions are viewed as continuing, permanent positions. If the Biomass Centre program is to be successfully continued following USAID's participation, the GOI must continue financing these positions and add additional positions in forest entomology, forest pathology, resource economics, silviculture, agronomy, and forest genetics as needed.

Annual workshops are suggested and programmed to insure communication between cooperating scientists and scientific organizations and to provide a formal mechanism for reporting annual progress. The third year workshop should present final results of the GOI/USAID program and

prioritize researchable problems for continued Biomass Centre programs. Table 1 indicates products that should result from this research program by the end of the third year.

Appendix G suggests an activity and budgeting schedule and desirable Covenants and Conditions Precedent. Appendix E suggests individuals and organizations with the technical expertise USAID would need to acquire for this project. Appendix H gives an indication of the scope of work to be provided by each of these specialist.

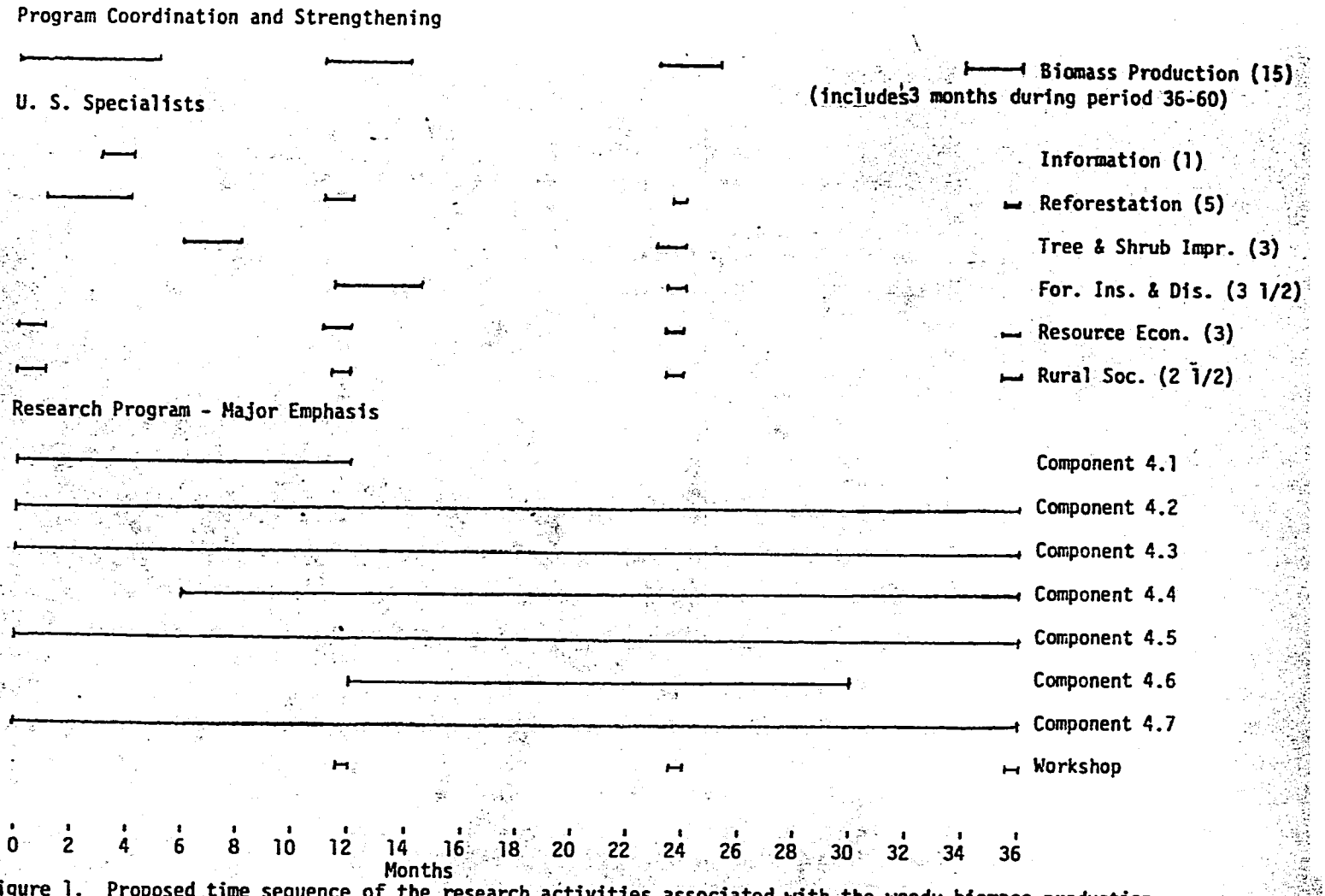

Figure 1. Proposed time sequence of the research activities associated with the woody biomass production program

Table 1. Anticipated Woody Biomass Production Research Program Products

Product	Year Completed
Bibliography of published information on biomass plantations in India and the surrounding region	First
A compendium listing the location, soil type, species, date of planting, density, agronomic practices employed and yield for energy and social forestry biomass plantations throughout India	First
Mathematical models that predict biomass plantation production as a function of species, soil, climate, density, intercrop, and agronomic practices and factors for marginal and submarginal lands throughout India	Third
Guidelines specifying desirable characteristics and agronomic practices for species, soils, and climates needed to insure high survival and rapid initial growth of plants in woody biomass plantations	Third
Guidelines specifying desirable timing, rates, and types of fertilization including intercrop plant species needed to insure long-term soil productivity in woody biomass plantations	Third
Guidelines specifying seed collection, seed storage, and plant propagation procedures for important woody plant species	Third
A compendium listing location, type and amount of animal, insect and disease damage, and the agronomic, biological, and edaphic characteristics of energy and social forestry biomass plantations throughout India	Second
A document outlining an Integrated Pest Management research program for woody biomass plantations in India	Second
Guidelines specifying investment levels by species, soils, climate, and agronomic practices resulting in desirable rates of return in woody biomass production for plantations throughout India	Third
Mathematical models that predict short-term, economic demand and supply curves for biomass as a function of energy costs, villiage social value systems, and energy supplies in selected rural villiages in southern India	Third

9.0 BUDGET SUMMARY - 3 YEARS

		USAID	GOI
Project Coordination and Institutional Strengthening		$336,600	Rs 3,91,500
National Botanical Research Institute		754,800	27,23,500
Existing Plantation Assessments	$109,800		
Field Trial Implementation	100,400		
Plantation Establishment Relationships	201,500		
Seed Procurement and Maintainence	197,200		
Nutrient Cycle Relationships	25,300		
Insect and Disease Impacts	97,500		
Economic and Social Assessments	23,100		
Madurai-Kamaraj University		601,600	25,51,500
Existing Plantation Assessments	51,300		
Field Trial Implementation	104,000		
Plantation Establishment Relationships	126,400		
Seed Procurement and Maintainence	56,300		
Nutrient Cycle Relationships	25,300		
Insect and Disease Impacts	56,300		
Economic and Social Assessments	182,000		
Total		$1,693,000	Rs 56,66,500

9.1 Project Coordination and Institutional Strengthening Budget

	USAID/3 Years		GOI
Personnel Statistician at NBRI[1]	$ 8,900	Rs 80,000	Rs
Consumables			20,000
Equipment			
National Travel/Consultants Annual workshops Coordination/Collaboration	33,300	3,00,000	1,50,000
Foreign Travel/Training	22,200	2,00,000	1,00,000
U.S. Specialists Biomass Production (15 months)	150,000	13,50,000	
Subtotal	214,400	19,30,000	2,70,000
Inflation (20%)	42,900	3,86,000	54,000
Contingency	79,300	7,13,000	67,500
Total	$336,600	Rs 30,29,000	Rs 3,91,500

1 Permanent Scientist Position (Rs 2200/mo)

9.2 National Botanical Research Institute Project Budgets - 3 Years

9.2.1 Existing Plantation Assessments Budget

		USAID/3 Years	GOI
Personnel Computer Systems Analyst/Programmer[1]	$ 7,800	Rs 70,000	Rs 1,30,000
Consumables			50,000
Equipment Large microcomputer- word/data processor	50,000	4,50,000	
National Travel/Consultants	5,600	50,000	25,000
Foreign Travel/Training	11,100	1,00,000	
U.S. Specialists Information Scientist (1 month) Biomass Production (see 9.1)	10,000	90,000	
Subtotal	84,500	7,60,000	2,05,000
Inflation (20%)	16,900	1,52,000	41,000
Contingency (10%)	8,400	76,000	20,500
Total	$109,800	Rs 9,88,000	Rs 2,66,500

1 Permanent Scientist Position (Rs 1940/mo)

9.2.2 Field Trial Implementation Budget

	USAID/3 Years		GOI
Personnel Forest Silviculturist/Agronomist[1]	$ 5,600	Rs 50,000	Rs 2,50,000
Consumables	2,200	20,000	20,000
Equipment Soil moisture meter and probes Drying oven for plant materials Bomb calorimeter Root growth chamber	19,500	1,75,000	
National Travel/Consultants	16,700	1,50,000	1,00,000
Foreign Travel/Training	33,300	3,00,000	
U.S. Specialists Biomass Production (see 9.1)			
Subtotal	77,300	6,95,000	3,70,000
Inflation (20%)	15,400	1,39,000	74,000
Contingency (10%)	7,700	69,500	37,000
Total	$100,400	Rs 9,03,500	Rs 4,81,000

1 Permanent Scientist Position (Rs 1390/mo)

9.2.3 Plantation Establishment Relationships Budget

	USAID/3 Years		GOI
Personnel Forest Silviculturist[1]	$ 7,800	Rs 70,000	Rs 2,50,000
Consumables	2,200	20,000	20,000
Equipment Deionizer Growth chambers Soil moisture meter and probes Mist chamber	98,900	8,90,000	
National Travel/Consultants			50,000
Foreign Travel/Training	11,100	1,00,000	
U.S. Specialists Reforestation (3 1/2 months)	35,000	3,15,000	
Subtotal	155,000	13,95,000	3,20,000
Inflation (20%)	31,000	2,79,000	64,000
Contingency (10%)	15,500	1,39,500	32,000
Total	$201,500	Rs 18,13,500	Rs 4,16,000

1 Permanent Scientist Position (Rs 1940/mo)

9.2.4 Seed Procurement and Maintainence Budget

	USAID/3 Years		GOI
Personnel	$	Rs	Rs 3,00,000
Consumables	1,100	10,000	30,000
Equipment Germinators Small walk-in freezer Moisture meter Low-temperature incubators Growth chamber Photomicrography unit	94,500	8,50,000	
National Travel/Consultants Collaboration with NCL	30,000	2,70,000	1,00,000
Foreign Travel/Training	11,100	1,00,000	
U.S. Specialists Tree and Shrub Improvement (1 1/2 months)	15,000	1,35,000	
Subtotal	151,700	13,65,000	4,30,000
Inflation (20%)	30,300	2,73,000	86,000
Contingency (10%)	15,200	1,36,500	43,000
Total	$197,200	Rs 17,74,500	Rs 5,59,000

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9.2.5 Nutrient Cycle Relationships Budget

		USAID/3 Years	GOI
Personnel Soil Scientist/Nutritionist[1]	$ 5,600	Rs 50,000	Rs 2,50,000
Consumables	1,100	10,000	20,000
Equipment			
National Travel/Consultants	1,700	15,000	30,000
Foreign Travel/Training	11,100	1,00,000	
U.S. Specialists			
Subtotal	19,500	1,75,000	3,00,000
Inflation (20%)	3,900	35,000	60,000
Contingency (10%)	1,900	17,500	30,000
Total	$25,300	Rs 2,27,500	Rs 3,90,000

9.2.6 Insect and Disease Impacts Budget

		USAID/3 Years	GOI
Personnel Forest Entomologist/Pathologist[2]	$ 5,600	Rs 50,000	Rs 1,50,000
Consumables			20,000
Equipment			
National Travel/Consultants	11,100	1,00,000	1,00,000
Foreign Travel/Training	33,300	3,00,000	
U.S. Specialists Insect and Disease (2 1/2 months)	25,000	2,25,000	
Subtotal	75,000	6,75,000	2,70,000
Inflation (20%)	15,000	1,35,000	54,000
Contingency (10%)	7,500	67,500	27,000
Total	$97,500	Rs 8,77,500	Rs 3,51,000

1 Permanent Scientist Position (Rs 1390/mo)

2 Permanent Scientist Position 1390/mo)

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9.2.7 Economic and Social Assessments Budget	USAID/3 Years		GOI
Personnel	$	Rs	Rs 1,40,000
Consumables			30,000
Equipment			
National Travel/Consultants	1,700	15,000	30,000
Foreign Travel/Training	11,100	1,00,000	
U.S. Specialists Resource Economist (1/2 month)	5,000	45,000	
Subtotal	17,800	1,60,000	2,00,000
Inflation (20%)	3,500	32,000	40,000
Contingency (10%)	1,800	16,000	20,000
Total	$23,100	Rs 2,08,000	Rs 2,60,000

9.3 Madurai-Kamaraj University Project Budgets - 3 Years

9.3.1 Existing Plantation Assessments Budget	USAID/3 Years		GOI
Personnel Forest Silviculturist[1]	$ 7,800	Rs 70,000	Rs 90,000
Consumables			50,000
Equipment Small microcomputer-word/data processor	30,000	2,70,000	
National Travel/Consultants	1,700	15,000	15,000
Foreign Travel /Training			
U.S. Specialists Biomass Production (see 9.1)			
Subtotal	39,500	3,55,000	1,55,000
Inflation (20%)	7,900	71,000	31,000
Contingency (10%)	3,900	35,500	15,500
Total	$51,300	Rs 4,61,500	Rs 2,01,500

1 Permanent Scientist Position (Rs 1940/mo)

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9.3.2 Field Trial Implementation Budget

		USAID/3 Years	GOI
Personnel Agronomist[1]	$ 5,600	Rs 50,000	Rs 2,00,000
Consumables	2,200	20,000	20,000
Equipment Field data recording Meterological Soil moisture meter and probes	22,200	2,00,000	
National Travel/Consultants	16,700	1,50,000	1,00,000
Foreign Travel/Training	33,300	3,00,000	
U.S. Specialists Biomass Production (see 9.1)			
Subtotal	80,000	7,20,000	3,20,000
Inflation (20%)	16,000	1,44,000	64,000
Contingency (10%)	8,000	72,000	32,000
Total	$104,000	Rs 9,36,000	Rs 4,16,000

1 Permanent Scientist Position (Rs 1390/mo)

9.3.3 Plantation Establishment Relationships Budget

	USAID/3 Years		GOI
Personnel Forest silviculturist[1]	$ 7,800	Rs 70,000	Rs 2,50,000
Consumables	2,200	20,000	20,000
Equipment Growth chambers Soil moisture meter and probes Mist chamber	61,200	5,50,000	
National Travel/Consultants			50,000
Foreign Travel/Training	11,100	1,00,000	
U.S. Specialists Reforestation (1 1/2 months)	15,000	1,35,000	
Subtotal	97,300	8,75,000	3,20,000
Inflation (20%)	19,400	1,75,000	64,000
Contingency (10%)	9,700	87,500	32,000
Total	$126,400	Rs 11,37,500	Rs 4,16,000

