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## **Resource Policy Analysis**

### **Documentation of ASM: The U.S. Agricultural Sector Model**

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# **DOCUMENTATION OF ASM: THE U.S. AGRICULTURAL SECTOR MODEL**

## **1.0 INTRODUCTION**

This publication documents the basic features, assumptions and usage of the agricultural sector model (ASM) of the United States that is currently resident in the Department of Agricultural Economics at Texas A&M. Various versions of the ASM have been and are being used to investigate the economic impacts of technological change, trade policy, commodity programs, environmental policy, and global warming on the U.S. agricultural sector (Baumes; Burton and Martin; Chattin; Tyner, et al.; Hamilton; Adams, Hamilton, and McCarl; Hickenbotham; House; Tanyeri-Abur; Coble, et al; Chang et al.; Chang, Eddleman, and McCarl; Adams, et al.). Work is underway with a version which includes details on farm practices and associated erosion levels which is used to evaluate soil and water conservation policy issues (Alt, et al.; Atwood, et al.). This documentation will cover two model versions: the basic model and the one with soil and water conservation extensions.

The current version of the ASM is implemented using a software package called GAMS (General Algebraic Modeling System, Brooke, Kendrick, and Meeraus). The GAMS language provides a concise way to describe the model structure and, permits modifications for application-specific needs. This document will cover the GAMS formulation.

The next section provides a brief description of the theoretical structure of ASM. The empirical side of ASM is described in following section providing an overview of model scope, data sources and GAMS implementation. Finally, we will discuss applications, model validation, and alternative model specifications.

## 2.0 MODEL OVERVIEW

### 2.1 Conceptual Features

Conceptually, the ASM is a price-endogenous mathematical programming model based on the spatial equilibrium models developed by Samuelson and Takayama and Judge as reviewed by McCarl and Spreen and Norton and Schiefer. ASM was originally designed to simulate competitive equilibrium solutions under a given set of demand and supply conditions. The ASM objective function is the summation of all areas beneath the product demand curves minus the summation of all areas under the import and factor supply curves. Collectively such an objective represents the area between the aggregate demand and supply curves to the left of their intersection. Economists also refer to that area as producers' and consumers' surplus. This objective function represents a social welfare function which, within the limitations of consumers' and producers' surplus (Just, Hueth and Schmitz), measures the benefits of producers' and consumers' from producing and consuming agricultural commodities. The production and consumption sectors are assumed to be made up of a large number of individuals operating under competitive market conditions. When producers' plus consumers' surplus is maximized, the model solution represents an intersection of the supply and demand curves and, thus, simulates a perfectly competitive market equilibrium. Prices and quantities for all factors of production and outputs are endogenously determined by the supply and demand relationships for all the commodities in the model.

The basic nature of ASM is summarized in the following underlying mathematical equations. Consider a sector containing agricultural commodity markets with the quantity traded being ( $Q_i$ ) produced by production possibilities  $X_{nk}$  using land ( $L_k$ ), labor ( $R_k$ ) and water ( $W_k$ ) as well as other



variable inputs (including seed, fertilizer, etc.). Let integrable inverse demand functions for the commodities exist and be given by:

$$(1) \quad P_i^Q = R_i(Q_i), \quad \text{for all commodities } i$$

Furthermore, assume inverse supply relations exist for land, labor and water by region which are given by

$$P_k^L = \mu_k(L_k), \quad \text{for all regions } k$$

$$(2) \quad P_k^R = \beta_k(R_k), \quad \text{for all regions } k$$

$$P_k^W = T_k(W_k) \quad \text{for all regions } k$$

where  $P^Q$ ,  $P^L$ ,  $P^R$ , and  $P^W$  are the corresponding commodity and regional factor prices.

The ASM formulation is essentially given by the following optimization problem:

$$\begin{aligned}
 (3) \quad \text{Max} \quad & \int_i R_i(Q_i) dQ_i & & \int_n c_{nk} X_{nk} & & \int_k \mu_k(L_k) dL_k & & \int_k \beta_k(R_k) dR_k & & \int_k T_k(W_k) dW_k \\
 (4) \quad \text{subject to} \quad & Q_i & & \int_n y_{ink} X_{nk} & & & & & & \#0, \text{for all } i, \\
 (5) \quad & & & \int_n X_{nk} & & L_k & & & & \#0, \text{for all } k, \\
 (6) \quad & & & \int_n f_{nk} X_{nk} & & R_k & & & & \#0, \text{for all } k, \\
 (7) \quad & & & \int_n g_{nk} X_{nk} & & & & W_k & & \#0, \text{for all } k.
 \end{aligned}$$

where the parameters other than these discussed above are:

$c_{nk}$ . the per unit variable input cost of producing the  $n^{\text{th}}$  production possibility in the  $k^{\text{th}}$  region;

$y_{ink}$ . the per acre yield of the  $i^{\text{th}}$  commodity using the  $n^{\text{th}}$  production possibility in the  $k^{\text{th}}$  region;

$f_{nk}$ . the per acre labor use of the  $n^{\text{th}}$  production possibility in the  $k^{\text{th}}$  region; and

$g_{nk}$  the per acre water use of the  $n^{\text{th}}$  production possibility in the  $k^{\text{th}}$  region.

The problem contains non-negative decision variables  $Q_i$  which give the amount of commodity  $i$  consumed;  $X_{nk}$  the amount of the  $n^{\text{th}}$  production possibility employed in the  $k^{\text{th}}$  region;  $L_k$  which is the amount of land supplied in region  $k$ ;  $R_k$  the amount of labor supplied in region  $k$ ; and  $W_k$  the amount of water supplied in region  $k$ .

Equation (3) is the objective function where producers' plus consumers' surplus is optimized.

Equation (4) depicts the supply/demand balance equations which are defined for all commodities.

Equations (5)-(7) balances usages of land, labor and water with supplies ( $L$ ,  $R$  and  $W$ ). On solution, this model yields market clearing levels for  $Q$ ,  $X$ ,  $L$ ,  $R$  and  $W$  which simulate a competitive equilibrium.

The shadow prices on equation (4) give market clearing prices for the commodities while the shadow prices on (5) - (7) give regional specific land, labor, and water prices.

## **2.2 Modeling Farm Programs**

The importance of the farm program in the early 80's and early 90's indicated that the ASM model could not be satisfactory be used in all cases unless farm program features were incorporated.

While such features distort the perfectly competitive equilibrium, they can be modeled as if the sector came to a perfectly competitive equilibrium with wedges between market and producer prices.

