A Guide to Running Alternative Scenarios with FASOM

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A USER'S GUIDE
TO THE FOREST AND AGRICULTURAL SECTOR OPTIMIZATION MODEL (FASOM)

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1. INTRODUCTION

This report provides a description of how to do alternative scenario runs with the **F**orest and **A**gricultural **S**ector **O**ptimization **M**odel (**FASOM**), a dynamic, nonlinear programming model of the forest and agricultural sectors in the United States. FASOM depicts the allocation of land, both within and between the forest and agricultural sectors. It has been developed for the U.S. Environmental Protection Agency (EPA) to evaluate the welfare and market impacts of alternative environmental policies to mitigate climate change.

This document is intended to provide users with information on how to use FASOM to analyze alternative policies. Instructions are given about how to define policy scenarios, modify the FASOM data to reflect a scenario, run the scenarios with the model, and select/create scenario and cross-scenario output.

This document is not intended to be a stand-alone document. There are four documents in particular to which users should have access, and which will be referenced in the course of this manuscript. These documents are:

A) FASOM Model Description — Adams, D.M., R.J. Alig, J.M. Callaway, B.A. McCarl, and S.M. Winnett. <u>The Forest and Agricultural Sector Optimization Model (FASOM): Model Structure and Policy Applications</u>. Forthcoming Research Paper, United States Forest Service, 1996. This document is a technically oriented description of FASOM. It discusses the assumptions behind the base data, the assumptions behind the model, and the specific computerized structure of FASOM.

B) GAMS Reference Manual — Brooke, A., D. Kendrick, and A. Meeraus. <u>GAMS: A User's Guide</u>. Boyd and Fraser Publishers, Version 2.25, 1993. FASOM is implemented in the GAMS programming language. This reference manual provides the most recent (but somewhat behind the times) guide to the GAMS language. Other information regarding GAMS also appears on the GAMS Development Corporation's World Wide Web site (www.gams.com).

C) McCarl, B.A. , A. Meeraus, W. I. Nayda, R. Ramen, and P. Steacy "So Your GAMS Model Didn't Work Right: A Guide to Model Repair." Draft book, Department of Agricultural Economics, Texas A&M University, 1996. Draft document which covers how to debug a GAMS model. This document shows how to fix a number of things that users might run into, such as compiler error problems, abnormal terminations, memory faults, etc. This is a several hundred page document, covering a lot of cases which might come up in FASOM use that are just not practical to cover when discussing the alternative runs set up here.

D) McCarl, B.A., T.H. Spreen. "Applied Mathematical Programming Using Algebraic Systems." Course Notes for Agricultural Economics 641, Texas A&M University, College Station, TX, 1996. This is a basically completed draft textbook which covers GAMS and algebraic mathematical programming modeling. The conceptual and theoretical basis for modeling techniques used in constructing FASOM are discussed therein. This document provides an introduction to GAMS applications which may be useful to some users.

1.1 What Alternative Runs Can I Run With FASOM Now?

There are a large number of policy scenarios and other issues that can be examined with FASOM. As of this date, the following issues either have been examined with FASOM or could be examined with minor modifications to the model:

Forestry

- The Stewardship Incentive Plan (SIP)
- Using Council of Economic Advisors demand projections
- Increased recycling
- Alterations in the cut from the National Forests
- Zero cut from the National Forests
- Consideration of the sticky response of nonindustrial private forest owners
- Adoption of alternative private discount rates
- Taxation on deforestation
- Adoption of longer forest rotations
- Least cost movement of agricultural lands into forestry
- Effects of climate change in forestry
- Use of milling residues for power generation
- Use of agriculturally grown poplar and willow in pulp production

Agriculture

- NAFTA and Central American induced increases in agricultural exports
- Policy implications of neglecting land transfers between forest and agriculture
- Elimination of production-based Farm Program payments

- Permanent retention of the Conservation Reserve Program
- Reversion of Conservation Reserve Program acres into agricultural production
- Movement of agricultural lands into forestry
- Cost of producing a given amount of agriculturally-produced feedstock for electricity generation
- Use of poplar and willow grown on agricultural lands for pulp production

Carbon related

- Increase carbon sequestration relative to a base
- Estimate the least-cost way of meeting a target level of carbon sequestration by a specified time period, or of meeting an evolving set of carbon targets
- Estimate the consequences of policies which subsidize land transfers from agriculture into forestry

Sectoral Linkages

- Subsidized land transfers from agriculture to forestry
- Policy implication of neglecting land transfers between forest and agriculture
- Use of milling residues for power generation
- Use of poplar and willow grown on agricultural lands for pulp production

1.2 Quick Start Guide — Dealing With This Manual

This document is designed to serve users with differing levels of expertise and interest. This quick start section provides recommended paths through the document for different user classes,[1] according to the user's level of GAMS expertise, and what the user wishes to do. First let us phrase the questions and the answers we consider to define user classes:

1) How much do you know about GAMS?

a) Not much and I don't care
b) Not much and I want to learn
c) Some
d) A lot

2) What do you want to do with FASOM?

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[1]Readers should note that this document assumes that the reader is familiar enough with the subject matter regarding forestry, agriculture, carbon sequestration, and biomass so that we can use many terms relevant to studies in those sectors without needing to define them.

a) Learn what can be done with it
b) Run some scenarios like those that have already been done.
c) Build my own code to run a new set of scenarios under the current model structure
d) Change the model structure and build new code

Each of the 16 possible answers portends a different path, or action, for the user to follow in using this document and the referenced documents. The table below considers all 16 possible interactions of the potential answers to the two questions above and recommends a specific action. The actions are described following the table.

Level of FASOM Interest	**GAMS Knowledge**			
	Not Much		Some	A Lot
	I don't care	I want to learn		
How can it be used?	Action 1	Action 3	Action 7	Action 11
Run existing scenarios	Action 2	Action 4	Action 8	Action 12
Build your own code	Not possible	Action 5	Action 9	Action 13
Restructure model	Not Possible	Action 6	Action 10	Action 14

Action 1

Largely this document is not for you. You have indicated that you don't have much GAMS knowledge and don't want any but only want to know how FASOM can be used. We would recommend that you read Chapter 1 of this document, and perhaps refer to tables 4.2 and 4.3 which list the scenarios and assumptions which can be employed, and then turn to the documents that describe existing studies that have been done. These include the documents in the bibliography that are on forest policy (Adams et al. 1996), the importance of treating the sectors as linked (Alig et al. 1996), biomass production (Turnure et al. 1995), forest climate change (Callaway et al.), carbon sequestration (Alig et al. 1995), and sectoral effects of farm program elimination and biofuels programs (Hurd et al. 1995 and Hurd et al. 1996).

Action 2

First follow action 1 as far as you wish. Then, based on your answer that you don't want to learn much about GAMS but want to run existing scenarios, we hope that you know something about text editing (e.g. using the DOS text editor) and are willing to follow the procedure for running existing scenarios as specified in section 4.2.1. There is also the possibility that you can change the nature of the output, by changing the authorization of the output as described in sections 6.2.1 and 6.2.2. If you wish to go further than this, you need to be willing to learn more about GAMS.

Action 3

You have indicated you want to learn something about GAMS and about how FASOM can be used. We would recommend that you pursue action 1 above and then we recommend you read either the tutorial in the Brooke et al. GAMS manual, or Chapter 5 of McCarl and Spreen. Then come back and start reading this document. In that reading we recommend Chapter 2 which makes some arguments about why we use GAMS, and Chapter 3 which sets up the general structure of the alternative runs. Then you can proceed from there on as far as your interests take you. However, if in fact you simply want to know how FASOM is used, perhaps you should just stop with action 1.

Action 4

Pursue actions 1 and 3 then read Chapter 3 and 4 of this document up to the end of section 4.2.2 (not entering 4.2.3). You should also read as much of Chapter 6 as you desire and if you are changing data, you might want to read Chapter 7 and some of Chapter 8.

Action 5

Here we would recommend pursuit of actions 1, 3, 4 and then careful reading of the remainder of the manual.

Action 6

Here you have told us that you don't know a lot about GAMS and you want to restructure the model. In this particular case, you need to read Chapter 5 of McCarl and Spreen, read the companion FASOM document by Alig et al., and read this document from beginning to end.

Action 7

Here we'd recommend that you follow action 1 and then review the material in Chapter 3 and the beginning of Chapter 4 of this document.

Action 8

Here we recommend that you follow action 7, then carefully work through Chapter 4 of this document through section 4.2, and then read Chapter 6, section 6.2.

Action 9

Here you have answered that you want to build your own code and you have some GAMS knowledge. We recommend that you read this document beginning to end, skipping where you already have advanced knowledge.

Action 10

Here we recommend pursuing action 9 and reviewing the reference manuals by McCarl and Spreen, Brooke et al., and McCarl et al.

Action 11

If you know a lot about GAMS and you just want to know what FASOM will do, we believe you will be best served by pursuing action 1 and then casually glancing through this document.

Action 12

Here we recommend that you pursue action 11, and then look at the first part of Chapter 4 through 4.2.2 and Chapter 6, section 6.5.2.

Action 13

Feel free to skip around within the document and use the table of contents to access material that you want.

Action 14

Pursue action 13 and get the documents that are referenced under action 10 for your information.

1.3 Installation Guide

Here we present a step-by-step guide to installing FASOM on your computer, followed by notes on particular computer systems. A good part of the material here assumes that users have knowledge of a text editor and DOS, and know enough about GAMS and computer usage to install the program.[2] Deficiencies in general computer use, DOS, text editing, etc. can be made up by consulting your computer specialists or reference manuals. Users needing to modify the GAMS batch files should consult Brooke, Kendrick and Meeraus and Appendix A. Users needing to figure out how to alter GAMS instructions and find compiler errors should consult Chapter 3 of McCarl et al.

1.3.1 Step-by-Step Installation

The FASOM system can be installed on virtually any computer since there are GAMS versions for most computer types. Here we cover installation starting from GAMS installation.

1.3.1.1 Step 1: Obtain and Install GAMS

Obtain GAMS software from the GAMS Development Corporation, Washington DC (202- 342-0180). You will have a choice of solvers; purchase CPLEX if you wish the best linear programming solver and MINOS if you wish to solve nonlinear models. Then install GAMS following the GAMS Corporation's installation instructions. In turn test GAMS as described in the *GAMS Installation and System Notes* that comes with the software.

1.3.1.2 Step 2: Make the FASOM File Storage Area

FASOM consists of a set of source files and possibly a set of study-specific files. We recommend you set up a set of subdirectories as follows:

Main Subdirectory	FASOM	Holds all FASOM studies and code
Subservient subdirectories within the FASOM directory	SOURCE	Holds all FASOM source code
	SMALL	Hold FASOM small model
	CLIMATE	Holds climate change study example
	BIOMASS	Holds biomass study example
	Other	Other study names as needed

Also make a subdirectory called "t" under each of the above subservient subdirectories.

[2] A word processor may not be a suitable text editor because, if the margins are not wide enough, it may reformat FASOM files so that they are unreadable by GAMS. Also, care must be taken so that only ASCII versions of the files are saved. As an alternative, the DOS text editor works well.

1.3.1.3 Step 3: Obtain the FASOM Software

The most recent version of FASOM can either be obtained on numerous disks or downloaded from the FASOM home computer system which is scout.tamu.edu. One should make arrangements through the FASOM development team or the authors. Other permissions may be needed from EPA.

1.3.1.4 Step 4: Copy the FASOM Files Onto Your Computer

Once FASOM has been obtained, load onto your computer the FASOM files that are listed in Appendix A. Do this by copying all files from any disks obtained or by using file transfer protocol (FTP) if downloading from the FASOM home computer system. If needed, use a DOS version of PKUNZIP or an UNIX version of "tar" to uncompress any compressed files.

1.3.1.5 Step 5: Adjust the Solver References

To do this requires several steps:

1. The base version of FASOM is set up for use with CPLEX on a UNIX machine. If you do not have CPLEX, use a text editor to alter the files FAMODEL.MOD, FASOLVLP.MOD, and FAALTRUN, removing any references to CPLEX[3]. Either delete these lines (typically OPTION LP=CPLEX;) or change the CPLEX string to the name of the most capable LP solver that you acquired with the GAMS version, whether it be BDMLP, OSL, MINOS5, etc.

2. If the model is to be nonlinear, you need to have a GAMS license to MINOS5. Once you have this, edit the FAMODEL.MOD and FAALTRUN files to replace the reference to the file FASOLVLP.MOD with FASOLVFP.MOD. Also change the FAMODEL.MOD file so the nonlinear terms are not suppressed, as discussed in Chapter 2.

1.3.1.6 Step 6: Adjust the INCLUDE Instructions to Reflect Your Computer Path Names

FASOM uses the GAMS $INCLUDE statement to incorporate numerous code segments. These include statements commonly reference the location on the base computer where the FASOM files are stored. For example the statement

```
$include "/mac/mccarl/agfor/source/fafordat.dat"
```

incorporates the file fafordat.dat into the GAMS code to be executed, assuming that code can be found on the associated hard disk in the file storage subdirectory named

[3]CPLEX may appear in either upper or lower case.

/mac/mccarl/agfor/source/

You need to change this storage reference so it corresponds to the path on your computer where the files are stored. Thus in all include statements alter the path name

/mac/mccarl/agfor/source/

to a pointer to your FASOM source path. If you created the FASOM file storage area as suggested in 1.3.2.2, you would use:

c:\fasom\source\

These changes would need to be made in the following files:

ALLOFIT.DAT
FAAGDAT.DAT
FAFORDAT.DAT
FAMODEL.MOD
FAALTRUN
FAFORRPT.REP
FAASMRPT.REP
FACOMPUT.SAV

as well as their counterparts ending with .SML or .MED. The GAMS compiler will aid you in this endeavor as it will give error messages until the paths are correct.

1.3.1.7 Step 7: Run the Small Model

Go to the subdirectory where the small model is stored. Make sure you have completed step 1.3.2.6, and that there is a subdirectory called t. Execute the job r.bat by typing r.bat at the prompt c:\FASOM\SOURCE\; then hit the enter key. FASOM then should go through all the way to the end. If you are having trouble, contact Bruce McCarl at (409) 845-1706, to get some help with the initial installation.

1.3.1.8 Step 8: Do Your Studies

FASOM is now installed and you may now conduct FASOM runs.

1.3.2 Notes on Computer Systems

The above material is general to all computer systems. This section addresses additional considerations regarding particular computer systems.

1.3.2.1 PC's DOS/OS2

PC machines running DOS and OS2 require some special treatment. Unfortunately, due to the size of FASOM, the DOS memory manager often does not work and the GAMS model malfunctions. When run with both the agricultural and forest sectors linked, FASOM can generate very large files during model compilation. Ability to execute such runs in DOS will depend in part on the specific PC installation. Most commonly GAMS execution terminates with an "insufficient memory" error generated by the machine's operating system and GAMS. The problem here appears to be base memory in the lower end of PC RAM (the first 640k). More memory can be freed up by eliminating unused drivers, network routines and memory caches from AUTOEXEC.BAT and CONFIG.SYS files. It may not be possible to free enough space, however, to run the largest versions of FASOM in DOS.

We have also been unable to run the full FASOM model in a DOS window in Windows for Workgroups 3.11. The GAMS people report that this is expected but assert that it will run with Windows 95 or windows NT**.**

An alternative platform that we have found to be quite stable is the OS/2 operating system. Once the system is installed (follow the instructions on the box), one simply moves to a DOS full screen session and executes FASOM from the DOS prompt in the usual fashion described above. Under OS/2 we have been able to load, compile and begin execution of full linked versions of FASOM (though we have never completed execution owing to the lengthy time requirement). On a 486/66 PC, execution of FASOM with the forest sector alone using a nonlinear formulation and the MINOS solver can take 24 hours. Using the segmented version and the BDMLP linear solver requires only 3-6 hours.

1.3.2.2 UNIX

The home system for FASOM is an HP7000 workstation, running UNIX. The only real difference in using UNIX is the path names which we talked about changing in section 1.3.2.6 above. The UNIX batch file, R, is also distributed along with the software.

1.3.3 FASOM Debugging and Basis Support

GAMSCHK and GAMSBAS are useful utilities for basis support, drawing the map reproduced in Appendix G and debugging the model. If one wishes to install these, one should obtain the GAMSBAS and GAMSCHK utilities installation instructions, and user documents from the World Wide Web page agrinet.tamu.edu/mccarl, and follow the directions. In using either of these utilities, one needs to be careful not to accidentally run FASOM with solves in loops because these utilities generate a tremendous amount of output for every element of the loop.

2. BACKGROUND

2.1 GAMS - Why Did We Use It?

FASOM is implemented in the GAMS algebraic modeling language. GAMS is an acronym for General Algebraic Modeling System. The preface of Brooke, Kendrick and Meeraus states that GAMS "is designed to make the construction and solution of large and complex mathematical programming models more straight forward for programmers and more comprehensible to users of models from other disciplines... ." Furthermore, they say GAMS allows "concise algebraic statements of models in a language that is easily read by both modelers and computers..." and that GAMS "can substantially improve productivity of modelers and greatly expand the extent and usefulness of mathematical programming applications and policy analysis, and decision making." Let us now review why we choose to use GAMS generally and for FASOM specifically.

As a language GAMS possesses two important attributes. First, it requires that the entire problem be cast in an algebraic format. Second, it automatically handles many functions needed when doing computational mathematical programming. Our reasons for using GAMS as the language in which FASOM is implemented can be explained along these two lines.[4]

2.1.1. Why Use Algebraic Modeling?

The major advantages of using an algebraic language involve the ability to concisely state problems in an abstract, general fashion, largely independent of the data and the exact application context. One can produce a formulation independent of the specific problem size which initially can be used with smaller test problems, but which will later permit the full problem to be analyzed. The dimensions of the problem can grow as additional cases and data are added without modifying the algebraic specification of the problem.

The above statements are easily illustrated in the case of the resource allocation problem. The algebraic form of the resource allocation problem is

$$\begin{aligned} \text{Max} \quad & \sum_j c_j X_j \\ \text{s.t.} \quad & \sum_j a_{ij} X_j \le b_i \quad \text{for all } i \\ & X_j \ge 0 \quad \text{for all } j \end{aligned}$$

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4 We will briefly review this topic here; readers interested in more on GAMS should refer to McCarl and Spreen, and Brooke, Kendrick and Meeraus.

where j identifies production possibilities, I identifies available resources, c_j is the profit when one unit of production possibility j is manufactured, X_j is the number of units of production possibility j that are made, a_{ij} is the number of units of resource I required per unit of X_j, and b_i is the endowment of resource I. Collectively this algebraic formulation maximizes total profit by determining how much of each production possibility to produce while staying within the bounds of available resources. This algebraic setup is valid for all resource allocation models regardless of the dimensions of I and j of the contents of the data parameters a_{ij}, c_j and b_i. The GAMS counterpart of the algebraic model is shown in Table 2.1 (tables are located at the end of this chapter).[5] We may explore correspondence between the GAMS and the algebraic formulations by setting up a table relating the algebraic symbols and their GAMS counterparts with line number references (Table 2.2). The data in Table 2.2 shows a one-to-one correspondence between each and every element of the algebraic model and the elements in the GAMS model. Also note that the GAMS model is more understandable as longer names are given for the symbols.

Table 2.1 can also be used to show the expansion flexibility of GAMS. The table depicts the resources of interest as the four specified in line 5. If one wished to add capacity, for example, then one would add the name on line 5, an endowment on line 14 or 15, and usage numbers after lines 23 and 28. The model part of this GAMS formulation (lines 30-47 in Table 2.1) would not require modification and is general for all resource allocation problems, regardless of size. Thus, because of the algebraically based language, one can write size-independent GAMS formulations.

The advantages gained by using an algebraically based language are accompanied by several disadvantages. Algebraic modeling and summation notation are difficult for some users. Some people will always desire to deal with the exact problem context, not an abstract general formulation.

2.1.2 Why Use GAMS?

Now, why use GAMS? GAMS requires algebraic modeling and thus, has some of algebraic modeling's advantages and disadvantages. At the same time, GAMS can be tailored to the problem, so its use introduces additional advantages which overcome some of the disadvantages.

2.1.2.1. Problem Formulation and Changes in Problem Formulation

GAMS aids both in initially formulating a problem and subsequently revising formulations. GAMS facilitates specification and debugging of an initial formulation by allowing the modeler to begin with a small data set. Then, after verifying correctness, the modeler can expand the model to a much broader

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[5] True understanding of Table 2.1 requires knowledge of GAMS. An introduction in the context of the resource allocation problem is given in Chapter 5 of McCarl and Spreen.

context. For example, one could alter the model in Table 2.1 so it covered 10,000 production possibilities and 1,000 resources without changing the code after line 29. Thus, one can test over small data sets, then move on to the full implementation. Both small and large data sets are defined for FASOM to permit such testing during implementation of new features.

Second, GAMS makes it easy to alter problem specifications. Historically, large models have been difficult to modify because traditional modeling approaches make it difficult to add new constraints or variables. On the other hand, GAMS allows one to add model features much more simply. Generally, with GAMS, modelers do not try to make a complete formulation the first time around. Instead GAMS modelers usually start with a small formulation and then add structural features as demanded by the analysis. GAMS also allows model code to be transferred between problem contexts (e.g., the structure used in FASOM is a slightly rewritten version of the code used in McCarl et al.'s ASM model).

2.1.2.2. Automated Computational Tasks

GAMS automatically performs calculations; checks the formulation for obvious flaws; chooses the solver; formats the programming problem to meet the exact requirements of the solver; causes the solver to execute the job; saves and submits the "advanced basis" (an intermediate step in calculations) when doing related solutions; and permits usage of the solution for report writing. Note when the model in Table 2.1 is solved, the following functions are carried out automatically without the need for user instructions:

a) the objective function is automatically computed (i.e., as in the case of the (PRICE(PROCESS)-PRODCOST(PROCESS) term in line 39 Table 2.1);

b) the model is set up in a format readable by the solver;

c) the solver is started and told to read the data then the problem is solved and the answer written; and

d) the answer is read by GAMS and displayed.

These are complex computational tasks which would require considerable computer programming effort if another modeling language were used. They are done by GAMS automatically without any commands on the user's behalf other than a GAMS startup instruction. GAMS also verifies the correctness of the algebraic model statements and allows empirical examination of the equations. Furthermore, since GAMS has been implemented on machines ranging from 286 to 486 PCS up to CRAY super computers, it allows portability of a model formulation between computer systems. Switching solvers is also simple, requiring either:

a) alteration of the solver option statement (see Brooke et al. page 105); or

b) changing from using linear to nonlinear programming by altering the SOLVE statement wording from "using LP" to "using NLP" (see Brooke et al. page 98).

The FASOM model exploits these features as both linear and nonlinear versions have been developed, and solvers such as CPLEX, OSL and MINOS5 have been used at various times on both HP UNIX-based work stations and PC-based OS2 implementations.

2.1.2.3. Facilitates Documentation and Later Use of Models

One other convenient feature of GAMS is its self-documenting nature. Perhaps the largest benefit GAMS has over traditional modeling techniques is that modelers can use longer names for variables, equations and sets while including within the model comments on model structure, data definitions etc., allowing a more complete and readable problem description within the model itself. Modelers partially document model structure, assumptions, and any calculation procedures used in the report writing as a byproduct of the modeling exercise within the source GAMS model file.[6] Comment statements can be inserted in the model by placing an asterisk in column one, followed by the comment (e.g., text identifying data sources or particular assumptions being used), or by using $ontext/$offtext sequences (see discussion in Brooke et al. page 42). Such documentation makes it easier for either the original author or others to alter the model structure and update data. Note how the documentation and definition content of Table 2.1 is well beyond that inherent in the algebraic form. GAMS models are usually readable to non-technical users.

2.1.2.4. Allows Use by Varied Personnel

Modeling personnel can be rare. Many detailed GAMS applications have been set up by modeling experts and subsequently are used by policy-makers with minimal assistance from modeling experts. Often, given proper documentation and instruction, clerical labor and nontechnical problem analysts can handle an analysis.

2.2 Computerized Structure of FASOM

The FASOM modeling systems is comprised of multiple files. This structure is adopted to separate different data and model elements, thereby allowing disciplinary and modeling/GAMS experts to work on selected parts of the system without directly affecting the other parts. The basic division we

[6]Appendix I of McCarl et al. covers practices that can be used to enhance this documentation.

use separates files into categories according to whether they involve data, data calculations, model specification, analysis execution, report writing and/or model support. Distinctions are also made between unifying files, forestry files, agricultural files and carbon files.

FASOM is comprised of a set of unifying files and a set of related sub-files. Appendix A provides lists of these files and shows how they are interrelated. There are six unifying files. These are:

ALLOFIT.DAT	Base data definition - Incorporates all base model data for agriculture, forestry, and carbon. Also executes a set of data calculations.
FAMODEL.MOD	FASOM mathematical programming model definition.
FARPT.REP	Definitions of parameters for the run-by-run report writer.
FAALTRUN	Defines and executes the alternative runs comprising a study.
FAFINAL.REP	Prints a comparison report across the runs made.
FACOMPUT.SAV	Saves scenario results in a GAMS readable file (Results.Put) which may be used in additional report writing.

Appendix A shows how all the other files in FASOM are contained in these six unifying files. Operationally during a run all the files are integrated by a batch file, as explained in section A.2 of Appendix A.

Table 2.1. GAMS Formulation of Resource Allocation Example

```
SET    PROCESS       TYPES OF PRODUCTION PROCESSES
                         /FUNCTNORM , FUNCTMXSML , FUNCTMXLRG
                         ,FANCYNORM , FANCYMXSML , FANCYMXLRG/
       RESOURCE      TYPES OF RESOURCES
                         /SMLLATHE,LRGLATHE,CARVER,LABOR/ ;

PARAMETER PRICE(PROCESS)     PRODUCT PRICES BY PROCESS
                  /FUNCTNORM  82, FUNCTMXSML  82, FUNCTMXLRG  82
                  ,FANCYNORM 105, FANCYMXSML 105, FANCYMXLRG 105/
          PRODCOST(PROCESS)     COST BY PROCESS
                  /FUNCTNORM  15, FUNCTMXSML  16  , FUNCTMXLRG  15.7
                  ,FANCYNORM  25, FANCYMXSML  26.5, FANCYMXLRG  26.6/
          RESORAVAIL(RESOURCE) RESOURCE AVAILABLITY
                  /SMLLATHE 140, LRGLATHE  90,
                   CARVER   120, LABOR    125/;

TABLE RESOURCES(RESOURCE,PROCESS) RESOURCE USAGE

              FUNCTNORM   FUNCTMXSML  FUNCTMXLRG
SMLLATHE         0.80       1.30        0.20
LRGLATHE         0.50       0.20        1.30
CARVER           0.40       0.40        0.40
LABOR            1.00       1.05        1.10
 +            FANCYNORM   FANCYMXSML  FANCYMXLRG
SMLLATHE         1.20       1.70        0.50
LRGLATHE         0.70       0.30        1.50
CARVER           1.00       1.00        1.00
LABOR            0.80       0.82        0.84;

POSITIVE VARIABLES
         PRODUCTION(PROCESS) ITEMS PRODUCED BY PROCESS;
VARIABLES
         PROFIT              TOTALPROFIT;
EQUATIONS
         OBJT                  OBJECTIVE FUNCTION ( PROFIT )
         AVAILABLE(RESOURCE)   RESOURCES AVAILABLE ;

 OBJT..  PROFIT =E=
            SUM(PROCESS,(PRICE(PROCESS)-PRODCOST(PROCESS))
                          * PRODUCTION(PROCESS)) ;

 AVAILABLE(RESOURCE)..
     SUM(PROCESS,RESOURCES(RESOURCE,PROCESS)*PRODUCTION(PROCESS))
                     =L= RESORAVAIL(RESOURCE);

MODEL RESALLOC /ALL/;
SOLVE RESALLOC USING LP MAXIMIZING PROFIT;
```

Table 2.2 Correspondence Between Algebraic Model And GAMS Code

Algebraic Model Symbol	Gams Model Item	Table 2.1 Line Number
j	PROCESS set	1
I	RESOURCE set	3
c_j	PRICE(PROCESS)-PRODCOST(PROCESS) data and computation	7-12,39
X_j	PRODUCTION(PROCESS) variable	31
a_{ij}	RESOURCES(RESOURCE,PROCESS) data table	17-28
b_i	RESORAVAIL(RESOURCE) parameter	13-15
Objective Function	OBJT expression	33,38-40
Resource Constraints	AVAILABLE(RESOURCE)	36,42-44

3. GENERAL NOTES ON RUNNING ALTERNATIVE RUNS[7]

Most models are built for use in a comparative analysis. Multiple model solutions are generated where in each solution (hereafter called a scenario) alterations are made to the data, constraints, or variables. Comparative statics studies compare reactions by the modeled entity, by examining differences between scenario-based solutions and a "base case" solution. GAMS has facilities for doing repeated comparative analyses and FASOM exploits them. This Chapter covers those facilities in a simpler case than FASOM for expository purposes. Chapters 4,6,7 and 8 cover the same steps in the FASOM context.

3.1 Structure of a Comparative Analysis

The basic structure of a comparative analysis is outlined in Figure 3.1 (figure is located at the end of this chapter). The first three boxes reflect a conventional GAMS program where the initial data and model are set up, and then a solution is executed. The comparative analysis begins with box four. The analysis is set up by identifying the scenarios, defining data for the scenarios, and saving the data that is to be changed between scenarios. In turn, for each scenario the data are restored to original levels, then the data and model differences for that scenario are imposed, the model is solved, the solution is reported, and data are saved for a comparative report. Finally, the comparative report is displayed.

Below we present an example of such a comparative analysis, in the context of the basic resource allocation problem used in Table 2.1 above (see McCarl and Spreen, Chapter 5, section 5.2 for a discussion of the problem). Here we solve a base case scenario, then solve scenarios with the labor and large lathe constraints in the AVAILABLE equation suppressed, and finally solve a scenario with 25% higher prices for fancy chairs.

Table 3.1 (tables are located at the end of this chapter) presents the GAMS specification for a comparative analysis. The specification consists of the following steps:

1) Set up the model with any modifications needed to accommodate the alternative runs to be done. In this example the model is set up in lines 2-52 of Table 3.1 (line 1 is empty and is not shown). These lines are a repeat of the model in Table 2.1 but with one major modification. Namely in line 43 the AVAILABLE(RESOURCE) constraint has been shown with a condition ($ sign) attached to permit us to suppress constraints in those equations[8]. This condition causes the constraints to be active only when there is a non-zero

---

[7]This section assumes the reader can read GAMS code. If not, the reader should refer to the quick start section (section 1.2), Action 3 to proceed.

[8]See Brooke et al. pages 92-95 for an explanation of the $ operator.

value entered in the resource availability parameter — RESORAVAIL(RESOURCE). Thus we will be able to suppress the constraints by setting the resource availability to zero. Beyond this we have added report writing.[9]

2) Define the parameters of any reports to be done on the scenarios or across the scenarios — lines 55-66.

3) Save any data which will be changed in the analysis scenarios in lines 72-77. Here we define arrays in which we will save the resource availability and prices, then put data into those arrays.

4) Define the scenarios (line 70) and any associated data (lines 79-85). Note: The scenarios are (a) a base case which leaves all the data alone (base); (b) a no labor constraint case which eliminates consideration of labor as a constraint (nolabor) ; © a no large lathe constraint case which eliminates consideration of the large lathe as a constraint (nolrglathe) ; and (d) a high price fancy chair scenario (hifancy).

5) Proceed one at a time to solve the scenarios — lines 87-105. This portion of the code consists of several substeps:

   (a) Reestablish data to base levels — Lines 88-89

   (b) Change the data so it reflects the particular scenario — Lines 90-92

   © Solve the scenario - Line 94

   (d) Summarize the results in a report - lines 96-98

   (e) Enter results for this scenario into a report comparing results across scenarios — lines 101-104

6) Output the comparative report — line 108.

The resultant output is given in Table 3.2. Note the results show varying profits, production patterns, resource usages, and resource values across the scenarios.

3.2 Components of a Comparative Analysis

[9] We also suppress excessive printouts with lines 48-50.

The above example shows the components of a comparative analysis involving alternative runs. Such a structure generally involves steps beyond the establishment and setup of the base model which include: (a) data alterations; (b) model structural component activation and deactivation; © comparative report writing ; and (d) repeated model solutions. Each merits separate discussion.

3.2.1 Data Alterations

One important process when running multiple scenarios involves revising data. Modelers must be aware that when revising data, GAMS changes all data items permanently regardless of their initial values. If one goes through a loop and changes a data item, that value is permanently changed. Thus the scenarios would become cumulative. To avoid this, one needs to reset the data to original values before beginning the execution of a scenario. This occurs in the above example through the commands involving saving data on lines 72-73 and 74-77, and the commands for restoring the saved values in lines 88-89. If this were not done the data changes would accumulate during the scenarios. For example the GAMS commands

```
SCALAR LAND /100/;
PARAMETER SAVELAND;
SAVELAND = LAND;
SET LANDCHANGE    SCENARIOS FOR CHANGES IN LAND/R1,R2,R3/
PARAMETER VALUE(LANDCHANGE) PERCENT CHANGE IN LAND
      /R1 +10 , R2 + 20 , R3 +30/;
LOOP ( LANDCHANGE,
   LAND = LAND * (1 + VALUE ( LANDCHANGE ) / 100. ) );
```

results in land equaling 110, 132 and 171.6 during the loop, with the original value of 617 being lost. However, alteration of the calculation statement so it operated from a saved parameter value

```
LAND = SAVELAND * (1 + VALUE ( LANDCHANGE ) / 100. )
```

results in values of 110 , 120, and 130.

One other important item involves computations. Whenever a SOLVE command is entered, GAMS automatically recomputes all terms specified in the optimization model equations (in all the .. expressions such as in lines 39-45 of table 3.1). However, no other computations are repeated when setting up the model. This leads to two concerns. First, all calculations that involve data changed within the scenarios must either be included in the model equations (the .. terms) or the calculations must be repeated. This can be illustrated as follows. Suppose a model was set up as follows:

```
Price(Crop) = 2.00;
Yield(Crop) = 100;
Cost(Crop) = 50;
PROFIT (Crop) = Price(Crop)*Yield(Crop)-Cost(Crop);
Equations
```

```
6                obj  objective function
7                Land      Land available;
8         Positive Variables      Acres(Crop)  Cropped Acres
9         Variables      Objf      Objective function;
10            obj..      objf=E=Sum(Crop,PROFIT(Crop)*Acres(Crop));
11        Land      Sum(Crop, Acres(Crop))=L=100;
12        Model     FARM /ALL/
13     *solve number 1
14        SOLVE FARM USING LP Maximizing OBJF;
15        Price (CROP)=2.50;
16     *solve number 2
17        SOLVE FARM USING LP Maximizing OBJF;
18        PROFIT (Crop)=Price (CROP)*Yield(Crop)-Cost(Crop);
19     *solve number 3
20        SOLVE FARM USING LP Maximizing OBJF;
```

In this case the second solve in line 16 would yield identical results to those obtained in the first solve in line 13, since even though PRICE is changed, the PROFIT term is not recomputed. The third solution resulting from line 19 would differ since PROFIT is recomputed in line 17. One could also fix this by changing the objective function specification to:

```
Obj..ObjF=E=SUM(Crop,(Price(CROP)*Yield(CROP)-Cost(CROP))Acres(CROP);
```

In that case the full objective function terms are automatically recomputed in every solve. To the extent possible FASOM is designed to avoid such problems. Users may avoid such problems by recalculating any computed items.[10]

Similarly, variable bounds and scaling factors are not automatically recomputed unless one reissues the statement defining .LO , .UP and .SCALE cases. Thus, when any of these items are computed and the data entering those computations are revised, their calculation needs to be repeated. FASOM does this for some of the bounds and scaling factors in the FAUPDATE.MOD and FAALTRUN code segments.

3.2.2 Changing Model Structure — Activation and Deactivation of Structure

Many comparative studies involve model structure modifications. One of the big advantages of using a modeling system is the ability to add/delete constraints, variables, or equation terms and reanalyze the problem. GAMS permits such modifications to be done using $ controls as in lines 43-45 of Table 3.1. Suppose we consider an alternative example. Suppose the following lines are used in a GAMS problem:

---

[10]Procedures to identify items which need to be recomputed are discussed in section 8.5 of this document.

```
SCALAR                        ISITACTIVE TELLS WHETHER ITEMS ARE ACTIVE      /0/;
CONDEQ$ISITACTIVE..  SUM(STUFF,X(STUFF)) =L= 1;
EQNOTH(INDEX)..      SUM(STUFF,R(INDEX,STUFF)*X(STUFF)) +
                               4*SUM(STUFF,Y(STUFF))$ISITACTIVE =L= 50;
```

This addition would cause the CONDEQ equation and the Y term in the EQNOTH equations to only appear in the empirical model when the ISITACTIVE parameter was nonzero. Thus, the sequence

```
ISITACTIVE = 0;
SOLVE MODELNAME USING LP MAXIMIZING OBJ;
ISITACTIVE =1;
SOLVE MODELNAME USING LP MAXIMIZING OBJ;
```

would cause the model to be solved with and without the CONDEQ constraint and the Y term in the EQNOTH equations.[11]

3.2.3 Solving Repeatedly

More than one model can be solved in a run. Thus, one can stack solve statements as in the example immediately above or loop over solves as in Table 3.1 in line 87.

3.2.4 Comparative Report Writing

The development of a comparative report writer is usually attractive when doing multiple runs. Report writing commands always use values from the most recent solution, so one must save the data if comparative reports are desired. The code in Table 3.1 contains such a report writer. In that case a place to store the report data is defined (parameter COMPAR) indexed over the loop set (RUNS)-see line 74. In turn, during loop execution the COMPAR array is saved with scenario-dependent values of variables and shadow prices in lines 101-104. Finally, when the output is displayed a comparison across scenarios appears (Table 3.2).

3.3 Comparative Runs in Complex Models

The above implementation of a comparative set of runs in a single file works for small simple models, but is not totally satisfactory for a complex model such as FASOM. FASOM contains thousands of lines of data, and the model solution from a “cold start” without a good initial basis can take a number of hours (up to 24 on a Pentium microcomputer), particularly when farm program target price convergence is required. As a consequence, the alternative run structure of FASOM, while conceptually the same, is operationally different.

[11] See Brooke et al. pages 92-95 for more explanation of the $ operator.

FASOM is divided into 6 modules as discussed in section 2.2 . The first module, ALLOFIT, integrates more than 40,000 lines of base data. The second module, FAMODEL.MOD, defines the programming model structure and gets the initial farm program convergence solution. The third module, FARPT.REP, defines report writer items. The fourth module, FAALTRUN, conducts the alternative runs analysis. The fifth and sixth modules, FAFINAL.REP and FACOMSAV.SAV, output the results of that analysis. Thus, the FASOM system goes through the same steps as in Figure 3.1, but uses a more complex computerized structure.

The batch file that runs FASOM is listed in the first part of Table 3.3. This batch file makes use of the GAMS file save and restart capabilities and therefore can be started and stopped at any point in the process. The usual way that alternative runs are done in FASOM is that the first three steps of Figure 3.1 are executed by including the GAMS commands in the batch file up through the FARPT.REP.[12] This means the model is setup and solved, then the solution is saved. In turn comparative statics runs are done using alternative versions of the FAALTRUN[13] and executing the remainder of the batch file as illustrated by the second batch file in Table 3.3. The system is designed that way to avoid the need for repeating the time consuming execution of the data setup and initial solution construction steps. The FAALTRUN module can be restarted utilizing the stored results from the preceding modules.

[12] In the FASOM context this is done using previously created batch files.

[13] The whole topic of FAALTRUN modification is discussed in all subsequent Chapters.

Table 3.1. Example of Comparative Run

```
SET    PROCESS       TYPES OF PRODUCTION PROCESSES
                         /FUNCTNORM , FUNCTMXSML , FUNCTMXLRG
                         ,FANCYNORM , FANCYMXSML , FANCYMXLRG/
       RESOURCE      TYPES OF RESOURCES
                         /SMLLATHE,LRGLATHE,CARVER,LABOR/ ;

PARAMETER PRICE(PROCESS)     PRODUCT PRICES BY PROCESS
                  /FUNCTNORM  82, FUNCTMXSML  82, FUNCTMXLRG  82
                  ,FANCYNORM 105, FANCYMXSML 105, FANCYMXLRG 105/
          PRODCOST(PROCESS)     COST BY PROCESS
                  /FUNCTNORM  15, FUNCTMXSML  16  , FUNCTMXLRG  15.7
                  ,FANCYNORM  25, FANCYMXSML  26.5, FANCYMXLRG  26.6/
          RESORAVAIL(RESOURCE) RESOURCE AVAILABLITY
                  /SMLLATHE 140, LRGLATHE  90,
                   CARVER   120, LABOR    125/

TABLE RESOURUSE(RESOURCE,PROCESS) RESOURCE USAGE

                 FUNCTNORM   FUNCTMXSML  FUNCTMXLRG
SMLLATHE            0.80        1.30        0.20
LRGLATHE            0.50        0.20        1.30
CARVER              0.40        0.40        0.40
LABOR               1.00        1.05        1.10
 +               FANCYNORM   FANCYMXSML  FANCYMXLRG
SMLLATHE            1.20        1.70        0.50
LRGLATHE            0.70        0.30        1.50
CARVER              1.00        1.00        1.00
LABOR               0.80        0.82        0.84;

POSITIVE VARIABLES
         PRODUCTION(PROCESS) ITEMS PRODUCED BY PROCESS;
VARIABLES
         PROFIT              TOTALPROFIT;
EQUATIONS
         OBJT                  OBJECTIVE FUNCTION ( PROFIT )
         AVAILABLE(RESOURCE)   RESOURCES AVAILABLE ;

 OBJT..  PROFIT =E=
            SUM(PROCESS,(PRICE(PROCESS)-PRODCOST(PROCESS))
                          * PRODUCTION(PROCESS)) ;

 AVAILABLE(RESOURCE)$RESORAVAIL(RESOURCE)..
     SUM(PROCESS,RESOURUSE(RESOURCE,PROCESS)*PRODUCTION(PROCESS))
                      =L= RESORAVAIL(RESOURCE);

MODEL RESALLOC /ALL/;
option solprint=off;
option limrow=0;
option limcol=0;

SOLVE RESALLOC USING LP MAXIMIZING PROFIT;
set type   types of chairs               /functional,fancy/
    item   items for reports             /level,production,usage,value/
```

```
     map(type,process)    map of chair types to processes
                  /functional.(FUNCTNORM , FUNCTMXSML , FUNCTMXLRG)
                   fancy     .(FANCYNORM , FANCYMXSML , FANCYMXLRG)/;

 parameter resourstat(resource,item) resource status
           chairs(type)              production of chairs;

           resourstat(resource,"usage")=available.l(resource);
           resourstat(resource,"value")=available.m(resource);
           chairs(type)=sum(map(type,process),production.l(process));

 display chairs,resourstat;

 set runs  /base,nolabor, noLRGLATHE ,hifancy/

 parameter savRESORAv(RESOURCE) saved resource availability
           savprice(process)    saved prices
           compar(item,*,runs)       comparative report;

           savRESORAv(RESOURCE)=RESORAVAIL(RESOURCE);
           savprice(process)=price(process);

 table adjust(*,runs) alternative run configuration
            base nolabor noLRGLATHE  hifancy
smllathe     0
lrglathe     0                1
labor        0     1
fancy        0                          0.25
functional   0                              ;

 loop(runs,
           RESORAVAIL(RESOURCE)=savRESORAv(RESOURCE);
           price(process)=savprice(process);
           RESORAVAIL(RESOURCE)$adjust(resource,runs)=0;
           price(process)$sum(map(type,process),adjust(type,runs))=
           price(process)*(1+sum(map(type,process),adjust(type,runs)));

           SOLVE RESALLOC USING LP MAXIMIZING PROFIT;

           resourstat(resource,"usage")=available.l(resource);
           resourstat(resource,"value")=available.m(resource);
           chairs(type)=sum(map(type,process),production.l(process));
           display chairs,resourstat;
           compar("level","profit",runs)=profit.l;
           compar("usage",resource,runs)=resourstat(resource,"usage");
           compar("value",resource,runs)=resourstat(resource,"value");
           compar("production",type,runs)=chairs(type);
      );
           option decimals=2;
           display compar;
```

Table 3.2. Comparative Report Writing Output

```
----     108 PARAMETER COMPAR        comparative report

                              BASE      NOLABOR  NOLRGLATHE      HIFANCY

LEVEL     .PROFIT         10417.29     11830.43    11002.82     12798.83
PRODUCTION.FUNCTIONAL        62.23       176.60       41.20         2.44
PRODUCTION.FANCY             78.20                   103.52       119.02
USAGE     .SMLLATHE         140.00       140.00      140.00       140.00
USAGE     .LRGLATHE          90.00        90.00       90.00        90.00
USAGE     .CARVER           103.09        70.64      120.00       120.00
USAGE     .LABOR            125.00       125.00      125.00        97.93
VALUE     .SMLLATHE          33.33        57.39        5.09        48.66
VALUE     .LRGLATHE          25.79        42.17       42.17        40.58
VALUE     .CARVER                                     34.63        19.45
VALUE     .LABOR             27.44        27.44       49.08
```

Table 3.3 Two Cases of the DOS Batch File

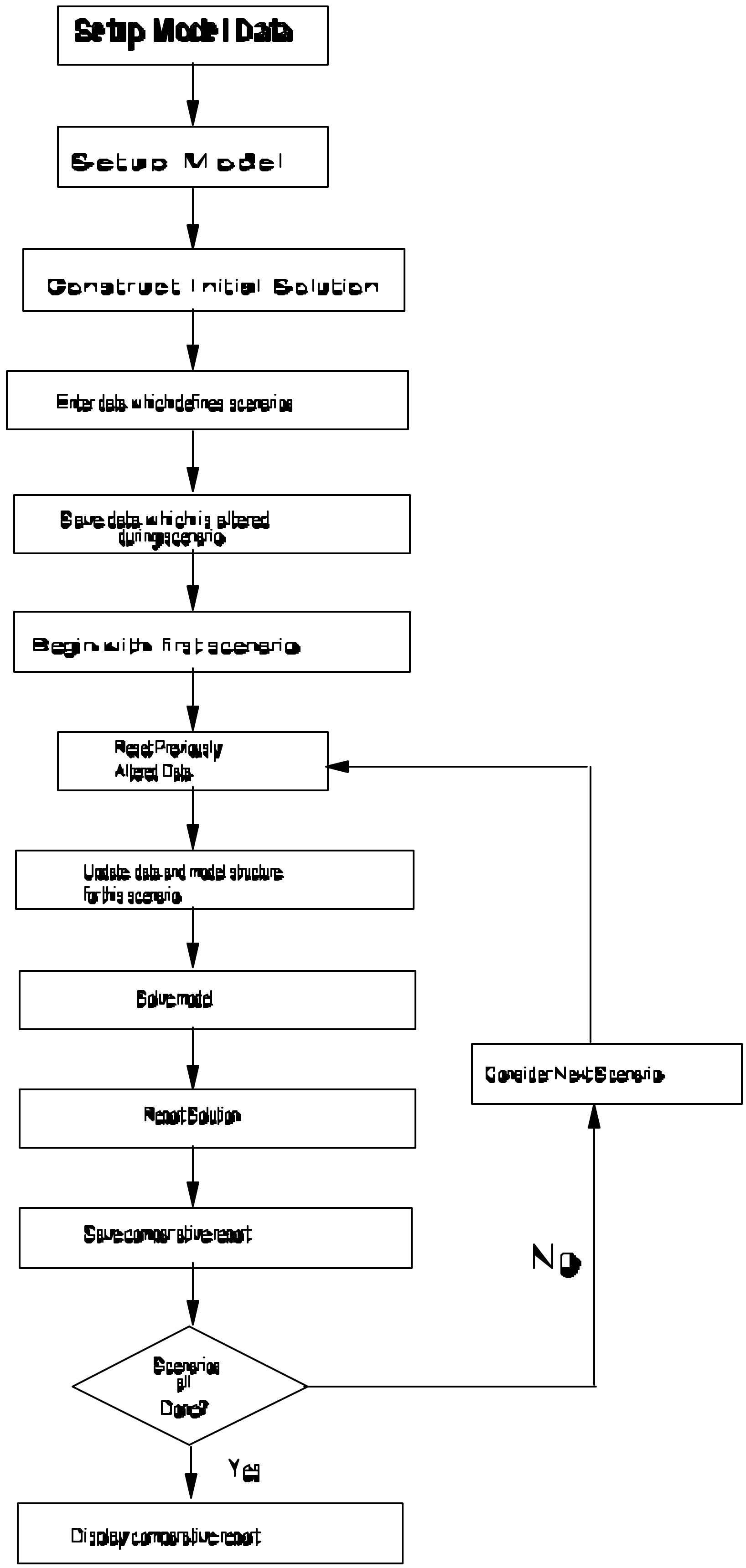
Case I: A complete FASOM run

command /c GAMS	ALLOFIT.DAT		S=.\t\f1
command /c GAMS	FAMODEL.MOD	R=.\t\f1	S=.\t\f2
command /c GAMS	FARPT.REP	R=.\t\f2	S=.\t\f3
command /c GAMS	FAALTRUN	R=.\t\f3	S=.\t\f4
command /c GAMS	FAFINAL.REP	R=.\t\f4	S=.\t\f5
command /c GAMS	FACOMSAV.SAV	R=.\t\f5	

Case II: A FASOM Alternative runs batch file starting from a stored solution

rem	command /c GAMS	ALLOFIT.DAT		S=.\t\f1
rem	command /c GAMS	FAMODEL.MOD	R=.\t\f1	S=.\t\f2
rem	command /c GAMS	FARPT.REP	R=.\t\f2	S=.\t\f3
command /c GAMS		FAALTRUN	R=.\t\f3	S=.\t\f4
command /c GAMS		FAFINAL.REP	R=.\t\f4	S=.\t\f5
command /c GAMS		FACOMSAV.SAV	R=.\t\f5	

Figure 3.1 Outline of a Comparative Model Analysis



4. SETTING UP A FASOM ALTERNATIVE RUN — GENERAL APPROACH

The FASOM system module FAALTRUN controls the process of comparative scenario analysis. When one wishes to do a FASOM comparative analysis one must make revisions in FAALTRUN. Three circumstances arise regarding alternative runs:

A) One may run a combination of the runs which are currently supported by FAALTRUN.

B) One may need to: (1) add new scenarios which are composites of already supported scenarios; or (2) slightly alter the alternative run data.

C) One may need to rebuild the alternative runs file for a different unanticipated set of scenarios.

Before discussing these alternatives, we first need to address the structure of the current FAALTRUN alternative runs file.

4.1 General Structure of FAALTRUN

FAALTRUN is the FASOM component which performs alternative runs. FASOM is generally structured as shown in Figure 3.1 with FAALTRUN doing all but the first three and last boxes. The GAMS code for FAALTRUN is shown in Table 4.1 (tables are located at the end of the chapter). Lines 1-19 deal with options regarding maximum iterations to farm program convergence (LIM) and solver function.[14] Lines 20-75 define the possible scenario runs that can be done by this version of FAALTRUN and include such things as changes in discount rates, changes in carbon targets, changes in the amount of public cut available, etc.[15] Lines 77-92 identify the exact set of runs to be done in this case. The exact runs that this particular version would execute are identified in line 89 — the BASE and STICKY scenarios would be done. Alteration of the incidence of asterisks in column one of lines 78-91 would cause different sets to be run[16]. This also shows the way that one identifies the runs to be done. Namely, select a subset out of lines 27-75 and list them as in line 89 with only that line activated, then those runs will be executed.

Lines 94-198 comprise the data defining the alternative runs. A key consideration in this section involves the set ASSUME and the table RUNVALUE. The set ASSUME, beginning on line 94,

---

[14] These lines, which will be repeated in all FAALTRUN files, are GAMS instructions covered in Brooke et al. and will not be discussed here.

[15] Table 4.2 groups these scenarios into broad classes.

[16] An asterisk in column one deactivates a line, causing it to be a comment.

identifies all the possible data assumptions that can be changed in a run.[17] These are coupled with data which tell what particular assumptions are used in a run, with data defining the assumption and with later calculations which implement the assumptions. The table RUNVALUE, beginning on line 130, pairs the assumptions with the runs. RUNVALUE contains a column for each scenario and at least one row for each assumption. Generally, a value of one is entered in the RUNVALUE table when a particular assumption is used in running a scenario. Thus, for example, in line 141 the one under the RECYC column and the HIRECYCLDEM row means use the high recycled demand assumption when running the RECYC (recycling) scenario. As noted above, RUNVALUE contains a column for each scenario and a row for each assumption. In turn, the entries in the table define exactly what assumptions compose each scenario. Thus, in lines 157-167 when we define the column for the scenario LESPUBSTK, which is less public cut under stickiness, we enter ones to indicate the scenario embodies three assumptions: low public cut demand, low public cut supply, and stickiness. A zero or omitted entry sets the assumption value at the base level. In other words, the base model assumption is used for all parameters when the alternative assumption is not specified. However, there are two notable exceptions. First, the CRP assumption gives the number of millions of acres remaining in the Conservation Reserve Program (CRP) after the year 2000, where the allowable numbers are 3, 13, 21, 33 and 36[18] as used in line 155. Second, the entry named CARBON tells FASOM that a scenario must exhibit at least the specified percentage increase in carbon sequestered in the decade 2040 relative to the base model 2040 carbon sequestration amount. Line 185 shows that scenarios with a minimum of 0.5%, 1%, 2%, and 5% increases have been defined.[19]

After the specification of the run assumptions, we include numerical data that are used to define the assumptions — lines 193-198. These data give assumptions regarding carbon, agriculture, biomass, forestry, deficiency payment, and Canada alternative runs. These are incorporated by including a set of data files. The included data files and the general nature of their contents are listed in Table 4.4.

Subsequently, locations are defined for storage of the original values for data items changed in the runs (lines 201-218) and those items are saved (220-231). Then we include a file which defines parameter names for the comparative report (line 245).

All of the instructions in FAALTRUN up to line 249 are setting up the alternative runs study. The lines from 249 on execute that study. This is done by repeatedly executing a set of instructions for each

---

[17] Table 4.3 lists these assumptions and identifies:
(a) the general type of assumptions involved
(b) the name of the assumption in the ASSUME set
(c)the place in the FASOM file structure where the assumption is defined
(d) the name of the file or files in which the alternative assumption data are defined
(e) the form of the alternative assumption, where S indicates that simply one alternative is used and R indicates that an alternative is chosen from a table of possible values.

[18] A zero entry is treated the same as an entry of 36 -- i.e., continue the current CRP.

[19] This is an old carbon sequestration analysis approach and is currently not being used. The scenarios Scen1a-Scen3d are the contemporary approach.

scenario. This in GAMS terms means we loop over the active runs defined in the set run (as defined in lines 77-91). In the loop the first action in lines 262-269 is to restore data to saved values so that each scenario starts off with the original data set. We also zero some parameters in lines 278-282.[20] We then save some scenario descriptions so they can be output (lines 284-288) and deactivate the carbon lower bound (lines 290-291).[21]

The next large section involves implementation of the assumptions as driven by their selection in the RUNVALUE table. These are implemented using GAMS replacement commands which appear in lines 293-460. The specific items altered and the associated line numbers are:

(a) Forest product demand (293-297).

(b) Forest product supply from public lands (299-303).

(c) Canadian supply (305-313).

(d) Intersectoral movement of products for pulp or power generation (315-320).

(e) CRP land reversion (326-340).

(f) Flag controlling whether a sticky run is to be done (342-343).

(g) Changes in agricultural foreign trade levels (345-351).

(h) Forest to agriculture land conversion costs (353-355).

(i) Forest minimum harvest ages (357-360).

(j) Use of discount rates where either 3% or 5% can be used in addition to the 4% base rate (362-373).

(k) Elimination of the farm program (375-379).

(l) Treatment of the sectors as independent (380-395).

(m) Special features if the sectors are independent, but the Parks and Hardie or Moulton and Richards runs are required (397-402).

---

[20]This needs to be done because GAMS does not always zero out prior stored solutions when variables or equations are eliminated by conditional statements. The zeroing insures that the old values are not retained.

[21] This illustrates the types of steps that need to be undertaken since GAMS does not recompute bounds automatically. We reset this lower bound so it is only active if called for in the scenario.

(n) Timber trade and transportation costs under recycling (405-411).

(o) Imposition of a 2040 minimum percentage increase in carbon sequestered from the base (413-417).

(p) Imposition of a demand for biomass feedstock in electrical generation (419-425).

(q) Activation of land transfers under the Moulton and Richards or Parks and Hardie assumptions when the forestry or ag models are run separately (427-434).

(r) Recomputation of the ISNEW, ISEXIST, and scaling parameters given changes in forest land use by other scenarios (436-460).

This is followed by the model solution (line 468). FAALTRUN then computes reports on an individual scenario for forestry, carbon, and agriculture in lines 480, 485, and 488. We also compute comparative cross-scenario reports in lines 482 and 491.