1 Permanent Scientist Position (Rs 1940/mo)

9.3.4 Seed Procurement and Maintainence Budget		USAID/3 Years	GOI
Personnel Forest geneticist[1]	$ 7,800	Rs 70,000	Rs 1,40,000
Consumables	1,100	10,000	10,000
Equipment			
National Travel/Consultants	8,300	75,000	50,000
Foreign Travel/Training	11,100	1,00,000	
U.S. Specialists Tree and Shrub Improvement (1 1/2 months)	15,000	1,35,000	
Subtotal	43,300	3,90,000	2,00,000
Inflation (20%)	8,700	78,000	40,000
Contingency (10%)	4,300	39,000	20,000
Total	$56,300	Rs 5,07,000	Rs 2,60,000

9.3.5 Nutrient Cycle Relationships Budget		USAID/3 Years	GOI
Personnel Soil Scientist/Nutritionist[2]	$ 5,600	Rs 50,000	Rs 3,00,000
Consumables	1,100	10,000	20,000
Equipment			
National Travel/Consultants	1,700	15,000	30,000
Foreign Travel/Training	11,100	1,00,000	
U.S. Specialists			
Subtotal	19,500	1,75,000	3,50,000
Inflation (20%)	3,900	35,000	70,000
Contingency (10%)	1,900	17,500	35,000
Total	$25,300	Rs 2,27,500	Rs 4,55,000

1 Permanent Scientist Position (Rs 1940/mo)

2 Permanent Scientist Position (Rs 1390/mo)

9.3.6 Insect and Disease Impacts Budget

	USAID/3 Years		GOI
Personnel Forest Entomologist/Pathologist[1]	$ 5,600	Rs 50,000	Rs 1,00,000
Consumables			10,000
Equipment			
National Travel/Consultants	16,600	1,50,000	1,00,000
Foreign Travel/Training	11,100	1,00,000	
U.S. Specialists Insect and Disease (1 month)	10,000	90,000	
Subtotal	43,300	3,90,000	2,10,000
Inflation (20%)	8,700	78,000	42,000
Contingency (10%)	4,300	39,000	21,000
Total	$56,300	Rs 5,07,000	Rs 2,73,000

1 Permanent Scientist Position (Rs 1390/mo)

9.3.7 Economic and Social Assessments Budget

			USAID/3 Years	GOI
Personnel	$ 44,400		Rs 4,00,000	Rs3,00,00
Temporary economic research scientists		2,00,000		
Temporary sociological research scientists		2,00,000		
Consumables	12,200		1,10,000	60,000
Econ		50,000		
Soco		60,000		
Equipment	5,600		50,000	
Econ		10,000		
Data analysis				
Soco		40,000		
Data analysis				
Data recorders				
Camera				
National Travel/Consultants	5,600		50,000	40,000
Econ		25,000		
Soco		25,000		
Foreign Travel/Training	22,200		2,00,000	
Econ		1,00,000		
Soco		1,00,000		
U.S. Specialists	50,000		4,50,000	
Resource Economist (2 1/2 months)				
Rural Sociologist (2 1/2 months)				
Subtotal	140,000		12,60,000	4,00,000
Inflation (20%)	28,000		2,52,000	80,000
Contingency (10%)	14,000		1,26,000	40,000
Total	$182,000		Rs 16,38,000	Rs5,30,00

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APPENDIX A

BIOMASS RESEARCH CENTRE

NATIONAL BOTANICAL RESEARCH INSTITUTE
LUCKNOW—226001
INDIA

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C O N T E N T S

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BIOMASS RESEARCH CENTRE
AT
NATIONAL BOTANICAL RESEARCH INSTITUTE
LUCKNOW.

In the developing countries of the world, an energy crisis, far more serious than the one associated with uncertainty in price and supply security of petroleum, is indicated in the foreseeable future. The evidence is overwhelming that with the increase in population, the pressure on supplies of non-commercial fuels as wood, dung and straw in preference to more expensive kerosene oil is steadily mounting. It is not widely appreciated that wood is an important energy source and 47% of the world wood harvest is burned for cooking, drying and heating. In the developing countries wood fires are a necessity for basic cooking, smoking and drying processes. It has been estimated that in the non-OPEC developing countries, non-commercial fuels as wood, dung and crop residues of an equivalent up to 90 per cent of their total energy use. The diversion of dung and crop residues from use in agriculture has led to a steady decline in agricultural productivity and scarcity of firewood has given rise to the so-called 'second-energy crisis'. In fact, scarcity of firewood has reached crisis proportions in large parts of South Asia, Africa, Central America and the Caribbean and has led to increasing deforestation, damage to ecosystems and rural poverty. In many developed and developing countries, 'Fuels from Biomass' programmes have been planned as the traditional fuels are becoming scarce and expensive. It is recognised that utilisation of plant materials as fuels

Best Available Document

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is not a very remote prospect and will play an important role in the energy-supply picture of the developing countries.

BIOMASS PLANTATIONS

The plant material presents a vast supply of ready energy which is renewable and has a low content of pollutants. The plant energy may be released by burning it directly or plant biomass may be converted into potential fuels such as methane, ethanol, or liquid fuels. Plant material as a source of energy is available as crop residue, native vegetation on non-farm lands and as special crops- the so-called energy farms. Serious thought is being given in some countries to the concept of silviculture biomass farms which includes planting of fast-growing species, harvesting them on short rotations of 2-4 years and regenerating them from remaining stems. That such biomass plantations could provide a sustained yield of wood for energy purpose in selected areas has been suggested as an appropriate technology to meet the upcoming energy crisis in the developing countries. A recent Dutch study of the cost of reforestation and fuelwood production of Sahel region where scarcity of firewood has reached crisis proportions, has shown that establishing firewood plantations is an economically feasible proposition for increasing supply of firewood. It is recognised that even if biomass systems may not provide a significant amount of energy in a given country in the future, the long term benefits to agriculture, forestry and land use would be considerable as the energy

plantations once established would help controlling soil erosion, improving water balance and even supplementing the traditional agriculture.

USE OF MARGINAL LANDS FOR BIOMASS PLANTATIONS

It has been suggested that 'biomass plantations' could be raised on marginal or uncultivated lands in some countries as the use of arable land for non-food purpose would come in conflict with food priority. Further if large amounts of fertilizers are needed to produce biomass in sufficiently large quantities to make it useful as a source of energy, then the prospect will not find acceptance. That may put a serious limitation to the establishment of energy farms in the developing countries which need massive inputs of fertilizers for increasing agricultural productivity to meet the needs of expanding population.

In India, saline and alkali soils occupy nearly 7 million hectares of land. These soils are useless for traditional cereal and grain crop agriculture because of the presence of soluble salts and sodium in excessive concentrations. Current information indicates that such lands, if properly managed, could be used for raising energy plantations.

CHOICE OF PLANT SPECIES FOR ENERGY PLANTATIONS ON MARGINAL LANDS

Fast-growing tree species with high potential of adaptation to 'usar' (saline and alkali) soils have been suggested by various workers. Documented cases of ameliorative effect of some tolerant species exist for

saline and alkali soils and eroded areas. In some countries nitrogen-fixing trees and shrubs have shown promise for use in short rotations and on marginal lands. For example, in West Africa, the soils under Acacia albida are richer by 25-100 per cent in organic matter and nitrogen, as well as exchangeable calcium and total exchangeable bases. It has been estimated that the annual return of nutrients to the soil in A. albida litter (maximum stand density 44 trees/hectare) is 187 kg. nitrogen, 9 kg. P_2O_5, 91 kg. K_2O, 311 kg. CaO and 69 kg. MgO. In India, Prosopis juliflora growing on sodic soils is reported to reduce soil pH and enhance growth of crops growing near it. A perennial legume that has attracted considerable attention in recent years is Leucaena leucocephala due to its high yield of dry matter (9.5 - 24.7 t/ha/year).

The recent upsurge of interest in the use of woody perennials that are capable of fixing atmospheric nitrogen is due to the fact that forest soils and agricultural lands in the tropics are deficient in nitrogen. Recognizing the need to increase productivity of the soil, application of nitrogen in the form of urea, nitrate or ammonia is steadily increasing. Farmers in the developing countries are presently investing about 5 billion dollars each year to buy commercial nitrogen fertilizers and that to provide adequate food to the people, the developing countries will need 50 million metric tonnes of fertilizers at an estimated cost of 25 billion dollars per annum by 2000 AD. Recent increase in the cost of these fertilizers with the price of natural gas and petroleum, which are used extensively in fertilizer manufacture, have put them out of the reach of farmers of average means. It is

evident then that the preferential use of arable land and limited supply of nitrogen fertilizers for food would restrict the 'biomass plantations' to marginal lands and use of nitrogen-fixing plants as a way of meeting the increased demand for wood in rural India. However to accelerate the production of substantial amounts of biomass in short rotation plantations, application of fertilizers may well prove an economically efficient cultural practice. It will be a necessity for marginal lands which are known to be deficient in nitrogen and phosphorus. Fertilization requirements of the species selected for evaluation of their biomass productivity are not known and that extensive study will be needed to determine the extent of response to fertilizers in terms of biomass productivity of young closely- planted stands. Such a study will involve detailed soil as also leaf analysis to identify nutrient deficiencies and monitor nutritional status of trees in relation to biomass productivity.

Alcohol Production from specific crops

The possibility of producing alcohol from some crops has been shown in some countries. In Australia, cassava (Manihot), Napier grass (Pennisetum) and sugarcane have been selected as the most desirable crops for producing biomass as a source of fuel. Brazil has planned an ambitious programme for production of alcohol from sugarcane, sorghum, cassava and other crops. Trial plantings of sugar beet and tapioca at Bahdia Research Station have shown fairly high adaptation potential of these crops to 'usar' soils. These crops could be considered for biomass production and processing into fuels.

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From the foregoing it can be seen that although the need for raising biomass plantations is becoming increasingly imperative in view of the fast approaching energy crisis and the plants that hold promise as potential source of energy have been identified, their potential for biomass production under varying soil and climatic conditions and responses to various agronomic practices has not been studied. This serves to emphasize the need to set up a few BIOMASS RESEARCH CENTRES in the country.

BIOMASS RESEARCH CENTRE AT NBRI

The National Botanical Research Institute, Lucknow has, over the years, made a comprehensive study of the potential use of 'usar' soils at Banthra Research Station for growing various plant species not only for the purpose of fuel but also for food, timber and fibre. The Institute has demonstrated that it is indeed possible to utilize the substandard soils for planting to alkali-tolerant species and that litter deposition and decomposition can change the exchange capacity of the soil thereby rendering the soil suitable for less tolerant species. By using special management techniques to reduce alkalinity, it has been possible to raise a man-made forest over an area of 1 hectare which is now a complete ecosystem having changed micro-metereology helped in improving and conserving soil, water balance and environment.

This research work which was evolved in response to the need for utilization of alkali soils at Banthra Research Station of the Institute has produced basic scientific contribution in the fields of soil fertility, ecology, physiological responses of plants to soil alkalinity, etc.

Existing facilities at NBRI

NBRI is one of the constituent national laboratories and institutes of CSIR. Its main laboratory complex located at Lucknow includes well-equipped laboratories with a wide range of sophisticated scientific instruments, a voluminous library and a modern auditorium. The Institute has first rate scientific expertise for advanced R & D work in the fields of plant ecology, physiology, cytogenetics and plant breeding, plant and soil chemistry, etc. It has a field research station at Banthra, a village 22 km from Lucknow on Lucknow-Kanpur National Highway, covering an area of 85 hectares of substandard soil. Situated as the research station is in a rural area, it can avail itself of the land, labour and equipment resources that may be offered by the farmers for establishing fuelwood plantations on 'usar' land. In fact a few farmers have shown interest in this part of the programme.

Site for Biomass Research Centre

The Biomass Research Centre is proposed to be established at Banthra Research Station of the Institute, where a 10-hectare piece of land has been

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earmarked for raising energy plantations. The site is located on the roadside on Lucknow-Kanpur Road and is easily approchable. Irrigation water supply is assured as the area selected has two tubewells.

COORDINATION WITH SOCIAL FORESTRY DEPARTMENT

As the main concern of the proposed research centre is to evaluate the biomass production potential of forest tree species, the NBRI recognises the need for an intimate involvement of the State Social Forestry Department which is engaged in raising energy plantations of some selected species on marginal lands in Lucknow and Pratapgarh. This work is being done enthusiastically by the Social Forestry Department but without the support of an organized research effort. Making use of these plantations, NBRI could design useful field trials to standardise agro-techniques to overcome constraints generally encountered in raising energy plantations on 'usar' lands. Collaboration with the Social Forestry Department should be useful in effective implementation of the extension programme as also preparing plantation designs.

OBJECTIVES OF THE BIOMASS RESEARCH CENTRE AT NBRI

1. To assess biomass production potential of plant species of proven adaptability to soil alkalinity as also of other species which may qualify as promising candidates; identification and multiplication of elite clones.

2. To identify and standardise agro-techniques including cropping patterns, rotation lengths, fertilizer responses, etc., to secure maximal biomass yield;

3. To undertake studies of nutrient cycling of selected species and nitrogen economy of selected legumes;

4. To assess the biomass production potential of selected crop plants and conversion of their biomass into alcohol;

5. To determine the economics of short-rotation biomass plantations;

6. To disseminate knowledge concerning management of firewood plantations in rural areas.

DURATION OF THE PROJECT

i. Research on identification of tolerant species, combinations of tree and shrub species for maximal yield of biomass, efficient use of fertilizers, nitrogen economy, determination of energy values, etc., will take 5 years.

ii. Long term ecological management of waste lands for energy crops, evolving a system of soil management, etc., will take more than 5 years and may continue for 10 years.

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Technical Programme

ENERGY PLANTATIONS

Agronomic Aspects

First Year

i. Establishing energy plantations of the tree species of proven adaptability to sodic soils particularly of the genera Acacia, Albizia, Terminalia, Dalbergia, Prosopis, Moringa and some quick growing shrubs Sesbania grandiflora, Leucaena leucocephala both as single plantations and in interspaces between trees to obtain long term and short term harvestings. Planting species which may qualify as promising candidates (Ailanthus excelsa, Spondias mangifera, etc.)

Area to be planted ..... 10 ha (over 2 years)

ii. Soil water relations including hydraulic conductivity of the sites selected for energy plantations.

iii. Evaluation of response to herbicides (if necessary), and planting density in terms of biomass productivity.

Second Year

i. Evaluation of response to differential application of N-P-K fertilizers and planting techniques.

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ii. Evaluation of response to varying degrees of soil sodicity.

Third Year

i. Evaluation of response to differential application of N-P-K fertilizer (contd.).

ii. Evaluation of soil moisture status as supplemented by irrigation and contribution from subsoil water from sapling to the stage of tree establishment.

Fourth Year

i. Biomass productivity of different species as influences by stand density, fertilization and planting techniques (contd.).

