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BIOCUT: A Microcomputer Based Economic Evaluation Model for Wood Energy Plantations

Model Description and Users Guide

S. Das
R. D. Perlack
W. F. Barron
P. Kroll

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S. Das
R. D. Perlack
W. F. Barron
Oak Ridge National Laboratory
Energy and Economic Analysis Section
Energy Division

and

P. Kroll
The Johns Hopkins University
Department of Geography and Environmental Engineering

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ABSTRACT

Increasing demands for fuelwood and wood energy feedstocks has placed severe pressures on forest resources in many developed and developing countries. Energy plantations are one concept under investigation for increasing the size and productivity of the wood resource base. The BIOCUT model described in this report is designed to facilitate the systematic investigation of a wide range of potential wood energy plantation applications and to provide reasonable estimates of net returns and minimum required product prices. There are five user-specified sets of input data in the BIOCUT model: (1) plantation scenario activities, (2) economic parameters, (3) plantation establishment activities, (4) operation and maintenance activities, and (5) harvesting, processing, and transportation. The BIOCUT model reports yearly information on the economic status of the plantation, cash-flows, and the age distribution of the standing biomass. The model calculates the net present value, the discounted average cost, internal rate of return, and benefit-cost ratio. Because of the high degree of uncertainty surrounding important biological and economic relationships, the model facilitates extended sensitivity analysis. Further, if upper and lower bounds can be defined for each important variable, the model can also be used to conduct a risk analysis. The risk analysis uses the parameters of the probability distribution rather than the distribution itself to construct the mean and variance of the net present value. With this information probability statements can be made about achieving various levels of net present value. The BIOCUT model is coded in PASCAL and operates on IBM personal computers and compatibles with 256K memory using the DOS 2.0 operating system.

1. INTRODUCTION

Increasing demands for fuelwood and wood energy feedstocks has placed severe pressures on forest resources in many developed and developing countries. Energy plantations are one approach that is receiving considerable attention for significantly increasing the size and productivity of the wood resource base (Ranney et al. 1984). Fast-growing trees, short-rotation (3 to 10 years), dense tree spacings (1 to 6 square meters per tree, extensive weed control, (and in some instances application of fertilizers to increase productivity and to replenish soil nutrients), characterize this wood production system. The concept generally involves the use of hardwood trees that coppice (i.e., resprout) after cutting to regenerate succeeding biomass crops at little or no additional costs.

Potential and existing applications of this energy concept include intensively managed plantation systems in moist temperate regions, systems with low levels of management in arid and semi-arid zones, and high productivity systems in tropical and semi-tropical areas. In each case the central economic evaluation issues are the same. First, how do the economics change from one wood energy plantation site to another. Second, which species and management alternatives offer the greatest net return per hectare in a specific setting. And third, in which areas of the plantation design do existing uncertainties about biological and economic relationships lead to the greatest economic risks.

To help analyze such questions, a cost simulation model (FIRSTCUT) was developed (Barron et al., 1983). The FIRSTCUT model was designed to facilitate the systematic investigation of a wide range of potential

wood energy plantation applications and to provide reasonable estimates of net returns and minimum required output prices. The model has been used to conduct economic evaluations of short-rotation intensive culture (SRIC) for the Short Rotation Woody Crops Program (e. g., Ranney et al., 1984). A major limitation on the use of FIRSTCUT model is that it operates on a mainframe computer. To take advantage of the flexibility and convenience of microcomputers and to overcome the inherent limitations of the mainframe based model, the FIRSTCUT computer code was reprogrammed and modified. The microcomputer based model, BIOCUT, retains many of the essential features of the mainframe model, while being transferrable and field analysis oriented--a major advantage in conducting on-site economic evaluations of wood energy plantations.

BIOCUT is intended for preliminary economic assessments in which the principal analytical objectives are: (1) to identify the most promising plantation designs (e.g., rotation ages, spacings, etc.) and silvicultural management alternatives, (2) to indicate the nature of potential tradeoffs in system design and operation, and (3) to facilitate extended sensitivity and risk analyses.

In BIOCUT the biomass plantation is modeled on the basis of a large number of user specified activities. These user specified activity values are defined so as to provide the capability to track separately the implications of changes in major production cost components, while keeping the description of each activity general enough to apply to a wide range of plantation designs. For example, through appropriate specification of costs, the model is equally applicable to a highly capital intensive operation in the United States and to a much more labor intensive plantation in a developing country.

The user specified activities in BIOCUT are grouped into five general categories: (1) plantation scenario activities, (2) economic parameters, (3) plantation establishment activities, (4) operation and maintenance activities, and (5) harvesting, processing, and transportation. The list of user specified inputs is relatively large, but this feature makes the program highly flexible and easy to use. Models which internally specify many important inputs have more limited applicability, and are likely to be too inflexible for preliminary resource evaluations where the implications of important uncertainties need to be examined. BIOCUT provides a convenient framework for structuring data requirements and performs calculations which would be time consuming if done external to the model.

The model can be used to analyze the economics of woody biomass production in two modes. The first mode assumes that the plantation is designed to provide a continuous yearly flow of product once the first harvest is made. The model accomplishes this by planting only a fraction of the total plantation in each of the establishment years. The fraction is dependent upon the user specified rotation age. For example, if a four year rotation age is specified then one fourth of the plantation is planted in each of the first four years. The second production mode does not assume this continuous synchronized forest but establishes the entire plantation at the outset. The BIOCUT model calculates four summary economic evaluation criteria--the net present value, the discounted average cost, the internal rate of return, and the benefit-cost ratio.

In economic evaluations of wood energy plantations a high degree of uncertainty often exists with regard to important biological and

economic relationships. The BIOCUT model is therefore specifically structured to expedite sensitivity analysis, permitting the detailed examination of the effects of changes in user specified activities on summary economic criteria. If the user is able to specify or describe the range of uncertainty for model cost and revenue activities then the model can be used to carry out risk analyses.

As previously noted, BIOCUT is a preliminary economic assessment model and not a highly detailed, financial cash-flow accounting program. Generally, for preliminary assessments the important economic question is whether the net present value is positive, accounting for economic and biological risk. Questions of tax and subsidy policy to alter the incidence of financial risk and returns to private investors are more relevant in later stages of evaluation when uncertainty has been reduced. In BIOCUT there is no consideration of taxes.

The next section of this report outlines in more detail each of the individual user specified options in the program. The economic evaluation criteria and the risk analysis option is described in Section three. Section four discusses the operation of the BIOCUT program. Some conclusions about the model are provided in the last section. The Appendices contain a listing of the computer code and a sample of the computer output.

2.0 USER-SPECIFIED INPUT OPTIONS

The user specified inputs are grouped into five categories: (1) plantation scenario activities, (2) financial/economic parameters, (3) plantation establishment activities, (4) operation and maintenance activities, and (5) harvesting, processing, and transportation.

There are no default values used in the model. Further, the model does not distinguish between real or nominal dollars. It is the responsibility of the user to specify input values in either real or nominal terms. The real dollar approach considers the effects of the overall inflation rate in the economy. Since the objective of the model is economic, this approach is generally preferred because it allows the direct comparison of costs and revenues from one year to another without the need to compute the relative purchasing power of a dollar in each year.

GROUP 1 - PLANTATION SCENARIO ACTIVITIES

Options:

1.01 Specify the total land area of the plantation.

Permissible Value:
Any positive number representing the area of the plantation in hectares. The area specified here represents the total land area required for system operation, i.e., including that for roads, buildings, etc. The value of the input in this option reflects the ultimate size of the plantation.

1.02 Specify the percentage of the total land area devoted to biomass.

Permissible Value:
A number between 1 and 100 representing the percentage of the total area of the plantation which will actually be planted. This value should represent the user's best estimate of the realistic upper limit on the proportion of the total land area in a given location which can actually be planted. This value may be very high (near 100%) for plantations in flat regions of relatively homogeneous soil conditions. In hilly regions

or those with relatively heterogeneous soil the value should probably be much lower.

1.03 Is the land purchased or leased?

Permissible Value:
P (purchase) or L (lease)

If Purchased:
Specify the cost per hectare.
Specify the resale value per hectare.

Permissible Value:
Any number representing the average cost of each hectare purchased or sold.

Indicate the land acquisition schedule.

Permissible Value:
Any number between 0 and 100 representing the percentage of the total plantation area (1.01) acquired in each establishment year.

If leased:
Specify the initial rental cost per hectare.

Permissible Value:
Any number representing the cost of a hectare of land the first year it is leased.

Specify the cost escalation factor as a percentage change in annual rent.

Permissible Value:
Any number (positive, negative, or zero) representing the annual percentage change in lease cost.

1.04 Specify the plantation harvesting age.

Permissible Value:
Any whole number between 0 and 10.

1.05 Specify the projected biomass yield for the seedling and coppice rotation in megagrams per hectare.

Permissible Value:
Any number representing the yield at harvest for the seedling (first-rotation) and coppice rotations.

1.06 Specify the energy content of the biomass in gigajoules per megagram.

Permissible Value.
Any positive number.

1.07 Specify the number of coppice harvests.

Permissible Value:
Any positive integer representing the number of coppice harvests before reestablishment of the plantation becomes necessary. A non-coppicing species may be modeled by inputting a zero value.

GROUP 2 - FINANCIAL/ECONOMIC PARAMETERS

2.01 Specify the last year in the evaluation period.

Permissible Value.
Any positive integer between 1 and 35.

2.02 Specify the annual discount rate.

Permissible Value:
Any positive number. The discount rate is the conversion factor that determines the "present (equivalent) value" of future costs and revenues.

2.03 Specify the initial expected selling price for projected outputs in dollars per dry megagram.

Permissible Value:
Any number representing the expected selling price per dry megagram (dry tonne equivalent) of production. The model assumes that this value is the initial price at harvest.

Specify the annual percentage change in selling price.

Permissible Value:
Any number (positive, zero, or negative) reflecting the annual percentage change (compounded) in the selling price of plantation outputs over the life of the evaluation period.

GROUP 3 - PLANTATION ESTABLISHMENT ACTIVITIES

3.01 Specify the infrastructure development costs.

Permissible Value:
Any number representing this cost. This option accounts for the need to set up the physical support system for plantation operation (e.g., roads, office space, electrical systems, trenching, and other landscaping to reduce erosion). It is a one-time cost incurred in the first year of project activity (year 1).

3.02 Specify the site preparation cost per hectare.

Permissible Value:

Any number representing the cost of preparing a hectare for first-time planting. Site preparation typically includes the costs of land clearing, raking, burning, and grading. The costs of mower conditioners, offset discs, disc harrows, site preparation labor, and operation and maintenance of the site preparation equipment should be specified here. The value specified here should include the estimated costs for clearing land of previous vegetation and possible landscaping activities minus any proceeds from the sale of standing timber. Note: Preplanting weed control after land clearing is specified separately (Option 3.04).

Specify the site preparation cost for replanted areas.

Permissible Value:

Any number representing the cost of preparing a hectare of land for replanting of new seedlings or cuttings. For coppicing species this cost is incurred only after the final coppice harvest.

3.03 Specify the seedling or cutting cost per hectare.

Permissible Value:

Any number representing the cost per hectare for seedlings or cuttings. This value is dependent on the assumed spacing or planting density of the biomass plantation.

3.04 Specify the cost of preplanting weed control per hectare.

Permissible Value:

Any number representing the cost per hectare of preplant weed control. This cost is only applicable at the time of planting. Weed control costs occuring after planting are accounted for in Option 4.03.

3.05 Specify the planting costs per hectare.

Permissible Value:

Any number representing the cost of planting the seedlings or cuttings per hectare.

GROUP 4 - OPERATION AND MAINTENANCE ACTIVITIES

4.01 Specify the normal managerial costs per hectare during a growing year.

Permissible Value:
Any number representing the cost of management efforts. This cost consists of management salaries, field foreman salaries, overhead, materials, and any other ongoing related expenses.

4.02 Specify whether fertilizer will be applied.

Permissible Value:
Y (yes) or N (no)

If yes.
Specify the type of fertilizer applied (N,P,K):
Specify the amount in kilograms per hectare.
Specify the cost per hectare.

4.03 Specify the type of post establishment weed control.

Permissible Value:
A single number of suboption choice.

If mechanical:
Specify the labor cost per hectare.
Specify the materials cost per hectare.

Permissible Value:
Any number representing the labor and equipment rental costs per hectare for each seedling and coppice growing year.

If chemical:
Specify the application cost per hectare.
Specify the amount applied.
Specify the costs of herbicides.

Permissible Value:
Any number representing the amount of herbicides applied and the costs of herbicides and application for each seedling and coppice growing year.

If both:
Respond as above.

4.04 Specify the type of post establishment pest control.

Permissible Value:
A single number for suboption choice.

If mechanical:
Specify the labor cost per hectare.
Specify the materials cost per hectare.

Permissible Value:
Any number representing the labor and equipment rental costs per hectare for each seedling and coppice growing year.

If chemical:
Specify the application cost per hectare.
Specify the amount applied.
Specify the costs of pesticides.

Permissible Value:
Any number representing the amount of pesticides applied and the costs of pesticides and application for each seedling and coppice growing year.

If both:
Respond as above.

4.05 Specify the type and costs of any special ongoing environmental protection activities.

Permissible Value:
Any description of the type of activity (e.g. trenching) and the annual cost of these activities.

4.06 Specify the additional cost per hectare for recurring activities not reflected elsewhere in Group 4:

Permissible Value:
Any number representing the annual cost in dollars per hectare for activities not covered in the above Group 4 Options.

GROUP 5 - HARVESTING, TRANSPORTATION, AND PROCESSING.

5.01 Specify the harvesting cost per hectare:

Permissible Value:
Any number representing the cost per hectare of this activity.

5.02 Specify the annual cost per megagram for transporting the harvested biomass to the conversion site:

Permissible Value:
Any number representing the cost per megagram for transportation..

5.03 Specify the annual cost per megagram for preparation of the biomass material.

Permissible Value:
Any number representing the cost per megagram of preparing the biomass for conversion (e.g. drying).

3.0 ECONOMIC EVALUATION CRITERIA AND THE RISK ANALYSIS OPTION

3.1 The BIOCUT model calculates four summary economic evaluation criteria -- the net present value, the discounted average cost, the internal rate of return, and the benefit-cost ratio. These criteria are summarized in Table 3.1. The net present value is used to define economic efficiency for the biomass plantation. The internal rate of return and benefit-cost ratio are provided as alternative evaluation criteria to the net present value. The discounted average cost is the minimum selling price required for the energy plantation to be viable over its economic life. While there are no specific optimization routines in the model, the user may readily optimize certain aspects (e.g., determining an optimal rotation age) of the plantation design by using the model in an iterative context and choosing the particular scenario that maximizes the net present value.

3.2 RISK ANALYSIS

In economic evaluations of wood energy plantations there is often a high degree of uncertainty surrounding important biological and economic relationships. The BIOCUT model is therefore specifically structured to expedite sensitivity analysis, permitting the detailed examination of the effects of changes in user specified activities on the net present value. If the user is able to specify or describe the range of uncertainty for model cost activities and revenue then the model can be used to carry out an expedient risk analysis. This is accomplished in BIOCUT using the parameter method (Davidson and Cooper, 1976).

Table 3.1 Economic evaluation criteria

Net Present Value

$$NPV = \sum_{t=0}^{t \leqslant 35} (P\ Q_t - C_t)\ (1+d)^{-t}$$

Discounted Average Cost

$$DAC = \sum_{t=0}^{T \leqslant 35} C_t\ (1+d)^{-t}\ /\ Q_t\ (1+d)^{-t}$$

Internal Rate of Return

$$\sum_{t=o}^{t \leqslant 35} (PQ_t - C_t)(1 + IRR)^{-t} = 0$$

Benefit - Cost Ratio

$$B/C = \sum_{t=0}^{T \leqslant 35} PQ_t\ /\ C_t$$

Where

d = discount rate

P = selling price

C_t = costs occurring in year t

Q_t = quantity harvested in year t

t = any year in the evaluation period

T = final year in the evaluation period, Tmax = 35.

The risk analysis computational procedure in the model is relatively straightforward. It relies on the parameters (mean and variance) of each of the cost and revenue activities probability distribution. The model requires that the user specify a low (a value such that there is only a 10% chance of a lower value) and a high value (a value such that there is only a 10% chance of a higher value) for each uncertain activity. With the individual means and variances for each uncertain activity, a mean and variance can be calculated for the net present value. The mean and variance for each activity is calculated as: $x = 1/4\ (L + 2M + H)$ and $s = (H - L)/2.65$, respectively. These equations provide an 80% interval estimate and are accurate for most distributions that exhibit central tendency (Davidson and Cooper, 1976 and Moder and Rogers, 1968). If the Central Limit Theorem is invoked then the user can make probability statements about the net present value.

4.0 BIOCUT PROGRAM OPERATION

The BIOCUT model is coded in PASCAL and operates on IBM personal computers and compatibles having 256k memory using the DOS 2.0 operating system. To operate the model the user must first type 'BIOCUT' after booting the system. Once BIOCUT is accessed all further responses must be in capitals. The user may wish to press 'caps lock' at this point. The model will then ask whether help is desired. Typing 'HELP' will list the program operating commands, which are summarized in Table 4.1.

Following the prompt 'Option?' the user can specify a word operating command (Table 4.1) or a number of the form #.## (where # is any integer). The command 'GET' can be used to retrieve a previously specified basecase scenario file. (A DOS file specification consists of any combination of up to eight alphanumeric characters followed by a period and up to three additional alphanumeric characters.) After retrieving a file the user may elect to use the 'LIST' command to examine the parameter values for the five groups of options. Responding with #.## allows the user to change that particular parameter value. The 'SAVE' command can be used to store a newly created scenario.

The 'RUN' command will execute the current scenario. The program responds with, 'Is this noncontinuous production?' A 'NO' response will indicate continuous production and the program will compute the summary economic criteria based on the establishment of a rotation age fraction of the plantation. For example, if a four-year rotation age is specified, the program will plant one-fourth of the total plantable area

Table 4.1 BIOCUT program operating commands

HELP	- Provides a summary list of options.
SAVE	- Saves the current scenario as a basecase file.
RUN	- Executes the currently specified file.
GET	- Retrieves an existing basecase scenario file.
LIST	- Lists the current scenario parameter values.
TITLE	- Labels the current scenario file.
STOP	- Ends execution of the program.
RISK	- Calls the risk analysis option.
OUTPUT	- Opens a file to receive the current listing of scenario parameter values and execution output.