4.2 Making Up Your Own FAALTRUN — A Step-by-Step Guide

Suppose that you wish to define your own FAALTRUN for a set of scenarios different from those used in Table 4.1 . Three different paths can be followed:

SIMPLE	You want to run a different set of the predefined scenarios in Table 4.1.
MINOR CHANGE	You want to run some scenarios which either: (a) embody the assumptions already present in different combinations and/or (b) reflect minor changes in existing assumption definitions.
CHALLENGING	You want to run different scenarios, changing data not now handled in FAALTRUN.

Each of these cases will be covered below.

4.2.1 SIMPLE — Selecting Different Runs to be Done

The simplest case in defining a new FAALTRUN involves users who wish to run a different set of alternative runs choosing among the runs which are already possible — for example, doing a carbon analysis. This is done by altering the list of scenarios to be run. In particular, one would us a text editor to edit FAALTRUN in the area between lines 78-92 of Table 4.1, redefining the scenarios to be run. Specifically, one would comment out line 89 by putting an asterisk in column one and adding a line after line 91, which contained the subset desired of the scenarios defined in lines 27-75. For example, suppose in our carbon analysis we wished to use the Moulton and Richards (mourich), Parks and Hardie (parkshar); Stewardship Incentive Program (SIP) and Carbon target runs (Scen1a-Scen3d).

One would then comment out line 89 and enter the following lines thereafter:

```
 /base, mourich, parkshar , sip ,  Scen1a , Scen1b , Scen1c ,
  Scen1d , Scen2a , Scen2b , Scen2c , Scen2d , Scen2e
  Scen2f ,  Scen3a ,  Scen3b , Scen3c , Scen3d/
```

4.2.2 MINOR CHANGE — Data and/or Scenario Descriptions are Altered

One may also wish to make a run in which: (a)some other scenarios are added which are composed using existing assumptions, or (b) data defining existing assumptions are altered or augmented. Let us consider cases of each of these.

4.2.2.1 Composing a New Scenario

Suppose that we wish to define a new scenario which uses a new combination of existing assumptions. For example, suppose we wish to look at the Parks and Hardie scenario with the stickiness constraint imposed and with zero public cut. In order to do this we go through several stages.

(1) Define a new scenario name — for this case let us call it ZPPHSTK.

(2) Add this name to the list of scenarios defined in FAALTRUN by inserting a line somewhere around say line 72 ; include a verbal scenario definition.

(3) Add this name to the set of active scenarios to be run — alter line 89 to run this (i.e., make line 89 into /base,zpphstk/) or add lines as discussed in the previous section.

(4) Augment the RUNVALUE table to define the assumptions used in this new scenario as follows:

(a) Enter a column for the new scenario. For this example, add a column for the ZPPHSTK scenario after line 183 (entering a plus to tell GAMS the table continues). Skip over and put in the name ZPPHSTK.

(b) Associate this with rows drawn from the ASSUME set which correspond to the desired assumptions. In the example under the + sign enter the names of the three elements from ASSUME in three rows. Use the names for the assumptions corresponding to zero public cut (pubzrf), Parks and Hardie (parkhar) and stickiness (sticky).

(c) Enter ones underneath the new scenario column ZPPHSTK column in each of those three rows. The resultant addition would be the following:

```
+          ZPPHSTK
```

```
parkhar          1
pubzrf                1
sticky                1
```

(5) Execute FAALTRUN starting from a stored solution by using the Case II batch file of Table 3.3 (i.e., commenting out of the upper six lines of code titled "Case I," and running the same batch file).

4.2.2.2 Making Minor Data Alterations

The second case could involve potentially altering data or introducing new data in some cases into the structure of the existing assumptions. Let us consider two cases of this.

4.2.2.2.1 Adding Data an\ an Assumption

Suppose for example we wanted to run a 7% discount rate run. Here we add a scenario definition and a new but highly related assumption. The steps would be:

(1) Add a scenario description for a 7% discount rate — perhaps DRATE7 by inserting a line somewhere near line 43 along with a description.

(2) Activate that scenario in the list of scenarios to be run by altering line 89 or adding a similar line.

(3) Add a new entry to the ASSUME set defining the presence of the new data assumption — Perhaps call this DRATE7 and insert it after line 120.

(4) Define that scenario in the RUNVALUE table by adding an entry like the following:

```
+         Drate7
drate7     1    .
```

(5) Alter the data calculations to reflect that new assumption — around line 363 put in the 7% analog to lines 364 and 365 as follows:

```
* 7%
discrate$runvalue("drate7",run)=0.07;
```

Make sure this appears before any repeated calculations involving the discount rate such as appear in 369. Placing the "discrate" calculation after line 369 would have an improper effect on the model solution since the discount parameter would not be recomputed.

(6) Execute FAALTRUN by using the Case II batch file of Table 3.3 (as described under 4.2.2.1 above).

4.2.2.2.2 Adding Data in the ALT Files

Another possibility for adding data involves adding new entries in the ALT data files (i.e., the files listed in Table 4.2) for carbon, agriculture, biomass, forestry, or Canadian supply. Suppose we wanted to add another carbon target scenario; this would involve the following steps:

(1) Follow steps 1-4 from above section 4.2.2.2.1 defining a new scenario in the RUNS set, activating the scenario in the RUN set, adding assumptions beyond those in the ASSUME set if needed and augmenting the RUNVALUE table. Suppose in the carbon case we add a new scenario6. We would then add the line

scenario6   a new carbon scenario defined however

in the vicinity of line 63 and would add it to the active scenarios in a line like line 89.

(2) Edit the data in the ALT data files,[22] adding to or changing that data. In the carbon case we would edit the FACARB.ALT file and put in the new scenario name as a column in the CARBDAT table. In turn we would enter the amount of carbon sequestration required under this scenario in each of the model decades as illustrated by the following sample lines drawn from FACARB.ALT with the addition shown in bold type:

```
table carbdat(decs,runs) carbon data targets for sequestration by decade end

            Scen1A     Scen2a    Scen1B    Scen2b    Scen3A  Scenario6
1990      24.811     25.737    25.011    25.937    24.811  24.811
2000      25.911     26.866    26.311    27.066    26.011  26.050
2010      27.011     27.728    27.611    27.928    27.311  27.200
2020      28.111     28.382    28.911    28.582    28.711  28.600
```

Similar modifications could be made to other data sets, for example the agricultural trade data set in the FAAG.ALT file or the forest products demand data or minimum harvest stage data in the FAFOR.ALT files.

One final note regarding changing these data: there are some cases where you simply change and alter the existing data and some cases where you define additional scenarios. In particular when one data item holds for all scenarios involving this parameter, then one would simply change the data, but when the data table defines multiple scenarios (as is the case with the forest products demand, and public supply), then one should add for example a new item in the assume set and expand the contents of the tables within FAFOR.ALT. Several examples will illustrate this issue. First consider altering the agricultural foreign trade increase for wheat from 10.5% to 11.5%. In that case one would go into FAAG.ALT and change the number in the AGTRADINC table below so the 10.5 in the first row is an 11.5.

---

[22]Choose the one to edit by referring to the lists and descriptions in Table 4.2 along with the lists of input data contents in Table 5.9.

TABLE AGTRADINC(ALLI,*)   Scenario defined Proportional Increases in AG TRADE by commod

```
             EXPORT   IMPORT
WHEAT         10.5
CORN          10
RICE          23
SOYBEANS      2.5
SOYBEANMEA    7.5
SOYBEANOIL    2.5
COTTON        10.5
SUGARCANE                0
BUTTER        15        40.5
amcheese      15        40.5
otcheese      15        40.5
nonfatdrym    15        40.5
nonfedbeef               8
fedbeef       12
pork          12.5   -11
chicken       30.5
eggs           6.5;
```

On the other hand, when the data are scenario-dependent, one would alter the data in a table where the scenarios are arguments. For example, above we added “scenario6" to the carbon targets by editing FACARB.ALT and specifying the scenario in the CARBDAT data table. Alternatively, one could alter numbers for the current scenarios by altering the data for the existing scenarios.

As a final example, if one wished to incorporate another public cut scenario, then one would need to add a new assumption in the ASSUME set of FAALTRUN, a new scenario in the RUNS and RUN sets of FAALTRUN, and new data in the ALTPUBSUP table in the FAFOR.ALT file defining the new public cut scenario. For example, in the ALTPUBSUP data we have the assumption HIPUBCTSUP representing a high public cut scenario. This name appears in the ASSUME set in line 110 of FAALTRUN, and in the table in FAFOR.ALT defining public cut numbers (ALTPUBSUP) as below. Also note that the scenario HIPUBCTSUP is in the set which identifies the public cut alternatives (PUBSCENAR) as defined in the FAFOR.ALT file.

```
TABLE altPUBSUP(pubscenar,POWNER,REG,DECS,PRODS) alternative  PUBLIC TIMBER HARVEST
* PUBLIC TIMBER HARVEST IN GROWING STOCK EQUIVALENTS
* ADJUSTED FOR LOGGING RESIDUES
                                  SAWTSW     PULPSW     FUELSW     SAWTHW     PULPHW     FUELHW
    hipubctsup.usfs  .PNWW .1990   2527.897   414.5303     0.0000    97.9597    11.8050   141.4141
    hipubctsup.usfs  .PNWE .1990   2264.206    52.9602   287.8437     0.2917     0.0000     0.0000
    hipubctsup.usfs  .PSW  .1990   2066.503    43.3488   314.4522    10.6936     8.7112    75.2721
    hipubctsup.usfs  .RM   .1990   3436.363   735.7972    70.1118    14.8504   128.5791    19.8403
    hipubctsup.usfs  .LS   .1990    102.301   216.6279    12.0815   209.1286   281.4246    73.6026
    hipubctsup.usfs  .CB   .1990     26.748    56.6403     3.1589    74.8977   100.7900    26.3602
    hipubctsup.usfs  .NE   .1990     25.776    30.1256     1.1688    66.0647   118.9773    46.1264
    hipubctsup.usfs  .SC   .1990    957.170   684.4055     2.2921    98.4332   172.6149    21.7943
    hipubctsup.usfs  .SE   .1990    266.809   245.3959     6.3540    41.7593    41.3043    24.2677
    hipubctsup.opub  .PNWW .1990   2800.085   494.1326     0.0000    92.3288    11.1264   133.2854
    hipubctsup.opub  .PNWE .1990    753.347    18.8336   102.3622    13.8842     0.0000     0.0000
```

4.2.3 CHALLENGING — Major Alterations in FAALTRUN

When one wishes to define and run scenarios which involve different data items to be revised, or whole new sets of calculations, yet a more complex procedure is followed. At this juncture, users can either add to the existing FAALTRUN or rebuild FAALTRUN. We covered cases where we modify the existing FAALTRUN in the section above. Here we concentrate on rebuilding FAALTRUN for an alternative study. Once again, such an exercise could involve varying degrees of complexity. One could limit activities to a redefinition of the RUNS, RUN, ASSUME and RUNVALUE parameters, staying with the basic FAALTRUN structure as used above or one could completely restructure FAALTRUN. We leave the discussion of the restructuring question to Chapter 7 and discuss the alteration of the basic FAALTRUN structure here.

4.2.3.1 Motivating Our Study — A Biomass Example

Suppose we wish to examine scenarios involving agricultural sector production of feedstocks for electrical energy generation as in the earlier FASOM study supported by EPA, USDA, DOE and OSTP (see the description in Turnure et al.). Further, suppose we wish to have either 50, 200, or 700 trillion BTUs (TBTUs) of biomass energy produced.[23] Suppose we also wish to examine the implications of alternative rates of technological change in woody crop production. The study would be done using woody crop and switchgrass budgets developed at Oak Ridge National Laboratory. Those budgets assume technological changes due to research investment that affect costs and yields. The estimated woody crop budgets have been questioned in terms of their assumption that yield rates will grow quickly while costs will grow slowly. Thus, suppose that we wish to consider cases of (a) static technology (i.e., woody crop and switch grass production yields and costs stay at current levels); (b) a lessened rate of woody crop yield growth where the rate of growth is cut by one half relative to the Oak Ridge base budgets; (c) higher degree of association between costs and yields, where the woody crop production costs are assumed to increase at 30 % of the rate of growth in yields; and (d) a combined case encompassing cases (b) & (c). Also suppose we wish to do the biomass analysis on an agriculture-only basis for a forty year time horizon.

4.2.3.2 Defining a new FAALTRUN for the Biomass Analysis

The study will be done by creating a custom version of FAALTRUN, which appears in Table 4.3. This section presents a step by step review of the creation of the GAMS code in that table.

Step 1) Prepare the appropriate model version. Since we want to restrict our attention to 40 years and agriculture-only, we must change some data in the initial FASOM elements.[24] This involves

(a) going into the sets definition FASETS.DAT and changing the decades allowed by the DEC set so that only the years 1990, 2000, 2010, and 2020 are run.

(b) Creating a version of FAMODEL.MOD which runs agriculture only, which is done by changing the YESFOR parameter so that it has a value of zero (as

---

[23] Each 7 TBTUs are approximately the feedstock needed for a 100 megawatt power plant, so we are specifying that between 7 and 100 powerplants will be fueled by agricultural biomass.

[24] See the discussion of changing the scope of FASOM in Chapter 5 for details on impleme Table 4.1 Numbered noting the decadal and sector specification changes.

discussed in Chapter 5).

Step 2) Copy a version of FAALTRUN to a new file name so that it may be altered without losing the original FAALTRUN. Use a text editor and remove unneeded parts as you work.

Step 3) Revise the description of the ASSUME set. Redefine the ASSUME set with five members (Table 4.5 lines 36-41) . These tell:

(*a) The number of TBTUs required (the "biomass" element in line 37);

(b) Whether to increase the rate of growth in future woody crop production costs in association with yield growth (the "increscost" element in line 38);

(c) Whether to decrease the rate of growth in future woody crop yields (the "decresyld" element in line 39);

(d) Whether to both increase woody crop costs and decrease yield growth (the "alterboth" element in line 40);

(e) Whether to hold woody crop and switch grass production technology at current levels (the "notech" element in line 41);

Step 4) Remove the old scenarios from the RUN and RUNS sets and define the scenarios relevant to this study. Considering all combinations of the assumptions, we would run a base model with no biomass production, then three levels of biomass production (50, 200, and 700 TBTUs) crossed with five technology levels (base- Oak Ridge biomass technology assumptions - and b-e above) or sixteen total scenarios. Thus we enter lines 30 and 31 in Table 4.5 which define the base scenario and fifteen alternatives.

Step 5) Identify the exact subset of runs to be done in the RUN set. We may then choose to run either a test set (base , bi10 and bi13 cases as specified in line 33) or the full set by deactivating (placing an asterisk in column one of) line 33 and activating line 34 (removing the asterisk from column one).

Step 6) Set up the RUNVALUE set that associates values of the assumptions with the run descriptions. Here we have entered lines 44-57 which define the fifteen alternative runs. Note that the base run is not mentioned and thus will have values of zero for all elements of ASSUME.

Step 7) Include the BIOMASS alternative run data from the base version of FAALTRUN (line 64).

Step 8) Include data on the alternative runs. Data giving the appropriate levels of costs and yields under the alternative technology assumptions b-d are included in lines 68-149.

Do this by

(a) Defining a set (BIOCRP) containing the names of the biomass crops (line 68)

(b) Define a set with the names of the technological alternatives (called SCENARIO - line 71)

(c) Enter a table which gives the costs and yields under the technological alternatives (lines 76-149). Note that these data were computed exogenously.

Step 9) Compute data arrays which can be used in setting up the alternative run data. The yield and cost assumptions will be established using the parameter called EWBUDDATA (formed in lines 152-165), which has the base assumption in the "OLD" position and the alternative in the "NEW" position. This is done so we have an array of the same dimension as the crop budget data which includes the regional and decadal specific names for poplar, willow, and switchgrass.

Step 10) Save the data that will be altered in the scenarios, in lines 185-6

Step 11) Cause the model to not consider forest logging residue or whole stands for biomass, in lines 188-9;

Step 12) Import the standard FASOM code which defines the places in which the comparative reports will be stored (line 198).

Now we are ready to begin the solution process. This is done by defining a GAMS loop over the active parameters (this runs from lines 208-294). In setting up this loop we follow the following steps:

(a) Restore data to saved base levels. This involves altering the lower bounds on TBTU demand, the upper bounds on crop budgets to permit access to new technology, and restoring the biomass crop yields and costs to base levels (lines 217-225).

(b) Change the biomass crop costs and yields to reflect the scenario technology (lines 237-42).

(c) Impose the TBTU requirement in line 244 and insure that it is consistent with the data for market penetration in lines 245-56.

(d) Set the upper bounds on advanced technology to zero if technology is to be static (lines 257-9).

(e) Repeat the solution and report writing sequence from the base FAALTRUN version (lines 270-294)

Subsequently we turn our attention to the output. There, we'd make modifications in the FAFINAL.REP file so that: a) no forestry tables were being displayed and b) the tables BIOMASS and REGBIOMASS were produced to summarize our biomass results. We would probably also choose to display the RUNVALUE table so we had a display in the output of what assumptions were used under each RUNVALUE. These latter items would be accomplished by making sure the following display statements were present and that they do not have asterisks in column one:

```
display runvalue;
display biomass;
display regbiomass;
```

Table 4.1 Numbered Listing of Basic FAALTRUN

```
$ontext
fasom alternative runs component for making base run without solve
$offtext
version("altrunfile","faaltrun","jan11996")=1;
lim=51 ;
*activating the following suppresses farm program iterations
*lim=1 ;
option lp=cplex;
option solprint=on ;
option solprint=off;
option solveopt=replace;
option limrow=0
option limcol=0;
OPTION RESLIM=2500000;
option iterlim=1000000;
*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
*define scenarios
*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
set runs      superset of runs that could be done
 /base        base model
  50psub      run with estab cost subsidized on land transfers to forest
  halfper     one half % increase in carbon sequestered in 2040
  oneper      1 % increase in carbon sequestered in 2040
  twoper      2 % increase in carbon sequestered in 2040
  fiveper     5 % increase in carbon sequestered in 2040
  sip         sip run
  ceademand   run with council of economic advisors demand
  recyc       run with increased recycling
  morpbcut    run with more public cut
  lsspbcut    run with less public cut
  zrfpubcut   run with less zero national forest public cut
  zrfpubplnt  run with less zero national forest  cut and plant cst lim
  mourich     run with moulton richards land transfer to forest
  parkshar     run with parks hardie land transfers to forest
  drate3      run with 3% discount rate
  drate5      run with 5% discount rate
  moreagexp   run with more ag exports
  hicnvcst    run with high cost land transfers to ag
  independ    run with no land transfers between forest and ag
  nofarmp     run without farm programs
  sticky      run with forest establishment constraints
  minhar      alternative minimum harvest age
  Scen1a      carbon scenario c(t) + 1.1
  Scen1b      carbon scenario c(t) + 1.3
  Scen1c      carbon scenario c(t) + 1.6
  Scen1d      carbon scenario c(t) + 0.926
  Scen2a      carbon scenario c(base t) + 1.1
```

```
  Scen2b      carbon scenario c(base t) + 1.3
  Scen2c      carbon scenario c(base t) + 1.6
  Scen2d      carbon scenario c(base t) + 1.1 for 2000 on
  Scen2e      carbon scenario c(base t) + 1.3 for 2000 on
  Scen2f      carbon scenario c(base t) + 1.6 for 2000 on
  Scen3a      carbon scenario c(t) + 1.1 + dt(.1)
  Scen3b      carbon scenario c(t) + 1.1 + dt(.2)
  Scen3c      carbon scenario c(t) + 0.926 + dt(.1)
  Scen3d      carbon scenario c(t) + 0.926 + dt(.2)
  basestick   base with stickiness
  morichstk   moulton richards with stickiness
  morpubstk   more public cut with stickiness
  lespubstk   less public cut with stickiness
  recycstk    recycling with stickiness
  zrfpubind   zero public cut with independent sectors
  scen3aind   carbon scenario 3a with independent sectors
  parkharind  parks and hardie with independent sectors
  permcrpind  permanent crp with independent sectors
  nofpind     no farm program with independent sectors
  permcrp     permanent crp at cbo level
 ,bi1*bi54    biofuel runs/

    run(runs)   subset of runs to be done
* /base,zrfpubcut,scen3a ,nofarmp,independ,parkshar,permcrp/
*/base,
* morpbcut    run with more public cut
* lsspbcut    run with less public cut
* mourich     run with moulton richards land transfer to forest
* recyc       run with increased recycling
* basestick   base with stickiness
* morichstk
* morpubstk
* lespubstk
* recycstk/
 /base,sticky/
*  /independ,zrfpubind,scen3aind,nofpind,parkharind,permcrpind/
* /base /
;

SET ASSUME   ITEMS CHANGED IN ALTERNATIVE RUNS
    /SIP         is sip run active
     crp         crp reversion level
     crpperman   is crp permanent
     subagconv   is ag conversion to timber subsidized
     reqagconv   do we require moulton and richards land conversion
     parkhar     do we require moulton and richards land conversion
     basedemand  do we use base demand
     marglnddem   do we use marginal land demand
     moulricdem   do we use moulton rich  demand
     hipubctdem   do we use high public cut demand
     lopubctdem   do we use low  public cut demand
     ceademand    do we use cea demand
     hirecyldem   do we use demand associated with increased recycling
     basepubsup   use base level of public supply
     pubzrf       do we use zero national forest public supply
     hipubctsup   do we use additional public supply
```

```
     lopubctsup   do we use less public supply
     basetrdcst  use base tradcst
     rectrdcst   use trade cost associated with increased recycle
     basetrncst  use base trn cost
     rectrncst    use transport cost associated with increased recycle
     recpubsup   use public supply associated with increased recycle
     nolandtran  do we wish to eliminate land transfers
     nofarmpro   do we wish to dump farm program
     drate3      do we wish to use a 3% discount rate
     drate5      do we wish to use a 5% discount rate
     canada      do we add Canadian supply to demand and pnw public sup
     incagexp    do we wish to use increased ag exports
     hicnvcst    do we wish to use a higher land conversion costs
     ominhar     do we wish to use higher minimum harvest ages
     sticky      do we wish to invoke the stickiness assumption
     carbon      carbon minimum increase in % in 2040
     biomact     do we wish biomass to be active
    /

TABLE     RUNVALUE(ASSUME,RUNs) ALTERNATIVE VALUES FOR RUNS

           base 50psub mourich parkshar sip ceademand recyc morpbcut lsspbcut
*moulricdem               1       1
hipubctdem                                                    1
lopubctdem                                                            1
SIP                                      1
subagconv         1
reqagconv                1
parkhar                          1
ceademand                                     1
hirecyldem                                             1
recpubsup                                              1
hipubctsup                                                    1
lopubctsup                                                            1
rectrdcst                                              1
rectrncst                                              1
biomact     0
canada      0
+            zrfpubind scen3aind nofpind parkharind permcrpind
nolandtran       1         1         1         1         1
pubzrf           1
nofarmpro                            1
*moulricdem                                     1
parkhar                                        1
crp                                                     21
crpperman                                                1
           + basestick  morichstk  morpubstk  lespubstk  recycstk
reqagconv                1
hirecyldem                                                   1
hipubctdem                              1
lopubctdem                                         1
hipubctsup                              1
lopubctsup                                         1
rectrdcst                                                    1
rectrncst                                                    1
sticky           1        1             1          1         1
```

```
+            zrfpubcut zrfpubplnt   (bi1*bi54)  permcrp
 pubzrf         1         1
*sticky                   1
biomact                                 1
crp                                                21
crpperman                                           1
+         independ nofarmp drate3 drate5 moreagexp hicnvcst minhar sticky
nolandtran     1
nofarmpro             1
drate3                       1
drate5                              1
incagexp                                     1
hicnvcst                                              1
ominhar                                                        1
sticky                                                                1

+            halfper  oneper  twoper  fiveper
carbon        0.5      1       2       5    ;


*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

*now define data needed in scenarios

*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$include /mac/mccarl/agfor/source/facarb.alt
$include /mac/mccarl/agfor/source/faag.alt
$include "/mac/mccarl/agfor/source/biomass.alt"
$include "/mac/mccarl/agfor/source/fafor.alt"
$include "/mac/mccarl/agfor/source/def2.alt"
$include /mac/mccarl/agfor/source/canada.alt


*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

*save data that will be changed in  scenarios

*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

parameter savPUBSUP(POWNER,REG,DECS,PRODS)  saved PUBLIC TIMBER HARVEST
          svFPDEMAND(prods,decs,params)
          savTRADCST(REG,TRADEREG,PRODS)
          savTRANCST(REG,PRODS)
          savCONVERT(REG,CLS,*,THREE)
          savminharv(reg,owner,species,site,mic)
          savcar  saved carbon level
          savdisc  saved discount rate
          savFARMPR(dec,FARMPRO,ALLI) saved farm program assumption
          sexportgrw(alli,decs)  saved export demand growth
          storcanada(decs,prods) stored Canadian supply data
          simportgrw(alli,decs) saved import supply growth;

sexportgrw(alli,dec) =exportgrw(alli,dec);
simportgrw(alli,dec) =importgrw(alli,dec);
savFARMPR(dec,FARMPRO,ALLI) = FARMPR(dec,FARMPRO,ALLI) ;
savdisc=discrate;
```

```
savcar = CARBONSE.l("2040") ;
savCONVERT(REGS,CLS,"CCOST",THREE)= CONVERT(REGS,CLS,"CCOST",THREE);
savPUBSUP(POWNER,REG,dec,PRODS) = PUBSUP(POWNER,REG,dec,PRODS);
svFPDEMAND(prods,dec,params)=FPDEMAND(prods,dec,params);
savTRADCST(REG,TRADEREG,PRODS)=TRADeCoST(REG,TRADEREG,PRODS);
savTRANCST(REG,PRODS)=TRANsCoST(REG,PRODS);
savminharv(reg,owner,species,site,mic)=minharv(reg,owner,species,site,mic);
storcanada(dec,prods)=supcanada(dec,prods);
examine("biomass")=0;
examine("residue")=0;
*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
*now define items for comparative report
*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$include /mac/mccarl/agfor/source/facomset.sav
*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
*now do scenarios
*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
LOOP(RUN ,
*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
*restore data to saved values
*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
CONVERT(REGS,CLS,"CCOST",THREE)=savCONVERT(REGS,CLS,"CCOST",THREE);
minharv(reg,owner,species,site,mic) = savminharv(reg,owner,species,site,mic);
exportgrw(alli,dec) =sexportgrw(alli,dec);
importgrw(alli,dec) =simportgrw(alli,dec);
discrate= savdisc;
FARMPR(dec,FARMPRO,ALLI) = savFARMPR(dec,FARMPRO,ALLI) ;
TRADeCoST(REG,TRADEREG,PRODS)= savTRADCST(REG,TRADEREG,PRODS);
TRAnsCoST(REG,PRODS)=  savTRAnCST(REG,PRODS);
*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
*define this scenario
*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
*set some levels to zero to avoid GAMS bug in replace option
   LaNDFROMAG.l(REG,CLS,dec)=0;
```

```
      carbonse.m(dec)=0;
      LaNDTOAG.l(REG,CLS,dec,THREE)=0   ;
      CONVRTTOAG.l(REG,CLS,dec,SPEC)=0;
      CONVRTFRAG.l(REG,CLS,dec,SPEC)=0;

   *fill examine with scenario descriptor
      examine("sip")=RUNVALUE("sip",RUN);
      examine("subagconv")=RUNVALUE("subagconv",RUN);
      examine("reqagconv")=RUNVALUE("reqagconv",RUN);
      examine("parkhar")=RUNVALUE("parkhar",RUN);

   *deactivate carbon scenario
      carbonse.lo(dec)=0;

   *put in desired forest products demand scenario
      if(sum(demscenar,    RUNVALUE(demscenar,RUN)) le 0,
             RUNVALUE("basedemand",RUN) =1   );
      FPDEMaND(prods,dec,params)= sum(demscenar,
         1$RUNVALUE(demscenar,RUN)*altFPDEM(demscenar,prods,dec,params));

   *put in public supply
      if(sum(pubscenar,    RUNVALUE(pubscenar,RUN)) le 0,
          RUNVALUE("basepubsup",RUN) =1   );
       PUBSUP(powner,reg,dec,prods)= sum(pubscenar,
     1$RUNVALUE(pubscenar,RUN)*altPUBSUP(pubscenar,powner,reg,dec,prods));

   *put in Canadian supply
      supcanada(dec,prods)=storcanada(dec,prods)*runvalue("canada",run);
      canada(dec,prods)=0;

   *adjust demand to reflect possible presence of canada
   *   note demand adjustment does not include mill residue stuff
       FPDEMAND(PRODS,DEC,"INTERCEPT") =
            FPDEMAND(PRODS,DEC,"INTERCEPT") +
             supcanada(dec,prods) ;

   *allow or disallow forest products to move to ag biomass
       movcomtoag.up(regs,dec,canmove)=0+inf$runvalue("biomact",run);

   *allow or dissallow ag products to move to pulp
       movcomfrag.up(regs,dec,agcanmove,prods)
           $agcor(regs,dec,agcanmove,prods)=0+inf$runvalue("biomact",run);

   *  print out data definition of scenario
      setup(assume)= runvalue(assume,run) ;
      display setup;

   *handle crp reversion assumption
      crprevert(reg,dec)=0;
      if( runvalue ("crp",run  ) eq 0, crprevert(reg,dec)=0;);
      if( runvalue ("crp",run  ) eq 36, crprevert(reg,dec)=0;);
      if( runvalue ("crp",run  ) eq 33,
        crprevert(reg,dec)= crpland(reg,"continue")-crpland(reg,"admin"););
      if( runvalue ("crp",run  ) eq 21,
        crprevert(reg,dec)= crpland(reg,"continue")-crpland(reg,"cbo"););
      if( runvalue ("crp",run  ) eq 13,
```

```
  crprevert(reg,dec)= crpland(reg,"continue")-crpland(reg,"default"););
   if( runvalue ("crp",run  ) eq 4 ,
  crprevert(reg,dec)= crpland(reg,"continue")-crpland(reg,"none"););
   if( runvalue ("crpperman",run) eq 0 ,
  crprevert(reg,dec)$(date(dec) gt 1990)=
   crpland(reg,"continue")-crpland(reg,"none"););

*define whether sticky constraints are to be imposed
yespllim=runvalue("sticky",run);

*ag trade assumptions -- alter rates of growth in trade
   exportgrw(alli,dec)
      $(runvalue("incagexp",run) gt 0 and date(dec) ge 1990)=
      sexportgrw(alli,dec)*(1+agtradinc(alli,"export")/100);
   importgrw(alli,dec)
        $(runvalue("incagexp",run) gt 0 and date(dec) ge 1990)=
   simportgrw(alli,dec)*(1+agtradinc(alli,"import")/100);

*alter land conversion costs to 1.5 times base levels
CONVERT(REGS,CLS,"CCOST",THREE) $runvalue("hicnvcst",run)
    =savCONVERT(REGS,CLS,"CCOST",THREE)*1.5;

*alter minimum harvest age to that in minharv.alt
   if(runvalue("ominhar",run) gt 0,
      minharv(reg,owner,species,site,mic) =
         newminharv(reg,owner,species,site,mic)) ;

*discount rate
*  3%
   discrate$runvalue("drate3",run)=0.03;
*  5%
   discrate$runvalue("drate5",run)=0.05;
*recompute discounting used in model
   DISC(DEC) = 1/((1+DISCRATE)** (DATE(DEC) - TODAY + 5));
wtag(dec) = sum(decadeyear,1/(1+DISCRATE)**(ord(decadeyear)-1));
wtag(dec)$(ord(dec)=card(dec)) = sum(decadeyear,wtag("1990")/
             (1+DISCRATE)**(10*((ord(decadeyear)-1))));
 landcost =  sum(yrss,1/(1+discrate)**(ord(yrss)-1))/
   sum(yrss$(ord(yrss) le 10),1/(1+discrate)**(ord(yrss)-1));

*alter data for ag farm program assumption
   FARMPR(dec,"target",ALLI) $runvalue("nofarmpro",run)=0.0001;
   FARMPR(dec,"defic",ALLI) $runvalue("nofarmpro",run)=0.0001;
   FARMPR(dec,"loanrate",ALLI) $runvalue("nofarmpro",run)=0.0001;
   FARMPR(dec,"diverpay",ALLI) $runvalue("nofarmpro",run)=0.0001;
*alter data to handle whether sectors are independent

*   first assume land can transfer
   LaNDFROMAG.up(REG,CLS,dec)=inf;
   LaNDTOAG.up(REG,CLS,dec,THREE)=inf   ;
   CONVRTTOAG.up(REG,CLS,dec,SPEC)=inf;
   CONVRTFRAG.up(REG,CLS,dec,SPEC)=inf;

*   now shutdown land transfers if sectors are to be independent
  if(runvalue("nolandtran",run) ne 0.,
     LaNDFROMAG.up(REG,CLS,dec)=0;
```

```
     LaNDTOAG.up(REG,CLS,dec,THREE)=0   ;
     CONVRTTOAG.up(REG,CLS,dec,SPEC)=0;
     CONVRTFRAG.up(REG,CLS,dec,SPEC)=0;
     movcomtoag.up(regs,dec,canmove)=0;
     movcomfrag.up(regs,dec,agcanmove,prods)=0;

*under independent runs allow land transfers for parks hardie moultruch
*                      runs only
*   and only allow them from ag to forestry in 1990
  if(examine("parkhar")+examine("reqagconv")  gt 0,
      LaNDFROMAG.up(REG,CLS,"1990")=inf;
      CONVRTFRAG.up(REG,CLS,"1990",SPEC)=inf;););


* alter timber trade costs
 TRADeCoST(REG,TRADEREG,PRODS)$runvalue("rectrdcst" ,run)=
      IMEXRC3(REG,TRADEREG,PRODS)   *runvalue("rectrdcst" ,run);

*alter timber domestic transport costs
 TRAnsCoST(REG,PRODS)$runvalue("rectrncst" ,run)=
      InterrC3(REG,PRODS)   *runvalue("rectrncst" ,run);

*put in data for 2040 minimum carbon constraint
   carbonse.lo("2040")=0;
   carbonse.lo("2040")$runvalue("carbon",run)=
     savcar*(1+runvalue("carbon",run)/100);
   carbonse.lo(dec)$carbdat(dec,run)=carbdat(dec,run);

* impose biomass demand
   demands.lo(dec,"tbtus") = demlo(run);
   loop(dec,
      if(demands.lo(dec,"tbtus") gt
          sum(input,inputdecq(dec,input)/scale("tbtus")),
         demands.lo(dec,"tbtus") =
           sum(input,inputdecq(dec,input))/scale("tbtus")-0.0001);) ;

*allow forced land to move when running one sector model
   if(yesag*yesfor eq 0,
       LaNDFROMAG.up(REGs,CLS,"1990")=smax(policy,
          examine(policy)*landmin(regs,policy))*1000;
       LaNDTOAG.up(REGs,CLS,dec,THREE)=0   ;
       CONVRTTOAG.up(REGs,CLS,dec,SPEC)=0;
       CONVRTFRAG.up(REGs,CLS,"1990",SPEC)=smax(policy,
          examine(policy)*landmin(regs,policy))*1000;);

*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
*given model setup recompute needed items
*   update isnew and isexist
      expol(policy)=no;
      expol(policy)$examine(policy)=yes;
*   temporarily authorize ag in forest model with forced land movement
      if((yesag eq 0
      and sum(policy,sum(regs,examine(policy)*landmin(regs,policy))) gt 0),
         yesag=10);
*actually compute
$include "/mac/mccarl/agfor/source/faupdate.mod"
```

```
*   deauthorize ag in forest model with forced land movement
if(yesag eq 10,yesag=0);

*update scaling information
 EXIST.scale(when,cohort,regs,CLS,OWNER,SPECIES,SITE,MIC,expol)
       $(rotation(regs,owner,species,site,mic) gt 0
        and ISEXIST(when,cohort,regs,CLS,OWNER,SPECIES,SITE,MIC,expol)
        gt 0  )
            =ascale("scfor");
 NEW.scale(dec,when,regs,CLS,OWNER,SPECIES,SITE,MIC,expol )
          $(rotation(regs,owner,species,site,mic) gt 0 and
           ISNEW(when,regs,CLS,OWNER,SPECIES,SITE,MIC,expol ) GT 0
            )
            =ascale("scfor");
*$ontext
*
*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

*now solve

*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$include "/mac/mccarl/agfor/source/fasolvlp.mod"

*$ontext

*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

*now do report writing

*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

if(yesfor,
*forest report writer
$include "/mac/mccarl/agfor/source/faforrpt.rep"
*save forest data for comparative reports
$include "/mac/mccarl/agfor/source/facomsav.sav"
 );
*carbon report writer
$include "/mac/mccarl/agfor/source/facrbrpt.rep"
if(yesag,
*ag report writer
$include "/mac/mccarl/agfor/source/faasmrpt.rep"
 );
*save ag and aggregate data for comparative reports
$include "/mac/mccarl/agfor/source/facompar.rep"
*$offtext

   );
```

Table 4.2 General Classification of Types of Scenarios in FAALTRUN	
General Type of Scenario	Names of Scenarios in this Class
Encourage Movement of Land to Forestry	50psub mourich parkshar mourichstk parkharind
Expand carbon sequestration in 2040	halfper oneper twoper fiveper
Expand carbon sequestration over time	Scen1a Scen1b Scen1c Scen1d Scen2a Scen2b Scen2c Scen2d Scen2e Scen2f Scen3a Scen3b Scen3c Scen3d Scen3aind
Encourage better forest land management	SIP
Alter discount rate	Drate3 Drate5
Alter recycling	recyc recystk
Alter public cut	morepbcut lsspbcut zrfpubcut morpubstk lespubstk

Stickiness-limited adjustment	sticky zrfpubplnt basestick mourichstk
Alter forest demand	ceademand
Alter ag exports	moreagexp
Discourage Land transfers to Ag	hicnvcst
Treat sectors independently	independ zrfpubind scen3aind nofpind pakharind perpcrpind nofpind
Eliminate farm program	nofarmp nofpind
Run with different minimum harvest use	minhar
Alter conservation reserve	permcrp permcrpind
Biofuel alternatives	,bil*bi54

Table 4.3 List of Assumptions Present in ASSUME Set Including Notes on where Base andAlternative Data are Located

Type of Assumption	Name(s) in ASSUME set	Location of Base Assumption Data	Place Where Alternative Data Reside	Current Form of Alteration[1]
Stewardship Incentive Program	SIP	None	MONEY in FAPOLDAT.DAT	S
Conservation Reserve Program	crp crpperman	FAAG.ALT	CRPLAND in FAAG.ALT	S
Agricultural land planted to trees	subagconv reqagconv parkhar	None	landmin in FAPOLDAT.DAT FAALTRUN POLICY in FAPOLDAT.DAT	S
Forestry demand	basedemand marglnddem moulrichdem hipubcutdem lopubcutdem ceademand hirecycldem	FPDMD.DAT	ALTFPDEM in FAFOR.ALT	R
Public supply	basepubsup pubzrf hipubctsup lopubctsup recpubsup	PUBLIC.DAT	ALTPUBSUP in FAFOR.ALT	R
Forest trade cost	basetrdest rectrdcst		INEXEC3 in FAFOR.ALT	S
Forest transport cost	basetrnsct rectrncst	inter.dat	INTERRC3 in FAFOR.ALT	S

[1] Codes for this entry are:

S indicating the data imposing this assumption are one unique set of replacements.
R indicating there are alternative sets of replacement data that may be chosen, based on the level of this assumption.

Table 4.3 List of Assumptions Present in ASSUME Set Including Notes on where Base andAlternative Data are Located

Type of Assumption	Name(s) in ASSUME set	Location of Base Assumption Data	Place Where Alternative Data Reside	Current Form of Alteration[1]
Land transfers	nonlandtran	unlimited	set to zero in FAALTRUN	S
Farm program	nofarmpro	FARMPROD in FAAGDAT.DAT	zeroed in FAALTRUN	S
Discount rate	Drate5 Drate3	0.04 in FASETS.SET	DISCRATE in FAALTRUN	R
Inclusion of Canadian	Canada	all zero	SUPCANADA in CANEA.ALT	S
Increase agricultural trade	incagexp	PDEMAND in FAAGDAT.DAT	AGTRADINC in FAAG.ALT	S
Alter land conversion cost	hicnvcst	CONVERT in FAFORDAT.DAT	Multiply in FAALTRUN	S
Alter forest minimum harvest age	ominhar	MINHARV in FAFOR.DAT	NEWMINHARV in FAFOR.ALT	S
Stickiness	sticky	None	STICKYTYPE in FAPOLDAT.DAT STICKYLIM in FAFORDAT.DAT	S
Carbon sequestration	carbon	None	CARBDAT in FACARB.ALT CARVONSE.LO in FAALTRUN	R

[1] Codes for this entry are:

S indicating the data imposing this assumption are one unique set of replacements.

R indicating there are alternative sets of replacement data that may be chosen, based on the level of this assumption.

Table 4.3 List of Assumptions Present in ASSUME Set Including Notes on where Base andAlternative Data are Located				
Type of Assumption	Name(s) in ASSUME set	Location of Base Assumption Data	Place Where Alternative Data Reside	Current Form of Alteration[1]
Biomass	biomact	cropbud, demandsl, inputdexq in BIOMASS.DAT and FAAGDAT.DAT	MAXBIO, CROPBUDSUP, DEMANDS.LO in BIOMASS.ALT	S

[1] Codes for this entry are:

S indicating the data imposing this assumption are one unique set of replacements.
R indicating there are alternative sets of replacement data that may be chosen, based on the level of this assumption.

Table 4.4 Data files for Alternatives

Filename	Type of Data	Data Included
FACARB.ALT	Carbon Targets	Carbon targets by decade (CARBDAT)
FAFOR.ALT	Forest	Forestry demand alternatives (ALTFPDEM)
		Public cut alternatives (ALTPUBSUP)
		Forest trade costs (IMEXRC3)
		Forest transport costs (INTERRC3)
		Minimum harvest age (NEWMINHARV)
FAAG.ALT	Agricultural	Changes in trade (AGTRADINC)
		CRP alternatives (CRPLAND)
DEF2.ALT	Deficiency Payments Guess	Deficiency payment levels (FARMPR)
CANADA.ALT	Canadian Supply	Canadian Supply (SUPCANADA)
BIOMASS.ALT	Biomass Requirements	Minimum TBTUS (DEMLO)
		Biomass penetration (MAXBI)
		Biomass penetration (MASBIO)
		Allow new technology (CROPBUGUP)

Table 4.5 Listing of Biomass Version of FAALTRUN

```

$ontext
fasom alternative runs component for making base run without solve

$offtext
version("altrunfile","faaltrun","jan11996")=1;

lim=51 ;
*activating the following suppresses farm program iterations
*lim=1 ;

option lp=cplex;
option solprint=on ;
option solprint=off;
option solveopt=replace;
option limrow=0
option limcol=0;
OPTION RESLIM=2500000;
option iterlim=1000000;


*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

*define scenarios

*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$


set runs      superset of runs that could be done
 /base        base model
 ,bi1*bi15    biofuel runs/
    run(runs)   subset of runs to be done
/base,bi10,bi13 /
*/base,bi1*bi15 /
;
SET ASSUME   ITEMS CHANGED IN ALTERNATIVE RUNS
    /biomass     indicator on how many tbtus to require
     increscost  use increased woody crop cost biomass conditions
     decresyld   use decreased woody crop yield biomass conditions
     alterboth   use woody higher cost and low yield biomass conditions
     notech      no advances in biomass technology over 2000 conditions
    /

TABLE     RUNVALUE(ASSUME,RUNs) ALTERNATIVE VALUES FOR RUNS
          bi1 bi2 bi3 bi4 bi5 bi6 bi7 bi8 bi9 bi10 bi11 bi12
biomass    50 500 700  50 500 700  50 500 700   50  500  700
increscost             1   1   1
decresyld                          1   1   1
alterboth                                        1   1    1
notech
+          bi13 bi14 bi15
biomass     50  500  700
increscost
decresyld
```

```
alterboth
notech      1   1     1
;

*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

*now define data needed in scenarios

*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$include "/mac/mccarl/agfor/source/biomass.alt"



set biocrp(crop) names of bio cropsa;
biocrp(crop)=yes$sum(bioyrs(decs,crop),1);
alias (biocrp,biocrps);
set  scenario(assume) names of tech assumptions
     / increscost,decresyld,alterboth,notech /

set itemr items describing technological alternatives
  /oldyield,newyield,oldtotcost,newtotcost,newcostchg,incresyld/
table RBUDAT (types,reg,itemr,scenario,decs) yields and costs

                                        2010        2020

POPLAR.LS.OLDYIELD  .INCRESCOST        5.13        7.10
POPLAR.LS.OLDYIELD  .DECRESYLD         5.13        7.10
POPLAR.LS.OLDYIELD  .ALTERBOTH         5.13        7.10
POPLAR.LS.OLDTOTCOST.INCRESCOST      158.41      165.45
POPLAR.LS.OLDTOTCOST.DECRESYLD       158.41      165.45
POPLAR.LS.OLDTOTCOST.ALTERBOTH       158.41      165.45
POPLAR.LS.NEWYIELD  .INCRESCOST        5.13        7.10
POPLAR.LS.NEWYIELD  .DECRESYLD         4.12        5.10
POPLAR.LS.NEWYIELD  .ALTERBOTH         4.12        5.10
POPLAR.LS.NEWTOTCOST.INCRESCOST      180.97      212.12
POPLAR.LS.NEWTOTCOST.DECRESYLD       158.41      165.45
POPLAR.LS.NEWTOTCOST.ALTERBOTH       164.99      180.57
POPLAR.LS.NEWCOSTCHG.INCRESCOST       22.55       46.66
POPLAR.LS.NEWCOSTCHG.ALTERBOTH         6.58       15.12
POPLAR.CB.OLDYIELD  .INCRESCOST        4.42        6.12
POPLAR.CB.OLDYIELD  .DECRESYLD         4.42        6.12
POPLAR.CB.OLDYIELD  .ALTERBOTH         4.42        6.12
POPLAR.CB.OLDTOTCOST.INCRESCOST      160.90      167.94
POPLAR.CB.OLDTOTCOST.DECRESYLD       160.90      167.94
POPLAR.CB.OLDTOTCOST.ALTERBOTH       160.90      167.94
POPLAR.CB.NEWYIELD  .INCRESCOST        4.42        6.12
POPLAR.CB.NEWYIELD  .DECRESYLD         3.55        4.40
POPLAR.CB.NEWYIELD  .ALTERBOTH         3.55        4.40
POPLAR.CB.NEWTOTCOST.INCRESCOST      183.99      215.66
POPLAR.CB.NEWTOTCOST.DECRESYLD       160.90      167.94
POPLAR.CB.NEWTOTCOST.ALTERBOTH       167.75      183.59
POPLAR.CB.NEWCOSTCHG.INCRESCOST       23.09       47.72
POPLAR.CB.NEWCOSTCHG.ALTERBOTH         6.85       15.64
POPLAR.SE.OLDYIELD  .INCRESCOST        5.34        7.61
POPLAR.SE.OLDYIELD  .DECRESYLD         5.34        7.61
POPLAR.SE.OLDYIELD  .ALTERBOTH         5.34        7.61
```

```
POPLAR.SE.OLDTOTCOST.INCRESCOST      161.69      168.73
POPLAR.SE.OLDTOTCOST.DECRESYLD       161.69      168.73
POPLAR.SE.OLDTOTCOST.ALTERBOTH       161.69      168.73
POPLAR.SE.NEWYIELD  .INCRESCOST        5.34        7.61
POPLAR.SE.NEWYIELD  .DECRESYLD         4.28        5.41
POPLAR.SE.NEWYIELD  .ALTERBOTH         4.28        5.41
POPLAR.SE.NEWTOTCOST.INCRESCOST      185.39      220.82
POPLAR.SE.NEWTOTCOST.DECRESYLD       161.69      168.73
POPLAR.SE.NEWTOTCOST.ALTERBOTH       168.85      186.56
POPLAR.SE.NEWCOSTCHG.INCRESCOST       23.70       52.09
POPLAR.SE.NEWCOSTCHG.ALTERBOTH         7.15       17.83
POPLAR.SC.OLDYIELD  .INCRESCOST        4.55        6.73
POPLAR.SC.OLDYIELD  .DECRESYLD         4.55        6.73
POPLAR.SC.OLDYIELD  .ALTERBOTH         4.55        6.73
POPLAR.SC.OLDTOTCOST.INCRESCOST      163.75      170.79
POPLAR.SC.OLDTOTCOST.DECRESYLD       163.75      170.79
POPLAR.SC.OLDTOTCOST.ALTERBOTH       163.75      170.79
POPLAR.SC.NEWYIELD  .INCRESCOST        4.55        6.73
POPLAR.SC.NEWYIELD  .DECRESYLD         3.56        4.65
POPLAR.SC.NEWYIELD  .ALTERBOTH         3.56        4.65
POPLAR.SC.NEWTOTCOST.INCRESCOST      193.61      236.82
POPLAR.SC.NEWTOTCOST.DECRESYLD       163.75      170.79
POPLAR.SC.NEWTOTCOST.ALTERBOTH       173.98      195.59
POPLAR.SC.NEWCOSTCHG.INCRESCOST       29.86       66.02
POPLAR.SC.NEWCOSTCHG.ALTERBOTH        10.23       24.80
WILLOW.NE.OLDYIELD  .INCRESCOST        6.41        8.15
WILLOW.NE.OLDYIELD  .DECRESYLD         6.41        8.15
WILLOW.NE.OLDYIELD  .ALTERBOTH         6.41        8.15
WILLOW.NE.OLDTOTCOST.INCRESCOST      103.23      107.43
WILLOW.NE.OLDTOTCOST.DECRESYLD       103.23      107.43
WILLOW.NE.OLDTOTCOST.ALTERBOTH       103.23      107.43
WILLOW.NE.NEWYIELD  .INCRESCOST        6.41        8.15
WILLOW.NE.NEWYIELD  .DECRESYLD         5.31        6.18
WILLOW.NE.NEWYIELD  .ALTERBOTH         5.31        6.18
WILLOW.NE.NEWTOTCOST.INCRESCOST      115.17      128.56
WILLOW.NE.NEWTOTCOST.DECRESYLD       103.23      107.43
WILLOW.NE.NEWTOTCOST.ALTERBOTH       106.70      113.39
WILLOW.NE.NEWCOSTCHG.INCRESCOST       11.94       21.14
WILLOW.NE.NEWCOSTCHG.ALTERBOTH         3.47        5.97


 parameter EWBUDDATA(ALLI,REG,CROP,WTECH,CTECH,TECH,*);
  EWBUDDATA(biocrps,REG,bioCRP,WTECH,CTECH,TECH,"old")=
  nEWBUDDATA(biocrps,REG,bioCRP,WTECH,CTECH,TECH);
  EWBUDDATA(biocrps,REG,bioCRP,WTECH,CTECH,TECH,"new")=
  nEWBUDDATA(biocrps,REG,bioCRP,WTECH,CTECH,TECH);
EWBUDDATA(biocrps,REG,bioCRP,WTECH,CTECH,TECH,"new")
  $(EWBUDDATA(biocrps,REG,bioCRP,WTECH,CTECH,TECH,"old") gt 0 and
  sum(biocor(decs ,biocrp,types),1) gt 0)=
  EWBUDDATA(biocrps,REG,bioCRP,WTECH,CTECH,TECH,"old") *
   (1+sum(biocor(decs,biocrp,types)
       $RBUDAT (types   ,reg,"oldyield","alterboth",decs   ),
             ( RBUDAT (types   ,reg,"newyield","alterboth",decs   )
             / RBUDAT (types   ,reg,"oldyield","alterboth",decs   ))-1)
            );

```

```
EWBUDDATA("addtocost",REG,bioCRP,WTECH,CTECH,TECH,"new")
  $(EWBUDDATA(biocrp,REG,bioCRP,WTECH,CTECH,TECH,"old") gt 0 and
  sum(biocor(decs ,biocrp,types),1) gt 0)=
   sum(biocor(decs ,biocrp,types),
   RBUDAT (types   ,reg,"newcostchg","alterboth",decs   ));
  EWBUDDATA(biocrps,REG,bioCRP,WTECH,CTECH,TECH,"new")$
  (EWBUDDATA(biocrps,REG,bioCRP,WTECH,CTECH,TECH,"new") le 0 and
  EWBUDDATA(biocrps,REG,bioCRP,WTECH,CTECH,TECH,"old") gt 0)=
  EWBUDDATA(biocrps,REG,bioCRP,WTECH,CTECH,TECH,"old");
*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
*save data that will be changed in  scenarios
*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
parameter savenewtch save newtech;
savenewtch = newtech;
examine("biomass")=0;
examine("residue")=0;
*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
*now define items for comparative report
*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$include /mac/mccarl/agfor/source/facomset.sav
*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
*now do scenarios
*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
LOOP(RUN ,
*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
*restore data to saved values
*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
newtech=savenewtch;
DEMANDS.up(DEC,"tbtus"  )=inf;
DEMANDS.lo(DEC,"tbtus"  )=0;
 CROPBUDGET.up(DEC,REGS,CROP,WTECH,CTECH,TECH)
        $CROPBUDGUP(DEC,REGS,CROP,WTECH,CTECH,TECH)=
 CROPBUDGUP(DEC,REGS,CROP,WTECH,CTECH,TECH) ;
* option CROPBUDGUP:2:1:5;display cropbudgup;
```

```
  nEWBUDDATA(biocrps,REG,bioCRP,WTECH,CTECH,TECH)
  =EWBUDDATA(biocrps,REG,bioCRP,WTECH,CTECH,TECH,"old");
  nEWBUDDATA("addtocost",REG,bioCRP,WTECH,CTECH,TECH)=0;

*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

*define this scenario

*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

*  print out data definition of scenario
   setup(assume)= runvalue(assume,run) ;
   display setup;

if(runvalue("decresyld",run)+runvalue("alterboth",run)  gt 0,
  nEWBUDDATA(biocrps,REG,bioCRP,WTECH,CTECH,TECH)
  =EWBUDDATA(biocrps,REG,bioCRP,WTECH,CTECH,TECH,"new"););
if(runvalue("increscost",run )+runvalue("alterboth",run )  gt 0,
  nEWBUDDATA("addtocost",REG,bioCRP,WTECH,CTECH,TECH)
  =EWBUDDATA("addtocost",REG,bioCRP,WTECH,CTECH,TECH,"new"););
* impose biomass demand
   demands.lo(dec,"tbtus") = runvalue("biomass",run);
loop(dec,
if(demands.lo(dec,"tbtus") gt
          sum(input,inputdecq(dec,input)/scale("tbtus")),
   demands.lo(dec,"tbtus") =
        sum(input,inputdecq(dec,input))/scale("tbtus")-0.0001);
         ) ;
   loop(dec,
      if(demands.lo(dec,"tbtus") gt
          sum(input,inputdecq(dec,input)/scale("tbtus")),
         demands.lo(dec,"tbtus") =
           sum(input,inputdecq(dec,input))/scale("tbtus")-0.0001);) ;

if(runvalue("notech",run),
CROPBUDGET.up(DEC,REGS,CROP,WTECH,CTECH,TECH)
        $CROPBUDGUP(DEC,REGS,CROP,WTECH,CTECH,TECH)= 0;);

*display demands.lo;
option cropbudget:2:1:5;display cropbudget.up;
*option newbuddata:2:1:5;display newbuddata;
*$ontext
*
*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

*now solve
*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$include "/mac/mccarl/agfor/source/fasolvlp.mod"

*$ontext

*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

*now do report writing

*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
```

```
if(yesfor,
*forest report writer
$include "/mac/mccarl/agfor/source/faforrpt.rep"
*save forest data for comparative reports
$include "/mac/mccarl/agfor/source/facomsav.sav"
 );
*carbon report writer
$include "/mac/mccarl/agfor/source/facrbrpt.rep"
if(yesag,
*ag report writer
$include "/mac/mccarl/agfor/source/faasmrpt.rep"
 );
*save ag and aggregate data for comparative reports
$include "/mac/mccarl/agfor/source/facompar.rep"
*$offtext

   );
```

5. MAKING MAJOR STRUCTURAL CHANGES IN FASOM

There are several parameters in FASOM which, depending on their values, can substantially alter the scope of the model. These involve model time length; linear - nonlinear nature; and inclusion of the forest and agricultural sectors. Each of these will be discussed separately.