However to do this one must assume that the farm program provisions remain in place long enough for the sector to adjust to their presence. This involves assuming for example, that base acreage building can occur, that farm program yields adjust to equal approximately the realized yields and that loan rate accumulations are disposed of in a manner which does not distort the markets in the model.

The five major farm program compounds included in the sector model are:

1) the commodity price support loans, 2) target prices and associated deficiency payments, 3) marketing loans, 4) flexibility acres and 5) conservation reserve program. The 50/92, 0/92 and paid diversion acreage reduction programs are also included. Model formulation features required to reflect the operation of these programs are presented in the following sections.

### 2.2.1 Price Support Loans

Under the price support program, the formulation assumes that farmers receive a payment equal to the support price (loan rate) for each unit of the commodity placed under the loan. Also the government is assumed to take possession of the commodity. The total production of participating farmers is assumed to be eligible for the loan. Soybean producers are unique because they do not participate, but are still eligible for the loan. This implies that eligible commodities face a demand curve which kinks at the loan rate and that government purchases maintain a market price floor at the loan rate.

In the sector model formulation, incorporating the loan rate requires addition of a government purchase activity ( $Q_i^{LN}$ ) which removes the commodity from the market clearing constraint while reflecting receipt of the loan rate ( $P_i^{LN}$ ) for those commodities in the objective function. Here, LN indicates the set of crops with a loan rate. Thus, equations (3) and (4) become:

$$\begin{aligned}
 (8) \quad & \text{Max} \quad \sum_{i \in LN} T_i(Q_i) dQ_i \quad + \quad \sum_{i \in LN} P_i^{LN} Q_i^{LN} \quad + \quad \sum_{n,k} E E c_{nk} X_{nk} \quad + \quad \sum_{k,m} E \mu_k(L_k) dL_k \quad + \quad \sum_{k,m} E \$_k(N_k) dN_k \quad + \quad \sum_{k,m} E T_k(W_k) dW_k \\
 (9) \quad & \text{subject to} \quad Q_i \quad + \quad Q_i^{LN} \quad + \quad \sum_{n,k} E E y_{ink} X_{nk} \quad = \quad 0 \quad \text{for all } i \in LN \\
 (10) \quad & \quad \quad \quad O_i^{LN} \quad + \quad \sum_{n,k} E E y_{ink}^P X_{nk} \quad = \quad 0 \quad \text{for all } i \in LN \\
 (11) \quad & \quad \quad \quad Q_i \quad + \quad \sum_{n,k} E E Y_{ink} X_{nk} \quad = \quad 0 \quad \text{for all } i \in LN
 \end{aligned}$$

Operationally, if the market price is greater than the loan rate, all production goes into the market. The optimality conditions insure that the loan rate provides a floor for the market price on the participating

production. The commodity is consumed in the market until the loan rate is reached. At the loan rate part will enter the market with the rest sold to the government. The presence of the constraint (10) restricts the loan purchase to be no more than the participating production (except for soybeans).

A potential conceptual problem exists with the loan rate part of the model. Namely when commodity is purchased under the loan it is removed from the market and never reenters. The loan rate only makes sense in either a stochastic world (ie. where the production in some years is considerably smaller than that in other years so the stocks to reenter the market) or in case where the loan rate commodities are put to some other usage not endogenous to the model whether it be PL480 exports, or some other use such that none of this commodity reenters the market. Actually the storage implicit with the loan rate conflicts with the equilibrium nature of the model. Net storage increases should not occur in a long run equilibrium model. The average withdrawals from storage should equal the average placements to storage and net storage addition should be zero.

### 2.2.2 Target Price and Deficiency Payment

The target price and associated deficiency payment features of the farm program model participating farmers reacting to a deficiency payment amounting to the difference between the target price and the market price when the market price is below the target price (in the absence of a marketing loan). The payment is based on the farm program yield.

There are several additional aspects of the program which need to be modeled which are.

1. Participants can voluntarily divert additional acreage into the optional diversion program, 0/92 or 50/92 programs in turn receiving payments on that land.

2. Statistics from the USDA Agricultural Stabilization and Conservation Service (ASCS) show because of various reasons (e.g. payment limitations) that some participating acreage does not receive full deficiency payments.
3. Some planted acres receive deficiency payments even though they are not harvested (cotton is an example where the 1986 enrolled paid acreage exceeded harvested acreage).
4. Participation is voluntary so there will be non participating production.

Formulation of a model incorporating the deficiency payment program provisions involves modeling the following production classes: (1) non-participating production, (2) participating production which receives deficiency payments; (3) 0/92 and 50/92 foregone production which receives payments as a function of deficiency payments; and (4) production above and below the farm program yield ( $\bar{Y}$ ) which partially enters the market when yields fall above  $\bar{Y}$  involves a shortfall being paid the deficiency payment when below  $\bar{Y}$  involves a shortfall paid the deficiency payment when below  $\bar{Y}$ ; (5) foregone production on planted participating land which is unharvested and (6) diverted acreage which receive diversion payments.

This leads to a model with several production categories. They are: (a) production eligible for deficiency payments based on the lesser of the actual and the farm program yield; (b) production which goes directly into the market and is ineligible for deficiency payments due to non-participation and/or that portion of the yield in excess of farm program yield; and

(c) entitlement yield for which farmers receive payments, but which is not really produced. The entitlement yield includes the cases of : a) actual yield falling short of the farm program yield with farmers paid for the farm program yield, b) production on enrolled but unharvested acreage, and c) foregone production on 0/92, 50/92 and diverted acreage. Compliance and other maintenance costs for set-aside, diverted and 0/92, 50/92 acres are accounted along with other production costs in the objective function. Land usage on the participating farms is computed as the total acreage used per acre harvested which includes the set-aside, 0/92, 50/92 and diverted acreage.

The above features mandate modification of the objective function, the land constraint and the commodity market clearing constraint. Denoting the farm program crops with FP, the objective function becomes:

$$(11) \text{ Max } \int_i R_i(Q_i) dQ_i + \int_{i \in \text{FP}} P_i^{\text{DEF}} Q_i^{\text{DEF}} - \sum_k C_{nk} X_{nk}^{\text{nonpart}} - \sum_k (C_{nk} + V_{2_{nk}}) X_{nk}^{\text{part}} \\ + \sum_k m_k(L_k) dL_k + \sum_k m_k(N_k) dN_k + \sum_k m_k T_k(W_k) dW_k$$

where

$P_i^{\text{DEF}}$  represents the deficiency payment per unit of the  $i^{\text{th}}$  farm program commodity;

$Q_i^{\text{DEF}}$  is the amount of commodity  $i$  receiving deficiency payments;

$V$  is the compliance cost associated with idled land

$2_{nk}$  is the set-aside 0/92, 50/92 and diverted acreage requirement for the acreage grown under the  $n^{\text{th}}$

production possibility in region  $k$ ;

$X_{nk}^{\text{Part}}$  is participating production

$X_{nk}$  non-part is the non-participating acreage.