BIOCUT program modules are described in Appendix A.

in each of the first four years of plantation operation. A 'YES' response denotes noncontinuous production. Here, the program will compute the summary economic criteria on the basis of establishing the entire plantable land area in the first year. Responses to the next two program queries will indicate the degree of detail desired in the program output.

If a user selects an option that has suboptions (e.g., option 4.03, post-establishment weed control) the user must go through all prompts before returning to the option request level. By holding down the control key (CTRL) and pressing the C key once, the user can exit from the programs.

5.0 SUMMARY

This report has described a microcomputer model for evaluating the economics of wood energy plantations and the motivation behind its development. The model was designed for preliminary energy assessments in which the basic economic question is whether and under what conditions wood energy plantations can provide feedstocks at acceptable costs. BIOCUT is not designed, nor is it suitable, for detailed financial analyses. In general, such analyses are only appropriate after reliable information exists on the most efficient plantation design, on the costs and returns to factors of production, and on the probability distribution of uncertain or inherently variable cost and output parameters. The BIOCUT modeling effort involved difficult choices between flexibility of application and incorporation of detail. Here, flexibility and ease of use were considered the more important attributes of a microcomputer model. The model was designed so that all input requirements are the responsibility of the user. The high flexibility of BIOCUT thus places considerable responsibility on the user, since he must insure that inputs are reasonable in the light of available data and that input values are internally consistent with each other.

REFERENCES

Barron, W. F., R. D. Perlack, P. Kroll, J. Cushman, and J. Ranney, FIRSTCUT: Preliminary Model for Short-Rotation Intensive Silviculture, Oak Ridge National Laboratory, ORNL/TM-8566, November 1983.

Davidson, L. B. and D. O. Cooper, "A Simple Way of Developing a Probability Distribution for Net Present Value," Journal of Petroleum Technology, September 1976.

Moder, J. J. and E. G. Rogers, "Judgement Estimates of the Moments of PERT Type Distributions," Management Science, 1968.

Ranney, J. W., J. L. Trimble, L. Wright, R. D. Perlack, J. H. Cushman, and C. Wenzel, Short-Rotation Woody Crops Program: Annual Progress Report for 1983, Oak Ridge National Laboratory, ORNL-6085, September 1984.

APPENDIX A
PROGRAM MODULES
COMPUTER CODE LISTING

APPENDIX A

BIOCUT Program Modules

MAIN PROGRAM

BIOCUT This is the main program unit and contains several subroutines besides the main program. Its primary function is to query the user for different program operating commands. This unit also contains the computational and report-generation subroutines. BIOCUT performs several functions to make program operation easier for the user. These include

1. providing an on-line HELP system of summary command descriptions,
2. exiting the program,
3. specification of a scenario title to appear on outputs,
4. saving and subsequently retrieving files containing the scenario parameters specified by the user,
5. displaying the scenario parameters and the output of a scenario,
6. opening a file to receive the output of a scenario,
7. simulating a scenario,
8. and conducting a risk analysis.

CALLS: COMPUT, HELP_ME, LIST, OPTION1, OPTION2, OPTION3, OPTION4, OPTION5, PLANT, PRINT, RISK

CONTAINS: COMPUT, LIST, PRINT, PLANT.

MODULE

HELP This is the only module called MODULE ONE, and is linked along with the main program unit. Its primary function is to query the user for input parameters and simulates the risk analysis

for project net present value. This has six different procedures for the five groups of available options and simulating the risk analysis.

Contains: OPTION1, OPTION2, OPTION3, OPTION4, OPTION5, OP43_44, RISK

Called by: BIOCUT, MAIN PROGRAM UNIT.

UTILITY AND NON-COMPUTATIONAL, NON-REPORT GENERATION SUBROUTINES.

HELP_ME This procedure lists the commands and options available to the user

Called by: BIOCUT

Calls: (none)

OPTION1 This procedure handles the input queries and data input for the plantation scenario options (i.e., 1.01 - 1.07).

Called by: BIOCUT

Calls: (none)

OPTION2 This procedure handles the input queries and data input for economic options (i.e., 2.01 - 2.03).

Called by: BIOCUT

Calls: (none)

OPTION3 This procedure handles the input queries and data input for the plantation establishment options (i.e., 3.01 - 3.05).

Called by: BIOCUT

Calls: (none)

OPTION4 This procedure handles the input queries and data input for operation and maintenance options (i.e., 4.01 - 4.06).

Called by: BIOCUT

Calls: OP43_44

OPTION5 This procedure handles the input queries and data input for harvesting decision options (i.e., 5.01 - 5.03).

Called by: BIOCUT

Calls: (none)

OP43-44 This procedure handles the input queries and data input in detail for Options 4.03 and 4.04 of BIOCUT.

Called by: OPTION4

Calls (none)

COMPUTATIONAL SUBROUTINES

COMPUT This procedure calculates yearly information on the financial status of the plantation, cash flows, the net present value, the discounted average cost, the internal rate of return, and the benefit-cost ratio.

Called by: BIOCUT

Calls: (none)

PLANT This procedure computes the plantation life cycle and also writes output to both the user and the output file.

Called by: BIOCUT, PRINT

Calls: (none)

RISK This procedures performs the risk analysis for net present value. This also displays the output of a risk analysis for a scenario.

Called by: BIOCUT

Calls: (none)

REPORT - GENERATION SUBROUTINES

LIST This procedure writes out the yearly financial results over the evaluation period.

Called by: BIOCUT

Calls: (none)

PRINT This procedure writes the scenario parameters to the output file and to the user. This also writes the yearly information on the financial status of plantation and project-summary results over the evaluation period to the output file.