5.1 Length and Scope of Model

FASOM operates over a number of decades, and the number of decades is controlled by the set DEC which is currently defined on the 27th line of FASETS.DAT, which is a subset of the set DECS. The set DECS gives the longest potential time horizon which can be simulated (line 27). The set DEC actually controls model time length and is a subset of DECS giving the time periods which are authorized beginning from 1990. The FASETS.DAT file contains several alternative specifications of DEC, as shown below. (Note that an asterisk in column one inactivates the alternative choices).

```
      DEC(DECS)  TIME PERIODS IN RESTRICTED MODEL
                 /1990,2000,2010,2020/
*                /1990,2000/
*                /1990/
*                /1990,2000,2010,2020/
*                /1990,2000,2010,2020,2030,2040,2050,2060,2070,2080/
```

The DEC specification is an important determinant of model size, as going from 2 to 3 decades adds half again as much to the agriculture model as well as substantially more in the forestry model. One must begin the decades with 1990 and when running the forestry model, one must include at least one other decade. Generally the FASOM time frame is altered primarily for testing, but also to reduce memory and solution time requirements. Ordinarily we recommend that 90 to 100 years be run in any forestry-related study. However, the agricultural part of the model can be run even on as small as a 1990-only basis.

There is another way in which the model scope can be altered, and that involves use of the small data files. These should only be employed for testing. Small data files are present which contain the full structure of the agricultural and forestry data sets but are greatly reduced in scope. On the forestry side there are two smaller data versions. The very small one is called FAFORDAT.SML and contains a "made up" set of whole number yield data to allow one to verify accuracy of yield changing exercises. There is also a FAFORDAT.MED data file which contains a data set which is consistent with the total FASOM data set on acreage and yields, but has a reduced set of management intensity classes, ownerships and site indices. [25]

[25] The aggregation implicit in the FAFORDAT.MED data file can be changed by running the file SMALL which will reaggregate the forest sector data in a user-defined fashion-creating a data set which can have a different set of regions, timber stand cohorts, management intensity classes, etc.

5.2 Changing the Nonlinear Nature of FASOM

The agricultural part of FASOM and the linked agricultural/forest version of FASOM have proven to be difficult and time consuming to solve as nonlinear programming problems[26]. As a consequence, the model by default is set up as a separable linear program[27]. However, the nonlinear version is still accessible. This required a special approach since the linear solvers - CPLEX and OSL - will not accept a problem if any nonlinear terms are present, even if those nonlinear terms are all removed by GAMS conditional statements. As a consequence, a change was made in the FAMODEL.MOD code to remove the nonlinear parts. Namely, the statements have been reduced to comments using the $ONTEXT/$OFFTEXT syntax. Thus FAMODEL.MOD contains lines like the following:[28]

```
*nonlinear text
$ontext
     (( -(fpDEMAND(PRODS,DEC,"INTERCEPT")
+sum(tradereg,TRADFOR(TRADEREG,"EXPORT",PRODS,DEC,"INTERCEPT")))
        /(fpDEMAND(PRODS,DEC,"SLOPE")
+sum(tradereg,TRADFOR(TRADEREG,"EXPORT",PRODS,DEC,"slope")))
       + 0.5/( fpDEMAND(PRODS,DEC,"SLOPE")
+sum(tradereg,TRADFOR(TRADEREG,"EXPORT",PRODS,DEC,"slope")))*
       (TERMVOLN(PRODS)))*
       (TERMVOLN(PRODS)))$(SEPFOR EQ 0)
*nonlinear text
$offtext
```

where the terms between the text statements are the code for implementing the nonlinear model. This modification causes GAMS to ignore all lines between the ontext and the offtext as a comment. If one wishes to go back to the nonlinear version which works (although slowly) in the forestry case, one has to put an * in front of all the $ontext and $offtext statements in these sequences which reactivates the lines in between[29]. One also has to change the parameter SEPFOR to zero in line 35 of FAMODEL.MOD so that the separable forestry model is deauthorized. If one can find a nonlinear solver to solve the nonlinear agricultural model (MINOS5 now fails to solve the agricultural model) one would change SEPAG to zero in line 36.

---

[26]There also have been difficulties with solution times. Namely a solution of the linked model using a program which is capable of solving nonlinear programs (MINOS5) has been shown to take up to five days on the exact same set of data that the linear solver - CPLEX - handles in six hours.

[27]The linearization is done using Separable Programming. The technique is explained in McCarl and Spreen section 9.2.1.

[28]We do not list the FAMODEL.MOD code here as it would span more than 50 pages and there are roughly 10 occurances of the code discussed, each set off by a line stating “nonlinear text” which may easily be found using a text editor. Thus, we only list a small segment of that file.

[29]Note: GAMS will not allow LP solvers like CPLEX to be used to analyze the problem if the nonlinear terms are not treated as text.

5.3 Specifying Sectors for Inclusion

Conceptually, FASOM is a linked model of the forest and agricultural sectors. However, it has been designed to allow one to run the sectors independently. This is controlled by using the YESAG and YESFOR parameters. These parameters can be set either in FAMODEL.MOD or FAALTRUN to deauthorize one or the other sector. For example, when the model is run with the parameter YESFOR equal to one and YESAG equal to zero then only the forestry model will be run. Similarly, if YESAG is set to one and YESFOR is set to zero then only the agricultural model will be run. Setting both parameters to one will result in a linked run being executed. The ability to turn these sectors on and off does cause some difficulty in the model structure and FAALTRUN. Specifically, problems can arise when one is running a scenario which involves intersectoral land or commodity movement but is running only one sector.[30]

5.4 Treating the Two Sectors as Independent

The model depicts transfers of land between forestry and agriculture as well as transfers of milling residues for biomass and woody crops for pulp. However, in some scenarios users may wish to prohibit intersectoral interactions. Such tranfers may be prohibited by setting LANDCON to one by inserting the statement

```
LANDCON=1;
```

somewhere after FAMODEL.MOD has been run (for example in the first part of FAALTRUN). Alternatively, one may block and transfer by using the assumption INDEPEND in FAALTRUN, as discussed in Chapter 4. Similarly, if the assumption BIOMACT in FAALTRUN is set to zero, then commodity movement will be blocked.

5.5 Biomass

One other major structural feature involves biomass production. Biomass can be produced on agricultural lands in the form of woody crops or switchgrass which are in turn fed into a demand for energy at power plants. Biomass consideration is activated by setting a demand for the biomass in the form of a lower bound on SDEMAND for TBTUs as in the following line or as done in FAALTRUN (line 248).

```
demands.lo(dec,"tbtus") = 700;
```

One also needs to activate the intersectoral movement of woody crops for pulp and logging residues for energy by setting BIOMACT to one in FAALTRUN.

---

[30] Special provisions have been made to accommodate the Moulton and Richards and Parks and Hardie scenarios with a forest-only run; other future scenarios involving intersectoral land or commodity movement will require model structure modifications.

Ethanol production is also part of some model versions. However, such features are not in the base FASOM version. There is a version of FAAGDAT.DAT which incorporates these ethanol features, but that is not up to date with the most recent FASOM version.

5.6 Forestry, Logging Residues and Biomass Harvest

At one point during the FASOM model development, data were generated for the hauling of forest logging residues to biomass-fueled power plants, and similarly for the harvesting of existing stands purely on a biomass basis. These options never appeared in any solution and are thus currently suppressed in FASOM, although the data for them are present and perhaps a study in the future would merit revisiting their capabilities. For example, the biomass assumptions and data in BIOMASS.DAT could be modified so the commodities BIOMASSSW, MILLRESSW, LOGRESSW, BIOMASSHW, MILLRESHW, and LOGRESHW are transferred, and then the BIOMASS processing in FAAGDAAT.DAT could be modified so these commodities are used.

6. SETTING UP A FASOM COMPARATIVE RUN STUDY — INPUT AND OUTPUT

Chapter 5 was written without much discussion of the FASOM input and output. Here we discuss those topics further.

6.1 What Input Data Can be Changed

Most studies will require changes in the FASOM data. Users will not always know the parameter names of data items to be changed and where those items appear in the vast file structure of FASOM. Thus, discussion of the FASOM input data is in order. On the other hand, we should note that a high level of general knowledge of the contents of FASOM is assumed. We will not discuss the nature of the individual input items and their use in the model. Users without that knowledge should read the companion FASOM documentation (Adams et al.).

There are many input parameters within FASOM. The table in Appendix C provides an alphabetical list of these. Here we provide lists grouping the input parameters by function, telling where they are defined and giving a brief description. Further, we differentiate between base model input and comparative runs input. The input parameters are grouped by function in the following tables (tables are located at the end of this chapter):

Base Model Input Parameter Category	Table Listing Input Parameters
Agricultural Inputs	Table 6.1
Biomass Inputs	Table 6.2
Carbon Inputs	Table 6.3
Forestry Inputs	Table 6.4
Intersectoral Movement Inputs	Table 6.5
Model Control Inputs	Table 6.6
Policy Inputs	Table 6.7
Dynamic Setup Inputs	Table 6.8

Within each of these tables is an alphabetical list of the input parameters, showing the file in which each parameter is primarily specified, and briefly describing their nature. Users wishing to find information about the units of these items should consult the comments statements that are in the code where the items appear. Thus, for example, if one wishes to specify the forestry parameter EXISTYLD, one should turn to the EXIST.DAT file, look at the notes there on units, and examine the structure of the existing input.

Any of these input parameters can be changed in an alternative run. However, when a parameter is changed one has to be careful that any parameters dependent upon it are also changed (as discussed in section 3.2.1 above). To discover whether this is the case, look up in Appendix G the table for the items you are considering changing, and if any of those items are referenced in a file whose name ends with DAT or MOD check to make sure that this item is not used in a calculation.

Specifically, Appendix G tells the file names where parameters are referenced and/or recomputed. If any of these file names fall in the presolution or solution category (files ending with .DAT or .MOD), use your text editor to search within that file for that item. If that item is used in a calculation (in a statement where one quantity is set equal to an expression involving the altered parameter defined by an = sign), then repeat that calculation in FAALTRUN after the new data value is entered.

An example may be in order. Suppose we were to change the discount rate (the item named DISCRATE). Appendix G shows this item is referenced in FASETS.DAT, FAAGDAT.DAT and FAMODEL.MOD. Text editing those files shows the presence of the following assignment statements which use DISCRATE:

```
DISC(DECs) = 1/((1+DISCRATE)** (DATE(DECs) - TODAY + 5));
wtag(dec) = sum(decadeyear,1/(1+DISCRATE)**(ord(decadeyear)-1));
wtag(dec)$(ord(dec)=card(dec)) = sum(decadeyear,wtag("1990")/
     (1+DISCRATE)**(10*((ord(decadeyear)-1))));
landcost =  sum(yrss,1/(1+discrate)**(ord(yrss)-1))/
     sum(yrss$(ord(yrss) le 10),1/(1+discrate)**(ord(yrss)-1));
```

Thus in FAALTRUN, as chown in Table 4.1, one would need to repeat these calculations after line 368 once the DISCRATE parameter was changed.

Table 6.9 provides a list of the input parameters “included into” FAALTRUN; any of these parameters may be changed using the process just described. Table 6.9 gives alternative values for some of the parameters listed in tables 6.1-6.8. In turn FAALTRUN contains code to selectively alter the value of those parameters depending on what scenarios are being run.

6.2 What Output Can be Generated

Users may wish to customize the FASOM output. Such customization may involve either a desire to receive more output, a desire to reformat the output, or a desire to compute entirely new items. More output can be obtained from FASOM because not all of the potential FASOM output is being printed out by either the individual sector report writers or the comparative report writers. Fundamentally, there are four classes of FASOM output:

(1) Individual scenario output which appears in FAALTRUN.LST

(2) Comparative cross-scenario output which appears in FAFINAL.LST

(3) Saved comparative output which appears in RESULTS.PUT and

(4) Diagnostic output which appears in FAFINAL.LST.

We will discuss each of these classes of output and their contents in this section. Here we will assume that the range of possible types of output in FASOM is adequate and that the user wishes to print out more or less of the potential FASOM output that is already being generated by the model, by authorizing or removing display statements. In section 6.3 we will discuss generating additional output and printing it.

6.2.1 Run-Specific Output

The first class of FASOM output is scenario-specific output generated by FASOM and stored in the FAALTRUN.LST file. This run-specific output will appear one scenraio at a time sequentially in that file. This output may be categorized according to whether it describes agricultural, forestry, intersectoral movement, or carbon activity. The different categories of outputs arise from computations in the individual sector report writers FAASMRPT.REP, FAFORRPT.REP, and FACRBRPT.REP. The user can cause any of these scenario-specific outputs to be displayed by editing the display statements in these three ".REP" files or by entering display statements in FAALTRUN. The four categories of data items, and the four tables in which they appear are listed below (the tables show the report writer for each data category):

Category	Associated Table
Agricultural	Table 6.10
Forestry	Table 6.11
Intersectoral Movement	Table 6.12
Carbon	Table 6.13

For example, the bottom of the file FAFORREP.REP contains the following lines:

```
*DISPLAY "PRIVATE HARVEST BY PRODUCT",HARVPROD;
*DISPLAY "TOTAL HARVEST BY PRODUCT",THPROD;
*DISPLAY "TOTAL SOFT HARVEST BY REGION/SPECIES",SWTHARV;
*DISPLAY "TOTAL HARD HARVEST BY REGION/SPECIES",HWTHARV;
*DISPLAY "EXTERNAL NET TRADE FLOWS", NETRADE;
*OPTION ROWTRADE:3:2:2;DISPLAY "EXTERNAL TRADE FLOWS", ROWTRADE;
*DISPLAY REGTRANS;
*DISPLAY "EXISTING SOFT INV. AREA",SWAREXIST;
*DISPLAY "NEW SOFT INV. AREA", SWARNEW;
*DISPLAY "EXISTING HARD INV. AREA", HWAREXIST;
*DISPLAY "NEW HARD INV. AREA", HWARNEW;
*DISPLAY "EXISTING SOFT INV. VOLUME", SWINEXI;
*DISPLAY "NEW SOFT INV. VOLUME", SWINNEW;
*DISPLAY "EXISTING HARD INV. VOLUME", HWINEXI;
*DISPLAY "NEW HARD INV. VOLUME", HWINNEW;
*DISPLAY "SOFTWOOD AREA BY AGE CLASS", SWAGEDIST;
*DISPLAY "HARDWOOD AREA BY AGE CLASS", HWAGEDIST;
*DISPLAY "DELIVERED LOG PRICES, $1990/CF", FPPRICE;
*DISPLAY "EXTERNAL TRADE PRICES", FPTRADE;
*DISPLAY "PRODUCT SUBSTITUTION", FPSUB;
*DISPLAY "US CONSUMPTION & PRODUCTION BALANCE", CONSBAL;
*DISPLAY "NON-ZERO LANDFROMAG ACTIVITIES",LANDTOFOR;
*DISPLAY "NON-ZERO CONVRTTOAG ACTIVITIES", FORTOAG;
*DISPLAY "NON-ZERO CONVRTFRAG ACTIVITIES", AGTOFOR;
*DISPLAY "PRIVATE SOFTWOOD INV. - START OF PERIOD", SWINTOT;
*DISPLAY "PRIVATE HARDWOOD INV. - START OF PERIOD", HWINTOT;
```

```
*DISPLAY "PRIVATE SW AREA BY AGE CLASS ENDING 2080", ENDSWDIST;
*DISPLAY "PRIVATE HW AREA BY AGE CLASS ENDING 2080", ENDHWDIST;
*DISPLAY "NEW ROTATION CHECK", NCHECK;
*DISPLAY "EXIST ROTATION CHECK", ECHECK;
*DISPLAY "TOTAL VALUE", TOTALVAL;
*DISPLAY "TOTAL VALUE BY PRODUCT", PRODVAL;
*DISPLAY "PRIVATE SW HARVEST", PRISWHAR;
*DISPLAY "PRIVATE HW HARVEST", PRIHWHAR;
*DISPLAY "PUBLIC SW HARVEST", PUBSWHAR;
*DISPLAY "PUBLIC HW HARVEST", PUBHWHAR;
*DISPLAY "PUBLIC CHECK", PUBCHECK;
*DISPLAY "PRIVATE CHECK", PRICHECK;
*DISPLAY HARDWOOD.L;
*DISPLAY HARDWOOD.M;
*DISPLAY HARDWOOD.LO;
*DISPLAY "AREA WEIGHTED SOFTWOOD ROTATION", SOFTAGE;
*DISPLAY "AREA WEIGHTED HARDWOOD ROTATION", HARDAGE;
*DISPLAY "AVERAGE ROTATION BY REGION", AVGROT;
*DISPLAY "FOREST PRODUCTS TERMINAL PRICES", TERMPRI;
```

Any of the data items shown in these lines can be displayed by removing the asterisk in column one. If this information is displayed, it will appear in the FAALTRUN.LST file on a run-by-run basis, and may be found by using a text editor to search FAALTRUN.LST for four minus signs (with no spaces in between).[31] — see Brooke et al. Page 114. The units in which the values are expressed are shown in Tables D.2 through D.5 in Appendix D. Be prepared to find the model repeated, and then the outputs. The outputs may be printed using any word processing software that can import an ASCII file. Display of these items does not result in a cross-run comparison.

All scenario-specific data items are also inlcuded in the comparative report writer (as discussed in the next section and in section 6.3.2) and can be displayed. Users wishing to obtain particular types of output will need to first review Tables 6.10-6.13 and select names of data items to be displayed. In turn, display statements would be added or authorized in the ".REP" file identified in Tables 6.10-6.13 as the primary defining file for the data item.

6.2.2 Cross-Scenario Output and Saved Comparative Output

Given that the fundamental purpose of this document is to talk about alternative runs, comparative output is the fundamental output of interest. The comparative output in FASOM is largely just aggregations of the individual sncenario output, so that when the output is displayed one gets a cross-scenario comparison, for example comparing the welfare under one scenario to the welfare under another, or forest product prices under one scenario to forest product prices under another. The comparative output is formed in FACOMPAR.REP, FACOMSAV.SAV, and to a lesser extent, in FAFINAL.REP. The main displays of the comparative output are all in FAFINAL.REP. Comparative data are also available in "PUT file" form as will be discussed in the next section. The comparative output data are categorized as follows:

[31] A word processing text editor may not find the four minus signs, but the DOS text editor will.

Category	Associated Table
Agricultural	Table 6.14
Forestry	Table 6.15
Intersectoral Movement	Table 6.16
Biomass	Table 6.17
Carbon	Table 6.18
Debugging Output	Table 6.19

FASOM reports results relative to the agricultural and forest sectors, carbon, intersectoral movement of land, and biomass production. These outputs may be found and printed by using a text editor to search FAFINAL.LST for four minus signs (with no spaces in between) as described in Section 6.21 above. However, these data are not necessarily part of the FAFINAL.LST file when a particular run is done. Users wishing to add to or reduce output in FAFINAL.LST will need to edit the bottom of FAFINAL.REP, authorizing or deauthorizing displays by (1) activating commented out displays, (2) commenting out existing displays, or (3) adding a new display statement to the code sequence. For convenience the bottom of FAFINAL.REP is reproduced in Table 6.20.

6.2.3 Saved Comparative Output - RESULTS.PUT

Because the FASOM model is being developed by people in Denmark, Colorado, Oregon, Texas, and Washington, D.C., the developers decided to make a version of the FASOM output which could be saved and shipped from site to site. This was done using the GAMS "putfile" capability which prints out a GAMS-readable file called RESULTS.PUT which contains all the model results. Each time FASOM is run, results are always saved to RESULTS.PUT. RESULTS.PUT integrates a large number of saved data items which can then be used with specialized displays. In particular, FAFINAL currently can run after either the full FASOM model or just after the saved RESULTS.PUT file. Specifically, when one executes the following DOS batch file in the model directory:

```
GAMS  RESULTS.PUT    S=.\t\RES
GAMS  FAFINAL.REP    R=.\t\RES
```
[32]

the resultant FAFINAL.LST would be identical to that obtained in a full FASOM run. This permits the model to be run at one site, and the results saved in RESULTS.PUT and transferred to another site, where additional report writing manipulations can be done. In particular, Darius Adams maintains code which manipulates the RESULTS.PUT data to produce additional output. This will not be discussed here, but more information may be obtained from Dr. Adams at Oregon State University.

The RESULTS.PUT file has another interesting attribute and one major shortcoming. RESULTS.PUT allows the results to be shared and transferred from one group to another. This is particularly useful when running the linked model, because the linked model requires a fast computer with substantial memory. By using RESULTS.PUT, the basic linked model can be solved on a fast

[32] The slashes should be backslashes (as shown) for DOS-based computers, and forward slashes for UNIX-based computers.

computer, the results saved, and the results shipped off to a disciplinary expert who may work with the saved results to display the exact tables that are needed for a report. This also allows one to permanently archive the results of the study so that at a later time one can go back and seek additional information or clarify study results. However, this comes with one shortcoming. The FASOM developers created two arrays in RESULTS.PUT, ABEXIST and ABNEW. Each array has the full dimension of the forestry solution for each run, making a ten dimensional array. These arrays become very large and can result in 8-10 Megabyte RESULTS.PUT files, in most studies. This can make transporting the RESULTS.PUT file difficult.

6.3 Adding to the Output

Most users will be interested in adding to the output. This can be done on a run-specific basis, a comparative run basis, or by using the saved RESULTS.PUT.

6.3.1 Adding to the Scenario-Specific Output

Users may find that the scenario output appearing in FAALTRUN.LST is not adequate and that items are needed that are not computed in the current .REP files. For example, a user may want output for a measure of the average forest management intensity class used in the various regions.

In such a case, one needs to

(1) Text edit the applicable report writer, and see if the item of interest can be computed by adapting existing statements. For example, when wanting data on timber inventory by management intevsity class (MIC) one could use the calculated sum TINV in FAFORRPT.REP.

(2) Define the exact dimension of the report writer item that is to be added and add that definition into the report item definition file FARPT.REP
We would add the statement

```
Parameter   AVGMIC(DECS,REG) avg mgtintensity class by region;
```

(3) Add a calculation for the item in the applicable report writer — in this case put it in the forestry report writer file (FAFORRPT.REP).

```
AVGMIC(REGs) =
 sum((DEC,OWNER,SPECIES,MIC), ord(mic)*TINV(DEC,regs,OWNER,SPECIES,MIC))/
 sum((DEC,OWNER,SPECIES,MIC),          TINV(DEC,regs,OWNER,SPECIES,MIC));
```

(4) Add a display to the report writer or FAALTRUN if so needed, e.g.,

```
display avgmic;
```

(5) If this is to be in the comparative output, use the procedures discussed in the next section.

In doing this report writing, the user should be aware of the one trick that is used throughout FASOM to avoid unnecessary calculations. If one specifies, for example, an eight-dimensional array; GAMS will go through and consider each and every element of that eight dimensional array, if that eight dimensional array has ten items in each place, then 10^8 items will be computed. To avoid this, we use conditional statements that specify that only certain variables be considered, as illustrated in the following code:

```
 1      SOFTAGEN(dec,OWNER,REGS,SITE,MIC) =
 2      SUM((WHEN,COHORT,CLS,SW,expol)$
 3      ( (EXIST.L(WHEN,COHORT,REGS,CLS,OWNER,SW,SITE,MIC,expol) GT 0) AND
 4      (ORD(WHEN) EQ ORD(DEC)) AND
 5      (ORD(WHEN) LT CARD(WHEN))),
 6      EXIST.L(WHEN,COHORT,REGS,CLS,OWNER,SW,SITE,MIC,expol)*
 7      (HARVAGE(WHEN)+TREEAGE(COHORT)))
 8      +
 9      SUM(OLDDEC $ (DATE(OLDDEC) LT DATE(DEC)),
10      SUM((WHEN,CLS,SW,expol) $
11      ((DATE(OLDDEC)+ELAPSED(WHEN) EQ DATE(DEC)) AND
12      (NEW.L(OLDDEC,WHEN,REGS,CLS,OWNER,SW,SITE,MIC,expol) GT 0) AND
13      (ORD(WHEN) LT CARD(WHEN))),
14      NEW.L(OLDDEC,WHEN,REGS,CLS,OWNER,SW,SITE,MIC,expol) * HARVAGE(WHEN)));
```

The term `$(EXIST.L(WHEN,COHORT,REGS,CLS,OWNER,SW,SITE,MIC,expol) GT 0)` in line 3 restricts attentions to non-zero variables involving treatment of existing acreage; line 12 contains similar features for new acreage. Such practices should be followed to avoid excessive computer usage in report writing.[33]

6.3.2 Adding to the Cross-Run Comparative Output

Much of the material that is computed in the scenario-by-scenario output is also retained for possible use in the comparative output. Before one decides to add something new to the comparative output, first you need to establish whether or not it has already been defined there. In order to do this, look at the lists in tables 6.14 through 6.19 and see if the parameter names suggest such an item has been defined. If not, look at the tables for the non-comparative report writing if any existing report writing can be saved in a comparative table. If not, you must build your own code. This raises three cases, which will be discussed in the following three sections.

6.3.2.1 Displaying Computed But Undisplayed Items

When one is interested in an already computed, potential output item, one will find that a display statement is either present or it is not. The display statement is the basic mechanism in GAMS for receiving output. Any item which is computed can be displayed using the DISPLAY syntax as discussed on page 64 of Brooke et al. In addition, the output may or may not be formatted as desired. The formatting of the display may be changed using the option involving decimals (page 145 in Brooke et al.) or the item-specific option as discussed on page 146. The latter item covers the placement of the

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[33]See Chapter 12 of McCarl et al. for further coverage of this topic.

indices in the output. One may also reorder tables by defining parameters with different index orders. For example, if we have defined the parameter X(ITEM1, ITEM2) and display it, the rows will be defined for the elements of ITEM1 and the columns for ITEM2. On the other hand if we define Y(ITEM2,ITEM1) and set Y(ITEM2,ITEM1)=X(ITEM1, ITEM2), and then display Y, the table will be transposed.

Generally all alterations in displays and reordering of subscripts should be entered into FAFINAL.REP.

6.3.2.2 Adding a Comparative Report for an Uncomputed Item

The second case regarding comparative output occurs when one can find an item in the sector-by-sector reports but not an item in the comparative reports. Suppose we wish to define a table that compares land values in agriculture by region across runs. There is a table defined in FAASMRPT.REP called LANDSUM which includes the rental rate by decade, region, and type of land. Definition of a comparative table of land rents would then be done by the following steps:

1) Define a parameter in FACOMSET.SAV where the data could be saved. Thus we would introduce the following statement which defines the parameter LANDRENT by decade, region, type of land, and run:

```
PARAMETER LANDRENT(DECS,REGS,LANDTYPE,RUNS) Comparative land rents;
```

2) Edit FACOMPAR.REP to introduce the following statement which saves elements from LANDSUM into LANDRENT:

```
LANDRENT(DEC,REG,LANDTYPE,RUN)=LANDSUM(DEC,REG,LANDTYPE,"RENTALRATE");
```

3) Edit FAFINAL.REP to introduce the statements:

```
OPTION LANDRENT:2:3:1;
DISPLAY LANDRENT;
```

This adds the LANDRENT data to the FAFINAL.LST output. The LANDRENT data are formatted[34] so that the data have two decimal places; the decade, region, and land type indices appear in the row definitions; and the run appears across the columns. This formatting approach would highlight the differences in land rental rates across scenarios.

6.3.2.3 Adding Computation of a New Item

The third case arises when one wishes to add a new item to the comparative report. In this case, one first has to define that item in a scenario-by-scenario basis and then create comparative report calculations and a display. This can involve either code that is exclusively introduced in the

[34]The formatting is done via the option statement as discussed on page 146 of Brooke et al.

FACOMPAR.REP or code that is introduced into one of the other report writers that is specific to a sector. The general steps to add an item are as follows:

Step 1) Define a place to save the comparative report writing data in FACOMSAV.SAV (as in the case of LANDRENT above).

Step 2) If the item does not require calculation in the sectoral-specific reports go to step three. Otherwise,

(a) Add a definition of a new sectoral-specific report item to the file FARPT.REP. Suppose for example we wish to have an average national land rental rate across regions and suppose we wish it to be defined by landtype. In this case we would add the definition of a parameter to FARPT.REP to hold the average rent.

```
PARAMETER AVGRENT(DEC,LANDTYPE) average land shadow price;
```

(b) Compute the new sectoral-specific item in one of the sectoral-specific report writers. In terms of the average rental rate example, we would add code to the bottom of FAASMRPT.REP as follows:

```
AVGRENT(DEC,LANDTYPE)$
        SUM(REG,    LANDSUM(DEC,REG,LANDTYPE,"USE"))
=   SUM(REG,    LANDSUM(DEC,REG,LANDTYPE,"RENTALRATE")*
                LANDSUM(DEC,REG,LANDTYPE,"USE"))/
    SUM(REG,    LANDSUM(DEC,REG,LANDTYPE,"USE"));
```

Note that in this calculation the dollar sign ensures that for a particular land type in a decade there is a nonzero quantity of land USED. The next three lines compute the average rental rate as a weighted average by taking the total revenue on the land as valued at that rental rate divided by acreage used.

Step 3) Define a place in the comparative report to store this item. In our average land rental rate case above we would insert the line

```
PARAMETER AVGLANDVAL(DECS,LANDTYPE,RUNS) Comparative land rents;
```

in the FACOMSET.SAV file.

Step 4) If the item was a sectoral-specific item that was calculated in step 2, we would define the value of this new parameter so it received the item calculated in step 2 as follows:

```
AVGLANDVAL(DECS,LANDTYPE,RUNS)=AVGRENT(DEC,LANDTYPE);
```

Otherwisw (if the item was not calculated in step 2), we would directly calculate it here as follows:

```
AVGLANDVAL(DECS,LANDTYPE,RUNS)$
```

```
          SUM(REG,     LANDSUM(DEC,REG,LANDTYPE,"USE"))
    =  SUM(REG,     LANDSUM(DEC,REG,LANDTYPE,"RENTALRATE")*
                    LANDSUM(DEC,REG,LANDTYPE,"USE"))/
       SUM(REG,     LANDSUM(DEC,REG,LANDTYPE,"USE"));
```

Step 5) Put a display statement in FAFINAL.REP

6.3.2.4 Notes on Adding Items

The overall philosophy of the FASOM model is to keep the base code as versatile as possible. We have programmed the individual sector report writers so they provide a superset of the individual sector information that will be needed in any single study. Similarly we have designed a relatively comprehensive set of calculations in FACOMPAR.REP and the files ending with SAV. Thus we encourage users to augment the contents of these files if new general outputs are needed. On the other hand, if one wishes to put in something that is likely to be of interest only in a particular study (e.g., some focus on the average change in water values in a water innovation study), then one should probably include this in the FAALTRUN code after the include statement for FAASMRPT.REP with comparative code inserted after the include for FACOMPAR.REP. In this way, the base FASOM code will remain as clean and debugged as possible, allowing its use in multiple studies.

6.3.3 Changing the Contents of RESULTS.PUT

The output in RESULTS.PUT as generated by FACOMPUT.SAV is implemented in a more technical manner than is any other part of the FASOM system, because of the way the GAMS "put" facility works. An attempt has been made to partially isolate the user from the technical requirements of PUT usage by employing the GAMS BATINCLUDE facility. Some general procedures have been written that save any array of two to ten dimensions. These procedures come in two categories. The first category takes an item name and assumes that its saved file is that item name started by SV. These are the PUTDAT5 etc. commands included in FACOMPUT.SAV. An example line from FACOMPUT.SAV is

```
$BATINCLUDE /MAC/MCCARL/AGFOR/SOURCE/PUTDAT4.UTL  SWINEXI DEC REG OWNER RUN
```

This line causes the data from the parameter SVSWINEXI to be saved and indicates that SVSWINEXI is 4 dimensional (since PUTDAT4.UTL is being used) defined over the sets DEC REG OWNER RUN. The result is that all nonzero entries in that array will be saved to the RESULTS.PUT file.

Similarly, the PUTDAT items actually save the named item. Thus the code

```
$BATINCLUDE /MAC/MCCARL/AGFOR/SOURCE/PUTDAT2.UTL  TOTSURP PARTIES RUN
```

in FACOMPUT.SAV would save all the non-zero data for two dimensional parameter TOTSURP defined over the indices PARTIES and RUN. As another example, when adding a new parameter named MINE(REG,PRODS), which is saved in the comparative runs structure as

SVMINE(REGS,PRODS,RUNS), one would include the statement

```
$BATINCLUDE /MAC/MCCARL/AGFOR/SOURCE/PUTDAT3.UTL MINE REG PRODS RUN
```

On the other hand, if the cross run comparison is named COMPMINE(REGS,PRODS,RUNS) without the “SV” prefix, one would include the statement

```
$BATINCLUDE /MAC/MCCARL/AGFOR/SOURCE/DATPUT3.UTL MINE REG PRODS RUN
```

One may also need to add different sets into the RESULTS.PUT file. For example, to include the set SPECIES in the RESULTS.PUT file, use the PUT SET command as follows:

```
$BATINCLUDE /MAC/MCCARL/AGFOR/SOURCE/PUTSET.UTL  SPECIES
```

Table 6.1 List of Agricultural Input Parameters by Function

Input Item Name	Primary Input File	Brief Description of Item Contents
DYNAM	FAAGDYN.DAT	ANNUAL RATES OF CHANGE IN PRODUCTS
DYNAMINP	FAAGDYN.DAT	DYNAMIC INFORMATION ON REGIONAL INPUTS
EROSION	FAAGDAT.DAT	EROSION DATA
FARMPROD	FAAGDAT.DAT	FARM PROGRAM DATA
INPUTELAS	FAAGDYN.DAT	ELASTICITIES GIVING INPUT USE CHANGE WITH RESPECT TO YIELD CHANGE
INPUTPRICE	FAAGDAT.DAT	NATIONAL INPUT PRICES
INPUTQUAN	FAAGDAT.DAT	MAXIMUM NATIONAL INPUT QUANTITY
LANDSUBDAT	FAMODEL.MOD	PASTURE TO CROP LAND SUBSTITUTE
NEWAUMSSUP	FAAGDAT.DAT	REGIONAL AUMS SUPPLY
NEWBUDDATA	FAAGDAT.DAT	CROP BUDGET DATA
NEWFPPART	FAAGDAT.DAT	FARM PROGRAM PARTICIPATION RATES
NEWLABSUPP	FAAGDAT.DAT	REGIONAL LABOR SUPPLY
NEWLANDAVL	FAAGDAT.DAT	MAXIMUM LAND AVAILABLE BY SUBREGION
NEWLIVEBUD	FAAGDAT.DAT	LIVESTOCK BUDGET DATA
NEWLNDSUPP	FAAGDAT.DAT	REGIONAL LAND SUPPLY DATA
NEWMIXDATA	FAAGDAT.DAT	REGIONAL HISTORICAL CROP MIXES
NEWNATMIXD	FAAGDAT.DAT	NATIONAL PRIMARY PRODUCT MIXDATA
NEWPOPULAT	FAAGDAT.DAT	POPULATION BY SUBREGION FOR WELFARE ACCTING
NEWWATSUP	FAAGDAT.DAT	REGIONAL WATER SUPPLY
PDEMAND	FAAGDAT.DAT	PRIMARY COMMODITY DOMESTIC DEMAND DATA
PEXPORT	FAAGDAT.DAT	PRIMARY COMMODITY EXPORT DEMAND DATA
PIMPORT	FAAGDAT.DAT	PRIMARY COMMODITY IMPORT SUPPLY DATA
PROCBUD	FAAGDAT.DAT	PROCESSING BUDGET DATA
SDEMAND	FAAGDAT.DAT	SECONDARY COMMODITY DOMESTIC DEMAND DATA
SEXPORT	FAAGDAT.DAT	SECONDARY COMMODITY EXPORT DEMAND DATA
SIMPORT	FAAGDAT.DAT	SECONDARY COMMODITY IMPORTSUPPLY DATA
TOL	FAAGDAT.DAT	FARM PROGRAM CONVERGENCE TOLERANCE PROPORTION

Table 6.2 List of Biomass Input Parameters by Function

Input Item Name	Primary Input File	Brief Description of Item Contents
BIOHARV	BIOMASS.DAT	BIOMASS HARVEST COSTS (1990$ PER CUBICFOOT)
BIOTRAN	BIOMASS.DAT	BIOMASS TRANSPORT COSTS (1990$ PER CU FT)
BTUCONV	BIOMASS.DAT	BTU AND UNIT CONVERSIONS FOR WOOD
MAXBIO	BIOMASS.ALT	MAXIMUM BIOMASS PENETRATION IN TBTU
MILLRESID	BIOMASS.DAT	MILL RESIDUE PER CU FT OF SAWTIMBER
NOMILLDEM	BIOMASS.DAT	FOREST PRODUCT DEMAND IN 1000 CU FT
RESIDUVAL	BIOMASS.DAT	RESIDUE VALUES
SUBLIMIT	BIOMASS.DAT	LIMIT ON POPLAR SUBSTITUTION

Table 6.3 List of Carbon Input Parameters by Function

Input Item Name	Primary Input File	Brief Description of Item Contents
AGSOILCARB	FACARBON.DAT	AG SOIL CARBON
BURNING	FACARBON.DAT	DISTRIBUTION OF BURNED PRODUCTS
CARBFATE	FACARBON.DAT	DATA ON FATE OF CARBON IN HARVESTED PRODUCTS
DECAYRATE	FACARBON.DAT	ANNUAL DECAY RATE OF TREE CARBON ON THE SITE
ECOSYSCARB	FACARBON.DAT	CARBON IN FOREST ECOSYSTEM
INCLDISPL	FACARBON.DAT	DO I INCLUDE DISPLACED CARBON AS SEQUESTERED ?
RESIDUEFR	FACARBON.DAT	PROPORTION NON MERCHANTABLE WOOD
TREECARB	FACARBON.DAT	TREE CARBON YIELD FACTORS

Table 6.4 List of Forestry Input Parameters

Input Item Name	Primary Input File	Brief Description of Item Contents
AVGROT	FAFORDAT.DAT	AVERAGE ROTATION AT REGIONAL LEVEL
CAPACITY	CAP.DAT	CAPACITY FOR FOREST PRODUCT PROCESSING
DEMANDQ	FAFORDAT.DAT	ANTICIPATED VOLUME OF CONSUMPTION
ESTCOST	EST.DAT	FORESTRY ESTABLISHMENT COSTS
EXISTYLD	EXIST.DAT	YIELDS OF EXISTING FOREST STANDS
FPDEM	FPDMD.DAT	FOREST PRODUCT DEMAND
FUELSUBDAT	FAFORDAT.DAT	CAUSE HARDWOOD FUEL TO SUBSTITUTE FOR SOFTWOOD
GROWCOST	GROW.DAT	FOREST MAINTENANCE COSTS
HARDMIN	FAMODEL.MOD	MINIMUM HARDWOOD ACREAGE
HARVCST	FAFORDAT.DAT	FOREST HARVEST COSTS
HCOSTINF	FAFORDAT.DAT	ASSUMED HARVEST COST INFLATION RATE
INVENT	INV.DAT	INITIAL TIMBER INVENTORY
LANDTRANS	FAFORDAT.DAT	TRANSFER OF TIMBERLAND TO URBANDEVELOPED USES
MINHARV	FAFORDAT.DAT	MINIMUM HARVEST AGE
NEWYLD	NEW.DAT	YIELDS OF NEW FORESTED STANDS
PUBSUP	PUBLIC.DAT	PUBLIC TIMBER HARVEST
RESCOST	FAFORDAT.DAT	FOREST HARVEST COSTS INCLUDING LOG RES
ROTATION	ROTATE.DAT	TYPICAL EQUILIBRIUM ROTATION AGE
STICKYLIM	FAFORDAT.DAT	STICKINESS LIMITS
SUPCANADA	CANADA.ALT	CANADIAN SUPPLY
TCOSTINF	FAFORDAT.DAT	ASSUMED TRANPORTCOST INFLATION RATE
TRADECOST	FAFORDAT.DAT	FOREST PRODUCT TRADE COSTS
TRADEI	FAFORDAT.DAT	ANTICIPATED VOLUME OF FOREST PRODUCT TRADE
TRADFOR	TRADEDMD.DAT	FOREST PRODUCT TRADE DEMANDSUPPLY
TRANSCOST	INTER.DAT	DOMESTIC WOOD MOVEMENT COSTS TO NATIONAL MARKET
TREEAGE	FAFORDAT.DAT	AGE OF TREES IN A COHORT
YESMILL	FAMODEL.MOD	IDENTIFIES MILL RESIDUES
YESMILLRES	FAMODSET.MOD	WHETHER OR NOT TO MODEL MILL RESIDUE
YESPLLIM	FASETS.DAT	IMPOSE PLANTING EXPEDITURE LIMITS

Table 6.5 List of Intersectoral Input Parameters

Input Item Name	Primary Input File	Brief Description of Item Contents
AGCONVERT	FAFORDAT.DAT	LAND TO FORESTRY AG LAND CONVERSION LIMITS
CONVERT	FAFORDAT.DAT	LAND TO AG CONVERSION COST AND AVAILABILITY
LANDCON	FAMODEL.MOD	IS LAND CONVERSION ALLOWED

Table 6.6 List of Model Control Parameters by Function

Input Item Name	Primary Input File	Brief Description of Item Contents
SEPAG	FAMODSET.MOD	IF ONE USE SEPARABLE PROGRAMMING FOR AGRICULTURE
SEPFOR	FAMODSET.MOD	IF ONE USE SEPARABLE PROGRAMMING FOR FORESTRY
YESAG	FAMODEL.MOD	IS AGRICULTURAL MODEL ACTIVE
YESFOR	FAMODEL.MOD	IS FORESTRY MODEL ACTIVE
LANDCON	FAMODEL.MOD	IS LAND CONVERSION ALLOWED
DEC	FASETS.DAT	DECADES IN MODEL

Table 6.7 List of Policy Design Parameters by Function

Input Item Name	Primary Input File	Brief Description of Item Contents
EXAMINE	FAPOLDAT.DAT	POLICIES TO STUDY
LANDMIN	FAPOLDAT.DAT	LAND REQUIRED UNDER A POLICY
MONEY	FAPOLDAT.DAT	LIMIT ON MONEY AVAILABLE
STICKYTYPE	FAPOLDAT.DAT	SWITCH FOR PLANTING RESTRICTIONS
YESBIOMA	FAPOLDAT.DAT	POLICY LINK TO BIOMASS PRODUCTS

Table 6.8 List of Dynamic Setup Parameters by Function

BASEYEAR	FASETS.DAT	MODEL BASEYEAR NOW 1990
DATE	FASETS.DAT	DATE OF MODEL DECS
DEC	FASETS.DAT	DECADES IN MODEL
DISCRATE	FASETS.DAT	DISCOUNT RATE
YESAG	FASETS.DAT	WHETHER OR NOT TO HAVE THE AG MODEL
YESFOR	FASETS.DAT	DO I DO THE FORESTRY MODEL

Table 6.9 List of Alternative run Input Parameters

Category	Input Item Name	Primary Input File	Brief Description of Item Contents
Forest Product			
	ALTFPDEM	FAFOR.ALT	ALTERNATIVE FOREST PRODUCT DEMAND
	ALTPUBSUP	FAFOR.ALT	ALTERNATIVE PUBLIC TIMBER HARVEST
	IMEXRC3	FAFOR.ALT	RECYCLE SCEN TRADE COSTS
	INTERRC3	FAFOR.ALT	RECYCLE SCEN TRANSPORT COSTS
	NEWMINHARV	FAFOR.ALT	REVISED MIN. HARV.
Agriculture			
	AGTRADINC	FAAG.ALT	AG TRADE INCREASES
	CRPLAND	FAAG.ALT	CRP LAND INCIDENCE BY CRP REVERSION SCEN
Run Control			
	RUNS	FAALTRUN	ALL ALLOWED SCENARIOS
	RUN	FAALTRUN	CHOSEN SCENARIOS
	ASSUME	FAALTRUN	ASSUMPTIONS WHICH COMPOSE RUNS
	RUNVALUE	FAALTRUN	ALTERNATIVE VALUES FOR RUNS
Intersectoral			
	LANDCON	FAALTRUN	ALLOWS LAND MOVEMENT
Carbon			
	CARBDAT	FACARB.ALT	CARBON SEQUESTRATION TARGETS

Table 6.10 List of Agricultural non Comparative Output Data

Output Parameter Name	Primary Defining File	Brief Description Of Item Contents
AGPRODUCT	FAASMRPT.REP	AG PRODUCT FOR REPORT WRITER
AGTRADBAL	FAASMRPT.REP	AG TRADE BALANCE
AUMSREG	FAASMRPT.REP	AUM USAGE
BALANCEP	FAASMRPT.REP	PRIMARY PRODUCT SUPPLY DEMAND BALANCE
BALANCES	FAASMRPT.REP	SECONDARY SUPPLY DEMAND BALANCE
CONVERGE	FASOLVLP.MOD	NUMBER CROPS FAILING FARM PRO CONVERGENCE
FACTORWEL	FAAGWEL.REP	FACTOR ORIENTED WELFARE
FFWEL	FAAGWEL.REP	REPRODUCTION OF WELFARE IN AG OBJ FUN
FWELFARE	FAASMRPT.REP	FOREIGN WELFARE
GFWEL	FAAGWEL.REP	ORIGINAL AG OBJ FUN
GOVCCC	FAASMRPT.REP	GOVERNMENT CCC LOAN COST SUMMARY
GOVDEF	FAASMRPT.REP	GOVERNMENT DEFICIENCY PAYMENT SUMMARY
GROSSREV	FAASMRPT.REP	GROSS REVENUE BY COMMODITY
HARVEST	FAASMRPT.REP	NATIONAL HARVESTED ACREAGE REPORT
HARVESTREG	FAASMRPT.REP	REGIONAL HARVESTED ACREAGE REPORT
IORESULTC	FAASMRPT.REP	IO RESULTS FOR PRIMARY COMMODITIES
IORESULTP	FAASMRPT.REP	IO RESULTS FOR PRODUCTION SYSTEMS
LABORSUM	FAASMRPT.REP	LABOR USE SUMMARY
LANDSUM	FAASMRPT.REP	LAND USE SUMMARY
NATEROSION	FAASMRPT.REP	NATIONAL EROSION
NATiNPUSE	FAASMRPT.REP	NATIONAL INPUT USAGES IN $1000
PCONSUR	FAASMRPT.REP	DOMESTIC CONSUMER SURPLUS
PROCSUM	FAASMRPT.REP	PROCESSING SUMMARY
PROCWEL	FAAGWEL.REP	PROCESSOR WELFARE PROB ZERO
PRODUCTWEL	FAAGWEL.REP	COMMODITY ORIENTED WELFARE
PRODUCWEL	FAASMRPT.REP	PRODUCER WELFARE
REGEROSION	FAASMRPT.REP	REGIONAL EROSION
REGINPUSE	FAASMRPT.REP	REGIONAL INPUT USAGES IN $1000
REGWELFAR	FAASMRPT.REP	REGIONAL WELFARE ACCOUNTING
RESULT	FASOLVLP.MOD	FARM PROGRAM ITERATION RESULTS
REVWEL	FAAGWEL.REP	WELFARE FROM FARM REV SHOULD BE ZERO
STUCK	FASOLVLP.MOD	TELLS WHEN FARM PROGRAM ITERATIONS STUCK
SUBREPORT	FAASMRPT.REP	SUBREGIONAL PRODUCTION REPORT
WATERSUM	FAASMRPT.REP	WATER USE SUMMARY
WELCON	FAAGWEL.REP	FOREST CONSUMER WELFARE
WELSUM	FAASMRPT.REP	SOCIAL WELFARE SUMMARY REPORT

Table 6.11 List of Forestry Non Comparative Output Data

Output Parameter Name	Primary Defining File	Brief Description of Item Contents
AVGROT	FAFORRPT.REP	AVERAGE ROTATION AT REGIONAL LEVEL
CONSBAL	FAFORRPT.REP	US CONSUMPTION & PRODUCTION BALANCE
DAVGROT	FAFORRPT.REP	AVG. ROTATION BY REGION - DENOM.
DISSURP	FAFORRPT.REP	DISCOUNTED SURPLUS
ENDPROD	FAFORRPT.REP	TERMVOLN MARGINALS
FORTOAG	FAFORRPT.REP	NON-ZERO CONVRTTOAG ACTIVITIES
FPPRICE	FAFORRPT.REP	DELIVERED LOG PRICES1990 $PER CUF
FPSUB	FAFORRPT.REP	PRODUCT SUBSTITUTION
FPTRADE	FAFORRPT.REP	EXTERNAL TRADE PRICES
FWEL	FAFORWEL.REP	TOTAL WELFARE FOR A CHECK
HARDAGE	FAFORRPT.REP	HW ROTATION AGE
HARDAREA	FAFORRPT.REP	HW INVENTORY AREA
HARVEXIST	FAFORRPT.REP	HARVEST OF EXISTING STANDS
HARVPROD	FAFORRPT.REP	FORESTHARVEST BY PRODUCT
HTINV	FAFORRPT.REP	TOTAL HW TIMBER INVENTORY VOLUME
HWINEXI	FAFORRPT.REP	EXISTING HARD INV. VOLUME
HWINNEW	FAFORRPT.REP	NEW HARD INV. VOLUME
MICCUT	FAFORRPT.REP	TIMBER HARVEST BY MIC
NAVGROT	FAFORRPT.REP	AVG. ROTATION BY REGION - NUM.
NETRADE	FAFORRPT.REP	EXTERNAL TRADE (ROW) REPORT
NEWFORES	FAFORRPT.REP	NEWLY FORESTED ACRES BY REGION
NEWPOL	FAFORRPT.REP	POLICY INDUCED LAND
OWEL	FAFORWEL.REP	TOTAL WELFARE
OWNHWPROD	FAFORRPT.REP	HARDWOOD HARV BY OWNER PRODUCT
REGSURP	FAFORRPT.REP	REGIONAL SURPLUS
REGTRANS	FAFORRPT.REP	DOMESTIC TRADE FLOWS
ROWTRADE	FAFORRPT.REP	EXTERNAL TRADE FLOWS
SOFTAGE	FAFORRPT.REP	SW ROTATION AGE
SOFTAREA	FAFORRPT.REP	SW INVENTORY AREA
STINV	FAFORRPT.REP	TOTAL SW TIMBER INVENTORY VOLUME
SWINEXI	FAFORRPT.REP	EXISTING SOFT INV. VOLUME
SWINNEW	FAFORRPT.REP	NEW SOFT INV. VOLUME
TERMPRI	FAFORRPT.REP	TERMINAL PRODUCT PRICES
TERMSURP	FAFORWEL.REP	TERMINAL CONDITION SURPLUS
TERMVOL	FAFORRPT.REP	TERMINAL VOLUME
THPROD	FAFORRPT.REP	TOTAL HARVEST BY PRODUCT & REGION
TINV	FAFORRPT.REP	TOTAL TIMBER INVENTORY
TOTSURP	FAFORWEL.REP	TOTAL SURPLUS

Table 6.12 List of Intersectoral Land Movement non Comparative Output Data

Output Parameter Name	Primary Defining File	Brief Description of Item Contents
AGTOFOR	FAFORRPT.REP	NON-ZERO CONVRTFRAG ACTIVITIES
LANDDISP	FAFORRPT.REP	LAND DISPOSITION
LANDTOFOR	FAFORRPT.REP	NON-ZERO LANDFROMAG ACTIVITIES

Table 6.13 List of Carbon Non Comparative Output Data

Output Parameter Name	Primary Defining File	Brief Description of Item Contents
CARBCAL	FACRBRPT.REP	CALCULATED CARBON
CARBONI	FARPT.REP	INITIAL CARBON AT MODEL BEGINNING
CARBONIB	FARPT.REP	INITIAL CARBON BREAKDOWN
CARBONRPT	FACRBRPT.REP	CARBON RESULTS

Table 6.14 List of Agricultural Comparative Output Data

Output Parameter Name	Primary Defining File	Brief Description of Item Contents
ACRES	FACOMPAR.REP	AREA ENROLLED IN POLICY PROGRAM (M ACRES)
AGLNDPRI	FAFINAL.REP	WEIGHTED TRANSFERRED AG LAND PRICE
AGTABLE	FACOMPAR.REP	TABLE OF AGRICULTURAL RESULTS
EROSIOND	FACOMPAR.REP	REGIONAL EROSION
INDEXS	FAFINAL.REP	FISHER IDEAL INDICES
IOANIMAL	FACOMPAR.REP	INPUT OUTPUT DATA ANIMAL SYSTEM VALUE
IOCOMMOD	FACOMPAR.REP	INPUT OUTPUT DATA ON COMMODITY VALUE
RUNACRES	FACOMPAR.REP	COMPARATIVE REPORT OF CROPPED ACRES
SLANDSUM	FACOMPAR.REP	SAVED AG LAND USE
SMAXLAND	FACOMPAR.REP	SAVED SHADOW PRICE

Table 6.15 List of Forestry Comparative Output Data

Output Parameter Name	Primary Defining File	Brief Description of Item Contents
FORLNDPRI	FAFINAL.REP	WEIGHTED TRANSFERRED FOREST LAND PRICE
IOPRICHECK	FACOMPAR.REP	PRIVATE CHECK
IOPRIHWHAR	FACOMPAR.REP	HW HARVEST VOLUME BY PRIVATE OWNERS
IOPRISWHAR	FACOMPAR.REP	SW HARVEST VOLUME BY PRIVATE OWNERS
IOPRODVAL	FACOMPAR.REP	TOTAL HARVEST VALUE BY PRODUCT
IOPUBCHECK	FACOMPAR.REP	PUBLIC CHECK
IOPUBHWHAR	FACOMPAR.REP	HW HARVEST VOLUME BY PUBLIC OWNERS
IOPUBSWHAR	FACOMPAR.REP	SW HARVEST VOLUME BY PUBLIC OWNERS
IOTOTALVAL	FACOMPAR.REP	IMPLAN TOTAL VALUE OF HARVEST
MICHARVEST	FACOMPAR.REP	ACRES HARVESTED BY MIC
REFOREST	FACOMPAR.REP	ACRES REFORRESTED BY MIC
SHARDWOOD	FACOMPAR.REP	SAVED SHADOW PRICE
SLANDBALAN	FACOMPAR.REP	SAVED SHADOW PRICE
STICKYSHAD	FACOMPAR.REP	SHADOW PRICE PLANTING EXPENDITURE LIMITS
SVAVGROT	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF AVGROT
SVCONSBAL	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF CONSBAL
SVENDPROD	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF ENDPROD
SVFPCAP	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF FPCAP
SVFPPRICE	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF FPPRICE
SVHARDAGE	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF HARDAGE
SVHARDAREA	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF HW INVENTORY AREA
SVHWINEXI	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF HWINVEXI
SVHWINNEW	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF HWINVNEW
SVMICCUT	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF MICCUT
SVNEWFORES	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF NEWFORES
SVNEWPOL	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF NEWPOL
SVREGSURP	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF REGSURP
SVSOFTAGE	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF SOFTAGE
SVSOFTAREA	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF SW INVENTORY AREA
SVSWINEXI	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF SWINVEXI
SVSWINNEW	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF SWINVNEW
SVTERMPRI	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF TERMPRI
SVTHPROD	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF THPROD
SVTOTSURP	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF TOTSURP
TIMBCONP	FACOMPAR.REP	TIMBER CONSUMERS PRICE INDEX
TIMBCONQ	FACOMPAR.REP	TIMBER CONSUMERS QUANTITY INDEX
TIMBCONS	FACOMPAR.REP	FOREST PRODUCTS CONSUMPTION (MMCF)
TIMBCONSP	FAFINAL.REP	PERCENT CHANGE FROM BASE CONSUMPTION
TIMBERHAR	FACOMPAR.REP	HARVEST AREA IN M ACRES
TIMBERHARP	FAFINAL.REP	PERCENT CHANGE FROM BASE HARVEST AREA
TIMBERINV	FACOMPAR.REP	TIMBERLAND AREA IN M ACRES
TIMBERINVP	FAFINAL.REP	PERCENT CHANGE FROM BASE TIMBERLAND AREA
TIMBINV	FACOMPAR.REP	TIMBER INVENTORY VOLUME (MILLION CU FT)
TIMBINV2	FAFINAL.REP	NATIONAL INVENTORY IN ACRES
TIMBINV21	FAFINAL.REP	NATIONAL INVENTORY IN (MILLION CU FT)
TIMBINV21A	FAFINAL.REP	REGIONAL INVENTORY IN (MILLION CU FT)
TIMBINV3	FAFINAL.REP	NATIONAL INVENTORY IN ACRES
TIMBINV31	FAFINAL.REP	NATIONAL INVENTORY IN MILLION CU FT BY SPECIES
TIMBINV31A	FAFINAL.REP	REGIONAL INVENTORY IN ACRES
TIMBPRICE	FACOMPAR.REP	FOREST PRODUCTS PRICE (82 PER CU FT DELIVERED)
TIMBPRICEP	FAFINAL.REP	PERCENT CHANGE FROM BASE PRODUCT PRICE
TIMBPROD	FACOMPAR.REP	FOREST PRODUCTS PRODUCTION (MMCF)

TIMBPRODP	FAFINAL.REP	PERCENT CHANGE FROM BASE PRODUCTION
TIMBPROP	FACOMPAR.REP	TIMBER PRODUCERS PRICE INDEX
TIMBPROQ	FACOMPAR.REP	TIMBER PRODUCERS QUANTITY INDEX

Table 6.16 List of Overall Welfare and Land Movement Comparative Output Data

Output Parameter Name	Primary Defining File	Brief Description of Item Contents
FAWELFARE	FACOMPAR.REP	NPV OF WELFARE
FAWELSUM	FACOMPAR.REP	WELFARE BY DECADE
LANDSHIFT	FAFINAL.REP	AGGREGATE NET LAND SHIFT BETWEEN SECTORS
NLANDDISP	FACOMPAR.REP	LAND DISPOSITION
PROGCOST	FACOMPAR.REP	POLICY COST ($ MILLION)
SAGLDTRNLI	FACOMPAR.REP	SAVED SHADOW PRICE
SCNVRTFRAG	FACOMPAR.REP	SAVED OPTIMAL VALUE
SCNVRTTOAG	FAFINAL.REP	SAVED OPTIMAL VALUE
SFORCEDLAN	FACOMPAR.REP	SAVED SHADOW PRICE
SHADCOST	FACOMPAR.REP	COST OF FORCING TREES ($ MILLION)
SLANDTRNLI	FACOMPAR.REP	SAVED SHADOW PRICE
SLNDFROMAG	FACOMPAR.REP	SAVED OPTIMAL VALUE
SLNDTOAG	FACOMPAR.REP	SAVED OPTIMAL VALUE
STRNFRLDBA	FACOMPAR.REP	SAVED SHADOW PRICE
STRNTOLDBA	FACOMPAR.REP	SAVED SHADOW PRICE
SVLANDDISP	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF LANDDISP

Table 6.17 List of Biomass Comparative Output Data

Output Parameter Name	Primary Defining File	Brief Description of Item Contents
BIOMASS	FACOMPAR.REP	NATIONAL BIOMASS SUPPLY
REGBIOMASS	FACOMPAR.REP	REGIONAL BIOMASS SUPPLY

Table 6.18 List of Carbon Comparative Output Data

Output Parameter Name	Primary Defining File	Brief Description of Item Contents
CARBCOST	FACOMPAR.REP	COST OF CARBON MINIMUM CONSTRAINTS
CARBFLUX	FAFINAL.REP	ANNUAL FOREST CARBON ADDITION
CARBFLUXP	FAFINAL.REP	PERCENT CHANGE IN ANNUAL CARBON ADDITION
CARBONINV	FACOMPAR.REP	CARBON INVENTORY
CARBONINVP	FAFINAL.REP	PERCENT CHANGE FROM BASE CARBON INVENTORY
CARBRPT	FACOMSAV.SAV	CARBON RESULTS
REGCARBINV	FACOMPAR.REP	REGIONAL CARBON INVENTORY

Table 6.19 List of Debugging Output Data

Output Parameter Name	Primary Defining File	Brief Description Of Item Contents
OPTIMALITY	FACOMPAR.REP	PROBLEM OPTIMALITY STAT (SHOULD EQUAL 1 OR 2)
SCREWUP	FAFINAL.REP	INDICATES IDENTICAL RUNS
VERSION	FAFINAL.REP	VERSION OF FILES IN FASOM

Table 6.20 Ouput control portion of FAFINAL.REP

```
*control output
display "if there are entries here then two runs are likely the same",
         screwup;
display version;
* display rmnew
option decimals=0
 display optimality
option decimals=3
 display stickyshad
option decimals=0
 display fawelsum
 display fawelfare
*display welfare.l;
option decimals=4
 display fawelfarep
option decimals=0
 display progcost
 display shadcost
option decimals=0
 display timberinv
option decimals=4
 display timberinvp
option decimals=0
 display timberhar
option decimals=4
 display timberharp
option decimals=0
 display carboninv
option decimals=4
 display carboninvp
option decimals=2
 display carbcost
 display timbprice
option decimals=4
 display timbpricep
option decimals=0
 display timbprod
option decimals=4
 display timbprodp
option decimals=0
 display timbcons
option decimals=4
 display timbconsp
 display  timbprop
 display timbproq
 display timbconp
 display timbconq
 option decimals=0
 display acres
 display timbinv
option decimals=4
 display carbflux;
 display carbfluxp;
 display regcarbinv
 option decimals=0
```

```
  display timberhar
 option decimals=4
  display timberharp
 display reforest;
display micharvest
display   nlanddisp
option decimals=3
display indexs;
option decimals=0;
display agtable;
*display runacres;
*icf input output measures
*display ioresultc,ioresultp;
* display ioTOTALVAL
*display ioPRODVAL
*display ioPRISWHAR
*display ioPRIHWHAR
*display ioPUBSWHAR
*display ioPUBHWHAR
*display ioPUBCHECK
*display ioPRICHECK
option decimals=2;
*display biomass;
option timbinv2:0:3:1;
option timbinv21:0:3:1;
option timbinv3:0:2:1;
option timbinv31:0:2:1;
display timbinv2,timbinv3;
display timbinv21,timbinv31;
display aglndpri,forlndPRI;
display  LANDSHIFT;
option  sCNVRTFRAG:2:4:1; display scnvrtfrag;
option  sCNVRTtoAG:2:4:1; display scnvrttoag;
option  slndtoAG:2:4:1; display slndtoag;
option  slndfromAG:2:3:1; display slndfromag;
 display sLANDBALAN,  shardwood,  sforcedlan,  sTRNtoLDBA,
 sTRNfrLDBA,  sLANDTRNLI,  sAGLDTRNLI,  sMAXLAND;
 display slandsum;
option timbinv21a:0:4:1;display timbinv21a;
option timbinv31a:0:4:1;display timbinv31a;
```

7. REDEFINING FAALTRUN — A CLIMATE CHANGE EXAMPLE

Most of the presentation in Chapter 4 assumed that users can accomplish their goals in running alternative scenarios or changing input data by modifying the existing version of FAALTRUN. However, there are cases where one needs to rebuild FAALTRUN. In particular, suppose that we needed to run scenarios which cannot now be run involving the modification of data not now treated in FAALTRUN. Such a case arises when doing a study of the impacts of climate change on forests. Suppose we hypothesize that climate change might: (a) increase the costs of establishing southern forests; (b) retard growth in southern forests, causing productivity to lag by ten years; and (c) cause regional and species-specific changes in tree rates of growth. This study would require modifications in the forestry yield arrays (EXISTYLD and NEWYLD) as well as forest establishment costs (EST). In addition, changes in the exogenous amounts of timber cut in Canada and on U.S. public lands would be made to reflect altered tree growth assumptions. Suppose we also wished our reports to be structured on a large regional basis covering three regions: north, south, and rest of the country.