The main differences between equation (3) and (11) involve the deficiency payment and compliance cost terms associated with participating in the farm programs.

The commodity market clearing constraint also requires modification. The constraint for commodities not covered by the program is largely unaffected.

$$(12) \quad Q_i \text{ \& \text{ ' ' } } y_{ink} X_{nk}^{\text{nonpart}} \# 0, \quad \text{for all } i \in \text{FP}.$$

However, the farm program commodity market clearing constraint is split into two constraints. One balances eligible participating production with that receiving deficiency payments.

$$(13a) \quad Q_i^{\text{DEF}} \text{ \& \text{ ' ' } } y_{ink}^3 a_i^3 X_{nk}^{\text{part}} \# 0, \text{ for all } i, \text{ FP}$$

and the other balances the total market

(13b)

$$Q_i \text{ \& \text{ ' ' } } Q_i^{\text{DEF}} \text{ \& \text{ ' ' } } E \text{ \& \text{ ' ' } } E \text{ \& \text{ ' ' } } y_{ink}^1 X_{nk}^{\text{nonpart}} \text{ \& \text{ ' ' } } (y_{ink}^1 a_i^1 \% y_{ink}^2 a_i^2 \% y_{ink}^4 a_i^3) X_{nk}^{\text{part}} \# 0, \quad \text{for all } i \in \text{FP}$$

Ignoring the subscripts,

$a^1$  is the proportion of nonparticipating cropland;

$a^2$  is the proportion of participating cropland which does not receive payment;

$a^3$  is the proportion of participating cropland which receives full payment

$y^1$  is the per acre yield on non-participating land

$y^2$  is the per acre yield on participating land

$y^3$  is the smaller of the farm program yield, or the actual yield and

$y^4$  is the per acre yield above farm program yield which is not eligible for payments.

The second term in equation (13a) accumulates the yield eligible for deficiency payments times participating acreage planted. Thus,  $Q_i^{DEF}$  represents commodities in the market receiving deficiency payments. Equation (13b) balances market demand with total production. This includes the amount produced which from acres which are not participating plus that does not receive payments (i.e. that produced on participating acres which is ineligible and that produced in excess of the farm program yield) plus the amount receiving deficiency payments ( $Q_i^{DEF}$ ). Thus, the participating quantities receive both the deficiency payment (by being transferred from the farm program row to the market) plus the market price.

To complete the model, the land endowment constraint becomes:

$$(14) \quad \sum_n [X_{nk}^{nonpart} + (1 - \alpha_{nk}) X_{nk}^{part}] + L_k \leq 0, \quad \text{for all } k;$$

where  $\alpha_{nk}$  times  $X_{nk}$  represents the required set-aside, 0/92, 50/92 and diverted acres times the participation rate.

### 2.2.3 Marketing Loans

The 1985 Farm Bill introduced marketing loans for rice and cotton. Marketing loans allow farmers to repay loans at the world price which may be lower than the U.S. price. The model, therefore, allows market price to fall below the marketing loan rate (MLR) and provide producers an additional payment (the difference between MLR and the market price) to offset the lower producer selling price. Modeling of these payments resembles that of the target price and deficiency payments. When the market price is below MLR, the per unit payment is the difference between the MLR and the market price with the deficiency payment equaling the difference between the target price and MLR. When market price is above MLR, there are no marketing loan based payments.



#### 2.2.4 Flexibility Acres

The 1990 farm program introduced the concept of flexibility acres under which the farm program commodities eligible are a only proportion of the base acreage. We do not model the base acreage conditions. Since they conflict with the overall equilibrium assumption of the model (ie. in the model supply adjusts to demand and demand adjust to supply but base acreage constraints limit adjustment). In order to continue solving longer run equilibrium problems and model possibilities that farmers may go in and out of the program to build base, the model is utilized without base acreage constraints but with a maximum participation rate cut down by the flexibility acreage. Thus, under the 1990 program where the flexibility acreage allowance was 15% what happens is that all maximum farm program participation rates are reduced by 15% which means that only 85% of the historical participating acreage can be paid and this therefore models and allows farmers to make adjustments in their base acreage.

#### 2.2.5 CRP Land

Yet another important component of the farm programs in the late 80's and early 90's involved the CRP program which removed approximately 35 million acres from production but only for a finite time period. If the program does not continue parts of the CRP acreage will revert into production. Thus we constructed features to mode this. Currently, ASM holds CRP acreage in a separate account. When CRP reversion is to be modeled, the land supply curve is shifted outward in a horizontal fashion by the amount of CRP land available and also the maximum land in each of the regions is shifted outward.

#### **2.2.6 Endogenization of Deficiency Payment**

Because market prices are endogenous in ASM, both the deficiency and marketing loan payments are also endogenously determined. A rapid executing, non-iterative formulation could not be found which simultaneously determines equilibrium prices and deficiency payment level. Consequently, an iterative approach is implemented as follows:

- (1). Input an initial guess for the summed deficiency plus marketing loan payment.
- (2). Solve ASM using the current guess.
- (3). Test to see if the producer price (i.e., the shadow price on the participating production row) has converged to the target price or a price above that. If for all commodities, either the participating price exceeds the target price with a zero summed payment or convergence is attained, stop.
- (4). Revise the summed payment so it equals the previous guess plus a fraction (currently set to 110%) of the difference between the participating producer price and the target price.
- (5). Set any negative payment to zero. Go to step (2).

### **2.2.7 Endogenization of Farm Program Participation**

ASM endogenizes the program participation rate. This is done as depicted in equations (13a, b) where both participating and non-participating production possibilities (budgets) are defined. The participating budgets are setup with the cropped acreage in the program set at the maximum participation rate. Thus if that rate were 90% in a region the activity would depict 90% of the yield times the flexibility requirement as deficiency payment eligible and 10% plus the flexibility requirements

as not. ASM then determines the optimal participation rate by selecting between the participating and non-participating budgets.

The yields are obtained based on the assumption that the removal of farm program provisions will reduce crop yields by eliminating slippage effects, as well as decrease marketing costs per harvested acre by the percentage reduction in yield. Thus the yield is set at the participation rate is endogenized in the sense that the choice of participation is determined by the relative price (per acre revenues minus cost) received on the participating land and non-participating land with any combination of participation between none and the base level permissible. The amount of 0/92, 50/92, diverted, unpaid and unharvested acreage is assumed to be in fixed proportion to the total participating acreage in a state and thus are not fully endogenized. The simulation of alternative farm program provisions can be achieved by altering the target prices, loan rates, diversion payments and set-aside requirements.