Called by: BIOCUT

Calls: PLANT

DATA STRUCTURES

STRUC1,...,STRUC5
These five record blocks represent the five different groups of scenario parameters for the available five groups of different options in BIOCUT. These record blocks pass the scenario parameters among COMPUT, PRINT, OPTION1, OPTION2, OPTION3, OPTION4, OPTION5, and RISK.

```
(*************************************************************)
(*                                                           *)
(* BBBBBB      I    OOOOO      CCCC     U    U   TTTTTTTTTT*)
(* B    B      I   O    O    C    C    U    U      TT     *)
(* B     B     I   O    O   C         U    U      TT     *)
(* B    B      I   O    O   C         U    U      TT     *)
(* B   BB      I   O    O   C         U    U      TT     *)
(* B    B      I   O    O   C         U    U      TT     *)
(* B     B     I   O    O   C         U    U      TT     *)
(* B    B      I   O    O    C    C   U    U      TT     *)
(* BBBBBB      I    OOOOO      CCCC     UUUUU      TT     *)
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(*                    MAIN PROGRAM UNIT                      *)
(*************************************************************)
(*************************************************************)


PROGRAM BIOCUT(INPUT,OUTPUT) ;

LABEL 1 ;
TYPE
   REAL = REAL8 ;

TYPE
   STRUC1 = RECORD (* OPTION 1 *)
   AREA : REAL ; (* LAND AREA OF PLANTATION *)
   PLAN : REAL ; (* PLANTED PORTION OF PLANTATION *)
   PURC : CHAR ; (* LAND PURCHASED/RENTED *)
   COS2 : REAL ; (* LAND PURCHASE COST *)
   COS1 : REAL ; (* LAND RENTAL COST *)
   RESEL :REAL ; (* LAND RESALE VALUE *)
   SCHD : ARRAY [1..15] OF REAL ; (* LAND ACQUISITION SCHEDULE *)
   CLEA : REAL ; (* CHANGE IN RENTAL COST *)
   YLD1 : REAL ; (* BIOMASS YIELD FOR SEEDLING *)
   YLD2 : REAL ; (* BIOMASS YIELD FOR COPPICE *)
   ENGY : REAL ; (* ENERGY CONTENT OF BIOMASS *)
   NUMB : INTEGER (* NUMBER OF COPPICE HARVESTS *)
END ;

   STRUC2 = RECORD (* OPTION 2 *)
   YEAR : INTEGER ; (* LAST YEAR EVALUATION PERIOD *)
```

```
      DISC : REAL ; (* DISCOUNT RATE *)
      SELL : REAL ; (* REAL SELLING PRICE *)
      CHNG : REAL   (* CHANGE IN SELLING PRICE *)
    END ;

      STRUC3 = RECORD (* OPTION 3 *)
      DEVL : REAL ; (* DEVELOPMENT COSTS *)
      PRP1 : REAL ; (* SITE PREP FOR NEWLY PLANTED AREAS *)
      PRP2 : REAL ; (* SITE PREP FOR REPLANTED AREAS *)
      COST : REAL ; (* COST OF SEEDLINGS *)
      WEED : REAL ; (* ANNUAL COST OF WEED CONTROL *)
      TILL : CHAR ; (* TILLAGE IS PRACTICED OR NOT *)
      PLAN : REAL   (* PLANTING COSTS *)
    END ;

      STRUC4 = RECORD (* OPTION 4 *)
      MNGR : REAL ; (* MANAGERIAL EXPENSES *)
      FTYP : PACKED ARRAY [1..20] OF CHAR ; (* FERTILIZER TYPE *)
      SAMT : ARRAY [1..35] OF REAL ; (* APPLICATION AMOUNT FOR SEEDLING *)
      SCST : ARRAY [1..35] OF REAL ; (* APPLICATION COST FOR SEEDLING *)
      CAMT : ARRAY [1..35] OF REAL ; (* APPLICATION AMOUNT FOR COPPICE *)
      CCST : ARRAY [1..35] OF REAL ; (* APPLICATION COST FOR COPPICE *)
      ETYP : PACKED ARRAY [1..20] OF CHAR ;(* ENVIR PROTECTION ACTIVITY*)
      ENVR : REAL ; (* ENVIRONMENTAL PROTECTION COSTS *)
      ADDL : REAL   (* RECURRING ACTIVITY COST *)
    END ;

      STRUC5 = RECORD (* OPTION 5 *)
      HRVS : REAL ; (* HARVESTING COSTS *)
      TRNP : REAL ; (* TRANSPORTATION COST *)
      PREP : REAL   (* MATERIAL PREP. COST *)
    END ;
    CHARAC = PACKED ARRAY [1..4] OF CHAR ;
    OUT = PACKED ARRAY [1..10] OF CHAR ;

(* VARIABLES USED IN COMPUTATION *)

    CALC = PACKED ARRAY [0..35] OF REAL ;

VAR  [PUBLIC]
   LAND : CALC ; (* LAND COST *)
   DEVL : CALC ; (* INFRASTRUCTURE DEVELOPMENT COST *)
   SPRP : CALC ; (* SITE PREPARATION COST *)
   PWCS : CALC ; (* PRE-PLANTING WEED CONTROL COST *)
   PLAN : CALC ; (* PLANTING COST *)
   MCST : CALC ; (* MANAGERIAL COST *)
   FCST : CALC ; (* FERTILIZATION COST *)
   WCST : CALC ; (* POST ESTABLISHMENT WEED CONTROL COST *)
   SCST : CALC ; (* SEEDLING COST *)
   PCST : CALC ; (* POST ESTABLISHMENT PEST CONTROL COST *)
   ACST : CALC ; (* ADDITIONAL COST *)
   HCST : CALC ; (* HARVESTING COST *)
   ECST : CALC ; (* SPECIAL ONGOING ENVIRONMENTAL COSTS *)
   TCST : CALC ; (* TRANSPORTATION COST *)
   REVN : CALC ; (* TOTAL REVENUE *)
```

```
   PV   : CALC ; (* PRESENT VALUE *)

VAR
   COST : CALC ; (* TOTAL COST *)
   AVG  : CALC ; (* PRESENT VALUE OF ANNUAL COST *)
   OUP  : CALC ; (* PRESENT VALUE OF OUTPUT *)
   PVCS : CALC ; (* PRESENT VALUE OF COST *)
   PVRV : CALC ; (* PRESENT VALUE OF REVENUE *)
   HARV : CALC ; (* AMOUNT HARVESTED IN EACH PERIOD *)
   NUMB,DISCNT,CHANGE,SCHNG,DAVG,DAVG1,AAVG,AAVG1,YLD,IRR,R,SUM : REAL ;
   LLMT,ULMT,J,K : INTEGER ;

(* VARIABLE DECLARATION FOR COMPUTATION ENDS HERE *)


VAR
   OUTPUT_FILE,TEMP_FILE,TX :TEXT ; (* FILE DECLARATION *)
   INPUT_FILE,TERM_FILE,LIST_FILE : PACKED ARRAY [1..10] OF CHAR ;
   TITLE : PACKED ARRAY [1..20] OF CHAR ; (* SCENARIO TITLE *)
   PSCY : ARRAY[1..10,1..35,1..10] OF INTEGER ;(*USED IN PLANT *)
   PCCY : ARRAY[1..10,1..35,1..10] OF INTEGER ;(*USED IN PLANT *)
   STAGE: ARRAY[1..35,1..10] OF INTEGER ; (*STAGES IN EACH LAND *)
   OPTION : CHARAC ; (* DIFFERENT OPTIONS *)
   PROMPT1 : STRUC1 ;
   PROMPT2 : STRUC2 ;
   PROMPT3 : STRUC3 ;
   PROMPT4 : STRUC4 ;
   PROMPT5 : STRUC5 ;
   DUMB1,DUMB2,DUMB3,DUMB4,I,S: INTEGER ;
   YRS : ARRAY[0..36] OF INTEGER ; (* FOR DIFFERENT YEARS OF OUTPUT *)
   OUT_PUT ,TERM,NET,CASS,KEY: CHAR ;

VAR [PUBLIC]  (* VARIABLES IN OPTION 4.03 & 4.04 *)
   SEED,SST2,SHM1,CEED,CST2,CHM1,SEST,SST3,SHM2,
   CEST,CST3,CHM2 : ARRAY [1..15] OF REAL ;

VAR [PUBLIC]  (* VARIABLES IN OPTION 4.03 & 4.04 *)
   MCLA,MSLA,MCMA,MSMA,PCLA,PSLA,PCMA,PSMA : ARRAY [1..35] OF REAL ;

VAR [PUBLIC]
    AGE1,AGE2,WTYP,PTYP : INTEGER ;

   PROCEDURE RISK(PTRUC2:STRUC2) ; EXTERN ;
   PROCEDURE HELP_ME(OPTION:CHARAC) ;EXTERN ;
   PROCEDURE OPTION1(VAR PTRUC1:STRUC1 ; OPTION :CHARAC) ; EXTERN ;
   PROCEDURE OPTION2(VAR PTRUC2:STRUC2 ; OPTION :CHARAC) ; EXTERN ;
   PROCEDURE OPTION3(VAR PTRUC3:STRUC3 ; OPTION :CHARAC) ; EXTERN ;
   PROCEDURE OPTION4(VAR PTRUC4:STRUC4 ; OPTION :CHARAC;A1,A2:INTEGER);
                                                          EXTERN ;
   PROCEDURE OPTION5(VAR PTRUC5:STRUC5 ; OPTION :CHARAC) ; EXTERN ;

   PROCEDURE PLANT; FORWARD ;
```

```
(*****************************************************************)
(*                                                               *)
(*  PROCEDURE COMPUT CALCULATES YEARLY INFORMATION ON THE FINANCIAL  *)
(*  STATUS OF THE PLANTATION, CASH FLOWS, THE NET PRESENT VALUE,     *)
(*  DISCOUNTED AVERAGE COST, INTERNAL RATE OF RETURN, AND BENEFIT-   *)
(*  COST RATIO.                                                      *)
(*                                                                   *)
(*****************************************************************)

PROCEDURE COMPUT(VARBL1:STRUC1;VARBL2:STRUC2;VARBL3:STRUC3;
                 VARBL4:STRUC4;VARBL5:STRUC5) ;
LABEL 2,5,99,100 ;

VAR
   SCYC : ARRAY [1..35,1..10] OF INTEGER ; (* PLANT AGE IN SEEDLING YR*)
   CCYC : ARRAY [1..35,1..10] OF INTEGER ; (* PLANT AGE IN COPPICE YR*)
   A,W,X,Y,Z,COUNT : INTEGER ;
   INIT : REAL ; (* FRACTION OF COST IN LAST YRS OF EVALUATION *)

BEGIN

(* CALCULATING LAND AREA OF EACH PLOT BASED ON SCENARIO *)

  IF CASS () 'Y'  THEN
   NUMB := VARBL1.PLAN*VARBL1.AREA*0.01/AGE1
  ELSE
   NUMB := VARBL1.PLAN*VARBL1.AREA*0.01 ;

(* CALCULATING COSTS FOR THE YEAR 0 *)

   LAND[0] := 0.0 ;
   DEVL[0] := VARBL3.DEVL ;
   SPRP[0] := 0.0 ;
   ACST[0] := 0.0 ;
   PWCS[0] := 0.0 ;
   HARV[0] := 0.0 ;
   COST[0] := LAND[0] + DEVL[0] + SPRP[0] + ACST[0] + PWCS[0] ;
   REVN[0] := 0 ;
   PV[0] := REVN[0] -COST[0] ;
   PVCS[0] := COST[0] ; PVRV[0] := 0.0 ;

(* INITIALIZATION *)

   LLMT := AGE1 ;
   ULMT := LLMT + AGE1 - 1 ;
   DISCNT := 1.0 ; CHANGE := 1.0 ;
   SCHNG := 1.0 ;  COUNT := 0 ;
   AVG[0] := COST[0] ;  DUP[0] := 0.0 ; YLD := 0 ;

(* CALCULATE AGE OF PLANTS OF EACH LAND IN EACH YEAR *)
(* THIS CALCULATION IS THEN USED IN CALCULATION OF FERTILIZATION,
   POST ESTABLISHMENT PEST AND WEED CONTROL COST ONLY WHEN IT IS
   NOT A NONCONTINUOUS SCENARIO *)

(* INITIALIZATION *)
```

```
IF CASS <> 'Y' THEN
BEGIN
 FOR Y := 1 TO AGE1 DO
  FOR W := 1 TO VARBL2.YEAR DO
   FOR X:= 1 TO AGE1 DO
    BEGIN
     SCYC[W,X] := 0 ;
     CCYC[W,X] := 0 ;
     PSCY[Y,W,X] := 0 ;
     PCCY[Y,W,X] := 0 ; STAGE[W,X] := 0
    END ; (* FOR Y LOOP ENDS HERE *)
(* INITIALIZATION ENDS HERE *)

  FOR X := 1 TO AGE1 DO
   BEGIN
    W := X ;  A := 1 ;
     WHILE (W <= VARBL2.YEAR)  DO
      BEGIN
       IF (VARBL2.YEAR-W)<(AGE1-1) THEN GOTO 5
       ELSE
       FOR Y := 1 TO AGE1 DO
        BEGIN
         IF (W <= VARBL2.YEAR) THEN
         BEGIN
          SCYC[W,Y] := SCYC[W,Y] + 1 ;
          PSCY[X,W,Y] := PSCY[X,W,Y] + 1 ;
          STAGE[W,X] := A ;
          W := W + 1
         END ; (* IF W <= VARBL2.YEAR LOOP ENDS HERE *)
        END ; (* FOR Y 1 TO AGE1 LOOP ENDS HERE *)
        A := A + 1 ;
       FOR Z := 1 TO VARBL1.NUMB DO
       BEGIN
        IF (VARBL2.YEAR-W)<(AGE1-1) THEN GOTO 5
        ELSE
        FOR Y := 1 TO AGE2 DO
         BEGIN
          IF (W <= VARBL2.YEAR) THEN
          BEGIN
           CCYC[W,Y] := CCYC[W,Y] + 1 ;
           PCCY[X,W,Y] := PCCY[X,W,Y] + 1 ;
           STAGE[W,X] := A ;
           W := W + 1
          END ; (* IF W <= VARBL2.YEAR ENDS HERE *)
         END ;  (* FOR Y 1 TO AGE2 ENDS HERE *)
       END ; (* FOR Z LOOP ENDS HERE *)
       A := A + 1 ;
      END; (* WHILE LOOP ENDS HERE *)
 5:END ; (* FOR X LOOP ENDS HERE *)
END ;  (* INITIALIZATION ENDS FOR SHORT ROTATION CASE *)

(*  START SIMULATION FOR EACH YEAR  *)

   FOR I := 1 TO VARBL2.YEAR DO
   BEGIN
```

```
    WCST[I] := 0 ;
    DISCNT  := DISCNT*(1+VARBL2.DISC*0.01) ; (* DISCOUNT FACTOR *)
    CHANGE  := CHANGE*(1+VARBL1.CLEA*0.01) ; (* CHANGE IN LEASE COST *)
    SCHNG := SCHNG*(1+VARBL2.CHNG*0.01) ;(* CHANGE IN SELLING PRICE *)
    FCST[I] := 0 ;
    PCST[I] := 0 ;
    IF (VARBL1.PURC = 'P') AND (I >15) THEN
     LAND[I] := 0.0 ;
    IF (VARBL1.PURC = 'P') AND (I<=15) THEN
     LAND[I] := VARBL1.SCHD[I] * VARBL1.AREA * VARBL1.COS1 * 0.01
    ELSE
     LAND[I] := VARBL1.COS2 * CHANGE *VARBL1.AREA ;

  (* IF IT IS NONCONTINUOUS CASE THEN GO TO LABEL 100 *)
   IF CASS = 'Y'
    THEN GOTO 100 ;

  (* INITIAL SITE PREPARATION, PRE-PLANTING WEED CONTROL AND OTHER COSTS*)

   IF I <= AGE1 THEN
    BEGIN
     SPRP[I] := NUMB * VARBL3.PRP1 ;
     IF VARBL1.PURC <> 'P' THEN
     LAND[I] := LAND[I] * (I/AGE1) ;
     MCST[I] := VARBL4.MNGR*VARBL1.AREA*VARBL1.PLAN*0.01*(I/AGE1);
     ECST[I] := VARBL1.AREA*VARBL1.PLAN*VARBL4.ENVR*0.01*(I/AGE1);
     ACST[I] := VARBL1.AREA*VARBL1.PLAN*VARBL4.ADDL*0.01*(I/AGE1);
     PWCS[I] := NUMB * VARBL3.WEED
    END
     ELSE
      BEGIN
       SPRP[I] := 0.0 ;
       PLAN[I] := 0.0 ;
       PWCS[I] := 0.0
      END ;

(* CALCULATION OF FERTILIZATION, WEED CONTROL, AND PEST CONTROL COSTS *)

  (* SEEDLING CYCLE *)

     FOR J := 1 TO AGE1 DO
      BEGIN
       CASE WTYP OF
        0 : WCST[I] := WCST[I] + 0.0 ;
        1 : WCST[I] := WCST[I] + (MSLA[J] + MSNA[J])*NUMB*SCYC[I,J];
        2 : WCST[I] := WCST[I] + (SEED[J] + SST2[J]*SHM1[J])*
                     NUMB * SCYC[I,J] ;
        3 : WCST[I] := WCST[I] +
                (MSLA[J] + MSNA[J] + SEED[J] + SST2[J]*SHM1[J])*
                 NUMB * SCYC[I,J] ;
           OTHERWISE
              WCST[I] := 0.0 + WCST[I]
       END ; (* CASE WTYP ENDS HERE *)

       CASE PTYP OF
```

```
        0 : PCST[I] := PCST[I] + 0.0 ;
        1 : PCST[I] := PCST[I] + (PSLA[J] + PSMA[J])*NUMB*SCYC[I,J] ;
        2 : PCST[I] := PCST[I] + (SEST[J] + SST3[J]*SHM2[J])*
                      NUMB * SCYC[I,J] ;
        3 : PCST[I] := PCST[I] +
                 (PSLA[J] + PSMA[J] + SEST[J] + SST3[J]*SHM2[J])*
                 NUMB * SCYC[I,J] ;
            OTHERWISE
             PCST[I] := 0.0 + PCST[I] ;
      END ; (* CASE PTYP ENDS HERE *)

      FCST[I] := FCST[I] + VARBL4.SCST[J] * NUMB * SCYC[I,J]
     END ; (* FOR 1 TO AGE1 DO LOOP ENDS HERE *)


    (* FOR COPPICE CYCLE *)

    IF (I ) AGE1)
     THEN
      BEGIN
       FOR J := 1 TO AGE2 DO
        BEGIN
         CASE WTYP OF
          1 : WCST[I] := WCST[I] + (MCLA[J] + MCMA[J])*NUMB*CCYC[I,J] ;
          2 : WCST[I] := WCST[I] + (CEED[J] + CST2[J]*CHM1[J])*
                        NUMB * CCYC[I,J] ;
          3 : WCST[I] := WCST[I] +
                (MCLA[J] + MCMA[J] + CEED[J] + CST2[J]*CHM1[J])*
                NUMB * CCYC[I,J] ;
         OTHERWISE
             WCST[I] := WCST[I] + 0.0
        END ; (* CASE WTYP FOR COPPICE CYCLE ENDS HERE *)

        CASE PTYP OF
         1 : PCST[I] := PCST[I] + (PCLA[J] + PCMA[J])*NUMB*CCYC[I,J] ;
         2 : PCST[I] := PCST[I] + (CEST[J] + CST3[J]*CHM2[J])*
                       NUMB * CCYC[I,J] ;
         3 : PCST[I] := PCST[I] +
               (PCLA[J] + PCMA[J] + CEST[J] + CST3[J]*CHM2[J])*
               NUMB * CCYC[I,J] ;
         OTHERWISE
             PCST[I] := PCST[I] + 0.0
        END ; (* CASE PTYP FOR COPPICE CYCLE ENDS HERE *)
        FCST[I] := FCST[I] + (VARBL4.CCST[J]*NUMB)*CCYC[I,J]
      END ; (* DO LOOP 1 TO CNIT ENDS HERE *)
     END ; (* COPPICE CYCLE BLOCK ENDS HERE *)

(* FOR SEEDLING CYCLE ONLY *)

     IF (I (= LLMT) AND (I )LLMT-AGE1) AND (VARBL2.YEAR-I)=AGE1-1)THEN
     BEGIN
      SCST[I] := VARBL3.COST * NUMB ;
      PWCS[I] := VARBL3.WEED * NUMB ;
      PLAN[I] := VARBL3.PLAN * NUMB
     END   (* SEEDLING CYCLE BEGIN BLOCK ENDS HERE *)
```

```
    ELSE
     BEGIN
      SCST[I] := 0.0 ;
      PWCS[I] := 0.0 ;
      PLAN[I] := 0.0
     END ;

(* SITE PREPARATION COST FOR REPLANTED AREAS *)

    IF (I)AGE1) AND (I)=LLMT-AGE1+1) AND (I(=ULMT-AGE1+1) AND
              (VARBL2.YEAR-I)=AGE1-1)
    THEN
    SPRP[I] := VARBL3.PRP2 * NUMB
    ELSE
    SPRP[I] := SPRP[I] + 0.0 ;

 (* HARVESTING PERIOD *)

    IF (I = LLMT) THEN K := 1 ;
    IF (K (= AGE1) AND (I)=AGE1) THEN
    BEGIN (* SEEDLING IS HARVESTED *)
     REVN[I] := (VARBL2.SELL * SCHNG)*VARBL1.YLD1*NUMB ;
     HARV[I] := VARBL1.YLD1 * NUMB ;
     COUNT := COUNT + 1 ;
     YLD := YLD + VARBL1.YLD1 * NUMB ;
     HCST[I] := VARBL1.YLD1 * NUMB * VARBL5.PREP ;
     TCST[I] := VARBL5.TRNP*NUMB*VARBL1.YLD1 ;
     K := K +1
    END
    ELSE
    BEGIN   (* COPPICE IS HARVESTED *)
     TCST[I] := VARBL5.TRNP*NUMB*VARBL1.YLD2 ;
     HARV[I] := VARBL1.YLD2 * NUMB ;
     COUNT := COUNT + 1 ;
     YLD := YLD + VARBL1.YLD2 * NUMB ;
     HCST[I] := VARBL1.YLD2 * NUMB * VARBL5.PREP ;
     REVN[I] := (VARBL2.SELL * SCHNG)*VARBL1.YLD2 * NUMB
    END ;

 (* HARVESTING IS DONE EACH PERIOD ONWARD FIRST HARVEST *)

   IF (I(AGE1) THEN
    BEGIN
     REVN[I] := 0.0 ;
     HCST[I] := 0.0 ;
     COUNT := 0 ;
     YLD := 0.0 ;
     HARV[I] := 0.0 ;
     TCST[I] := 0.0
    END
     ELSE
      HCST[I] := VARBL5.HRVS * NUMB + HCST[I] ;

 (* OTHER INCIDENTAL COSTS *)
```

```
    IF I ) AGE1 THEN
    BEGIN
     MCST[I] := VARBL4.MNGR*VARBL1.AREA*VARBL1.PLAN*0.01;
     ECST[I] := VARBL1.AREA*VARBL1.PLAN*VARBL4.ENVR*0.01;
     DEVL[I] := 0.0 ;
     ACST[I] := VARBL1.AREA *VARBL1.PLAN * VARBL4.ADDL * 0.01
    END ;

(* MODIFY COSTS IF HARVEST EXTENDS BEYOND THE EVALUATION PERIOD *)