The above study design is radically different from anything supported by FAALTRUN and thus requires its reconstruction. In reconstructing FAALTRUN we will follow our general alternative run steps as discussed in Chapter 3. The structure of the reconstructed FAALTRUN is given in Table 7.1 (tables are located at the end of this chapter).

7.1 Defining the Scenarios

The scenarios are defined in lines 26-31.[35] Here we simply give numerical names (R1-R5) to the scenarios. This is actually part of a more general set of scenarios where over 100 are run, but only five are reproduced here to conserve space. Lines 27 to 31 choose the specific runs to be done, in this case selecting them all (line 31).

7.2 Entering Scenario Data

The data that define the alternative runs are entered in lines 37-62. We first name the various assumptions that will be changed in the ASSUME set. These are percentage changes in yield, percentage increases in establishment costs, and whether or not productivity is lagged by 10 years. The data are then specified for each run. Note, data for the "BASE" scenario are not specified so by default all changes to base values are assumed to be zero. Then for each scenario, wood species, and region, data are entered for each assumption. Looking at lines 40-50, note that in the R1 scenario we cause changes in lags for hardwoods and softwoods in the south (SE and SC regions). The R2 scenario has a 200 percent increase in southern establishment costs while R4 and R5 have 50% reductions in southern yields, with accompanying yield reductions in the north (lines 55-56).

We also include the Canadian alternative data file (CANADA.ALT) since the Canadian part of FASOM will be used here (line 64).

---

[35] All line number references in this chapter are to Table 7.1.

7.3 Saving Base Values for Data that are Altered

The next phase involves saving any data altered in the scenarios (lines 70-84). In this case we are going to save the establishment costs, the Canadian data and the public supply data (the latter two will be changed when yields are changed). Data are saved by defining parameters into which the data are to be saved, followed by replacement statements which actually save the data.

7.4 Augmenting Report Writing Definitions

The next phase is to define parameters for run-specific report writing. The general principle used here is that the FASOM source report writers generate more information than is generally needed in any study. Thus we use those report writers and pick out the subset of their information we want for the study at hand; we can augment this information with additional reports as needed and as discussed in Chapter 6. In our climate example, lines 86-116 set up the report requirements specific to the climate study while line 117 includes the parameters defined in the base FASOM source code. The climate study specific report writing definitions include:

(a) specification of new composite regions (lines 90-93);

(b) a parameter (line 95) which will be used to display the name of the run being executed in the FAALTRUN.LST file;

(c) New inventory tables which are not comparative in nature (97-101); and

(d) Additional cross-run comparisons, generally aggregated to the large regions (lines 105-115).

7.5 Setup for Data Respecification

We then need to set up the scenario computations. We define several needed parameters:

(a) WHENCL (lines 122-126) which gives us the years over which we will compute production lags; and

(b) Parameters in lines 128-140 which create data items for storing data that we compute in the process of running the scenarios with different yields, costs and lag adjustments.

We then relate the timber products in the model to the species classes for which the assumption adjustments are defined (lines 146-148) and increase forest products demand to reflect Canadian imports at preclimate change levels (lines 150-153). This is followed by computation of quantities required to do the data adjustments. Namely:

(a) acreage of existing and new stands by whether they are softwoods or hardwoods (lines 157-167).

(b) a storage array holding the land allocation solution in the forestry base model (lines 168-172).

(c) the base model total volume, and area of timber produced as well as average yield per acre by mic, owner, decade and product (lines 173-197).

7.6 Looping Through the Scenarios

The work described in the previous five steps has all been preparatory to running the alternative runs. Now we turn to the alternative run sequence as defined from line 198 to the bottom of the program. This begins with a loop over runs followed by the calculation and display of the WHICHRUNS parameter. That action places an individual run name reference above any scenario-specific data that are displayed. We then go through the loop steps identified in each of the following subheadings.

7.6.1 Restoring Changed Data to Base Levels

Lines 204-208 reestablish the base data for the reforested stand yields (NEWYLD), existing yield (EXISTYLD), and public supply (PUBLIC). We don't need to reestablish the establishment costs and Canadian supply because we use formulas based on their saved value.

7.6.2 Altering FASOM Data to Reflect the Scenario

Next we adjust the data to reflect the scenario.

(a) Lines 210-214 alter establishment cost by multiplying it times one plus the percentage change divided by 100.

(b) Lines 216-240 implement forestry yield adjustments. This is done iteratively using a loop where yield in period n+1 is yield in period n times one plus the growth rate in the original data times the climate change sensitivity factor. The growth rate is figured as the difference between the saved yield in n+1 and the yield in n, all divided by the yield in n. This is done first for period 1, then for period 2, etc. Thus, if the base data have 30% growth between the first and second periods and climate change reduces growth by half, we would compute new tree size as 1.15 times old tree size. This is done for both the existing and the new crops. This adjustment assumption does not allow the size of the initial existing trees to go down, rather the trees just grow at a slower rate.

(c) Yield lags are implemented in lines 242-256.

(d) The yields are checked for the possibility that some negative numbers have been introduced lines 258-262.

(e) Adjustments are made in public and Canadian cut (lines 292-308). Adjustments are made for these items assuming that we can use the reduction in total base model forest inventory under the scenario-specific harvest regime as a basis for the reduction. Thus, if the yield change evaluated using the base solution results in a total forest inventory with 5% less wood than in the base case, then we will reduce the Canadian and public cut by 5%. This is implemented by first computing, with the base model inventory structure, the decadal pattern of volume per acre under the base scenario solution and the volume per acre under the alternative yields. The difference between the two is then applied to the public and Canadian cuts. This assumes that the cut regime is exogenous, and thus if the base model inventory per acre declines by 5%, then the public cut and the Canadian cut would decline by the same percentage. The computations in the public cut are done using the data for the medium management intensity class and other private landholders by region. The computations for Canada are made using Pacific Northwest regional data.

7.6.3 Solving

After the data are set up, the model is then solved. This is done using exactly the same solve statement as in the original FAALTRUN (line 311).

7.6.4 Reporting on a Sector-by-Sector Basis

Following the solution, the forestry report writer is invoked (line 314). Here we start with exactly the same call which is used in the base FAALTRUN, but then add new inventory volume computations (lines 316-467). These new computations will be used in our comparative report. We also include the carbon and agricultural report writers, although we are not using that data in the solution.

7.6.5 Constructing the Comparative Report

The comparative report is again included just as in the base version of FAALTRUN in lines 483 and 484. We also add some new commands to save cross-run comparisons of:

(a) Inventory data on acreage and volumetric basis (lines 357-366)

(b) Total production (lines 367-405)

(c) Production and inventory in the large climate regions (lines 407-421).

(d) Total harvested acres (lines 422-435)

(e) Total production by ownership (lines 436- 467).

(f) Finally, in lines 473-481, we put in some aggregate reports on welfare. This concludes the loop.

7.7 Displaying Output

The climate change study also required that FINAL.REP be rebuilt with new calculations added to sum up certain items of interest, and alternative items being displayed in the output. This is included in the FASOM files and is called FAFINAL.CLI. The main modifications include:

(a) addition of the set NUMBER to reorder the output so we get total first, then south, followed by north and other; and

(b) addition of sets which tell what data items are to be reported.

7.8 General Computer Approach

From the discussion above, a number of general principles for building FAALTRUN versions emerge.

(1) Try to use as much of the base FASOM code as possible, and only introduce the modifications in FAALTRUN and FAFINAL.REP for particular studies. We do this to exploit the debugged nature of the general FASOM code and to permit any improvements that are made in the base FASOM code to automatically be incorporated in the FAALTRUN code.

(2) Rebuild the FAFINAL.REP code to produce the data needed for a study. Note that through the use of the batch file one can suppress all steps but the FAFINAL.REP step and tailor the output to the study needs. Further, do not display too much. It only takes a few minutes to add a display of some of the stored items.

(3) If rebuilding FAALTRUN, adopt a step-by-step approach as shown in Figure 3.1 or as followed in the subheadings of this chapter.

Table 7.1 Listing of Climate Change version of FAALTRUN

```
$ontext
FASOM alternative runs component for making base run without solve

$offtext
version("altrunfile","climatever","jan11996")=1;

lim=51 ;
*activating the following suppresses farm program iterations
*lim=1 ;

option lp=cplex;
option solprint=on ;
option solprint=off;
option solveopt=replace;
option limrow=0
option limcol=0;
OPTION RESLIM=2500000;
option iterlim=1000000;

*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

*define scenarios

*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

set runs       the run to be done
 /base        base model
  r1*r5    climate change run/

set run(runs) subset of runs to be done;
    run(runs)=yes;

*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
*define data for the scenarios
*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

set assume  scenario assumptions which will change /yield,ecost,lag/

table newclimdat(runs,spec,reg,assume)  climate scenario data
             se.yield   sc.yield   se.ecost   sc.ecost   se.lag   sc.lag
r1.hardwood     0          0           0          0         1         1
r2.hardwood     0          0          200        200        0         0
r3.hardwood     0          0          500        500        0         0
r4.hardwood   -50        -50           0          0         0         0
r5.hardwood   -50        -50           0          0         0         0
r1.softwood     0          0           0          0         1         1
r2.softwood     0          0          200        200        0         0
r3.softwood     0          0          500        500        0         0
r4.softwood   -50        -50           0          0         0         0
r5.softwood   -50         -50           0          0         0         0
+              pnww.yield  pnwe.yield  ls.yield   rm.yield    ne.yield
r1.hardwood     0           0             0          0           0
r2.hardwood     0           0             0          0           0
r3.hardwood     0           0             0          0           0
r4.hardwood   -50         -50           -50        -50         -50
```

```
r5.hardwood   -25         -25           -25        -25         -25
r1.softwood     0           0             0          0           0
r2.softwood     0           0             0          0           0
r3.softwood     0           0             0          0           0
r4.softwood   -50         -50           -50        -50         -50
r5.softwood   -25         -25           -25        -25         -25
;


$include /mac/mccarl/agfor/source/canada.alt

*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
*places to save data that will be changed in  scenarios
*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

parameter savPUBSUP(POWNER,REG,DECS,PRODS)  saved PUBLIC TIMBER HARVEST
          saveNEWYLD(WHEN,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS)
          savESTCOST(REG,CLS,MIC,SPECIES)
          storcanada(decs,prods) stored canadian supply data
          svEXISTYLD(WHEN,COHORT,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS);

savPUBSUP(POWNER,REG,DECS,PRODS) = PUBSUP(POWNER,REG,DECS,PRODS);
saveNEWYLD(WHEN,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS)$
          NEWYLD(WHEN,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS)=
          NEWYLD(WHEN,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS);
svEXISTYLD(WHEN,COHORT,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS)$
          EXISTYLD(WHEN,COHORT,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS)=
          EXISTYLD(WHEN,COHORT,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS);
savestcost(reg,cls,mic,species)=estcost(reg,cls,mic,species);
storcanada(decs,prods) = canada(decs,prods) ;

*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
*define report writing arrays and special Elements
*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

set climregs  aggregate regions for output /south,north,other/
    climmap(climregs,reg) map individual regions to aggregate regions
        /  south.(SE,SC),north.(PNWW,PNWE,LS,RM,ne),
           other.(CB,GP,SW,PSW)/;
*run specific material
parameter whichruns(runs) tells which run we are on
;
parameter
 newHWINNEW(dec,REG,OWNER,mic,hprods) hardwood new tree vol inv begin period
 newHardEXs(dec,REG,OWNER,mic,hprods) hardwood exist tree vol inv period begin
 newSWINNEW(dec,REG,OWNER,mic,sprods) softwood new tree vol inv begin period
 newSoftEXs(dec,REG,OWNER,mic,sprods) softwood exist tree vol inv period begin

*cross run comparative reports

parameter
regrun(decs,*,parties,runs)           regional surplus by decade
runprod(spec,dec,REG,PRODS,runs)      products by species and run
newtinv(spec,dec,runs,mic,reg)        inventory in volume start of pd
newinv(spec,dec,reg,runs)             inventory in acres start of pd
tinvcli(spec,dec,climregs,runs)       production by owner and big reg
tmiccli(spec,mic,climregs,dec,runs)   production by mgt and big region
```

```
productcli(dec,climregs,prods,runs)   all prod include canada and public
productprv(dec,climregs,prods,runs)   private production
harvestcli(dec,climregs,spec,runs)    harvested acres by species
harvowncli(dec,climregs,*,owner,runs) harvest by owner
;
$include /mac/mccarl/agfor/source/facomset.sav

*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
*setup for scenario computation
*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
set whencl(when) times of harvest which will be computed over
      /NOW,PLUS10,PLUS20,
       PLUS30,PLUS40,PLUS50,PLUS60
      ,PLUS70,PLUS80,PLUS90/
;

parameter
qcanada(dec,prods,runs)                 change in Canadian supply
runsexistl(when,cohort,reg,cls,owner,species,site,mic) base sol exist land
runsnewl(olddec,when,reg,cls,owner,species,site,mic,policy) base sol new land
softexist(reg,cls,owner,sw,site,cohort,mic,when) HARVEST of exist soft ACRES
hardexist(reg,cls,owner,hw,site,cohort,mic,when) HARVEST of exist hard ACRES
softnew(reg,cls,owner,sw,site,mic,when,decs)     reestablished softwood
hardnew(reg,cls,owner,hw,site,mic,when,decs)     reestablished hardwood
voltimber(mic,reg,owner,decs,prods)   Volume of timber produced base model
AREAtimber(mic,reg,owner,decs)     AREA of timber harvested base model
volbyarea(mic,reg,owner,dec,prods) timber yield per unit area base model
voltimbe3(mic,reg,owner,decs,prods) prod via base acres scenario yield
volbyare3(mic,reg,owner,dec,prods) yield pr acre plant via base acres under
this scenario yield





set woodtype(prods,spec)  relate products to hard and softwood
   /(pulpsw,sawtsw,fuelsw,biomasssw,millressw,logressw).softwood
    (pulphw,sawthw,fuelhw,biomasshw,millreshw,logreshw).hardwood/;

*adjust demand to reflect presence of canada at base level
    FPDEMAND(PRODS,DEC,"INTERCEPT") =
         FPDEMAND(PRODS,DEC,"INTERCEPT") +
          supcanada(dec,prods) ;

*retain base model solution

*save acreage
SOFTEXIST(REG,CLS,OWNER,SW,SITE,COHORT,MIC,WHEN) =
   sum(policy,
     EXIST.L(when,cohort,REG,CLS,OWNER,SW,SITE,MIC,policy))*SCFOR;
HARDEXIST(REG,CLS,OWNER,HW,SITE,COHORT,MIC,WHEN) =
   sum(policy,
        EXIST.L(when,cohort,REG,CLS,OWNER,HW,SITE,MIC,policy))*SCFOR;
SOFTNEW(REGS,CLS,OWNER,SW,SITE,MIC,WHEN,DECS) =
  (  SUM(POLICY,NEW.L(decs,when,REGS,CLS,OWNER,SW,SITE,MIC,POLICY)*SCFOR));
HARDNEW(REGS,CLS,OWNER,HW,SITE,MIC,WHEN,DECS) =
   (SUM(POLICY,  NEW.L(decs,when,REGS,CLS,OWNER,HW,SITE,MIC,POLICY)*SCFOR));
```

```
runsexistl(when,cohort,regs,cls,owner,species,site,mic)=sum(policy,
  exist.l(when,cohort,regs,cls,owner,species,site,mic,policy));
*compute new acres summed accross policy
runsnewl(olddec,when,regs,cls,owner,species,site,mic,policy)=
  new.l(olddec,when,regs,cls,owner,species,site,mic,policy);
*compute  volume of timber during a decade
 voltimber(mic,regs,owner,dec,prods)=  SUM(WHEN$
    (TODAY+ELAPSED(WHEN) EQ DATE(DEC)),
    SUM((cohort,CLS,SPECIES,SITE),
       runsEXISTl(when,cohort,REGS,CLS,OWNER,SPECIES,SITE,mic)*SCFOR*
       EXISTYLD(when,cohort,REGS,CLS,OWNER,SPECIES,SITE,mic,prods))) +
     (SUM(OLDDEC$ (DATE(OLDDEC) LE DATE(DEC)),
        SUM(WHEN$ (DATE(OLDDEC)+ELAPSED(WHEN) EQ DATE(DEC)
                  AND WHENDONE(OLDDEC,WHEN) GT 0 ),
        SUM((CLS,SPECIES,SITE,POLICY),
          runsnewl(olddec,when,REGS,CLS,OWNER,SPECIES,SITE,mic,POLICY)
         *SCFOR*NEWYLD(when,REGS,CLS,OWNER,SPECIES,SITE,mic,prods)))));
*compute area of timber
AREAtimber(mic,regs,owner,dec)=
  SUM((SPECIES,cohort,cls,site),sum(when$(ord(when) eq ord(dec)),
     runsEXISTl(when,cohort,REGs,CLS,OWNER,SPECIES,SITE,MIC)*SCFOR))
 + SUM(OLDDEC$ (DATE(OLDDEC) LT DATE(DEC)),
     SUM(WHEN$ (DATE(OLDDEC)+ELAPSED(WHEN) EQ DATE(DEC)),
       SUM((CLS,SITE,policy,species),
          runsnewl(olddec,when,REGS,CLS,OWNER,Species,SITE,mic,policy)
          *scfor)));
*compute volume per unit area
volbyarea(mic,regs,owner,dec,prods) $AREAtimber(mic,regs,owner,dec) =
  voltimber(mic,regs,owner,dec,prods) /
  AREAtimber(mic,regs,owner,dec) ;
option lp=cplex;
LOOP(run,
whichruns(runs)=0;
whichruns(run)=1;
display whichruns;
* reestablish data at original levels
   nEWYLD(WHEN,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS)=
       savenEWYLD(WHEN,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS);
   EXISTYLD(WHEN,COHORT,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS)=
       svEXISTYLD(WHEN,COHORT,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS);
   PUBSUP(POWNER,REG,DECS,PRODS) = savPUBSUP(POWNER,REG,DECS,PRODS);

*increase establishment cost
  ESTCOST(REG,CLS,MIC,SPECIES)=savESTCOST(REG,CLS,MIC,SPECIES)*
    (1+sum(spmappr(species,spec),newclimdat(run,spec,reg,"ecost"))/100);
*option estcost:2:1:3;display estcost;
* figure in yield percentage changes
loop(whencl,
*  new plantings
if(sum((spec,reg),newclimdat(run,spec,reg,"yield")),
   newYLD(whencl+1,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS)$(
      saveNEWYLD(whencl,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS) gt 0
      and ord(whencl) lt card(whencl) and
      sum(woodtype(prods,spec),newclimdat(run,spec,reg,"yield")))=
      newYLD(whencl,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS) *
     (1+ (((saveNEWYLD(whencl+1,REG,CLS,OWNER,SPECIES,SITE,MIC,prods) -
             saveNEWYLD(whencl,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS))
```

```
           / saveNEWYLD(whencl,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS))*
            (1+sum(woodtype(prods,spec),
                    newclimdat(run,spec,reg,"yield"))/100)));

*adjust yields for existing trees
  EXISTYLD(whencl+1,COHORT,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS)$(
    svEXISTYLD(whencl,COHORT,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS) gt 0
    and ord(whencl) lt card(whencl)
      and sum(woodtype(prods,spec),newclimdat(run,spec,reg,"yield")))=
     EXISTYLD(whencl,COHORT,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS) *
  (1+(((svEXISTYLD(whencl+1,COHORT,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS)
     - svEXISTYLD(whencl,COHORT,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS))
        / svEXISTYLD(whencl,COHORT,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS)
           * (1+ sum(woodtype(prods,spec),
                         newclimdat(run,spec,reg,"yield")/100)))));
);

*lag yields
* existing trees
if(sum((spec,reg),newclimdat(run,spec,reg,"lag")),
 EXISTYLD(whencl+1,COHORT,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS)$(
 svEXISTYLD(whencl,COHORT,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS) gt 0 and
      ord(whencl) lt card(whencl)
     and sum(woodtype(prods,spec),newclimdat(run,spec,reg,"lag")))=
      svEXISTYLD(whencl,COHORT,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS);
*new trees
  newYLD(whencl+1,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS)
   $(savenEWYLD(whencl,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS) gt 0 and
     ord(whencl) lt card(whencl)  and
     sum(woodtype(prods,spec),newclimdat(run,spec,reg,"lag")))=
     saveNEWYLD(whencl,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS));
 );

* Make any negative yields equal to zero
EXISTYLD(WHEN,COHORT,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS)
 $(EXISTYLD(WHEN,COHORT,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS) lt 0)=0;
NEWYLD(WHEN,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS)
 $(NEWYLD(WHEN,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS) lt 0) = 0 ;

*option existyld:2:1:8;display existyld;
*option newyld:2:1:7;display newyld;
*compute timber volume at these yields but with base land area
voltimbe3(mic,regs,owner,dec,prods)=
   SUM(WHEN$ (TODAY+ELAPSED(WHEN) EQ DATE(DEC)),
     SUM((cohort,CLS,species,SITE),
       runsEXISTl(when,cohort,REGS,CLS,OWNER,SPECIES,SITE,mic)*SCFOR*
       EXISTYLD(when,cohort,REGS,CLS,OWNER,SPECIES,SITE,mic,prods))) +
  SUM(OLDDEC$ (DATE(OLDDEC) LE DATE(DEC)),
     SUM(WHEN$ (DATE(OLDDEC)+ELAPSED(WHEN) EQ DATE(DEC)
                AND WHENDONE(OLDDEC,WHEN) GT 0 ),
         SUM((CLS,SITE,species,POLICY),
            runsnewl(olddec,when,REGS,CLS,OWNER,SPECIES,SITE,mic,POLICY)
           *scfor*NEWYLD(when,REGS,CLS,OWNER,SPECIES,SITE,mic,prods))));

*compute per unit volume
volbyare3(mic,regs,owner,dec,prods)
   $ AREAtimber(mic,regs,owner,dec) =
```

```
      voltimbe3(mic,regs,owner,dec,prods)
     /   AREAtimber(mic,regs,owner,dec) ;





   *
   *  P U B L I C   C U T
   *
   PUBSUP(POWNER,REG,DEC,PRODS)$volbyarea("ME",reg,"OP",dec,prods) =
           PUBSUP(POWNER,REG,DEC,PRODS) *
       (1+(sum(species,volbyare3("ME",reg,"OP",dec,prods) -
            volbyarea("ME",reg,"OP",dec,prods)) /
            volbyarea("ME",reg,"OP",dec,prods))) ;
   *display "public cut after changes";
   *display pubsup;
   *changing the public supply to account for changes in CANADIAN supply

   *** COMPUTATIONS FOR CANADA (AUG/25/1994) ***
   qcanada(dec,prods,run)$volbyarea("ME","PNWW","OP",dec,prods)=
     (1+  ((volbyare3("ME","PNWW","OP",dec,prods) -
         volbyarea("ME","PNWW","OP",dec,prods)) /
         volbyarea("ME","PNWW","OP",dec,prods))) ;
   canada(dec,prods)=storcanada(dec,prods)*qcanada(dec,prods,run);
   *display "canada cut after changes";
   *display canada;

   *$ontext
   $include "/mac/mccarl/agfor/source/fasolvlp.mod"
   *$ontext
   if(yesfor,
   $include "/mac/mccarl/agfor/source/faforrpt.rep"

   *climate change run specific output non comparative
   * NOW COMPUTE INVENTORY VOLUMES  (At start of period)
    newSoftEXs(dec,REGS,OWNER,mic,sprods) =
         SUM(WHEN$(TODAY+ELAPSED(WHEN) GE DATE(DEC)),
         SUM((cohort,CLS,SPECIES,SITE,policy)$
          EXIST.L(when,cohort,REGS,CLS,OWNER,SPECIES,SITE,MIC,policy),
          EXIST.L(when,cohort,REGS,CLS,OWNER,SPECIES,SITE,MIC,policy)
         *SCFOR*
          SUM(TIME2$(10*(ORD(TIME2)-1)+TODAY EQ DATE(DEC)),
          yesbiomass(regs,sprods,policy)
        *eXISTYLD(time2,cohort,REGS,CLS,OWNER,SPECIES,SITE,MIC,sprods))));
    newSWINNEW(dec,REGS,OWNER,mic,sprods) =
       SUM(DECSP$(DATE(DECSP) LT DATE(DEC)),
         SUM(WHEN$(DATE(DECSP)+ELAPSED(WHEN) GE DATE(DEC)),
           SUM((CLS,SPECIES,SITE,POLICY)$
              NEW.L(decsp,when,REGS,CLS,OWNER,SPECIES,SITE,MIC,POLICY),
              NEW.L(decsp,when,REGS,CLS,OWNER,SPECIES,SITE,MIC,POLICY)
             *SCFOR*
              SUM(TIME2$((ORD(DECSP)+ORD(TIME2)-1) EQ ORD(DEC)),
                  yesbiomass(regs,sprods,policy)*
            nEWYLD(time2,REGS,CLS,OWNER,SPECIES,SITE,MIC,sprods)))));
   newHardEXs(dec,REGS,OWNER,mic,hprods) =
      SUM(WHEN$(TODAY+ELAPSED(WHEN) GE DATE(DEC)),
```

```
      SUM((cohort,CLS,SPECIES,SITE,policy)
     $EXIST.L(when,cohort,REGS,CLS,OWNER,SPECIES,SITE,MIC,policy),
       EXIST.L(when,cohort,REGS,CLS,OWNER,SPECIES,SITE,MIC,policy)*SCFOR*
        SUM(TIME2$(10*(ORD(TIME2)-1)+TODAY EQ DATE(DEC)),
          yesbiomass(regs,hprods,policy)*
        eXISTYLD(time2,cohort,REGS,CLS,OWNER,SPECIES,SITE,MIC,hprods))));
    newHWINNEW(dec,REGS,OWNER,mic,hprods) =
      SUM(DECSP$(DATE(DECSP) LT DATE(DEC)),
         SUM(WHEN$(DATE(DECSP)+ELAPSED(WHEN) GE DATE(DEC)),
           SUM((CLS,SPECIES,SITE,POLICY)$
           NEW.L(decsp,when,REGS,CLS,OWNER,SPECIES,SITE,MIC,POLICY),
           NEW.L(decsp,when,REGS,CLS,OWNER,SPECIES,SITE,MIC,POLICY)*SCFOR*
           SUM(TIME2$((ORD(DECSP)+ORD(TIME2)-1) EQ ORD(DEC)),
           yesbiomass(regs,hprods,policy)
           *NEWYLD(time2,REGS,CLS,OWNER,SPECIES,SITE,MIC,hprods)))));


   *climate change run comparative report writing
    newinv("softwood",dec,regs,run) = sum((owner),SWINEXI(dec,regs,OWNER)+
                                               SWINNEW(dec,regs,OWNER));
    newinv("hardwood",dec,regs,run) = sum((owner),hWINEXI(dec,regs,OWNER)+
                                               hWINNEW(dec,regs,OWNER));
    newtinv("softwood",dec,run,mic,regs)   =
           sum((sprods,owner),newsoftexs(dec,regs,OWNER,mic,sprods)
          +newSWINNEW(dec,regs,OWNER,mic,sprods));
    newtinv("hardwood",dec,run,mic,regs)   =
           sum((hprods,owner),newhardexs(dec,regs,OWNER,mic,hprods)
                            + newhWINNEW(dec,regs,OWNER,mic,hprods));
   RUNPROD(spec,dec,REGs,PRODS,run) =
     SUM(WHEN$ (TODAY+ELAPSED(WHEN) EQ DATE(DEC)),
      SUM((cohort,CLS,OWNER,SPECIES,SITE,MIC,policy)
         $EXIST.l(when,cohort,REGS,CLS,OWNER,SPECIES,SITE,MIC,policy),
                yesbiomass(regs,prods,policy)*
         EXIST.L(when,cohort,REGS,CLS,OWNER,SPECIES,SITE,MIC,policy)
                                                                 *SCFOR*
         EXISTYLD(when,cohort,REGS,CLS,OWNER,SPECIES,SITE,MIC,prods)))
      + SUM(OLDDEC$ (DATE(OLDDEC) LE DATE(DEC)),
         SUM(WHEN$ (DATE(OLDDEC)+ELAPSED(WHEN) EQ DATE(DEC)
              AND WHENDONE(OLDDEC,WHEN) GT 0 ),
           SUM((CLS,OWNER,SPECIES,SITE,MIC,POLICY)
             $NEW.l(olddec,when,REGS,CLS,OWNER,SPECIES,SITE,MIC,policy),
                yesbiomass(regs,prods,policy)*
              NEW.L(olddec,when,REGS,CLS,OWNER,SPECIES,SITE,MIC,POLICY)
                                                                 *SCFOR*
              NEWYLD(when,REGS,CLS,OWNER,SPECIES,SITE,MIC,prods) )))
      + SUM((POWNER), PUBSUP(POWNER,REGS,DEC,PRODS))
    +  scfor*   sum(products$(1$bioprods(products) le 0
                        and 1$yesmill(prods) gt 0
                        and yesitis(regs,products) gt 0
                        and transcost(regs,products) ne 0),
            millresid(regs,dec,products,prods)*
            TRANSFOR.l(REGS,PRODuctS,DEC)$(transcost(regs,products)
                                                                  NE 0))
    + scfor*    sum((tradereg,products)$(1$bioprods(products) le 0
                        and 1$yesmill(prods) gt 0
                        and yesitis(regs,products) gt 0
                        and tradecost(regs,tradereg,products) ne 0) ,
```

```
          millresid(regs,dec,products,prods)*
          TRADEFPTRN.l(REGS,TRADEREG,PRODuctS,DEC,"EXPORT")$
            (TRADFOR(TRADEREG,"EXPORT",PRODuctS,DEC,"INTERCEPT") GT 0  OR
             TRADFOR(TRADEREG,"EXPORT",PRODuctS,DEC,"MINQ")      GT 0  OR
             TRADFOR(TRADEREG,"EXPORT",PRODuctS,DEC,"FIXP")      GT 0))
     + scfor*SUM((products,products2)$
       (yesitis(regs,products2) gt 0),
        PRODUCTSUB.l(regs,PRODUCTS,PRODuctS2,DEC)
        *millresid(regs,dec,products,prods)
        $SUBS(PRODUCTS,PRODuctS2))
 ;
 productcli(dec,climregs,prods,run)=
        sum(climmap(climregs,reg),sum(spec,
        runprod(spec,dec,reg,prods,run)))            ;
 tinvcli("softwood",dec,climregs,run)=
        sum(climmap(climregs,reg),
        newinv("softwood",dec,reg,run))   ;
 tinvcli("hardwood",dec,climregs,run)=
        sum(climmap(climregs,reg),
        newinv("hardwood",dec,reg,run))   ;
 tmiccli("hardwood",mic,climregs,dec,run)=
        sum(climmap(climregs,reg),
        newtinv("hardwood",dec,run,mic,reg))   ;
 tmiccli("softwood",mic,climregs,dec,run)=
        sum(climmap(climregs,reg),
        newtinv("softwood",dec,run,mic,reg))   ;
 harvestcli(dec,climregs,"softwood",run)=
    sum((climmap(climregs,reg),sw,CLS,OWNER,SITE,COHORT,MIC,WHEN)
                                                          $(ord(when)
    eq ord(dec)),SOFTEXIST(REG,CLS,OWNER,SW,SITE,COHORT,MIC,WHEN))+
     sum((climmap(climregs,reg),sw,CLS,OWNER,SITE,MIC,WHEN,decsp)
     $(ord(when)+ord(decsp) eq ord(dec)+1),
    SOFTNEW(REG,CLS,OWNER,SW,SITE,MIC,WHEN,DECSp));
 harvestcli(dec,climregs,"hardwood",run)=
    sum((climmap(climregs,reg),hw,CLS,OWNER,SITE,COHORT,MIC,WHEN)
                                                       $(ord(when)
    eq ord(dec)),hardEXIST(REG,CLS,OWNER,hW,SITE,COHORT,MIC,WHEN))+
     sum((climmap(climregs,reg),hw,CLS,OWNER,SITE,MIC,WHEN,decsp)
     $(ord(when)+ord(decsp) eq ord(dec)+1),
    hardNEW(REG,CLS,OWNER,hW,SITE,MIC,WHEN,DECSp));
 productcli(dec,climregs,prods,run)=
        sum(climmap(climregs,reg),thprod(dec,reg,prods));
 productprv(dec,climregs,prods,run)=
        sum(climmap(climregs,reg),harvprod(reg,dec,prods));
 harvestcli(dec,climregs,"softwood",run)=
    sum((climmap(climregs,reg),sw,CLS,OWNER,SITE,COHORT,MIC,WHEN)
    $(ord(when) eq ord(dec)),
       SOFTEXIST(REG,CLS,OWNER,SW,SITE,COHORT,MIC,WHEN))+
     sum((climmap(climregs,reg),sw,CLS,OWNER,SITE,MIC,WHEN,decsp)
     $(ord(when)+ord(decsp) eq ord(dec)+1),
    SOFTNEW(REG,CLS,OWNER,SW,SITE,MIC,WHEN,DECSp));
 harvestcli(dec,climregs,"hardwood",run)=
    sum((climmap(climregs,reg),hw,CLS,OWNER,SITE,COHORT,MIC,WHEN)
        $(ord(when) eq ord(dec)),
            hardEXIST(REG,CLS,OWNER,hW,SITE,COHORT,MIC,WHEN))+
    sum((climmap(climregs,reg),hw,CLS,OWNER,SITE,MIC,WHEN,decsp)
        $(ord(when)+ord(decsp) eq ord(dec)+1),
```

```
              hardNEW(REG,CLS,OWNER,hW,SITE,MIC,WHEN,DECSp));
   harvowncli(dec,climregs,"softwood",owner,run)=
      sum((climmap(climregs,reg),sw,CLS,SITE,COHORT,MIC,WHEN)
           $(ord(when) eq ord(dec)),
             SOFTEXIST(REG,CLS,OWNER,SW,SITE,COHORT,MIC,WHEN))+
      sum((climmap(climregs,reg),sw,CLS,SITE,MIC,WHEN,decsp)
           $(ord(when)+ord(decsp) eq ord(dec)+1),
            SOFTNEW(REG,CLS,OWNER,SW,SITE,MIC,WHEN,DECSp));
    harvowncli(dec,climregs,"hardwood",owner,run)=
       sum((climmap(climregs,reg),hw,CLS,SITE,COHORT,MIC,WHEN) $(ord(when)
       eq ord(dec)),hardEXIST(REG,CLS,OWNER,hW,SITE,COHORT,MIC,WHEN))+
        sum((climmap(climregs,reg),hw,CLS,SITE,MIC,WHEN,decsp)
           $(ord(when)+ord(decsp) eq ord(dec)+1),
       hardNEW(REG,CLS,OWNER,hW,SITE,MIC,WHEN,DECSp));
   );

   $include "/mac/mccarl/agfor/source/facrbrpt.rep"
   if(yesag,
   $include "/mac/mccarl/agfor/source/faasmrpt.rep"
    );
   *climate change run accounting of welfare by climate region
             regrun(dec,reg,"domforpro",run) =
             regsurp(dec,reg,"domforpro");
             regrun(dec,"total","domforcon",run) =
             regsurp(dec,"total","domforcon");
             regrun(dec,reg,"publiccut",run) =
             regsurp(dec,reg,"publiccut");
             regrun(dec,"total","foregnfor",run) =
             regsurp(dec,"total","foregnfor");

   $include "/mac/mccarl/agfor/source/facompar.rep"
   $include "/mac/mccarl/agfor/source/facomsav.sav"
   *end of the loop "runs"
   *$offtext
   );
```

8. CHECKING OUT YOUR STUDY — MAKING SURE DATA ARE RIGHT

One of the ongoing concerns with any alternative runs study is insuring that each comparative run is properly implemented, solved and reported. This section deals with methods to address such concerns, first from a generic GAMS viewpoint, then in a FASOM context.

8.1 A Generic GAMS Approach — Use a Small Model

GAMS allows one to work with large models. Even the PC-based GAMS can be used to solve problems with thousands of variables and equations. However, debugging such large formulations is not easy. Our recommendation is to use the algebraic structure of GAMS to **work from small to large**. We illustrate the reasons for our recommendation with examples .

8.1.1 Example in a Transportation Context

Table 8.1 (tables are located at the end of this chapter) contains a GAMS input file for a transportation model. This file contains several sections. The first part (lines 1-22) defines the context identifying supply points (called PLANTS) and destinations (called MARKETS) as well as the available supply at each plant, the required demand at each market and the distance from each plant to each market. The second part (lines 23-26) calculates cost as a function of distance. The third part (lines 27-49) contains the model definition. The fourth part (lines 51-53) solves the model. The fifth part (lines 54-93) engages in report writing.

This example can be used to illustrate the "small to large" point. Suppose we set up another version of the model where we have more supply and demand locations. In that version (Table 8.2) we expand the problem to 10 supply and 5 demand points. Let us examine what happened when the formulation was expanded. In this case:

(a) The supply and demand sets were expanded to their new size;

(b) The supply availability and demand requirement data were expanded and altered to cover all points; and

(c) The distance table was expanded to include all pairs of plants and markets.

(d) The data calculation, model definition, model solution and report writing sections are identical to those in lines 23-93 of Table 8.1.

Also, the structure and set names in the data section are identical in Tables 8.1 and 8.2 but the data contents vary (e.g., lines 1-3, 6, 9, 14 and 19 of Table 8.2 have exact counterparts in Table 8.1).

The question now is what did we not have to do? There were no changes in the algebraic content of the data names or set specifications. Nor were there changes in data calculation, model structure, or report writing. Only the specific data elements were changed. Thus, with GAMS, a model can be fully worked out in a smaller setting, then expanded to a larger setting without bearing the computational and human cost of dealing with a large data set and the associated output.

This does not mean that debugging can be done entirely with the small data set. However, if one judiciously develops the small data set so that it has all the features of the large data set, we have found that most of the work can be done in that simpler setting. Thus, if we were going to eventually use 200 supply and 100 demand locations we could preserve exactly the same code from lines 23 on of Table 8.1, and only have to revise the data element definitions.

8.2 FASOM: A More Complex Example

The primary importance of the "small to large" point cannot be overemphasized. Thus, we now illustrate the point in the FASOM context. The small version of FASOM is included in a subdirectory called small. Here we have the files FAAGDAT.SML, FAFORDAT.SML, FASETS.SML, ALLOFIT.SML, FAFORDAT.MED[36] and ALLOFIT.MED. These data sets have the same structure as their larger counterparts but have much less data than is present in the full system. For example, if one contrasts any of the SML files with their larger counterparts (the DAT files) one can see the same structure is used, but many more commodities, regions, cohorts, etc. appear in the DAT files. The remainder of the FASOM files are independent of problem size and may be used with either version. The smallest version is run by the file S.BAT.

The purpose of these small files is model diagnosis. We use them in implementing and testing changes in model structure, alternative runs code and report writing. When we have verified our model structure we then test using the full model via the normal ALLOFIT.DAT file repeating the same processes.

This is also one other point relative to the use of small model versions. In using the FASOM model there are times when we wish to add various features or modify features with respect to particular set elements. For example, at one point we were interested in examining and working with energy crop (biomass) production. In that case we altered the small model data sets so we were sure to include a region with biomass production data, since in previous small model versions we didn't have such production. Thus we tailored the small model to allow us to develop and test additional model components before we fully implemented them in the large model. The hour or so it took to revise the small model was more than regained in the greatly reduced time it took to insure that biomass was modeled properly and that one could vary the biomass level and still obtain appropriate outputs. Again, this strategy allows one to fully work on the GAMS calculation, model, alternative runs and report writing instructions, making sure that the structure is proper before turning to the larger empirical counterpart.

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[36] The files ending with MED give a larger Forest data version which can be aggregated in different ways using the utility program SMALL.UTL.

8.3 Making Small Parts of Large Models

The small to large strategy can also be applied in the large model context in terms of computer implementation. This involves use of restart files. In particular, consider the overall FASOM structure of the model depicted in Appendix A. We could have made ALLOFIT.DAT an all-inclusive file rather than running the FAMODEL.MOD, FARPT.REP, FAALTRUN, FAFINAL.REP and FACOMSAV.SAV files separately through restart files. Such an expanded ALLOFIT.DAT file would have the following lines added at the bottom.

```
$INCLUDE "FAMODEL.MOD"
$INCLUDE "FARPT.REP"
$INCLUDE "FAALTRUN"
$INCLUDE "FAFINAL.REP"
$INCLUDE "FACOMSAV.SAV"
```

Now suppose we wished to use this implementation to alter the contents of FAFINAL.REP. That means that in order to modify that file we would execute the data setup, data calculation, model setup, model solution and the comparative study before FAFINAL.REP runs. On the other hand, if we use save and restart files, we can simply run from the saved files and work only with FAFINAL.REP. Similarly, one can work with any of the individual report writers or with the comparative report writer by simply restarting the program. Thus one could use the instruction

```
COMMAND /C GAMS FAFORWEL.REP R= .\t\savefile
```

to test the forest welfare report writer-providing savefile is the file retained after FAALTRUN has been run[37].

Further, we can go into the report writer file and use $ONTEXT/$OFFTEXT commands to deactivate parts of the report writer so that we are just working on the particular calculation of interest. By using this strategy, one can usually revise a calculation and test its execution very quickly. This is particularly important in FASOM because some runs can take hours; by using these procedures modules can be tested in minutes.

8.4 The Golden Rule Of FASOM Debugging

The above material puts us in a position where we can now summarize a recommended set of steps which we think should be pursued by all when debugging FASOM alternative runs. The rule guiding these steps is **WORK FROM SMALL TO LARGE**. The steps are:

(a) Insure the small data sets contain the types of structural features you need to manipulate (e.g., if you wish to work with Forest Industry (FI) owners on the lowest land class (LL) land, make sure the FAFORDAT.SML or MED has data representing that case).

(b) Implement all data calculations, model features and report writing calculations in the small

[37]See Brooke et al. pages 150-153 for more discussion of these features.

model.

(c) Exhaustively check the results of Step (b), making sure all the data items, data calculations, model coefficients and report writing are correct. Also verify that the model equations are proper and that the solution makes sense. See the discussion in section 8.5 for recommendations on how to implement such checking.

(d) Switch to the FASOM version with the full data set and test. It may be desirable at this point to isolate components one at a time so they may be worked on quickly. For example, when working on input data calculations, suppress solutions until the input data are correct. Similarly, when working on the model structure, start from a restart file with all input data calculations complete.

One additional suggestion: we feel that as additional structural features are added to the large model, they should also be added to the small model. We realize that not everything can be done in the small model. However, we have rarely encountered a case where the "extra" effort to work with the small model did not save 10 times the work and a lot of frustration.

8.5 Testing a New FAALTRUN - An Example in the Climate Change Context

The above notes talk about how to test an alternative run setup. That discussion gives general principles and procedures, but is not terribly specific. Thus, let us discuss a very specific case.

In particular, let's discuss the testing we would use to verify whether or not the climate change model of Chapter 7 is working properly. In doing this, we assume that the code segments preceding FAALTRUN are working and thus we will only test the code from FAALTRUN on. We will also present the steps that we would use in a fashion which is independent of model size. However, we wish to stress the recommendation, that we would debug using a small model version first. To achieve this we'd use ALLOFIT.SML and set YESAG to zero. Thus we would depict a 30 year forestry version of the model, with limited data, and pursue the steps that we outline here. Then we would go back and partially follow the steps with the medium data set. Finally we would use the large data set.

In this testing, there are five questions to be examined:

(1) Are the preliminary calculations being done properly?

(2) Are the right scenarios being looped over?

(3) Are the alternative scenario data being set up properly?

(4) Is the structure of the alternative scenario programming models proper?

(5) Are any added report writing calculations being performed properly?

8.5.1 Initial Model Setup

GAMS will check the scenario definitions and data tables, so we assume compilation errors have been repaired. Subsequently, if one is not sure the data are properly included, one can enter display statements for RUN, ASSUME, and NEWCLIMDAT, making sure that everything looks proper.

Beyond this, however, we need to verify the accuracy of the calculations for acreage inventory, total volume inventory, and yield per acre. We will do this by displaying these items and then comparing them with our knowledge of what is in the total forestry base. We also could add some calculations to sum these up on a national basis, and compare them with the sum across the existing inventory table for 1990 inventory times the existing yield harvested now. The basic methodology is to display the calculation results and compare them to side calculations to verify their accuracy. Use of the small model would pay considerable dividends since one could calculate by hand the expected results, for verification purposes. Also we would speed up the process by suppressing the looping part of the program and having the batch file only run the FAALTRUN component.[38]

8.5.2 Checking Data Alterations within the Loop

The data alterations within the loop change the public and Canadian supply, establishment costs, and forest yields. To check the data alterations, compare the data items under the base case with the repective items in an alternative scenario. In this comparison, examine both whether the recalculated numbers are correct, and whether the data altered in previous scenarios are properly reset (i.e., when yields are changed but establishment costs are not, then insure that the base establishment cost is used, not the establishment cost from a previously run scenario). This can be done manually or through GAMS calculations. For manual calculations, remove the asterisk of lines 268, 269, 298, and 308 to display the data under each scenario, and manually compare displays of the parameters after they have been changed with the base scenario and possibly with a pre-loop display (i.e., we could display the same items at the stage of line 199). Save time by suppressing the solve part of the loop, by activating the text features in lines 310 and 486, and running only for selected scenarios which illustrate the case (e.g., one might choose one scenario which changed establishment cost, one which implemented a lag, and one which implemented differential rates of yield growth for different species in different areas). Again, the value of using a small model cannot be overstated, because the displays of the FASOM new and existing yields for one scenario constitute some 40,000 lines. Also, using the small model with yield data in whole numbers allows one to quickly recognize whether or not the scenarios are being changed properly.

Parts of the checking process can be automated. For example, the code below defines the parameter called CHEKYLD and computes that parameter as equal to one for a region if the sum of the differences between the saved existing yields and the revised existing yields is non-zero, then displays CHEKYLD.

---

[38] This would involve putting an $ontext statement right before the loop statement in line 200 and putting an $offtext statement right after loop ends at line 488.

```
Parameter CHKYIELD(REGS) check of whether new or exist yields change by region;
chkyield(regs)=

      1$(sum((time2,cohort,CLS,OWNER,SPECIES,SITE,MIC,prods),
           abs( eXISTYLD(time2,cohort,REGS,CLS,OWNER,SPECIES,SITE,MIC,prods)
                 -     sveXISTYLD(time2,cohort,REGS,CLS,OWNER,SPECIES,SITE,MIC,prods)))
   + sum((time2,REGS,CLS,OWNER,SPECIES,SITE,MIC,sprods),
                abs(       nEWYLD(time2,REGS,CLS,OWNER,SPECIES,SITE,MIC,prods)
                   -  savenEWYLD(time2,REGS,CLS,OWNER,SPECIES,SITE,MIC,prods))));

 display chkyld;
```

Thus one can use the power of GAMS calculations to quickly review reams of numbers.

We feel that these procedures should always be used and the solution deferred until one is sure that a "garbage in - garbage out" situation is avoided.

8.5.3 Checking the Model Structure

The climate change case does not alter model structure (the model structure is altered only when constraints or variables are being activated or deactivated by the scenario). However, in general, one would want to examine whether particular constraints such as the stickiness limits were properly being imposed. This involves either using the LIMROW/LIMCOL options[39] in conjunction with the solve statement, or using GAMSCHK as discussed in the GAMSCHK document or in McCarl et al. Chapter 8.

8.5.4 Checking Report Writer Items

Once the model is solved, then the reports need to be examined. Ordinarily this would not involve checking the existing report writers, as they have been rather thoroughly debugged. Rather one focuses on new additions. Here one would ordinarily sum up national totals and display existing reports to see whether the national totals are consistent. For example, when the aggregate region inventories are formed, one can check their national totals against the existing inventory tables for consistency. We can perform similar checks on welfare and other data items.

One can also use a rule of reason to examine, for example, under a scenario where climate change has a severe negative effect on yields, whether total production has declined, as expected, and prices have gone up as they should, to get some feel for whether the overall model seems to be functioning properly.

8.6 Dealing with Suspicious Runs

When one obtains results of a run which one does not believe, there are several steps that should be taken.

[39]See Brooke et al. pages 103 and 114-116 for a discussion of these options.

First, one should look at the display of OPTIMALITY, VERSION and SCREWUP parameters.

OPTIMALITY — The OPTIMALITY parameter should always be a one or two, telling you that the solver has reached a feasible solution. If the OPTIMALITY parameter is different from one or two, one should go back to the FAALTRUN.LST file and look at the solution status of each of the solves to make sure that none of the scenario models were unbounded or infeasible. If any scenario was unbounded or infeasible, then one might want to restart just that scenario and follow some of the instructions in the GAMSCHK document (McCarl) or in McCarl et al. Chapter 9.

SCREWUP — The SCREWUP output reports a one if the output across the principal welfare items for two scenarios on an item-by-item basis differs by less than a particular criterion times total welfare, currently set at .001%. If SCREWUP reports a one, it probably means that the results of the two identified scenarios are nearly identical and one should go back and review carefully their scenario setups to make sure in fact the data are being set up properly. This would be done by initially checking the data as above, then by going to some more advanced tests using GAMSCHK or the LIMROW/LIMCOL displays to see if in fact the coefficients in the model are reflecting the data changes. The McCarl et al. book covers how to do such things in Chapter 8.

VERSION — The VERSION reports the dates of creation of the file versions being used, as well as the settings of some key parameters. Examine this to make sure that the proper file versions of the FASOM model are being used, (e.g., not the small versions), that the proper selection of forest and agricultural models are activated, and that the separable programming flag is properly set.

All these tests being passed, one must then go back and carefully review the data, the data calculations and the model structure to see what is happening, and/or accept the results and try to explain them.

One can also display parts of the model. For example, the statement DISPLAY EXIST.L: would display the allocation of existing forest land under each scenario so that one could look at what was happening. One could also authorize a lot more of the run-specific output , or do some summary calculations to develop detailed information on a particular phenomenon of interest. This may also involve examining model structural details within the programming model using either LIMROW/LIMCOL or GAMSCHK.

There is also one final source of error if the OBJ equation was revised in FAMODEL.MOD, and that is that the welfare accounting is malfunctioning. The welfare accounting in the model has been very carefully balanced, and it will need to be rebalanced if any terms are added to the algebraic specification of the model objective function. If that has been done, and the welfare accounting has not been rebalanced, then the model solutions should be expected to yield unusual welfare results as there will not be a full accounting of welfare.