Fifth Year

i. Biomass production at different rotation lengths- appraisal of the data.

ii. Economics of the short-rotation energy plantations.

Ecological Aspects

First Year

i. Establishment of energy plantations comprising 2000 saplings of the selected tree species as also of potentially promising species.

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ii. Growth behaviour in relation to factors suchas solar intensity, photoperiodism, etc.

iii. Biomass productivity estimations at varying intervals.

Second Year

i. Growth and energy status as influenced by soil heterogenity.

ii. Cycling of nutrients in relation to biomass production.

iii. Establishing a plantation of 300 saplings of a selected single tree species.

iv. Biomass productivity estimations (contd.).

Third Year

i. Compartmental transfer of energy

ii. Energy conserving efficiency of vegetation.

iii. Energy budget of various ecosystems

iv. Biomass productivity estimations (contd.).

Fourth Year

i. Primary, gross and net production of various ecosystems.

ii. Biomass productivity estimations (contd.).

Fifth Year

i. Fat and protein contents of various plant parts.

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ii. Economics of energy plantations

iii. Biomass budget.

Nutritional Aspects

First Year

i. Examination of the soil profiles of the sites selected for biomass plantations.

ii. To determine the limits of alkali tolerance of sugar beet and Napier grass.

*iii. To evaluate the ameliorative effect of canopy covers of various tree species on pH, conductivity, organic matter content and exchangeable base status of the soil.

*iv. To determine seasonal variations in the nutrient concentrations of various plant parts and nutritional status of tree species in relation to standing biomass.

Second Year

i. To determine the limits of alkali tolerance of tree species- Dalbergia, Albizia, Terminalia and crop plants for alcohol production- sweet sorghum and cassava.

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*ii. Seasonal variation in the nutrient contents of the soil under different canopy covers.

iii. Seasonal variations in the nutrient concentrations of various plant parts.

Third Year

i. Seasonal variations in the nutrient contents of the soil under different canopy covers.

ii. Nutrient cycling in energy plantations raised at Banthra Research Station.

iii. Alkali tolerance of *Leucena leucocephala* in terms of biomass producvity.

iv. Nitrogen economy of selected perennial legumes.

Fourth Year
Fifth Year

Studies initiated in the third year will be continued.

(* to be carried out in the plantations of the State Forest Department).

Technical Programme (contd.

CROPS FOR ALCOHOL

Biomass Production

First Year	i. Evaluation of cultivars of sorghum, sweet sorghum, sugar beet, cassava and Napier grass for their biomass production on soils of mineral stress.
Second Year Third Year	Identification and standardization of cultural practices for increasing biomass production of promising cultivars-competition control, planting distances, fertilization, irrigation.
Fourth Year Fifth Year	Large scale plantations of selected cultivars of proven adaptability; to determine the cost of production.

Biomass conversion into alcohol

First Year	Selection of suitable microorganisms for conversion of starch-sugar-alcohol. The fermentation of alcohol may be single stage or two stage fermentation.
Second Year	Evaluation of conversion into alcohol, determination of parameters for optimum production. Natural selection/induced mutations for producing strains with greater tolerance to alcohol concentration.

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Third Year: Continuous cultivation technique or batch culture technique for the production of alcohol either at atmospheric pressure or reduced pressure. Engineering design and costing of the process with a view to affect reduction in energy requirements for the production of alcohol.

Evaluation of residue on stillage as animal feed or any other purpose.

Technical Programme

Extension

This programme is proposed to be carried out in collaboration with Social Forestry Department of the State Government, and will be taken up in the second year.

i. Demonstrating the agrotechniques used in raising short-rotation firewood plantations on marginal lands and propagating the concept of fuelwood forests amongst the villagers.

ii. Assisting the prospective farmers in establishing firewood plantations by providing them with seedlings of tree species found suitable for the purpose.

iii. Disseminating the knowledge generated by the project amongst the rural people through publications, popular lectures, etc.

iv. Maintaining a nursery for multiplication and distribution of seedlings to the prospective farmers.

Introduction

Identification and multiplication of elite clones.

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RESEARCH TERMS

The research teams will consist of the following scientists.

National Botanical Research Institute

1. Dr. S.D. Khanduja (Principal investigator)
2. Shri V. Chandra
3. Shri G.S. Srivastava
4. Shri P.N. Misra
5. Shri V.K. Garg
6. Dr. S.C. Verma

Central Drug Research Institute

1. Dr. V.C. Vora
2. Dr. S.K. Basu
3. Shri A.W. Khan
4. Dr. M.C. Bhatia

UP Social Forestry Directorate

1. Shri K.M. Tewari, Director, Social Forestry
2. Assistant Director, Territorial Division
3. Range Officer, Territorial Range.

STAFF REQUIREMENT

Academic

Research Associates	4	Agronomy, Ecology, Plant and Soil Analysis, Statistics
Senior Research Fellows	2	Biomass processing into alcohol

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Junior Research Associates	2	Agronomy (crops for alcohol) Genetics.
Junior Research Fellows	4	Plant and Soil Analysis, Ecology, Agronomy.
Field/Laboratory Technicians	9	Ecology, Agronomy, Alcohol crops, Processing, Soil and Plant Analysis, Statistics, Extension & Economics.
Other Personnels (Tractor Driver)	1	

RESEARCH RESPONSIBILITIES BREAK-UP

A Energy Plantations

i.	Preparation of site, planting designs, establishing plantations, fertilizer responses, optimum length of rotation, economics of plantations.	Shri P.N. Misra (NBRI)
ii.	Biomass productivity estimations, energy budget of various ecosystems, primary, gross and net production, biomass budget and economics.	Dr. S.C. Verma (NBRI)
iii.	Soil profile examination, limits of alkali tolerance, of various species, nutrient contents of the soil, nitrogen economy of selected legume.	Shri V.K. Garg (NBRI)
iv.	Monitoring fertilizer responses by analysis of plant parts; nutritional status in relation to biomass, etc.	Dr. S.D. Khanduja (NBRI).
v.	Introduction of potentially promising strains of various tree species, identification and multiplication of elite clones.	Shri G.S. Srivastava (NBRI)

B Crops for alcohol

vi.	Standardisation of cultural practices for increasing biomass production of selected crops- sugar beet, sweet sorghum, cassava, Napier grass.	Shri V. Chandra (NBRI)
vii.	Biomass conversion into alcohol, selection of suitable microorganisms, determination of parameters for optimum production, etc.	Dr. V.C. Vora and associates (CDRI)

C. Extension

Evaluation of the research results of the project; standing biomass studies in existing plantations; to coordinate with NBRI in disseminating the research findings, propagating the concept of fuelwood plantations in rural areas.	Shri K.M. Tewari, Director, Social Forestry, UP, and Staff.

(The association of Dr. S.C. Srivastava, Project Coordinator (S), Indian Institute of Sugarcane Research, Lucknow, will be duly acknowledged)

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BUDGET (Rs. in lakhs)

Staff (Academic)	Years I	II	III	IV	V	Total
4 Research Associates (Rs. 1000-15000)	0.600	0.600	0.600	0.600	0.600	3.000
2 Senior Research Fellows (Rs. 800)	0.192	0.192	0.192	-	-	0.576
2 Junior Research Associates (Rs. 700)	0.168	0.168	0.168	0.168	0.168	0.840
4 Junior Research Fellows (Rs. 400 2 years Rs. 500 3 years)	0.192	0.192	0.240	0.240	0.240	1.104
9 Laboratory/Field Technicians (Rs.350 fixed)	0.378	0.378	0.378	0.378	0.378	1.890
Other Personnel						
1 Tractor Driver (Rs.260-400)	0.058	0.059	0.060	0.061	0.062	0.300
	1.588	1.589	1.630	1.447	1.448	7.710
Travel	0.150	0.150	0.150	0.150	0.150	0.750

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Non-recurring expenditure

	Year I	II	III	IV	V	Total
Tractor with implements	1.500	-	-	-	-	1.500
*Scientific equipment	2.000	2.000	-	-	-	4.000
Establishing energy Plantations at Banthra	0.600	0.400	-	-	-	1.000
Plant sheds	2.000	1.500	-	-	-	3.500
Contingencies (Office furniture, accessories, communication services, etc.)	0.600	-	-	-	-	0.600
	6.700	3.900	-	-	-	10.600
Recurring expenditure						
Expandable apparatus, chemicals, etc.	0.200	0.200	0.200	0.200	0.200	1.000
Casual labour (field, secretarial assistance, data processing, etc.)	0.800	0.800	0.800	0.800	0.800	4.000
Transport	0.100	0.100	0.100	0.100	0.100	0.500
Contingencies	0.300	0.300	0.300	-	-	0.900
(Bioconversion others)	0.200	0.200	0.200	0.200	0.200	1.000
	1.600	1.600	1.600	1.300	1.300	7.400

*Listed on page [illegible]

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YEAR-WISE BREAK-UP

Head	Year I	II	III	IV	V	Total
Salaries	1.588	1.589	1.638	1.447	1.448	7.710
Travel	0.150	0.150	0.150	0.150	0.150	0.750
Non-recurring	6.700	3.900	-	-	--	10.600
Recurring	1.600	1.600	1.600	1.300	1.300	7.400
GRAND TOTAL	10.038	7.239	3.388	2.897	2.898	26.460

SCIENTIFIC EQUIPMENT

1. Kjeltech System II N autoanalyser
2. Digital Flame Photometer
3. Digital conductivity meter
4. Oxygen bomb calorimeter
5. Sunshine recorder
6. Solar meter
7. Leaf area recorder
8. Scales, Incubators, etc.

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APPENDIX B[1]

WOODY BIOMASS PRODUCTION SYSTEM ON SUB-STANDARD SOILS

1 Rough drafts

PROJECT: WOODY BIOMASS PRODUCTION SYSTEMS ON SUB-STANDARD SOILS

Problems and its Significance

In the developing countries of the world, an energy crisis, far more serious than the one associated with uncertainty in price and supply of petroleum, is indicated in the forseeable future. It is often not appreciated that fuelwood is the fourth largest energy resource after petroleum, coal and natural gas and close to half the world population depends upon firewood for cooking and heating. About 100 million people in the developing countries are estimated to live in areas where there is an acute shortage of firewood and another 1,000 million meet their firewood requirements by cutting forest trees far in excess of sustainable yields through natural regeneration. It has been estimated that 10 to 15 million hectares of forest area is being exploited every year to meet the fuelwood requirements in the developing countries. Approximately, 930 million cubic metres of wood, 800 tonnes of animal wastes and crop residues are burnt in the developing countries every year. The so-called "second energy crisis", associated with the scarcity of firewood, has led to increasing depletion of tree resources, resulting in frequent devastating floods, shortage of water in rivers during summer and increased diversion of dry animal dung and agriculture crop residues for burning, depriving the soil of valuable nutrient elements. Considering the present trend of population growth, over 50 million hectares of fuel wood would have to be planted in the developing countries by the year 2000 to meet the projected demand for cooking food.

Fuel Wood Problem in India

A study of the pattern of energy use in rural India shows that 80% of the energy requirements is met from traditional sources, including wood, cowdung and crop residues. The current consumption of fuelwood in the country is around 256 million cubic metres which is estimated to rise to 300 million cubic metres by 1990. In large parts of India, at least one member of every poor family is engaged in collecting firewood for the family for 230 to 300 days an year. The problem of scarcity of firewood has been aggravated by escalation in the prices of conventional fuel and rise in the demand for traditional fuel. Deforestation to meet the increasing demand for wood has brought in its wake erosion of soil. It is estimated that nearly 6 million tonnes of soil nutrients are being swept to the sea alongwith the top soil. It is suggested that India may be able to produce enough food in the years to come but will have virtually no firewood available for cooking it in less than 20 years. The need for raising fuelwood plantations has, therefore, become imperative more than ever before.

Consequently, it has been suggested to augment the supply of firewood by raising firewood plantations on uncultivated substandard lands as the use of arable land for non-food purpose would come in conflict with food priority. But, large-scale use of fertilizers to produce fuel in sufficiently large quantities to be used as a source of energy, will also make the proposition unacceptable.

In India, saline and alkali soils account for nearly 7 million hectare of land. These soils are useless for agriculture because of the presence of soluble salts and sodium in excessive concentrations. But, such lands, if properly managed, could be profitably used for raising energy plantations.

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Objective

The proposed project on Woody Biomass Production aims at evaluation of certain selected trees and shrubs for their biomass production potential; standardisation of agro-techniques for management of high density, short-rotation biomass plantation on sound economic lines, including rapid multiplication of elite clones; study of nutrient cycling; cropping pattern; fertilizer responses; energy input and output; identification of pests and diseases and development of control measures, etc.

Organization

The proposed project will be managed through DST/CSIR, Government of India, by the Director, National Botanical Research Institute, Lucknow, in collaboration with the Chief Conservator of Forests/Director of Social Forestry, U.P., who will be assisted by a Project Co-ordinator and Project Associates, as per the following list:

1. Dr. T.N. Khoshoo, Director, National Botanical Research Institute, Lucknow
2. Project Co-ordinator
3. Project Associates
4. Conservator of Forest - Research & Development, U.P.
5. Administrative Officer, National Botanical Research Institute, Lucknow
6. Finance & Accounts Officer, National Botanical Research Institute, Lucknow

Personnel : Enclosed
Budget : Enclosed
Duration : 5 years. Take-off period - 6 months

NBRI's Contribution

The NBRI, engaged as it is in the exploitation of non-traditional/underutilized economic plants and utilization of substandard soils, has already been seized of this problem and has an on-going R&D programme for biomass/energy plants, which has been in operation for the last about two years. The Institute has been actively engaged in R&D work on the so-called 'crops of the future', such as, woody biomass plantations, petro-crops, lubricant crops, rubber crops, protein-rich algae, etc., and large-scale experimental plantations have already been raised on substandard soils. Sophisticated instrumentation facilities, such as, Scanning Electron Microscope, Atomic Absorption Spectrophotometer, Amino-acid Analyser, Densitometer, UV Spectrophotometer, G.L.C., Cold Room, etc., have been created to assist the speedy execution of the programme. In view of the excellent multi-disciplinary expertise (in the form of personnel), sophisticated equipment, and a rich library, possessing about 45,000 volumes and subscribing to 570 Research periodicals, and an information set-up and the required infra-structural facilities available at the Institute, the Department of Science and Technology, Government of India, has sponsored a Biomass Research Centre and a scheme on petro-crops at the Institute. Thirty-five thousand trees of 12 tree species of proven adaptability are being raised on an area of 10 hectares of substandard land at the Biomass Research Centre, at the Institute's Banthra Research Station. Plantations of Jojoba (Simmondsia chinensis), Euphorbia tirucalli (petro crop), Euphorbia lathyris (latex crop), etc. algal culture ponds, etc., have also been established.

The relevant scientific expertise at the Institute, its sophisticated equipment, land and other infra-structural facilities will be made available for the proposed project on energy biomass production.

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Project 1: Estimation of woody biomass production by deep/shallow rooted trees and shrub species of proven adaptability to sub-standard soils.