    IF (VARBL2.YEAR-I (= AGE1-1) AND (VARBL1.PURC = 'P') THEN
      LAND[I] := -(VARBL1.RESEL * NUMB) ;
    IF (VARBL2.YEAR-I ( AGE1-1) THEN
      BEGIN
       INIT := VARBL2.YEAR - I ;
       INIT := ((1.0 + INIT)/AGE1) ;
       MCST[I] := MCST[I] * INIT ;
       ECST[I] := ECST[I] * INIT ;
       ACST[I] := ACST[I] * INIT ;
       IF VARBL1.PURC () 'P' THEN
       LAND[I] := LAND[I] * INIT
      END ;

IF CASS = 'N' THEN GOTO 99 ;   (* IF A CONTINUOUS SCENARIO *)


(*****************NONCONTINUOUS CASE*********************)

(* INITIALIZE THE COSTS *)

100: SPRP[I] := 0.0 ; PWCS[I] := 0.0 ;
     HARV[I] := 0.0 ; PLAN[I] := 0.0 ;
     FCST[I] := 0.0 ; PCST[I] := 0.0 ;
     WCST[I] := 0.0 ; HCST[I] := 0.0 ;
     SCST[I] := 0.0 ; TCST[I] := 0.0 ;
     DEVL[I] := 0.0 ; REVN[I] := 0.0 ;
     MCST[I] := VARBL4.MNGR * VARBL1.AREA * VARBL1.PLAN * 0.01 ;
     ACST[I] := VARBL4.ADDL * VARBL1.AREA * VARBL1.PLAN * 0.01 ;
     ECST[I] := VARBL4.ENVR * VARBL1.AREA * VARBL1.PLAN * 0.01 ;

(* CALCULATION OF FERTILIZATION AND PEST CONTROL COST *)

IF I (= AGE1  THEN
 BEGIN
  FCST[I] := VARBL4.SCST[I] * NUMB ;
  PCST[I] := (PSLA[I] + PSMA[I]) * NUMB
 END
  ELSE
   BEGIN
    FCST[I] := VARBL4.CCST[I-AGE1] * NUMB ;
    PCST[I] := (PCLA[I-AGE1] + PSMA[I-AGE1]) * NUMB
   END ;

(* INITIAL COSTS *)
```

```
IF I = 1 THEN
 BEGIN
  SPRP[1] := NUMB * VARBL3.PRP1 ;
  PLAN[1] := NUMB * VARBL3.PLAN ;
  PWCS[1] := NUMB * VARBL3.WEED ;
  SCST[I] := NUMB * VARBL3.COST
 END ;

(* HARVESTING COSTS *)

IF I = AGE1 THEN
 BEGIN   (* SEEDLING IS HARVESTED *)
  HARV[I] := VARBL1.YLD1 * NUMB ;
  YLD := YLD + VARBL1.YLD1 * NUMB ;
  COUNT := COUNT + 1 ;
  TCST[I] := VARBL5.TRNP * NUMB * VARBL1.YLD1 ;
  HCST[I] := (VARBL1.YLD1 * VARBL5.PREP + VARBL5.HRVS) * NUMB ;
  REVN[I] := VARBL2.SELL * SCHNG * VARBL1.YLD1 * NUMB
 END ;

IF (I = VARBL2.YEAR) AND (AGE1 () VARBL2.YEAR) THEN
 BEGIN   (* COPPICE IS HARVESTED *)
  HARV[I] := VARBL1.YLD2 * NUMB ;
  YLD := YLD + VARBL1.YLD2 * NUMB ;
  COUNT := COUNT + 1 ;
  TCST[I] := VARBL5.TRNP * NUMB * VARBL1.YLD2 ;
  HCST[I] := (VARBL1.YLD2 * VARBL5.PREP + VARBL5.HRVS) * NUMB ;
  REVN[I] := VARBL2.SELL * SCHNG * VARBL1.YLD2 * NUMB
 END ;

 YLD := (VARBL1.YLD1 + VARBL1.YLD2) * NUMB ;

(*********CALCULATION OF COSTS IN NONCONTINUOUS CASE ENDS HERE********)

    (* SUMMING UP ALL THE COSTS *)

99 :COST[I] := DEVL[I] +  SPRP[I] + PWCS[I] + PLAN[I] +
               MCST[I] + FCST[I] + WCST[I] + SCST[I] + PCST[I] +
               ACST[I] + HCST[I] + TCST[I] + ECST[I] + LAND[I] ;

     PVCS[I] := PVCS[I-1] + COST[I]/DISCNT ;
     PVRV[I] := PVRV[I-1] + REVN[I]/DISCNT ;
     PV[I] := PV[I-1] + (REVN[I] - COST[I])/DISCNT ;

(* MODIFY LIMITS TO KEEP TRACK OF SEEDLING AND COPPICE CYCLE *)

    IF I = LLMT
      THEN
       BEGIN
        LLMT := LLMT + VARBL1.NUMB * AGE2 + AGE1 ;
        ULMT := LLMT + AGE1 - 1
       END ;

   (* CALCULATING FOR DISCOUNTED AVERAGE COST *)
```

```
   AVG[I]:=AVG[I-1]+
         (COST[I]/DISCNT) ;
   OUP[I]:= OUP[I-1]+(HARV[I]/DISCNT) ;

   END ; (* FOR LOOP 1 TO VARBL2.YEAR ENDS HERE *)

  (* DISCOUNTED AVERAGE COST *)

   DAVG := AVG[VARBL2.YEAR] /OUP[VARBL2.YEAR] ;
   DAVG1 := DAVG/VARBL1.ENGY ;

  (* ANNUALIZED AVERAGE COST *)

   AAVG := AVG[VARBL2.YEAR] * (VARBL2.DISC *0.01*DISCNT/(DISCNT-1.0))*
                    (COUNT/YLD) ;
   AAVG1 := AAVG/VARBL1.ENGY ;

  (* CALCULATING INTERNAL RATE OF RETURN *)

   IRR := -0.05 ; R := 1.0 ; SUM := 990.0 ;
   WHILE NOT (SUM < 50.0)  DO
    BEGIN
     R := 1.0 ; IRR := IRR + 0.05 ; SUM := 0.0 ;
     IF IRR > 99.0 THEN GOTO 2 ;
     FOR I := 0 TO VARBL2.YEAR DO
      BEGIN
       SUM := SUM + ((REVN[I]-COST[I])/R) ;
       R := ( 1 + IRR * 0.01 ) * R
      END   (* FOR I 0 TO VARBL2.YEAR LOOP ENDS HERE *)
     END ;  (* WHILE NOT LOOP ENDS HERE *)

2:END ; (*PROCEDURE ENDS HERE *)

(*************************************************************)
(*                                                           *)
(*  PROCEDURE PRINTS YEARLY INFORMATION ON THE FINANCIAL  STATUS  *)
(*  OF PLANTATION AND PROJECT SUMMARY RESULTS ON THE OUTPUT FILE. *)
(*                                                           *)
(*                                                           *)
(*************************************************************)

PROCEDURE PRINT(TS:OUT;VARBL1:STRUC1;VARBL2:STRUC2;VARBL3:STRUC3;
                VARBL4:STRUC4;VARBL5:STRUC5) ;

LABEL 10,11,20,90,99,100 ;

VAR P : INTEGER ;

BEGIN

(* INITIALIZE *)
 OUT_PUT := 'N' ;
 IF TERM = 'Y' THEN
   ASSIGN(TX,'CON:')
  ELSE
```

```
  ASSIGN(TX,TS) ;
  REWRITE(TX) ;

(* WRITE TO THE OUTPUT FILE *)
WRITELN ;
WRITELN(TX);
WRITELN(TX,'_____________________________________________');
WRITELN(TX,TITLE) ;
WRITELN(TX,'_____________________________________________');
WRITELN(TX) ;
WRITELN(TX,'PLANTATION SCENARIO ACTIVITIES') ;
WRITELN(TX,'_____________________________') ;
WRITELN(TX,'1.01 Total Land Area of Plantation:      ',VARBL1.AREA::2,
            ' ha');
WRITELN(TX,'1.02 Planted Portion of Plantation:      ',VARBL1.PLAN::2,
            ' %');
IF VARBL1.PURC='P'
 THEN
  BEGIN
    WRITELN(TX,'1.03 Land is Purchased at:               ',VARBL1.COS1::2,' $/ha') ;
   WRITELN(TX,'     Resale Value in Real Cost:          ',VARBL1.RESEL::2,' $/ha') ;
   WRITELN(TX,'     Proportion of Plantation Acquired in:');
   FOR I:= 1 TO 15 DO
    BEGIN
     IF VARBL1.SCHD[I] <> 0.0 THEN
     WRITELN(TX,'      Year',I:4,':',VARBL1.SCHD[I]::2,' %')
    END (* FOR I LOOP ENDS HERE *)
  END  (* BEGIN BLOCK ENDS HERE *)
  ELSE
   BEGIN
    WRITELN(TX,'1.03 Land is Leased at:                  ',VARBL1.COS2::2,' $/ha');
    WRITELN(TX,'     Increasing At Real Annual Rate of:  ',VARBL1.CLEA::2,' %') ;
   END;  (* ELSE LOOP ENDS HERE *)

WRITELN(TX,'1.04 Plantation Harvesting Period:       ',AGE1,' yrs');
WRITELN(TX,'1.05 Projected Biomass Yield for Seedling:',VARBL1.YLD1::2,
                                    ' MG/ha') ;
WRITELN(TX,'     Projected Biomass Yield for Coppice: ',VARBL1.YLD2::2,
                                    ' MG/ha') ;
WRITELN(TX,'1.06 Energy Content of Biomass:          ',VARBL1.ENGY::2,
                                   ' GJ/dry MG');
WRITELN(TX,'1.07 Coppice Cycles Before Return to Seedling:',VARBL1.NUMB);
WRITELN (TX);
WRITELN (TX);

IF TERM = 'Y' THEN
  BEGIN
   WRITE('O.K TO CONTINUE ? (Y/N) ') ;
   READLN(NET) ;
   IF NET = 'N' THEN
   GOTO 100
  END ;  (*  TERM = 'Y' BEGIN BLOCK ENDS HERE *)


(* NOW WRITE OPTION 2 *)
```

```
WRITELN(TX,'FINANCIAL/ECONOMIC PARAMETERS') ;
WRITELN(TX,'________________________') ;
WRITELN(TX,'Calculations Will Be in Real Dollars.');
WRITELN(TX) ;
WRITELN(TX,'2.01 Last Year in Evaluation Period:      ',VARBL2.YEAR);
WRITELN(TX,'2.02 Discount Rate:                       ',VARBL2.DISC::2,
                          ' %');
WRITELN(TX,'2.03 Initial Real Selling Price:          ',VARBL2.SELL::2,
                 ' $/dry MG');
WRITELN(TX,'     Annual Change in Real Selling Price: ',VARBL2.CHNG::2,
                 ' %');
WRITELN(TX);
WRITELN(TX);

(* NOW WRITE OPTION 3 *)

WRITELN(TX,'PLANTATION ESTABLISHMENT ACTIVITIES');
WRITELN(TX,'____________________________');
WRITELN(TX,'3.01 Infrastructure Development Costs:    ',VARBL3.DEVL::2,' $');
WRITELN(TX,'3.02 Site Prep for Newly Planted Areas:   ',VARBL3.PRP1::2,' $/ha');
WRITELN(TX,'     Site Prep for Replanted Areas:       ',VARBL3.PRP2::2,' $/ha') ;
WRITELN(TX,'3.03 Cost of Seedlings:                   ',VARBL3.COST::2,' $/ha');
WRITELN(TX,'3.04 Pre-Planting Weed Control:');
IF VARBL3.TILL = 'Y' THEN
WRITELN(TX,'     Tillage is Practiced. Annual Cost:   ',VARBL3.WEED::2,' $/ha')
ELSE
 WRITELN(TX,'     Tillage is Not Practiced.Annual Cost:',VARBL3.WEED::2,' $/ha');
WRITELN(TX,'3.05 Annual Planting Costs:               ',VARBL3.PLAN::2,' $/ha');
WRITELN(TX);
WRITELN(TX);

IF TERM = 'Y' THEN
  BEGIN
   WRITE('O.K TO CONTINUE ? (Y/N) ') ;
   READLN(NET) ;
   IF NET = 'N' THEN
   GOTO 100
  END ;

(* WRITE OPTION 4 *)

WRITELN(TX,'OPERATION AND MAINTENANCE ACTIVITIES');
WRITELN(TX,'_____________________________');
WRITELN(TX,'4.01 Manager Expenses:                    ',VARBL4.MNGR::2,' $/ha');
IF VARBL4.SAMT[1] = 0.0
  THEN
   WRITELN(TX,'4.02 No Fertilizer is Applied.')
  ELSE
   BEGIN
    WRITELN(TX,'4.02 Type of Fertilizer : ',VARBL4.FTYP) ;
    WRITELN(TX,'                          Application              Cost ');
    FOR I := 1 TO AGE1 DO
    WRITELN(TX,'Seedling Year',I:4,':',VARBL4.SAMT[I]::2,' Kg/ha;',
              VARBL4.SCST[I]::2,' $/ha');
```

```
    FOR I := 1 TO AGE2 DO
    WRITELN(TX,'Coppice Year ',I:4,':',VARBL4.CAMT[I]::2,' Kg/ha;',
              VARBL4.CCST[I]::2,' $/ha');
   END; (* ELSE LOOP ENDS HERE *)

IF TERM = 'Y' THEN
  BEGIN
   WRITE('O.K TO CONTINUE ? (Y/N) ') ;
   READLN(NET) ;
   IF NET = 'N' THEN
   GOTO 100
  END ;

IF (WTYP=0)
 THEN
  WRITELN(TX,'4.03 Post-Establishment Weed Control: None')
 ELSE
  WRITELN(TX,'4.03 Post-Establishment Weed Control:') ;
IF WTYP = 0 THEN GOTO 99 ;
IF WTYP = 2 THEN GOTO 10;

WRITELN(TX,'Mechanical Method            Labor Cost',
          '            Material Cost');
FOR I:= 1 TO AGE1 do
WRITELN(TX,'Seedling Year',I:4,':',MSLA[I]::2,' $/ha;',MSMA[I]::2,' $/ha');
FOR I:= 1 TO AGE2 DO
WRITELN(TX,'Coppice Year ',I:4,':',MCLA[I]::2,' $/ha;',MCMA[I]::2,' $/ha');
IF WTYP=1 THEN GOTO 99 ;

10:WRITELN(TX,'Chemical Method       Applic. Cost',
          '    Chem Amt      Chem Cost');
FOR I:= 1 TO AGE1 DO
WRITELN(TX,'Seedling Year',I:4,':',SEED[I]:9:2,' $/ha',SST2[I]:9:2,
          ' Kg/ha',SHM1[I]:9:2,' $/Kg');
FOR I:= 1 TO AGE2 DO
WRITELN(TX,'Coppice Year ',I:4,':',CEED[I]:9:2,' $/ha',CST2[I]:9:2,
          ' Kg/ha',CHM1[I]:9:2,' $/Kg');

 99:IF TERM = 'Y' THEN
  BEGIN
   WRITE('O.K TO CONTINUE ? (Y/N) ') ;
   READLN(NET) ;
   IF NET = 'N' THEN
   GOTO 100
  END ;

IF PTYP=0 THEN WRITELN(TX,'4.04 Post-Establishment Pest Control: None')
 ELSE
  WRITELN(TX,'4.04 Post-Establishment Pest Control:') ;
IF PTYP=0 THEN GOTO 90 ;
IF PTYP = 2 THEN GOTO 20 ;

WRITELN(TX,'Mechanical Method            Labor Cost',
        '            Material Cost');
FOR I:= 1 TO AGE1 DO
```

```
 WRITELN(TX,'Seedling Year',I:4,':',PSLA[I]::2,'$/ha;',PSMA[I]::2,' $/ha');
 FOR I:= 1 TO AGE2 DO
 WRITELN(TX,'Coppice Year',I:4,':',PCLA[I]::2,' $/ha;',PCMA[I]::2,' $/ha');
 IF PTYP=1 THEN GOTO 90 ;

20:WRITELN(TX,'Chemical Method       Applic. Cost',
          '    Chem Amt      Chem Cost');
 FOR I := 1 TO AGE1 DO
 WRITELN(TX,'Seedling Year',I:4,':',SEST[I]:9:2,' $/ha',SST3[I]:9:2,
     ' Kg/ha',SHM2[I]:9:2,' $/Kg');
 FOR I:= 1 TO AGE2 DO
 WRITELN(TX,'Coppice Year ',I:4,':',CEST[I]:9:2,' $/ha',CST3[I]:9:2,
    ' Kg/ha',CHM2[I]:9:2,' $/Kg');

90:WRITELN(TX,'4.05 Environmental Protection Activities:');
 WRITELN(TX,'     ',VARBL4.ETYP);
 WRITELN(TX,'     Annual Cost of These Activities:     ',
        VARBL4.ENVR::2, ' $/ha');
 WRITELN(TX,'4.06 Cost of Other Recurring Activities:  ',
         VARBL4.ADDL::2, ' $/ha');
 WRITELN(TX);
 WRITELN(TX);

 (*  WRITE OPTION 5 *)

 WRITELN(TX,'HARVESTING DECISION ACTIVITIES');
 WRITELN(TX,'________________________');
 WRITELN(TX,'5.01 Harvesting Costs:                    ',VARBL5.HRVS::2,' $/ha');
 WRITELN(TX,'5.02 Ann. Harvested Material Transp. Cost:',VARBL5.TRNP::2,' $/MG');
 WRITELN(TX,'5.03 Ann. Harvested Material Prep. Cost:  ',VARBL5.PREP::2,' $/MG');
 IF TERM = 'Y' THEN GOTO 100 ;

 (* NOW WRITE YEARLY FINANCIAL RESULTS *)

 IF DUMB2 = 0 THEN GOTO 11 ;
 IF DUMB2 () 0 THEN
  BEGIN
   S := 1 ;
   WHILE YRS[S] () 99 DO
    BEGIN
     P := YRS[S] ;
     CASE DUMB2 OF
     1 : WRITELN(TX,'NET PRESENT VALUE : $',PV[YRS[S]]::2);
     2 : BEGIN
          WRITELN(TX,'BIOCUT Economic Evaluation Program for Biomass ',
                   'Plantations ') ;
          WRITELN(TX) ;
          WRITELN(TX,'Oak Ridge National Laboratory ') ;
          WRITELN(TX,'FINANCIAL RESULTS OF PLANTATION FOR YEAR', P:4) ;
          WRITELN(TX,'_____________________________________') ;
          WRITELN(TX) ;
          WRITELN(TX,' 1.  Land Cost                          $',LAND[P]::2);
          WRITELN(TX,' 2.  Infrastructure Development Cost    $',DEVL[P]::2);
          WRITELN(TX,' 3.  Site Preparation Cost              $',SPRP[P]::2);
          WRITELN(TX,' 4.  Pre-Planting Weed Control Cost     $',PWCS[P]::2);
```

```
        WRITELN(TX,' 5.  Seedling Cost                        $',SCST[P]::2);
        WRITELN(TX,' 6.  Planting Cost                        $',PLAN[P]::2);
        WRITELN(TX,' 7.  Managerial Cost                      $',MCST[P]::2);
        WRITELN(TX,' 8.  Fertilization Cost                   $',FCST[P]::2);
        WRITELN(TX,' 9.  Post Establishment Weed Control Cost $',WCST[P]::2);
        WRITELN(TX,' 10. Post Establishment Pest Control Cost $',PCST[P]::2);
        WRITELN(TX,' 11. Harvesting Cost                      $',HCST[P]::2);
        WRITELN(TX,' 12. Transportation Cost                  $',TCST[P]::2);
        WRITELN(TX,' 13. Special Ongoing Environmental Cost   $',ECST[P]::2);
        WRITELN(TX,' 14. Additional Cost                      $',ACST[P]::2);
        WRITELN(TX,' 15. Total Costs                          $',COST[P]::2);
        WRITELN(TX,' 16. Harvest                     Megagrams',HARV[P]::2);
        WRITELN(TX,' 17. Income from Harvest                  $',REVN[P]::2);
        WRITELN(TX,' 18. Current Year Cash Flow               $',(REVN[P]-
                                                        COST[P])::2);
        WRITELN(TX,' 19. Net Present Value to Date            $',PV[P]::2) ;
        WRITELN(TX) ;
        WRITELN(TX) ;
       END ; (* BEGIN DUMB2 = 2 ENDS HERE *)
    END ; (* CASE LOOP ENDS HERE *)
  WRITELN ;
  WRITELN ;
  IF DUMB4 () 0 THEN PLANT ;
  S := S + 1 ;
  END ; (* WHILE LOOP ENDS HERE *)
 END ; (* BEGIN LOOP ENDS HERE *)

(* NOW WRITE THE PROJECT SUMMARY RESULTS *)

 11:IF (YRS[S] = 99) OR (DUMB2=0) THEN
  BEGIN
    WRITELN;
    WRITELN(TX,'Project Summary              ') ;
    WRITELN(TX,'_____________________________________________') ;
    WRITELN(TX,'Discounted Average Cost      ',DAVG::2,' $/MEGAGRAM');
    WRITELN(TX,'                             ',DAVG1::2,' $/GJ');
    (*WRITELN(TX,'Annualized Average Cost      ',AAVG::2,' $/MEGAGRAM');*)
    (*WRITELN(TX,'                             ',AAVG1::2,' $/GJ');*)
    WRITELN(TX,'Internal Rate of Return      ',IRR::2,' %') ;
    WRITELN(TX,'Net Present Value            ',PV[VARBL2.YEAR]::2,' $') ;
    WRITELN(TX,'Benefit/Cost Ratio           ',
                          (PVRV[VARBL2.YEAR]/PVCS[VARBL2.YEAR])::2);
    CLOSE(TX)
  END ;  (* IF YRS[S]=99 LOOP ENDS HERE *)

100:IF TERM = 'Y' THEN CLOSE(TX) ;
   TERM := 'N';

END;(* PROCEDURE ENDS HERE *)
```

```
(*************************************************************)
(*                                                           *)
(*  PROCEDURE LIST WRITES THE YEARLY FINANCIAL RESULTS ONLY ON  *)
(*  THE TERMINAL.                                            *)
(*                                                           *)
(*************************************************************)

 PROCEDURE LIST(P:INTEGER) ;

 BEGIN
      WRITELN('BIOCUT Economic Evaluation Program for Biomass ',                    'Plantations
') ;
      WRITELN ;
      WRITELN('Oak Ridge National Laboratory ') ;