Table 8.1 Example Transport Model

```
*                    DATA DEFINITION

SETS  PLANT    PLANT LOCATIONS
         /NEWYORK  , CHICAGO , LOSANGLS /
     MARKET   DEMAND MARKETS
            /MIAMI,   HOUSTON, MINEPLIS, PORTLAND/

PARAMETERS   SUPPLY(PLANT)  QUANTITY AVAILABLE AT EACH PLANT
            /NEWYORK   100, CHICAGO   275, LOSANGLS   90/
           DEMAND(MARKET)   QUANTITY REQUIRED BY DEMAND MARKET
             /MIAMI     100, HOUSTON    90,
              MINEPLIS  120, PORTLAND   90/;

 TABLE DISTANCE(PLANT,MARKET) DISTANCE FROM EACH PLANT TO EACH MARKET

                 MIAMI   HOUSTON   MINEPLIS   PORTLAND
        NEWYORK      1300     1800       1100       3600
        CHICAGO      2200     1300        700       2900
        LOSANGLS     3700     2400       2500       1100

     ;

*                    DATA CALCULATION

 PARAMETER COST(PLANT,MARKET)    CALCULATED COST OF MOVING GOODS;
          COST(PLANT,MARKET) = 50 + 1 * DISTANCE(PLANT,MARKET);

*                    MODEL DEFINITION

 POSITIVE VARIABLES
        SHIPMENTS(PLANT,MARKET) AMOUNT SHIPPED OVER A TRANSPORT ROUTE;
 VARIABLES
        TCOST                TOTAL COST OF SHIPPING OVER ALL ROUTES;
 EQUATIONS
        TCOSTEQ              TOTAL COST ACCOUNTING EQUATION
        SUPPLYEQ(PLANT)        LIMIT ON SUPPLY AVAILABLE AT A PLANT
        DEMANDEQ(MARKET)       MINIMUM REQUIREMENT AT A DEMAND MARKET;

 TCOSTEQ..          TCOST =E=
                 SUM((PLANT,MARKET), SHIPMENTS(PLANT,MARKET)*
                                COST(PLANT,MARKET));

 SUPPLYEQ(PLANT)..   SUM(MARKET, SHIPMENTS(PLANT, MARKET))
                              =L= SUPPLY(PLANT);

 DEMANDEQ(MARKET)..  SUM(PLANT,  SHIPMENTS(PLANT, MARKET))
                              =G= DEMAND(MARKET);
```

Table 8.1 (continued)

```

 MODEL TRANSPORT /ALL/;

*                     MODEL SOLUTION

 SOLVE TRANSPORT USING LP MINIMIZING TCOST;

*                     REPORT WRITING

PARAMETER MOVEMENT(*,*)  COMMODITY MOVEMENT;
MOVEMENT(PLANT,MARKET)=SHIPMENTS.L(PLANT,MARKET);
MOVEMENT("TOTAL",MARKET)=SUM(PLANT,SHIPMENTS.L(PLANT,MARKET));
MOVEMENT(PLANT,"TOTAL")=SUM(MARKET,SHIPMENTS.L(PLANT,MARKET));
MOVEMENT("TOTAL","TOTAL")=SUM(MARKET,MOVEMENT("TOTAL",MARKET));

OPTION DECIMALS=0;
DISPLAY MOVEMENT;

PARAMETER COSTS(*,*)  COMMODITY MOVEMENT COSTS BY ROUTE;
COSTS(PLANT,MARKET)=COST(PLANT,MARKET)*SHIPMENTS.L(PLANT,MARKET);
COSTS("TOTAL",MARKET)
   =SUM(PLANT,COST(PLANT,MARKET)*SHIPMENTS.L(PLANT,MARKET));
COSTS(PLANT,"TOTAL")
   =SUM(MARKET,COST(PLANT,MARKET)*SHIPMENTS.L(PLANT,MARKET));
COSTS("TOTAL","TOTAL")=TCOST.L;
OPTION DECIMALS=0;
DISPLAY COSTS;

PARAMETER SUPPLYREP(PLANT,*)  SUPPLY REPORT;
SUPPLYREP(PLANT,"AVAILABLE")=SUPPLY(PLANT);
SUPPLYREP(PLANT,"USED")=MOVEMENT(PLANT,"TOTAL");
SUPPLYREP(PLANT,"MARGVALUE")=ABS(SUPPLYEQ.M(PLANT));
OPTION DECIMALS=2;
DISPLAY SUPPLYREP;

PARAMETER DEMANDREP(MARKET,*)  DEMAND REPORT;
DEMANDREP(MARKET,"REQUIRED")=DEMAND(MARKET);
DEMANDREP(MARKET,"RECIEVED")=MOVEMENT("TOTAL",MARKET);
DEMANDREP(MARKET,"MARGCOST")=ABS(DEMANDEQ.M(MARKET));
OPTION DECIMALS=2;
DISPLAY DEMANDREP;

PARAMETER CMOVEMENT(*,*) COSTS OF CHANGING COMMODITY MOVEMENT PATTERN;
CMOVEMENT(PLANT,MARKET)=SHIPMENTS.M(PLANT,MARKET);
OPTION DECIMALS=2;
DISPLAY CMOVEMENT;
```

Table 8.2 Example Transport Model -- Larger Version

```
*                    DATA DEFINITION
SETS  PLANT    PLANT LOCATIONS
         /NEWYORK  , CHICAGO , LOSANGLS , BALTIMORE , WASHINGTON
          PHILADEL , LASVEGAS,  RENO    , SEATTLE   , BOISE/
     MARKET   DEMAND MARKETS
           /MIAMI,   HOUSTON, MINEPLIS, PORTLAND,BOSTON/

PARAMETERS   SUPPLY(PLANT)  QUANTITY AVAILABLE AT EACH PLANT
            /NEWYORK   100, CHICAGO    75, LOSANGLS   90,
             BALTIMORE  80, WASHINGTON 70, PHILADEL   60,
             LASVEGAS   40, RENO       20, SEATTLE    55,
             BOISE      10/
           DEMAND(MARKET)   QUANTITY REQUIRED BY DEMAND MARKET
            /MIAMI     100, HOUSTON    90,
             MINEPLIS  120, PORTLAND   90
             BOSTON    180/;

  TABLE DISTANCE(PLANT,MARKET) DISTANCE FROM PLANT TO MARKET

                 MIAMI   HOUSTON   MINEPLIS   PORTLAND  BOSTON
       NEWYORK      1300     1800      1100       3600     150
       CHICAGO      2200     1300       700       2900     800
       LOSANGLS     3700     2400      2500       1100    3800
       BALTIMORE    1100     1600      1200       3700     350
       WASHINGTON   1050     1550      1200       3700     400
       PHILADEL     1200     1700      1150       3650     250
       LASVEGAS     3300     2100      2300       1300    3600
       RENO         3400     2200      2200        900    3400
       SEATTLE      3700     2500      1900        250    3500
       BOISE        3500     2200      1700        450    3300
       ;

 *                   DATA CALCULATION

  PARAMETER COST(PLANT,MARKET)    CALCULATED COST OF MOVING GOODS;
          COST(PLANT,MARKET) = 50 + 1 * DISTANCE(PLANT,MARKET);

 *                   MODEL DEFINITION

  POSITIVE VARIABLES
      SHIPMENTS(PLANT,MARKET) AMOUNT SHIPPED OVER A TRANSPORT ROUTE;
  VARIABLES
      TCOST                TOTAL COST OF SHIPPING OVER ALL ROUTES;
  EQUATIONS
      TCOSTEQ              TOTAL COST ACCOUNTING EQUATION
      SUPPLYEQ(PLANT)       LIMIT ON SUPPLY AVAILABLE AT A PLANT
      DEMANDEQ(MARKET)      MINIMUM REQUIREMENT AT A DEMAND MARKET;

  TCOSTEQ..          TCOST =E=
                 SUM((PLANT,MARKET), SHIPMENTS(PLANT,MARKET)*
```

```
                                   COST(PLANT,MARKET));
```

Table 8.2 (continued)

```
SUPPLYEQ(PLANT)..   SUM(MARKET, SHIPMENTS(PLANT, MARKET))
                              =L= SUPPLY(PLANT);
DEMANDEQ(MARKET)..  SUM(PLANT,  SHIPMENTS(PLANT, MARKET))
                              =G= DEMAND(MARKET);
MODEL TRANSPORT /ALL/;
*                      MODEL SOLUTION
SOLVE TRANSPORT USING LP MINIMIZING TCOST;
*                      REPORT WRITING
PARAMETER MOVEMENT(*,*)  COMMODITY MOVEMENT;
MOVEMENT(PLANT,MARKET)=SHIPMENTS.L(PLANT,MARKET);
MOVEMENT("TOTAL",MARKET)=SUM(PLANT,SHIPMENTS.L(PLANT,MARKET));
MOVEMENT(PLANT,"TOTAL")=SUM(MARKET,SHIPMENTS.L(PLANT,MARKET));
MOVEMENT("TOTAL","TOTAL")=SUM(MARKET,MOVEMENT("TOTAL",MARKET));
OPTION DECIMALS=0;
DISPLAY MOVEMENT;
PARAMETER COSTS(*,*)  COMMODITY MOVEMENT COSTS BY ROUTE;
COSTS(PLANT,MARKET)=COST(PLANT,MARKET)*SHIPMENTS.L(PLANT,MARKET);
COSTS("TOTAL",MARKET)
   =SUM(PLANT,COST(PLANT,MARKET)*SHIPMENTS.L(PLANT,MARKET));
COSTS(PLANT,"TOTAL")
   =SUM(MARKET,COST(PLANT,MARKET)*SHIPMENTS.L(PLANT,MARKET));
COSTS("TOTAL","TOTAL")=TCOST.L;
OPTION DECIMALS=0;
DISPLAY COSTS;
PARAMETER SUPPLYREP(PLANT,*)  SUPPLY REPORT;
SUPPLYREP(PLANT,"AVAILABLE")=SUPPLY(PLANT);
SUPPLYREP(PLANT,"USED")=MOVEMENT(PLANT,"TOTAL");
SUPPLYREP(PLANT,"MARGVALUE")=ABS(SUPPLYEQ.M(PLANT));
OPTION DECIMALS=2;
DISPLAY SUPPLYREP;
PARAMETER DEMANDREP(MARKET,*)  DEMAND REPORT;
DEMANDREP(MARKET,"REQUIRED")=DEMAND(MARKET);
DEMANDREP(MARKET,"RECIEVED")=MOVEMENT("TOTAL",MARKET);
DEMANDREP(MARKET,"MARGCOST")=ABS(DEMANDEQ.M(MARKET));
OPTION DECIMALS=2;
DISPLAY DEMANDREP;
PARAMETER CMOVEMENT(*,*) COST CHANGING COMMODITY MOVEMENT PATTERN;
CMOVEMENT(PLANT,MARKET)=SHIPMENTS.M(PLANT,MARKET);
OPTION DECIMALS=2;
```

105 DISPLAY CMOVEMENT;

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Appendix A: Current File Structure

This appendix details the structure and sequence of the files that make up the FASOM model. FASOM is implemented in the GAMS algebraic modeling language. The model is made up of a number of files, to allow separation of distinctly different types of data and to allow disciplinary experts to work on selected parts of the model. Functionally the program can be divided in several ways. The division we describe separates files into categories according to whether they involve computer runs (these are the batch files and have the extension BAT for the PC); data (such files are given the extension .DAT); model specification (such files are given the extension .MOD); analysis execution (such files are given the extension .ALT); report writing (such files are given the extension .REP) and/or model support (such files are given the extension .UTL). Distinctions will also be made between unifying files, forestry files, agricultural files and carbon files.

A.1 Batch File Sequence

The DOS version of the basic FASOM batch file is given at the top of Table A-1. This file runs six program modules in sequence, linked through GAMS save and restart files. The save and restart files are placed in a subdirectory called "t" within the current directory (as controlled by the .\t\ syntax). The program modules run are:

ALLOFIT.DAT	Includes all agricultural, forestry, and carbon data as well as associated data calculations.
FAMODEL.MOD	Defines the FASOM optimization model.
FARPT.REP	Provides set, alias, and parameter definitions for the report writer.
FAALTRUN	Causes the base model and the report writers to be run. Policy experiments may be run using FAAGTREE, FACARRUN and FAALTRUN.
FAFINAL.REP	Prints a summary report of aggregate results comparing across the runs made.
FACOMPUT.SAV	Saves scenario results in a GAMS readable file (Results.Put) which may be used in additional report writing.

Users may also use an advanced basis[40]. Using the file FABAS.UTL writes that basis and authorizing the statement $INCLUDE "FABAS.BAS" in FAMODEL.MOD incorporates that basis.

A.2 Specifications For Each Main File

[40] See the discussion of why to use an advanced basis in McCarl et al. Chapter 11. Further details on how to use an advanced basis are given in the GAMSBAS instructions (McCarl 1996).

ALLOFIT.DAT[41] This file includes all the FASOM data. The files included and a brief description follow:

BIOMASS.DAT	- Biomass and crop residue data
CAP.DAT	- Forest milling capacity
EST.DAT	- Forest establishment costs
EXIST.DAT	- Existing forest yield curves
FAAGDAT.DAT	- Agricultural sector data
FAAGDYN.DAT	- Agricultural sector dynamics
FAASMCAL.DAT	- Agricultural data calculations
FACARBON.DAT	- Carbon data
FAFOR.DAT	- Forestry sector data
FASETS.DAT	- Core model structure
FPDMD.DAT	- Forest product demand
GROW.DAT	- Forest stand growing costs
INTER.DAT	- Forest domestic transport data
INV.DAT	- Forest inventory data
NEW.DAT	- New forest yield curves
PUBLIC.DAT	- Forest public cut data
ROTATE.DAT	- Typical forest rotation age data
TRADEDMD.DAT	- Forest foreign trade demand and supply

FAMODEL.MOD Controls the model structure and includes the following:

FAPOLDAT.DAT	- Policy alternative data
FAMODSET.MOD	- Model structure data (largely for separable programming)
FAUPDATE.MOD	- Updates forest incidence arrays
FASCALE.MOD	- Scaling data
FABAS.BAS	- Stored solution for advanced basis start (optional)
DEF.MOD	- Guess at deficiency payments (optional)
FASOLVLP.MOD	- Solves model

FARPT.REP Sets up base report writing arrays. Contains no "include" files

FAALTRUN Executes alternative runs. This file includes the following:

DEF2.ALT	Guess at agricultural deficiency payments (optional)
FAFORDAT.ALT	Alternative data for forest-related runs giving demand levels, public cut

[41] The indented non-bolded files are included in the bolded files.

alternatives, rotation ages, transport data and trade data.

CANADA.ALT	Data on forest product imports from Canada
FACOMSET.SAV	Array definition for saved results
FAUPDATE.MOD	Updates key forestry incidence data
FASOLVLP.MOD	Solves model
FACOMSAV.SAV	Saves comparative forestry data
FAFORRPT.REP	Forestry data report writer
FAFORWEL.REP	Forestry welfare calculations
FAASMRPT.REP	Agricultural data report writer
FAAGWEL.REP	Agricultural welfare calculations
FACRBRPT.REP	Carbon report writer
FACOMPAR.REP	Alternative run comparison report writer

FAFINAL.REP Summarizes output

FACOMPUT.SAV Saves results data in the results.put file . Includes

PUTSET.UTL	Puts a set
PUTSET2.UTL	Puts a set
PUTDAT.UTL	Puts a one dimensional data item
PUTDAT*.UTL	Puts a multi dimensional data item
DATPUT*.UTL	Puts a multi dimensional data item

A.3 Batch Files

The FASOM model is run with a batch file. Versions of the overall batch file for both DOS and UNIX are listed in table A.1. These batch files use the GAMS save and restart file features. Thus, when one is executing any GAMS program one can arbitrarily divide that program into, for example, two components. In turn one can execute all the statements up to the division point, and then save the restart file as discussed in Brooke, Kendrick and Meeraus in Chapter 14. Subsequently, one can resume execution starting from the division point and execute the rest of the file. This feature is exploited in FASOM to allow us to separate data files from program execution, while allowing efficient solution and debugging. A couple of notes are in order on the batch files as listed:

1) Two batch files are given for each machine type. The difference between the full batch files (cases I and III) and the partial batch files (cases II and IV) is that the first three lines in the partial files are treated as comment. Thus both partial batch files use the model after the ALLOFIT.DAT, FAMODEL, and FARPT.REP components have been executed. Thus, one has the advanced basis arising from the base model solution and can start running from FAALTRUN with the restarted files specified as if one had done all the execution of all the statements up to then.

2) The restart files specifications include the notation ./t/ or .\t\ which causes the restart files to be

placed in a subdirectory called “t” within the current directory. Restart files are placed in a subdirectory to keep the directory uncluttered.

3) The FAMODEL.MOD line contains the command codex=1 because GAMS has limits on how much code can be included in a loop. The codex=1 option expands those limits. This is a necessary feature of the large model runs on all machines.

4) The DOS version uses “COMMAND /C” in front of the DOS GAMS call. This insures that DOS does not forget where it is, which it otherwise would in regular MSDOS versions all the way up to 6.0. This command may not be needed in the Windows, Windows NT or OS2 implementations, but the command does work in those cases.

Table A.1 Batch files

Panel A Two cases of the DOS batch file

Case I a complete FASOM run

```
command /c GAMS   ALLOFIT.DAT                          S=.\t\f1
command /c GAMS   FAMODEL.MOD               R=.\t\f1   S=.\t\f2
command /c GAMS   FARPT.REP                 R=.\t\f2   S=.\t\f3
command /c GAMS   FAALTRUN        codex=1   R=.\t\f3   S=.\t\f4
command /c GAMS   FAFINAL.REP               R=.\t\f4   S=.\t\f5
command /c GAMS   FACOMSAV.SAV              R=.\t\f5
```

Case II a FASOM Alternative runs batch file starting from a stored solution

```
rem   command /c GAMS   ALLOFIT.DAT                    S=.\t\f1
rem   command /c GAMS   FAMODEL.MOD         R=.\t\f1   S=.\t\f2
rem   command /c GAMS   FARPT.REP           R=.\t\f2   S=.\t\f3
command /c GAMS   FAALTRUN        codex=1   R=.\t\f3   S=.\t\f4
command /c GAMS   FAFINAL.REP               R=.\t\f4   S=.\t\f5
command /c GAMS   FACOMSAV.SAV              R=.\t\f5
```

Panel B Two cases of the UNIX batch file

Case III a complete FASOM run

```
gams    allofit.dat                r=./t/f1  s=./t/f1
gams    famodel.mod                r=./t/f2  s=./t/f2
gams    farpt.rep                  r=./t/f3  s=./t/f3
gams    faaltrun      -codex 1     r=./t/f4  s=./t/f4
gams    fafinal.rep                r=./t/f5  s=./t/f5
gams    facomsav.sav
```

Case IV a FASOM Alternative runs batch file starting from a stored solution

```
#gams   allofit.dat                r=./t/f1  s=./t/f1
#gams   famodel.mod                r=./t/f2  s=./t/f2
#gams   farpt.rep                  r=./t/f3  s=./t/f3
gams    faaltrun      -codex 1     r=./t/f3  s=./t/f4
gams    faaltrun                   r=./t/f4  s=./t/f4
gams    fafinal.rep                r=./t/f5  s=./t/f5
gams    facomsav.sav
```

Appendix B Table of Major GAMS Syntax Items

A number of GAMS features are quite commonly used in the document above. Here we present a very brief glossary of these with a short definition of the purpose, a place in the FASOM structure where this item is used and then references to the supporting documents giving the location where the material is covered.

Item	Purpose	Example of Usage in FASOM[1]	Location in Reference where Discussion of Item can be Found[2]
SET	Defines indexes in algebraic model	Table 2.1 Lines 1-5	BKM Chapter 4 MS Chapter 5.1.1
Parameter	Defines indexed data items either with explicit values or to be calculated	Table 2.1 Lines 7-15 (value) Table 3.1 Lines 61-66 (calculations)	BKM Chapter 5,6 MS Chapter 5.1.3
Scalar	Defines a single unindexed data item	Section 3.2.1 Example	BKM Chapter 5 MS Chapter 5.1.3
=	Used in calculating parameter values in assignment statements	Section 3.2.1	BKM Chapter 6 MS Chapter 5.1.2,5.1.3,5.1.4
Table	Defines multidimensional indexed items and include values	Table 2.1 Lines 17-28	BKM Chapter 5 MS Chapter 5.1.3
Variables	Defines unknowns in optimization model without sign restriction	Table 2.1 line 32	BKM Chapter 7 MS Chapter 5.1.5
Positive Variables	Defines nonnegative unknowns in optimization model	Table 2.1 Line 31	BKM Chapter 7 MS Chapter 5.1.5

[1] A reference to Table and Line refers to a place in this manual. A filename refers to a FASOM file.

[2] MS stands for McCarl and Spreen.
ME stands for McCarl et al.
BKM stands for Brooke, Kendrick and Meeraus

Item	Purpose	Example of Usage in FASOM[1]	Location in Reference where Discussion of Item can be Found[2]
Equations	Names and dimensions constraints in optimization model	Table 2.1 Lines 34-36	BKM Chapter 8 MS Chapter 5.1.6
..	Used in specifying algebraic statement of programming model constraints and objective function	Table 2.1 Lines 38-44	BKM Chapter 8 MS Chapter 5.1.7
$ONTEXT $OFFTEXT	Causes entries in between to be treated as comment	Table 4.1 Lines 1-4	BKM page 42
*	Causes a line to be treated as comment when placed in column 1	Table 4.1 Lines 8-9	BKM page 42
.UP, .LO	Used to enter upper and lower bounds on variables	Table 4.1 Lines 5,7 415-418	BKM Chapter 7 MS Chapter 5.1.8
.SCALE	Used to enter scaling for variables and equations	Table 4.1 Lines 446-455	ME Chapter 10
.L	Used to reference optimal value for variable	Table 3.1 Lines 64-66	BKM pg. 122-123
.m	Used to reference optimal value for a dual variable (shadow price)	Table 3.1 Lines 64-66	BKM page 31

[1] A reference to Table and Line refers to a place in this manual. A filename refers to a FASOM file.
[2] MS stands for McCarl and Spreen.
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Item	Purpose	Example of Usage in FASOM[1]	Location in Reference where Discussion of Item can be Found[2]
**** $Number	GAMS marker for compilation errors		BKM pg. 122-123 ME Chapter 6
Display	Mechanism with which GAMS displays output	Table 3.1 Line 68	BKM Chapter 13
Option Preceding Display	Method to control decimals and format of display	Table 4.3 Line 261	BKM pg. 145-8
$INCLUDE	Mechanism for including files in a GAMS code	Table 4.1 Line 491	BKM pg. 273
$BATINCLUDE	Mechanism for including a file with arguments	Section 6.3.3 FACOMPUT.SAV	BKM pg. 273
$	Conditional in setup of programming model equation or calculation	Table 3.1 Line 43 Section 6.3.1 step 5 Section 3.2	BKM pg 72, 92-5 ME Chapter 12
LOOP	Syntax which allows repeated execution of a code segment	Table 3.1 Line 87	BKM Chapter 12 pg. 278
IF	Syntax which allows conditional execution of a code segment	Table 4.1 Line 294-6	BKM pg. 283-4
PUT	Alternative output choice. Allows spreadsheet communication	Section 6.3.3 FACOMPUT.SAV	BKM pg. 275-281

[1] A reference to Table and Line refers to a place in this manual. A filename refers to a FASOM file.
[2] MS stands for McCarl and Spreen.
ME stands for McCarl et al.
BKM stands for Brooke, Kendrick and Meeraus

Item	Purpose	Example of Usage in FASOM[1]	Location in Reference where Discussion of Item can be Found[2]
SOLVE	Syntax which causes model solution to occur	Table 2.1 Line 47	BKM Chapter 9
MODEL	Syntax which tells what equations are in optimization model	Table 2.1 Line 46	BKM Chapter 9

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[1] A reference to Table and Line refers to a place in this manual. A filename refers to a FASOM file.

[2] MS stands for McCarl and Spreen.
ME stands for McCarl et al.
BKM stands for Brooke, Kendrick and Meeraus

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Appendix C: List of Data Parameters in the Model and Where they are Defined

There are many different data items within the FASOM model. These are listed here in alphabetical order. The data items are separated by function in Chapter 5, and are explained in terms of their bases and units in the accompanying FASOM documentation. Thus, we limit ourselves to a list here. In this list, please note that we have classified the inputs into several classes. The class CARBON refers to carbon input data, FORESTRETURN refers to forest, SETUP refers to the model setup, BIOMASS to biomass, and FOREST LAND AG to land interface input. When the symbol "-alt" is attached to an item, that means that this is input to the FAALTRUN alternative runs part of the FAOSM system.

Table C.1 List of Input Parameters - Alphabetic Order

Input item Name	Input Class	Primary Input File	Brief Description of Item Contents
AGCONVERT	FOREST-AG	FAFORDAT.DAT	LAND TO FORESTRY AG LAND CONVERSION LIMITS
AGSOILCARB	CARBON	FACARBON.DAT	AG SOIL CARBON
AGTRADINC	AG-ALT	FAAG.ALT	AG TRADE INCREASES
ALTFPDEM	FOREST-ALT	FAFOR.ALT	ALTERNATIVE FOREST PRODUCT DEMAND
ALTPUBSUP	FOREST-ALT	FAFOR.ALT	ALTERNATIVE PUBLIC TIMBER HARVEST
AVGROT	FOREST	FAFORDAT.DAT	AVERAGE ROTATION AT REGIONAL LEVEL
BASEYEAR	SETUP	FASETS.DAT	MODEL BASEYEAR NOW 1990
BIOHARV	BIOMASS	BIOMASS.DAT	BIOMASS HARVEST COSTS (1990$ PER CUBICFOOT)
BIOTRAN	BIOMASS	BIOMASS.DAT	BIOMASS TRANSPORT COSTS (1990$ PER CU FT)
BTUCONV	BIOMASS	BIOMASS.DAT	BTU AND UNIT CONVERSIONS FOR WOOD
BURNING	CARBON	FACARBON.DAT	DISTRIBUTION OF BURNED PRODUCTS
CAPACITY	FOREST	CAP.DAT	CAPACITY FOR FOREST PRODUCT PROCESSING
CARBDAT	CARBON-ALT	FACARB.ALT	CARBON DATA
CARBFATE	CARBON	FACARBON.DAT	DATA ON FATE OF CARBON IN HARVESTED
CONVERT	FOREST-AG	FAFORDAT.DAT	LAND TO AG CONVERSION COST AND AVAILABILITY
CRPLAND	AG-ALT	FAAG.ALT	CRP LAND INCIDENCE BY CRP REVERSION SCEN
DATE	SETUP	FASETS.DAT	DATE OF MODEL DECS
DECAYRATE	CARBON	FACARBON.DAT	ANNUAL DECAY RATE OF TREE CARBON
DEMANDQ	FOREST	FAFORDAT.DAT	ANTICIPATED VOLUME OF CONSUMPTION
DISCRATE	SETUP	FASETS.DAT	DISCOUNT RATE
DYNAM	AG	FAAGDYN.DAT	ANNUAL RATES OF CHANGE IN AG PRODUCTS
DYNAMINP	AG	FAAGDYN.DAT	DYNAMIC INFORMATION ON REGIONAL INPUTS
ECOSYSCARB	CARBON	FACARBON.DAT	CARBON IN FOREST ECOSYSTEM
ELAPSED	SETUP	FASETS.DAT	ELAPSED TIME
EROSION	AG	FAAGDAT.DAT	EROSION DATA
ESTCOST	FOREST	EST.DAT	FORESTRY ESTABLISHMENT COSTS
EXAMINE	POLICY	FAPOLDAT.DAT	POLICIES TO STUDY
EXISTYLD	FOREST	EXIST.DAT	YIELDS OF EXISTING FOREST STANDS
FARMPROD	AG	FAAGDAT.DAT	AG FARM PROGRAM DATA
FPDEM	FOREST	FPDMD.DAT	FOREST PRODUCT DEMAND
FUELSUBDAT	FOREST	FAFORDAT.DAT	CAUSES HARDWOOD FUEL TO SUBSTITUTE FOR SOFTWOOD
GROWCOST	FOREST	GROW.DAT	FOREST MAINTENANCE COSTS
HARDMIN	FOREST	FAMODEL.MOD	MINIMUM HARDWOOD ACREAGE
HARVCST	FOREST	FAFORDAT.DAT	FOREST HARVEST COSTS
HCOSTINF	FOREST	FAFORDAT.DAT	ASSUMED HARVEST COST INFLATION RATE
IMEXRC3	FOREST-ALT	FAFOR.ALT	RECYCLE SCEN TRADE COSTS FROM LR RC3
INCLDISPL	CARBON	FACARBON.DAT	DO I INCLUDE DISPLACED CARBON AS SEQUESTERED ?
INPUTELAS	AG	FAAGDYN.DAT	ELASTICITIES INPUT USE CHANGE WITH RESPECT TO YIELD CHANGE
INPUTPRICE	AG	FAAGDAT.DAT	NATIONAL INPUT PRICES
INPUTQUAN	AG	FAAGDAT.DAT	MAXIMUM AG NATIONAL INPUT QUANTITY
INTERRC3	FOREST-ALT	FAFOR.ALT	RECYCLE SCEN TRANSPORT COSTS FROM LR RC3
INVENT	FOREST	INV.DAT	INITIAL TIMBER INVENTORY
LANDCON	FOREST-AG	FAMODEL.MOD	IS LAND CONVERSION ALLOWED
LANDMIN	POLICY	FAPOLDAT.DAT	LAND REQURED UNDER A POLICY
LANDSUBDAT	AG	FAMODEL.MOD	PASTURE TO CROP LAND SUBSTITUTE
LANDTRANS	FOREST	FAFORDAT.DAT	TRANSFER OF TIMBERLAND TO URBANDEVELOPED USES
MAXBIO	BIOMASS	BIOMASS.ALT	MAXIMUM BIOMASS PENETRATION IN TBTUS
MILLRESID	BIOMASS	BIOMASS.DAT	MILL RESIDUE PER CU FT OF SAWTIMBER
MINHARV	FOREST	FAFORDAT.DAT	MINIMUM HARVEST AGE
MONEY	POLICY	FAPOLDAT.DAT	LIMIT ON MONEY AVAILABLE
NEWAUMSSUP	AG	FAAGDAT.DAT	AG REGIONAL AUMS SUPPLY
NEWBUDDATA	AG	FAAGDAT.DAT	AG CROP BUDGET DATA
NEWFPPART	AG	FAAGDAT.DAT	AG FARM PROGRAM PARTICIPATION RATES
NEWLABSUPP	AG	FAAGDAT.DAT	AG REGIONAL LABOR SUPPLY

NEWLANDAVL	AG	FAAGDAT.DAT	AG MAXIMUM LAND AVAILABLE BY SUBREGION
NEWLIVEBUD	AG	FAAGDAT.DAT	AG LIVESTOCK BUDGET DATA
NEWLNDSUPP	AG	FAAGDAT.DAT	AG REGIONAL LAND SUPPLY DATA
NEWMINHARV	FOREST-ALT	FAFOR.ALT	REVISED MIN. HARV.
NEWMIXDATA	AG	FAAGDAT.DAT	AG REGIONAL HISTORICAL CROP MIXES
NEWNATMIXD	AG	FAAGDAT.DAT	AG NATIONAL PRIMARY PRODUCT MIXDATA

Table C.1 List of input parameters - Alphabetic Order (continued)

Input item Name	Input Class	Primary Input File	Brief Description of Item Contents
NEWPOPULAT	AG	FAAGDAT.DAT	POPULATION BY SUBREGION FOR WELFARE ACCTING
NEWWATSUP	AG	FAAGDAT.DAT	AG REGIONAL WATER SUPPLY
NEWYLD	FOREST	NEW.DAT	YIELDS OF NEW FORESTED STANDS
NOMILLDEM	BIOMASS	BIOMASS.DAT	FOREST PRODUCT DEMAND IN 1000 CU FT
PDEMAND	AG	FAAGDAT.DAT	AG PRIMARY COMMODITY DOMESTIC DEMAND DATA
PEXPORT	AG	FAAGDAT.DAT	AG PRIMARY COMMODITY DOMESTIC DEMAND DATA
PIMPORT	AG	FAAGDAT.DAT	AG PRIMARY COMMODITY DOMESTIC DEMAND DATA
PROCBUD	AG	FAAGDAT.DAT	AG PROCESSING BUDGET DATA
PUBSUP	FOREST	PUBLIC.DAT	PUBLIC TIMBER HARVEST
RESCOST	FOREST	FAFORDAT.DAT	FOREST HARVEST COSTS INCLUDING LOG RES
RESIDUEFR	CARBON	FACARBON.DAT	PROPORTION NON MERCHANTABLE WOOD
RESIDUVAL	BIOMASS	BIOMASS.DAT	RESIDUE VALUES
ROTATION	FOREST	ROTATE.DAT	TYPICAL EQUILIBRIUM ROTATION AGE
RUNVALUE	ALTRUN	FAALTRUN	ALTENATIVE VALUES FOR RUNS
SDEMAND	AG	FAAGDAT.DAT	AG SECONDARY COMMODITY DOMESTIC DEMAND DATA
SEPAG	MODEL	FAMODSET.MOD	IF ONE USE SEPARABLE PROGRAMMING FOR AGRICULTURE
SEPFOR	MODEL	FAMODSET.MOD	IF ONE USE SEPARABLE PROGRAMMING FOR FORESTRY
SEXPORT	AG	FAAGDAT.DAT	AG SECONDARY COMMODITY DOMESTIC DEMAND DATA
SIMPORT	AG	FAAGDAT.DAT	AG SECONDARY COMMODITY DOMESTIC DEMAND DATA
STICKYLIM	FOREST	FAFORDAT.DAT	STICKINESS LIMITS
STICKYTYPE	POLICY	FAPOLDAT.DAT	SWITCH FOR PLANTING RESTRICTIONS
SUBLIMIT	BIOMASS	BIOMASS.DAT	LIMIT ON POPLAR SUBSTITUTION
SUPCANADA	FOREST	CANADA.ALT	CANADIAN SUPPLY(INTERN ADJUSTED FOR MILLRES)
TCOSTINF	FOREST	FAFORDAT.DAT	ASSUMED TRANPORTCOST INFLATION RATE
TOL	AG	FAAGDAT.DAT	FARM PROGRAM CONVERGENCE TOLERANCE PROPORTION
TRADECOST	FOREST	FAFORDAT.DAT	FOREST PRODUCT TRADE COSTS
TRADEI	FOREST	FAFORDAT.DAT	ANTICIPATED VOLUME OF FOREST PRODUCT TRADE
TRADFOR	FOREST	TRADEDMD.DAT	FOREST PRODUCT TRADE DEMANDSUPPLY
TRANSCOST	FOREST	INTER.DAT	DOMESTIC WOOD MOVEMENT COSTS TO NATIONAL MARKET
TREEAGE	FOREST	FAFORDAT.DAT	AGE OF TREES IN A COHORT
TREECARB	CARBON	FACARBON.DAT	TREE CARBON YIELD FACTORS
YESAG	SETUP	FASETS.DAT	WHETHER OR NOT TO HAVE THE AG MODEL
YESBIOMA	POLICY	FAPOLDAT.DAT	POLICY LINK TO BIOMASS PRODUCTS
YESFOR	SETUP	FASETS.DAT	DO I DO THE FORESTRY MODEL
YESMILL	FOREST	FAMODEL.MOD	IDENTIFIES MILL RESIDUES
YESMILLRES	FOREST	FAMODSET.MOD	WHETHER OR NOT TO MODEL MILL RESIDUE
YESPLLIM	FOREST	FASETS.DAT	IMPOSE PLANTING EXPEDITURE LIMITS

Appendix D: Description of FASOM Output File Items

Summary FASOM output is produced in the FAFINAL.LST file by the GAMS instructions of the FASOM model. Other output also appears in the alternative runs file output FAALTRUN.LST and in the detailed put file RESULTS.PUT. This appendix defines a number of the data items appearing in these output files.

Table D.1 presents a list of all potential FASOM output data items in alphabetic order giving the type of output, the location of its formation, and a brief description. Table D.2 covers selected cross scenario comparative forest output from the FAFINAL.REP comparative report giving further definition and units. Table D.3 does the same for non-comparative scenario-by-scenario carbon output, reviewing items produced by FAALTRUN.REP. Table D.4 presents a more detailed description of the information in Table D.2, while Table D.4 presents more detail on the agricultural comparative output.

All output items that are available are listed alphabetically in Table D.1. Chapter 5 presents a list of those items by function.

Table D.1 List of Potential Output Data - Alphabetic Order

Parameter Name	Output Class	Primary Defining File	Brief Description of Item Contents
ACRES	COMPAR - AG	FACOMPAR.REP	AREA ENROLLED IN POLICY PROGRAM (M ACRES)
AGLNDPRI	COMPAR - AG	FAFINAL.REP	WEIGHTED TRANSFERRED AG LAND PRICE
AGPRODUCT	AG	FAASMRPT.REP	AG PRODUCT FOR REPORT WRITER
AGTABLE	COMPAR - AG	FACOMPAR.REP	TABLE OF AGRICULTURAL RESULTS
AGTOFOR	ALL	FAFORRPT.REP	NON-ZERO CONVRTFRAG ACTIVITIES
AGTRADBAL	AG	FAASMRPT.REP	AG TRADE BALANCE
AUMSREG	AG	FAASMRPT.REP	AUM USAGE
AVGROT	FOREST	FAFORRPT.REP	AVERAGE ROTATION AT REGIONAL LEVEL
BALANCEP	AG	FAASMRPT.REP	PRIMARY PRODUCT SUPPLY DEMAND BALANCE
BALANCES	AG	FAASMRPT.REP	SECONDARY SUPPLY DEMAND BALANCE
BIOMASS	COMPAR - BIO	FACOMPAR.REP	NATIONAL BIOMASS SUPPLY
CARBCAL	CARBON	FACRBRPT.REP	CALCULATED CARBON
CARBCOST	COMPAR - CARB	FACOMPAR.REP	COST OF CARBON MINIMUM CONSTRAINTS
CARBFLUX	COMPAR - CARB	FAFINAL.REP	ANNUAL FOREST CARBON ADDITION
CARBFLUXP	COMPAR - CARB	FAFINAL.REP	PERCENT CHANGE IN ANNUAL CARBON ADDITION
CARBONI	CARBON	FARPT.REP	INITIAL CARBON AT MODEL BEGINNING
CARBONIB	CARBON	FARPT.REP	INITIAL CARBON BREAKDOWN
CARBONINV	COMPAR - CARB	FACOMPAR.REP	CARBON INVENTORY
CARBONINVP	COMPAR - CARB	FAFINAL.REP	PERCENT CHANGE FROM BASE CARBON INVENTORY
CARBONRPT	CARBON	FACRBRPT.REP	CARBON RESULTS
CARBRPT	COMPAR - CARB	FACOMSAV.SAV	CARBON RESULTS
CONSBAL	FOREST	FAFORRPT.REP	US CONSUMPTION & PRODUCTION BALANCE
CONVERGE	FARMPRO	FASOLVLP.MOD	NUMBER OF CROPS NOT MEETING FARM PRO CONVERGENCE
DAVGROT	FOREST	FAFORRPT.REP	AVG. ROTATION BY REGION - DENOM.
DISSURP	FOREST	FAFORRPT.REP	DISCOUNTED SURPLUS
ENDPROD	FOREST	FAFORRPT.REP	TERMVOLN MARGINALS
EROSIOND	COMPAR - AG	FACOMPAR.REP	REGIONAL EROSION
FACTORWEL	AG	FAAGWEL.REP	FACTOR ORIENTED WELFARE
FAWELFARE	COMPAR - INT	FACOMPAR.REP	NPV OF WELFARE
FAWELSUM	COMPAR - INT	FACOMPAR.REP	WELFARE BY DECADE
FFWEL	AG	FAAGWEL.REP	REPRODUCTION OF WELFARE IN AG OBJ FUN
FORLNDPRI	COMPAR - FOR	FAFINAL.REP	WEIGHTED TRANSFERRED FOREST LAND PRICE
FORTOAG	FOREST	FAFORRPT.REP	NON-ZERO CONVRTTOAG ACTIVITIES
FPPRICE	FOREST	FAFORRPT.REP	DELIVERED LOG PRICES1990 $PER CUF
FPSUB	FOREST	FAFORRPT.REP	PRODUCT SUBSTITUTION
FPTRADE	FOREST	FAFORRPT.REP	EXTERNAL TRADE PRICES
FWEL	FOREST	FAFORWEL.REP	TOTAL WELFARE FOR A CHECK
FWELFARE	AG	FAASMRPT.REP	FOREIGN WELFARE
GFWEL	AG	FAAGWEL.REP	ORIGINAL AG OBJ FUN
GOVCCC	AG	FAASMRPT.REP	GOVERNMENT CCC LOAN COST SUMMARY
GOVDEF	AG	FAASMRPT.REP	GOVERNMENT DEFICIENCY PAYMENT SUMMARY
GROSSREV	AG	FAASMRPT.REP	GROSS REVENUE BY COMMODITY
HARDAGE	FOREST	FAFORRPT.REP	HW ROTATION AGE
HARDAREA	FOREST	FAFORRPT.REP	HW INVENTORY AREA
HARVEST	AG	FAASMRPT.REP	NATIONAL HARVESTED ACREAGE REPORT
HARVESTREG	AG	FAASMRPT.REP	REGIONAL HARVESTED ACREAGE REPORT
HARVEXIST	FOREST	FAFORRPT.REP	HARVEST OF EXISITING STANDS
HARVPROD	FOREST	FAFORRPT.REP	FOREST HARVEST BY PRODUCT
HTINV	FOREST	FAFORRPT.REP	TOTAL HW TIMBER INVENTORY VOLUME
HWINEXI	FOREST	FAFORRPT.REP	EXISTING HARD INV. VOLUME
HWINNEW	FOREST	FAFORRPT.REP	NEW HARD INV. VOLUME
INDEXS	COMPAR - AG	FAFINAL.REP	FISHER IDEAL INDEXES
IOANIMAL	COMPAR - AG	FACOMPAR.REP	INPUT OUTPUT DATA ANIMAL SYSTEM VALUE
IOCOMMOD	COMPAR - AG	FACOMPAR.REP	INPUT OUTPUT DATA ON COMMODITY VALUE

IOPRICHECK	COMPAR - FOR	FACOMPAR.REP	PRIVATE CHECK
IOPRIHWHAR	COMPAR - FOR	FACOMPAR.REP	HW HARVEST VOLUME BY PRIVATE OWNERS
IOPRISWHAR	COMPAR - FOR	FACOMPAR.REP	SW HARVEST VOLUME BY PRIVATE OWNERS
IOPRODVAL	COMPAR - FOR	FACOMPAR.REP	TOTAL HARVEST VALUE BY PRODUCT
IOPUBCHECK	COMPAR - FOR	FACOMPAR.REP	PUBLIC CHECK

Table D.1 List of Potential Output Data - Alphabetic Order (continued)

Parameter Name	Output Class	Primary Defining File	Brief Description of Item Contents
IOPUBHWHAR	COMPAR - FOR	FACOMPAR.REP	HW HARVEST VOLUME BY PUBLIC OWNERS
IORESULTC	AG	FAASMRPT.REP	IO RESULTS FOR PRIMARY COMMODITIES
IORESULTP	AG	FAASMRPT.REP	IO RESULTS FOR PRODUCTION SYSTEMS
IOTOTALVAL	COMPAR - FOR	FACOMPAR.REP	IMPLAN TOTAL VALUE OF HARVEST
LABORSUM	AG	FAASMRPT.REP	LABOR USE SUMMARY
LANDDISP	ALL	FAFORRPT.REP	LAND DISPOSITION
LANDSHIFT	COMPAR - INT	FAFINAL.REP	AGGREGATE NET LAND SHIFT BETWEEN SECTORS
LANDSUM	AG	FAASMRPT.REP	LAND USE SUMMARY
LANDTOFOR	ALL	FAFORRPT.REP	NON-ZERO LANDFROMAG ACTIVITIES
MICCUT	FOREST	FAFORRPT.REP	TIMBER HARVEST BY MIC
MICHARVEST	COMPAR - FOR	FACOMPAR.REP	ACRES HARVESTED BY MIC
NATEROSION	AG	FAASMRPT.REP	NATIONAL EROSION
NATINPUSE	AG	FAASMRPT.REP	NATIONAL INPUT USAGES IN $1000
NAVGROT	FOREST	FAFORRPT.REP	AVG. ROTATION BY REGION - NUM.
NETRADE	FOREST	FAFORRPT.REP	EXTERNAL TRADE (ROW) REPORT
NEWFORES	FOREST	FAFORRPT.REP	NEWLY FORESTED ACRES BY REGION
NEWPOL	FOREST	FAFORRPT.REP	POLICY INDUCED LAND
NLANDDISP	COMPAR - INT	FACOMPAR.REP	LAND DISPOSITION
OPTIMALITY	DEBUG	FACOMPAR.REP	PROBLEM OPTIMALITY STATUS (SHOULD EQUAL 1 OR 2)
OWEL	FOREST	FAFORWEL.REP	TOTAL WELFARE
OWNHWPROD	FOREST	FAFORRPT.REP	HARDWOOD HARV BY OWNER PRODUCT
PCONSUR	AG	FAASMRPT.REP	DOMESTIC CONSUMER SURPLUS
PROCSUM	AG	FAASMRPT.REP	PROCESSING SUMMARY
PROCWEL	AG	FAAGWEL.REP	PROCESSOR WELFARE PROB ZERO
PRODUCTWEL	AG	FAAGWEL.REP	COMMODITY ORIENTED WELFARE
PRODUCWEL	AG	FAASMRPT.REP	PRODUCER WELFARE
PROGCOST	COMPAR - INT	FACOMPAR.REP	POLICY COST ($ MILLION)
REFOREST	COMPAR - FOR	FACOMPAR.REP	ACRES REFORRESTED BY MIC
REGBIOMASS	COMPAR - BIO	FACOMPAR.REP	REGIONAL BIOMASS SUPPLY
REGCARBINV	COMPAR - CARB	FACOMPAR.REP	REGIONAL CARBON INVENTORY
REGEROSION	AG	FAASMRPT.REP	REGIONAL EROSION
REGINPUSE	AG	FAASMRPT.REP	REGIONAL INPUT USAGES IN $1000
REGSURP	FOREST	FAFORRPT.REP	REGIONAL SURPLUS
REGTRANS	FOREST	FAFORRPT.REP	DOMESTIC TRADE FLOWS
REGWELFAR	AG	FAASMRPT.REP	REGIONAL WELFARE ACCOUNTING
RESULT	FARMPRO	FASOLVLP.MOD	FARM PROGRAM ITERATION RESULTS
REVWEL	AG	FAAGWEL.REP	WELFARE FROM FARM REV SHOULD BE ZERO
ROWTRADE	FOREST	FAFORRPT.REP	EXTERNAL TRADE FLOWS
RUNACRES	COMPAR - AG	FACOMPAR.REP	COMPARATIVE REPORT OF CROPPED ACRES
SAGLDTRNLI	COMPAR - INT	FACOMPAR.REP	SAVED SHADOW PRICE
SCNVRTFRAG	COMPAR - INT	FACOMPAR.REP	SAVED OPTIMAL VALUE
SCNVRTTOAG	COMPAR - INT	FACOMPAR.REP	SAVED OPTIMAL VALUE
SFORCEDLAN	COMPAR - INT	FACOMPAR.REP	SAVED SHADOW PRICE
SHADCOST	COMPAR - INT	FACOMPAR.REP	COST OF FORCING TREES ($ MILLION)
SHARDWOOD	COMPAR - FOR	FACOMPAR.REP	SAVED SHADOW PRICE
SLANDBALAN	COMPAR - FOR	FACOMPAR.REP	SAVED SHADOW PRICE
SLANDSUM	OMPAR - AG	FACOMPAR.REP	SAVED AG LAND USE
SLANDTRNLI	COMPAR - INT	FACOMPAR.REP	SAVED SHADOW PRICE
SLNDFROMAG	COMPAR - INT	FACOMPAR.REP	SAVED OPTIMAL VALUE
SLNDTOAG	COMPAR - INT	FACOMPAR.REP	SAVED OPTIMAL VALUE
SMAXLAND	COMPAR - AG	FACOMPAR.REP	SAVED SHADOW PRICE
SOFTAGE	FOREST	FAFORRPT.REP	SW ROTATION AGE
SOFTAREA	FOREST	FAFORRPT.REP	SW INVENTORY AREA
STICKYSHAD	COMPAR - FOR	FACOMPAR.REP	SHADOW PRICE PLANTING EXPENDITURE LIMITS
STINV	FOREST	FAFORRPT.REP	TOTAL SW TIMBER INVENTORY VOLUME
STRNFRLDBA	COMPAR - INT	FACOMPAR.REP	SAVED SHADOW PRICE

STUCK	FARMPRO	FASOLVLP.MOD	TELLS WHEN FARM PROGRAM ITERATIONS ARE STUCK
SUBREPORT	AG	FAASMRPT.REP	SUBREGIONAL PRODUCTION REPORT
SVAVGROT	COMPAR - FOR	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF AVGROT
SVCONSBAL	COMPAR - FOR	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF CONSBAL

Table D.1 List of Potential Output Data - Alphabetic Order (continued)

Parameter Name	Output Class	Primary Defining File	Brief Description of Item Contents
SVENDPROD	COMPAR - FOR	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF ENDPROD
SVFPCAP	COMPAR - FOR	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF FPCAP
SVFPPRICE	COMPAR - FOR	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF FPPRICE
SVHARDAGE	COMPAR - FOR	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF HARDAGE
SVHARDAREA	COMPAR - FOR	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF HW INVENTORY AREA
SVHWINEXI	COMPAR - FOR	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF HWINVEXI
SVHWINNEW	COMPAR - FOR	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF HWINVNEW
SVLANDDISP	COMPAR - INT	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF LANDDISP
SVMICCUT	COMPAR - FOR	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF MICCUT
SVNEWFORES	COMPAR - FOR	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF NEWFORES
SVNEWPOL	COMPAR - FOR	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF NEWPOL
SVREGSURP	COMPAR - FOR	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF REGSURP
SVSOFTAGE	COMPAR - FOR	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF SOFTAGE
SVSOFTAREA	COMPAR - FOR	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF SW INVENTORY AREA
SVSWINEXI	COMPAR - FOR	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF SWINVEXI
SVSWINNEW	COMPAR - FOR	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF SWINVNEW
SVTERMPRI	COMPAR - FOR	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF TERMPRI
SVTHPROD	COMPAR - FOR	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF THPROD
SVTOTSURP	COMPAR - FOR	FACOMSAV.SAV	COMPARATIVE RUN SAVE OF TOTSURP
SWINEXI	FOREST	FAFORRPT.REP	EXISTING SOFT INV. VOLUME
SWINNEW	FOREST	FAFORRPT.REP	NEW SOFT INV. VOLUME
TERMPRI	FOREST	FAFORRPT.REP	TERMINAL PRODUCT PRICES
TERMSURP	FOREST	FAFORWEL.REP	TERMINAL CONDITION SURPLUS
TERMVOL	FOREST	FAFORRPT.REP	TERMINAL VOLUME
THPROD	FOREST	FAFORRPT.REP	TOTAL HARVEST BY PRODUCT & REGION
TIMBCONP	COMPAR - FOR	FACOMPAR.REP	TIMBER CONSUMERS PRICE INDEX
TIMBCONQ	COMPAR - FOR	FACOMPAR.REP	TIMBER CONSUMERS QUANTITY INDEX
TIMBCONS	COMPAR - FOR	FACOMPAR.REP	FOREST PRODUCTS CONSUMPTION (MMCF)
TIMBCONSP	COMPAR - FOR	FAFINAL.REP	PERCENT CHANGE FROM BASE FOREST CONSUMPTION
TIMBERHAR	COMPAR - FOR	FACOMPAR.REP	HARVEST AREA IN M ACRES
TIMBERHARP	COMPAR - FOR	FAFINAL.REP	PERCENT CHANGE FROM BASE HARVEST AREA
TIMBERINV	COMPAR - FOR	FACOMPAR.REP	TIMBERLAND AREA IN M ACRES
TIMBERINVP	COMPAR - FOR	FAFINAL.REP	PERCENT CHANGE FROM BASE TIMBERLAND AREA
TIMBINV	COMPAR - FOR	FACOMPAR.REP	TIMBER INVENTORY VOLUME (MILLION CU FT)
TIMBINV2	COMPAR - FOR	FAFINAL.REP	NATIONAL INVENTORY IN ACRES
TIMBINV21	COMPAR - FOR	FAFINAL.REP	NATIONAL INVENTORY IN MILLION CU FT
TIMBINV21A	COMPAR - FOR	FAFINAL.REP	REGIONAL INVENTORY IN MILLION CU FT
TIMBINV3	COMPAR - FOR	FAFINAL.REP	NATIONAL INVENTORY IN ACRES
TIMBINV31	COMPAR - FOR	FAFINAL.REP	NATIONAL INVENTORY IN ACRES
TIMBINV31A	COMPAR - FOR	FAFINAL.REP	REGIONAL INVENTORY BY SPECIES IN MILLION CU FT
TIMBPRICE	COMPAR - FOR	FACOMPAR.REP	FOREST PRODUCTS PRICE (82 PER CU FT DELIVERED)
TIMBPRICEP	COMPAR - FOR	FAFINAL.REP	PERCENT CHANGE FROM BASE FOREST PRODUCTS PRICE
TIMBPROD	COMPAR - FOR	FACOMPAR.REP	FOREST PRODUCTS PRODUCTION (MMCF)
TIMBPRODP	COMPAR - FOR	FAFINAL.REP	PERCENT CHANGE FROM BASE FOREST PRODUCTS PRODUCTION
TIMBPROP	COMPAR - FOR	FACOMPAR.REP	TIMBER PRODUCERS PRICE INDEX
TIMBPROQ	COMPAR - FOR	FACOMPAR.REP	TIMBER PRODUCERS QUANTITY INDEX
TINV	FOREST	FAFORRPT.REP	TOTAL TIMBER INVENTORY
TOTSURP	FOREST	FAFORWEL.REP	TOTAL SURPLUS
VERSION	DEBUG	FAFINAL.REP	VERSION OF FILES IN FASOM
WATERSUM	AG	FAASMRPT.REP	WATER USE SUMMARY
WELCON	AG	FAAGWEL.REP	FOREST CONSUMER WELFARE
WELSUM	AG	FAASMRPT.REP	SOCIAL WELFARE SUMMARY REPORT

Table D.2 Selected Comparative Forest Output — Units and Deeper Description

FAWELSUM	Net present value of total welfare. The units are in million dollars and are net present value over the decade of interest. The components of this table are:	
	DOMFORCON	Domestic forest consumers' surplus
	DOMFORPRO	Domestic forest producers' surplus
	PUBLICCUT	Revenue to harvest from public ownership
	FOREGNFOR	International producers' plus consumers' surplus to importers and exporters
	TRANSPORTFOR	Surplus to goods transport; ordinarily should be near zero
	DOMESTICFOR	Total domestic forest consumers' plus producers’ surplus
	ALLFOR	All forest welfare
	FORPRGCOST	Cost of subsidies in forest sector
	NETFOR	Net surplus in forest sector
	AGCONSWELF	Agricultural consumers' surplus
	AGPRODWELF	Agricultural producers' surplus
	AGFORWELF	Agricultural surplus accuring to foreign parties
	AGTOTWELF	Total agricultural surplus
	AGDOMWEL	Total agricultural surplus to domestic sources
	AGGOVTCOST	Cost of farm program operations
	AGNETWELF	Net welfare to agriculture
	BOTHGRAND	Total welfare to agriculture and forest
	BOTHDOMEST	Total domestic welfare to agriculture and forest
	BOTHGOVCST	Total government cost to agriculture and forest of subsidies and farm programs
	BOTHNETWEL	Net welfare to agriculture and forestry
FAWELFARE	The net present value of forest sector welfare, including consumers' surplus, producers' surplus, foreign interests' surplus, returns to public cut, and terminal conditions. The units are in million dollars. The components of this table are:	
	DOMFORCON	Forest products domestic consumers' surplus
	DOMFORPRO	Forest products domestic producers' surplus
	PUBLICCUT	Public cut surplus (which actually is total revenue to public cut since public costs are not included)
	DOMESTFOR	Total of above three measures

	FOREIGNFOR	Forest products surplus to foreign imports and exports (note this is just foreign surplus since the curves are excess supply and demand relations and cannot be interpreted as consumers' or producers' surplus for particular parties)
	TRANSPRTFOR	Transport welfare - should not be used
	FORPRGCOST	Forest subsidy costs
	NETFOR	Net welfare to forestry
	AGCONSWELF	Agricultural consumers' surplus
	AGPRODWELF	Agricultural producers' surplus
	AGFORWELF	Agricultural surplus accruing to foreign parties
	AGTOTWELF	Total agricultural surplus
	AGDOMWEL	Total agricultural surplus to domestic sources
	AGGOVTCOST	Cost of farm program operations
	AGNETWELF	Net welfare to agriculture
	RESIDUAL	Deviation from total objective (should be small)
	BOTHGRAND	Total welfare to agriculture and forest
	BOTHDOMEST	Total domestic welfare to agriculture and forest
	BOTHGOVCST	Total government cost to agriculture and forest of subsidies and farm programs
	BOTHNETWEL	Net welfare to agriculture and forestry
	ALLFOR	Total of DOMESTFOR + FOREIGNFOR
	FORTERMINAL	Consumers' surplus to the terminal conditions
	GRANDFOR	Total of ALLFOR + FORTERMINAL -- interpretable as total NPV of welfare
FAWELFAREP	Percentage changes in FAWELFARE from the base scenario. Note that a 1.0 value means a 1% increase from the base	
MICHARVEST	Thousands of acres harvested by management intensity class (MIC) and owner for entire US	
NETWELF	Net present values of total welfare less program costs. This has the GRANDFOR data from the FAWELFARE table, the NPV of sips program costs (FORPRGCOST), and their difference in million dollars (NETWELF = GRANDFOR - FORPRGCOST)	
NETWELFP	Percent change in NETWELF	
PROGACRES	Thousands of acres enrolled in policy programs	
PROGCOST	Program cost by decade and type of policy, in million dollars	
REFOREST	Thousands of acres reforested by management intensity class (MIC) and owner for entire US	

TIMBERINV	National timber inventory by decade in thousands of acres. This table also reports ownership, species and management intensity class. The ownership classes are OP for other private and FI for industrial forests. The species are SOFSOF for softwood following softwood, HARSOF for softwood following hardwood, SOFHAR for hardwood following softwood, and HARHAR for hardwood following hardwood.
TIMBERINVP	Percentage change in TIMBERINV
TIMBERHAR	National timber harvest by decade in thousands of acres. This table also reports ownership and species. The ownership classes and species are as above.
TIMBERHARP	Percentage change in TIMBERHAR
TIMBPRICE	Forest product price in $ 1990 / CF by decade and product for pulpwood, sawtimber and fuelwood from softwoods and hardwoods.
TIMBPRICEP	Percentage change in TIMBPRICE
TIMBPROD	Forest products production by decade and product in million CF.
TIMBPRODP	Percentage change in TIMBPROD.
TIMBCONS	Forest Products Consumption by decade and product probably in thousand CF.
TIMBCONSP	Percentage change in TIMBCONS
TIMBPROP	Timber producers price index relative to the base
TIMBPROQ	Timber producers quantity index relative to the base
TIMBCONP	Timber consumers price index relative to the base
TIMBCONQ	Timber consumers quantity index relative to the base
TIMBINV	Total softwood and hardwood timber inventory in million cu ft
TNEW	An enumeration of all SIP acres in the last run, i.e., in the 50% and sip run, in thousands of acres

Table D.3 Selected Combined Comparative Carbon Output — Units and Deeper Description

CARBFLUX	Annual carbon addition in million metric tons/yr
CARBFLUXP	Percent change in annual carbon addition
CARBONINV	Metric tons of carbon in inventory by decade in millions of metric tons
CARBONINV	Percentage change in CARBONINV
REGCARBINV	Metric tons of carbon in inventory by decade and region in millions of metric tons

Table D.4 Units and Item Descriptions Scenario by Scenario Output

LANDDISP	Land actions by region and decade in thousand acres:	
	HARVEXST	Harvest of existing stands
	HARVNEW	Harvest of reestablished stands
	CONVRTFRAG	Land converted from agriculture
	TRANSFER	Land lost or added to the forest base due to urban/suburban, infrastructural, and other nonfarm actions
	REFOREST	Land "replanted" to any of the management intensity classes (MIC) (including LL)
	CONVRTOAG	land shifted from forest to agriculture
SOFTEXIST	Harvest of existing softwood acres, displayed by region, land class, owner, species, site quality; then the rows show initial age class (cohort) and management intensity class (MIC) and the columns show the decade of the projection in which harvested. Units are 1000s of acres.	
HARDEXIST	The same thing as SOFTEXIST for hardwood species groups	
SOFTNEW and HARDNEW	Harvest of reestablished stands by region, land class, owner, species, and site quality. The rows give the management intensity class (MIC) when regenerated and age of harvest in decades (so PLUS40 is 40 years, etc.) and the columns show the period in the projection in which the stand was regenerated (planted). So if you add the age of harvest to the decade regenerated you can tell when the stand is next cut (e.g., 1990 + 40 = 2030). Units are 1000s of acres.	
NETRADE	Shows by region, decade and product the net offshore trade of the various regions: a positive number is a net export, a negative number a net import. Volumes in million cubic feet.	
CONSBAL	Shows total US consumption, production, substitution, imports, exports and apparent consumption (as a check) of products by decade. Volumes are in million cubic feet. At times the apparent consumption check column will show a larger volume than the consumption column. The latter is the "real" amount consumed since it is possible to harvest material and not use it or downgrade (substitute) it--this may have some interesting carbon accounting consequences. Note that the USNETSUB is the net substitution column: a positive number is material received from a higher product category and a negative number is material shifted down to a lower product category (SAWT is higher than PULP, which is higher than FUEL).	