### **2.3 Aggregation**

Linear programming models have often been cited as having aggregation problems. The linear programming aggregation problem has been studied for a number of years (i.e. see the developments from Day to Onal and McCarl with the literature as cited in between). The aggregation problem arises since it is not possible to model the full micro economic detail of all firms in the agriculture sector. As a consequence aggregate models have to be used. In ASM subregional level models are used to depict all production within a state. This can lead to excessive specialization as in a linear programming model basic solutions permit only as many nonzeros in a solution as there are constraints. And in the case there are only three or four constraints in each sub region. Thus in a state with ten or fifteen cropping possibilities and a 15 or so of livestock possibilities this would yield excessively specialized solution.

The aggregation problem is approached in ASM in two different ways. Basically one approach is used for crops and the different approach is used for livestock.

### 2.3 Crop Mixes

The approach that is used for crops follows the aggregation discussions in Onal and McCarl. In that approach the crops in a region are required to fall in a combination of historical crops in that region. The basic modeling approach, say in a typical region, is reflected by the equations below:

$$X_{is} - \sum_m A_{ims} C_{ms} = 0 \text{ for all } i \text{ and } s$$

$$\sum_i X_{is} - \sum_m \sum_i A_{ims} C_{ms} = 0 \text{ for all } s$$

In this table  $X_{is}$  are the cropping possibilities for crop  $i$  in region  $s$   $A_{ims}$  is the amount of the  $i$  crop observed in the  $m$ th historical mix in region  $s$  and  $C_{ms}$  is the amount of the  $m$ th historical mix that is utilized in region  $s$ . The two equations require that the acreage devoted to crop  $i$  in region  $s$  ( $X_{is}$ ) equal the historical mix times a mix variable. In the second constraint total acres farmed is set equal to the total acreage coverage by the mixes. This allows the acreage of the historic mixes to float up and down but requires that crops fall in a combination of the historic proportions.

The reason for this kind of modeling falls back to a theoretical basis based on Dantig-Wolfe decomposition. This is a case where theoretically one is dealing with an aggregate model while ignoring a lot of constraints. In such a case, the solution to the aggregate model has to be at an extreme point to the constraints that are being ignored. In this case then the solution should not reflect individual acreage of individual crops but rather should reflect a mix of a number of crops. The historical crop mixes give

this information. They in effect contain the information on the constraints faced by farmers when allocating land. Thus ASM includes these restriction on a state by state basis covering all of the major crops in the model. The source of the historical crop mixes is acreage harvested in USDA Agricultural statistics from approximately 1970-90.

### 2.3.2 National-Livestock Mixes

Due to possibility that livestock numbers fluctuate up and down substantially, it was decided not to use the crop mix approach for livestock. Rather it was decided to require distribution of subregional livestock numbers across the country to fall into a convex combination of the historical livestock numbers in that subregion. This prevents extreme specialization again. For example in some very early solutions that was found because the model didn't have transportation and spatial price differentials that all the production of certain types of animals was headquartered in one or two states.

The approach used here is reflected by the following equation:

$$\sum_j L_{sij} X_j \leq \sum_m Q_{sim} Y_{im} \quad \text{for all } s \text{ and } i$$

Where  $L_{sij}$  is the number of units of commodity  $i$  produced in state  $s$  by livestock production activity  $X_j$  which gives the number of units of the  $j$ th livestock production activity undertaken. Simultaneously  $Q_{sim}$  is the number of units of the commodity  $i$  produced in subregion  $s$  in the  $m$ th historical period and  $Y_{im}$  is the amount of the  $m$ th region activity for commodity  $i$  uses in the model. What this model then does is spread production out across the region according to the historical pattern.

## 2.4 Foreign Trade

An important aspect of ASM is that it depicts an economy open to foreign trade. Both processed and unprocessed commodities can be imported or exported. Explicit excess demand

equations are specified for exports and excess supply equations are specified for imports. Incorporation of these features into the model modifies the objective function and product balance equations so that they become

$$\int_{Q_i} R_i(Q_i) dQ_i - \int_{Q_i^{Exp}} S_i(Q_i^{Exp}) dQ_i^{Exp} + \int_{Q_i^{Imp}} S_i(Q_i^{Imp}) dQ_i^{Imp} + \sum_n \sum_k c_{nk} X_{nk} + \sum_k \mu_k(L_k) dL_k + \sum_k p_k(R_k) dR_k + \sum_k m_k$$

The new objective function terms are positive the area under the excess demand equation ( $\int_{Q_i} R_i(Q_i) dQ_i$ ) for exports minus negative the integral of the area underneath the excess supply equation for imports ( $-\int_{Q_i^{Exp}} S_i(Q_i^{Exp}) dQ_i^{Exp}$ ). We also modify the product balance equation so that we reflect exports ( $Q_i^{Exp}$ ) as a usage of the commodity and imports ( $Q_i^{Imp}$ ) as an alternative supply of the commodity. The net affect is the objective we now maximize total domestic and the rest of the world producers' and consumers' surplus. We add a term to the product balance which shows two sources of supply now domestic production and imports as well as two sources of demand which are exports and domestic consumption.

## 2.5 Processing

Agriculture commodities are quite frequently substitutable in demand. For example, sorghum is almost a perfect substitute for corn in many uses on a calorie for calorie basis and beet sugar is a perfect substitute for cane based sugar. Also, a number of feed grains are substitutes in terms of livestock feeding. ASM contains a set of processing activities which make secondary commodities. Secondary commodities are generally included in the model either to represent substitution or to aid in meeting the demand in commonly available statistics. For example, soybeans are crushed into soybean meal and soybean oil because these things frequently flow into different markets with different amounts

of the two commodities being exported. The processing activities in the model are generally relatively simplistic reflecting a simplified view of the resources used in processing. They largely contain primary commodity usage, secondary commodity yield and a cost. Thus, for example, in soybean crushing the processing activity uses one unit of soybeans and generates a given number of pounds of soybean meal and tons of soy bean oil at a cost. The cost is usually the observed price differential between the value of the outputs and the value of the inputs according to Agriculture statistics. The basic processing addition to the model then is as reflected below :

$$\begin{aligned}
 & \text{Max} \quad \sum_m R_i(Q_i)dQ_i \quad - \quad \sum_j P_j(S_j)dS_j \quad + \quad \sum_n E C_{nk} X_{nk} \quad + \quad \sum_k \mu_k(L_k)dL_k \quad + \quad \sum_k B_k(R_k)dR_k \quad + \quad \sum_k T_k(W_k)dW_k \\
 \text{subject to} \quad & Q_i \quad + \quad \sum_n E y_{ink} X_{nk} \quad - \quad \sum_m P_{mi} Z_m \quad \leq 0, \text{ for } i \\
 & \quad \quad \quad + \quad \sum_n E Y_{mj} Z_m \quad \leq 0, \text{ for } j
 \end{aligned}$$

Where the variable  $Z_m$  is the  $m$ th processing activity  $P_{Mi}$  is the amount of the  $i$ th primary product used  $Y_{mj}$  is and the yield of the  $m$ th secondary product. The variable and the consumption of processed products. Note that in terms of the processing activities and the processed commodities they can go to usages in other processing export/import or domestic consumption.