      WRITELN('FINANCIAL RESULTS OF PLANTATION FOR YEAR', P:4) ;
      WRITELN('_____________________________________') ;
      WRITELN ;
      WRITELN(' 1.  Land Cost                          $',LAND[P]::2);
      WRITELN(' 2.  Infrastructure Development Cost    $',DEVL[P]::2);
      WRITELN(' 3.  Site Preparation Cost              $',SPRP[P]::2);
      WRITELN(' 4.  Pre-Planting Weed Control Cost     $',PWCS[P]::2);
      WRITELN(' 5.  Seedling Cost                      $',SCST[P]::2);
      WRITELN(' 6.  Planting Cost                      $',PLAN[P]::2);
      WRITELN(' 7.  Managerial Cost                    $',MCST[P]::2);
      WRITELN(' 8.  Fertilization Cost                 $',FCST[P]::2);
      WRITELN(' 9.  Post Establishment Weed Control Cost $',WCST[P]::2);
      WRITELN(' 10. Post Establishment Pest Control Cost $',PCST[P]::2);
      WRITELN(' 11. Harvesting Cost                    $',HCST[P]::2);
      WRITELN(' 12. Transportation Cost                $',TCST[P]::2);
      WRITELN(' 13. Special Ongoing Environmental Cost $',ECST[P]::2);
      WRITELN(' 14. Additional Cost                    $',ACST[P]::2);
      WRITELN(' 15. Total Costs                        $',COST[P]::2);
      WRITELN(' 16. Harvest                     Megagrams',HARV[P]::2);
      WRITELN(' 17. Income from Harvest                $',REVN[P]::2);
      WRITELN(' 18. Current Year Cash Flow             $',(REVN[P]-
                                                         COST[P])::2);
      WRITELN(' 19. Net Present Value to Date          $',PV[P]::2) ;
      WRITELN ;
      WRITELN ;

 END ; (* PROCEDURE ENDS HERE *)

(*************************************************************)
(*                                                           *)
(*  PROCEDURE PLANT REPORTS THE PLANTATION LIFE CYCLE AT THE    *)
(*  TERMINAL AND IN THE OUTPUT FILE.                         *)
(*                                                           *)
(*************************************************************)

PROCEDURE PLANT ;
LABEL 11 ;

 VAR
  N , O , PLOT,P : INTEGER ;
```

```
 CULT,TEMP2 : REAL ;
BEGIN
 PLOT := 0 ; CULT := 0 ;
 IF (DUMB3=2) OR (DUMB3=1) THEN ASSIGN(TX,'CON:');
 IF (DUMB3=2) OR (DUMB3=1) THEN REWRITE(TX) ;
 WRITELN(TX,'DESCRIPTION OF PLANTATION AT END OF YEAR ',YRS[S]:2) ;
 WRITELN(TX,'_____________________________________________________');

 (* WRITE  ONLY WHEN FULL ANNUAL DETAILS ASKED  *)

 IF (DUMB3=2) OR (DUMB4=2)  THEN
  BEGIN
   WRITELN(TX,'Plot   Area(ha)  Stage  Age     Megagrams Sold');
   IF CASS = 'Y' THEN GOTO 11 ; (* NONCONTINUOUS SCENARIO *)
   FOR O := 1 TO AGE1 DO
   FOR N := 1 TO AGE1 DO
   IF (PSCY[O,YRS[S],N] <> 0) OR (PCCY[O,YRS[S],N] <> 0) THEN
    BEGIN
     TEMP2 := 0.0 ;
     IF N=AGE1 THEN
      TEMP2 := HARV[YRS[S]] ;
     WRITELN(TX,O:2,NUMB:10:2,'      ',STAGE[YRS[S],O]:2,'    ',N:2,TEMP2::2);
     PLOT := PLOT + 1 ;
     CULT := CULT + NUMB ;
    END ;   (* IF PSCY[O,YRS[S],N] LOOP ENDS HERE  *)
  END ;(* DUMB3=2 OR DUMB4=2 LOOP ENDS HERE *)

(******************** NONCONTINUOUS SCENARIO **********************)

11:IF CASS = 'Y' THEN
 BEGIN
   PLOT := 1 ;
   CULT := PROMPT1.PLAN * PROMPT1.AREA * 0.01 ;
   IF (DUMB3=2) OR (DUMB4=2) THEN
    BEGIN
     IF YRS[S] <= AGE1 THEN P := 1
     ELSE P := 2 ;
     IF YRS[S] <= AGE1 THEN O := YRS[S]
     ELSE O := YRS[S] - AGE1 ;
     WRITELN(TX,PLOT:2,CULT:10:2,'      ',P:2,'    ',O:2,HARV[YRS[S]]::2);
    END ; (* IF DUMB3=2 OR DUMB4=2 LOOP ENDS HERE  *)
 END ; (* IF CASS = 'Y' LOOP ENDS HERE *)

 (* NONCONTINUOUS SCENARIO ENDS HERE *)

  WRITELN(TX,'Number of Separate Plots:          ',PLOT);
  WRITELN(TX,'Area Under Cultivation:            ',CULT::2,' ha');
  WRITELN(TX,'Biomass Production:                ',HARV[YRS[S]]::2,' Megagrams') ;
  WRITELN(TX) ;
  WRITELN(TX) ;
  NET := 'N' ;
END ; (* PROCEDURE ENDS HERE *)
```

```
(*************************************************************)
(*                                                           *)
(*                        MAIN PROGRAM                       *)
(*                                                           *)
(*************************************************************)

BEGIN
 (* WRITE THE HEADING  *)

 FOR I := 1 TO 22 DO
 BEGIN
  CASE I OF
  1:WRITELN('*******************************************************');
  22:WRITELN('*******************************************************');
  4:WRITELN('BBBBBB       I     OOOOO       CCCC     U     U   TTTTTTTTTT');
  5:WRITELN('B     B      I    O     O     C    C    U     U       TT    ');
  6:WRITELN('B      B     I    O     O    C          U     U       TT    ');
  7:WRITELN('B     B      I    O     O    C          U     U       TT    ');
  8:WRITELN('B   BB       I    O     O    C          U     U       TT    ');
  9:WRITELN('B     B      I    O     O    C          U     U       TT   ');
  10:WRITELN('B      B     I    O     O    C          U     U       TT   ');
  11:WRITELN('B     B      I    O     O     C    C    U     U       TT   ');
  12:WRITELN('BBBBBB       I     OOOOO       CCCC      UUUUU       TT   ');
  17:WRITELN('          ECONOMIC MODEL OF BIOMASS PLANTATIONS           ');
  18:WRITELN('                     VERSION 1.0                          ');
  19:WRITELN('             OAK RIDGE NATIONAL LABORATORY                ');
  20:WRITELN('              OAK RIDGE, TENNESSEEE 37831                 ');
   OTHERWISE
    WRITELN ;
  END; (* CASE I OF ENDS HERE  *)
 END ; (* FOR I := 1 TO 22 LOOP ENDS HERE  *)
WRITELN ; KEY := CHR(10) ;
WRITE('HIT ANY KEY AND RETURN WHEN READY........');READLN(KEY);
FOR I := 1 TO 25 DO
WRITELN ;

(*  INITIALIZATION  *)

  WRITELN('WELCOME TO BIOCUT, VERSION 1.0 ! ') ;
  WRITELN ;
  WRITE('DO YOU WANT HELP ? TYPE "HELP" IF YES ELSE NO :') ;
  READLN(OPTION) ;
  IF OPTION= 'HELP' THEN HELP_ME(OPTION) ;
  WRITE('OPTION? ') ;
  READLN (OPTION) ;
  TERM := 'N';
  NET := 'N' ; CASS := 'N' ;

(*  READ OPTION TILL YOU WANT TO STOP   *)

  WHILE NOT (OPTION[1] = 'N') DO
   BEGIN
      CASE OPTION[1] OF
        'H' : HELP_ME(OPTION) ;
        'S' : BEGIN
```

```
      WRITELN('GIVE THE NAME OF FILE WHERE TO SAVE THIS',
              ' SCENARIO, e.g. ABC.DAT') ;
      READLN(INPUT_FILE) ;
      ASSIGN(OUTPUT_FILE,INPUT_FILE) ;
      REWRITE(OUTPUT_FILE) ;
      WRITELN(OUTPUT_FILE,PROMPT1.PURC,PROMPT3.TILL,PROMPT4.FTYP,
      PROMPT4.ETYP,TITLE,PROMPT1.AREA,PROMPT1.PLAN,
      PROMPT1.COS2,PROMPT1.COS1,PROMPT1.RESEL,PROMPT1.CLEA,
      PROMPT1.YLD1,PROMPT1.YLD2,PROMPT1.ENGY,PROMPT1.NUMB,
      PROMPT2.YEAR,PROMPT2.DISC,PROMPT2.SELL,PROMPT2.CHNG,
      PROMPT3.DEVL,PROMPT3.PRP1,PROMPT3.PRP2,PROMPT3.COST,PROMPT3.WEED,
      PROMPT3.PLAN,PROMPT4.MNGR,PROMPT4.ENVR,PROMPT4.ADDL,
      PROMPT5.HRVS,PROMPT5.TRNP,PROMPT5.PREP,AGE1,AGE2,WTYP,PTYP);
     FOR I := 1 TO 15  DO
     WRITELN(OUTPUT_FILE,PROMPT1.SCHD[I],SEED[I],SST2[I],SHM1[I],
       CEED[I],CST2[I],CHM1[I],SEST[I],SST3[I],SHM2[I],CEST[I],
       CST3[I],CHM2[I] ) ;
     FOR I := 1 TO 35  DO
     WRITELN(OUTPUT_FILE,MCLA[I],MSLA[I],MCMA[I],MSMA[I],PCLA[I],
       PSLA[I],PCMA[I],PSMA[I],PROMPT4.SAMT[I],PROMPT4.SCST[I],
       PROMPT4.CAMT[I],PROMPT4.CCST[I]) ;
     CLOSE(OUTPUT_FILE) ;
    END ;
'G' : BEGIN
      WRITELN('GIVE THE NAME OF YOUR BASECASE SCENARIO FILE',
              ' e.g. ABC.DAT') ;
      READLN(INPUT_FILE) ;
      ASSIGN(TEMP_FILE,INPUT_FILE) ;
      RESET(TEMP_FILE) ;
      READLN(TEMP_FILE,PROMPT1.  PURC,PROMPT3.TILL,PROMPT4.FTYP,
      PROMPT4.ETYP,TITLE,  PROMPT1.AREA,PROMPT1.PLAN,PROMPT1.COS2,
      PROMPT1.COS1,PROMPT1.RESEL,PROMPT1.CLEA,
      PROMPT1.YLD1,PROMPT1.YLD2,PROMPT1.ENGY,PROMPT1.NUMB,
      PROMPT2.YEAR,PROMPT2.DISC,PROMPT2.SELL,PROMPT2.CHNG,
      PROMPT3.DEVL,PROMPT3.PRP1,PROMPT3.PRP2,PROMPT3.COST,PROMPT3.WEED,
      PROMPT3.PLAN,PROMPT4.MNGR,PROMPT4.ENVR,PROMPT4.ADDL,
      PROMPT5.HRVS,PROMPT5.TRNP,PROMPT5.PREP,AGE1,AGE2,WTYP,PTYP);
      FOR I := 1 TO 15  DO
      READLN(TEMP_FILE,PROMPT1.SCHD[I],SEED[I],SST2[I],SHM1[I],
      CEED[I],CST2[I],CHM1[I],SEST[I],SST3[I],SHM2[I],CEST[I],
      CST3[I],CHM2[I] ) ;
      FOR I := 1 TO 35  DO
      READLN(TEMP_FILE,MCLA[I],MSLA[I],MCMA[I],MSMA[I],PCLA[I],
      PSLA[I],PCMA[I],PSMA[I],PROMPT4.SAMT[I],PROMPT4.SCST[I],
      PROMPT4.CAMT[I],PROMPT4.CCST[I]) ;
      CLOSE(TEMP_FILE) ;
     END ;
'R' : BEGIN
     (*   RISK OPTION *)

     IF (OPTION[2] = 'I') AND (OPTION[4]='K') THEN
       RISK(PROMPT2)
     ELSE   (* RUN OPTION  *)
     BEGIN
      WRITE('IS THIS A NONCONTINUOUS SCENARIO ? (Y/N)');READLN(CASS);
```

```
COMPUT(PROMPT1,PROMPT2,PROMPT3,PROMPT4,PROMPT5) ;

(*  GIVE THE DETAIL AT WHICH RESULTS ARE DESIRED  *)

WRITELN('AT WHAT DETAIL FINANCIAL RESULTS BE REPORTED');
WRITELN('AT THE TERMINAL ?') ;
WRITELN ;
WRITELN('  0 - FINAL SUMMARY RESULTS ONLY ') ;
WRITELN('  1 - ANNUAL SUMMARY ') ;
WRITELN('  2 - FULL ANNUAL DETAILS ') ;
WRITE('TYPE IN NUMBER : '); READLN(DUMB1) ;
WRITELN('AT WHAT DETAIL SHOULD THE PLANTATION LIFE CYCLE BE');
WRITELN(' REPORTED AT THE TERMINAL ? ');
WRITELN;
WRITELN('  0 - NOT AT ALL') ;
WRITELN('  1 - ANNUAL SUMMARY');
WRITELN('  2 - FULL ANNUAL DETAILS');
WRITE('TYPE IN NUMBER : '); READLN(DUMB3);
IF OUT_PUT = 'Y' THEN
 BEGIN
  WRITELN('AT WHAT DETAIL FINANCIAL RESULTS BE REPORTED');
  WRITELN('IN THE OUTPUT FILE ?') ;
  WRITELN('  0 - FINAL SUMMARY RESULTS ONLY ');
  WRITELN('  1 - ANNUAL SUMMARY ');
  WRITELN('  2 - FULL ANNUAL DETAILS ');
  WRITE('TYPE IN NUMBER : ');READLN(DUMB2);
  WRITELN('AT WHAT DETAIL SHOULD THE PLANTATION LIFE CYCLE BE');
  WRITELN(' REPORTED IN THE OUTPUT FILE ?');
  WRITELN;
  WRITELN('  0 - NOT AT ALL') ;
  WRITELN('  1 - ANNUAL SUMMARY');
  WRITELN('  2 - FULL ANNUAL DETAILS');
  WRITE('TYPE IN NUMBER : '); READLN(DUMB4)
 END  (* OUTPUT = Y LOOP ENDS HERE *)
ELSE
DUMB2 := 0 ;

(* GET THE YEAR FOR WHICH THE RESULT IS DESIRED  *)

IF (DUMB1 <> 0) OR (DUMB2 <> 0) OR(DUMB3<>0) OR(DUMB4<>0)THEN
BEGIN
 WRITE('WHICH YEARS ? ** END WITH 99 ** : '); S := 0 ;
 WHILE YRS[S] <> 99 DO
  BEGIN
   S := S + 1 ;
   READ(YRS[S])
  END ;
  READLN
END ;  (* IF DUMB1 <> 0 ......... LOOP ENDS HERE  *)

(* WRITE THE YEARLY RESULTS  *)

IF (DUMB1 <> 0) OR (DUMB3 <> 0) THEN
 BEGIN
  S := 1 ;  NET := 'Y' ;
```

```
        WHILE YRS[S] <> 99 DO
         BEGIN
            (* PLANTATION LIFE CYCLE  *)
          IF (DUMB3 <> 0) AND (NET = 'Y') THEN PLANT ;
          IF (DUMB3=2) OR (DUMB3=1) THEN CLOSE(TX) ;
          CASE DUMB1 OF
           1 : WRITELN('NET PRESENT VALUE : $',PV[YRS[S]]::2);
           2 : BEGIN
                IF S = 1 THEN LIST(YRS[1])
                ELSE
                 BEGIN
                  WRITE('O.K TO CONTINUE ? (Y/N) ');
                  READLN(NET);
                  IF NET = 'Y' THEN LIST(YRS[S])
                   ELSE
               GOTO 1 ;
                 END ;   (* ELSE BEGIN LOOP ENDS HERE *)
               END ;  (* BEGIN LOOP ENDS HERE *)
               OTHERWISE WRITELN ;
           END ; (* CASE OPTION ENDS HERE *)
           S := S + 1 ;
           WRITE('O.K TO CONTINUE ? (Y/N) ');READLN(NET);
         END ; (* WHILE LOOP ENDS HERE *)
       END ;  (* IF DUMB1 <> 0 LOOP ENDS HERE *)
       DUMB3 := 0 ;

       (* WRITE PROJECT SUMMARY RESULTS *)

       IF (YRS[S] = 99) OR (DUMB1 = 0) THEN
       BEGIN
        WRITELN('Project Summary                                    ');
        WRITELN('__________________________________________________');
        WRITELN('Discounted Average Cost          ',DAVG::2,' $/MEGAGRAM');
        WRITELN('                                 ',DAVG1::2,' $/GJ');
        (*WRITELN('Annualized Average Cost          ',AAVG::2,' $/MEGAGRAM') ;*)
        (*WRITELN('                                 ',AAVG1::2,' $/GJ');*)
        WRITELN('Internal Rate of Return          ',IRR::2,' %');
        WRITELN('Net Present Value                ',PV[PROMPT2.YEAR]::2,' $');
        WRITELN('Benefit/Cost Ratio               ',
                 (PVRV[PROMPT2.YEAR]/PVCS[PROMPT2.YEAR])::2);
        CASS := 'N' ;
       END ;
         (* WRITING OUT TO THE OUTPUT FILE *)

       1:IF OUT_PUT = 'Y' THEN
       PRINT(TERM_FILE,PROMPT1,PROMPT2,PROMPT3,PROMPT4,PROMPT5);
      END ; (* ELSE RUN OPTION LOOP ENDS HERE *)
      END ;
'L' : BEGIN
       TERM := 'Y' ;
       LIST_FILE := 'LIST      ';
       PRINT(LIST_FILE,PROMPT1,PROMPT2,PROMPT3,PROMPT4,PROMPT5)
       END ;
'O' : BEGIN
       WRITELN('NAME OF FILE TO RECEIVE OUTPUT FILE, e.g. ABC.OUT:');
```

```
            READLN(TERM_FILE) ;
            OUT_PUT := 'Y'
           END ;
      'T' : BEGIN
            WRITELN('GIVE THE NAME, DESCRIPTION OF YOUR SCENARID,',
            ' MAXIMUM OF 20 CHARACTERS :') ;
            WRITELN ;
            READLN(TITLE)
           END ;
      '1' : OPTION1(PROMPT1,OPTION);
      '2' : OPTION2(PROMPT2,OPTION);
      '3' : OPTION3(PROMPT3,OPTION) ;
      '4' : OPTION4(PROMPT4,OPTION,AGE1,AGE2) ;
      '5' : OPTION5(PROMPT5,OPTION) ;
           OTHERWISE
              WRITELN('***ERROR*** INVALID OPTION **********') ;
     END ; (* CASE OPTION ENDS *)

     WRITELN ;
     WRITE('OPTION? ') ;
     READLN(OPTION) ;
     IF OPTION = 'STOP' THEN
      BEGIN
       WRITE('DID YOU WANT TO SAVE THIS SCENARIO BEFORE SIGNING OFF ?',
            ' (Y/N) ') ; READLN(OPTION[1]) ;
       IF OPTION[1] = 'Y' THEN OPTION := 'SAVE' ;
      END ;
    END ; (* WHILE NOT LOOP ENDS *)
END . (* MAIN PROGRAM ENDS HERE *)

(*****************************************************************)

(*************************************************************)
(*   ***   ***    *****   *****    *    *  *      ****** *)
(*   *  * *  *   *    *  *    *   *    *  *      *     *)
(*   *  *  *  *   *    *  *     *  *    *  *      ****  *)
(*   *     *  *   *    *  *    *  *    *  *      *     *)
(*   *     *    *****   *****     *****   *****  ****** *)
(*************************************************************)
(*************************************************************)
(*                                                           *)
(*  MODULE ONE WHICH IS CALLED HELP.PAS CONTAINS ALL PROCEDURES *)
(*  FOR THE VARIOUS OPTIONS AND ALSO CONTAINS RISK PROCEDURE    *)
(*                                                           *)
(*************************************************************)
(*************************************************************)


   MODULE ONE [PUBLIC] ;

   (*   DECLARATION OF VARIABLES    *)

   TYPE
        REAL = REAL8 ;
   TYPE CHARC = PACKED ARRAY [1..4] OF CHAR ;
```

```
    STRUC1  = RECORD     (* OPTION 1 *)
    AREA :REAL ;
    PLAN :REAL ;
    PURC :CHAR ;
    COS2 :REAL ;
    COS1 :REAL ;
    RESEL:REAL ;
    SCHD :ARRAY [1..15] OF REAL ;
    CLEA :REAL ;
    YLD1 :REAL ;
    YLD2 :REAL ;
    ENGY :REAL ;
    NUMB :INTEGER
END ;

    STRUC2 = RECORD    (* OPTION 2 *)
    YEAR : INTEGER ;
    DISC : REAL ;
    SELL : REAL ;
    CHNG : REAL
END ;

    STRUC3 = RECORD     (* OPTION 3 *)
    DEVL : REAL ;
    PRP1 : REAL ;
    PRP2 : REAL ;
    COST : REAL ;
    WEED : REAL ;
    TILL : CHAR ;
    PLAN : REAL
END ;

    STRUC4 = RECORD      (* OPTION 4 *)
    MNGR :REAL ;
    FTYP :PACKED ARRAY [1..20] OF CHAR ;
    SAMT :ARRAY [1..35] OF REAL ;
    SCST :ARRAY [1..35] OF REAL ;
    CAMT :ARRAY [1..35] OF REAL ;