LANDTOFOR	An accounting of land shifted from agriculture to forestry by region, decade and land class, in thousands of acres
FORTOAG	Represents land shifted from forestry to agriculture by region and decade, in thousands of acres
AGTOFOR	The same totals as from LANDTOFOR but summing across the land classes, in thousands of acres
SWINTOT HWINTOT	Total softwood and hardwood inventories (in million cubic feet) by owner, region, and decade

Table D.5 Agricultural Sector Outputs

INDEXS	Fisher ideal price and quantity indices for a number of agricultural products, giving the change in those items relative to the base model result by decade. The indices and the products in them are:	
	grain	CORN, SOYBEANS, WHEAT, SORGHUM, RICE, BARLEY, OATS
	livestock	OTHERLIVES(MOSTLY HORSES), CULL DAIRY COWS, CULL BEEF COWS, MILK, HOGS SLAUGHTERED, FEEDER PIGS, LIVE CALVES, BEEF YEARLINGS, CALVES SLAUGHTERED, NONFED BEEF, FED BEEF, CULL SOWS, POULTRY, LAMBS SLAUGHTERED, LAMBS FOR FEEDING, CULL EWES, WOOL
	othercrop	SILAGE, HAY, COTTON, SOYBEANS, SUGARCANE, SUGARBEET, POTATOES
	feeds	FEEDGRAIN, DAIRYPROT1, HIGHPROTSW, LOWPROTSWI, LOWPROTCAT,HIGHPROTCA, GLUTENFEED
	processed	SOYBEANMEA, SOYBEANOIL, FLUIDMILK, BUTTER, AMCHEESE, OTCHEESE, ICECREAM, NONFATDRYM, COTTAGECHE, SKIMMILK, CREAM, HFCS, BEVERAGES, CONFECTION, BAKING, CANNING, REFSUGAR, CANEREFINI, CORNOIL, ETHANOL, COSYRUP, DEXTROSE FROZENPOT, DRIEDPOT, CHIPPOT, STARCH
	meats	FEDBEEF, VEAL, NONFEDBEEF, PORK
	chemicals	NITROGEN, POTASSIUM, PHOSPOROUS, LIMEIN, CHEMICALCO
	otherinput	OTHERVARIA, PUBLICGRAZ, CUSTOMOPER, SEEDCOST, CAPITAL, REPAIRCOST, VETANDMED, MARKETING, INSURANCE, MACHINERY, MANAGEMENT, LANDTAXES, GENERALOVE, NONCASHVAR, MGT, FUELANDOTH, CROPINSUR, IRRIGATION, MISCCOST,PROCCOST, TRANCOST, MISCINPUT

AGTABLE	Table of agricultural results which summarizes a number of items by decade. They include:	
	CROPLAND	Use of crop land in thousand acres
	PASTURE	Use of pasture land in thousand acres
	DRYLAND	Use of dryland crop land in thousand acres
	IRRIGLAND	Use of irrigated crop land in thousand acres
	WATER	Use of irrigation water in thousand acre feet
	LABOR	Use of labor in thousand hours
	TOTALWELF	Total surplus in agricultural model in thousand $
	CONSWELF	Total domestic agricultural consumers surplus in agricultural model in thousand $
	PRODWELF	Total domestic agricultural producers' surplus in agricultural model in thousand $
	FORWELF	Total foreign surplus in agricultural model in thousand $
	DOMESTWEL	Total domestic surplus in agricultural model in thousand $
	GOVTCOST	Total government program cost in agricultural model in thousand $
	NETWELF	Net agricultural surplus after subtracting government cost in thousand $
	TRADBAL	Agricultural trade balance in thousand $

Appendix E TAMM Interface Guide

The TAMM model (Adams and Haynes, in press) provides the forest product demand relations for both domestic and foreign trade, intra-regional harvest and transportation costs, and certain cost inflation factors for the forest sector of FASOM. This appendix describes each of these inputs and its origin within TAMM, and suggests ways inputs might be modified to develop various scenarios. Each section below begins with a listing of the code that defines the parameter or table in question and includes all or (for larger parameters) a sample of the data.

Table E.1 Transportation costs for trade flows (fafordat.dat)

```
TABLE TRADECOST(REG,TRADEREG,PRODS)   TRADE COSTS
* TRANSPORTATION COSTS FOR EXPORT AND IMPORT TRADE
* This is for the base run
               SAWTSW   PULPSW   SAWTHW   PULPHW
PNWW .TPNWW     0.001    0.335    0.307    0.001
PNWE .TPNWE     0.664    0.359    0.307    0.001
PSW  .TPSW      0.482    0.319    0.307    0.001
RM   .TRM       0.993    0.311    0.307    0.001
LS   .TLS       1.520    0.246    0.120    0.001
CB   .TCB       1.520    0.246    0.120    0.001
NE   .TNE       1.331    0.001    0.001    0.006
SC   .TSC       0.930    0.688    0.454    0.187
SE   .TSE       0.955    0.702    0.536    0.203
```

Transport costs in FASOM are pseudo-costs whose function is to preserve typical interregional log price differentials and not to represent actual costs of moving logs of various types to the national demand center. The table tradecost shown in Table E.1 includes costs (price differentials) for external trade flows. The table is identical, in the current implementation of FASOM, to the domestic transport cost table. Thus "foreign" prices will differ from regional prices by the amounts shown in the table.

Table E.2 Demand relations for trade flows

```
TABLE TRADFOR(TRADEREG,TRADE,PRODS,DECs,PARAMS) FOREST PRODUCT TRADE DEMAND-SUPPLY
* FORM: QUANTITY (MMCF) = INTERCEPT + SLOPE*PRICE($1990/CF)
* GROWING STOCK VOLUMES ADJUSTED FOR NON-GS AND LOG RES

$INCLUDE "tradedmd.dat"

Example lines from file:

                              INTERCEPT      SLOPE
    TNE   .EXPORT.SAWTSW.1990    32.329     -6.286
    TLS   .IMPORT.SAWTSW.1990     0.022      0.021
    TCB   .EXPORT.SAWTSW.1990
    TSE   .EXPORT.SAWTSW.1990     0.557     -0.045
    TSC   .EXPORT.SAWTSW.1990     1.152     -0.087
    TRM   .IMPORT.SAWTSW.1990     0.610      0.533
    TPSW  .EXPORT.SAWTSW.1990    16.633     -2.044
    TPNWW .EXPORT.SAWTSW.1990   955.878   -105.481
    TPNWE .EXPORT.SAWTSW.1990
    TNE   .EXPORT.SAWTHW.1990     4.427     -0.298
    TLS   .EXPORT.SAWTHW.1990     2.910     -0.195
    TCB   .EXPORT.SAWTHW.1990
```

.

Forest sector trade direction is prespecified in FASOM for each region and product: either imports or exports for a given region and product. In the TRADFOR file exports are driven by export demand equations (hence negative price slopes) and imports by import supply functions (hence positive price slopes). The functions vary over time following TAMM/NAPAP's base projections of log trade. Coefficients were derived by developing linear functions that pass through the TAMM/NAPAP base case price and quantity points using an assumed price elasticity (since log trade is not price sensitive in TAMM/NAPAP). The relations do not vary between FASOM runs. These relations could be shifted in any desired pattern to mimic alternative future log trade scenarios by shifting intercepts and slopes appropriately.

Table E.3 Public Timber Harvest

```
TABLE PUBSUP(POWNER,REG,DECS,PRODS)  PUBLIC TIMBER HARVEST
* PUBLIC TIMBER HARVEST IN GROWING STOCK EQUIVALENTS
* ADJUSTED FOR LOGGING RESIDUES

$INCLUDE "public.dat"

Example lines from file:

*** PUBSUP demand data from LR 187 ***
*** spreadsheet name is PUB187.wk1 ***

                          SAWTSW     PULPSW     FUELSW     SAWTHW     PULPHW     FUELHW
    USFS  .PNWW .1990   1211.490   198.0899     0.0000    97.8726    11.8943   141.1885
    USFS  .PNWE .1990   1931.884    46.2738   245.8999     0.2917     0.0000     0.0000
    USFS  .PSW  .1990   1740.652    36.7260   260.7817    10.6952     8.7811    75.2153
    USFS  .RM   .1990   3046.093   662.8002    62.8051    14.9154   129.2629    19.7728
    USFS  .LS   .1990    105.896   224.6978    12.3221   210.3700   284.9416    72.1931
    USFS  .CB   .1990     27.688    58.7503     3.2218    75.3424   102.0496    25.8554
    USFS  .NE   .1990     23.845    27.8088     1.0589    66.5672   121.0842    45.2754
    USFS  .SC   .1990    812.682   582.2248     1.8493    99.1312   175.1572    20.6304
```

Public harvest is measured in million cubic feet like all aggregate volumes in the forest sector. Harvests can be varied in any desired fashion by simply expanding or contracting the base case values in the public.dat file. In today's policy environment there are no obvious guidelines as to "sensible" or "realistic" values. Two alternative files corresponding to the "high" and "low" public cut scenarios are included in the basic FASOM data set.

Table E.4 Harvest and Hauling Costs Ignoring Residues

```
TABLE HARVCST(PRODS,REG) FOREST HARVEST COSTS
*HARVEST COST BY PRODUCT (1990 DOLLARS PER CUBIC FOOT)

             NE      LS      CB      SE      SC      RM     PSW    PNWW    PNWE
SAWTSW     0.63    0.46    0.46    0.41    0.43    0.65    0.61    0.69    0.52
SAWTHW     0.63    0.46    0.46    0.41    0.43    0.65    0.61    0.69    0.52
PULPSW     0.63    0.46    0.46    0.41    0.43    0.65    0.61    0.69    0.52
PULPHW     0.63    0.46    0.46    0.41    0.43    0.65    0.61    0.69    0.52
FUELSW        0       0       0       0       0       0       0       0       0
FUELHW        0       0       0       0       0       0       0       0       0
```

As defined in FASOM, "harvest costs" include both harvesting and hauling costs. They represent the regional costs of moving logs from the forest to the "average" regional processing point. If FASOM is run ignoring the treatment and disposition of residues generated in processing of SAWT, costs in the HARVCST table are used. These costs and residue revenues are related as follows:

let PL be the price of delivered logs ignoring any residue revenues per unit log volume,
RR residue revenues per unit log volume, and
hh harvest and hauling costs per log (total log volume).

Then unit profit to the sawtimber stumpage seller, when residue revenues are explicitly considered is PL + RR - hh. That is, the sawlog buyer will pay a price that includes the amount of anticipated residue revenues. If residues are ignored in the simulation, then unit profit to the stumpage seller is PL - hh, where hauling costs are lower because residue is left in the forest. Table HARVCST above contains these latter costs. Table RESCOST below contains the costs when residues are fully recognized in the analysis.

Table E.5 Harvest and Hauling Costs Including Residues

```
  TABLE RESCOST(PRODS,REG) FOREST HARVEST COSTS INCLUDING LOG RES
*HARVEST COST BY PRODUCT WITH LOG RES REMOVAL(1990 $ PER FT3)

          NE      LS      CB      SE      SC      RM     PSW    PNWW    PNWE
SAWTSW   0.76    0.55    0.55    0.49    0.52    0.78    0.73    0.83    0.62
SAWTHW   0.79    0.55    0.55    0.51    0.54    0.78    0.79    0.83    0.52
PULPSW   0.76    0.55    0.55    0.49    0.52    0.78    0.73    0.83    0.62
PULPHW   0.79    0.55    0.55    0.51    0.54    0.78    0.79    0.83    0.52
FUELSW      0       0       0       0       0       0       0       0       0
FUELHW      0       0       0       0       0       0       0       0       0
```

These costs are similar to those in the HARVCST table but include the costs of moving the total log volume, including residues and by-products, from forest to mill.

Table E.6 Transport Costs for Domestic Products

```
TABLE TRANSCOST(REG,PRODS) DOMESTIC WOOD MOVEMENT COSTS TO NATIONAL MARKET
*  TRANSPORT COST FOR WOOD MOVEMENTS (1990 DOLLARS PER CUBIC FOOT)
*  COMBINED INTRA AND INTERREGIONAL HAUL COSTS

$INCLUDE "inter.dat"

All of file inter.dat:

*** transportation costs for national demand

* Base run
* from NEWTRAN.WK1 (from NPULP187.WK1 and NSAWT187.WK1)

               SAWTSW   PULPSW   SAWTHW   PULPHW   FUELSW   FUELHW
    PNWW        0.001    0.335    0.307    0.001    0.001    0.001
    PNWE        0.664    0.359    0.307    0.001    0.001    0.001
    PSW         0.482    0.319    0.307    0.001    0.001    0.001
```

RM	0.993	0.311	0.307	0.001	0.001	0.001
LS	1.520	0.246	0.120	0.001	0.001	0.001
CB	1.520	0.246	0.120	0.001	0.001	0.001
NE	1.331	0.001	0.001	0.006	0.001	0.001
SC	0.930	0.688	0.454	0.187	0.001	0.001
SE	0.955	0.702	0.536	0.203	0.001	0.001

;

As noted in the case of table TRADECOST above, transport costs are used in the forest sector of FASOM to preserve historical log price differentials between regions. The values in the table were derived by computing the differences between the largest regional log price for a particular product and prices in all other regions for that product. Data were average prices over the late 1980s and early 1990s. In the case of SAWTSW, for example, the largest regional price was in the PNWW. Its transport cost was set to essentially zero (.001). Prices in the CB region were $1.52/cf lower and so have a transport cost of 1.52 in the inter.dat table. Note that the prices in question here are "mill delivered" prices. In any region these are the prices of stumpage plus intra-regional harvest and hauling costs.

Table E.7 Projected Inflation in Harvest and Transport Costs

TABLE HCOSTINF(DECS,REG) ASSUMED HARVEST COST INFLATION RATE

	NE	LS	CB	SE	SC	RM	PSW	PNWW	PNWE
1990	1.0051	1.0051	1.0051	1.0051	1.0051	1.0128	1.0417	1.0400	1.0495
2000	1.0102	1.0102	1.0102	1.0102	1.0102	1.0409	1.1301	1.1210	1.1443
2010	1.0179	1.0179	1.0179	1.0179	1.0179	1.0827	1.2180	1.2012	1.2360
2020	1.0332	1.0332	1.0332	1.0332	1.0332	1.1363	1.2646	1.2379	1.2937
2030	1.0408	1.0408	1.0408	1.0408	1.0408	1.1899	1.3458	1.3116	1.3789
2040	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2050	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2060	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2070	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2080	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

table TCOSTINF(DECS,REG) ASSUMED TRANPORTCOST INFLATION RATE

	NE	LS	CB	SE	SC	RM	PSW	PNWW	PNWE
1990	1.0051	1.0051	1.0051	1.0051	1.0051	1.0128	1.0417	1.0400	1.0495
2000	1.0102	1.0102	1.0102	1.0102	1.0102	1.0409	1.1301	1.1210	1.1443
2010	1.0179	1.0179	1.0179	1.0179	1.0179	1.0827	1.2180	1.2012	1.2360
2020	1.0332	1.0332	1.0332	1.0332	1.0332	1.1363	1.2646	1.2379	1.2937
2030	1.0408	1.0408	1.0408	1.0408	1.0408	1.1899	1.3458	1.3116	1.3789
2040	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2050	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2060	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2070	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2080	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Levels of interregional transport costs (domestic and trade) and intraregional harvest and hauling costs can be adjusted in a systematic fashion over time by means of the inflation multiplier factors in the HCOSTINF and TCOSTINF tables. These represent (one plus) decadal percentage changes in their respective costs. In the case of interregional transport costs, these factors adjust the interregional log price differentials.

Table E.8 Domestic Forest Products Demand Equations

```
TABLE FPDEM(PRODS,DECS,PARAMS) FOREST PRODUCT DEMAND
* FORM: QUANTITY (MMCF) = INTERCEPT + SLOPE*PRICE($1990/CF)
* GROWING STOCK VOLUMES ADJUSTED FOR NON-GS AND LOG RES

$INCLUDE "fpdmd.dat"

Full fpdmd.dat file:

*** BASE SCENARIO ***

*national SAWT demand data from NSAWT187.WK1
*national PULP demand data from NPULP187.WK1
*national fuelwood from original fpdmd table

                          INTERCEPT       SLOPE    MAXQ       MINQ      FIXP
    SAWTSW   .1990        96004.088  -11165.916
    SAWTSW   .2000        97489.135  -11664.346
    SAWTSW   .2010       102632.797  -11263.018
    SAWTSW   .2020        105972.54  -10661.295
    SAWTSW   .2030       108375.088  -10402.029
    SAWTSW   .2040       108375.088  -10402.029
    SAWTSW   .2050       108375.088  -10402.029
    SAWTSW   .2060       108375.088  -10402.029
    SAWTSW   .2070       108375.088  -10402.029
    SAWTSW   .2080       108375.088  -10402.029
    SAWTHW   .1990       27262.3613   -3370.469
    SAWTHW   .2000       29492.0414   -3500.538
    SAWTHW   .2010       31748.0961   -3567.738
    SAWTHW   .2020       33822.3923   -3598.586
    SAWTHW   .2030       36009.4357   -3608.356
    SAWTHW   .2040       36009.4357   -3608.356
    SAWTHW   .2050       36009.4357   -3608.356
    SAWTHW   .2060       36009.4357   -3608.356
    SAWTHW   .2070       36009.4357   -3608.356
    SAWTHW   .2080       36009.4357   -3608.356
    PULPSW   .1990        40930.708   -7765.501
    PULPSW   .2000        43136.160   -8357.377
    PULPSW   .2010        46135.443   -8364.931
    PULPSW   .2020        55363.031   -8487.485
    PULPSW   .2030        65790.861   -8723.459
    PULPSW   .2040        65790.861   -8723.459
    PULPSW   .2050        65790.861   -8723.459
    PULPSW   .2060        65790.861   -8723.459
    PULPSW   .2070        65790.861   -8723.459
    PULPSW   .2080        65790.861   -8723.459
    PULPHW   .1990        32133.314   -5980.751
    PULPHW   .2000        44149.674  -10451.773
    PULPHW   .2010        49737.662  -13049.930
    PULPHW   .2020        49160.637   -8837.830
    PULPHW   .2030        47840.502   -8202.341
    PULPHW   .2040        47840.502   -8202.341
    PULPHW   .2050        47840.502   -8202.341
    PULPHW   .2060        47840.502   -8202.341
    PULPHW   .2070        47840.502   -8202.341
    PULPHW   .2080        47840.502   -8202.341

            FUELSW .1990                                      1118.531      0.01
            FUELHW .1990                                      7110.229      0.01
```

```
            FUELSW .2000                                   1428.144      0.01
            FUELHW .2000                                   7635.221      0.01
            FUELSW .2010                                   1480.570      0.01
            FUELHW .2010                                   7891.985      0.01
            FUELSW .2020                                   1427.462      0.01
            FUELHW .2020                                   8228.207      0.01
            FUELSW .2030                                   1477.184      0.01
            FUELHW .2030                                   8905.774      0.01
            FUELSW .2040                                   1477.184      0.01
            FUELHW .2040                                   8905.774      0.01
            FUELSW .2050                                   1477.184      0.01
            FUELHW .2050                                   8905.774      0.01
            FUELSW .2060                                   1477.184      0.01
            FUELHW .2060                                   8905.774      0.01
            FUELSW .2070                                   1477.184      0.01
            FUELHW .2070                                   8905.774      0.01
            FUELSW .2080                                   1477.184      0.01
            FUELHW .2080                                   8905.774      0.01
;
```

SAWT and PULP demand in FASOM are price sensitive; FUEL demand is not. Demand relations for SAWT and PULP represent aggregate national demands for these products. Volumes are in millions of cubic feet, prices in $1990/cf. The SAWT relations were derived from TAMM by cumulating the regional derived log demand functions from sawtimber-using industries (lumber, plywood and miscellaneous products excluding log exports). Regional prices were adjusted to the "national average" price used in FASOM and all volumes were converted to roundwood equivalents adjusted for non-growing stock and other removals. PULP demand relations were derived by aggregating pulpwood consumption quantities from NAPAP projections for each decade. Linearized demand curves were developed from (1) these volumes, (2) an average national pulpwood price (also derived from NAPAP), and (3) assumptions regarding demand elasticities. Demand curves shift in the current FASOM input only for the decades 1990 through 2030 and are held constant thereafter.

Sets of demand relations were developed from TAMM/NAPAP runs for scenarios involving alternative base macroeconomic forecasts (the "CEA" run), increased recycling (the "recyc" run) and other specific cases. Use of these alternative demand schemes, while readily feasible in the FASOM structure, raises some significant new analytical complexities. Direct comparison of welfare levels and changes between scenarios is difficult because the evolution of both demand and supply will differ. For example, in the case of a hypothetical change in public harvest, alternative demand relations might be derived from TAMM/NAPAP and used but the various welfare changes observed between this and the base case will involve both shifts in supply and shifts in demand induced by the modified time paths of prices. Interpretation of some change in consumer surplus in this context is not clear, since FASOM deals with only a subset of the markets for goods and services impacting consumers. This is a generic problem in the welfare analysis of dynamic systems (not just a problem with FASOM), and merits close attention in applications of the FASOM structure. In this light, it may be prudent (and it is certainly simpler) to employ a fixed demand file with any given set of scenarios.

Developing alternative sets of demand equations in this fashion requires full access to the TAMM/NAPAP system and the reduction procedures (spreadsheets) used to convert the TAMM/NAPAP output to FASOM compatible input. Useful alternative scenarios of variation in future demand conditions can also be developed, however, by simply shifting the base demand relations in some fashion consistent with the scenarios of interest. Appropriate shifts can be estimated using the base price and quantity results as starting points, then raising or lower intercepts and slopes to fit the qualitative characteristics of a specific scenario.

Table E.9 Log Demand Capacity

```
 TABLE CAPACITY(PRODS,CAPARG)  CAPACITY FOR PROCESSING

$INCLUDE "cap.prn"

Full cap.dat file:

                      NOWINPLACE  EXISTDEPRC  COSTNEW   NEWDEPREC
* NATIONAL CAPACITY TABLE  (note revised pulp capacities)
             SAWTSW      107561       0         2.203        0
             SAWTHW       55570       0         2.365        0
*            PULPSW       30164       0         6.892        0
             PULPSW       60000       0         6.892        0
*            PULPHW       22520       0         7.158        0
             PULPHW       45000       0         6.892        0
             FUELSW      999999       0             0        0
;
```

Values in the table labelled NOWINPLACE are estimates of 1990 decade processing capacities for the products indicated. There is no bound on fuelwood demand. COSTNEW are costs per cubic foot of adding an additional cubic foot of processing capacity. The present base case does not utilize the depreciation options. We have yet to observe a solution in which the capacity limits were binding constraints.

Appendix F Notes on the Transient Climate Change Study

This Appendix describes the use of a separate alternative runs file for a specialized climate change analysis.

F.1 Runs Allowed

Three climate scenarios can be run (GISS, GFD3 and UKMO) coupled with three different assumptions about climate change phase-in. The data for the agricultural part of these climate scenarios is relatively complete. Only the UKMO scenario requires work. The forestry and phase-in data are place holders only. Let us now review the structure of the alternative runs file for a specialized climate change analysis, which is provided in Table F.1.

F.2 Agricultural

F.2.1 Export Market

Lines 35-45 specify the data from the IIASA climate change scenario results telling the expected percentage increase in price and decrease in the level of U.S. exports by scenario. In turn, I took the observed price changes in a climate change ASM analysis and entered those in lines 47-56. This price change is the percentage price increase expected due to climate change. I then took the IIASA expected price and adjusted it for the price that was predicted in the ASM climate change scenario and then computed the percentage price adjustment in the demand curve. This eliminates the movement in the demand curve due to US climate change, and shifts the curve only for foreign climate change (the US change will be endogenous in FASOM and I do not wish to double count). Then I computed the percentage quantity adjustment in the export demand curve. This is implemented in lines 75-83, which compute the net effect of the climate change. The results of this calculation will be used to adjust the parameters of export demand.

F.2.2 Crop Yield and Water Use Changes

The crop yield and water use climate sensitivity data are entered in lines 84-473. These give the effects by crop, irrigation status, and region in terms of the GISS, GFDL, and UKMO scenarios. The UKMO data is incomplete for all cases except corn, soybeans and wheat. The data all give the proportional increase. Thus an entry of 148 means a 148% increase or a yield of 2.48 times the base yield. Similarly a -60 means the yield will be 60% less, or 40% of the base yield.

F.2.3 Animal Climate Change Effects

The animal climate change effects are summarized in lines 476-635. In this table there are pasture effects (which are not used), a cost effect and a yield effect for the GISS and GFDL models. The cost effect gives the dollar increase in cost in regions which use wheat grazing. The yield effect gives the percentage change in livestock outputs. In this table an entry of -2.25 means that one produces 2.25% less beef under this climate scenario. The cost data are specified for the UKMO scenario; the yield data are not.

F.2.4 Water Effects

The estimated effects of climate change on water supply data are specified in lines 636-650. This gives the percentage change in fixed water availability by region.

F.2.5 Forest Yield Effects

The place holders for forest yield growth effects by scenario, region and species are given in lines 653-668. This gives the percentage change in yields. No real numbers are present in this table as these are due to be supplied by Hagler Bailly Consulting, Inc.

Climate Based Land Transfers

A trial table of the climate based land transfers appears in lines 670-672. These data give the net number of acres added because of the climate scenario by region, class of land, owner, site class of land, decade and species. Only one row is entered here because I have no real idea of what data will ultimately be entered here.

The next entry gives the test set of climate phase-in assumptions, in lines 674-686. The entries are the proportion of the full climate change effect which is realized in a decade. Here three place holder scenarios are present, one of which is no effect, another is half in each decade and the third is full and immediate climate change.

Selecting the Runs

The current code specifies seven runs. The assumptions used under these runs are identified in the RUNVAL table in lines 687-694. These include a base run with no climate change effect (base); and then runs that have each of the two climate phase-in assumptions coupled with each of the three climate scenarios. Notice run one is a NOW assumption with the GISS scenario, while run two adopts the HALF assumption and GISS. The next part of the file (lines 697-752) replicates the original climate change which is described in Chapter 7. The solve loop appears in line 838 through the end. Here then we restore the new data we're going to change in lines 844-851 and we change the crop yield where the crop yield is changed according to the scenario we are running, by multiplying times 1+percentage change/100 (lines 852-858). We also change crop inputs and crop profits according to a technological finding by Evenson where the rate of change in inputs and profits is assumed to be 50% of the rate of change in yield (859-872). Thus if there is a 10% change in yield all the input costs go up 5% and the profit term which holds marketing costs and other sorts of costs also goes up by half the rate of change in yield. Water use is adjusted in lines 873-879, and there is an option to print out the adjusted data. Lines 881-888 make adjustments in animal livestock yields, while 889-894 adjust the cost of producing animals as a function of the specified yield change. Lines 895-901 adjust the pasture use where pasture use is increased at the inverse end of the rate of change in hay yields. Thus if hay yields go up by 10% then the pasture yields will be divided by 110 or reduced. The next section (lines 903-915) reduces the AUM supply. The AUM supply in terms of both the private quantity and public maximum is changed according to the hay yields. Then in lines 917-930 we change the fixed and pumped quantities of water. Finally in lines 931-952 we adjust export levels adjusting the prices in the yields using the information computed from the IIASA study.

The next section of the model adjusts the forest data (lines 954-1004). This uses the same methodology as described in Chapter 7. However, only the yield changes are retained here, not the lag or cost changes. Subsequently the rest of the model is exactly as described in the base FAALTRUN above.

Table F.1 Alternative Runs File for a Specialized Climate Change Analysis

\

```
$offsymlist offsymxref
$ontext
fasom alternative runs component for making base run without solve

$offtext
version("altrunfile","climatever","jan11996")=1;

lim=51 ;
*activating the following suppresses farm program iterations
*lim=1 ;

option lp=cplex;
option solprint=on ;
option solprint=off;
option solveopt=replace;
option limrow=0
option limcol=0;
OPTION RESLIM=2500000;
option iterlim=1000000;

*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

*define scenarios

*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

set runs       the run to be done
 /base        base model
  r1*r6    climate change run/

set run(runs) subset of runs to be done /base,r1/;
*   run(runs)=yes;

*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
*define data for the scenarios
*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

set assume  scenario assumptions which will change /giss,gfd3,ukmo,
      base,                        none , half, now/
set items  climate change effects   / PASTURE,COST,YIELD,WATERUSE  /
    climscen(assume) scen climate scenarios  /base,giss,gfd3,ukmo/
    pqs /ex,pr/
    cropset /avg,Wheat, Rice, CoarseGr, ProteinF/;
table iiasa(cropset,pqs,climscen) export market conditions from IIASA

                         GISS           GFD3          UKMO
*prices
          Wheat.pr        3.22            17.34       100.83
          Rice.pr        35.22            26.73       116.19
          CoarseGr.pr    16.81            31.76       101.14
          ProteinF.pr     2.87            12.75       119.06
*export quantities at adaptation level 1
```

```
            Wheat.ex      -3.93            -0.48           5.25
            Rice .ex      10.62            -1.12         -18.43
            CoarseGr.ex   21.23             0.09         -15.41
            ProteinF.ex    9.21            -17.95        -31.89;
table pchang(alli,climscen)  asm price changes

                  BASE    GISS     GFD3     UKMO
 Wheat            3.34     2.94     3.44     4.36
 Sorghum          2.42     2.97     3.05     3.80
 Rice            10.13    12.19    12.48    40.25
 Corn             2.57     2.47     2.83     4.02
 Soybeans         5.46     4.10     4.74     7.37
 Soybeanoil     193.93   141.98   166.41   343.13
 Soybeanmea       7.89     6.20     6.99     8.49
;
 set corresp(cropset,alli)
           / coarsegr.(corn,sorghum,barley,oats),
             rice    . rice,
             proteinf.(soybeanmea, soybeanoil, soybeans),
             wheat   . wheat,
             avg     .(cotton,silage,hay,SUGARCANE,SUGARBEET,POTATOES)/;

  iiasa(cropset,"pr",climscen)$iiasa(cropset,"ex",climscen) =
      sum(corresp(cropset,alli)$pchang(alli,"base"),pchang(alli,climscen)/
                                 pchang(alli,"base")*100-100)/
      sum(corresp(cropset,alli),1$pchang(alli,climscen));

     iiasa("avg",pqs,climscen) = sum(cropset,
                                    iiasa(cropset,pqs,climscen))/4.;
iiasa(cropset,pqs,climscen)=1.00+iiasa(cropset,pqs,climscen)/100;
display iiasa;

table      rclcrpchn(alli,wtech,reg,climscen,items) crop changes due to
climate

                              GISS.yield GFD3.yield UKMO.yield  GISS.wateruse
GFD3.wateruse   UKMO.wateruse

COTTON    .DRYLAND.CB       102.181      85.249
COTTON    .DRYLAND.SE         7.414       0.578
COTTON    .DRYLAND.PSW        2.087       9.872
COTTON    .DRYLAND.RM        -1.042      34.484
COTTON    .DRYLAND.SW        -0.618      57.728
COTTON    .DRYLAND.SC         3.553      -9.375
COTTON    .IRRIG  .NE                                              -25.852
-33.347
COTTON    .IRRIG  .CB       102.181      85.249                    -25.852
-33.347
COTTON    .IRRIG  .SE         0.363     -25.538                    -25.279
-33.021
COTTON    .IRRIG  .LS                                              -25.852
-33.347
COTTON    .IRRIG  .PNWE                                            -25.852
-33.347
```

```
COTTON    .IRRIG  .PSW       -5.792     -11.095                   -21.701
-23.533
COTTON    .IRRIG  .RM       -13.275     -10.010                   -27.616
-34.818
COTTON    .IRRIG  .GP                                             -25.852
-33.347
COTTON    .IRRIG  .SW       -10.319      14.286                   -25.985
-34.821
COTTON    .IRRIG  .SC        -0.182     -37.534                   -25.279
-33.021
CORN      .DRYLAND.NE         7.367     -53.950      -7.258
CORN      .DRYLAND.CB         0.133     -74.008     -21.475
CORN      .DRYLAND.SE        17.050     -36.267     -14.533
CORN      .DRYLAND.LS        -4.600    -100.000     -23.833
CORN      .DRYLAND.PNWE     118.810      76.513     140.200
CORN      .DRYLAND.PSW      -26.490     -72.487     364.450
CORN      .DRYLAND.RM        52.364      14.552      59.412
CORN      .DRYLAND.GP        65.855      28.809     -23.075
CORN      .DRYLAND.SW         6.452     -23.759     -11.450
CORN      .DRYLAND.SC        28.917     -25.367     -17.450
CORN      .IRRIG  .NE        15.359      -5.063     -13.742     -14.112
-7.931      -0.183
CORN      .IRRIG  .CB         5.469     -24.967     -26.175     -13.317
-7.465      -0.056
CORN      .IRRIG  .SE        24.945      16.125     -15.367     -12.876
-9.492       0.251
CORN      .IRRIG  .LS         6.400      -7.600     -24.500     -27.400
-1.100       0.041
CORN      .IRRIG  .PNWE     128.400     125.400      16.350     -27.300
-19.150       0.086
CORN      .IRRIG  .PSW      -16.900     -23.600     -14.350       2.800
-3.100       0.152
CORN      .IRRIG  .RM        38.186      23.500     -26.775     -17.976
-9.291       0.256
CORN      .IRRIG  .GP        60.525      52.475     -25.975     -21.400
-5.425       0.241
CORN      .IRRIG  .SW         8.908       6.444     -34.912      -4.668
-8.315       0.055
CORN      .IRRIG  .SC        36.909      15.373     -32.467     -14.112
-7.931       0.049
SOYBEANS  .DRYLAND.NE        40.440     -61.660     -23.717
SOYBEANS  .DRYLAND.CB        52.192     -59.958     -38.108
SOYBEANS  .DRYLAND.SE       -17.983     -59.650     -36.383
SOYBEANS  .DRYLAND.LS       114.000     -50.600     -25.033
SOYBEANS  .DRYLAND.PNWE                             -28.500
SOYBEANS  .DRYLAND.PSW                              -77.900
SOYBEANS  .DRYLAND.RM                               -29.562
SOYBEANS  .DRYLAND.GP        55.004      53.775      -9.500
SOYBEANS  .DRYLAND.SW       -26.014     -25.173     -67.337
SOYBEANS  .DRYLAND.SC       -12.950     -47.500     -62.683
SOYBEANS  .IRRIG  .NE        56.225      19.677      14.433      35.283
45.425       0.973
SOYBEANS  .IRRIG  .CB        61.182      13.222      -5.792      37.503
48.037       1.051
```

SOYBEANS	.IRRIG	.SE	5.704	21.687	-1.600	35.283	45.425	1.831
SOYBEANS	.IRRIG	.LS	114.000	47.500	13.167	-2.500	39.300	0.947
SOYBEANS	.IRRIG	.PNWE			17.350	35.283	45.425	0.292
SOYBEANS	.IRRIG	.PSW			-39.400	35.283	45.425	0.565
SOYBEANS	.IRRIG	.RM			1.800	35.283	45.425	0.360
SOYBEANS	.IRRIG	.GP	58.950	53.775	20.925	12.625	44.800	0.551
SOYBEANS	.IRRIG	.SW	-17.324	37.452	-34.125	57.452	44.116	0.889
SOYBEANS	.IRRIG	.SC	10.737	33.837	-25.733	35.283	45.425	1.220
WHEAT	.DRYLAND	.NE	12.533	-2.850	2.725			
WHEAT	.DRYLAND	.CB	3.533	9.633	-3.225			
WHEAT	.DRYLAND	.SE	-47.950	-54.467	-37.150			
WHEAT	.DRYLAND	.LS	22.400	39.500	-4.267			
WHEAT	.DRYLAND	.PNWE	103.450	75.800	59.150			
WHEAT	.DRYLAND	.PSW	-65.218	-60.021	-39.450			
WHEAT	.DRYLAND	.RM	15.204	40.179	0.900			
WHEAT	.DRYLAND	.GP	44.100	53.725	-7.825			
WHEAT	.DRYLAND	.SW	-87.237	-74.287	-63.087			
WHEAT	.DRYLAND	.SC	-60.317	-72.633	-47.983			
WHEAT	.IRRIG	.NE	16.101	9.421	-0.400	85.483	51.594	-0.090
WHEAT	.IRRIG	.CB	9.262	23.507	-1.158	85.483	51.594	0.006
WHEAT	.IRRIG	.SE	-27.310	-42.196	-35.717	85.483	51.594	0.073
WHEAT	.IRRIG	.LS	25.968	51.771	3.733	85.483	51.594	0.093
WHEAT	.IRRIG	.PNWE	91.800	81.935	21.450	-61.200	-58.750	0.001
WHEAT	.IRRIG	.PSW	-61.650	-47.750	-43.850	41.700	16.650	-0.230
WHEAT	.IRRIG	.RM	-1.312	13.562	-13.812	76.362	41.987	0.499
WHEAT	.IRRIG	.GP	46.709	53.725	10.775	51.287	26.946	0.269
WHEAT	.IRRIG	.SW	-81.212	-47.882	-51.387	159.319	109.848	1.091
WHEAT	.IRRIG	.SC	-56.749	-43.191	-44.633	85.483	51.594	1.184
SORGHUM	.DRYLAND	.NE	-5.993	-11.127				
SORGHUM	.DRYLAND	.CB	12.589	18.431				
SORGHUM	.DRYLAND	.SE	-6.535	-1.195				
SORGHUM	.DRYLAND	.PSW	2.558	24.715				
SORGHUM	.DRYLAND	.RM	9.231	54.816				
SORGHUM	.DRYLAND	.GP	6.352	7.440				
SORGHUM	.DRYLAND	.SW	5.113	66.367				
SORGHUM	.DRYLAND	.SC	-6.666	-4.717				

SORGHUM	.IRRIG	.NE	-10.546	-40.072	-21.157	-35.581
SORGHUM	.IRRIG	.CB	5.645	-8.664	-21.454	-34.063
SORGHUM	.IRRIG	.SE	-11.088	-30.140	-21.157	-35.581
SORGHUM	.IRRIG	.LS			-21.157	-35.581
SORGHUM	.IRRIG	.PNWE			-21.157	-35.581
SORGHUM	.IRRIG	.PSW	-1.995	-4.230	-5.998	-6.635
SORGHUM	.IRRIG	.RM	-12.736	-14.756	-22.513	-37.806
SORGHUM	.IRRIG	.GP	4.834	-2.208	-21.603	-33.304
SORGHUM	.IRRIG	.SW	-14.454	-1.541	-22.924	-44.007
SORGHUM	.IRRIG	.SC	-11.219	-33.662	-21.157	-35.581
SILAGE	.DRYLAND	.NE	4.133	-43.675		
SILAGE	.DRYLAND	.CB	0.133	-74.008		
SILAGE	.DRYLAND	.SE	17.050	-36.267		
SILAGE	.DRYLAND	.LS	-4.600	-100.000		
SILAGE	.DRYLAND	.PNWE	125.008	104.366		
SILAGE	.DRYLAND	.PSW	-32.083	-74.367		
SILAGE	.DRYLAND	.RM	55.810	27.390		
SILAGE	.DRYLAND	.GP	63.058	27.400		
SILAGE	.DRYLAND	.SW	19.700	4.383		
SILAGE	.DRYLAND	.SC	28.917	-25.367		
SILAGE	.IRRIG	.NE	19.316	7.092	-18.653	-8.332
SILAGE	.IRRIG	.CB	15.316	-23.241	-18.653	-8.332
SILAGE	.IRRIG	.SE	31.253	15.939	-18.653	-8.332
SILAGE	.IRRIG	.LS	6.400	-7.600	-27.400	-1.100
SILAGE	.IRRIG	.PNWE	128.400	125.400	-27.300	-19.150
SILAGE	.IRRIG	.PSW	-16.900	-23.600	2.800	-3.100
SILAGE	.IRRIG	.RM	38.186	23.500	-18.544	-9.341
SILAGE	.IRRIG	.GP	60.525	52.475	-21.400	-5.425
SILAGE	.IRRIG	.SW	30.469	44.772	-17.309	-10.090
SILAGE	.IRRIG	.SC	44.100	25.400	-18.653	-8.332
HAY	.DRYLAND	.NE		-17.000		
HAY	.DRYLAND	.CB	-1.000	-13.000		
HAY	.DRYLAND	.SE	6.000	5.000		
HAY	.DRYLAND	.LS		-17.000		

HAY	.DRYLAND.PNWE	-7.000	14.000		
HAY	.DRYLAND.PSW	5.000	-5.000		
HAY	.DRYLAND.RM	3.000	13.000		
HAY	.DRYLAND.GP	1.000	13.000		
HAY	.DRYLAND.SW	-4.000	-41.000		
HAY	.DRYLAND.SC	51.000	8.000		
SUGARCANE	.DRYLAND.SE	-9.300	-14.400		
SUGARCANE	.DRYLAND.SW	6.350	-6.950		
SUGARCANE	.DRYLAND.SC	22.000	0.500		
SUGARCANE	.IRRIG .NE			15.100	-1.100
SUGARCANE	.IRRIG .CB			15.100	-1.100
SUGARCANE	.IRRIG .SE	-17.650	-43.150	15.100	-1.100
SUGARCANE	.IRRIG .LS			15.100	-1.100
SUGARCANE	.IRRIG .PNWE			15.100	-1.100
SUGARCANE	.IRRIG .PSW			15.100	-1.100
SUGARCANE	.IRRIG .RM			15.100	-1.100
SUGARCANE	.IRRIG .GP			15.100	-1.100
SUGARCANE	.IRRIG .SW	-2.000	-35.700	15.100	-1.100
SUGARCANE	.IRRIG .SC	13.650	-28.250	15.100	-1.100
POTATOES	.DRYLAND.NE	-27.302	-47.911		
POTATOES	.DRYLAND.SE	-20.632	-17.691		
POTATOES	.DRYLAND.PNWE	-5.282	4.209		
POTATOES	.DRYLAND.PSW	17.418	26.009		
POTATOES	.DRYLAND.RM	16.485	25.026		
POTATOES	.DRYLAND.SW	17.418	26.009		
POTATOES	.DRYLAND.SC	-15.082	-39.691		
POTATOES	.IRRIG .NE	-56.920	-86.520	19.687	62.228
POTATOES	.IRRIG .CB			16.150	36.977
POTATOES	.IRRIG .SE	-50.250	-56.300	17.667	40.202
POTATOES	.IRRIG .LS			16.150	36.977
POTATOES	.IRRIG .PNWE	-34.900	-34.400	26.800	32.500
POTATOES	.IRRIG .PSW	-12.200	-12.600	10.100	9.000
POTATOES	.IRRIG .RM	-13.133	-13.583	11.862	16.807
POTATOES	.IRRIG .GP			16.150	36.977
POTATOES	.IRRIG .SW	-12.200	-12.600	13.125	22.989

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POTATOES  .IRRIG  .SC        -44.700     -78.300                    15.775
39.614
TOMATOFRSH.DRYLAND.NE         21.244     -35.935
TOMATOFRSH.DRYLAND.CB         19.564     -40.935
TOMATOFRSH.DRYLAND.SE         36.691     -30.085
TOMATOFRSH.DRYLAND.LS         25.600     -37.200
TOMATOFRSH.DRYLAND.PSW        30.124     -35.735
TOMATOFRSH.DRYLAND.SW         15.324     -43.035
TOMATOFRSH.DRYLAND.SC         37.674     -37.160
TOMATOFRSH.IRRIG  .NE         28.120      30.800                    17.075
58.710
TOMATOFRSH.IRRIG  .CB         26.440      25.800                    21.891
67.243
TOMATOFRSH.IRRIG  .SE         43.567      36.650                    32.750
92.583
TOMATOFRSH.IRRIG  .LS         32.476      29.535                    20.270
60.252
TOMATOFRSH.IRRIG  .PNWE                                             20.270
60.252
TOMATOFRSH.IRRIG  .PSW        37.000      31.000                    48.600
94.200
TOMATOFRSH.IRRIG  .RM                                               20.270
60.252
TOMATOFRSH.IRRIG  .GP                                               20.270
60.252
TOMATOFRSH.IRRIG  .SW         22.200      23.700                     2.709
12.257
TOMATOFRSH.IRRIG  .SC         44.550      29.575                    24.907
69.701
TOMATOPROC.DRYLAND.NE         25.384     -34.487
TOMATOPROC.DRYLAND.CB         23.704     -39.487
TOMATOPROC.DRYLAND.SE         24.964     -39.487
TOMATOPROC.DRYLAND.LS         25.600     -37.200
TOMATOPROC.DRYLAND.PSW        34.264     -34.287
TOMATOPROC.DRYLAND.RM         19.464     -41.587
TOMATOPROC.IRRIG  .NE         28.120      30.800                    19.933
71.250
TOMATOPROC.IRRIG  .CB         26.440      25.800                    24.750
79.783
TOMATOPROC.IRRIG  .SE         27.700      25.800                    24.750
79.783
TOMATOPROC.IRRIG  .LS         28.336      28.087                    23.700
75.300
TOMATOPROC.IRRIG  .PNWE                                             23.700
75.300
TOMATOPROC.IRRIG  .PSW        37.000      31.000                    48.600
94.200
TOMATOPROC.IRRIG  .RM         22.200      23.700                    20.762
66.562
TOMATOPROC.IRRIG  .GP                                               23.700
75.300
TOMATOPROC.IRRIG  .SW                                               23.700
75.300
TOMATOPROC.IRRIG  .SC                                               23.700
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75.300
ORANGEFRSH.DRYLAND.SE       -31.340     -54.060
ORANGEFRSH.DRYLAND.PSW       60.160      59.790
ORANGEFRSH.DRYLAND.RM        -5.340      27.140
ORANGEFRSH.DRYLAND.SW       -83.640     -92.660
ORANGEFRSH.IRRIG  .NE                                               24.425
8.975
ORANGEFRSH.IRRIG  .CB                                               24.425
8.975
ORANGEFRSH.IRRIG  .SE        56.600      51.000                     24.425
8.975
ORANGEFRSH.IRRIG  .LS                                               24.425
8.975
ORANGEFRSH.IRRIG  .PNWE                                             24.425
8.975
ORANGEFRSH.IRRIG  .PSW      148.100     164.850                     28.900
6.900
ORANGEFRSH.IRRIG  .RM        82.600     132.200                     24.059
8.628
ORANGEFRSH.IRRIG  .GP                                               24.425
8.975
ORANGEFRSH.IRRIG  .SW         4.300      12.400                     23.672
9.841
ORANGEFRSH.IRRIG  .SC                                               24.425
8.975
ORANGEPROC.DRYLAND.SE       -31.340     -54.060
ORANGEPROC.DRYLAND.PSW       60.160      59.790
ORANGEPROC.DRYLAND.RM        -5.340      27.140
ORANGEPROC.DRYLAND.SW       -83.640     -92.660
ORANGEPROC.IRRIG  .NE                                               24.425
8.975
ORANGEPROC.IRRIG  .CB                                               24.425
8.975
ORANGEPROC.IRRIG  .SE        56.600      51.000                     24.425
8.975
ORANGEPROC.IRRIG  .LS                                               24.425
8.975
ORANGEPROC.IRRIG  .PNWE                                             24.425
8.975
ORANGEPROC.IRRIG  .PSW      148.100     164.850                     28.900
6.900
ORANGEPROC.IRRIG  .RM        82.600     132.200                     24.059
8.628
ORANGEPROC.IRRIG  .GP                                               24.425
8.975
ORANGEPROC.IRRIG  .SW         4.300      12.400                     23.672
9.841
ORANGEPROC.IRRIG  .SC                                               24.425
8.975
GRPFRTFRSH.DRYLAND.SE       -31.340     -54.060
GRPFRTFRSH.DRYLAND.PSW       60.160      59.790
GRPFRTFRSH.DRYLAND.RM        -5.340      27.140
GRPFRTFRSH.DRYLAND.SW       -83.640     -92.660
GRPFRTFRSH.IRRIG  .NE                                               24.425
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8.975
GRPFRTFRSH.IRRIG  .CB                                                24.425
8.975
GRPFRTFRSH.IRRIG  .SE        56.600      51.000                      24.425
8.975
GRPFRTFRSH.IRRIG  .LS                                                24.425
8.975
GRPFRTFRSH.IRRIG  .PNWE                                              24.425
8.975
GRPFRTFRSH.IRRIG  .PSW      148.100     164.850                      28.900
6.900
GRPFRTFRSH.IRRIG  .RM        82.600     132.200                      24.059
8.628
GRPFRTFRSH.IRRIG  .GP                                                24.425
8.975
GRPFRTFRSH.IRRIG  .SW         4.300      12.400                      23.672
9.841
GRPFRTFRSH.IRRIG  .SC                                                24.425
8.975
GRPFRTPROC.DRYLAND.SE       -31.340     -54.060
GRPFRTPROC.DRYLAND.PSW       60.160      59.790
GRPFRTPROC.DRYLAND.RM        -5.340      27.140
GRPFRTPROC.DRYLAND.SW       -83.640     -92.660
GRPFRTPROC.IRRIG  .NE                                                24.425
8.975
GRPFRTPROC.IRRIG  .CB                                                24.425
8.975
GRPFRTPROC.IRRIG  .SE        56.600      51.000                      24.425
8.975
GRPFRTPROC.IRRIG  .LS                                                24.425
8.975
GRPFRTPROC.IRRIG  .PNWE                                              24.425
8.975
GRPFRTPROC.IRRIG  .PSW      148.100     164.850                      28.900
6.900
GRPFRTPROC.IRRIG  .RM        82.600     132.200                      24.059
8.628
GRPFRTPROC.IRRIG  .GP                                                24.425
8.975
GRPFRTPROC.IRRIG  .SW         4.300      12.400                      23.672
9.841
GRPFRTPROC.IRRIG  .SC                                                24.425
8.975


table
  rclianCHN(ANIMAL,reg,items,climscen) animal changes due to climate

*                  PASTURE     PASTURE        COST        COST        COST
 YIELD       YIELD
*                     GISS        GFD3        GISS        GFD3        UKMO
  GISS        GFD3
                  PASTURE.giss PASTURE.gfd3 COST.giss   COST.gfd3  cost.ukmo
YIELD.giss  YIELD.gfd3
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BEEFCOWS .NE
-2.250      -2.250
BEEFCOWS .CB
-2.000      -2.000
BEEFCOWS .SE
-5.000      -5.000
BEEFCOWS .LS
-2.000      -2.000
BEEFCOWS .PNWE
-3.500      -3.500
BEEFCOWS .PSW
-3.500      -3.500
BEEFCOWS .RM
-3.500      -3.500
BEEFCOWS .GP
-2.000      -2.000
BEEFCOWS .SW
-5.000      -5.000
BEEFCOWS .SC
-5.000      -5.000
COWCALF  .NE          3.841        3.881
-2.250      -2.250
COWCALF  .CB          3.451        3.272
-2.000      -2.000
COWCALF  .SE          3.232        3.610
-5.000      -5.000
COWCALF  .LS          3.620        3.863
-2.000      -2.000
COWCALF  .PNWE       26.059       28.423
-3.500      -3.500
COWCALF  .PSW        26.059       28.423
-3.500      -3.500
COWCALF  .RM         25.584       26.797
-3.500      -3.500
COWCALF  .GP         12.029       10.849
-2.000      -2.000
COWCALF  .SW         19.613       25.096
-5.000      -5.000
COWCALF  .SC          4.779        6.142
-5.000      -5.000
DAIRY    .NE          0.328        0.332
-2.250      -2.250
DAIRY    .CB          0.215        0.204
-2.000      -2.000
DAIRY    .SE          0.400        0.440
-5.000      -5.000
DAIRY    .LS          0.198        0.211
-2.000      -2.000
DAIRY    .PNWE        0.278        0.303
-3.500      -3.500
DAIRY    .PSW         0.278        0.303
-3.500      -3.500
DAIRY    .RM          0.753        0.788
-3.500      -3.500
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DAIRY    .GP          0.569       0.513
-2.000      -2.000
DAIRY    .SW          2.574       3.543
-5.000      -5.000
DAIRY    .SC          0.760       0.977
-5.000      -5.000
SHEEP    .NE          0.131       0.132
SHEEP    .CB          0.097       0.092
SHEEP    .SE          0.120       0.134
SHEEP    .LS          0.155       0.165
SHEEP    .PNWE        0.118       0.129
SHEEP    .PSW         0.118       0.129
SHEEP    .RM          0.305       0.320
SHEEP    .GP          0.332       0.299
SHEEP    .SW          2.772       3.814
SHEEP    .SC          0.445       0.601
STOCKSCAV.NE
-3.333      -3.333
STOCKSCAV.CB
-3.500      -3.500
STOCKSCAV.SE
-1.500      -1.500
STOCKSCAV.LS
-3.500      -3.500
STOCKSCAV.PNWE
-3.500      -3.500
STOCKSCAV.PSW
-3.500      -3.500
STOCKSCAV.RM
-3.500      -3.500
STOCKSCAV.GP
-3.500      -3.500
STOCKSCAV.SW          0.866       1.170      61.992      86.175     676.809
-1.500      -1.500
STOCKSCAV.SC                                 88.888     124.220    1375.880
-1.500      -1.500
STOCKHCAV.NE
-3.333      -3.333
STOCKHCAV.CB
-3.500      -3.500
STOCKHCAV.SE
-1.500      -1.500
STOCKHCAV.LS
-3.500      -3.500
STOCKHCAV.PNWE
-3.500      -3.500
STOCKHCAV.PSW
-3.500      -3.500
STOCKHCAV.RM
-3.500      -3.500
STOCKHCAV.GP
-3.500      -3.500
STOCKHCAV.SW          0.866       1.170
-1.500      -1.500
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STOCKHCAV.SC
-1.500      -1.500
STOCKSYEA.NE
-3.333      -3.333
STOCKSYEA.CB
-3.500      -3.500
STOCKSYEA.SE
-1.500      -1.500
STOCKSYEA.LS
-3.500      -3.500
STOCKSYEA.PNWE
-3.500      -3.500
STOCKSYEA.PSW
-3.500      -3.500
STOCKSYEA.RM
-3.500      -3.500
STOCKSYEA.GP
-3.500      -3.500
STOCKSYEA.SW         0.785       1.060      62.091      86.888     671.313
-1.500      -1.500
STOCKSYEA.SC                                76.640     107.102    1186.300
-1.500      -1.500
STOCKHYEA.NE
-3.333      -3.333
STOCKHYEA.CB
-3.500      -3.500
STOCKHYEA.SE
-1.500      -1.500
STOCKHYEA.LS
-3.500      -3.500
STOCKHYEA.PNWE
-3.500      -3.500
STOCKHYEA.PSW
-3.500      -3.500
STOCKHYEA.RM
-3.500      -3.500
STOCKHYEA.GP
-3.500      -3.500
STOCKHYEA.SW         0.819       1.106
-1.500      -1.500
STOCKHYEA.SC
-1.500      -1.500

table      rclwatchn(reg,climscen)  water climate change

            GISS        GFD3        UKMO

NE       -35.167      -6.955      12.333
CB       -49.167      14.083      30.333
SE        -5.750      -6.250     -27.167
LS       -37.333     -30.500      13.500
PNWE      24.500       8.000      25.000
PNWW      24.500       8.000      25.000
PSW       40.500     -59.000     -29.000
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RM       -10.125       4.187      28.812
GP       -53.500     -18.250     -29.500
SW       -49.500     -44.875     -64.812
SC       -25.833       5.000     -23.667;