Objectives:

1. To determine annual biomass production of indivial species;

2. Effect of plant density on the biomass productivity of different species every year;

3. To determine the water and fertilizer/manure needs of different species and the critical time for their application to secure maximal biomass production;

4. To evolve schedules of fertilizer and irrigation for maximum biomass production per unit area per unit time for a given species.

Methods/approach:

1. Species evaluation trials with respect to their growth behaviour and biomass productivity including root growth pattern.

2. Plant spacing at varying plant population per unit area.

3. Scheduling of irrigation on the basis of soil moisture depletion pattern. The soil moisture regimes may be fixed on the basis of available soil moisture (ASM). Concurrent experiments may be run on the frequency of irrigation keeping the quantity of water fixed in order to judge the best suited method of monitoring the irrigation needs for maximum biomass production.

4. Fertilizer needs and critical time of fertilizer application will be determined separately or combined with the irrigation experiments for different species.

Results expected:

The proposed project will provide data on the biomass production potential of selected species, their response to varying nutrient and moisture regimes and identification of suitable agronomic techniques to secure maximum biomass production from a unit area of land.

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Personnel:

1. Scientist 'B' - 1
2. Senior Scientific Asstt. - 1
3. Senior Technical Asstt. - 1
4. Junior Technical Asstt. - 2

Equipments:

1.	Soil moisture probes	Rs. 1.0 lakh
2.	Driers with provision to record the moisture content of the samples.	Rs. 0.30 "
3.	Root growth chambers	Rs. 0.25 "
4.	Oxygen bomb Calorimeter	Rs. 0.20 "

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Project 2: Estimation of energy budget at economic analysis of biomass plantation.

Objectives:

(i) To develop input-output energy budgets for the anticipated range at biophysical and socio-economic conditions associated with proposed energy plantations;

(ii) To develop an economic analysis of energy plantations for use in identifying proper levels of investments.

Personnel:

1.	Scientist 'B' (Agricultural Economics)	- 1
2.	Senior Technical Assistant	- 2
3.	Junior Technical Assistant	- 1

Travelling

US Consultant to India for 3 months Rs. 0.80 lakhs

Project: 3 Woody biomass seed and germplasm collection and storage methodologies

Objectives:

(i) To determine criteria for seed and germplasm selection with emphasis on production and insect disease resistance;

(ii) To identify methodology for collecting and drying seed;

(iii) To determine optimum conditions of storage in relation to seed viability through time;

(iv) To cytogenetic information: on chromosome number and interspecific cross compatability wherever possible in some of the fast growing taxa for subsequent improvement programme.

Method/Approaches

(i) Location of high performance trees and shrubs on the basis of growth, seed yield and insect and disease resistance through survey;

(ii) Collection and drying methodologies;

(iii) Storage at room and low temperatures;

(iv) Viability testing through time.

Results expected

The project will provide baseline information on the viability of seeds, optimum storage conditions;and ~~also~~ incidence of insect and diseases affecting the seeds.

Personnel

1. Senior Technical Asstt. - 2
2. Junior Technical Asstt. - 2

Equipment

1.	Germinators	- 3	Rs. 1.5 lakhs
2.	Walk in freezer	- 1	Rs. 3.0 "
3.	Moisture meters	- 3	Rs. 0.10 "
4.	Low temperature incubators.	- 3	Rs. 0.30 "

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Project 4 : Identification of insect and disease agents potentially associated with woody biomass plantations.

Objectives:

(i) To identify insect pests and diseases affecting woody perennials;

(ii) determine the extent of occurrence and damage to woody perennials;

(iii) To work out control measures including rate and time of application of pesticides.

Method/Approach:

(i) Survey of existing forest plantations for identifying pests and diseases affecting various plant parts;

(ii) Field testing of fungicides and insecticides applied at varying concentrations and different stages of plant growth.

Result expected:

The investigations would provide information on the field susceptibility of the woody plants to insect pests and diseases and efficacy of various fungicides and insecticides in controlling them.

Personnel:

(i)	Scientist B	(Plant pathology) (Entomology)	2
(ii)	Senior Technical Assistant		2

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Project 5: Nutrient budget and nutrient cycling in woody biomass plantations

Objectives:

(i) To determine the effect of intercropping and plant species on soil nutrition associated with deep and shallow rooted biomass species;

(ii) To identify the effect of continued woody biomass production on soil nutrition with and without intercropping;

(iii) To determine agronomic system to maintain or enhance soil and plant nutrient budgets under continued energy plantation system.

(iv) To monitor fertilizer response through leaf analysis and establish leaf nutrient concentrations associated with optimum growth.

Method/Approach

(i) Chemical analysis of soil in the rooting zone, and plant parts (root, stem and leaf) for macro and micro-nutrient elements at specified intervals;

(ii) Litter fall, its rate of decomposition and release of nutrients.

(iii) Changes in physical characteristics of the soil

Results expected:

The present investigations will provide information on the ameliorative effect of woody perennials, grown as mono and mixed culture, on the soil ~~incipient~~ indicate nutrient concentrations associated with optimum growth and incipient deficiencies of nutrient elements limiting plant growth.

Personnel:

1. Scientist 'B' - 1
2. Senior Technical Assistants - 2

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Project 6 : Identification of methodologies and procedure associated with the establishment and initial growth of woody biomass species in energy plantations.

Objects:

1. Studies on the root growth pattern of seedlings in the nursery and shoot to root ratio for successful establishments of the transplants;

2. To determine the optimum depth and frequency of irrigation to maintain a desirable moisture status of the soil to ensure maximum survival of saplings in the field.

3. To determine the optimum season of planting for maximum survival of the saplings and economizing the water needs.

4. Studies of soil temperature as associated with its moisture content at varying soil depths and its influence on the degree of survival.

5. Effect of brackish irrigation water on the survival of seedlings.

Methods/Approach:

1. Studies on the root growth pattern of different species will be undertaken in growth chambers under a set of identical conditions and the shoot/root ratio will be determined to serve as a criterion in assessing degree of survival.

2. Studies on levels of soil moisture status under varying depths and frequency of irrigation and its effect on degree of survival of the saplings for a period of two years.

3. The degree of survival of the saplings planted in different seasons i.e. rainy season (July - September) and spring season (February - March) will be studied. The economy in terms of irrigation water and other cultural operations will be used to determine the suitable period of transplanting.

4. ~~The~~ Extremes in soil temperature in summer and winter cause set back to the establishment of saplings in the initial stages. These effects can be offset to a great extent through supplemental irrigation. Irrigation schedule will, therefore, be evolved to maintain a desired level of the soil temperature to ensure greater success.

5. A study will be undertaken on the effect of brackish water on growth of saplings and salt build up in the soil.

Result expected:

On the abnormal soil which constitutes the substratum for the present studies, initial establishment of the saplings for raising biomass plantations poses a major problem. Such studies as envisaged in the present programme will provide solutions to the basic and practical problems generally encountered in the establishment of successful plantations.

Equipments:

(i)	Deionizer	- One	Rs. 0.50
(ii)	Growth chamber	- 2 Nos	Rs. 1.00
(iii)	Soil moisture probes	- 6 Nos	Rs. 0.10

Personnel:

(i)	Senior Technical Assistant (Forest Range)	- 2
(ii)	Junior Technical Assistant (Forest)	- 2
(iii)	Scientist B (Assistant Conservator of Forests)	- 1

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Project 7

Rapid multiplication of some trees through tissue culture for woody biomass production.

Description of Problem and Significance

By far, the tissue culture has found its best applied use in micro-propagation of plants, including production of cloned plants. Tissue culture is invaluable, particularly, for initial building up of propagation stocks of elite clones/individuals of not only those plant species which are intractable, but also those propagating easily. At present, around 300 plant species, including woody trees, have been demonstrated to be clonally propagatable through tissue culture (Murashige, 1980). Multiplication rates have been increased to phenomenal magnitude, to even million-fold in certain cases, by the application of tissue culture. Such aspects of tissue culture research will be exploited for rapid multiplication of elite individuals of some fast growing woody trees, viz., Leucaena, Casuarina, Eucalyptus and hybrid Populus.

Objectives

1. To develop methods for rapid propagation of above-mentioned plant species.
2. To standardize acclimatization procedures for successful field transplantation of in vitro-raised plants.

Results Expected

Rapid clonal multiplication of elite individuals of woody plant species and their field cultivation will go a long way to augment production of woody biomass in a much shorter period of time than is possible by conventional methods.

Methods:

The standard tissue culture methods will be employed to realize the objectives of the project. Shoot apices and/or axillary shoot buds of elite individuals of above-mentioned plant species will be induced to proliferate *in vitro* at a fast rate. Alternatively, differentiation of shoots/plantlets will be induced in excised vegetative organs(stem, leaf and root) in order to select a particular organ of a particular plant species having the highest regenerative potentiality.

Attempts will also be made to regenerate plants via somatic callus cultures, primarily to augment the rate of multiplication.

Nutritional experiments will be conducted to achieve not only a good percentage of rooting with minimum intervening callusing of *in vitro*-regenerated shoots, but also to obtain a tap root like system which is desirable for their establishment in soil as well as better anchorage.

Acclimatization procedures will be standardized for successful transplantation of *in vitro*-raised plants in soil and their subsequent growth under field conditions.

Personnel:

Senior Scientific Assistant	-	Two
Junior Scientific Assistant	-	One
Junior Technical Assistant	-	One
Senior Lab. Assistant	-	One
Field Attendant	-	One

Budget

A. Salary:

SSA	2	Rs. 12,720 p.a-/head	Rs. 1,27,200
JSA	1	Rs. 10,200 p.a./had	Rs. 51,000
JTA	1	Rs. 10,200 p.a./head	Rs. 51,000
SLA	1	Rs. 9,360 p.a./head	Rs. 46,800
F.A.	1	Rs. 5,520 p.a./head	Rs. 27,600
		Rs.	3,03,600 / 5 Years

B. Equipment

1.	Plant growth chamber One (For acclimatization of in vitro-raised plants before their transplantation under fied conditions)	Rs. 3 ,00,000
2.	Photomicroscope (Wild) One or Photomacrography unit (Tassovar) (For observations and photography of differentiating cultures)	Rs. 60,000
	Rs.	3,60,000
C.	Travel: Rs. 5,000 p.a.	Rs. 25,000
	Grand Total: A+B+C	Rs. 6,88,600 / 5 Years

Implementation Schedule

1st year

Establishment of different plant species in aseptic culture

2nd & 3rd years

Experimentations regarding proliferation of explants (shoot apices/axillary buds) of elite individuals and induction of organogenetic differentiation in excised organ segments and their calli.

4rth year

Optimization of the rate of proliferation of shoots and organogenetic differentiation. Rooting of in vitro-regenerated shoots resulting in the formation of complete plants.

5th year

Acclimatization experiments for successful transplantion of in vitro-raised plants in soil and initiation of their field cultivation.

I. Project 8 : Setting up a Data Bank for Woody Biomass and other Energy Plants.

II. Description and Significance: For any R&D Projects, particularly, of the extension type, it is very necessary for the scientists engaged in these projects to keep abreast of the work going on elsewhere in the fields of their interest and to keep posted with all the information already available or being generated on their subjects. Since it is not possible for the active research workers to attend to this aspect themselves satisfactorily, it is essential that a professional information set-up be associated with these projects, to feed the scientists with all the requisite information as adequately and as speedily as possible.

It is presumed that a sizeable amount of information is already available on the woody biomass/energy plants and it should be collected, documented and provided to the scientists to serve as starting points for their respective research programmes.

III. Objective: To build up a data bank of diverse types of information, particularly, on agro-techniques, disease and pest control, increased yield, socio-economics, etc., of woody biomass/energy plants.

IV. Methods/Approach: To collect, document and supply information, preferably, with the help of a computer facility.

V. Equipment: A Mini-Computer facility

VI. Personnel Required:

1. Scientist 'D' (Computer Programmer) - Two (Pay grade Rs. 700-1300)
2. Key-Board Operator (S.T.A.) - Four (Pay grade Rs. 550-700)
3. S.L.A. (Maintenance Assistants) - Two (Pay grade Rs. 380-640)

VII. Travel: Visit to USA of the Project Associate concerned (Head, Data Bank) to study the modern computerised systems of information, particularly, in the field of economic botany.

VIII. Budget for 5 years

1. Mini-Computer Facility (Procurement, Installation, etc.) Rs. 5.000 lakhs

2. Salaries of Personnel

a) Scientists 'B' (2) (Computer Programmers)	Rs. 1.590 lakhs	@ Rs. 15900 per annum, per head.
b) S.T.A.'s (4) (Key-Board Operators)	Rs. 2.496 lakhs	@ Rs. 12480 per annum, per head.
c) S.L.A.s(4) (Maintenance Assistants)	Rs. 0.913 lakhs	@ Rs. 9132 per annum, per head.
d) Travel to U.S.A. of the Project Associate	Rs. 0.300	

Total Budget for 5 years: Rs.10.299 lakhs

= Say Rs.10.300 lakhs

+ an escalation of 5% per head, per annum in salaries.

IX. Facilities/Expertise already available at NBRI

NBRI has an Economic Botany Information Service which is staffed with experienced professional information scientists and also possesses some equipment for information processing. It is already engaged in the collection, documentation and dissemination of scientific information in certain selected areas of economic botany, including woody biomass and other energy plantations and has built up some information base in these areas. This Service will be associated with the setting up of the proposed Data Bank.

X. Additional Usefulness of Mini-Computer Facility

The Mini-Computer Facility of the Data Bank may also be used for designing research experiments and for other R & D requirements of the project.

Staff requirement

A. Scientific

Sl. No.	Designation	No.	Area of Research
1.	Scientist 'C'	1	Statistics
2.	Scientist 'B'	7	Agronomy, Agril.Economi Plant Pathology, Enthomology, Informatio and Nutrition.
3.	Senior Scientific Asstt.	1	Agronomy
4.	Senior Technical Asstt.	15	Agronomy, Economics Seed storage, Pathology, Nutrition, Nursery, Information.
5.	Junior Technical Asstt.	7	Agronomy, Economics Seed storage, Nursery
6.	Senior Lab. Asstt.	2	Information

B. Secretarial

1.	Junior Technical Asstt.	3	Secretarial assistance

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Sl. No.	Equipment		Cost (Rs.in lakhs)
1.	Growth Chambers	- 2	2.00
2.	Mini Computer	- 1	5.00
3.	Soil moisture probes	- 6	1.10
4.	Driers with provision to record content of the samples	- 1	0.30
5.	Root growth chamber	- 1	0.25
6.	Oxygen bomb Calorimeter	- 1	0.20
7.	Germinators	- 3	1.50
8.	Walk-in-~~process~~ freezer/cold room (5 x 3 mts)	- 1	3.00
9.	Low temperature incubators moisture meters	- 3	0.40
10.	Dendrometer	- 1	0.60
11.	Deionizer	- 1	0.50
		Total:	14.85

	Total (5 years)
Travel:	Rs.
1. Within the country	1.00 lakh
2. International (for project personnel for training, consultations, attending Conferences)	3.5 "
Conferences and Workshops	
Once in Two year and one workshop every year	1.0 "
Office and other costs	0.30 "
Permanent Equipment	
(Steel furniture, Typewriter, Photostate machines, Calculators & Duplicators)	3.0 "
Contingencies	
(Fertilizers, pesticides, fuel, plants, maintenance expenses for plantations, Chemicals and Glasswares)	5.0 "
Staff salaries	

Research Team

1.	Dr. T. N. Khoshoo	Director
2.	Dr. S. D. Khanduja	Scientist
3.	Shri V. Chandra	"
4.	Shri B. R. Juneja	"
5.	Shri P. N. Misra	"
6.	Dr. Mohinder Pal	"
7.	Dr. H. C. Chaturvedi	"
8.	Shri A. N. Chaturvedi	Conservator of Forest Uttar Pradesh.