The processing activities contain several features a couple of which are worth mentioning. Generally the processing activities either take primary commodities and convert them to some mixture of secondary commodities, ie. soybeans to soybean meal and oil or take primary commodities and apply transformation coefficients to obtain different quantities ie. they convert beef on the hoof to carcass beef. Also they may depict different mixtures of primary commodities which can be used in creating secondary commodities. Generally this is done in feed mixing.

## 2.5 Profit Calculation

One important conceptual feature of the model involves the so called profit calculation. The model is structured based on farm production budgets and USDA Agricultural Statistics National average prices. However there is a problem in using these and that is that prices received are really received at the farm level not at the national level and so there are regional differentials in price. Similarly the source farm production budgets all report different regional prices. Furthermore the USDA prices received can be on a different basis ie. they might involve the price received at the elevator rather than the price received at the farm or in the field. Under these circumstances, the decision was made to rely on the economic theory of the competitive market and structure the model so that the marginal cost of production at current levels of production equals the marginal cost of production. This led to the "profit" calculation based on an idea originally expressed by Miller & Miller and later utilized by Fajardo et al. Each production and processing budget comes from actual production actual activity that was undertaken during the year that the budget was collected. When production budgets are collected one does not collect data on the production possibility set rather one collects data on actual observations of the actual production patterns. As such then in the base year one needs to assume that these goods are being produced for the price that prevails in the national market. Consequently a term is computed for each budget which equates the marginal value of its output and the marginal cost of input. Thus if one has a corn production activity which uses land, labor, water and miscellaneous inputs one calculates a profit term which is equal to the base period corn price times base period corn yield minus the base period water price times the amount of water used minus the rental rate of land times land used minus the prevailing labor wage rate times labor used minus the sum of the other input prices times quantity used. This residual is called "profit". If one in turn solves the



model and adds this profit as a cost term where this term explains marketing costs omitted from the model along with nominal rents to certain fixed factors then if the shadow prices in the model fall at the base period prices for the crops and factors then this model has a zero reduced cost and therefore is a candidate to be a basic activity of a solution in a linear programming model. This is done for both the crop production and livestock activities.

## 2.6 Demand Curve Integration

A number of features are used in the context of handling the demand curve which merit discussion. First the demand curve is assumed to be an own quantity dependent inverse demand curve which can be integrated. The general form of the integral on the demand curve is where  $\int_a^Q P(Q)dQ$  and A&B give the limits of integration P(Q) the demand curve and Q the quantity over which the integral curve is swept. Generally in the model the equivalent form of this is where  $Q^* \int_a^Q P(Q)dQ$  is the equilibrium quantity in the solution and Q is a lower bound on integration. There are some particular procedures used in ASM for setting up this demand curve which merit review.

First all the demand curves are assumed to be of the cost elasticity form  $P = P(Q) = F Q^{1/E}$  where F is a constant and E the elasticity. The demand curve is set up so it passes through a given price quantity point with a given elasticity thus giving a price  $\hat{P}$  quantity  $\hat{Q}$  and the elasticity. The curve parameter F is specified so that

$$F = \hat{P} \hat{Q}^{1/E}$$

which renders the original curve of the form

$$P = \hat{P} (Q/\hat{Q})^{1/E}.$$

This curve has a numerical accuracy attributes as forming the ratio  $Q$  over  $\hat{Q}$  and then exponentiating.

When this curve is integrated one faces the difficulty that the curve becomes asymptotic to the axis. Thus given inelastic curve for small  $Q$  of  $Q$  one gets very large areas. In that particular case the integration was reexpressed so that it is of the form as follows

$$P = \hat{P} (Q/\hat{Q})^{1/E}$$

which after integration becomes

$$\frac{\hat{P}}{(1 - \frac{1}{E})} (Q/\hat{Q})^{1/E} \Big|_{\hat{Q}/10}^{\hat{Q}} = \frac{\hat{P}}{1 - \frac{1}{E}} (Q/\hat{Q})^{\frac{E-1}{E}} \Big|_{\hat{Q}/10}^{\hat{Q}} = \frac{\hat{P}}{(1 - \frac{1}{E})} \left[ (Q/\hat{Q})^{\frac{E-1}{E}} - \left(\frac{1}{10}\right)^{\frac{E-1}{E}} \right]$$

This is the formula that is used in the model. Note this formula requires that  $E$  cannot equal the numerical value minus one as the denominator becomes undefined. This particular formulation has a couple of implications. First an obviously the quantity cannot fall below  $1/a$  the equilibrium quantity. But assuming the demand curve is properly formed this is quite an unusual occurrence. Second, the area is not as large as one might get as one might truly integrated the curve out from zero as a very large block near the axis is cut off. The truncation factor  $a$  is set at the point where the quantity is equal to  $1/10$ th equilibrium quantity or the price is equal to 10 times the equilibrium quantity this mean in a case of in elastic demand curves that the quantity is larger than  $1/10$ th the equilibrium.

## 2.10 Dynamic Setting

Features have been added to the ASM model to do dynamic updating. These features involve the ability to project forward yields, domestic demand, import and exports for the major commodities.

Also the quantities available of cropland, pasture, AUMS, labor, and water as well as the prices of inputs are projected. They are also features in the model to update the usage of inputs by the crop and livestock budgets. Empirically the basic mechanisms for this updating falls in two classes. There are items that are updated based on time and those updated based on yield changes. The time updated items include yield levels, demands, import levels and supplies and quantities of available inputs. In all cases these are updated by a formula  $(1 + r_i)^t$  where  $r_i$  is the annual rate of change for item  $i$ . The  $r_i$  terms have been estimated by using 40 years of agricultural statistics to determine the annual percentage rate at which those items have increased over time. The model then takes the base yields starting in 1990 and the elapsed time to the desired year multiplies the base number by the  $(1 + r_i)^{t-base}$  and comes out with updated numbers. It is important in this setting to remember that both yields and demands are being updated. It is also important in this regard to be careful in terms of the balancing rates of growth in demand across uses. As for example one might consider changing the rate of growth in corn disappearance to do this one needs to consider export, domestic demand, and feeding dimensions all of which are treated in various functions.