*note phase in only active on yield
table newclimdat(assume,spec,reg,items)  forest climate scenario data
             se.yield   sc.yield
giss.hardwood     0          0
gfd3.hardwood   -50        -50
ukmo.hardwood   -50        -50
giss.softwood     0          0
gfd3.softwood   -50        -50
ukmo.softwood   -50        -50
+               pnww.yield  pnwe.yield  ls.yield   rm.yield    ne.yield
giss.hardwood     0          0             0          0           0
gfd3.hardwood   -50        -50           -50        -50         -50
ukmo.hardwood   -25        -25           -25        -25         -25
giss.softwood     0          0             0          0           0
gfd3.softwood   -50        -50           -50        -50         -50
ukmo.softwood   -25        -25           -25        -25         -25
;

table cliLANDTR(REG,CLS,OWNER,SITE,DEC,SPEC,climscen) climate based landtrn
                                   giss  gfd3 ukmo
pnww.foronly.fi.lo.1990.softwood    0      0    0   ;

table climphasin(decs,assume)  climate phase assumptions
             none   half  now
1990          0      .5    1
2000          0      .5    1
2010          0      .5    1
2020          0      .5    1
2030          0      .5    1
2040          0      .5    1
2050          0      .5    1
2060          0      .5    1
2070          0      .5    1
2080          0      .5    1
2090          0      .5    1;
table runval(assume,runs)  climate phase in assumptions
             base r1 r2 r3 r4 r5 r6
none          1
half                  1     1
now                1     1
giss               1  1
ukmo                           1  1
gfd3                     1  1
 ;
$include /mac/mccarl/agfor/source/canada.alt

*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
*places to save data that will be changed in  scenarios
*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
```

```
parameter savPUBSUP(POWNER,REG,DECS,PRODS)  saved PUBLIC TIMBER HARVEST
          saveNEWYLD(WHEN,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS)
          savESTCOST(REG,CLS,MIC,SPECIES)
          storcanada(decs,prods) stored canadian supply data
          svEXISTYLD(WHEN,COHORT,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS);

savPUBSUP(POWNER,REG,DECS,PRODS) = PUBSUP(POWNER,REG,DECS,PRODS);
saveNEWYLD(WHEN,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS)$
          NEWYLD(WHEN,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS)=
          NEWYLD(WHEN,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS);
svEXISTYLD(WHEN,COHORT,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS)$
          EXISTYLD(WHEN,COHORT,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS)=
          EXISTYLD(WHEN,COHORT,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS);
savestcost(reg,cls,mic,species)=estcost(reg,cls,mic,species);
storcanada(decs,prods) = canada(decs,prods) ;


*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
*define report writing arrays and special Elements
*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

set climregs  aggregate regions for output /south,north,other/
    climmap(climregs,reg) map individual regions to aggregate regions
        /  south.(SE,SC),north.(PNWW,PNWE,LS,RM,ne),
           other.(CB,GP,SW,PSW)/;
*run specific material
parameter whichruns(runs) tells which run we are on
;
parameter
 newHWINNEW(dec,REG,OWNER,mic,hprods)  hardwood new tree volume inv start of
period
 newHardEXs(dec,REG,OWNER,mic,hprods)  hardwood exist tree volume inv start of
period
 newSWINNEW(dec,REG,OWNER,mic,sprods)  softwood new tree volume inv start of
period
 newSoftEXs(dec,REG,OWNER,mic,sprods)  softwood exist tree volume inv start of
period

*cross run comparative reports

parameter
regrun(decs,*,parties,runs)           regional surplus by decade
runprod(spec,dec,REG,PRODS,runs)      products by species and run
newtinv(spec,dec,runs,mic,reg)        inventory in volume start of pd
newinv(spec,dec,reg,runs)             inventory in acres start of pd
tinvcli(spec,dec,climregs,runs)       production by owner and big reg
tmiccli(spec,mic,climregs,dec,runs)   production by mgt and big region
productcli(dec,climregs,prods,runs)   all prod include canada and public
productprv(dec,climregs,prods,runs)   private production
harvestcli(dec,climregs,spec,runs)    harvested acres by species
harvowncli(dec,climregs,*,owner,runs) harvest by owner
;
$include /mac/mccarl/agfor/source/facomset.sav
```

```
*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
*setup for scenario computation
*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
set whencl(when) times of harvest which will be computed over
      /NOW,PLUS10,PLUS20,
       PLUS30,PLUS40,PLUS50,PLUS60
      ,PLUS70,PLUS80,PLUS90/
;

parameter
qcanada(dec,prods,runs)                 change in Canadian supply
runsexistl(when,cohort,reg,cls,owner,species,site,mic) base sol exist land
runsnewl(olddec,when,reg,cls,owner,species,site,mic,policy) base sol new land
softexist(reg,cls,owner,sw,site,cohort,mic,when) HARVEST of existing soft
ACRES
hardexist(reg,cls,owner,hw,site,cohort,mic,when) HARVEST of existing hard
ACRES
softnew(reg,cls,owner,sw,site,mic,when,decs)     reestablished softwood
hardnew(reg,cls,owner,hw,site,mic,when,decs)     reestablished hardwood
voltimber(mic,reg,owner,decs,prods)   Volume of timber produced base model
AREAtimber(mic,reg,owner,decs)     AREA of timber harvested base model
volbyarea(mic,reg,owner,dec,prods) timber yield per unit area base model
voltimbe3(mic,reg,owner,decs,prods) prod if planted via base acres under this
scenario yield
volbyare3(mic,reg,owner,dec,prods) yield pr acre if planted via base acres
under this scenario yield

set woodtype(prods,spec)  relate products to hard and softwood
   /(pulpsw,sawtsw,fuelsw,biomasssw,millressw,logressw).softwood
    (pulphw,sawthw,fuelhw,biomasshw,millreshw,logreshw).hardwood/;

*adjust demand to reflect presence of canada at base level
    FPDEMAND(PRODS,DEC,"INTERCEPT") =
         FPDEMAND(PRODS,DEC,"INTERCEPT") +
          supcanada(dec,prods) ;

*retain base model solution

*save acreage
SOFTEXIST(REG,CLS,OWNER,SW,SITE,COHORT,MIC,WHEN) =
   sum(policy,
     EXIST.L(when,cohort,REG,CLS,OWNER,SW,SITE,MIC,policy))*SCFOR;
HARDEXIST(REG,CLS,OWNER,HW,SITE,COHORT,MIC,WHEN) =
   sum(policy,
        EXIST.L(when,cohort,REG,CLS,OWNER,HW,SITE,MIC,policy))*SCFOR;
SOFTNEW(REGS,CLS,OWNER,SW,SITE,MIC,WHEN,DECS) =
  (  SUM(POLICY,NEW.L(decs,when,REGS,CLS,OWNER,SW,SITE,MIC,POLICY)*SCFOR));
HARDNEW(REGS,CLS,OWNER,HW,SITE,MIC,WHEN,DECS) =
   (SUM(POLICY,  NEW.L(decs,when,REGS,CLS,OWNER,HW,SITE,MIC,POLICY)*SCFOR));
runsexistl(when,cohort,regs,cls,owner,species,site,mic)=sum(policy,
  exist.l(when,cohort,regs,cls,owner,species,site,mic,policy));
*compute new acres summed accross policy
runsnewl(olddec,when,regs,cls,owner,species,site,mic,policy)=
  new.l(olddec,when,regs,cls,owner,species,site,mic,policy);
```

```
*compute  volume of timber during a decade
 voltimber(mic,regs,owner,dec,prods)=  SUM(WHEN$
    (TODAY+ELAPSED(WHEN) EQ DATE(DEC)),
    SUM((cohort,CLS,SPECIES,SITE),
       runsEXISTl(when,cohort,REGS,CLS,OWNER,SPECIES,SITE,mic)*SCFOR*
       EXISTYLD(when,cohort,REGS,CLS,OWNER,SPECIES,SITE,mic,prods))) +
     (SUM(OLDDEC$ (DATE(OLDDEC) LE DATE(DEC)),
        SUM(WHEN$ (DATE(OLDDEC)+ELAPSED(WHEN) EQ DATE(DEC)
                  AND WHENDONE(OLDDEC,WHEN) GT 0 ),
        SUM((CLS,SPECIES,SITE,POLICY),
          runsnewl(olddec,when,REGS,CLS,OWNER,SPECIES,SITE,mic,POLICY)
         *SCFOR*NEWYLD(when,REGS,CLS,OWNER,SPECIES,SITE,mic,prods)))));
*compute area of timber
AREAtimber(mic,regs,owner,dec)=
  SUM((SPECIES,cohort,cls,site),sum(when$(ord(when) eq ord(dec)),
     runsEXISTl(when,cohort,REGs,CLS,OWNER,SPECIES,SITE,MIC)*SCFOR))
 + SUM(OLDDEC$ (DATE(OLDDEC) LT DATE(DEC)),
     SUM(WHEN$ (DATE(OLDDEC)+ELAPSED(WHEN) EQ DATE(DEC)),
       SUM((CLS,SITE,policy,species),
          runsnewl(olddec,when,REGS,CLS,OWNER,Species,SITE,mic,policy)
          *scfor)));
*compute volume per unit area
volbyarea(mic,regs,owner,dec,prods) $AREAtimber(mic,regs,owner,dec) =
  voltimber(mic,regs,owner,dec,prods) /
  AREAtimber(mic,regs,owner,dec) ;

option lp=cplex;

*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
LOOP(run,
whichruns(runs)=0;
whichruns(run)=1;
display whichruns;
climphas(dec)=sum(assume, climphasin(dec,assume)*runval(assume,run));
display climphas;
*restore data to base levels
  NEWBUDDATA(ALLI,REG,CROP,WTECH,CTECH,TECH)=
      savBUDDATA(ALLI,REG,CROP,WTECH,CTECH,TECH) ;
  PEXPORT(PRIMARY,SDITEM)=  savPEXPORT(PRIMARY,SDITEM)  ;
  Sexport(SECONDARY,SDITEM)=savSexport(SECONDARY,SDITEM);
  NEWaumssup(REG,aumsitem)=savaumssup(REG,aumsitem);
  NEWWATSUP(REG,WATERITEM)=savWATSUP(REG,WATERITEM);
  NEWLIVEBUD(ALLI,REG,ANIMAL,LIVETECH)=savLIVEBUD(ALLI,REG,ANIMAL,LIVETECH);
*change crop yield
  NEWBUDDATA(crop,REG,CROP,WTECH,CTECH,TECH)
  =NEWBUDDATA(crop,REG,CROP,WTECH,CTECH,TECH)
   *(1+
       sum(climscen,runval(climscen,run)*
          rclcrpchn(crop,wtech,reg,climscen,"yield"))
     /100);
*change crop inputs to reflect yield change
  NEWBUDDATA(input,REG,CROP,WTECH,CTECH,TECH)
  =NEWBUDDATA(input,REG,CROP,WTECH,CTECH,TECH)
   *(1+
```

```
       0.5*sum(climscen,runval(climscen,run)*
          rclcrpchn(crop,wtech,reg,climscen,"yield"))
     /100);
*change crop inputs to reflect yield change
  NEWBUDDATA("profit",REG,CROP,WTECH,CTECH,TECH)
  =NEWBUDDATA("profit",REG,CROP,WTECH,CTECH,TECH)
   *(1+
       0.5*sum(climscen,runval(climscen,run)*
          rclcrpchn(crop,wtech,reg,climscen,"yield"))
     /100);
*change water use
  NEWBUDDATA("water",REG,CROP,WTECH,CTECH,TECH)
  =NEWBUDDATA("water",REG,CROP,WTECH,CTECH,TECH)
   *(1+
       sum(climscen,runval(climscen,run)*
          rclcrpchn(crop,wtech,reg,climscen,"wateruse"))
     /100);
option newbuddata:2:1:5;display newbuddata;
*change livestock yield
  NEWLIVEBUD(primary,REG,ANIMAL,LIVETECH)
  $(NEWLIVEBUD(primary,REG,ANIMAL,LIVETECH) lt 0)
  =NEWLIVEBUD(primary,REG,ANIMAL,LIVETECH)
   *(1+
       sum(climscen,runval(climscen,run)*
         rclianCHN(ANIMAL,reg,"yield",climscen)
     /100));
*change livestock cost
  NEWLIVEBUD("profit",REG,ANIMAL,LIVETECH)
  $NEWLIVEBUD("profit",REG,ANIMAL,LIVETECH)
  =NEWLIVEBUD("profit",REG,ANIMAL,LIVETECH)
   + sum(climscen,runval(climscen,run)*
         rclianCHN(ANIMAL,reg,"cost",climscen) );
*change livestock pasture use
  NEWLIVEBUD("pasture",REG,ANIMAL,LIVETECH)
  =NEWLIVEBUD("pasture",REG,ANIMAL,LIVETECH)
   /(1+
       sum(climscen,runval(climscen,run)*
          rclcrpchn("hay","dryland",reg,climscen,"yield"))
     /100);
option newlivebud:3:1:3;display newlivebud;
*change aum supply
  NEWaumssup(REG,"privateq")
  =NEWaumssup(REG,"privateq")
   *(1+
       sum(climscen,runval(climscen,run)*
          rclcrpchn("hay","dryland",reg,climscen,"yield"))
     /100);
  NEWaumssup(REG,"publicmax")
  =NEWaumssup(REG,"publicmax")
   *(1+
       sum(climscen,runval(climscen,run)*
          rclcrpchn("hay","dryland",reg,climscen,"yield"))
     /100);
display newaumssup;
```

```
*change water supply
  NEWWATSUP(REG,"fixedmax")=
  NEWWATSUP(REG,"fixedmax")
   *(1+
       sum(climscen,runval(climscen,run)*
    rclwatchn(reg,climscen) )
     /100);
  NEWWATSUP(REG,"pumpq")=
  NEWWATSUP(REG,"pumpq")
   *(1+
       sum(climscen,runval(climscen,run)*
    rclwatchn(reg,climscen) )
     /100);
display newwatsup;
*change exports
PEXPORT(PRIMARY, "QUANTITY") $sum(corresp(cropset,primary),1
     $sum(climscen,runval(climscen,run)*IIASA(cropset,"ex",climscen)))
                             =sum(corresp(cropset,primary),
     PEXPORT(PRIMARY, "QUANTITY")
     *sum(climscen,runval(climscen,run)*IIASA(cropset,"ex",climscen)));
PEXPORT(PRIMARY, "price"   ) $sum(corresp(cropset,primary),1
     $sum(climscen,runval(climscen,run)*IIASA(cropset,"ex",climscen)))
                             =sum(corresp(cropset,primary),
     PEXPORT(PRIMARY, "price"   )
     *sum(climscen,runval(climscen,run)*IIASA(cropset,"pr",climscen)));
sEXPORT(secondARY, "QUANTITY") $sum(corresp(cropset,secondary),1
     $sum(climscen,runval(climscen,run)*IIASA(cropset,"ex",climscen)))
                             =sum(corresp(cropset,secondary),
     sEXPORT(secondARY, "QUANTITY")
     *sum(climscen,runval(climscen,run)*IIASA(cropset,"ex",climscen)));
sEXPORT(secondARY, "price"   ) $sum(corresp(cropset,secondary),1
     $sum(climscen,runval(climscen,run)*IIASA(cropset,"ex",climscen)))
                             =sum(corresp(cropset,secondary),
     sEXPORT(secondARY, "price"   )
     *sum(climscen,runval(climscen,run)*IIASA(cropset,"pr",climscen)));
display pexport,sexport;
* reestablish data at original levels
   nEWYLD(WHEN,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS)=
       savenEWYLD(WHEN,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS);
   EXISTYLD(WHEN,COHORT,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS)=
       svEXISTYLD(WHEN,COHORT,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS);
   PUBSUP(POWNER,REG,DECS,PRODS) = savPUBSUP(POWNER,REG,DECS,PRODS);
   cliLANDTRN(REG,CLS,OWNER,SITE,DEC,SPEC) =
       sum(climscen,runval(climscen,run)*
     cliLANDTR(REG,CLS,OWNER,SITE,DEC,SPEC,climscen)) ;

* figure in yield percentage changes
*  new plantings
if(sum((spec,reg,climscen),
      runval(climscen,run)*newclimdat(climscen,spec,reg,"yield")) gt 0,
loop(whencl,
   newYLD(whencl+1,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS)$(
      saveNEWYLD(whencl,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS) gt 0
      and ord(whencl) lt card(whencl) and
```

```
      sum(woodtype(prods,spec),
    sum(climscen,
      runval(climscen,run)*newclimdat(climscen,spec,reg,"yield"))
    ))=
      newYLD(whencl,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS) *
     (1+ (((saveNEWYLD(whencl+1,REG,CLS,OWNER,SPECIES,SITE,MIC,prods) -
             saveNEWYLD(whencl,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS))
           / saveNEWYLD(whencl,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS))*
            (1+sum(woodtype(prods,spec),
    sum(climscen,
      runval(climscen,run)*newclimdat(climscen,spec,reg,"yield"))
      )/100)));
*adjust yields for existing trees
  EXISTYLD(whencl+1,COHORT,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS)$(
    svEXISTYLD(whencl,COHORT,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS) gt 0
    and ord(whencl) lt card(whencl)
    and  sum(woodtype(prods,spec),
    sum(climscen,
      runval(climscen,run)*newclimdat(climscen,spec,reg,"yield"))
    ))=
     EXISTYLD(whencl,COHORT,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS) *
  (1+(((svEXISTYLD(whencl+1,COHORT,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS)
     - svEXISTYLD(whencl,COHORT,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS))
        / svEXISTYLD(whencl,COHORT,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS)
           * (1+ sum(woodtype(prods,spec),
    sum(climscen,
      runval(climscen,run)*newclimdat(climscen,spec,reg,"yield"))
      )/100)))));
);
* Make any negative yields equal to zero
EXISTYLD(WHEN,COHORT,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS)
 $(EXISTYLD(WHEN,COHORT,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS) lt 0)=0;
NEWYLD(WHEN,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS)
 $(NEWYLD(WHEN,REG,CLS,OWNER,SPECIES,SITE,MIC,PRODS) lt 0) = 0 ;

option existyld:2:1:8;display existyld;
option newyld:2:1:7;display newyld;
*compute timber volume at these yields but with base land area
voltimbe3(mic,regs,owner,dec,prods)=
   SUM(WHEN$ (TODAY+ELAPSED(WHEN) EQ DATE(DEC)),
     SUM((cohort,CLS,species,SITE),
       runsEXISTl(when,cohort,REGS,CLS,OWNER,SPECIES,SITE,mic)*SCFOR*
       EXISTYLD(when,cohort,REGS,CLS,OWNER,SPECIES,SITE,mic,prods))) +
  SUM(OLDDEC$ (DATE(OLDDEC) LE DATE(DEC)),
     SUM(WHEN$ (DATE(OLDDEC)+ELAPSED(WHEN) EQ DATE(DEC)
                AND WHENDONE(OLDDEC,WHEN) GT 0 ),
         SUM((CLS,SITE,species,POLICY),
            runsnewl(olddec,when,REGS,CLS,OWNER,SPECIES,SITE,mic,POLICY)
           *scfor*NEWYLD(when,REGS,CLS,OWNER,SPECIES,SITE,mic,prods))));
*compute per unit volume
volbyare3(mic,regs,owner,dec,prods)
   $ AREAtimber(mic,regs,owner,dec) =
   voltimbe3(mic,regs,owner,dec,prods)
  /   AREAtimber(mic,regs,owner,dec) ;
```

```
*
*  P U B L I C   C U T
*
PUBSUP(POWNER,REG,DEC,PRODS)$volbyarea("ME",reg,"OP",dec,prods) =
        PUBSUP(POWNER,REG,DEC,PRODS) *
    (1+(sum(species,volbyare3("ME",reg,"OP",dec,prods) -
         volbyarea("ME",reg,"OP",dec,prods)) /
         volbyarea("ME",reg,"OP",dec,prods))) ;
*display "public cut after changes";
display pubsup;
*changing the public supply to account for changes in CANADIAN supply

*** COMPUTATIONS FOR CANADA (AUG/25/1994) ***
qcanada(dec,prods,run)$volbyarea("ME","PNWW","OP",dec,prods)=
  (1+  ((volbyare3("ME","PNWW","OP",dec,prods) -
      volbyarea("ME","PNWW","OP",dec,prods)) /
      volbyarea("ME","PNWW","OP",dec,prods))) ;
canada(dec,prods)=storcanada(dec,prods)*qcanada(dec,prods,run);
*display "canada cut after changes";
display canada;
option lp=gamschk;
lim=1 ;
*$ontext
$include "/mac/mccarl/agfor/source/fasolvlp.mod"
$ontext
if(yesfor,
$include "faforrpt.clr"

*climate change run specific output non comparative
* NOW COMPUTE INVENTORY VOLUMES  (At start of period)
 newSoftEXs(dec,REGS,OWNER,mic,sprods) =
      SUM(WHEN$(TODAY+ELAPSED(WHEN) GE DATE(DEC)),
      SUM((cohort,CLS,SPECIES,SITE,policy)$
       EXIST.L(when,cohort,REGS,CLS,OWNER,SPECIES,SITE,MIC,policy),
       EXIST.L(when,cohort,REGS,CLS,OWNER,SPECIES,SITE,MIC,policy)
      *SCFOR*
       SUM(TIME2$(10*(ORD(TIME2)-1)+TODAY EQ DATE(DEC)),
       yesbiomass(regs,sprods,policy)
     *eXISTYLD(time2,cohort,REGS,CLS,OWNER,SPECIES,SITE,MIC,sprods))));
 newSWINNEW(dec,REGS,OWNER,mic,sprods) =
    SUM(DECSP$(DATE(DECSP) LT DATE(DEC)),
      SUM(WHEN$(DATE(DECSP)+ELAPSED(WHEN) GE DATE(DEC)),
        SUM((CLS,SPECIES,SITE,POLICY)$
           NEW.L(decsp,when,REGS,CLS,OWNER,SPECIES,SITE,MIC,POLICY),
           NEW.L(decsp,when,REGS,CLS,OWNER,SPECIES,SITE,MIC,POLICY)
          *SCFOR*
           SUM(TIME2$((ORD(DECSP)+ORD(TIME2)-1) EQ ORD(DEC)),
               yesbiomass(regs,sprods,policy)*
         nEWYLD(time2,REGS,CLS,OWNER,SPECIES,SITE,MIC,sprods)))));
newHardEXs(dec,REGS,OWNER,mic,hprods) =
   SUM(WHEN$(TODAY+ELAPSED(WHEN) GE DATE(DEC)),
   SUM((cohort,CLS,SPECIES,SITE,policy)
  $EXIST.L(when,cohort,REGS,CLS,OWNER,SPECIES,SITE,MIC,policy),
    EXIST.L(when,cohort,REGS,CLS,OWNER,SPECIES,SITE,MIC,policy)*SCFOR*
```

```
     SUM(TIME2$(10*(ORD(TIME2)-1)+TODAY EQ DATE(DEC)),
       yesbiomass(regs,hprods,policy)*
     eXISTYLD(time2,cohort,REGS,CLS,OWNER,SPECIES,SITE,MIC,hprods))));
 newHWINNEW(dec,REGS,OWNER,mic,hprods) =
   SUM(DECSP$(DATE(DECSP) LT DATE(DEC)),
      SUM(WHEN$(DATE(DECSP)+ELAPSED(WHEN) GE DATE(DEC)),
        SUM((CLS,SPECIES,SITE,POLICY)$
        NEW.L(decsp,when,REGS,CLS,OWNER,SPECIES,SITE,MIC,POLICY),
        NEW.L(decsp,when,REGS,CLS,OWNER,SPECIES,SITE,MIC,POLICY)*SCFOR*
        SUM(TIME2$((ORD(DECSP)+ORD(TIME2)-1) EQ ORD(DEC)),
        yesbiomass(regs,hprods,policy)
        *NEWYLD(time2,REGS,CLS,OWNER,SPECIES,SITE,MIC,hprods)))));


*climate change run comparative report writing
 newinv("softwood",dec,regs,run) = sum((owner),SWINEXI(dec,regs,OWNER)+
                                               SWINNEW(dec,regs,OWNER));
 newinv("hardwood",dec,regs,run) = sum((owner),hWINEXI(dec,regs,OWNER)+
                                               hWINNEW(dec,regs,OWNER));
 newtinv("softwood",dec,run,mic,regs)   =
        sum((sprods,owner),newsoftexs(dec,regs,OWNER,mic,sprods)
       +newSWINNEW(dec,regs,OWNER,mic,sprods));
 newtinv("hardwood",dec,run,mic,regs)   =
        sum((hprods,owner),newhardexs(dec,regs,OWNER,mic,hprods)
                         + newhWINNEW(dec,regs,OWNER,mic,hprods));
RUNPROD(spec,dec,REGs,PRODS,run) =
  SUM(WHEN$ (TODAY+ELAPSED(WHEN) EQ DATE(DEC)),
   SUM((cohort,CLS,OWNER,SPECIES,SITE,MIC,policy)
      $EXIST.l(when,cohort,REGS,CLS,OWNER,SPECIES,SITE,MIC,policy),
             yesbiomass(regs,prods,policy)*
      EXIST.L(when,cohort,REGS,CLS,OWNER,SPECIES,SITE,MIC,policy)
                                                         *SCFOR*
      EXISTYLD(when,cohort,REGS,CLS,OWNER,SPECIES,SITE,MIC,prods)))
   + SUM(OLDDEC$ (DATE(OLDDEC) LE DATE(DEC)),
      SUM(WHEN$ (DATE(OLDDEC)+ELAPSED(WHEN) EQ DATE(DEC)
           AND WHENDONE(OLDDEC,WHEN) GT 0 ),
        SUM((CLS,OWNER,SPECIES,SITE,MIC,POLICY)
          $NEW.l(olddec,when,REGS,CLS,OWNER,SPECIES,SITE,MIC,policy),
             yesbiomass(regs,prods,policy)*
           NEW.L(olddec,when,REGS,CLS,OWNER,SPECIES,SITE,MIC,POLICY)
                                                         *SCFOR*
           NEWYLD(when,REGS,CLS,OWNER,SPECIES,SITE,MIC,prods) )))
   + SUM((POWNER), PUBSUP(POWNER,REGS,DEC,PRODS))
 +  scfor*   sum(products$(1$bioprods(products) le 0
                     and 1$yesmill(prods) gt 0
                     and yesitis(regs,products) gt 0
                     and transcost(regs,products) ne 0),
         millresid(regs,dec,products,prods)*
         TRANSFOR.l(REGS,PRODuctS,DEC)$(transcost(regs,products)
                                                          NE 0))
 + scfor*    sum((tradereg,products)$(1$bioprods(products) le 0
                     and 1$yesmill(prods) gt 0
                     and yesitis(regs,products) gt 0
                     and tradecost(regs,tradereg,products) ne 0) ,
```

```
            millresid(regs,dec,products,prods)*
            TRADEFPTRN.l(REGS,TRADEREG,PRODuctS,DEC,"EXPORT")$
              (TRADFOR(TRADEREG,"EXPORT",PRODuctS,DEC,"INTERCEPT") GT 0  OR
               TRADFOR(TRADEREG,"EXPORT",PRODuctS,DEC,"MINQ")      GT 0  OR
               TRADFOR(TRADEREG,"EXPORT",PRODuctS,DEC,"FIXP")      GT 0))
       + scfor*SUM((products,products2)$
         (yesitis(regs,products2) gt 0),
          PRODUCTSUB.l(regs,PRODUCTS,PRODuctS2,DEC)
          *millresid(regs,dec,products,prods)
          $SUBS(PRODUCTS,PRODuctS2))
   ;
   productcli(dec,climregs,prods,run)=
          sum(climmap(climregs,reg),sum(spec,
          runprod(spec,dec,reg,prods,run)))            ;
   tinvcli("softwood",dec,climregs,run)=
          sum(climmap(climregs,reg),
          newinv("softwood",dec,reg,run))   ;
   tinvcli("hardwood",dec,climregs,run)=
          sum(climmap(climregs,reg),
          newinv("hardwood",dec,reg,run))   ;
   tmiccli("hardwood",mic,climregs,dec,run)=
          sum(climmap(climregs,reg),
          newtinv("hardwood",dec,run,mic,reg))   ;
   tmiccli("softwood",mic,climregs,dec,run)=
          sum(climmap(climregs,reg),
          newtinv("softwood",dec,run,mic,reg))   ;
   harvestcli(dec,climregs,"softwood",run)=
      sum((climmap(climregs,reg),sw,CLS,OWNER,SITE,COHORT,MIC,WHEN)
                                                              $(ord(when)
      eq ord(dec)),SOFTEXIST(REG,CLS,OWNER,SW,SITE,COHORT,MIC,WHEN))+
       sum((climmap(climregs,reg),sw,CLS,OWNER,SITE,MIC,WHEN,decsp)
       $(ord(when)+ord(decsp) eq ord(dec)+1),
      SOFTNEW(REG,CLS,OWNER,SW,SITE,MIC,WHEN,DECSp));
   harvestcli(dec,climregs,"hardwood",run)=
      sum((climmap(climregs,reg),hw,CLS,OWNER,SITE,COHORT,MIC,WHEN)
                                                           $(ord(when)
      eq ord(dec)),hardEXIST(REG,CLS,OWNER,hW,SITE,COHORT,MIC,WHEN))+
       sum((climmap(climregs,reg),hw,CLS,OWNER,SITE,MIC,WHEN,decsp)
       $(ord(when)+ord(decsp) eq ord(dec)+1),
      hardNEW(REG,CLS,OWNER,hW,SITE,MIC,WHEN,DECSp));
   productcli(dec,climregs,prods,run)=
          sum(climmap(climregs,reg),thprod(dec,reg,prods));
   productprv(dec,climregs,prods,run)=
          sum(climmap(climregs,reg),harvprod(reg,dec,prods));
   harvestcli(dec,climregs,"softwood",run)=
      sum((climmap(climregs,reg),sw,CLS,OWNER,SITE,COHORT,MIC,WHEN)
      $(ord(when) eq ord(dec)),
         SOFTEXIST(REG,CLS,OWNER,SW,SITE,COHORT,MIC,WHEN))+
       sum((climmap(climregs,reg),sw,CLS,OWNER,SITE,MIC,WHEN,decsp)
       $(ord(when)+ord(decsp) eq ord(dec)+1),
      SOFTNEW(REG,CLS,OWNER,SW,SITE,MIC,WHEN,DECSp));
   harvestcli(dec,climregs,"hardwood",run)=
      sum((climmap(climregs,reg),hw,CLS,OWNER,SITE,COHORT,MIC,WHEN)
          $(ord(when) eq ord(dec)),
```

```
               hardEXIST(REG,CLS,OWNER,hW,SITE,COHORT,MIC,WHEN))+
       sum((climmap(climregs,reg),hw,CLS,OWNER,SITE,MIC,WHEN,decsp)
           $(ord(when)+ord(decsp) eq ord(dec)+1),
               hardNEW(REG,CLS,OWNER,hW,SITE,MIC,WHEN,DECSp));
    harvowncli(dec,climregs,"softwood",owner,run)=
       sum((climmap(climregs,reg),sw,CLS,SITE,COHORT,MIC,WHEN)
            $(ord(when) eq ord(dec)),
              SOFTEXIST(REG,CLS,OWNER,SW,SITE,COHORT,MIC,WHEN))+
       sum((climmap(climregs,reg),sw,CLS,SITE,MIC,WHEN,decsp)
            $(ord(when)+ord(decsp) eq ord(dec)+1),
             SOFTNEW(REG,CLS,OWNER,SW,SITE,MIC,WHEN,DECSp));
     harvowncli(dec,climregs,"hardwood",owner,run)=
        sum((climmap(climregs,reg),hw,CLS,SITE,COHORT,MIC,WHEN) $(ord(when)
        eq ord(dec)),hardEXIST(REG,CLS,OWNER,hW,SITE,COHORT,MIC,WHEN))+
         sum((climmap(climregs,reg),hw,CLS,SITE,MIC,WHEN,decsp)
            $(ord(when)+ord(decsp) eq ord(dec)+1),
        hardNEW(REG,CLS,OWNER,hW,SITE,MIC,WHEN,DECSp));
    );

    $include "facrbrpt.clr"
    if(yesag,
    $include "faasmrpt.clr"
     );
    *climate change run accounting of welfare by climate region
              regrun(dec,reg,"domforpro",run) =
              regsurp(dec,reg,"domforpro");
              regrun(dec,"total","domforcon",run) =
              regsurp(dec,"total","domforcon");
              regrun(dec,reg,"publiccut",run) =
              regsurp(dec,reg,"publiccut");
              regrun(dec,"total","foregnfor",run) =
              regsurp(dec,"total","foregnfor");