APPENDIX C

Biomass Centre

RESEARCH PROPOSALS

School of Biological Sciences
Madurai-Kamaraj University
PALKALAI NAGAR,
MADURAI-625021

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PROPOSAL

for

BIOMASS CENTRE

at

ADURAI KAMARAJ UNIVERSITY

MADURAI 21

Increase in farm productivity in the predominantly rural India is the only way by which the 'quality of life' of the masses can be improved. Presently, lack of available energy, either for agriculture, domestic or industry in the rural area is one of the major limiting factor that acts as a constraint for the growth of economy and farm productivity. While extensive agricultural research, improvement in agronomic practices, development of high yielding varieties may help in the marginal increase in the agriculture yields, higher input of energy for irrigation, manuring, or pest control, is the only answer for detaining substantial gains in this sector, if the experience of the western and other industrially developed countries any indication.

In contrast, in India, muscle power from human and animal sources are the only energy concentrate used for agriculture. Very little chemical fertilizers and pesticides are available, and most irrigation depends upon rain or gravity flow. Commercial forms of energy, viz., fossil fuels and electricity are the scarce and are not easily available at the farm site where their need is predominant, mainly because of the capital intensive nature of them.

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Besides the problem of worldwide scarcity of fossil fuels and their increasing costs also aggravate the situation further.

It is therefore imperative to look for alternative sources of energy, which are easy to detain, less expensive, renewable, and made available at the farm site without difficulty. It is also pollution free. Among the options available, utilization of solar energy either by direct or indirect means is the obvious choice. Nuclear fission as a source of energy though attractive at present, may not be most suitable as it is capital insensive, high technology oriented and has got to be highly centralized with the problems of harmful waste disposal.

Presently, there are various methods by which solar energy is being harvested and utilized. They include direct methods such as heat collection, photo voltaic devices, and indirect ways through plant photosynthesis where solar energy is harvested and stored as plant cover which in general term referred to as biomass.

Biomass

The term biomass is used to include everything that grows or has grown and can be turned into energy in a variety of ways. The most pragmatic plan for using solar energy is to tap the energy stored in biomass-from sewage to sorghum-wood; wood-wastes, agricultural wastes, animal wastes; algae; municipal sewage and so on.

Biomass is the ultimate source of food, wood, fibres and fuels. Biomass collected in the form of wood, foliage, roots, algae and for that matter any agricultural and

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forest waste can be converted into energy either in gaseous, liquid and solid forms as shown in Fig. 1.

The question is, are we having enough biomass for conversion into energy for use in each village or in a cluster of villages? In a 'recycling society' like ours, every bit of the agricultural waste and plants grown in the marginal lands are used in one form or other to meet the meagre energy demands in a traditional albeit in an efficient way. With the rapid population growth, firewood scarcity is spreading even in remote villages. For example even in a moderate sized city like Madurai with a population of less than a million the fuelwood requirements have risen from 185 tons in 1974 to 320 tons per day in 1977. Likewise charcoal consumption rose from 100 tons in 1975 to 120 tons per day in 1977. The common fuel wood in Madurai comes from the species of quick growing Acacia and Prosopis. A hectare of 5 year old Acacia can supply 50 tons of wood and therefore 6.5 hectares have to be filled everyday. This may give some idea of the magnitude of the problem. Recently, firewood was rationed in the Nilgiris District and there was ques for sawdust.

Therefore we must do something urgently to augment the biomass production on a war footing similar to the efforts made for agricultural production in all the countries. Development of social forestry, firewood forest and energy forests on a scientific basis are suggested. Definite plant development programmes through proper breeding based on mass selection and mutations with the emphasis on total biomass rather than specific plant part like grain or fibre have to be undertaken. Basic research to understand and improve the solar energy harvesting processes of the plants should be encouraged to improve the efficiency of biomass production.

It is therefore important to set up at least a few 'Biomass Centres' through out the country on the lines of Agricultural Research Stations developed a few decades ago for improving the farm productivity. The proposed biomass centre at Madurai would have the following overall objectives:

1) broaden the resource base for biomass through proper assessment and survey of the land and water potential,

2) to formulate a critical assessment of the available municipal wastes and agricultural and forest wastes for energy conversions,

3) to concentrate on energy crops, both terrestrial and aquatic so as to meet the most immediate demands of the rural population for their domestic and farm use,

4) assessment of the present end uses of the biomass and to undertake feasibility studies on more efficient uses of the same for obtaining maximum energy.

5) undertake studies on the appropriate technology which include energy crop, production systems, harvesting and collecting transportation, pre-treatment and conversion technology.

6) area and need based determination of end product for energy use, such as direct heat, steam, electricity, alcohol or gases or (co-generations)

under these sets overall objectives, the following areas of studies will be commenced to begin with :

A. Start energy plantations on selected field conditions besides on experimental plots ;

   i) The fast growing species with high energy value among the existing tree species of the region.

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ii) Conduct mass survey and selection and breeding for better growth and energy harvesting.

iii) Determine the most suitable agronomic practices to obtain the maximal biomass yield.

iv) Establish systems to collect maximal biomass from sewage ponds and other water reservoirs through micro algal system.

v) Undertake basic studies on forest tree photosynthesis, determine the plant form and plant type for maximal solar energy harvest.

vi) Undertake studies on 'N' economy of the selected energy-forest plants such as the one seen in the symbiotic association between Casuarina and Actinomycetes.

vii) Propagate the concept of 'Social and/or fuelwood forests' among the villages nearby with suitable extension work.

The function of the extension wing will include:

1) Training of the farmers
2) Development of Nursery
3) Distribution of seedlings
4) Co-ordinate with the state forest and silviculture wings
5) Develop and dissiminate improved methods of using biomass for domestic and agricultural use.

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B. Undertake socio economic survey based on energy end uses to build a sound data base.

Based on the experience gained the centre will expand to undertake a wide range of activities as indicated in Fig. 2 to cater for the regions having a wide variety of agroclimatic conditions.

As a part of this overall objective, a biomass centre at Madurai is proposed to begin with based on the following considerations :

a) Madurai is in the middle of rural settings, in predominantly semi arid region with a lot of marginal land.

b) The city is large enough to have the scientific support of the Madurai Kamaraj University, State Silvicultore Department, State Forest Department, Agriculture University.

c) It is one of the centres in which active photosynthetic research and primary productivity studies are being persued.

To achieve the above objectives the proposed centre will have the following facilities :

A biomass centre with laboratory, office, extension wings adjoining/inside the university area will be developed along with a field facility for trials to an extent of about 50 acres. Part of the land will be made available by the University and part will be procured. The details of the laboratory facilities for achieving the above objectives are given in the following budget estimate:

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1. Fifty acres of land.
2. Development of land, water facility.
3. Buildings, for farm machinery and laboratory 10,000 sq ft
4. Equipments for field photosynthesis, growth measurements, energy contents, heat values, flash points, etc.
5. Vehicle : Van and Power Tiller
6. Office equipments and furniture

FIGURE 1

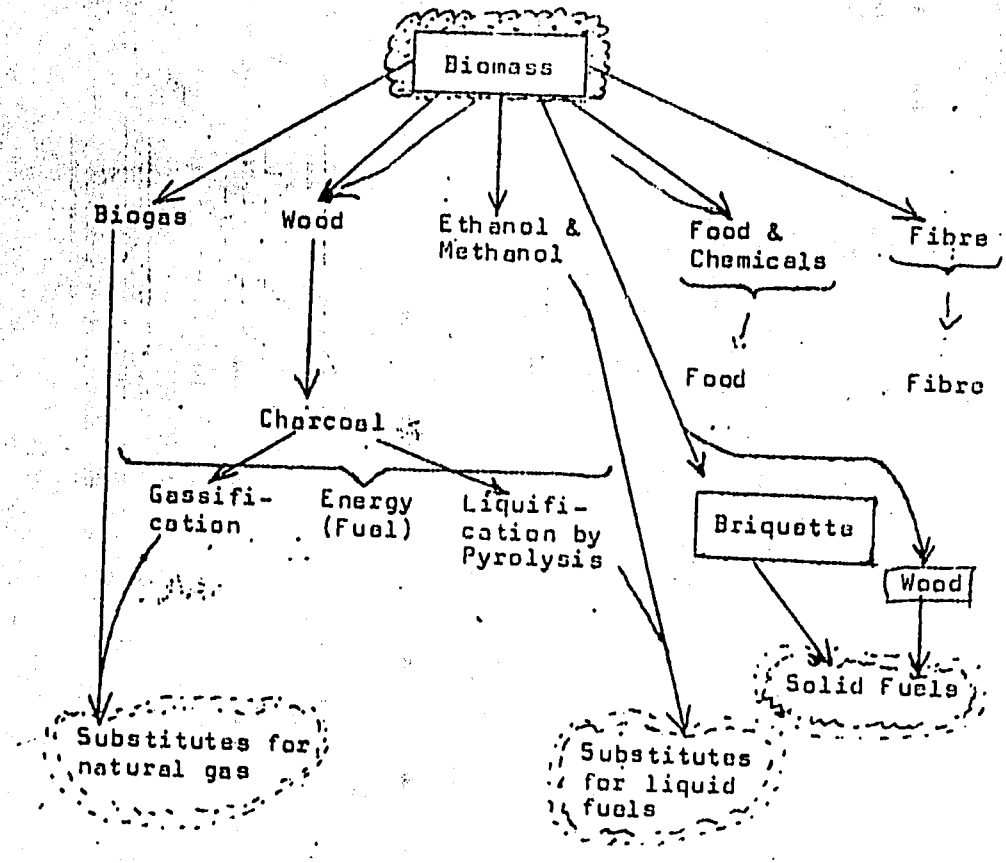

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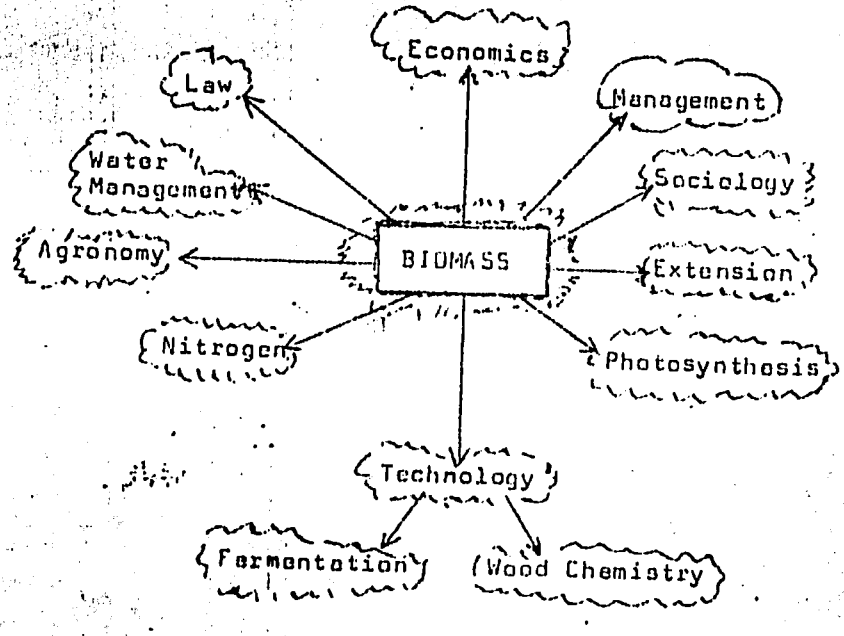
FIGURE 2


Economics
Law
Management
Water Management
Sociology
Agronomy
BIOMASS
Extension
Nitrogen
Photosynthesis
Technology
Fermentation
Wood Chemistry

FUELWOOD PLANTATIONS FOR HOT ARID ZONES - LAB-CUM-PILOT PLANTATION STUDIES ON FIVE MAJOR TREE FORMS IN MADURAI-RAMNAD DISTRICTS

Introduction :

In both rural and semi-urban area, where more than 85% of the population live, non-commercial fuels such as firewood, dung-cake, waste products, etc., account for nearly 90% of the domestic energy demands and the existing resources of these items are fast dwindling. Compared to domestic needs, energy demands for agriculture which forms the predominant preoccupation is far less and is carried out to the extent of about 75% with muscle power i.e. human and bullock energy.

The energy shortage for domestic needs rather than food shortage is expected to increasingly pose difficult problems in the next decade. In recent years firewood prices are soaring ahead of most other items; while alternative sources of domestic energy such as gobar gas, solar devices, etc., have not been developed sufficiently.

At a per capita use of 0.5 to 0.7 tonnes of firewood per year, any moderate sized community utilizes the available firewood at a rate several fold higher than they are naturally replenished within their revenue limits. Consequently enormous time and energy are spent on collecting cirewood, often times treckking 4-5 km per day. It is estimated that of the human hours spent per annum on domestic activities, 10% went towards firewood gathering.

The fuelwood crisis is brewing to a proportion hitherto unknown and its consequences are far more serious to the rural economy and the way of living than the consequences of fossil fuel crisis, upon developed nations and urban communities.

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Secondly, to improve the 'quality of life' of the millions of Indians, increase in the farm productivity is the only way available for the present. Higher input of energy for irrigation, manuring, transport is needed for obtaining substantial gains in this sector.

Improvement in the firewood position through systematic effort will not only facilitate the diversion of nearly 20% of the available manpower from fuelwood gathering to productive farmwork, but also will constitute a substantial feedstock for any energy conversion system in the rural set up for use in agriculture and rural industries.

Very little systematic study has been done to select and to cultivate fuelwood trees in the rural areas in India. Transfer of technology or experience cannot be effective in undertaking plantation works in a massive scale as each region has got to develop and use the best tree forms and plantation practices that suit the specific agro-climatic conditions of their own.

Objectives :

1) To screen and identify the best suited tree forms that can be used for large scale plantation under the agro-climatic conditions prevalent in the hot arid districts utilizing the land under uneconomic cultivation and/or marginal lands.

2) To determine the best 'agronomic' practices for obtaining the maximal output from the selected fast growing tree forms such as spacing, rotation time, manuring, pest control, harvesting, etc.

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3) To improve the draught and heat resistant characteristics of the selected plant species for sustained growth and yield, through mass selection breeding through cultures.

4) To determine the physico-chemical properties of the selected firewood plantation trees and their charcoal such as flash point, burning velocity, burning properties, economic evaluation of carbonization, etc.