The other major updating feature involves input adjustments related to yield levels. Such updating is done for crop input uses, crop profits, livestock feed use and livestock profits. The procedure used here is that an elasticity giving the response of input usage to a percentage change in yield is utilized. Input usage is changed by the percentage change in yield times that elasticity. Elasticities are based on three different assumptions. First, based on some results derived by Bob Evenson, the elasticities for inputs for which we have no data are set at 0.5. This includes crop and livestock profits as well as in some cases some of the other crop inputs. Second, the elasticity of input

change with respect to crops has been derived from a 15 year period from the mid 70's to the early 90's. During this period the percentage change in input usage per percent change in yields is explicitly calculated and then used in specifying the elasticity. When such data are not available a 0.5 is used. Third, livestock feed use is assumed to be directly proportional to yield increases, thus if there is a 10% increase in milk output there is a 10% increase in assumed feed consumption.

The overall procedure then is to input the desired year then project all the demand, yield import, and export figures. Subsequently based on the yields input use in the production budgets are updated using the elasticity of input use change with the respect to yield change times the projected yield change.

### **3.0 TABLEAU FORMULATION OF ASM**

#### **3.1 Overview**

Figure 1 presents an overview of ASM tableau. The model contains 16 types of activities and 16 equations. The activities are:

- (1). Program Crop Production - production of crops covered by the farm program which are participating in the program.
- (2). Non-participating Crop Production - production of crops not covered under the farm program and non-participating production of farm program crops.
- (3). Livestock Production- production of livestock.
- (4). Crop Mix- usage of historically observed crop mixes by region.

- (5). Livestock Mix - usages of historically observed national distributions among the regions on selected livestock commodities.
- (6). Land Supply - supply of cropland, pasture land, and rangeland (on an Animal Unit Months (AUM) basis) available according to supply curves.
- (7). Water Supply - supply of water including fixed price (surface water sources) and pumped water (ground water sources) components according to supply curves.
- (8). Labor supply - supply of family and hired labor supply according to supply curves.
- (9). Input Purchase - use of a set of fixed price inputs.
- (10). Processing - quantity of primary commodities processed into secondary agricultural products.
- (11). Domestic Demand - quantity of domestic consumption of primary and secondary products according to demand curves.
- (12). Export Demand - quantity of primary and secondary commodities exported according to excess demand curves.
- (13). Import Supply - amount of imports of primary and secondary commodities according to excess supply curves.
- (14). CCC Loan - government purchases of some primary and secondary commodities under the CCC Loan program.
- (15). Deficiency Payment - receipt of deficiency payments to eligible farm program participating commodities.

- (16). Other Farm Program Payments - 50/92, paid acres, diverted acres and other program payments where agriculture gets payments for commodities not being produced.

The ASM equations include an objective function and 15 constraints. The constraints are as follows:

- (1). Cropland - balances land available for crops with total cropland use while accounting for the migration of cropland in and out of agriculture.
- (2). Maximum Cropland - limits the maximum amount of cropland that can be in use at any time.
- (3). Pasture Land - balances the supply of pasture land against livestock use of pasture land accounting for adjustments for pasture land transferring in and out of agriculture.
- (4). Maximum Pasture Land - imposes a limit on the maximum amount of pasture land used.
- (5). Water - balances irrigation water supply with the water utilized in crop and possibly livestock production.
- (6). Fixed Water Maximum - limits the maximum amount of fixed price (surface sources) water.
- (7). Labor - balances labor used in production with total labor supply including both family and hired labor.
- (8). Maximum Family Labor - imposes a maximum on the family labor available.
- (9). National Inputs - balances the supply of agricultural inputs with the usage by processing crop and livestock production.

- (10). Primary Products - balances primary products supplied and consumed. The primary products are supplied by crop and livestock production or imports. They can be consumed in livestock production, processing or market demand activities.
- (11). Secondary Commodities - balances the secondary commodity supplied and demanded.
- (12). Farm Program Products - balances participating production with that receiving deficiency payments.
- (13). Other Farm Program Provisions - balances the supply of diverted production eligible for farm program payments with the commodities for which payments are made.
- (14). Crop Mix - constrains crops within each region to fall within an acreage mix that had occurred historically.
- (15). Livestock Mix - constrains livestock commodities fall within their national historical distribution.

## **3.2 Variables**

The agricultural variables are defined in more detail below including some variables not mentioned in Figure 1. A full list of all these variables appears in the appendix.

### **3.2.1 Program Crop Production**

Crops can be produced inside or outside the farm program context. The model depicts participating farm program crop production differentiated by decade, region, type of crop, water technology (dryland or irrigated) and conceivably crop technology. These variables appear in the ASM with:

- < The objective function coefficient is the negative of the per acre cost of miscellaneous inputs plus nominal profits.
- < The land balance coefficient accounts for both the use of an acre that is harvested plus the use of any acreage which must be set aside according to farm program provisions.
- < The primary market balance row coefficient equals only the amount of production not eligible for deficiency payments which equals that produced from land not participating in the farm program plus the amount produced in excess of the farm program yield.
- < The farm program yield balance equation coefficient equals the amount of the crop produced that is eligible for deficiency payments.
- < The coefficient in the 50/92 balance row is the foregone yield quantity incurred by participation in the 50/92 program. Note this is not actual yield but is "foregone."
- < A negative coefficient in the paid diversion row giving the amount of foregone yield eligible for diversion payments due to the participation in the paid diversion program.
- < A negative coefficient in the unharvested production row giving the production foregone because it is left unharvested but is eligible for deficiency payments.
- < A negative coefficient in the artificial yield row which reflects the yield short fall in cases when the actual yield is below the farm program yield reflecting deficiency payments on crops that are not grown.
- < A positive coefficient in the secondary balance constraint giving the use of secondary products in production. In general this is zero.



- < A positive coefficient in the cropland maximum row giving the use of cropland including set-aside land.
- < A positive coefficient in the water row giving the use of irrigation water for production activities which are irrigated.
- < A positive coefficient in the labor row giving the use of labor for crop production.
- < A positive coefficient in the input balance row giving the use of inputs for production.
- < A positive coefficient whose value is 1.0; in the regional crop mix equation and a negative one in the regional total crop mix equation showing the number of harvested acres of this crop.
- < Upper or lower bounds when relevant.