    CCST :ARRAY [1..35] OF REAL ;
    ETYP :PACKED ARRAY [1..20] OF CHAR ;
    ENVR :REAL ;
    ADDL :REAL
END ;

    STRUC5 = RECORD       (* OPTION 5 *)
    HRVS : REAL ;
    TRNP : REAL ;
    PREP : REAL
END ;


PASS = ARRAY [1..35] OF REAL ;
PAS1 = ARRAY [1..15] OF REAL ;
CAL = PACKED ARRAY [0..35] OF REAL ;
```

```
VAR  [EXTERN]   (*  VARIOUS COSTS *)
   LAND : CAL ; (* LAND COST *)
   DEVL : CAL ; (* INFRASTRUCTURE DEVELOPMENT COST *)
   SPRP : CAL ; (* SITE PREPARATION COST *)
   PWCS : CAL ; (* PRE-PLANTING WEED CONTROL COST *)
   PLAN : CAL ; (* PLANTING COST *)
   MCST : CAL ; (* MANAGERIAL COST *)
   FCST : CAL ; (* FERTILIZATION COST *)
   WCST : CAL ; (* POST ESTABLISHMENT WEED CONTROL COST *)
   SCST : CAL ; (* SEEDLING COST *)
   PCST : CAL ; (* POST ESTABLISHMENT PEST CONTROL COST *)
   ACST : CAL ; (* ADDITIONAL COST *)
   HCST : CAL ; (* HARVESTING COST *)
   ECST : CAL ; (* SPECIAL ONGOING ENVIRONMENTAL COSTS *)
   TCST : CAL ; (* TRANSPORTATION COST *)
   REVN : CAL ; (* TOTAL REVENUE *)
   PV   : CAL ; (* PRESENT VALUE *)

   VAR [EXTERN]
        SEED,SST2,SHM1,CEED,CST2,CHM1,SEST,SST3,SHM2,
        CEST,CST3,CHM2: PAS1 ;
   VAR [EXTERN]
        MCLA,MSLA,MCMA,MSMA,PCLA,PSLA,PCMA,PSMA: PASS ;

   VAR [EXTERN]
       AGE1,AGE2,WTYP,PTYP : INTEGER ;

   PROCEDURE OP43_44(VAR A4,B4,C4,D4,E4,F4:PAS1; VAR G4,H4,I4,J4:PASS;
                              A,B,C:INTEGER) ; FORWARD ;

(*************************************************************)
(*                                                           *)
(*   PROCEDURE HELP LISTS THE VARIOUS OPTIONS AVAILABLE .    *)
(*                                                           *)
(*************************************************************)


   PROCEDURE HELP_ME(OPTION : CHARC ) ;

   LABEL
         10,20,30,40,50,60,99 ;

   VAR
      I,HELL : INTEGER ;
      OK : CHAR ;
   BEGIN
      IF OPTION  <> 'HELP'
        THEN
           BEGIN
             WRITELN('*** ERROR **** INVALID OPTION ****') ;
             GOTO 99
           END
         ELSE
            BEGIN
              OK := 'N' ;
```

```
          WRITELN('WHICH LIST OF OPTIONS SHOULD BE DISPLAYED ?') ;
          WRITELN('  0-PROGRAM OPERATING COMMANDS ') ;
          WRITELN('  1-PLANTATION SCENARIO OPTIONS ') ;
          WRITELN('  2-FINANCIAL/ECONOMIC OPTIONS ') ;
          WRITELN('  3-PLANTATION ESTABLISHMENT OPTIONS ') ;
          WRITELN('  4-OPERATION AND MAINTENANCE OPTIONS ') ;
          WRITELN('  5-HARVESTING DECISION OPTIONS ') ;
          WRITELN('  6-ALL OF THE ABOVE ') ;
          WRITE(' ? ') ;
          READLN(HELL) ;
          CASE HELL OF
             0 : GOTO 10 ;
             1 : GOTO 20 ;
             2 : GOTO 30 ;
             3 : GOTO 40 ;
             4 : GOTO 50 ;
             5 : GOTO 60 ;
             6 : GOTO 10 ;
               OTHERWISE
                 WRITELN('**ERROR**INVALID CHOICE---RETURNING',
                        ' TO OPTION REQUEST MODE') ;
           END ; (* CASE ENDS *)
        END ; (* ELSE BEGIN LOOP ENDS HERE *)

(* DIFFERENT OPTIONS START HERE *)

10 : BEGIN
      WRITELN('PROGRAM OPERATING COMMANDS ');
      WRITELN('___________________________');
      WRITELN('HELP   TYPE OUT THIS HELP MESSAGE ');
      WRITELN('STOP   END EXECUTION OF THIS PROGRAM ');
      WRITELN('RUN    EXECUTE THE CURRENTLY SPECIFIED FILE ');
      WRITELN('SAVE   SAVE THE CURRENT SCENARIO AS A BASECASE FILE ');
      WRITELN('GET    RETRIEVE AN EXISTING BASECASE SCENARIO FILE ') ;
      WRITELN('LIST   LIST THE CURRENT SCENARIO ON TERMINAL ') ;
      WRITELN('OUTPUT OPEN A FILE TO RECEIVE PRINTOUT ') ;
      WRITELN('TITLE  GIVE THE TITLE TO CURRENT SCENARIO ') ;
      WRITELN('RISK   DO THE RISK ANALYSIS ') ;
      WRITELN ;
      IF HELL = 6 THEN WRITE('O.K TO CONTINUE ? (Y/N) ') ;
      IF HELL = 6 THEN READLN(OK) ;
      IF (HELL () 6) OR (OK () 'Y')  THEN GOTO 99
    END ; (* LABEL 10 LOOP ENDS HERE *)

20 : BEGIN
      WRITELN('PLANTATION SCENARIO OPTIONS ');
      WRITELN('___________________________ ');
      WRITELN('1.01    TOTAL LAND AREA OF PLANTATION ');
      WRITELN('1.02    TOTAL PLANTED PORTION OF PLANTATION ');
      WRITELN('1.03    LAND PURCHASE OR LEASE, AND COST ');
      WRITELN('1.04    PLANTATION HARVESTING PERIOD') ;
      WRITELN('1.05    BIOMASS YIELD FOR SEEDLING AND COPPICE ');
      WRITELN('1.06    ENERGY CONTENT OF BIOMASS ');
      WRITELN('1.07    NUMBER OF COPPICE CYCLES BEFORE RETURN TO',
                       'SEEDLING PLANTING ');
```

```
      WRITELN ;
      IF HELL = 6 THEN WRITE('O.K TO CONTINUE ? (Y/N) ') ;
      IF HELL = 6 THEN READLN(OK) ;
      IF (HELL <> 6) OR (OK <> 'Y')  THEN GOTO 99
    END ;  (* LABEL 20 LOOP ENDS HERE *)

30 : BEGIN
      WRITELN('FINANCIAL/ECONOMIC OPTIONS ') ;
      WRITELN('_________________________ ') ;
      WRITELN('2.01    LAST YEAR OF EVALUATION PERIOD ') ;
      WRITELN('2.02    DISCOUNT RATE ') ;
      WRITELN('2.03    EXPECTED REAL SELLING PRICE OF PLANTATION ');
      WRITELN('        OUTPUTS ') ;
      WRITELN ;
      IF HELL = 6 THEN WRITE('O.K TO CONTINUE ? (Y/N) ') ;
      IF HELL = 6 THEN READLN(OK) ;
      IF (HELL <> 6) OR (OK <> 'Y')  THEN GOTO 99
    END ; (* LABEL 30 ENDS HERE *)

40 : BEGIN
      WRITELN('PLANTATION ESTABLISHMENT OPTIONS ');
      WRITELN('_______________________________ ');
      WRITELN('3.01    INFRASTRUCTURE DEVELOPMENT COSTS ') ;
      WRITELN('3.02    SITE PREPARATION COST ') ;
      WRITELN('3.03    SEEDLING COST ') ;
      WRITELN('3.04    PRE-PLANTING WEED CONTROL COST ') ;
      WRITELN('3.05    PLANTING COSTS ') ;
      WRITELN ;
      IF HELL = 6 THEN WRITE('O.K TO CONTINUE ? (Y/N) ') ;
      IF HELL = 6 THEN READLN(OK) ;
      IF (HELL <> 6) OR (OK <> 'Y')  THEN GOTO 99
    END ; (* LABEL 30 LOOP ENDS HERE *)

50 : BEGIN
      WRITELN('OPERATION AND MAINTENANCE OPTIONS ') ;
      WRITELN('_______________________________ ') ;
      WRITELN('4.01    MANAGERIAL EXPENSES ') ;
      WRITELN('4.02    FERTILIZER APPLICATION AND COST ') ;
      WRITELN('4.03    POST-ESTABLISHMENT WEED CONTROL AND COST ') ;
      WRITELN('4.04    POST-ESTABLISHMENT PEST CONTROL AND COST ') ;
      WRITELN('4.05    ONGOING ENVIRONMENTAL PROTECTION ACTIVITIES ') ;
      WRITELN('4.06    OTHER RECURRING COSTS ') ;                     ;
      WRITELN ;
      IF HELL = 6 THEN WRITE('O.K TO CONTINUE ? (Y/N) ') ;
      IF HELL = 6 THEN READLN(OK) ;
      IF (HELL <> 6) OR (OK <> 'Y')  THEN GOTO 99
    END ; (* LABEL 40 LOOP ENDS HERE *)

60 : BEGIN
      WRITELN('HARVESTING DECISION OPTIONS ') ;
      WRITELN('_________________________ ') ;
      WRITELN('5.01    HARVEST LABOR COSTS ') ;
      WRITELN('5.02    COST OF HARVESTED MATERIAL TRANSPORT TO ') ;
      WRITELN('        COLLECTION SITE ') ;
      WRITELN('5.03    COST OF BIOMASS MATERIAL PREPARATION (E.G. ');
```

```
        WRITELN('        CHIPPING CUTTING) ') ;
        WRITELN ;
      END ; (* LABEL 50 LOOP ENDS HERE *)

99: END ; (* PROCEDURE ENDS HERE *)

(*************************************************************)
(*                                                           *)
(*   PROCEDURE OPTION1 READS THE DATA FOR PLANTATION SCENARIO  *)
(*   OPTIONS.                                                *)
(*                                                           *)
(*************************************************************)

 PROCEDURE OPTION1(VAR VARBL1: STRUC1 ; OPTION :CHARC) [PUBLIC];

 LABEL 99 ;
 VAR
  I :INTEGER ; TEMP : REAL ;

 BEGIN

    IF (OPTION[2] <> '.') AND (OPTION[3] <> '0')
      THEN
        BEGIN
         WRITELN('***ERROR*** INVALID OPTION ***') ;
         GOTO 99
        END
      ELSE
        BEGIN
          CASE OPTION[4] OF
          '1':BEGIN    (* OPTION 1.01 *)
               WRITELN('SPECIFY THE TOTAL LAND AREA OF THE PLANTATION');
               WRITE('(IN HECTARES) : ') ; READLN(VARBL1.AREA) ;
              END ;
          '2':BEGIN      (* OPTION 1.02 *)
               WRITELN('SPECIFY THE PERCENTAGE OF THE TOTAL LAND AREA') ;
               WRITE(' DEVOTED TO BIOMASS: ') ; READLN(VARBL1.PLAN)
              END ;
          '3':BEGIN      (* OPTION 1.03 *)
               WRITE('IS THE LAND PURCHASED OR LEASED ? (P/L) ');
               READLN(VARBL1.PURC) ;
               IF (VARBL1.PURC = 'P') THEN (* LAND IS PURCHASED *)
                 BEGIN
                   WRITE('SPECIFY THE COST PER HECTARE: $');
                   READLN(VARBL1.COS1) ;
                   WRITE('SPECIFY THE RESALE VALUE PER HECTARE : $') ;
                   READLN(VARBL1.RESEL)
                 END  (* IF VARBL1.PURC='P' LOOP ENDS HERE  *)
                    ELSE
                      BEGIN (* LAND IS LEASED *)
                        WRITE('SPECIFY THE INITIAL YEAR RENTAL COST PER ',
                              'HECTARE :$') ;
                        READLN(VARBL1.COS2) ;
                        WRITELN('SPECIFY THE COST ESCALATION FACTOR(IN',
                              ' REAL UNINFLATED TERMS )') ;
```

```
                    WRITE('AS A PERCENTAGE CHANGE IN ',
                          ' ANNUAL RENT:$') ; READLN(VARBL1.CLEA)
                  END ; (* ELSE VARBL1.PURC='P' LOOP ENDS HERE *)

            (* IF LAND IS PURCHASED, GIVE THE LAND ACQUISITION SCHEDULE *)
               IF VARBL1.PURC = 'P'
               THEN
                BEGIN
                 TEMP := 0.0 ;
                 WRITELN('INDICATE THE LAND ACQUISITION SCHEDULE :');
                 FOR I := 1 TO 15 DO
                  BEGIN
                   WRITE('YEAR',I:3,' :') ; READLN(VARBL1.SCHD[I]) ;
                   TEMP := TEMP + VARBL1.SCHD[I] ;
                   IF (ABS(100-TEMP) ( 0.001 ) THEN GOTO 99
                  END ; (* DO LOOP ENDS HERE *)
                 END ; (* ACQUISITION LOOP ENDS HERE *)
            END ;
        '4':BEGIN        (* OPTION 1.04  *)
             WRITE('SPECIFY THE PLANTATION HARVESTING AGE: ') ;
             READLN(AGE1) ;
             (* SINCE SEEDLING GROWING PERIOD IS EQUAL TO COPPICE
                    GROWING PERIOD *)
             AGE2 := AGE1 ;
            END ;
        '5':BEGIN        (* OPTION 1.05  *)
             WRITELN('SPECIFY THE PROJECTED BIOMASS YIELD FOR ',
                    ' SEEDLING') ;
             WRITE(' IN MEGAGRAMS PER HECTARE : ') ;READLN(VARBL1.YLD1) ;
             WRITELN('SPECIFY THE PROJECTED BIOMASS YIELD FOR COPPICE');
             WRITE(' IN MEGAGRAMS PER HECTARE : ') ;READLN(VARBL1.YLD2);
            END ;
        '6':BEGIN        (* OPTION 1.06  *)
             WRITELN('WHAT IS THE ENERGY CONTENT OF THE BIOMASS ');
             WRITE('IN GIGAJOULES PER MEGAGRAM ? ');READLN(VARBL1.ENGY)
            END ;
        '7':BEGIN        (*  OPTION 1.07   *)
             WRITE('SPECIFY THE NUMBER OF COPPICE HARVESTS: ');
             READLN(VARBL1.NUMB)
            END ;
                OTHERWISE
                  WRITELN('***ERROR*** INVALID OPTION ***') ;
        END ;  (* CASE OPTION ENDS *)
  99:END ; (* ELSE LOOP ENDS HERE *)

 END ; (* PROCEDURE ENDS HERE *)

(*************************************************************)
(*                                                           *)
(*  PROCEDURE OPTION2 READS THE DATA FOR FINANCIAL/ECONOMIC  *)
(*  OPTIONS .                                                *)
(*                                                           *)
(*************************************************************)

PROCEDURE OPTION2(VAR VARBL2:STRUC2 ; OPTION:CHARC) ;
```

```
LABEL 99 ;
BEGIN

  IF (OPTION[2] () '.') AND (OPTION[3] () '0') THEN
    BEGIN
     WRITELN('***ERROR**** INVALID OPTION ***') ;
     GOTO 99
    END
   ELSE
    BEGIN
      CASE OPTION[4] OF
      '1' : BEGIN      (* OPTION 2.01  *)
            VARBL2.YEAR := 0 ;
            WHILE (VARBL2.YEAR)35) OR (VARBL2.YEAR=0) DO
             BEGIN
              WRITE('SPECIFY THE LAST YEAR IN THE EVALUATION ',
                    'PERIOD :') ; READLN(VARBL2.YEAR) ;
              IF VARBL2.YEAR)35 THEN
               WRITELN('***THE LAST YEAR IN EVALUATION PERIOD',
                       ' CAN BE NO GREATER THAN 35 ***')
             END ; (* WHILE LOOP ENDS HERE *)
            END ;
      '2' : BEGIN   (*  OPTION 2.02   *)
             WRITE('SPECIFY THE ANNUAL DISCOUNT RATE (%) : ') ;
             READLN(VARBL2.DISC)
            END ;
      '3' : BEGIN    (*  OPTION 2.03  *)
             WRITELN('SPECIFY THE INITIAL EXPECTED REAL SELLING',
                    ' PRICE FOR') ;
             WRITELN('PROJECT OUTPUTS, (I.E. THE PRICE AT THE ',
                    'START OF THE FIRST HARVEST)') ;
             WRITE('DOLLARS PER DRY MEGAGRAM :$') ; READLN(VARBL2.SELL) ;
             WRITELN('SPECIFY THE ANNUAL REAL PERCENTAGE CHANGE IN');
             WRITE(' EXPECTED SELLING PRICE : ');READLN(VARBL2.CHNG)
            END ;
            OTHERWISE
             WRITELN('***ERROR*** INVALID OPTION ****') ;
      END ; (* CASE OPTION ENDS *)
  99: END ; (* ELSE LOOP ENDS HERE *)

END ; (* PROCEDURE ENDS HERE *)

(*************************************************************)
(*                                                           *)
(*  PROCEDURE OPTION3 READS THE DATA FOR PLANTATION ESTABLISHMENT *)
(*  OPTIONS.                                                 *)
(*                                                           *)
(*************************************************************)

PROCEDURE OPTION3(VAR VARBL3:STRUC3 ;OPTION:CHARC) ;

LABEL 99 ;

BEGIN
```

```
 IF (OPTION[2] <> '.') AND (OPTION[3] <> '0') THEN
   BEGIN
    WRITELN('***ERROR***INVALID OPTION***') ;
    GOTO 99
   END
  ELSE
   BEGIN
    CASE OPTION[4] OF
    '1' : BEGIN   (*  OPTION 3.01  *)
           WRITE('SPECIFY THE INFRASTRUCTURE DEVELOPMENT COSTS :$');
           READLN(VARBL3.DEVL)
          END ;
    '2' : BEGIN    (*  OPTION 3.02  *)
           WRITE('SPECIFY THE SITE PREPARATION COST PER HECTARE: ');
           READLN(VARBL3.PRP1) ;
           WRITELN('SPECIFY SITE PREPARATION COST PER HECTARE FOR',
                  ' AREAS') ;
           WRITE('RETURNING TO SEEDLING AFTER A PREVIOUS HARVEST :$');
           READLN(VARBL3.PRP2)
          END ;
    '3' : BEGIN     (*  OPTION 3.03  *)
           WRITE('SPECIFY THE SEEDLING OR CUTTING COST PER HECTARE : $');
           READLN(VARBL3.COST)
          END ;
    '4' : BEGIN     (*  OPTION 3.04   *)
           VARBL3.TILL := 'Y' ; (* THIS VARIABLE NOT IN OPERATION *)
           WRITELN('SPECIFY THE COST OF PRE-PLANTING WEED ',
                  'CONTROL') ;
           WRITE('PER HECTARE : $') ;
           READLN(VARBL3.WEED)
          END ;
    '5' : BEGIN      (*  OPTION 3.05  *)
           WRITE('SPECIFY THE PLANTING COSTS PER HECTARE: $') ;
           READLN(VARBL3.PLAN)
          END ;
           OTHERWISE
            WRITELN('***ERROR***INVALID OPTION***') ;
    END ; (* CASE OPTION ENDS *)
99: END ; (* ELSE LOOP ENDS HERE *)

END ; (* PROCEDURE ENDS HERE *)

(*************************************************************)
(*                                                           *)
(*  PROCEDURE OPTION4 READS THE DATA FOR OPERATION AND MAINTENANCE*)
(*  OPTIONS.                                                 *)
(*                                                           *)