5) To undertake socio economic survey of the energy use patterns in the State for the first time.

Investigating Group : Prof. A. Gnanam (Project Co-ordinator)
Dr. Kondas, State Silviculturist.
The District Forest Officer.
Dr. Vankatasubramanian, Department of Sociology
Besides the District Collector, Block Development Officer and other Government Officials will be included.

Outline of the project work :

Viability of the following fast growing short rotation trees will be assessed for mass cultivation as fuelwood plantation :

1) Moringa tinctoria
2) Acacia planiformis
3) Erythrina indica
4) Butea monosperma
5) Millingtonia hortensia
6) Growelia robusta
7) Casuarina equisetifolia
8) Odina odier
9) Eucalyptus globulifera
10) Muntengia sp.
11) Ailanthus excelsa
12) Sterospermum orcirotorium
13) Dolichandra falcatum
14) Tremma orientalis

Each of the five species selected out of the above list from Preliminary studies will be planted in adjoining plots of about an acre each for systematic analysis of their adaptability, growth performance, biomass production. The optimal

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agronomic conditions will be established for maximal biomass production and fuelwood collection.

Plantation work will be undertaken in the vast arid outfields at Madurai Kamaraj University. The University has agreed to spare about 20 acres of land for this field trial. The University is located in a typical arid-marginal land expanse of the Madurai District.

Simultaneous field trials will be undertaken at a few selected villages in Madurai-Ramnad Districts. Usilampatti (total farming village), Thirumangalam (both dry and wet farming) and Katchaikatti villages are selected for their representative nature and proximity. The co-operation of the State and community development personnel will be solicited for raising the plantations in these villages utilizing the rural idle labour, state lands and available funds in a co-operative pattern of undertaking. Data collection and initial support will be the responsibility of the project while the produce and benefit will be made available to the community involved.

Katchaikatti village with its 5 hamlets will be chosen for intensive study for socio economic survey and for fuelwood plantation as it is a quite representative rural unit. There are 4323 acres of dry land and 510 acres of wet land with a population of 9602 in this group of hamlets where 50-100 acres of land (marginal land) can be obtained for experimental plantation.

All the field level studies will be undertaken as a co-operative venture with the active help and participation of the District Collector and Officials of the Rural Development, Director, NSS and the Agricultural University personnel.

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Sharing of responsibilities :

A Objectives (1), (2) and (3) above will be carried out with the co-operative efforts of Dr. Kondas, the District Forest Officer and Prof. A. Gnanam.

B Objective (4) will be monitored by the School of Biological Sciences.

C Socio economic survey (Objective5) will be done by the Economics and Sociology Departments of the University.

Additional studies :

Mass selection and propagation of the drought and heat resistant varieties will be done by traditional as well as specific tissue culture techniques at the School of Biological Sciences, Madurai Kamaraj University and at Tamil Nadu Agricultural University.

Basic field photosynthetic studies will constitute one of the criteria for selection of the best adapted tree species to the agroclimatic condition.

Water management studies including the drip irrigation method will be undertaken as water conservation is an important criteria for success in the arid zone.

Duration of the project :

'Proof of concept' part of the project will be restricted to 3 years but the trials will be continued for 5 years for determining the overall performance of the selected trees.

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Budget :

	At University Field Rs.	Vadipatti Rs.
A. Non-recurring :		
Bore well and pipelines	50,000	25,000
Land preparation	10,000	10,000
Plantation	20,000	20,000
Van (transport)	65,000	-
Equipment (scale, moisture meters, flash point units, ovens, etc.)	25,000	-
	1,70,000	55,000
B. Recurring for 3 years :		
Casual labour + pesticides and maintenance	30,000	30,000
Chemicals and glassware	24,000	-
Transport	30,000	-
Secretarial assistance and office supplies	24,000	-
Socio economic survey	10,000	-
Research assistants - 6	43,200	-
Field assistants - 4	19,200	-
Contingency expenses	12,000	-
	2,00,400	30,000
Total of A and B	3,70,400	85,000
Grand total	Rs. 4,55,400	

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ENERGY CONSUMPTION STUDY AND RURAL DEVELOPMENT WITH SPECIAL REFERENCE TO KACHAIKATTI VILLAGE IN MADURAI DISTRICT

Introduction

Energy consumption in India has not been studied in depth at the rural level empirically taking into account both the renewable and non-renewable resources. Though isolated studies have been made of village economies, no scientific studies have been made of village energy demand and supply particularly in Madurai District. During the recent past the level of energy consumption in the rural areas has increased considerably with greater demand for non-renewable resources like electricity, diesel oil, kerosene, cooking gas, etc. It is also a fact that with an increasing population the traditional renewable energy resources are getting depleted at a faster rate than formerly visualised. Nevertheless, it would be possible through suitable strategies to check the increasing demand for non-renewable energy resources by concentrating on the development and augmentation of renewable energy resources within the village economy.

Objectives

It is possible to identify various objectives in terms of energy consumption and rural development. However the focus in this study will be the following :

1 To study the various forms of energy available-renewable and non-renewable in a selected village. The available forms of energy in one village may not be the same as that of another. It is therefore necessary to inventory the forms of energy sources available in the particular village and evolve suitable methods of employing the same.

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2. To study the existing pattern of energy consumption. A study of the pattern of energy consumption has to take into account many factors like income-distribution, occupational distribution, socio-cultural practices, family composition, farm size, cropping patterns, level of education, etc.

   In studying these variables it is intended to work out the general pattern of consumption and how it is related to the general development of the village.

3. To assess the potential level of available energy in the village and nearby areas. The assessment of available energy will be in terms of firewood available, changes in cropping patterns, cattle and livestock population, etc. It is intended to make a feasible study of how far the village can be made self-sufficient regarding its energy requirements.

4. To estimate the energy demand in the village in the coming three years and to assess the feasibility of meeting this demand from the available supply and through developing renewable forms of energy and alternative supplies.

Village chosen for study in Madurai District :

A preliminary study was made to choose a representative village where research could be carried on for a period of three years on 'Energy resources and rural development'. Three regions were chosen - the Usilampatti area where mostly dry farming is carried on, the Thirumangalam area where dry farming and wet farming is practised and the Vadipatti panchayat block where both dry farming and wet farming is followed. The Usilampatti area was not representative due to the dry farming methods alone that were practised.

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Thirumangalam is semi-urbanised and the villages are not representative in the fact that development agencies like Gandhi Nikaten in the block have changed the rural environment there. So, it was decided to concentrate on the Vadipatti panchayat Union which is about 20 miles from Madurai City.

The Vadipatti panchayat union has 31 revenue villages - the largest village being Ketchaikatti with a population of 9,602. The smallest is Chinnamanaichenpatti with a population of 248. The second populous village Sholavandan is semi urban in character with a population of 8,308. The arable area is well irrigated and the land is used for paddy and sugarcane cultivation mainly (wet lands). Dry farming is virtually non-existent. The village cannot be considered to be representative for purposes of energy analysis.

It was decided to choose Ketchaikatti, a village about 24 miles from the Madurai Kamaraj University. This village has 5 hamlets. They are Semnipatti, Kutladampatti, Matchaipatti, Ramaiyanpatti, Poonchampatti and Chokkalingapuram. It is near the Sirumalai Hills. In matters of energy the following sources are utilized.

1. Firewood from Sirumalai Hills
2. Diesel Oil for pumpsets
3. Electricity for pumpsets
4. Dry cow-dung for cooking purposes
5. Bullocks for cultivation

Both dry and wet cultivation are followed. There are 4323 acres of dry land where cholam, cambu and groundnut are cultivated. The wet lands comprise 510 acres where mainly paddy is cultivated.

In our considered opion this village with its 5 hamlets is quite representative and the study is to be made for a period of 3 years.

Methodology :

The first stage of the study is to collect the base line data from the village. The data relating to various forms of available sources of energy, the pattern of energy consumption and rural development have to be collected.

A census survey will be conducted at the village by economic investigators with a pre-tested questionnaire. The survey shall include the following :

1. Human energy in terms of age group, types of work, etc.
2. Bullock energy number of days worked and seasons employed.
3. Agricultural residue in terms of quantity used, variety, value and area of agricultural land,
4. Cattle dung used as fuel, manure, cost of collection, gobar gas and livestock population.
5. Biomass used - firewood, charcoal
6. Electricity consumed
7. Petroleum products

The second stage of the study will be the analysis of the collected data in order to bring out specific relationships among various factors of rural development and energy consumption.

The above two stages of the study will give the existing level of development and energy consumption. In order to study changes in the energy consumption pattern and its impact

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on rural development a similar study will be undertaken in the second and third years which will make it possible to compare the patterns and development level at the three yearly periods.

Project Personnel

Directory : (Honorary)

Dr. John D.K.Sundarsingh
Professor and Head
Department of Economics
Madurai Kamaraj University
Madurai 625021

Assistant Directors : (Honorary)

1. Dr. T. Valuthi Varagunasingh - Lecturer, Department of Economics, M.K.University
2. Mr. R. Edward Benjamin - -do- -do-
3. Dr. K. Ramachandran - -do- -do-
4. Mrs. K. Dhulasi Birundha - -do- -do-

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SOCIO-CULTURAL INFLUENCES ON THE USE OF VARIOUS SOURCES OF ENERGY IN A RURAL SETTING : DOMESTIC AGRICULTURE AND VILLAGE INDUSTRIES

This study will focus on the Social and Cultural influences on the use of various sources of energy in Tamil Nadu villages. Energy has got a very important role to play in a man's day-to-day life. For every action we require energy. Rural household uses, various sources of energy for domestic purposes, agriculture production and village industries. Energy used for the above said three purposes can be broadly classified into three categories such as (i) Human energy, (ii) Mechanical energy and (iii) Animal energy. The progress of our nation depends upon the progress of rural people, since eighty percent of India's population is rural. Energy is one of the component needs of the integrated rural development.

Wood is the principal source of energy in the rural areas. Wood is very cheap where forest land is available. Where forest land is remotely situated from the village it may be replaced by cowdung or commercial items like charcoal, oil, gas or electricity. Due to industrilisation and urbanisation people from villages migrated to nearby cities where domestic fuel is expensive especially wood, as it has to be transported from the far away forests. The people have to adopt other sources of energy for their domestic use. Often this results in the use of kerosene, charcoal, coal and LPG. According to one estimate about 55 - 60% of the energy consumed in India is utilised for domestic purposes. As far as Tamil Nadu villages are concerned firewood and cowdung are the two major sources of energy for domestic use.

Moreover these two are primarily the poor man's power source. Commercial fuels such as coke, coal and kerosene are utilised primarily by urban populations and by the rural rich. In villages where joint families exist some members go to forest to collect firewood and also to collect cowdung. Mostly women and children do this work while menfolk go for other jobs. One thing that is to be noted here is that the cost of human energy spent to collect firewood and dung in certain villages is more than that of the commerical fuel available in the market. Still people insist on the traditional way of collecting firewood and cowdung. It has become a part of their culture. The present study will make an effort to understand the social and cultural background of these people and also their attitude towards the use of other sources of energy in village life in three major areas of activity, (1) domestic, (2) agriculture and (3) village industries.

Energy has an important role to play in agricultural growth, and in supporting specific kinds of industries and services that are essential for agricultural production. Agriculture which accounts for about 48% of the national income is the kingpin of the national economy. Indian agriculture has undergone rapid modernisation due to the scientific advancement. Tamil Nadu villages have also been influenced by the modernisation process and as a result of the rapid changes in the use of seeds, fertilizers and new cultivation techniques are visible. This modernisation has also seen in the mechanisation of farms like the use of tractors, electric motor pumpsets and other devices. Human energy in the form of labour is also used in considerable

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amount for various agricultural operations. Animal energy is used mainly for the purposes of land preparation and transportation of agricultural products from villages to nearby markets. Energy requirements in agricultural sector can be broadly classified in the following categories based on the activities which consume energy : (1) Land preparation, (2) sowing, (3) fertilizer output, (4) irrigation, (5) inter-culture, (6) harvesting, (7) threshing and winnewing and (8) transportation. For the above said uses, energy can be provided in various forms ranging from human, animal, mechanical, solar and electrical energy. Due to mechanization in agrirulture, a number of changes have taken place in the total value system of Tamil Nadu villages which has its impact on the use of new sources of energy. This can be studied by a close interview with the farmers. The human energy used for farming in the earlier days was much more than that of the human energy used in modern farming.

After independence we have revitalised the village and cottage industries which provide regular employment to the farmers or labourers even during lean seasons. These industries are primarily depnded upon human energy and partially on other sources of energy. Thus this is still true there is an increasing trend in the use of electricity, diesel, charcoal, etc. The major village industries in Tamil Nadu are soap making, oil crushing, weaving, honey making, etc. For all the above said purposes mostly they use human energy. Introduction of machinery in coir making lead to some sort of socio economic problems in certain villages. So it will be interesting to find out the reaction of Tamil Nadu villagers towards the introduction of the new sources of energy in these fields.

As has been pointed out earlier Tamil Nadu villages are undergoing rapid changes due to many reasons and it will be interesting to study the social and cultural influences on the use of various sources of energy in their different activities like, domestic agriculture and village industries.

Objectives :

1) To study the influences of social and cultural habits of the rural people in the use of traditional fuels vis-a-vis modern fuels for domestic purposes.
2) To understand the changing value system of Tamil Nadu villagers as a result of the potential and actual uses of the newly introducted sources of energy for domestic, agriculture and village industries.
3) a. To study the impact of the introduction of commercial energy for the purposes of domestic, agriculture and village industries.
   b. To study the impact of the introduction of labour saving devices in the household, in agriculture and in village industries.
4) To find out whether there is any relationship between the use of mechanical energy and the level of literacy of the villagers.
5) To understand the role of different agencies in bringing changes in the use of new sources of energy among the villagers, and
6) To study the influence of modernisation as revealed in the use pattern of energy among villagers.

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Methodology :

1. Sampling : The area to be covered is the whole of Tamil Nadu. Villages will be selected using the cluster sampling technique. The sample size would be 1% of the total villages in Tamil Nadu. This selection will be done on the basis of socio-economic criteria like literacy, per capita income, levels of housing, ownership of land and pattern of cultivation, etc., levels of industrial development; proximity to urban centres; and the development of modern transport and communication facilities. Within a village, respondents will be selected using the stratified random sampling technique on a household basis at the rate of one per hundred households.

2. Tool : Data will be collected using a pre-tested interview schedule. Before the final study a pilot study will be undertaken in three villages in Madurai District.

3. Analysis : Qualitative data will be analysed manually, while the quantitative data will be analysed with the help of computer wherever necessary.

Principal Investigator : Dr. Venkatarathinum
Head
Department of Sociology
Madurai Kamaraj University
Madurai 625021

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APPENDIX D[1]

DESCRIPTION OF PROBLEM AND JUSTIFICATION

(1) In both rural and semi-urban area, where more than 85% of the population live, non-commercial fuels such as firewood, dung-cake, waste products, etc., account for nearly 90% of the domestic energy demands and the existing resources of these items are fast dwindling. Compared to domestic needs, energy demands for agriculture which forms the predominant preoccupation is far less and is carried out to the extent of about 75% with muscle power i.e. human and bullock energy.