    $include "/mac/mccarl/agfor/source/facompar.rep"
    $include "/mac/mccarl/agfor/source/facomsav.sav"
    *end of the loop "runs"
    $offtext
    );
```

Appendix G   List of All Items Used in FASOM And Reference Locations

Due to the complex multiple file structure of FASOM, a user looking for a particular data item might need to go on a hunting expedition. However, a program was recently written which maps out the incidence of parameters (i.e., data items) and sets in the FASOM file structure.[42] The resultant output appears below. The output contains a table for sets (G.1), and one for parameters (G.2). The columns in the tables are defined as follows:

- ITEM NAME This is the name of the item in the GAMS listing. For example, in Table G.1, the first set is named AGCANMOVE.
- DECLARED This tells where the set or parameter statement appears.
- DEFINED Tells where values are entered into the item. This indicates which items have exogenous set labels or numerical data specified, and in which files they appear.
- ASSIGNED Indicates the files in which values are computed into this item.
- CONTROL Indicates where a set is used to sum over various items or define an equation.
- REF Indicates the FASOM files where an item is used in calculations or display statements.

For example, in Table G.1 the first set AGCANMOVE is declared in the BIOMASS.DAT file, and there it is given a value. Then it is used as a control in FASCALE, FAMODEL, FAALTRUN, FAFORWEL, and FAAGWEL, and it is referenced in the same files. If one then wishes to find out where a data item is used, one can use this table to find the FASOM files where the data item is used, and then use a text editor to locate the data item within each FASOM file.

[42] When this program is ready for public release it will be made available to FASOM users.

Table G.1 Files where Actions on SETS Appear

ITEM NAME	DECLARED	DEFINED	ASSIGNED	CONTROL	REF
AGCANMOVE	biomass.dat	biomass.dat		fascale.mod	fascale.mod
				famodel.mod	famodel.mod
				faaltrun	faaltrun
				faforwel.rep	faforwel.rep
				faagwel.rep	faagwel.rep
AGCLS	fapoldat.dat	fapoldat.dat		fapoldat.dat	famodel.mod
				famodel.mod	
AGCOR	biomass.dat	biomass.dat	biomass.dat	famodel.mod	biomass.dat
				faforrpt.rep	fascale.mod
				faasmrpt.rep	famodel.mod
					faaltrun
					faforwel.rep
AGMAP	fafinal.rep	fafinal.rep			fafinal.rep
AGPRODCT	farpt.rep	farpt.rep			farpt.rep
AGRESULTS	facomset.sav	facomset.sav		putset2.utl	facomset.sav
				datput3.utl	putset2.utl
					datput3.utl
AGTYPE	fafinal.rep	fafinal.rep		fafinal.rep	fafinal.rep
ALLI	faagdat.dat	faagdat.dat		faagdat.dat	faagdat.dat
				faagdyn.dat	faagdyn.dat
				biomass.dat	biomass.dat
				faasmcal.dat	faasmcal.dat
				allmap	allmap
				fascale.mod	famodel.mod

			faaltrun	fascale.mod
			faagwel.rep	farpt.rep
			faasmrpt.rep	faag.alt
			fafinal.rep	faaltrun
			putset2.utl	facomset.sav
			datput4.utl	faagwel.rep
				faasmrpt.rep
				fafinal.rep
				putset2.utl
				datput4.utl
ALLPARTIES	farpt.rep	farpt.rep	fafinal.rep	farpt.rep
			putset.utl	facomset.sav
			datput2.utl	fafinal.rep
			datput3.utl	putset.utl
				datput2.utl
				datput3.utl
ANIMAL	faagdat.dat	faagdat.dat	faagdyn.dat	faagdat.dat
			faasmcal.dat	faagdyn.dat
			fascale.mod	faasmcal.dat
			famodel.mod	famodel.mod
			faasmrpt.rep	fascale.mod
			faagwel.rep	facomset.sav
			facompar.rep	faasmrpt.rep
			putset2.utl	faagwel.rep
			datput4.utl	facompar.rep
				putset2.utl
				datput4.utl
APROD	facomput.sav		putset2d.utl	putset2d.utl
AREAMAP	fafinal.rep	fafinal.rep	fafinal.rep	

AREAS	fafinal.rep	fafinal.rep		fafinal.rep	fafinal.rep	
ASSUME	faaltrun	faaltrun		faaltrun	faaltrun	
				putset2.utl	fafor.alt	
				datput.utl	facomset.sav	
					putset2.utl	
					datput.utl	
AUMSITEM	faagdat.dat	faagdat.dat			faagdat.dat	
BALIT	fafinal.rep	fafinal.rep		fafinal.rep	fafinal.rep	
BALITEM	farpt.rep	farpt.rep		putset2.utl	farpt.rep	
				datput4.utl	facomset.sav	
					fafinal.rep	
					putset2.utl	
					datput4.utl	
BIOCOR	biomass.dat	biomass.dat				**** no use
BIOFUEL	biomass.dat	biomass.dat		facompar.rep		
BIOINPUTLM	biomass.dat	biomass.dat	biomass.dat		biomass.dat	
BIOPROC	biomass.dat	biomass.dat			biomass.alt	
BIOPRODS	fafordat.dat	fafordat.dat		biomass.dat	biomass.dat	
				famodset.mod	famodset.mod	
				famodel.mod	fascale.mod	
				farpt.rep	famodel.mod	
				putseta.utl	faforwel.rep	
					faforrpt.rep	
					putseta.utl	
BIOYEAR	biomass.dat	biomass.dat		biomass.alt	biomass.dat	

					biomass.alt
BIOYRS	biomass.dat	biomass.dat	biomass.dat		biomass.dat
					biomass.alt
BIOYRSP	biomass.dat	biomass.dat	biomass.dat		biomass.dat
					biomass.alt
BTUITEM	biomass.dat	biomass.dat			biomass.dat
C	faagdat.dat	faagdat.dat		fasolvlp.mod	faagdat.dat
					fasolvlp.mod
CANMOVE	biomass.dat	biomass.dat		biomass.dat	biomass.dat
				fascale.mod	famodel.mod
				famodel.mod	faforrpt.rep
				faaltrun	faasmrpt.rep
				faasmrpt.rep	faagwel.rep
				faagwel.rep	
CAPARG	fafordat.dat	fafordat.dat		fafordat.dat	cap.dat
				putset.utl	putset.utl
CARBONFATE	facarbon.dat	facarbon.dat			facarbon.dat
CARBSEC	facomset.sav	facomset.sav		putset.utl	facomset.sav
				datput3.utl	putset.utl
				datput4.utl	datput3.utl
					datput4.utl
CARBT	farpt.rep	farpt.rep		facomsav.sav	farpt.rep
				facrbrpt.rep	facomset.sav
				putset2.utl	facomsav.sav
				datput6.utl	facrbrpt.rep
					putset2.utl

					datput6.utl
CARBTYP	farpt.rep	farpt.rep		farpt.rep	farpt.rep
				facomsav.sav	facomset.sav
				facrbrpt.rep	facomsav.sav
				facompar.rep	facrbrpt.rep
				putset.utl	facompar.rep
				datput6.utl	putset.utl
				datput2.utl	datput6.utl
					datput2.utl
CARBWHERE	facarbon.dat	facarbon.dat			facarbon.dat
CITEM	farpt.rep	farpt.rep		facomsav.sav	farpt.rep
				putset.utl	facomset.sav
				putdat4.utl	facomsav.sav
					putset.utl
					putdat4.utl
CLS	fasets.dat	fasets.dat		fafordat.dat	inv.dat
				faagdat.dat	exist.dat
				facarbon.dat	new.dat
				famodel.mod	fafordat.dat
				fapoldat.dat	est.dat
				famodset.mod	grow.dat
				faupdate.mod	faagdat.dat
				fascale.mod	facarbon.dat
				farpt.rep	famodel.mod
				faaltrun	fapoldat.dat
				faforrpt.rep	famodset.mod
				faforwel.rep	faupdate.mod
				facomsav.sav	fascale.mod

			facrbrpt.rep	farpt.rep
			faagwel.rep	faaltrun
			facompar.rep	facomset.sav
			fafinal.rep	faforrpt.rep
			putset.utl	faforwel.rep
			putdat5.utl	facomsav.sav
			datput10.utl	facrbrpt.rep
			datput5.utl	faagwel.rep
			datput7.utl	facompar.rep
			datput4.utl	fafinal.rep
			datput3.utl	putset.utl
				putdat5.utl
				datput10.utl
				datput5.utl
				datput7.utl
				datput4.utl
				datput3.utl
COHORT	fafordat.dat	fafordat.dat	fafordat.dat	fafordat.dat
			facarbon.dat	inv.dat
			famodset.mod	exist.dat
			faupdate.mod	facarbon.dat
			fascale.mod	famodset.mod
			famodel.mod	faupdate.mod
			farpt.rep	famodel.mod
			faaltrun	fascale.mod
			faforrpt.rep	farpt.rep
			faforwel.rep	facomset.sav
			facrbrpt.rep	faaltrun
			facompar.rep	faforrpt.rep
			putset.utl	faforwel.rep

			datput10.utl	facrbrpt.rep
				facompar.rep
				putset.utl
				datput10.utl
COHORT2	famodset.mod		faupdate.mod	faupdate.mod
COHORTS	fafordat.dat		facarbon.dat	facarbon.dat
			famodel.mod	famodel.mod
			facrbrpt.rep	facrbrpt.rep
COMPREG	fafinal.rep	fafinal.rep	fafinal.rep	fafinal.rep
CONVDAT	fafordat.dat	fafordat.dat	putset.utl	fafordat.dat
				putset.utl
COST	faagdat.dat	faagdat.dat	faasmcal.dat	faasmcal.dat
			famodel.mod	famodel.mod
			faagwel.rep	faagwel.rep
CROP	faagdat.dat	faagdat.dat	biomass.dat	faagdat.dat
			faasmcal.dat	biomass.dat
			fascale.mod	faasmcal.dat
			famodel.mod	famodel.mod
			def.dat	fascale.mod
			biomass.alt	farpt.rep
			def2.alt	biomass.alt
			faasmrpt.rep	facomset.sav
			faagwel.rep	faasmrpt.rep
			facompar.rep	faagwel.rep
			putset.utl	facompar.rep
			datput4.utl	putset.utl
				datput4.utl

CRPINCID	faag.alt	faag.alt			faag.alt
CRPMIXALT	faagdat.dat	faagdat.dat		faasmcal.dat	faagdat.dat
				fascale.mod	faasmcal.dat
				famodel.mod	famodel.mod
					fascale.mod
CTECH	faagdat.dat	faagdat.dat		faasmcal.dat	faagdat.dat
				fascale.mod	faasmcal.dat
				famodel.mod	famodel.mod
				biomass.alt	fascale.mod
				faasmrpt.rep	farpt.rep
				faagwel.rep	biomass.alt
				facompar.rep	faasmrpt.rep
					facompar.rep
DEC	fasets.dat	fasets.dat		fasets.dat	fasets.dat
				faagdat.dat	faagdat.dat
				faagdyn.dat	faagdyn.dat
				biomass.dat	biomass.dat
				faasmcal.dat	fapoldat.dat
				famodel.mod	faupdate.mod
				fapoldat.dat	famodel.mod
				fascale.mod	fascale.mod
				def.dat	fasolvlp.mod
				fasolvlp.mod	farpt.rep
				farpt.rep	facarb.alt
				facarb.alt	biomass.alt
				biomass.alt	canada.alt
				def2.alt	faaltrun
				canada.alt	facomset.sav
				faaltrun	faforrpt.rep

			faforrpt.rep	faforwel.rep
			faforwel.rep	facomsav.sav
			facomsav.sav	facrbrpt.rep
			facrbrpt.rep	faasmrpt.rep
			faasmrpt.rep	faagwel.rep
			faagwel.rep	facompar.rep
			facompar.rep	fafinal.rep
			fafinal.rep	facomput.sav
			facomput.sav	putdat4.utl
			putdat4.utl	putdat3.utl
			putdat3.utl	putdat7.utl
			putdat7.utl	putdat5.utl
			putdat5.utl	putdat6.utl
			putdat6.utl	datput10.utl
			datput10.utl	datput4.utl
			datput4.utl	datput3.utl
			datput3.utl	datput5.utl
			datput5.utl	datput6.utl
			datput6.utl	datput2.utl
			datput2.utl	datput.utl
			datput.utl	datput7.utl
			datput7.utl	
DEC2	fasets.dat		famodel.mod	famodel.mod
			faforrpt.rep	faforrpt.rep
			faforwel.rep	faforwel.rep
DECADEYEAR	faagdat.dat	faagdat.dat	faagdat.dat	faagdat.dat
DECS	fasets.dat	fasets.dat	fasets.dat	fasets.dat
			fafordat.dat	tradedmd.dat
			biomass.dat	public.dat

				facarbon.dat	fafordat.dat
				famodel.mod	fpdmd.dat
				famodset.mod	faagdat.dat
				fascale.mod	biomass.dat
				farpt.rep	facarbon.dat
				fafor.alt	faasmcal.dat
				faforrpt.rep	allmap
				facomsav.sav	famodel.mod
				facompar.rep	fapoldat.dat
				fafinal.rep	famodset.mod
				putset.utl	fascale.mod
					farpt.rep
					facarb.alt
					biomass.alt
					fafor.alt
					canada.alt
					faaltrun
					facomset.sav
					faforrpt.rep
					facomsav.sav
					facompar.rep
					fafinal.rep
					putset.utl
DECSP	fasets.dat			facarbon.dat	facarbon.dat
				famodel.mod	famodel.mod
				faforrpt.rep	faforrpt.rep
				facrbrpt.rep	facrbrpt.rep
				facompar.rep	facompar.rep
DEMSCENAR	fafor.alt	fafor.alt		fafor.alt	fafor.alt
				faaltrun	faaltrun

DIR	famodel.mod	famodel.mod		famodel.mod	famodel.mod
				faupdate.mod	
ECOCARBTYP	facarbon.dat	facarbon.dat		facarbon.dat	facarbon.dat
				famodel.mod	famodel.mod
				farpt.rep	farpt.rep
				facrbrpt.rep	facrbrpt.rep
ESOURCE	faagdat.dat	faagdat.dat			faagdat.dat
EXISTCLS	fapoldat.dat	fapoldat.dat		fapoldat.dat	famodel.mod
				famodel.mod	
EXPOL	fapoldat.dat		fapoldat.dat	faupdate.mod	faupdate.mod
			faaltrun	faaltrun	faaltrun
			facomput.sav	faforrpt.rep	faforrpt.rep
				faforwel.rep	faforwel.rep
				putdat4.utl	putdat4.utl
				datput10.utl	datput10.utl
				datput3.utl	datput3.utl
FARMPRO	faagdat.dat	faagdat.dat		faasmcal.dat	faagdat.dat
				allmap	faasmcal.dat
				faaltrun	allmap
					faaltrun
FEEDS	faagdyn.dat	faagdyn.dat		faagdyn.dat	
FORBIOFUEL	biomass.dat	biomass.dat		facompar.rep	
FORTYPES	biomass.dat	biomass.dat		facompar.rep	facompar.rep
GROSSITEM	farpt.rep	farpt.rep			farpt.rep
HARVLAND	farpt.rep	farpt.rep		faasmrpt.rep	farpt.rep

				faasmrpt.rep
HPRODS	fafordat.dat	fafordat.dat	faforrpt.rep	biomass.dat
			putseta.utl	faforrpt.rep
				facompar.rep
				putseta.utl
HW	fafordat.dat	fafordat.dat	famodel.mod	famodel.mod
			faforrpt.rep	farpt.rep
			putseta.utl	faforrpt.rep
				putseta.utl
ICCC	farpt.rep	farpt.rep	faasmrpt.rep	faasmrpt.rep
IDEF	farpt.rep	farpt.rep	faasmrpt.rep	faasmrpt.rep
INPUT	faagdat.dat	faagdat.dat	biomass.dat	faagdat.dat
			faasmcal.dat	biomass.dat
			fascale.mod	faasmcal.dat
			famodel.mod	famodel.mod
			biomass.alt	fascale.mod
			faaltrun	farpt.rep
			faforwel.rep	biomass.alt
			faasmrpt.rep	faaltrun
			faagwel.rep	faforwel.rep
			facompar.rep	faasmrpt.rep
				faagwel.rep
				facompar.rep
IOMAP	farpt.rep	farpt.rep	faasmrpt.rep	
			facompar.rep	
IOREGS	farpt.rep	farpt.rep	faasmrpt.rep	farpt.rep
			facompar.rep	facomset.sav

				putset.utl	faasmrpt.rep
				datput4.utl	facompar.rep
				datput3.utl	putset.utl
					datput4.utl
					datput3.utl
ITEMCCC	farpt.rep	farpt.rep			farpt.rep
ITEMCS	farpt.rep	farpt.rep		faasmrpt.rep	farpt.rep
					faasmrpt.rep
ITEMDEF	farpt.rep	farpt.rep			farpt.rep
ITEMFOR	farpt.rep	farpt.rep		faasmrpt.rep	farpt.rep
					faasmrpt.rep
ITER	faagdat.dat	faagdat.dat		fasolvlp.mod	faagdat.dat
					famodel.mod
					fasolvlp.mod
ITWEL	farpt.rep	farpt.rep		faagwel.rep	farpt.rep
				faasmrpt.rep	faagwel.rep
					faasmrpt.rep
LABORITEM	faagdat.dat	faagdat.dat			faagdat.dat
LABRITEM	farpt.rep	farpt.rep		faasmrpt.rep	farpt.rep
					faasmrpt.rep
LANDITEM	faagdat.dat	faagdat.dat			faagdat.dat
LANDITM	farpt.rep	farpt.rep			farpt.rep
LANDTRAN	fasets.dat	fasets.dat			famodset.mod
LANDTWO	faagdat.dat	faagdat.dat		faasmrpt.rep	faagwel.rep

					faasmrpt.rep	
LANDTYPE	faagdat.dat	faagdat.dat		faagdyn.dat	faagdat.dat	
				facarbon.dat	faagdyn.dat	
				faasmcal.dat	facarbon.dat	
				famodel.mod	faasmcal.dat	
				faupdate.mod	famodel.mod	
				fascale.mod	faupdate.mod	
				facrbrpt.rep	fascale.mod	
				faagwel.rep	farpt.rep	
				faasmrpt.rep	facomset.sav	
				facompar.rep	facrbrpt.rep	
				putset.utl	faagwel.rep	
				datput4.utl	faasmrpt.rep	
					facompar.rep	
					putset.utl	
					datput4.utl	
LIVESTOCK	faagdat.dat	faagdat.dat				**** no use
LIVETECH	faagdat.dat	faagdat.dat		faasmcal.dat	faagdat.dat	
				fascale.mod	faasmcal.dat	
				famodel.mod	famodel.mod	
				faasmrpt.rep	fascale.mod	
				faagwel.rep	faasmrpt.rep	
					faagwel.rep	
LNDMATFRFR	faagdat.dat	faagdat.dat		famodel.mod	famodel.mod	
				facrbrpt.rep	faagwel.rep	
LNDMATTOFR	faagdat.dat	faagdat.dat		famodel.mod	faupdate.mod	
				facrbrpt.rep	famodel.mod	
LNDSM	farpt.rep	farpt.rep		faforrpt.rep	farpt.rep	

				facomsav.sav	facomset.sav
				facompar.rep	faforrpt.rep
				putset.utl	facomsav.sav
				putdat4.utl	facompar.rep
				datput3.utl	putset.utl
					putdat4.utl
					datput3.utl
LTECH	faagdyn.dat	faagdyn.dat			faagdyn.dat
MAPCREG	fafinal.rep	fafinal.rep		fafinal.rep	
MATCHEM	biomass.dat	biomass.dat			biomass.dat
MERCHPARAM	facarbon.dat	facarbon.dat			facarbon.dat
MIC	fafordat.dat	fafordat.dat		fafordat.dat	inv.dat
				fapoldat.dat	exist.dat
				famodset.mod	new.dat
				faupdate.mod	fafordat.dat
				fascale.mod	est.dat
				famodel.mod	grow.dat
				farpt.rep	rotate.dat
				faaltrun	fapoldat.dat
				faforrpt.rep	famodset.mod
				faforwel.rep	faupdate.mod
				facomsav.sav	famodel.mod
				facrbrpt.rep	fascale.mod
				facompar.rep	farpt.rep
				fafinal.rep	fafor.alt
				putset.utl	faaltrun
				putdat7.utl	facomset.sav
				putdat5.utl	faforrpt.rep

				putdat6.utl	faforwel.rep
				datput10.utl	facomsav.sav
				datput5.utl	facrbrpt.rep
					facompar.rep
					fafinal.rep
					putset.utl
					putdat7.utl
					putdat5.utl
					putdat6.utl
					datput10.utl
					datput5.utl
MIC2	famodset.mod			faupdate.mod	faupdate.mod
MIXFEED	faagdat.dat	faagdat.dat		farpt.rep	faasmrpt.rep
				faasmrpt.rep	
NATMIXALT	faagdat.dat	faagdat.dat		fascale.mod	faagdat.dat
				famodel.mod	famodel.mod
					fascale.mod
NONFEED	farpt.rep		farpt.rep	faasmrpt.rep	farpt.rep
					faasmrpt.rep
OLDDEC	fasets.dat			famodel.mod	famodel.mod
				faforrpt.rep	faforrpt.rep
				faforwel.rep	faforwel.rep
				facompar.rep	facompar.rep
OWNER	fafordat.dat	fafordat.dat		fafordat.dat	inv.dat
				fapoldat.dat	exist.dat
				famodset.mod	new.dat
				faupdate.mod	fafordat.dat

			fascale.mod	rotate.dat
			famodel.mod	famodel.mod
			farpt.rep	fapoldat.dat
			faaltrun	famodset.mod
			faforrpt.rep	faupdate.mod
			faforwel.rep	fascale.mod
			facomsav.sav	farpt.rep
			facrbrpt.rep	fafor.alt
			faagwel.rep	faaltrun
			facompar.rep	facomset.sav
			fafinal.rep	faforrpt.rep
			putset.utl	faforwel.rep
			putdat7.utl	facomsav.sav
			putdat5.utl	facrbrpt.rep
			putdat6.utl	faagwel.rep
			datput10.utl	facompar.rep
			putdat4.utl	fafinal.rep
			datput5.utl	putset.utl
			datput4.utl	putdat7.utl
			datput7.utl	putdat5.utl
				putdat6.utl
				datput10.utl
				putdat4.utl
				datput5.utl
				datput4.utl
				datput7.utl
PARAMS	fafordat.dat	fafordat.dat	fafordat.dat	tradedmd.dat
			famodset.mod	fpdmd.dat
			famodel.mod	fafordat.dat
			fafor.alt	biomass.dat

			faaltrun	famodset.mod
			putset.utl	famodel.mod
				fafor.alt
				faaltrun
				putset.utl
PARTIES	farpt.rep	farpt.rep	faforwel.rep	farpt.rep
			facomsav.sav	facomset.sav
			facompar.rep	faforwel.rep
			putset.utl	facomsav.sav
			putdat2.utl	facompar.rep
			putdat4.utl	putset.utl
				putdat2.utl
				putdat4.utl
POLICY	fapoldat.dat	fapoldat.dat	fapoldat.dat	fapoldat.dat
			famodset.mod	famodset.mod
			fascale.mod	famodel.mod
			famodel.mod	fascale.mod
			faaltrun	farpt.rep
			facomsav.sav	facomset.sav
			facrbrpt.rep	faaltrun
			faasmrpt.rep	facomsav.sav
			faagwel.rep	facrbrpt.rep
			facompar.rep	faasmrpt.rep
			fafinal.rep	faagwel.rep
			facomput.sav	facompar.rep
			putset2.utl	fafinal.rep
				facomput.sav
				putset2.utl
POLICYTERM	fapoldat.dat	fapoldat.dat		fapoldat.dat

POWNER	fafordat.dat	fafordat.dat	fafordat.dat	public.dat
			famodel.mod	fafordat.dat
			farpt.rep	famodel.mod
			fafor.alt	farpt.rep
			faaltrun	fafor.alt
			faforwel.rep	faaltrun
			faforrpt.rep	facomset.sav
			facompar.rep	faforwel.rep
			putset.utl	faforrpt.rep
			datput4.utl	facompar.rep
				putset.utl
				datput4.utl
PQ	facomset.sav	facomset.sav		facomset.sav
PRIMARY	faagdat.dat	faagdat.dat	faagdat.dat	faagdat.dat
			faagdyn.dat	faagdyn.dat
			biomass.dat	biomass.dat
			faasmcal.dat	faasmcal.dat
			fascale.mod	famodel.mod
			famodel.mod	fascale.mod
			faforrpt.rep	farpt.rep
			faasmrpt.rep	facomset.sav
			faagwel.rep	faforrpt.rep
			facompar.rep	faasmrpt.rep
			putset2.utl	faagwel.rep
			datput4.utl	facompar.rep
				putset2.utl
				datput4.utl
PRIMARYQ	biomass.dat		biomass.dat	biomass.dat

PROCESSALT	faagdat.dat	faagdat.dat	biomass.dat	faagdat.dat
			faasmcal.dat	biomass.dat
			fascale.mod	faasmcal.dat
			famodel.mod	famodel.mod
			farpt.rep	fascale.mod
			faagwel.rep	farpt.rep
			faasmrpt.rep	faagwel.rep
			facompar.rep	faasmrpt.rep
				facompar.rep
PROCITEM	farpt.rep	farpt.rep		farpt.rep
PRODS	fafordat.dat	fafordat.dat	fafordat.dat	fafordat.dat
			biomass.dat	cap.dat
			facarbon.dat	tradedmd.dat
			famodel.mod	public.dat
			fapoldat.dat	exist.dat
			famodset.mod	new.dat
			faupdate.mod	inter.dat
			fascale.mod	fpdmd.dat
			farpt.rep	biomass.dat
			fafor.alt	facarbon.dat
			canada.alt	famodel.mod
			faaltrun	fapoldat.dat
			faforrpt.rep	famodset.mod
			faforwel.rep	faupdate.mod
			facomsav.sav	fascale.mod
			facrbrpt.rep	farpt.rep
			faagwel.rep	fafor.alt
			faasmrpt.rep	canada.alt
			facompar.rep	faaltrun
			fafinal.rep	facomset.sav

			putset.utl	faforrpt.rep
			putset2d.utl	faforwel.rep
			putdat4.utl	facomsav.sav
			putdat3.utl	facrbrpt.rep
			putdat2.utl	faagwel.rep
			datput3.utl	faasmrpt.rep
			datput4.utl	facompar.rep
				fafinal.rep
				putset.utl
				facomput.sav
				putset2d.utl
				putdat4.utl
				putdat3.utl
				putdat2.utl
				datput3.utl
				datput4.utl
PRODUCTS	fafordat.dat		fafordat.dat	fafordat.dat
			biomass.dat	biomass.dat
			fascale.mod	fascale.mod
			famodel.mod	famodel.mod
			faforwel.rep	farpt.rep
			faforrpt.rep	faforwel.rep
				faforrpt.rep
PRODUCTS2	famodel.mod		famodel.mod	famodel.mod
			faforrpt.rep	faforrpt.rep
PUBSCENAR	fafor.alt	fafor.alt	faaltrun	fafor.alt
				faaltrun
REG	fasets.dat	fasets.dat	fasets.dat	fasets.dat

fafordat.dat	fafordat.dat
faagdat.dat	public.dat
faagdyn.dat	inv.dat
allmap	exist.dat
biomass.dat	new.dat
facarbon.dat	est.dat
faasmcal.dat	grow.dat
famodel.mod	inter.dat
fascale.mod	rotate.dat
farpt.rep	faagdat.dat
biomass.alt	faagdyn.dat
fafor.alt	allmap
faaltrun	biomass.dat
faforrpt.rep	facarbon.dat
facomsav.sav	faasmcal.dat
facrbrpt.rep	famodel.mod
faasmrpt.rep	fapoldat.dat
faagwel.rep	famodset.mod
facompar.rep	fascale.mod
facomput.sav	farpt.rep
putset2.utl	faag.alt
putdat4.utl	biomass.alt
putdat7.utl	fafor.alt
putdat6.utl	faaltrun
datput10.utl	facomset.sav
putdat2.utl	faforrpt.rep
datput4.utl	facomsav.sav
datput2.utl	facrbrpt.rep
datput7.utl	faasmrpt.rep
datput3.utl	faagwel.rep
datput5.utl	facompar.rep

					fafinal.rep
					facomput.sav
					putset2.utl
					putdat4.utl
					putdat7.utl
					putdat6.utl
					datput10.utl
					putdat2.utl
					datput4.utl
					datput2.utl
					datput7.utl
					datput3.utl
					datput5.utl
REGBIG	biomass.dat	biomass.dat		biomass.alt	biomass.dat
					biomass.alt
REGBIOM	biomass.dat	biomass.dat			facompar.rep
REGLOT	farpt.rep	farpt.rep		facomsav.sav	facomsav.sav
				fafinal.rep	fafinal.rep
REGMAP	biomass.dat	biomass.dat			biomass.alt
REGPROC	biomass.dat	biomass.dat		facompar.rep	
REGS	fasets.dat		fasets.dat	fafordat.dat	fafordat.dat
				faasmcal.dat	faasmcal.dat
				famodel.mod	famodel.mod
				fapoldat.dat	fapoldat.dat
				famodset.mod	famodset.mod
				faupdate.mod	faupdate.mod
				fascale.mod	fascale.mod

			farpt.rep	farpt.rep
			biomass.alt	biomass.alt
			faaltrun	faaltrun
			faforrpt.rep	faforrpt.rep
			faforwel.rep	faforwel.rep
			facomsav.sav	facomsav.sav
			facrbrpt.rep	facrbrpt.rep
			faagwel.rep	faagwel.rep
			faasmrpt.rep	faasmrpt.rep
			facompar.rep	facompar.rep
			fafinal.rep	fafinal.rep
			putdat4.utl	putdat4.utl
			datput6.utl	datput6.utl
REGSUR	facomput.sav	facomput.sav	putset2.utl	putset2.utl
			putdat4.utl	putdat4.utl
RUN	faaltrun	faaltrun	faaltrun	faaltrun
			fafinal.rep	facomsav.sav
			facomput.sav	facompar.rep
			putset2.utl	fafinal.rep
			putdat2.utl	facomput.sav
			putdat4.utl	putset2.utl
			putdat3.utl	putdat2.utl
			putdat7.utl	putdat4.utl
			putdat5.utl	putdat3.utl
			putdat6.utl	putdat7.utl
			datput10.utl	putdat5.utl
			datput4.utl	putdat6.utl
			datput3.utl	datput10.utl
			datput2.utl	datput4.utl
			datput5.utl	datput3.utl

				datput6.utl	datput2.utl	
				datput.utl	datput5.utl	
				datput7.utl	datput6.utl	
					datput.utl	
					datput7.utl	
RUNS	faaltrun	faaltrun		facarb.alt	faaltrun	
				biomass.alt	facarb.alt	
				fafinal.rep	biomass.alt	
					facomset.sav	
					fafinal.rep	
RUNT	fafinal.rep			fafinal.rep	fafinal.rep	
SAMEAS					famodel.mod	**** no assn val
					biomass.alt	
SCREWUP	fafinal.rep		fafinal.rep		fafinal.rep	
SDITEM	faagdat.dat	faagdat.dat			faagdat.dat	
SECONDARY	faagdat.dat	faagdat.dat		faagdat.dat	faagdat.dat	
				faasmcal.dat	faagdyn.dat	
				fascale.mod	faasmcal.dat	
				famodel.mod	famodel.mod	
				faagwel.rep	fascale.mod	
				faasmrpt.rep	farpt.rep	
				facompar.rep	faagwel.rep	
					faasmrpt.rep	
					facompar.rep	
SIPMIC	fapoldat.dat		fapoldat.dat	fascale.mod	fascale.mod	
				famodel.mod	famodel.mod	

SITE	fafordat.dat	fafordat.dat	fafordat.dat	fafordat.dat
			famodel.mod	inv.dat
			fapoldat.dat	exist.dat
			famodset.mod	new.dat
			faupdate.mod	rotate.dat
			fascale.mod	famodel.mod
			farpt.rep	fapoldat.dat
			faaltrun	famodset.mod
			faforrpt.rep	faupdate.mod
			faforwel.rep	fascale.mod
			facomsav.sav	farpt.rep
			facrbrpt.rep	fafor.alt
			faagwel.rep	faaltrun
			facompar.rep	facomset.sav
			putset.utl	faforrpt.rep
			putdat7.utl	faforwel.rep
			putdat6.utl	facomsav.sav
			datput10.utl	facrbrpt.rep
			datput7.utl	faagwel.rep
				facompar.rep
				putset.utl
				putdat7.utl
				putdat6.utl
				datput10.utl
				datput7.utl
SITE2	fafordat.dat			fafordat.dat
SPEC	fafordat.dat	fafordat.dat	biomass.dat	fafordat.dat
			facarbon.dat	biomass.dat
			faupdate.mod	facarbon.dat
			fascale.mod	famodel.mod

			famodel.mod	faupdate.mod
			farpt.rep	fascale.mod
			faaltrun	farpt.rep
			faforrpt.rep	facomset.sav
			facrbrpt.rep	faforrpt.rep
			faagwel.rep	facrbrpt.rep
			facompar.rep	faagwel.rep
			fafinal.rep	facompar.rep
			putset.utl	fafinal.rep
			putset2d.utl	putset.utl
			datput3.utl	putset2d.utl
			datput7.utl	datput3.utl
			datput5.utl	datput7.utl
				datput5.utl
SPECIES	fafordat.dat	fafordat.dat	fafordat.dat	fafordat.dat
			fapoldat.dat	inv.dat
			famodset.mod	exist.dat
			faupdate.mod	new.dat
			fascale.mod	est.dat
			famodel.mod	grow.dat
			farpt.rep	rotate.dat
			faaltrun	fapoldat.dat
			faforrpt.rep	famodset.mod
			faforwel.rep	faupdate.mod
			facomsav.sav	famodel.mod
			facrbrpt.rep	fascale.mod
			facompar.rep	farpt.rep
			fafinal.rep	fafor.alt
			putset.utl	faaltrun
			putset2d.utl	facomset.sav

			putdat7.utl	faforrpt.rep
			datput10.utl	faforwel.rep
			datput5.utl	facomsav.sav
			datput4.utl	facrbrpt.rep
				facompar.rep
				fafinal.rep
				putset.utl
				putset2d.utl
				putdat7.utl
				datput10.utl
				datput5.utl
				datput4.utl
SPECIES2	fafordat.dat		fafordat.dat	fafordat.dat
			faupdate.mod	famodset.mod
				faupdate.mod
SPMAPFOL	fafordat.dat	fafordat.dat	fafordat.dat	fafordat.dat
			putset2d.utl	fascale.mod
				famodel.mod
				putset2d.utl
SPMAPPR	fafordat.dat	fafordat.dat	faupdate.mod	famodel.mod
			famodel.mod	farpt.rep
			facrbrpt.rep	facrbrpt.rep
			fafinal.rep	putset2d.utl
			putset2d.utl	
SPRODS	fafordat.dat	fafordat.dat	faforrpt.rep	biomass.dat
			putseta.utl	faforrpt.rep
				facompar.rep
				putseta.utl

STANDTYP	farpt.rep	farpt.rep	farpt.rep	farpt.rep
			facomsav.sav	facomset.sav
			facrbrpt.rep	facomsav.sav
			putset.utl	facrbrpt.rep
			datput6.utl	putset.utl
				datput6.utl
STEPS	famodset.mod	famodset.mod	fascale.mod	famodset.mod
			famodel.mod	famodel.mod
			faforwel.rep	faforwel.rep
			faforrpt.rep	faforrpt.rep
			facrbrpt.rep	facrbrpt.rep
			faagwel.rep	faagwel.rep
			faasmrpt.rep	faasmrpt.rep
STICKYFORM	fafordat.dat	fafordat.dat	fascale.mod	fafordat.dat
			famodel.mod	fapoldat.dat
			facompar.rep	famodel.mod
				fascale.mod
				facomset.sav
				facompar.rep
SUBLIM	biomass.dat	biomass.dat		famodel.mod
SUBS	fafordat.dat	fafordat.dat	putset2d.utl	fafordat.dat
				fascale.mod
				famodel.mod
				faforwel.rep
				faforrpt.rep
				putset2d.utl
SW	fafordat.dat	fafordat.dat	faforrpt.rep	farpt.rep
			putseta.utl	faforrpt.rep

				putseta.utl
TECH	faagdat.dat	faagdat.dat	faasmcal.dat	faagdat.dat
			fascale.mod	faasmcal.dat
			famodel.mod	famodel.mod
			biomass.alt	fascale.mod
			faasmrpt.rep	biomass.alt
			faagwel.rep	faasmrpt.rep
			facompar.rep	faagwel.rep
				facompar.rep
THREE	fafordat.dat	fafordat.dat	faupdate.mod	fafordat.dat
			famodset.mod	famodset.mod
			fascale.mod	faupdate.mod
			famodel.mod	famodel.mod
			faaltrun	faaltrun
			faagwel.rep	facomset.sav
			facompar.rep	faagwel.rep
			fafinal.rep	facompar.rep
			putset.utl	fafinal.rep
			datput4.utl	putset.utl
			datput5.utl	datput4.utl
				datput5.utl
TIME	fasets.dat	fasets.dat	facarbon.dat	fasets.dat
			famodel.mod	facarbon.dat
			facrbrpt.rep	famodel.mod
			putset.utl	farpt.rep
				facrbrpt.rep
				putset.utl
TIME2	famodset.mod		famodel.mod	famodel.mod

				faforrpt.rep	faforrpt.rep
				faforwel.rep	faforwel.rep
				facrbrpt.rep	facrbrpt.rep
TRADE	fafordat.dat	fafordat.dat		fafordat.dat	tradedmd.dat
				fascale.mod	fafordat.dat
				famodel.mod	famodel.mod
				faforwel.rep	fascale.mod
				faforrpt.rep	farpt.rep
				putset.utl	faforwel.rep
					faforrpt.rep
					putset.utl
TRADEREG	fafordat.dat	fafordat.dat		fafordat.dat	fafordat.dat
				fascale.mod	tradedmd.dat
				famodel.mod	famodel.mod
				faaltrun	fascale.mod
				faforwel.rep	farpt.rep
				faforrpt.rep	fafor.alt
				facomsav.sav	faaltrun
				putset.utl	faforwel.rep
					faforrpt.rep
					facomsav.sav
					putset.utl
TRANSTYPE	fafordat.dat	fafordat.dat		putset.utl	fafordat.dat
					putset.utl
TYPEDYN	faagdyn.dat	faagdyn.dat			faagdyn.dat
TYPES	biomass.dat	biomass.dat		facompar.rep	biomass.dat
					facompar.rep
WATERITEM	faagdat.dat	faagdat.dat			faagdat.dat

WATRITEM	farpt.rep	farpt.rep		faasmrpt.rep	farpt.rep
					faasmrpt.rep
WHEN	fasets.dat	fasets.dat		fafordat.dat	exist.dat
				facarbon.dat	new.dat
				famodset.mod	fafordat.dat
				faupdate.mod	facarbon.dat
				fascale.mod	famodset.mod
				famodel.mod	faupdate.mod
				faaltrun	famodel.mod
				faforrpt.rep	fascale.mod
				faforwel.rep	farpt.rep
				facrbrpt.rep	facomset.sav
				facompar.rep	faaltrun
				datput10.utl	faforrpt.rep
					faforwel.rep
					facrbrpt.rep
					facompar.rep
					datput10.utl
WHEN2	famodset.mod		famodset.mod	famodset.mod	famodset.mod
				faupdate.mod	faupdate.mod
				famodel.mod	famodel.mod
				facrbrpt.rep	facrbrpt.rep
WTECH	faagdat.dat	faagdat.dat		faasmcal.dat	faagdat.dat
				fascale.mod	faasmcal.dat
				famodel.mod	famodel.mod
				biomass.alt	fascale.mod
				faasmrpt.rep	biomass.alt
				faagwel.rep	faasmrpt.rep

				facompar.rep	faagwel.rep
					facompar.rep
YRSS	famodel.mod	famodel.mod		famodel.mod	famodel.mod

Table G.2 Files where Actions on PARAMETERS Appear

ITEM NAME DECLARED DEFINED ASSIGNED REF

ABEXIST facomset.sav facompar.rep datput10.utl

ABNEW facomset.sav facompar.rep datput10.utl

ACRES facomset.sav facompar.rep fafinal.rep
facomput.sav
datput3.utl

AGCONVERT fafordat.dat fafordat.dat fafordat.dat fafordat.dat
famodel.mod

AGESINCE facarbon.dat facarbon.dat famodel.mod
facrbrpt.rep

AGING facarbon.dat facarbon.dat famodel.mod
facrbrpt.rep

AGINGNEW facarbon.dat facarbon.dat famodel.mod
facrbrpt.rep

AGLANDGRW faagdat.dat faagdyn.dat famodel.mod
faagwel.rep

AGLNDPRI fafinal.rep fafinal.rep fafinal.rep

AGMOVEDATA biomass.dat biomass.dat famodel.mod
faforwel.rep
faforrpt.rep
faagwel.rep
faasmrpt.rep

AGPRODUCT farpt.rep faasmrpt.rep faagwel.rep
faasmrpt.rep

AGQDYN faagdat.dat faagdat.dat famodel.mod
faagdyn.dat faasmrpt.rep
faagwel.rep
facompar.rep

AGQUANDYN faagdat.dat faagdat.dat faagdat.dat

AGSOILCARB facarbon.dat facarbon.dat facarbon.dat facarbon.dat
famodel.mod
facrbrpt.rep

AGTABLE facomset.sav facompar.rep fafinal.rep
datput3.utl

AGTOFOR farpt.rep faforrpt.rep **** no use

AGTRADBAL farpt.rep faasmrpt.rep facompar.rep

AGTRADINC faag.alt faag.alt faaltrun

AINPUTELAS faagdyn.dat faagdyn.dat famodel.mod
faasmrpt.rep
faagwel.rep

ALTFPDEM fafor.alt fafor.alt fafor.alt fafor.alt
faaltrun

ALTPUBSUP fafor.alt fafor.alt fafor.alt faaltrun

ASCALE fascale.mod fascale.mod fascale.mod fascale.mod
faaltrun

AUMSREG farpt.rep faasmrpt.rep facompar.rep

AVGROT fafordat.dat fafordat.dat fafordat.dat fafordat.dat
faforrpt.rep famodel.mod
farpt.rep
faforrpt.rep
faforwel.rep
facomsav.sav
putdat2.utl

BADECOCARB facarbon.dat facarbon.dat **** no use

BALANCEP farpt.rep faasmrpt.rep faasmrpt.rep
facompar.rep

BALANCES farpt.rep faasmrpt.rep faasmrpt.rep

facompar.rep

BASEYEAR fasets.dat fasets.dat faagdat.dat

BIOHARV biomass.dat biomass.dat famodset.mod

BIOINVOLVE fapoldat.dat fapoldat.dat fapoldat.dat

BIOMASS facomset.sav facompar.rep facompar.rep

BIOPOLICY fapoldat.dat fapoldat.dat fapoldat.dat
famodset.mod famodset.mod

BIOTRAN biomass.dat biomass.dat biomass.dat

BSCALE fascale.mod fascale.mod fascale.mod

BTUCONV biomass.dat biomass.dat biomass.dat biomass.dat
facompar.rep

BURNING facarbon.dat facarbon.dat facarbon.dat

CANADA famodel.mod famodel.mod famodel.mod
canada.alt faforwel.rep
faaltrun faforrpt.rep

CAPACITY cap.dat cap.dat fafordat.dat fafordat.dat
famodset.mod famodset.mod
fascale.mod
famodel.mod
faforwel.rep
faforrpt.rep

CARBCAL facomset.sav facrbrpt.rep datput.utl

CARBCOST facomset.sav facompar.rep fafinal.rep
datput2.utl

CARBDAT facarb.alt facarb.alt facarb.alt facarb.alt
faaltrun

CARBFATE facarbon.dat facarbon.dat facarbon.dat facarbon.dat
famodel.mod

facrbrpt.rep

CARBFLUX fafinal.rep fafinal.rep fafinal.rep

CARBFLUXP fafinal.rep fafinal.rep fafinal.rep

CARBONI farpt.rep farpt.rep fafinal.rep
facomput.sav

CARBONIB farpt.rep farpt.rep farpt.rep
datput2.utl

CARBONINV facomset.sav facompar.rep facompar.rep
fafinal.rep fafinal.rep
datput3.utl

CARBONINVP fafinal.rep fafinal.rep fafinal.rep

CARBONRPT farpt.rep farpt.rep facomsav.sav
facrbrpt.rep facrbrpt.rep
facompar.rep

CARBRPT facomset.sav facomsav.sav datput6.utl

CONSBAL farpt.rep faforrpt.rep faforrpt.rep
facomsav.sav
facompar.rep
putdat4.utl

CONVERGE faagdat.dat faagdat.dat fasolvlp.mod fasolvlp.mod

CONVERT fafordat.dat fafordat.dat faaltrun faupdate.mod
famodset.mod
famodel.mod
faaltrun
faagwel.rep

CORD biomass.alt biomass.alt biomass.alt

COUNT facomset.sav putset.utl putset.utl
putseta.utl putdat2.utl
putset2d.utl putdat4.utl
putdat2.utl putdat3.utl

			putdat4.utl	putdat7.utl
			putdat3.utl	putdat5.utl
			putdat7.utl	putdat6.utl
			putdat5.utl	datput10.utl
			putdat6.utl	datput4.utl
			datput10.utl	datput3.utl
			datput4.utl	datput2.utl
			datput3.utl	datput5.utl
			datput2.utl	datput6.utl
			datput5.utl	datput.utl
			datput6.utl	datput7.utl
			datput.utl	
			datput7.utl	
COUNTIT	farpt.rep		farpt.rep	farpt.rep
CRIT	fafinal.rep		fafinal.rep	fafinal.rep
CROPBUDGUP	biomass.alt		biomass.alt	biomass.alt
CROPMIXY	faagdat.dat		faagdat.dat	famodel.mod
CRPLAND	faag.alt	faag.alt		faaltrun
CRPREVERT	famodel.mod faaltrun		famodel.mod	famodel.mod
CSCALE	fascale.mod		fascale.mod	fascale.mod
DATE	fasets.dat	fasets.dat	fasets.dat faagdat.dat biomass.dat famodset.mod famodel.mod biomass.alt faaltrun faforrpt.rep faforwel.rep facrbrpt.rep faasmrpt.rep faagwel.rep facompar.rep	fasets.dat

DAVGROT farpt.rep faforrpt.rep faforrpt.rep

DECAYRATE facarbon.dat facarbon.dat facarbon.dat

DEMANDGRW faagdat.dat faagdyn.dat famodel.mod
faagwel.rep
faasmrpt.rep

DEMANDQ fafordat.dat fafordat.dat fafordat.dat fafordat.dat
famodset.mod famodset.mod
famodel.mod
faforwel.rep
faforrpt.rep

DEMLO biomass.alt biomass.alt faaltrun

DISC fasets.dat fasets.dat fasets.dat
faaltrun famodel.mod
fasolvlp.mod
faforwel.rep
faforrpt.rep
faagwel.rep
faasmrpt.rep
facompar.rep
fafinal.rep
datput.utl

DISCRATE fasets.dat fasets.dat faaltrun fasets.dat
faagdat.dat
famodel.mod
faaltrun
faforrpt.rep
faforwel.rep

DISSURP farpt.rep faforrpt.rep faforrpt.rep

DYNAM faagdyn.dat faagdyn.dat faagdyn.dat

DYNAMINP faagdyn.dat faagdyn.dat faagdyn.dat

DYNINPCOST faagdat.dat faagdat.dat famodel.mod
faasmrpt.rep

DYNINPCST faagdat.dat faagdat.dat faagdat.dat

ECOSYSCARB facarbon.dat facarbon.dat facarbon.dat facarbon.dat
famodel.mod
farpt.rep
facrbrpt.rep

ELAPSED fasets.dat fasets.dat famodset.mod
faupdate.mod
famodel.mod
faforrpt.rep
faforwel.rep
facrbrpt.rep
facompar.rep

ENDPROD farpt.rep faforrpt.rep facomsav.sav
putdat2.utl

EROSION faagdat.dat faagdat.dat faasmrpt.rep

EROSIOND facomset.sav facompar.rep **** no use

ESTCOST est.dat est.dat faupdate.mod
famodel.mod
faforwel.rep
facompar.rep

EXAMINE fapoldat.dat fapoldat.dat faaltrun fapoldat.dat
famodset.mod
fascale.mod
famodel.mod
faaltrun
faforrpt.rep
faforwel.rep
facrbrpt.rep
faasmrpt.rep
faagwel.rep

EXISTYLD exist.dat exist.dat famodset.mod
faupdate.mod
famodel.mod
farpt.rep
faforrpt.rep

faforwel.rep
facrbrpt.rep

EXPORTGRW faagdat.dat faagdyn.dat famodel.mod
faaltrun faaltrun
faagwel.rep
faasmrpt.rep

FACTORWEL farpt.rep faagwel.rep faagwel.rep
faasmrpt.rep faasmrpt.rep

FARMPR allmap allmap famodel.mod
def.dat fasolvlp.mod
fasolvlp.mod faaltrun
def2.alt faasmrpt.rep
faaltrun faagwel.rep

FARMPROD faagdat.dat faagdat.dat faasmcal.dat faasmcal.dat
allmap

FARMPROGY faagdat.dat faagdat.dat famodel.mod
allmap fasolvlp.mod
faagwel.rep
fafinal.rep
datput.utl

FAWELFARE facomset.sav facompar.rep facompar.rep
fafinal.rep fafinal.rep
datput2.utl

FAWELFAREP fafinal.rep fafinal.rep fafinal.rep

FAWELSUM facomset.sav facompar.rep facompar.rep
fafinal.rep
datput3.utl

FFWEL farpt.rep faagwel.rep **** no use

FORLNDPRI fafinal.rep fafinal.rep fafinal.rep

FORTOAG farpt.rep faforrpt.rep **** no use

FPCAP farpt.rep faforrpt.rep facomsav.sav putdat3.utl

FPDEM fpdmd.dat fpdmd.dat fafordat.dat fafordat.dat
famodset.mod
fafor.alt

FPDEMAND famodset.mod famodset.mod famodel.mod
faaltrun fafor.alt
faaltrun
faforwel.rep
faforrpt.rep

FPDMD farpt.rep faforrpt.rep faforrpt.rep

FPPRICE farpt.rep faforrpt.rep facomsav.sav
facompar.rep
putdat4.utl

FPSCALE fascale.mod fascale.mod fascale.mod

FPSUB farpt.rep faforrpt.rep **** no use

FPTRADE farpt.rep faforrpt.rep **** no use

FUELSUBDAT fafordat.dat fafordat.dat famodel.mod
faforrpt.rep
faforwel.rep

FWEL farpt.rep faforwel.rep faforwel.rep
faagwel.rep

FWELFARE farpt.rep faasmrpt.rep faasmrpt.rep

GFWEL farpt.rep faagwel.rep faagwel.rep

GOVCCC farpt.rep faasmrpt.rep faasmrpt.rep

GOVDEF farpt.rep faasmrpt.rep faasmrpt.rep

GROSSREV farpt.rep faasmrpt.rep faasmrpt.rep

GROWCOST grow.dat grow.dat faupdate.mod
famodel.mod

faforwel.rep
facompar.rep

HARDAGE farpt.rep faforrpt.rep facomsav.sav
putdat6.utl

HARDAGED farpt.rep faforrpt.rep faforrpt.rep

HARDAGEN farpt.rep faforrpt.rep faforrpt.rep

HARDAREA farpt.rep faforrpt.rep facomsav.sav

HARDMIN famodel.mod famodel.mod famodel.mod

HARVAGE farpt.rep farpt.rep faforrpt.rep

HARVCOST famodset.mod famodset.mod famodel.mod
faforrpt.rep
faforwel.rep

HARVCST fafordat.dat fafordat.dat famodset.mod

HARVEST farpt.rep faasmrpt.rep faasmrpt.rep
facompar.rep

HARVESTREG farpt.rep faasmrpt.rep faasmrpt.rep

HARVEXIST farpt.rep faforrpt.rep facompar.rep

HARVPROD farpt.rep faforrpt.rep **** no use

HCOSTINF fafordat.dat fafordat.dat fafordat.dat fafordat.dat
famodel.mod
faforrpt.rep
faforwel.rep

HTINV farpt.rep faforrpt.rep **** no use

HWINEXI farpt.rep faforrpt.rep faforrpt.rep
facomsav.sav
facompar.rep
putdat4.utl

HWINNEW farpt.rep faforrpt.rep faforrpt.rep
facomsav.sav
facompar.rep
putdat4.utl

IMEXRC3 fafor.alt fafor.alt faaltrun

IMPORTGRW faagdat.dat faagdyn.dat famodel.mod
faaltrun faaltrun
faagwel.rep
faasmrpt.rep

INCLDISPL facarbon.dat facarbon.dat famodel.mod
facrbrpt.rep

INDEXS fafinal.rep fafinal.rep fafinal.rep

INPUTDECQ faasmcal.dat faasmcal.dat faasmcal.dat
biomass.alt fascale.mod
famodel.mod
biomass.alt
faaltrun

INPUTELAS faagdyn.dat faagdyn.dat faagdyn.dat famodel.mod
faasmrpt.rep
faagwel.rep

INPUTPRICE faagdat.dat faagdat.dat faasmcal.dat
famodel.mod
faforwel.rep
faasmrpt.rep
faagwel.rep

INPUTQUAN faagdat.dat faagdat.dat faasmcal.dat

INTERRC3 fafor.alt fafor.alt faaltrun

INVENT inv.dat inv.dat fafordat.dat
faupdate.mod
fascale.mod
famodel.mod
farpt.rep

IOANIMAL	facomset.sav		facompar.rep	datput4.utl
IOCOMMOD	facomset.sav		facompar.rep	datput4.utl
IOPRICHECK	facomset.sav		facompar.rep	datput4.utl
IOPRIHWHAR	facomset.sav		facompar.rep	datput4.utl
IOPRISWHAR	facomset.sav		facompar.rep	datput4.utl
IOPRODVAL	facomset.sav		facompar.rep	datput4.utl
IOPUBCHECK	facomset.sav		facompar.rep	datput4.utl
IOPUBHWHAR	facomset.sav		facompar.rep	datput4.utl
IOPUBSWHAR	facomset.sav		facompar.rep	datput4.utl
IORESULTC	farpt.rep		faasmrpt.rep	facompar.rep
IORESULTP	farpt.rep		faasmrpt.rep	facompar.rep
IOTOTALVAL	facomset.sav		facompar.rep	datput3.utl
IPLACE	biomass.alt	biomass.alt		**** no use
ISCALE	fascale.mod	fascale.mod	fascale.mod	fascale.mod
ISCROPLAND	famodel.mod	famodel.mod		famodel.mod
ISCROPPROD	farpt.rep		faasmrpt.rep	faasmrpt.rep
ISEXIST	famodset.mod		faupdate.mod	faupdate.mod
		fascale.mod		
		famodel.mod		
		faaltrun		
		faforwel.rep		
ISNEW	famodset.mod		faupdate.mod	faupdate.mod
		famodset.mod		
		fascale.mod		
		famodel.mod		
		faaltrun		

faforwel.rep
faforrpt.rep
facrbrpt.rep

LABORGRW faagdat.dat faagdyn.dat famodel.mod
faagwel.rep
faasmrpt.rep

LABORSUM farpt.rep faasmrpt.rep faasmrpt.rep
facompar.rep

LANDCON famodel.mod famodel.mod famodel.mod
facrbrpt.rep
faagwel.rep

LANDCOST famodel.mod famodel.mod famodel.mod
faagwel.rep

LANDDISP farpt.rep faforrpt.rep faforrpt.rep
facomsav.sav
facompar.rep
putdat4.utl

LANDMIN fapoldat.dat fapoldat.dat fapoldat.dat fapoldat.dat
famodel.mod
faaltrun

LANDSHIFT fafinal.rep fafinal.rep fafinal.rep

LANDSUBDAT famodel.mod famodel.mod famodel.mod
faagwel.rep
faasmrpt.rep

LANDSUM farpt.rep faasmrpt.rep faasmrpt.rep
facompar.rep

LANDTOFOR farpt.rep faforrpt.rep **** no use

LANDTRANS fafordat.dat fafordat.dat fafordat.dat

LANDTRN fafordat.dat fafordat.dat fafordat.dat
famodel.mod
faforrpt.rep

LASTDAY	fasets.dat		fasets.dat	fasets.dat
			famodset.mod	
			famodel.mod	
			faforrpt.rep	
			faforwel.rep	
			faasmrpt.rep	
			faagwel.rep	
LIM	famodel.mod		famodel.mod	fasolvlp.mod
		faaltrun	fafinal.rep	
			facomput.sav	
MAXBI	biomass.alt		biomass.alt	biomass.alt
MAXBIO	biomass.alt	biomass.alt		biomass.alt
MICCUT	farpt.rep		faforrpt.rep	facomsav.sav
			facompar.rep	
			putdat5.utl	
MICHARVEST	facomset.sav		facompar.rep	fafinal.rep
			datput5.utl	
MILLRESID	biomass.dat	biomass.dat	biomass.dat	biomass.dat
			famodel.mod	
			faforrpt.rep	
MINHARV	fafordat.dat	fafordat.dat	fafordat.dat	fafordat.dat
		faaltrun	faupdate.mod	
			faaltrun	
MONEY	fapoldat.dat	fapoldat.dat		famodel.mod
MOVEDATA	biomass.dat		biomass.dat	biomass.dat
			famodel.mod	
			faforrpt.rep	
			faasmrpt.rep	
			faagwel.rep	
			facompar.rep	
MSCALE	fascale.mod		fascale.mod	fascale.mod

NATEROSION farpt.rep faasmrpt.rep **** no use

NATINPUSE farpt.rep faasmrpt.rep faagwel.rep
facompar.rep

NAVGROT farpt.rep faforrpt.rep faforrpt.rep

NETRADE farpt.rep faforrpt.rep **** no use

NEWAUMSSUP faagdat.dat faagdat.dat faasmcal.dat
famodel.mod
faagwel.rep

NEWBUDDATA faagdat.dat faagdat.dat faasmcal.dat faasmcal.dat
fascale.mod
famodel.mod
biomass.alt
faasmrpt.rep
faagwel.rep
facompar.rep

NEWFORES farpt.rep faforrpt.rep facomsav.sav
putdat7.utl

NEWFPPART faagdat.dat faagdat.dat faasmcal.dat faasmcal.dat
famodel.mod
faasmrpt.rep

NEWLABSUPP faagdat.dat faagdat.dat faasmcal.dat
famodel.mod
faagwel.rep
faasmrpt.rep

NEWLANDAVL faagdat.dat faagdat.dat allmap allmap
famodel.mod famodel.mod
biomass.alt

NEWLIVEBUD faagdat.dat faagdat.dat faasmcal.dat faasmcal.dat
fascale.mod
famodel.mod
faasmrpt.rep
faagwel.rep

NEWLNDSUPP faagdat.dat faagdat.dat allmap allmap
famodel.mod faasmcal.dat
famodel.mod
faagwel.rep

NEWMINHARV fafor.alt fafor.alt faaltrun

NEWMIXDATA faagdat.dat faagdat.dat faasmcal.dat
fascale.mod
famodel.mod

NEWNATMIXD faagdat.dat faagdat.dat fascale.mod
famodel.mod

NEWPOL farpt.rep faforrpt.rep facomsav.sav
facompar.rep
putdat4.utl

NEWPOPULAT faagdat.dat faagdat.dat faasmrpt.rep

NEWTECH biomass.alt biomass.alt biomass.alt

NEWWATSUP faagdat.dat faagdat.dat faasmcal.dat
famodel.mod
faagwel.rep
faasmrpt.rep

NEWYLD new.dat new.dat fafordat.dat fafordat.dat
famodset.mod
faupdate.mod
famodel.mod
faforrpt.rep
faforwel.rep
facrbrpt.rep

NLANDDISP facomset.sav facompar.rep fafinal.rep
datput3.utl

NOMILLDEM biomass.dat biomass.dat biomass.dat biomass.dat
famodset.mod
fafor.alt

OPTIMALITY facomset.sav facompar.rep fafinal.rep datput.utl

OWEL farpt.rep faforwel.rep faforwel.rep

OWNHWPROD farpt.rep faforrpt.rep **** no use

OWNSWPROD farpt.rep faforrpt.rep **** no use

P0Q0 facomset.sav facompar.rep facompar.rep
fafinal.rep fafinal.rep

P0Q1 facomset.sav facompar.rep facompar.rep
fafinal.rep fafinal.rep

P1Q0 facomset.sav facompar.rep facompar.rep
fafinal.rep fafinal.rep

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faasmrpt.rep

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faasmrpt.rep

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faasmrpt.rep

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facompar.rep

POLINC fapoldat.dat fapoldat.dat fapoldat.dat

PRICHECK farpt.rep farpt.rep facompar.rep

PRIHWHAR farpt.rep farpt.rep facompar.rep

PRISWHAR farpt.rep farpt.rep facompar.rep

PROCBUD faagdat.dat faagdat.dat faasmcal.dat biomass.dat
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faasmrpt.rep
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PROCSUM farpt.rep faasmrpt.rep **** no use

PROCWEL farpt.rep faagwel.rep faagwel.rep
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PRODUCTWEL farpt.rep faagwel.rep faagwel.rep
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PRODVAL farpt.rep farpt.rep facompar.rep

PROFITL faasmcal.dat faasmcal.dat faasmcal.dat

PROFITPR faasmcal.dat faasmcal.dat faasmcal.dat

PROGCOST facomset.sav facompar.rep facompar.rep
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PSCALE fascale.mod fascale.mod fascale.mod fascale.mod

PUBCHECK farpt.rep farpt.rep facompar.rep

PUBHWHAR farpt.rep farpt.rep facompar.rep

PUBSUP public.dat public.dat fafordat.dat fafordat.dat
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faaltrun
faforwel.rep
faforrpt.rep

PUBSWHAR farpt.rep farpt.rep facompar.rep

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faagwel.rep
faasmrpt.rep

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REGCARBINV facomset.sav facompar.rep facompar.rep
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RESULT faagdat.dat fasolvlp.mod fasolvlp.mod

REVWEL farpt.rep faagwel.rep faagwel.rep
faasmrpt.rep

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faforwel.rep

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SAVCONVERT faaltrun faaltrun faaltrun

SAVDISC faaltrun faaltrun faaltrun

SAVFARMPR faaltrun faaltrun faaltrun

SAVMINHARV faaltrun faaltrun faaltrun

SAVPUBSUP faaltrun faaltrun **** no use

SAVTRADCST faaltrun faaltrun faaltrun

SAVTRANCST faaltrun faaltrun faaltrun

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faagwel.rep
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faasmrpt.rep

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faasmrpt.rep

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faasmrpt.rep

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facompar.rep

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faasmrpt.rep
facompar.rep

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facrbrpt.rep
faasmrpt.rep

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faasmrpt.rep

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fafinal.rep
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datput3.utl

SHARDWOOD facomset.sav facompar.rep fafinal.rep
datput4.utl

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SIMPORTGRW faaltrun faaltrun faaltrun

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fafinal.rep datput4.utl

SLNDTOAG facomset.sav facompar.rep fafinal.rep
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SOFTAGEN farpt.rep faforrpt.rep faforrpt.rep

SOFTAREA farpt.rep faforrpt.rep facomsav.sav

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STICKYLIM fafordat.dat fafordat.dat fascale.mod
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STICKYSHAD facomset.sav facompar.rep fafinal.rep

STICKYTYPE fapoldat.dat fapoldat.dat famodel.mod

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STRNTOLDBA facomset.sav facompar.rep fafinal.rep
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faforrpt.rep

SUBLIMIT biomass.dat biomass.dat famodel.mod

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SUPCANADA canada.alt canada.alt canada.alt canada.alt
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SVENDPROD facomset.sav facomsav.sav putdat2.utl

SVFPCAP facomset.sav facomsav.sav putdat3.utl

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SVLANDDISP facomset.sav facomsav.sav putdat4.utl

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SVNEWPOL facomset.sav facomsav.sav putdat4.utl

SVREGSURP facomset.sav facomsav.sav putdat4.utl

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facompar.rep
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faforrpt.rep

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faforwel.rep

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faforrpt.rep

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faforrpt.rep

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TIMBCONQ	facomset.sav	facompar.rep fafinal.rep datput2.utl
TIMBCONS	facomset.sav	facompar.rep facompar.rep fafinal.rep datput3.utl
TIMBCONSP	fafinal.rep	fafinal.rep fafinal.rep
TIMBERHAR	facomset.sav	facompar.rep fafinal.rep datput4.utl
TIMBERHARP	fafinal.rep	fafinal.rep fafinal.rep
TIMBERINV	facomset.sav	facompar.rep fafinal.rep datput5.utl
TIMBERINVP	fafinal.rep	fafinal.rep fafinal.rep
TIMBINV	facomset.sav	facompar.rep fafinal.rep datput3.utl
TIMBINV2	fafinal.rep	fafinal.rep fafinal.rep
TIMBINV21	fafinal.rep	fafinal.rep fafinal.rep
TIMBINV21A	fafinal.rep	fafinal.rep fafinal.rep
TIMBINV3	fafinal.rep	fafinal.rep fafinal.rep
TIMBINV31	fafinal.rep	fafinal.rep fafinal.rep
TIMBINV31A	fafinal.rep	fafinal.rep fafinal.rep
TIMBPRICE	facomset.sav	facompar.rep facompar.rep fafinal.rep datput3.utl
TIMBPRICEP	fafinal.rep	fafinal.rep fafinal.rep
TIMBPROD	facomset.sav	facompar.rep facompar.rep fafinal.rep datput3.utl

TIMBPRODP fafinal.rep fafinal.rep fafinal.rep

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TIMBPROQ facomset.sav facompar.rep fafinal.rep
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TOLER faagdat.dat fasolvlp.mod fasolvlp.mod

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faforrpt.rep

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faforrpt.rep

TRADFOR tradedmd.dat tradedmd.dat fafordat.dat fafordat.dat
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faforrpt.rep

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faforrpt.rep

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faforrpt.rep

TREECARB facarbon.dat facarbon.dat facarbon.dat facarbon.dat
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facrbrpt.rep

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VERSION allmap allmap allmap
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inv.dat
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new.dat
est.dat
grow.dat
inter.dat
fpdmd.dat

rotate.dat
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faagdyn.dat
biomass.dat
facarbon.dat
faasmcal.dat
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fapoldat.dat
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faupdate.mod
fascale.mod
fasolvlp.mod
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faag.alt
fafor.alt
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facrbrpt.rep
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WELPRO farpt.rep **** no use

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WELRESID2 farpt.rep **** no use

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facrbrpt.rep
facompar.rep

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WTAG faagdat.dat faagdat.dat faagdat.dat
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faasmrpt.rep
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YESAG fasets.dat fasets.dat famodel.mod faupdate.mod
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fasolvlp.mod
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facrbrpt.rep
faasmrpt.rep
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fafinal.rep

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YESBIOMASS fapoldat.dat famodset.mod famodset.mod
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facrbrpt.rep
faasmrpt.rep
faagwel.rep

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faagwel.rep

YESFOR fasets.dat fasets.dat famodel.mod famodset.mod
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facrbrpt.rep

YESMILL famodel.mod famodel.mod famodel.mod
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YESMILLRES famodset.mod famodset.mod famodset.mod

YESMIX faasmcal.dat faasmcal.dat faasmcal.dat
famodel.mod

YESOP famodset.mod famodset.mod **** no use

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faaltrun

YESPNWW famodel.mod famodel.mod famodel.mod

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YESTWID famodel.mod famodel.mod famodel.mod

YR biomass.dat biomass.dat biomass.alt

YSPOLICY fapoldat.dat fapoldat.dat famodset.mod
famodset.mod faupdate.mod

Files where actions on EQUATIONS appear

ITEM NAME	DECLARED	DEFINED	ASSIGNED	REF
AGLDTRNLIM	famodel.mod	famodel.mod	fascale.mod	famodel.mod
				facompar.rep
ARTIFICIAL	famodel.mod	famodel.mod	fascale.mod	famodel.mod
				faagwel.rep
				faasmrpt.rep
AUMSR	famodel.mod	famodel.mod	fascale.mod	famodel.mod
				faagwel.rep
AVAILMONEY	famodel.mod	famodel.mod	fascale.mod	famodel.mod
BEND	famodel.mod	famodel.mod	fascale.mod	famodel.mod
BENDINVEN	famodel.mod	famodel.mod	fascale.mod	famodel.mod
CAPACLIM	famodel.mod	famodel.mod	fascale.mod	famodel.mod
CARBON	famodel.mod	famodel.mod	fascale.mod	famodel.mod
CAUMSR	famodel.mod	famodel.mod	fascale.mod	famodel.mod
CLABOR	famodel.mod	famodel.mod	fascale.mod	famodel.mod
CLAND	famodel.mod	famodel.mod	fascale.mod	famodel.mod
CNENDINVEN	famodel.mod	famodel.mod	fascale.mod	famodel.mod
COSTBAL	famodel.mod	famodel.mod	fascale.mod	famodel.mod
CPRDBALDEM	famodel.mod	famodel.mod	fascale.mod	famodel.mod
CPRIBALDOM	famodel.mod	famodel.mod	fascale.mod	famodel.mod
CPRIBALEXP	famodel.mod	famodel.mod	fascale.mod	famodel.mod
CPRIBALIMP	famodel.mod	famodel.mod	fascale.mod	famodel.mod

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CSECBALEXP famodel.mod famodel.mod fascale.mod famodel.mod

CSECBALIMP famodel.mod famodel.mod fascale.mod famodel.mod

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faasmrpt.rep

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INVENTORYA famodel.mod famodel.mod fascale.mod famodel.mod

LABOR famodel.mod famodel.mod fascale.mod famodel.mod
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faasmrpt.rep

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MAXCONV famodel.mod famodel.mod famodel.mod

MAXINP famodel.mod famodel.mod fascale.mod famodel.mod

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P5092 famodel.mod famodel.mod fascale.mod famodel.mod
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faasmrpt.rep

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facompar.rep

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faforrpt.rep

PRODBALSUP famodel.mod famodel.mod fascale.mod famodel.mod
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faforrpt.rep
facompar.rep

PUBAUMS famodel.mod famodel.mod fascale.mod famodel.mod

SECONDBAL famodel.mod famodel.mod fascale.mod famodel.mod
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faasmrpt.rep

SIPLANDBAL famodel.mod famodel.mod fascale.mod famodel.mod

STICKY   famodel.mod famodel.mod fascale.mod famodel.mod
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TRADEBAL   famodel.mod famodel.mod fascale.mod famodel.mod
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faforrpt.rep

TRNFRLDBAL famodel.mod famodel.mod fascale.mod famodel.mod
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TRNTOLDBAL famodel.mod famodel.mod fascale.mod famodel.mod
facompar.rep

UNHARVEST famodel.mod famodel.mod fascale.mod famodel.mod
faagwel.rep
faasmrpt.rep

WATERR   famodel.mod famodel.mod fascale.mod famodel.mod
faagwel.rep
faasmrpt.rep

WELFAR   famodel.mod famodel.mod fascale.mod famodel.mod

Files where actions on VARIABLES appear

ITEM NAME DECLARED   DEFINED   ASSIGNED   REF

ARTIF   famodel.mod   fascale.mod famodel.mod
faagwel.rep
faasmrpt.rep

AUMSPRIV   famodel.mod   fascale.mod famodel.mod
famodel.mod faagwel.rep

AUMSPRIVS famodel.mod fascale.mod famodel.mod
faagwel.rep

AUMSPUB famodel.mod fascale.mod famodel.mod
faagwel.rep

BUILDCAP famodel.mod fascale.mod famodel.mod
famodel.mod faforwel.rep
faforrpt.rep

CARBONSE famodel.mod fascale.mod famodel.mod
famodel.mod faaltrun
faaltrun facompar.rep

CCCLOANP famodel.mod fascale.mod famodel.mod
faagwel.rep
faasmrpt.rep

CCCLOANS famodel.mod fascale.mod famodel.mod
faagwel.rep
faasmrpt.rep

CONVRTFRAG famodel.mod fascale.mod famodel.mod
famodel.mod faforrpt.rep
faaltrun facrbrpt.rep
facompar.rep

CONVRTTOAG famodel.mod fascale.mod famodel.mod
famodel.mod faforrpt.rep
faaltrun facrbrpt.rep
facompar.rep

COSTS famodel.mod fascale.mod famodel.mod
faforwel.rep
faforrpt.rep

CROPBUDGET famodel.mod fascale.mod famodel.mod
famodel.mod faasmrpt.rep
biomass.alt faagwel.rep
facompar.rep

DEFPRODN famodel.mod fascale.mod famodel.mod
faagwel.rep

faasmrpt.rep

DEMANDFOR famodel.mod fascale.mod famodel.mod
famodel.mod faforwel.rep
faforrpt.rep

DEMANDFORS famodel.mod fascale.mod famodel.mod
faforwel.rep
faforrpt.rep

DEMANDP famodel.mod fascale.mod famodel.mod
famodel.mod faagwel.rep
faasmrpt.rep

DEMANDPS famodel.mod fascale.mod famodel.mod
faagwel.rep
faasmrpt.rep

DEMANDS famodel.mod fascale.mod famodel.mod
famodel.mod faaltrun
biomass.alt faagwel.rep
faaltrun faasmrpt.rep

DEMANDSS famodel.mod fascale.mod famodel.mod
faagwel.rep
faasmrpt.rep

DEMARTIF famodel.mod fascale.mod famodel.mod

DIVPRODN famodel.mod fascale.mod famodel.mod
faagwel.rep
faasmrpt.rep

ENDFUELSUB famodel.mod fascale.mod famodel.mod
faforrpt.rep
faforwel.rep

EXIST famodel.mod fascale.mod famodel.mod
faaltrun faforrpt.rep
faforwel.rep
facrbrpt.rep
facompar.rep

EXPORTP famodel.mod fascale.mod famodel.mod
famodel.mod faagwel.rep
faasmrpt.rep

EXPORTPS famodel.mod fascale.mod famodel.mod
faagwel.rep
faasmrpt.rep

EXPORTS famodel.mod fascale.mod famodel.mod
famodel.mod faagwel.rep
faasmrpt.rep

EXPORTSS famodel.mod fascale.mod famodel.mod
faagwel.rep
faasmrpt.rep

FAMILY famodel.mod fascale.mod famodel.mod
faagwel.rep
faasmrpt.rep

FUELSUB famodel.mod fascale.mod famodel.mod

HIRED famodel.mod fascale.mod famodel.mod
famodel.mod faagwel.rep
faasmrpt.rep

HIREDS famodel.mod fascale.mod famodel.mod
faagwel.rep
faasmrpt.rep

IMPORTP famodel.mod fascale.mod famodel.mod
famodel.mod faagwel.rep
faasmrpt.rep

IMPORTPS famodel.mod fascale.mod famodel.mod
faagwel.rep
faasmrpt.rep

IMPORTS famodel.mod fascale.mod famodel.mod
famodel.mod faagwel.rep
faasmrpt.rep

IMPORTSS famodel.mod fascale.mod famodel.mod

faagwel.rep
faasmrpt.rep

LANDFROMAG famodel.mod fascale.mod famodel.mod
famodel.mod faforrpt.rep
faaltrun facompar.rep

LANDSUB famodel.mod fascale.mod famodel.mod
faagwel.rep
faasmrpt.rep

LANDSUPPLS famodel.mod famodel.mod
facrbrpt.rep
faagwel.rep

LANDSUPPLY famodel.mod famodel.mod famodel.mod
facrbrpt.rep
faagwel.rep

LANDTOAG famodel.mod fascale.mod famodel.mod
famodel.mod faagwel.rep
faaltrun facompar.rep

LVSTBUDGET famodel.mod fascale.mod famodel.mod
famodel.mod faasmrpt.rep
faagwel.rep

MIXR famodel.mod fascale.mod famodel.mod

MOVCOMFRAG famodel.mod fascale.mod famodel.mod
faaltrun faforwel.rep
faforrpt.rep
faagwel.rep
faasmrpt.rep

MOVCOMTOAG famodel.mod fascale.mod famodel.mod
faaltrun faforrpt.rep
faasmrpt.rep
faagwel.rep
facompar.rep

NATMIX famodel.mod fascale.mod famodel.mod

NEW famodel.mod fascale.mod famodel.mod
faaltrun faforrpt.rep
faforwel.rep
facrbrpt.rep
facompar.rep

PRDN5092 famodel.mod fascale.mod famodel.mod
faagwel.rep
faasmrpt.rep

PROCESS famodel.mod fascale.mod famodel.mod
famodel.mod faagwel.rep
faasmrpt.rep
facompar.rep

PRODUCTSUB famodel.mod fascale.mod famodel.mod
faforwel.rep
faforrpt.rep

TERMVOLN famodel.mod fascale.mod famodel.mod
faforwel.rep
faforrpt.rep

TERMVOLNS famodel.mod fascale.mod famodel.mod
faforwel.rep

TOLR famodel.mod fascale.mod famodel.mod
famodel.mod

TRADEFPTRN famodel.mod fascale.mod famodel.mod
faforwel.rep
faforrpt.rep

TRADEQUAN famodel.mod fascale.mod famodel.mod
famodel.mod faforwel.rep
faforrpt.rep

TRADEQUANS famodel.mod fascale.mod famodel.mod
faforwel.rep
faforrpt.rep

TRANSFOR famodel.mod fascale.mod famodel.mod
faforwel.rep

faforrpt.rep

TWID	famodel.mod	fascale.mod famodel.mod famodel.mod	
UNHARV	famodel.mod	fascale.mod famodel.mod faagwel.rep faasmrpt.rep	
WATERFIX	famodel.mod	fascale.mod famodel.mod faagwel.rep faasmrpt.rep	
WATERVAR	famodel.mod	fascale.mod famodel.mod famodel.mod faagwel.rep faasmrpt.rep	
WATERVARS	famodel.mod	fascale.mod famodel.mod faagwel.rep faasmrpt.rep	
WELFARE	famodel.mod	fascale.mod famodel.mod fasolvlp.mod faforwel.rep faagwel.rep facompar.rep	

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