(*************************************************************)

PROCEDURE OPTION4(VAR VARBL4:STRUC4 ; OPTION:CHARC ; AG11,AG12:INTEGER);

LABEL 99 ;

VAR DUMMY : CHAR ;
```

```
   I : INTEGER ;

BEGIN
 IF (OPTION[2]  () '.') AND (OPTION[3] () '0')
  THEN
   BEGIN
    WRITELN('***ERROR*** INVALID OPTION ***') ;
    GOTO 99
   END
  ELSE
   BEGIN
    CASE OPTION[4] OF
    '1':BEGIN     (* OPTION 4.01 *)
         WRITELN('SPECIFY NORMAL MANAGERIAL EXPENSES PER HECTARE') ;
         WRITE('DURING A GROWING YEAR: $') ; READLN(VARBL4.MNGR)
        END ;
    '2':BEGIN      (*  OPTION 4.02  *)
         WRITE('WILL ANY FERTILIZER BE APPLIED ? (Y/N)') ;
         READLN(DUMMY) ;
         IF DUMMY = 'N' THEN  (* IF FERTILIZER NOT APPLIED   *)
          BEGIN
           FOR I := 1 TO AGE2 DO
           BEGIN
           VARBL4.CAMT[I] := 0.0 ; VARBL4.CCST[I] := 0.0 ;
           END ;
           FOR I := 1 TO AGE1 DO
           BEGIN
           VARBL4.SAMT[I] := 0.0 ; VARBL4.SCST[I] := 0.0
           END ;
          END    (*  IF FERTLIZER NOT APPLIED LOOP ENDS HERE   *)
         ELSE
          BEGIN   (* FERTILIZER IS APPLIED  *)
           WRITELN('SPECIFY THE TYPE OF FERTILIZER APPLIED (N,P,K):');
           READLN(VARBL4.FTYP) ;
           WRITELN('SPECIFY THE AMOUNT (IN KILOGRAMS PER HECTARE) OF FERTILIZER') ;
           WRITELN('APPLIED IN A EACH YEAR : ');

         (*     SEEDLING  CYCLE     *)

           FOR I := 1 TO AG11 DO
            BEGIN
             WRITE('   YEAR',I:3,' OF SEEDLING CYCLE:');
             READLN(VARBL4.SAMT[I])
            END ;
           WRITELN('SPECIFY THE APPLICATION COST  PER HECTARE:');
           FOR I := 1 TO AG11 DO
            BEGIN
             WRITE('   YEAR',I:3,' OF SEEDLING CYCLE:');
             READLN(VARBL4.SCST[I])
            END ;

       (* FOR COPPICE CYCLE *)

           WRITELN ;
           WRITELN('SPECIFY THE AMOUNT (IN KILOGRAMS PER HECTARE) OF FERTILIZER') ;
```

```
      WRITELN('APPLIED IN EACH YEAR :') ;
      FOR I := 1 TO AG12 DO
       BEGIN
        WRITE('   YEAR',I:3,' OF COPPICE CYCLE:') ;
        READLN(VARBL4.CAMT[I])
       END ;
      WRITELN('SPECIFY THE APPLICATION COST PER HECTARE:');
      FOR I := 1 TO AG12 DO
       BEGIN
        WRITE('   YEAR',I:3,' OF COPPICE CYCLE:') ;
        READLN(VARBL4.CCST[I])
       END
     END (* ELSE LOOP ENDS HERE *)
    END ; (* CASE OPTION '2' ENDS HERE *)

'3':BEGIN    (* OPTION 4.03  *)
     WRITELN('SPECIFY THE TYPE OF POST ESTABLISHMENT WEED CONTROL:');
     WRITELN('       0 - NONE ') ;
     WRITELN('       1 - MECHANICAL METHOD') ;
     WRITELN('       2 - CHEMICAL METHOD') ;
     WRITELN('       3 - BOTH MECHANICAL AND CHEMICAL METHODS');
     WRITELN ;
     WRITE('TYPE IN NUMBER OF CHOICE : ');READLN(WTYP);
     IF (WTYP(0) AND (WTYP)3) THEN
     WRITELN('***INVALID RESPONSE***,TYPE "4.03" AGAIN')
      ELSE
       BEGIN
        IF WTYP = 0 THEN
         WRITELN('NO POST ESTABLISHMENT WEED CONTROL WILL BE USED.')
         ELSE  (* CALL OP43_44 PROCEDURE  *)
          OP43_44(SEED,SST2,SHM1,CEED,
               CST2,CHM1,MCLA,MSLA,MCMA,MSMA,WTYP,AG11,AG12);
         END; (* ELSE LOOP ENDS HERE *)

    END ;
'4':BEGIN       (*  OPTION 4.04  *)
     WRITELN('SPECIFY THE TYPE OF POST ESTABLISHMENT PEST CONTROL:');
     WRITELN('       0 - NONE ') ;
     WRITELN('       1 - MECHANICAL METHOD') ;
     WRITELN('       2 - CHEMICAL METHOD') ;
     WRITELN('       3 - BOTH MECHANICAL AND CHEMICAL METHODS');
     WRITELN ;
     WRITE('TYPE IN NUMBER OF CHOICE : ');READLN(PTYP);
     IF (PTYP(0) AND (PTYP)3) THEN
     WRITELN('***INVALID RESPONSE***,TYPE "4.04" AGAIN')
      ELSE
       BEGIN
        IF PTYP = 0 THEN
          WRITELN('NO POST ESTABLISHMENT PEST CONTROL WILL BE USED.')
        ELSE   (*    CALL  OP43_44 PROCEDURE   *)
         OP43_44(SEST,SST3,SHM2,CEST,CST3,CHM2,PCLA,PSLA,PCMA,PSMA,
                 PTYP,AG11,AG12)
       END ; (* ELSE LOOP ENDS HERE *)
    END ;
'5':BEGIN      (*  OPTION 4.05  *)
```

```
        WRITELN('SPECIFY THE TYPE OF SPECIAL ONGOING ENVIRONMENTAL');
        WRITE(' PROTECTION ACTIVITIES :');READLN(VARBL4.ETYP) ;
        WRITE('SPECIFY THE ANNUAL COST PER HECTARE OF THESE',
               ' ACTIVITIES :$') ; READLN(VARBL4.ENVR)
       END ;
   '6':BEGIN      (*  OPTION 4.06  *)
        WRITELN('SPECIFY THE ADDITIONAL COST PER HECTARE FOR',
               ' RECURRING') ;
        WRITE('ACTIVITIES NOT REFLECTED ELSEWHERE IN GROUP 4 ',
              'PARAMETERS : $') ; READLN(VARBL4.ADDL)
       END ;
        OTHERWISE
         WRITELN('***ERROR*** INVALID OPTION ***') ;
   END ; (* CASE OPTION ENDS *)
 99 : END ; (* ELSE LOOP ENDS HERE *)

 END ; (* PROCEDURE ENDS HERE *)


(*********************************************************)
(*                                                       *)
(*  PROCEDURE OP43_44 READS THE DETAILED DATA FOR OPTIONS  *)
(*  4.03 & 4.04.                                         *)
(*                                                       *)
(*********************************************************)

PROCEDURE OP43_44 ;

LABEL 10,99 ;

VAR
    I : INTEGER ;

BEGIN
 IF A = 2 THEN GOTO 10 ;

 FOR I := 1 TO B DO   (* MECHANICAL CONTROL OF SEEDLING CYCLE  *)
  BEGIN
   WRITELN('MECHANICAL CONTROL FOR YEAR',I:3,' OF SEEDLING CYCLE :');
   WRITELN ;
   WRITE('SPECIFY THE LABOR COST PER HECTARE : $');READLN(H4[I]) ;
   WRITE('SPECIFY THE EQUIPMENT COST PER HECTARE : $');READLN(J4[I]);
   WRITELN
  END ;
 FOR I := 1 TO C DO    (* MECHANICAL CONTROL OF COPPICE CYCLE *)
  BEGIN
   WRITELN('MECHANICAL CONTROL FOR YEAR',I:3,' OF COPPICE CYCLE :');
   WRITELN ;
   WRITE('SPECIFY THE LABOR COST PER HECTARE : $');READLN(G4[I]) ;
   WRITE('SPECIFY THE EQUIPMENT COST PER HECTARE : $');READLN(I4[I]);
   WRITELN
  END ;

 IF A = 1 THEN GOTO 99 ;
```

```
10 : FOR I := 1 TO B DO  (* CHEMICAL CONTROL OF SEEDLING CYCLE *)
 BEGIN
  WRITELN('CHEMICAL CONTROL FOR YEAR',I:3,' OF SEEDLING CYCLE: ');
  WRITELN ;
  WRITE('SPECIFY THE APPLICATION COST PER HECTARE : $');READLN(A4[I]);
  WRITE('SPECIFY THE AMOUNT APPLIED (IN KILOGRAMS PER HECTARE) : ');READLN(B4[I]);
  WRITE('SPECIFY THE COSTS OF HERBICIDES PER HECTARE : ');READLN(C4[I]);
  WRITELN
 END ;
FOR I := 1 TO C DO       (* CHEMICAL CONTROL OF COPPICE CYCLE  *)
 BEGIN
  WRITELN('CHEMICAL CONTROL FOR YEAR',I:3,' OF COPPICE CYCLE: ');
  WRITELN ;
  WRITE('SPECIFY THE APPLICATION COST PER HECTARE : $');READLN(D4[I]);
  WRITE('SPECIFY THE AMOUNT APPLIED (IN KILOGRAMS PER HECTARE) : ');READLN(E4[I]);
  WRITE('SPECIFY THE COSTS OF HERBICIDES PER HECTARE : ');READLN(F4[I]);
  WRITELN
 END ;

99 : END ; (* PROCEDURE ENDS HERE *)

(*************************************************************)
(*                                                           *)
(*  PROCEDURE OPTION5 READS THE DATA FOR HARVESTING DECISION  *)
(*  OPTIONS.                                                 *)
(*                                                           *)
(*************************************************************)

PROCEDURE OPTION5(VAR VARBL5:STRUC5 ; OPTION:CHARC) ;

LABEL 99 ;

BEGIN
 IF (OPTION[2] <> '.') AND (OPTION[3] <> '0') THEN
  BEGIN
   WRITELN('***ERROR***INVALID OPTION ****') ;
   GOTO 99
  END
 ELSE
  BEGIN
   CASE OPTION[4] OF
   '1' : BEGIN     (* OPTION 5.01  *)
         WRITE('SPECIFY THE HARVESTING COST PER HECTARE: $');
         READLN(VARBL5.HRVS)
        END ;
   '2' : BEGIN     (*  OPTION 5.02  *)
         WRITELN('SPECIFY THE ANNUAL COST PER MEGAGRAM FOR TRANSPORTING');
         WRITE(' THE HARVESTED MATERIAL TO THE CONVERSION SITE: $');
         READLN(VARBL5.TRNP)
        END ;
   '3' : BEGIN      (*  OPTION 5.03  *)
         WRITELN('SPECIFY THE ANNUAL COST PER MEGAGRAM FOR PREPARATION');
         WRITE(' OF THE BIOMASS MATERIAL : $');
         READLN(VARBL5.PREP)
        END ;
```

```
        OTHERWISE
         WRITELN('***ERROR***INVALID OPTION***') ;
  END ; (* CASE OPTION ENDS *)
99: END ; (* ELSE LOOP ENDS HERE *)

END ; (* PROCEDURE ENDS HERE *)

(*************************************************************)
(*                                                           *)
(*  PROCEDURE RISK DOES RISK ANALYSIS FOR PROJECT UNCERTAINITY  *)
(*  PRESENT VALUE.                                           *)
(*                                                           *)
(*************************************************************)

 PROCEDURE RISK (VARBL2 :STRUC2) ;

VAR
   PCOST : ARRAY [1..15,1..3] OF REAL ;
   T1,T2,T3,CMEAN,CDEVN,DISCNT : REAL ;
   I,J : INTEGER ;

BEGIN
 WRITELN('WELCOME TO THE RISK ANALYSIS ! ') ;
 WRITELN ;

 (* INITIALIZATION *)
 FOR I := 1 TO 15 DO
  FOR J := 1 TO 3 DO
   PCOST[I,J] := 0.0 ;
 PCOST[1,2] := LAND[0] ;      PCOST[2,2] := DEVL[0] ;
 PCOST[3,2] := SPRP[0] ;      PCOST[4,2] := PWCS[0] ;
 PCOST[5,2] := PLAN[0] ;      PCOST[6,2] := MCST[0] ;
 PCOST[7,2] := FCST[0] ;      PCOST[8,2] := WCST[0] ;
 PCOST[9,2] := SCST[0] ;      PCOST[10,2] := PCST[0] ;
 PCOST[11,2] := ACST[0] ;     PCOST[12,2] := HCST[0] ;
 PCOST[13,2] := ECST[0] ;     PCOST[14,2] := TCST[0] ;
 PCOST[15,2] := REVN[0] ;

(* FIND THE PRESENT VALUE OF COSTS *)
 DISCNT := 1.0 ;
 FOR I := 1 TO VARBL2.YEAR DO
  BEGIN
   DISCNT := DISCNT * (1+ VARBL2.DISC * 0.01 ) ;
   PCOST[1,2] := PCOST[1,2] + LAND[I]/DISCNT ;
   PCOST[2,2] := PCOST[2,2] + DEVL[I]/DISCNT ;
   PCOST[3,2] := PCOST[3,2] + SPRP[I]/DISCNT ;
   PCOST[4,2] := PCOST[4,2] + PWCS[I]/DISCNT ;
   PCOST[5,2] := PCOST[5,2] + PLAN[I]/DISCNT ;
   PCOST[6,2] := PCOST[6,2] + MCST[I]/DISCNT ;
   PCOST[7,2] := PCOST[7,2] + FCST[I]/DISCNT ;
   PCOST[8,2] := PCOST[8,2] + WCST[I]/DISCNT ;
   PCOST[9,2] := PCOST[9,2] + SCST[I]/DISCNT ;
   PCOST[10,2] := PCOST[10,2] + PCST[I]/DISCNT ;
   PCOST[11,2] := PCOST[11,2] + ACST[I]/DISCNT ;
   PCOST[12,2] := PCOST[12,2] + HCST[I]/DISCNT ;
```

```
  PCOST[13,2] := PCOST[13,2] + ECST[I]/DISCNT ;
  PCOST[14,2] := PCOST[14,2] + TCST[I]/DISCNT ;
  PCOST[15,2] := PCOST[15,2] + REVN[I]/DISCNT ;
 END ;

(* NOW READ THE HIGH AND LOW VALUES *)

WRITELN('NOW GIVE THE LOW & HIGH VIEW FOR EACH OF THE COSTS, "TYPE 99 FOR',
      ' HELP" :') ;
WRITELN ;
WRITE('PARAMETER ? ') ; READLN(I) ;

WHILE NOT (I=100) DO
 BEGIN
  CASE I OF
   99 : BEGIN
         WRITELN('WHICH COST PARAMETER DO YOU WISH TO CHANGE ? ') ;
         WRITELN('    1 - LAND COST ') ;
         WRITELN('    2 - INFRASTRUCTURE DEVELOPMENT COST ');
         WRITELN('    3 - SITE PREPARATION COST ') ;
         WRITELN('    4 - PRE-PLANTING WEED CONTROL COST ') ;
         WRITELN('    5 - PLANTING COST ') ;
         WRITELN('    6 - MANAGERIAL COST ') ;
         WRITELN('    7 - FERTILIZATION COST ') ;
         WRITELN('    8 - POST ESTABLISHMENT WEED CONTROL COST');
         WRITELN('    9 - SEEDLING COST ') ;
         WRITELN('   10 - POST ESTABLISHMENT PEST CONTROL COST ') ;
         WRITELN('   11 - ADDITIONAL COST ') ;
         WRITELN('   12 - HARVESTING COST ') ;
         WRITELN('   13 - SPECIAL ONGOING ENVIRONMENTAL COSTS ') ;
         WRITELN('   14 - TRANSPORTATION COST ') ;
         WRITELN('   15 - REVENUE ') ;
         WRITELN('   99 - HELP ') ;
         WRITELN('  100 - STOP ') ;
        END ;
  OTHERWISE
   BEGIN
    IF(I=1) THEN WRITELN('LAND COST :: MOST LIKELY VALUE :',PCOST[I,2]::2);
    IF(I=2) THEN WRITELN('DEVL COST :: MOST LIKELY VALUE :',PCOST[I,2]::2);
    IF(I=3) THEN WRITELN('PREP COST :: MOST LIKELY VALUE :',PCOST[I,2]::2);
    IF(I=4) THEN WRITELN('WEED COST :: MOST LIKELY VALUE :',PCOST[I,2]::2);
    IF(I=5) THEN WRITELN('PLAN COST :: MOST LIKELY VALUE :',PCOST[I,2]::2);
    IF(I=6) THEN WRITELN('MANG COST :: MOST LIKELY VALUE :',PCOST[I,2]::2);
    IF(I=7) THEN WRITELN('FERT COST :: MOST LIKELY VALUE :',PCOST[I,2]::2);
    IF(I=8) THEN WRITELN('WEED COST :: MOST LIKELY VALUE :',PCOST[I,2]::2);
    IF(I=9) THEN WRITELN('SEED COST :: MOST LIKELY VALUE :',PCOST[I,2]::2);
    IF(I=10) THEN WRITELN('PEST COST :: MOST LIKELY VALUE :',PCOST[I,2]::2);
    IF(I=11) THEN WRITELN('ADDL COST :: MOST LIKELY VALUE :',PCOST[I,2]::2);
    IF(I=12) THEN WRITELN('HARV COST :: MOST LIKELY VALUE :',PCOST[I,2]::2);
    IF(I=13) THEN WRITELN('ENVR COST :: MOST LIKELY VALUE :',PCOST[I,2]::2);
    IF(I=14) THEN WRITELN('TRAN COST :: MOST LIKELY VALUE :',PCOST[I,2]::2);
    IF(I=15) THEN WRITELN('REVN COST :: MOST LIKELY VALUE :',PCOST[I,2]::2);
    IF(I)15) THEN WRITELN('** INVALID PARAMETER ** TYPE 99 FOR HELP **')
    ELSE
     BEGIN
```

```
      WRITE('LOW VALUE ? (%) ') ;   READLN(PCOST[I,1]) ;
      WRITE('HIGH VALUE ? (%) ') ;  READLN(PCOST[I,3]) ;
     END ;
   END ; (* OTHERWISE LOOP ENDS HERE *)
  END ; (* CASE OPTION ENDS HERE *)
  WRITE('PARAMETER ? ** WHEN DONE TYPE "100" : ') ; READLN(I) ;
END ; (* WHILE NOT LOOP ENDS HERE *)

 (* COMPUTE MEAN AND STANDARD DEVIATION *)

 CMEAN := 0.0 ; CDEVN := 0.0 ;
 FOR I :=  1 TO 15 DO
  BEGIN
   IF (PCOST[I,1] = 0.0) AND (PCOST[I,3] = 0.0) AND (I(15) THEN
   CMEAN := CMEAN - PCOST[I,2]
    ELSE
     BEGIN
      IF (PCOST[I,1] = 0.0 ) AND (PCOST[I,3] = 0.0) AND (I=15)THEN
      CMEAN := CMEAN + PCOST[I,2]
       ELSE
        BEGIN
         T1 := (1 + PCOST[I,1]*0.01) ;
         T2 := (1 + PCOST[I,3]*0.01) ;
         T3 := ((T2-T1)*PCOST[I,2])/2.65 ;
         IF I ( 15 THEN
         CMEAN := CMEAN - ((T1+2.0+T2)*PCOST[I,2])/4.0
         ELSE
         CMEAN := CMEAN + ((T1+2.0+T2)*PCOST[I,2])/4.0 ;
         CDEVN := CDEVN + (T3 * T3)
        END   (* ELSE BEGIN T1 LOOP ENDS HERE  *)
     END   (*  ELSE BEGIN IF PCOST[I,1] LOOP ENDS HERE  *)
  END ; (* FOR I LOOP ENDS HERE *)

 (* NOW WRITE THE RESULTS *)

 WRITELN('Risk Analysis Results For Project Uncertainity Present Value :');
 WRITELN('_____________________________________________________________');
 WRITELN ;
 WRITELN('                 PARAMETER                LOW(%) ',
      'MOST LIKELY($)  HIGH(%) ') ;
 WRITELN;
 FOR I := 1 TO 15 DO
 BEGIN
  CASE I OF
   1 : WRITE('LAND COST                          ');
   2 : WRITE('INFRASTRUCTURE DEVELOPMENT COST    ');
   3 : WRITE('SITE PREPARATION COST              ');
   4 : WRITE('PRE-PLANTING WEED CONTROL COST     ');
   5 : WRITE('PLANTING COST                      ');
   6 : WRITE('MANAGERIAL COST                    ');
   7 : WRITE('FERTILIZATION COST                 ');
   8 : WRITE('POST ESTABLISHMENT WEED CONTROL COST ');
   9 : WRITE('SEEDLING COST                      ');
  10 : WRITE('POST ESTABLISHMENT PEST CONTROL COST ');
  11 : WRITE('ADDITIONAL COST                    ');
```

```
  12 : WRITE('HARVESTING COST                    ');
  13 : WRITE('SPECIAL ONGOING ENVIRONMENTAL COSTS ');
  14 : WRITE('TRANSPORTATION COST                ');
  15 : WRITE('REVENUE                            ');
 END ; (* CASE OPTION ENDS HERE *)
 WRITELN(PCOST[I,1]:9:2,PCOST[I,2]:9:2,PCOST[I,3]:13:2)
END ; (* FOR I LOOP ENDS HERE *)
WRITELN ;
WRITELN ;
CDEVN := SQRT(CDEVN) ;
WRITELN('Project View       : ',PVIVARBL2.YEAR]::2, ' $') ;
WRITELN('Mean               : ',CMEAN::2, ' $') ;
WRITELN('Standard Deviation : ',CDEVN::2, ' $') ;
WRITELN('Low View(10%)      : ',(CMEAN-1.28*CDEVN)::2, ' $') ;
WRITELN('High View(90%)     : ',(CMEAN+1.28*CDEVN)::2, ' $') ;

END ; (* PROCEDURE RISK ENDS HERE *)


END.

(*****************************************************************)
```