(2) The energy shortage for domestic needs rather than food shortage is expected to increasingly pose difficult problems in the next decade. In recent years firewood prices are soaring ahead of most other items; while alternative sources of domestic energy such as gobar gas, solar devices, etc., have not been developed sufficiently.

(3) The fuelwood crisis is brewing to a proportion hitherto unknown and its consequences are far more serious to the rural economy and the way of living than the consequences of fossil fuel crisis, upon developed nations and urban communities.

(3a) At a per capita use of 0.5 to 0.7 tonnes of firewood per year, any moderate sized community utilizes the available firewood at a rate several fold higher than they are naturally replenished within their revenue limits. Consequently enormous time and energy are spent on collecting firewood, often times trekking 4-5 km per day. It is estimated that of the human hours spent per annum on domestic activities, 18% went towards firewood gathering.

(4) It has been estimated that the fuelwood supply from the existing forests resources account for only less than 15% of the total need in Tamil Nadu. The rest are derived

1 Rough Drafts.

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and this is practically true for other States as well from the privately owned as well as from the unreserved forest lands that belong to the Government or to the community as a whole. This resource is the least organised and over exploited, and therefore cannot last long. This has been the cause for the present fuelwood crisis in the rural India. Hence, an attempt to initiate social agro forestry programmes were thought of a few years ago and this concept has been promoted extensively throughout the country.

(5) Improvement in the fuelwood position through systematic effort will not only facilitate the diversion of nearly 20% of the available manpower from fuelwood gathering to productive farmwork, but also will constitute a substantial feedstock for any energy conversion system in the rural set up for use in agriculture and rural industries.

(6) Though these programmes are initiated well over 20 years ago in the South not much of tangiable results have been achieved for want of systematic approach to the problem with any survey of available land, and scientific data base. Although thousands of acres have been planted by the various agencies, no proper information about the productivity levels or the suitablity of a chosen plant species to the soil or climatic conditions are available. No specific targets in terms of fuelwood productivity has been set except for the extent of plantation area.

(7) Transfer of technology or experience gained elsewhere cannot be effective in undertaking plantation works in a massive scale as each region has got to develop and use the best tree forms and plantation practices that suit the specific agro-climatic conditions of their own.

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OBJECTIVES:

The object of the proposal is to determine the most suitable plant species and their silvicultural parameters maximal woody biomass production under six major categories of agro-climatic conditions of the region viz:

1) Coastal belt (Saline and Saltmarsh)
2) Inland arid Zones
3) Lands with marginal irrigation facilities
4) Rain fed area
5) Intermedrary levels and
6) Reclaimable lands such as water tanks, lakes, river canal bunds.

Productivity data and performance projects of existing plantations sponsored by State agencies will be determined and requisite scientific and operational details will be worked out to improve the productivity per unit area besides formulating "Package" programmes with more suitable plant types for the future plantation efforts for fuelwood in all the six available land types.

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RESULTS EXPECTED:

The on going social agro-forestery programmes under the State support suffer from the following:

(1) Only 2 or 3 genera are extensively used for massive plantation under all agro-climatic conditions based on their extreme hardiness to grow under a variety of conditions.

(2) No experimental approach has been used to elicit any kind of data viz.. the productivity Rotation cycle, Slivicultural practice such as manuring, posticide application, plant density, seeling physiology etc..,

(3) The most hardy species were planted on the pattern of traditional "Subsistance Farming" rather than making any effort to optimizing their yields (Minimal risk approach rather than maximizing the productivity)

The following results are expected out of this study:

(A) At Species Selection Level:

Best suited plant species to varying agro-climatic conditions (Salineacid soils, rainfed, irrigated arid conditions) will be identified with suitable alternatives based on end-use criteria such as fuelwood, fodder or comibation of both.

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(B) At Planatation Level:

(1) Appropriate seed storage and nursary technologies will be developed to cut back on wastage in expenditure at this important step of silvicultural practice.

(2) Suitable methodologies and procedures associated with the establishment and intial growth of woody biomass species will be developed such as:

(a) Shoot/root ratio of the seedlings well optimize their survival after planting

(b) Amount, duration and timing of irrigation needed during the early phases of their establishment in the field

(c) Soil factors, photo synthetic competence of the seedlings, irrigation and post-care methods etc..,

(3) Suitable inter-cropping patterns, plant cropping mixes will be worked out both to safeguard against soil-nutrient depletion as well as to maximize the return from the area.

(4) For each identified species a cost benefit analysis of such as energy input/output budgets for the anticipated range of physical and social conditions will be assessed.

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METHODS OF APPROACH:

Within this broarder perspectives, a series of well defined individual programme will be charted for intensive study. They would include:

1) Mass selection in each of the selected region for the identifying the best adopted woody species and estimation of woody biomass production.
2) Establish seed storage and nursary technology centres for distribution of seeds and seedlings.

This programme will include the study of seedling physiology of the selected species such as the best shoot/root ratio, pre-plantation treatments for lowering their mortality and for shortening the years of rotation cycle, photosynthetic potential, seed dressing with nitrogen fixing bacterial cultures and/or antifungal materials.

3) Collection of data on productivity growth performance soil types coppicing potential, intercropping etc.., from the existing plantations developed by various agencies.
4) Establish new plantations with well developed experimental designs for each plant species for continious monitoring and collection of other data on other species, other than the ones already in use.
5) Determination of selection criteria and woody biomass plantation in the saltmarsh and saline soils of the vast coastal region etc..,

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WOODY BIOMASS PRODUCTION FOR FUELWOOD

Species Selection	Production of Seeds & Seedlings	Plantation		Silviculture practice	Extension
		Existing	New		
1.From local population	1.Storage	Data collection	Experimental design for quick and reliable data	1.Plant density	1.Training of personnel in Data Collection Plantation work Silviculture
2.From exotic ones	2.Germination	Productivity in terms:		2.Water regime	2.Propagation of Woody Biomass concept
3.Growth criteria(fast/slow)	3.Nursary technology	1.Photosynthesis		3.Inter cropping crop-mixes	3.Energy use patterns etc..,
4.Edaphic criteria(soil/climate)	4.Germination physiology for optimizing the survival and productivity	2.Soil types		4.Soil Nutrient statue after and before	
	5.Identification of methods for early assessment of productivity potencial	3.Irriagation regions		5.Plantation date	
				6.Pest control	
				7.Fertilizer	

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Ist Phase:

Mass selection of woody biomass species at various agroclimatic zones based on their natural standing, Colonizing ability and ability to withstand stress conditions.

Porpagation through seed selection and cuttings of the best and the next best species selected from the different zones.

Selection of short rotation woody species for social forestry programme for plantation in and around house-holds with multi-purpose end-use criteria, such as Fuelwood, fodder and cottage-industry.

Experimental layouts in the university complex of selected species to collect data on crop rotation, productivity, crop density, irrigation demands, plantation care and dertilizer demands.

Data collection from selected existing plantations.

II phase:

Seedling Physiology:
a. Under controlled conditions

b. Under simulated field conditions
Shoot/root ratio, Optimization of irrigation reggimes for plantation site performance, Photosynthetic parameters etc.

Development of inter corpping - Plant associations and mixes for Soil nutrient effects.

Development of plantation designs for unse by the Governmental agencies in their new plantation programmes

III Phase:

Data collection on the performance profile of eisting and new plantations- Mortality, growth rates and pest reistance etc.

Feed back information collection from foresters involved in the social forestry programme and other plantati n effeorts.

Assessment of the Secondary benefits from pruned branches, pod collection gums etc.

Soil analysis and metereological data based information analysis

IV Phase:

Cost benefit analysis- Wood chemical/energy analysis and social benefit and acceptance assessment.

Additional trials and extension of plantation

V Phase:

Coppicing potential and coppicing Induction with chemicals and Hormone studies
Porductivity measuremen
Contijued feed back as ments from the field experience
Integrat pest mans nt.
Toxi lysi -.

Item	University contribution	DST contribution	USAID contribution
	Rs.	Rs.	Rs.
Non-recurring			
1) Building space (Field Lab - 2,000 sq.ft) @ 100/- Rs sq ft	-	-	2,00,000
2) Land	50 acres		
and fencing	25,000	-	-
3 Farm machinery and implements	-	-	1,00,000
4) Water facility : Borewell	-	-	10,000
Electric pumps	-	15,000	-
Pipe lines for distributing systems	-	-	20,000
Transport (vehicles)	-	75,000	1,60,000
6) Establishment of seed storage and nursery technology	-	50,000	-
7) General equipment:			
a) Growth chambers	-	-	4,50,000
b) IRGA	25,000	-	-
c) Recording devices, meterological equipments, etc.	-	-	2,00,000
d) Basic analytical equipments, calometers, radiation counters	5,00,000	-	-
e) Light meters, porometers, etc.	-	1,50,000	-
f) Office equipments	-	-	10,000
g) Stand by - Generator	40,000		
Total	5,90,000	2,90,000	14,50,000

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Item	University contribution	DST contribution	USAID contribution
Non-Recurring - per annum	Rs.	Rs.	Rs.
1) Consumables : Chemicals, Pesticides, etc.	—	10,000	20,000
Fertilizers	-	-	10,000
Seeds, seedlings, etc.	-	3,000	8,000
Local transportation	-	10,000	20,000
Maintenance of equipments and machinery	-	15,000	15,000
4) Local travel	-	5,000	10,000
5) International travel	-	7	7
6) Plantation expenses	-	10,000	30,000
7) Electricity and water supply	20,000	-	-
8) Printing and Publications	-	-	5,000
Personnel			
1) Silviculturist (2 posts)	-	18,000	24,000
2) Principal Investigator	30,000	-	-
3) Research Associate (2 posts)	-	15,000	15,000
4) Research Assistant (4 posts)	-	15,000	15,000
5) Secretarial Assistance and stationery, etc.	-	-	15,000
6) Field Assistants (6 posts)	-	-	24,000
7) Farm mechanic (1 post)	-	10,800	-
8) Casual Labour	-	5,000	5,000
Total p.a.	50,000	1,16,800	2,26,000
Non-Recurring for 5 years	2,50,000	5,84,000	10,80,000
Non-Recurring	5,80,000	2,90,000	10,50,000
	8,80,000	10,00,800	21,66,000

Estimation of Village Energy and Woody Bio-mass Requirements

1. Introduction

During the recent past the level of energy consumption has increased considerably with greater demand for non-renewable resouces, whose supply is restricted. Therefore it has become necessary to concentrate on renewable energy resources, especially in the rural economy. In this context, it is proposed to estimate the energy and woody bio-mass requirements in selected villages of Madurai District.

2. Objectives:

(i) To study the various forms of energy used in the villages.

(ii) To assess the requirements and supplies of fuel food and bio-mass.

(iii) To determine the pattern of energy consumption.

(iv) To determine the pattern of supply of energy .

(v) To estimate the demand for and supply of fuel wood and bio-mass for the immediate future (5 years).

3. Data and Methodology:

The villages of Madurai district may be classified into one of three broad categories, namely, (i) agro-urban villages (ii) agrarian villages and (iii) backward villages. For the present study three villages, one for each of the above categories is selected and they are the following:

(i) Sholavandan village - this is an agro - urban village, situated at a distance of 18 kms North of Madurai City, with about 2000 household and 10,000 population.

(ii) Chatrapatti Village - This is purely an agrarian village, situated at a distance of about 40 kms., South of Madurai City, with about 200 households and 1000 population.

(iii) Vadakkampati Village - This is a backward village, situated at a distance of 20 kms., West of Madurai city, with about 400 households and 2000 population.

For the present study, it is proposed to cover 1000 households as given below:

(i) Sholavandan - 400 households to be chosen at random

(ii) Chatrapatti - All the households 200 in number

(iii) Vadakkampatti- All the households 400 in number

The required data has to be collected both from the chosen households and village officers. For collecting data from households a detailed schedule will be prepared and administered at the household level by investigators. The schedule will include the following aspects:

a. Household and demographic particulars

b. Socio-economic data which include those on income, assets and land holdings, education, caste, religion, consumption, etc.

c. Energy requirements which will include data on quantities and values of the following:

i) agricultural residue (ii) cow dung (iii) fuel wood (iv) charcoal (v) kerosene, etc.

To assess the availability of energy resources in the respective village areas, it is also necessary to know the geography and the ecology of the villages and their surroundings. Data regarding these have to be collected from the village officers and taluk offices.

The study of consumption pattern of different energy resources will involve the use of multiple linear regression. The variation in the patterns of consumption between the three villages can be studied through the estimated regression equations. In the demand estimation, the per capita requirement for each type of energy resource has to be worked out. The estimation of demand in future requires the projection of population, and per capita energy requirements. For this linear equations may be used.

4. Budget

4.1. Personnel

Statisticians ..... 2 Rs.750 p.m. each

Investigators ..... 7 Rs.600 p.m. each

Typist ..... 1 Rs.400 p.m. each

4.2. Expenditure year-wise: (in Rupees)

Sr. No.	Item	I year	II year	III year	IV year
1.	Staff	73,200	73,200	73,200	73,200
2.	Stationery & Printing	4,500	2,500	2,500	2,500
3.	Travel	3,000	3,000	3,000	3,000
4.	Computation	1,500	1,500	1,500	1,500
5.	Miscellaneous	500	500	500	500
	Total	82,700	80,700	80,7[illegible]	[illegible],700

Total estimate for four years Rs.3,24,800/-

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Director: (Honorary, with no remuneration)

Dr. John D.K. Sundarsingh
Professor and Head
Department of Economics
Madurai Kamaraj University
Madurai-625021

Assistant Directors: Dr. T. Valuthi Varagunasingh
Reader

Dr. R.E. Benjamin
Lecturer

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Estimation of village energy and woody biomass requirements

In our rural society various forms of energy used includes wood, cow-dung, kerosene etc according to their availability. The consumption of energy is also according to some social ~~values~~ variables namely the level of literacy, urban contact, the type of communication in the village etc. So the social constraints of the village determine the type of energy used by them. The traditional and indigenous forms of energy is used even today by our villagers and even the mode of collection of energy is same as older days.

Wood is the principal source of energy in our rural areas because of availability and lesser cost. In Tamil Nadu domestic energy is coming largely from wood, both in the urban and rural areas. The rural folk depends on wood for domestic purpose as well as for commercial purposees. The villagers spent a good amount of time in collecting the energy and in the traditional joint family a section of the members will be entitled to do this job.

As the Indian society is not much changed especially the village side the traditional way of consumption of energy is still in practice. As long as the value system of the villagers remain traditional they will be reluctant to adopt new forms of energy resourses.

Energy is used not only for the domestic purpose but also for the agricultural growth and in supporting specific kinds od industries and services that are essential for agricultural production. Thus broadly village energy goes in three different ways namely domestic, agricultural and industrial. The demand for energy is increasing day by day due to modernisation but the rate of supply of energy is not catching up to that rate as the resouses of energy supply is very limited in the rural areas.