### 3.2.2 Non-Participating Crops

These variables are essentially identical to the farm program production variable above. The differences are that the land use is only one acre, that the production occurs only in the primary balance row and that there are no entries for program deficiency payment, 50/92, etc. rows. These variables have the same dimensions as above and are defined both for non-program crops and for nonparticipating acreage of program crops.

### 3.2.3 Livestock Production

The model solves for the number of livestock reared. Livestock are depicted as users of land labor and feedstuffs while producing both final products (ie. animals for slaughter) and intermediate products (ie. calves for feeding). These variables are defined by region, type of animal, and livestock

technology choice. The activities reflect production of multiple products. The variables enter the model formulation with:

- < A negative entry in the objective function giving the miscellaneous costs and profits for the livestock production activity.
- < A positive entry in the land use balance giving the use of crop and pasture land. Usually this is confined to pasture land.
- < A positive entry in the AUM use balance giving the use of AUMS in livestock production.
- < A positive entry in the crop and pasture maximum land constraints.
- < Both negative and positive entries in the primary balances reflecting production and use of primary agricultural products. Some commodities i.e. hogs produced, feeder pigs, cull sows, will only be produced appearing with negative signs while usages of feedstuffs such as corn and soybeans will appear with positive coefficients.
- < A positive entry in the secondary balances reflecting the use of some secondary commodities in livestock production. In particular, feed and soybean meal are used for feedstuffs.
- < A positive entry in the water row when there is water use for irrigated pasture.
- < A positive entry in the labor row giving labor use for production.
- < A positive entry in the input balance giving the agricultural input usage.
- < A positive entry in the national crop mix row controlling the production of commodities so it is consistent with the national commodity mixes.
- < Upper and lower bounds when present.

### 3.2.4 Land Supply

The land supply variables reflect the provision of pasture land, cropland, and AUM grazing land according to the specified supply curve. These variables are defined by region and land type. The variable enters the model with

- < A negative entry in the objective function giving the integral of the area underneath the land supply curve depicting as a cost of using land.
- < A negative one in the land supply balance indicating supply of land.
- < A positive one in the maximum constraint on land availability.

### 3.2.5 Processing

The processing variables reflect the transformation of primary agricultural products into one or more secondary products and are defined by processing alternative. In the model, these activities include feed mixing, corn sweetener manufacturer, sugar refining, soybean crushing, livestock slaughter, etc. See the list in the Scope of ASM appendix. These variables enter the model with:

- < A negative entry in the objective function giving the costs and profit considerations of processing.
- < A positive entry in the primary commodity balance reflecting use of primary commodities in processing. Negative entries are also possible when primary commodities are supplied by processing.
- < A negative entry in the secondary balance reflecting production of secondary commodities positive entries are also possible when secondary commodities are used as inputs in processing. This structure can be somewhat complex. For example, confectioneries are produced by a processing activity but also use the secondary commodity refined sugar.
- < A positive entry in the input balance giving the processing usage of agricultural inputs.
- < Maximum and minimum bounds on processing.

### 3.2.6 Variable Price Water Supply

The model depicts supply of both fixed price water and variable price pumped water. The variable price water supply indicates that more water can be pumped at successively higher prices. The quantity that is pumped depicts both groundwater and the use of certain surface water. The variable price water supplies are defined by subregion. This variable enters the model with:

- < A negative entry in the objective function giving the integral of the area underneath the water supply curve.
- < A negative one in the water balance to indicate a supply of water.

### 3.2.7 Fixed Price Water Supply

The counterpart to the variable price water variable above is the fixed price water variable. The fixed price water is available at a fixed price up to a quantity upper limit. This situation reflects publically owned surface water which is sold to farmers at a fixed price up to the quantity that they have been allocated. This variable is defined by subregion and enters the model with:

- < A negative entry appears in the objective function reflecting the price of the fixed water activities.
- < A negative one in the water balance indicating supply of water.
- < A positive one in the fixed price water maximum drawing on the fixed price water availability.

### 3.2.8 Hired Labor Supply

Labor supply is defined in an analogous fashion to the water supply above. There is a supply of family labor at a fixed price and then a supply of hired labor according to a supply schedule. The hired

labor activity depicts that supply schedule and reflects a successively higher wage rate as more labor is hired. This is defined by region. The variable enters the model with:

- < A negative entry in the objective function giving the area underneath the hired labor supply schedule.
- < A negative one in the labor balance reflecting supply.

### 3.2.9 Family Labor Supply

The second part of the labor supply is family labor which is made available at a lower price than the hired labor wage rate and is available up to a fixed quantity. The family labor variable enters the model as follows:

- < A negative entry in the objective function giving the cost of family labor.
- < A negative one in the labor balance indicates supply.
- < A positive one in the family labor limit row drawing against the maximum amount of family labor that is available.

### 3.2.10 Public AUM Grazing Supply

Animal unit months (AUMS) of grazing are supplied via a two part structure. The first part refers to the state and federal supplies through such agencies as the Bureau of Land Management and Forest Service. This land is available at a fixed rental rate up to a maximum. The public grazing variable enters the model with 3 coefficients. They are

- < A negative entry in the objective function giving the cost of public grazing.
- < A negative one in the AUM grazing balance reflecting the supply of public grazing.
- < A positive one in the public grazing limit row.

### 3.2.11 Private AUM Grazing Supply

Animal unit months of grazing are also supplied from private sources via a supply curve.

These variables enter the model with

- < A negative entry in the objective function giving the area under the private grazing supply curve.
- < A negative one in the AUMS grazing balance indicating supply.

Upper bounds on total private grazing availability.

### 3.2.12 Domestic Demand for Primary Commodities

Primary products can be used to satisfy domestic demand. Such demand is defined for decade and for each of the primary commodities which have nonzero demand. The variables enter the model as follows:

- < A positive entry in the objective function giving the area underneath the demand curve for the commodity. This can involve a price elastic curve, a perfectly elastic demand curve (if a fixed price is involved) or no entry if a minimum is all that is involved.
- < A positive one in the primary balance indicating a demand.
- < Upper and lower limits on the maximum quantity demand.

### 3.2.13 Primary Imports Supply

Selected primary commodities can be imported. These activities indicate the imports of primary commodities for each primary commodity and decade. The variables enter the model with:

- < A negative entry in the objective function giving the area under the import supply equations.
- < A negative one in the primary commodity balance row indicating a supply of a commodity.
- < A bound gives the maximum and minimum quantity that can be imported.