APPENDIX B
SAMPLE OUTPUT

BIOMASS PLANTATION

PLANTATION SCENARIO ACTIVITIES

1.01 Total Land Area of Plantation:	1.00 ha
1.02 Planted Portion of Plantation:	90.00 %
1.03 Land is Leased at:	80.00 $/ha
Increasing At Real Annual Rate of:	0.00 %
1.04 Plantation Harvesting Period:	5 yrs
1.05 Projected Biomass Yield for Seedling:	60.00 MG/ha
Projected Biomass Yield for Coppice:	72.00 MG/ha
1.06 Energy Content of Biomass:	19.70 GJ/dry MG
1.07 Coppice Cycles Before Return to Seedling:	3

FINANCIAL/ECONOMIC PARAMETERS

Calculations Will Be in Real Dollars.

2.01 Last Year in Evaluation Period:	23
2.02 Discount Rate:	4.00 %
2.03 Initial Real Selling Price:	50.00 $/dry MG
Annual Change in Real Selling Price:	0.50 %

PLANTATION ESTABLISHMENT ACTIVITIES

3.01 Infrastructure Development Costs:	75.00 $
3.02 Site Prep for Newly Planted Areas:	50.00 $/ha
Site Prep for Replanted Areas:	100.00 $/ha
3.03 Cost of Seedlings:	550.00 $/ha
3.04 Pre-Planting Weed Control:	
Tillage is Not Practiced.Annual Cost:	200.00 $/ha
3.05 Annual Planting Costs:	50.00 $/ha

OPERATION AND MAINTENANCE ACTIVITIES

4.01 Manager Expenses: 30.00 $/ha

4.02 Type of Fertilizer : NPK

		Application	Cost
Seedling Year	1:	200.00 Kg/ha;	75.00 $/ha
Seedling Year	2:	0.00 Kg/ha;	0.00 $/ha
Seedling Year	3:	200.00 Kg/ha;	75.00 $/ha
Seedling Year	4:	0.00 Kg/ha;	0.00 $/ha
Seedling Year	5:	0.00 Kg/ha;	0.00 $/ha
Coppice Year	1:	200.00 Kg/ha;	75.00 $/ha
Coppice Year	2:	0.00 Kg/ha;	0.00 $/ha
Coppice Year	3:	0.00 Kg/ha;	0.00 $/ha
Coppice Year	4:	0.00 Kg/ha;	0.00 $/ha
Coppice Year	5:	0.00 Kg/ha;	0.00 $/ha

4.03 Post-Establishment Weed Control:

Chemical Method		Applic. Cost	Chem Amt	Chem Cost
Seedling Year	1:	90.00 $/ha	1.00 Kg/ha	0.00 $/Kg
Seedling Year	2:	90.00 $/ha	0.00 Kg/ha	0.00 $/Kg
Seedling Year	3:	0.00 $/ha	0.00 Kg/ha	0.00 $/Kg

Seedling Year	4:	0.00 $/ha	0.00 Kg/ha	0.00 $/Kg
Seedling Year	5:	0.00 $/ha	0.00 Kg/ha	0.00 $/Kg
Coppice Year	1:	0.00 $/ha	0.00 Kg/ha	0.00 $/Kg
Coppice Year	2:	0.00 $/ha	0.00 Kg/ha	0.00 $/Kg
Coppice Year	3:	0.00 $/ha	0.00 Kg/ha	0.00 $/Kg
Coppice Year	4:	0.00 $/ha	0.00 Kg/ha	0.00 $/Kg
Coppice Year	5:	0.00 $/ha	0.00 Kg/ha	0.00 $/Kg

4.04 Post-Establishment Pest Control:

Chemical Method		Applic. Cost	Chem Amt	Chem Cost
Seedling Year	1:	0.00 $/ha	0.00 Kg/ha	0.00 $/Kg
Seedling Year	2:	90.00 $/ha	0.00 Kg/ha	0.00 $/Kg
Seedling Year	3:	0.00 $/ha	0.00 Kg/ha	0.00 $/Kg
Seedling Year	4:	90.00 $/ha	0.00 Kg/ha	0.00 $/Kg
Seedling Year	5:	0.00 $/ha	0.00 Kg/ha	0.00 $/Kg
Coppice Year	1:	0.00 $/ha	0.00 Kg/ha	0.00 $/Kg
Coppice Year	2:	90.00 $/ha	0.00 Kg/ha	0.00 $/Kg
Coppice Year	3:	0.00 $/ha	0.00 Kg/ha	0.00 $/Kg
Coppice Year	4:	90.00 $/ha	0.00 Kg/ha	0.00 $/Kg
Coppice Year	5:	0.00 $/ha	0.00 Kg/ha	0.00 $/Kg

4.05 Environmental Protection Activities:
Annual Cost of These Activities: 0.00 $/ha

4.06 Cost of Other Recurring Activities: 0.00 $/ha

HARVESTING DECISION ACTIVITIES

5.01 Harvesting Costs: 1500.00 $/ha
5.02 Ann. Harvested Material Transp. Cost: 4.00 $/dry MG
5.03 Ann. Harvested Material Prep. Cost: 0.00 $/dry MG

(Results for years 5, 10, and 20)

BIOCUT Economic Evaluation Program for Biomass Plantations

Oak Ridge National Laboratory
FINANCIAL RESULTS OF PLANTATION FOR YEAR 5

1.	Land Cost	$	80.00
2.	Infrastructure Development Cost	$	0.00
3.	Site Preparation Cost	$	9.00
4.	Pre-Planting Weed Control Cost	$	36.00
5.	Seedling Cost	$	99.00
6.	Planting Cost	$	9.00
7.	Managerial Cost	$	27.00
8.	Fertilization Cost	$	27.00
9.	Post Establishment Weed Control Cost	$	32.40
10.	Post Establishment Pest Control Cost	$	32.40
11.	Harvesting Cost	$	270.00
12.	Transportation Cost	$	43.20
13.	Special Ongoing Environmental Cost	$	0.00
14.	Additional Cost	$	0.00
15.	Total Costs	$	665.00
16.	Harvest	dry MG	10.80
17.	Income from Harvest	$	553.64

18.	Current Year Cash Flow	$	-111.36
19.	Net Present Value to Date	$	-1143.95

DESCRIPTION OF PLANTATION AT END OF YEAR 5

Plot	Area(ha)	Stage	Age	dry MG Sold
1	0.18	1	5	10.80
2	0.18	1	4	0.00
3	0.18	1	3	0.00
4	0.18	1	2	0.00
5	0.18	1	1	0.00

Number of Separate Plots: 5
Area Under Cultivation: 0.90 ha
Biomass Production: 10.80 dry MG

BIOCUT Economic Evaluation Program for Biomass Plantations

Oak Ridge National Laboratory
FINANCIAL RESULTS OF PLANTATION FOR YEAR 10

1.	Land Cost	$	80.00
2.	Infrastructure Development Cost	$	0.00
3.	Site Preparation Cost	$	0.00
4.	Pre-Planting Weed Control Cost	$	0.00
5.	Seedling Cost	$	0.00
6.	Planting Cost	$	0.00
7.	Managerial Cost	$	27.00
8.	Fertilization Cost	$	13.50
9.	Post Establishment Weed Control Cost	$	0.00
10.	Post Establishment Pest Control Cost	$	32.40
11.	Harvesting Cost	$	270.00
12.	Transportation Cost	$	51.84
13.	Special Ongoing Environmental Cost	$	0.00
14.	Additional Cost	$	0.00
15.	Total Costs	$	474.74
16.	Harvest	dry MG	12.96
17.	Income from Harvest	$	681.14
18.	Current Year Cash Flow	$	206.40
19.	Net Present Value to Date	$	-756.74

DESCRIPTION OF PLANTATION AT END OF YEAR 10

Plot	Area(ha)	Stage	Age	dry MG Sold
1	0.18	2	5	12.96
2	0.18	2	4	0.00
3	0.18	2	3	0.00
4	0.18	2	2	0.00
5	0.18	2	1	0.00

Number of Separate Plots: 5
Area Under Cultivation: 0.90 ha
Biomass Production: 12.96 dry MG

BIOCUT Economic Evaluation Program for Biomass Plantations

Oak Ridge National Laboratory
FINANCIAL RESULTS OF PLANTATION FOR YEAR 20

1.	Land Cost	$	64.00
2.	Infrastructure Development Cost	$	0.00
3.	Site Preparation Cost	$	0.00
4.	Pre-Planting Weed Control Cost	$	0.00
5.	Seedling Cost	$	0.00
6.	Planting Cost	$	0.00
7.	Managerial Cost	$	21.60
8.	Fertilization Cost	$	0.00
9.	Post Establishment Weed Control Cost	$	0.00
10.	Post Establishment Pest Control Cost	$	32.40
11.	Harvesting Cost	$	270.00
12.	Transportation Cost	$	51.84
13.	Special Ongoing Environmental Cost	$	0.00
14.	Additional Cost	$	0.00
15.	Total Costs	$	439.84
16.	Harvest	dry MG	12.96
17.	Income from Harvest	$	715.97
18.	Current Year Cash Flow	$	276.13
19.	Net Present Value to Date	$	488.15

DESCRIPTION OF PLANTATION AT END OF YEAR 20

Plot	Area(ha)	Stage	Age	dry MG Sold
1	0.18	2	5	12.96
2	0.18	2	4	0.00
3	0.18	2	3	0.00
4	0.18	2	2	0.00

Number of Separate Plots:	4
Area Under Cultivation:	0.72 ha
Biomass Production:	12.96 dry MG

Project Summary

Discounted Average Cost	46.66 $/MEGAGRAM
	2.37 $/GJ
Internal Rate of Return	8.70 %
Net Present Value	927.45 $
Benefit/Cost Ratio	1.14

OPTION? RISK

PARAMETER	LOW (%)	MOST LIKELY ($)	HIGH (%)
LAND COST	-5.00	972.94	10.00
INFRASTRUCTURE	0.00	75.00	0.00
SITE PREPARATION	0.00	40.07	0.00
PREPLANT WEED CONTROL	0.00	160.27	0.00
PLANTING COST	-15.00	40.07	5.00
MANAGERIAL COST	0.00	328.37	0.00
FERTILIZATION COST	-10.00	232.87	15.00
POST EST. WEED CONTROL	0.00	141.47	0.00
SEEDLING COST	0.00	440.73	0.00
POST EST. PEST CONTROL	-10.00	393.74	25.00
ADDITIONAL COST	0.00	0.00	0.00
HARVESTING COST	-30.00	3031.28	10.00
ENVIRONMENTAL COSTS	0.00	0.00	0.00
TRANSPORATION COSTS	0.00	549.13	0.00
REVENUE	-25.00	7333.36	10.00

NON-RISK MEAN	:	927.45 $
RISK MEAN	:	775.17 $
STANDARD DEVIATION	:	1074.10 $
80 % CONFIDENCE INTERVAL		
LOW (10 %)	:	-599.67 $
HIGH (10 %)	:	2150.02 $

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