Now the question arises. If the villagers are encouraged to produce to some sort of new energy on their own, will they accepted it? Will they change the traditional values and adopt new values as for as energy is concerned? Will they co-operate to the alien influence?

Focuseing attention on the above points the main objectives ethe study will be the following:

1. A socio cultural survey to understand the social and the cultural background of the villagers.

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2. To study the present pattern of energy consumption.
3. To study the traditional values and their relationship to the consumption of energy.
4. To study the woody biomass requirements for the next five years.
5. To s tudy the attitude of people towards the modernisation of energy.
6. To understand the role of different agencies in bringing changes in the use of new sources of energy among the villagers.
7. To study the impact of woody biomass in the life of villagers.

and

8. To find out the changing village structure.

Methodology.

Sampling (See appendix 1.)

The villages of the Districts will be selected after a pilot survey and will be stratrified on the basis of the availability of the energy resources along with the rate of development(Multi-Phase Sampling) After clustering the villages a sample will be selected for detailed study(Stratified Cluster Sampling). Census method will be used for house-hold survey.

Tools and Techniques.

Interview-Schedule, Case study, Participant observation, Depth interview.

Duration.

Stage 1.	to	Stage 3.	18 months.
Stage 3	to	Stage 4.	20 months.
Stage 4	to	Stage 5	22 months.

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PERSONNEL

Directors(Honorary)	1) Dr.R.Venkataratnam, Professor and Head, Department of Sociology, Madurai Kamaraj University, Madurai - 625021.	
Co-Director(Honorary)	2) Dr.(Mrs)L.Thara Bhai, Reader, Department of Sociology, Madurai Kamaraj University, Madurai-625021.	
Research Officer (Rs 1200-50-1300-60-1900)	one 21252.00X5.	106160.00
Research Associates (Rs700-40-1100-50-1600)	Four 18228.00 X4X5.	364560.00
Research Assistants (Rs 480-20-540-25-790)	Eight	276400.00
Research Fellows (Rs600 X 4 X 12 X 5)	Four	144000.00
Statistician (Rs 700-40-1100-50-1600)	One	18228.00
Field Assistants (Rs 250-8-330-10-400)	Four	78000.00
Clerk (Rs360-20-540-25-640)	One	53550.00
Attender (Rs300-10-360-15-450)	One	38375.00
Driver (Rs355-10-405-15-480-20-620)	One	35000.00
		1114273.00

OTHER EXPENDITURE

Stationary (Rs10000.00X5)	50000.00
Office equipments	50000.00
Furniture	100000.00
Books & Periodicals	20000.00
T.A. for the personnel (Rs10000.00 X 5)	50000.00
Vechicle(Van)	100000.00
Cycle	500.00
Maintainence charges	5000 .00
Miscellaneous	18775.00
	394275.00
Grand total	1508548.00

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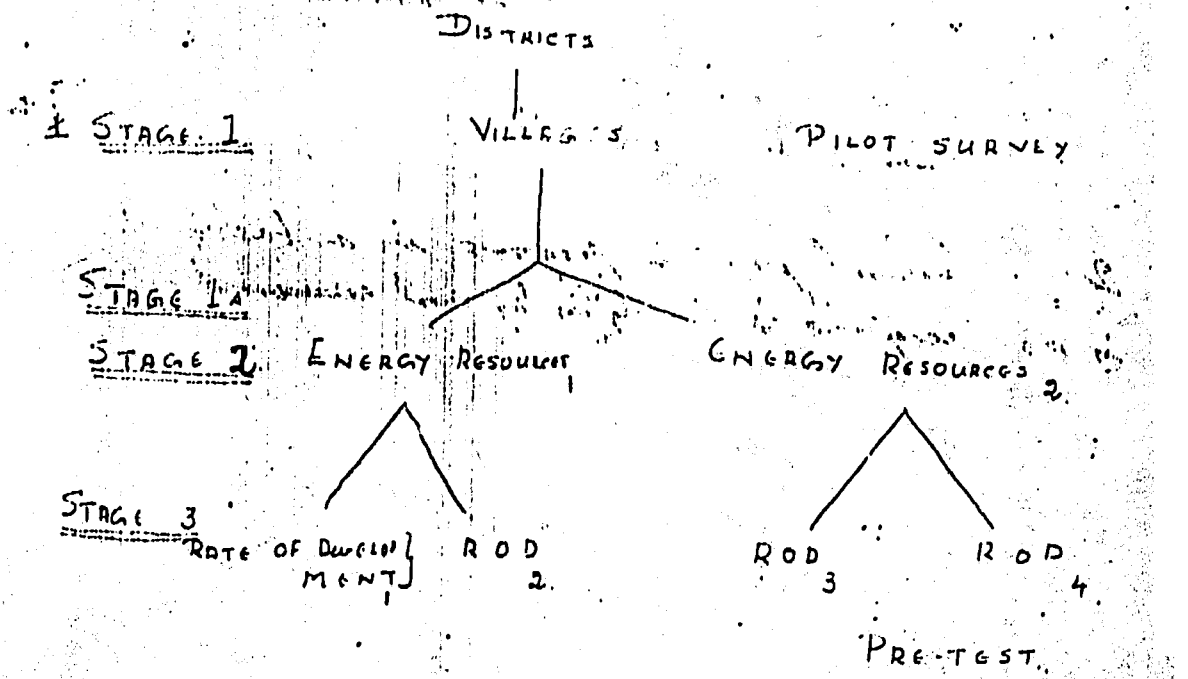
Appendix 1

METHODOLOGY

SELECTION OF THE SAMPLE.



SOCIO-ECONOMIC SURVEY 1

STAGE 4 ESTIMATION OF THE IMPACT OF NEW SOURCE OF ENERGY AMONG THE VILLAGES

SOCIO ECONOMIC SURVEY 2

STAGE 5 STUDY OF CHANGING VILLAGE STRUCTURE

APPENDIX E. Techincial Expertise: Suggested Organizations and Individuals

Organizations

UNIFOR
CID
SECID

Individuals

Biomass Production Specialist
- Dr. Al Ek, School of Forestry, University of Minnesota
- Dr. Harold Burkhardt, College of Natural Resources, VPI
- Dr. Peter Ffolliott, Forest and Natural Resources, Univ. of Arizona
- Dr. Charles Hatch, College of FWR, University of Idaho

Information Scientist
- Dr. Ron Force, Reference Librarian, Washington State Univ

Reforestation Specialist
- Dr. Brian Cleary, School of Forestry, Oregon State Univ.
- Dr. David Wenny, College of FWR, University of Idaho

Tree and Shrub Improvement Specialist
- Dr. Bill Libby, School of Natural Resources, Univ. of Calif.-Berkeley
- Dr. Lauren Fins, Inland Empire Tree Improvement Cooperative, University of Idaho

Forest Insect and Disease Specialist
- Dr. Karel Stoszek, College of FWR, University of Idaho
- Dr. Ron Stark, WSBW Project Director, Pacific Northwest Forest & Range Expt. Sta., USDA F.S.

Resource Economist
- Dr. Hans Gregerson, School of Forestry, Univ. of Minnesota
- Dr. Robert Gregory, School of Natural Resources, Univ. of Michigan
- Dr. Lee Medema, College of FWR, University of Idaho

Rural Sociologist
- Dr. Gary Machlis, Cooperative Park Studies Unit, Univ. of Idaho

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APPENDIX F. Organizations and Individuals Visited

New Dehli

- Government of India, Department of Science and Technology
  - Mr. M. Dayal, Energy Advisor
  - Dr. J. Dhar, Principal Scientific Officer
- Inspector General of Forests
  - Mr. N. D. Bachkheti

Dehra Dun

- Forest Research Institute and College
  - Dr. R. N. Kaul, Director
  - Dr. M. M. Pant, Dean
  - Mr. O. N. Kaul
  - Dr. K. Gurumurti
  - Mr. S. P. Singh

Lucknow

- National Botanical Research Institute
  - Dr. T. N. Khoshoo, Director
  - Dr. J. K. Maheshwari
  - Dr. S. D. Khanduja
  - Dr. M. N. Gupta
  - Dr. P. D. Dogra
  - Dr. H. C. Chaturvedi
  - Mr. V. Chandra
  - Mr. P. N. Misra
  - Mr. B. R. Juneja
- Research and Development Circle, U.P.
  - Mr. A. N. Chaturvedi, Conservator of Forests

Madurai

- Madurai-Kamaraj University
  - Dr. A. Gnanam, Biomass Centre Director
  - Dr. S. Krishnaswamy
  - Dr. John D. K. Sundarsingh
  - Dr. (Mrs.) L. Thara Bhai
- State Social Forestry Department
  - Mr. S. Sankaramurthy, Conservator of Forests
  - Mr. James Joseph, Conservator of Forests
  - Dr. S. Kondas, Conservator of Forests
- Agriculture University
  - Dean of College
- Government Officials
  - Collector

APPENDIX G. Implementation Plan

1. Scheduling and Budgeting

a. 6-month Start-up Period
   1. Recruit staff (US/Indo)
   2. Preliminary work plans are developed
   3. Intensify the literature review effort
   4. Order equipment not dependent on project design

b. Project Work Plan Development and Approval (6-month period)
   1. U.S. consultants are in place at the Biomass Centres
   2. Indian staff is hired and in place
   3. Project development tour is completed
   4. Formal work plans are prepared per schedule

c. Project Execution and Reporting (30-month period)
   1. Research program is carried out
   2. Annual workshops are held and progress reports are prepared and submitted to GOI/USAID
   3. Research products are distributed to social forestry organizations and the scientific community

d. Project Budgeting
   1. Funding will be in two tranches. The initial traunch is to cover funds for the first 12 months of the project (a and b). The second trauch is to begin after the approval of the formal work plans.

   2. Annual expenditures

	Year 1	2	3	4	5
	Rs (Lakhs)				
AID	51	51	51	0	0
GOI	19	19	19	33	33
Total	70	70	70	33	33

Total project Cost = Rs 276 Lakh
$ 3.1 million
($1.7 million U.S. and $1.4 million GOI)

APPENDIX G. Continued

2. Covenants and Conditions Precedent

a. Personnel
   1. Must have personnel ceiling for permanent full-time scientist positions and support personnel (CP)

b. Performance
   1. Formal work plans are prepared for GOI/USAID approval by (date) (Cov)
   2. Project development tour and annual workshops and progress reports per schedule (Cov)
   3. Research products disseminated (Cov)

c. Monitoring and Review
   1. U.S. consultant assessment reports at the end of each assignment
   2. Annual workshop and progress report documentation (Cov)

APPENDIX H. Technicial Expertise: Scope of Work

Biomass Production Specialist

1. Work directly with the Biomass Centre Directors in coordinating woody biomass production research program activities between the two biomass centers, forestry organizations and agricultural universities

2. Assist Biomass Centre Directors in focusing the direction of the woody biomass production research program on critical energy and social forestry plantation needs.

3. Work directly with U.S. specialists in coordinating individual research components into the woody biomass production research program

4. Formulate and conduct a biomass plantation assessment tour in collaboration with the Biomass Centre Directors, forestry organization and agricultural universities

5. Provide assistance with and identify training needed in methodologies associated with the quantification of research results

6. Prepare written reports 1) identifying individuals needing quantitativ training, 2) describing the specific type and length of training needed, and 3) assessing, upon complètion, the impact of the training on the program.

7. Prepare written reports 1) evaluating the progress of the woody biomass production program, 2) defining problems and constraints affecting woody biomass production program results, and 3) recommending needed woody biomass production program modifications

Information Scientist

1. Formulate a computer-compatible system for indexing biomass literature that is consistent with NBRI's needs and compatible with its current information services and library

2. Determine the type of training needed in computerized information management systems

3. Prepare a written report 1) describing a computer-compatible system for indexing biomass literature, 2) identifying individuals needing computerized information management systems training, and 3) describing the specific type and length of training needed

APPENDIX H. Continued

Reforestation Specialist

1. Tour selected forest nursury production facilities and biomass plantations and identify critical factors and practices affecting plant survival

2. Work directly with the Biomass Production Specialist to identify ways of coordinating factors affecting plantation establishment into the woody biomass production research program

3. Formulate a research problem analysis that addresses nursury management and plantation survival needs

4. Determine the type of training needed by research scientists working in the nursury management and plantation survival research program

5. Prepare a written report 1) describing the research problem analysis, 2) identifying individuals needing nursury management and plantation survival research training, 3) describing the specific type and length of training needed, and 4) assessing the progress of the plantation establishment relationships component of the woody biomass research program

Tree and Shrub Improvement Specialist

1. Tour selected biomass plantations and natural forests on marginal and submarginal lands and identify factors which may suggest apparent genetic differences in woody plants

2. Formulate a genetic tree and shrub improvement program for woody plant plantations

3. Determine the type of training needed by research seientists working in the genetics research program

4. Prepare a written report 1) describing the genetic tree and shrub improvement program, 2) identifying individuals needing genetics training, 3) describing the specific type and length of training needed, and 4) assessing the progress of the seed procurement and maintainence component of the woody biomass research program

APPENDIX H. Continued

Forest Insect and Disease Specialist

1. Tour selected biomass plantations and natural forests on marginal and submarginal lands, identify apparent animal, insect and disease damage, and assess factors that may result in future animal, insect and disease problems

2. Work directly with the Biomass Production Specialist to identify ways of coordinating animal, insect and disease factors affecting biomass plantation production into the research program

3. Formulate an Integrated Pest Management research program for woody biomass plantations

4. Determine the type of training needed by research seientists working in pest management research programs

5. Prepare a written report 1) describing the integrated pest management research program, 2) identifying individuals needing pest management research training, 3) describing the specific type and length of training needed, and 4) assessing the progress of the insects and disease impacts component of the woody biomass research program

Resource Economist

1. Identify factors which influence biomass investments and supply/demand relationships

2. Work directly with the Biomass Production Specialist and the Rural Sociologist to coordinate economic and social factors affecting biomass plantation production into the research program

3. Formulate a research problem analysis that addresses biomass plantation investment needs both in terms of economic and social factors.

4. Determine the type of training needed by research scientists working in the resource economics research program

5. Prepare a written report 1) describing the research problem analysis, 2) identifying individuals needing resource economics training, 3) describing the specific type and length of training needed, and 4) assessing the progress of the economic and social assessments conponent of the woody biomass research program

APPENDIX H. Continued

Rural Sociologist

1. Identify factors which influence a village's consumption habits, goals and value systems

2.. Work directly with the Biomass Production Specialist and the Resource Economist to coordinate economic and social factors affecting biomass plantation production into the research program

3. Formulate a research problem analysis focused at social factors influencing biomass plantation production and consumption

4. Determine the type of training needed by research scientists working in the rural sociology research program

5. Prepare a written report 1) describing the research problem analysis, 2) identifying individuals needing rural sociology training, 3) describing the specific type and length of training needed, and 4) assessing the progress of the economic and social assessment component of the woody biomass research program

PROJECT NUMBER:

PROCESS:	ACTION:	DATES:	INITIALS:
CATALOGUE	✓	2/25/82	DV
ABSTRACT			
FICHE			

COMMENTS:

DC/DIU