### 3.2.14 Primary Exports Demand

A number of primary commodities are exported. The export variable indicates the quantity of such exports and is entered in much the same format as the domestic demand equations where the variable is defined for each primary commodity with the activity contain the following:

- < A positive entry in the objective function giving the area under the export demand curve.
- < A positive one indicating a use of the commodity from the commodity balance.
- < Upper and lower bound constraints on the quantity exported.

#### 3.2.15 Secondary Commodity Demand, Imports and Exports

These variables depict the demand imports and exports of processed commodities and are identical in concept to the three immediately discussed above. They all have:

- < Objective function coefficients that reflect the area underneath their respective curves with the area being positive for domestic demand and exports and negative for imports.
- < Positive ones in the secondary commodities balance row under the domestic demand and export activities with a (minus one) present for import supply.
- < Upper and lower limits.

#### 3.2.17 Regional Crop Mixes

The regional crop mix variables equal the acres produced under each of the historical observed cropping patterns. Collectively, their presence restrains harvested crop acreage to fall somewhere in the historical observations. These activities are defined by region and for the historical observations in the model. Currently, these consist of about a twenty year series. These activities also help resolve the aggregation problem as explained in McCarl. These variables enter the model with:

- < A negative entry in the crop mix by crop rows giving the amount of the commodity in the crop mix.

- < A negative entry in the total crop mix row giving the sum of the acreage in the crop mix.

### 3.2.15 National Mix

The national mix variables give the amount of commodity by region in each historically observed production pattern. The variables require that the spread of production of selected commodities among the regions be consistent with historical national mixes for that commodity. These activities are defined for a particular set of commodities and their historical alternatives. They are also dropped after the first 20 years. These variables have:

- < A negative entry in the national mix rows giving the number of units of the commodity produced in a given model region.

### 3.2.18 National Input Supply

The national input supply activities depict the supply of inputs with assured constant prices and are defined by input type. The inputs are listed in "The Scope of ASM". The variables enter the model with:

- < A negative entry in the objective function giving the price of the input is reflected.
- < A negative one in the input balance reflecting supply of the input is entered.

### 3.2.19 CCC Loan Purchase

The Commodity Credit Corporation acquisitions of commodities put under loan are reflected in the CCC Loan purchase variables. Commodities placed under loan are removed from the marketplace and are assumed to be disposed in some non-market distorting usage. These variables are defined for each eligible commodity with:

- < A positive entry in the objective function giving the price of the commodity as paid under the loan is entered as a revenue.



- < A positive one in the primary or secondary balance for eligible commodities indicating use of a unit of the commodity.

### 3.2.20 Deficiency Payments

The deficiency payment variable gives the amount of crops receiving deficiency payments. This is present for the decades and primary commodities which receive such payments. This payment is varied through iteration to make sure that the difference between the market price and the target price is equal to the deficiency payment. This variable enters the model with:

- < A positive entry enters the objective function reflects the deficiency payment as revenue. This coefficient is iterated over to obtain convergence on deficiency payments.
- < A negative one in the primary commodity balance indicating a supply of commodity appears.
- < A positive one in the farm program commodity balance indicating commodity usage appears.

The variable transfers the commodity from a row accounting for goods eligible for deficiencies payments to the market row and reflects receipt of the deficiency payment. This causes the market price to be less than or equal to the farm program price.

### 3.2.21 Miscellaneous Farm Program Payments

These variables reflect government payments for farm program provisions involving 50/92, diverted acres, unharvested production, and production below farm program yield. The program activities divert acreage from production and farmers are paid for foregone production. These are defined for each commodity that the farm program is active in. These variables enter the model with:

- < The objective function coefficient is the deficiency payment found during the iterations.

- < A one is entered reflecting the fact that one unit of the other farm program provisions are used.

### 3.2.22 Tolerance Allowing Variables

Tolerance variables are entered to avoid infeasibility and cycling when dealing with the crop and national mixes. They allow small deviations from these mixes. These are defined for each crop and region for the regional crop mixes and by commodity and region for the national crop mixes.

## **3.3 Model Equations**

### 3.3.1 The Objective Function

The basic objective function components include the discounted area underneath the domestic and export demand curves for the commodities; plus the deficiency and other farm program payments; minus the area under the import, land, labor, AUMS, and water supply curves; minus the miscellaneous cost of production. The overall value measure is the net present value of consumers' and producers' surplus. The particular terms in the agricultural part of the objective function are:

- < A positive entry under the domestic demands giving the area underneath the primary and secondary demand curves. The demand curves are constant elasticity curves. There also is the provision for the demand curve to be either fixed price where the area is price times quantity, or fixed quantity in which case no area is entered. The demand curve integration also involves a truncation factor where the demand curve is integrated from the larger of 1/10 of the quantity or the quantity that would cause 10 times the price. This is done since the constant elasticities demand curves go asymptotic to the axis and can lead to very large areas.
- < A positive entry under the export demand variables giving the area under the curves for both primary and secondary commodities computed in a fashion analogous to the domestic demand.

- < A negative entry under the import supply curves giving the area under the curve for both primary and secondary commodities, again, with provisions for fixed price and fixed quantity curves.
- < A negative entry for the land supply curves, for pasture, and cropland. The calculations can involve a constant elasticity, fixed price or fixed quantity supply curve.
- < A negative entry for the AUM fixed price supply activities giving the price at which such grazing land can be rented.
- < A negative entry for the pumped water variables giving the area under the pumped water constant elasticity supply curve.
- < A negative entry for the fixed price water variables giving the price of fixed water.
- < A negative entry for the family labor variables giving the price of family labor.
- < A negative entry for the hired labor variables giving the area underneath the hired labor constant elasticity supply curve.
- < A negative entry in the constant supply curve giving the area underneath the AUM private AUM grazing.
- < Negative the costs and profits of processing.
- < A negative entry for the crop production variables giving production costs for program and non-program crops where the cost is the sum of several miscellaneous cost items and farm profits.
- < A negative entry for the livestock production variables giving production costs including profits and miscellaneous cost.
- < A negative entry for the AUM private land supply activities giving the area under the supply curve.
- < A negative entry for the input acquisition variables giving the input prices.
- < A positive entry for the deficiency payments variables reflecting farmer revenues from government deficiency payments. This will be iterated over when the farm program is present.

- < A positive entry for the loan rate variables reflecting revenue from placing crops under loan.
- < A positive entry for the 50/92, unharvested acreage, artificial, and diverted acreage variables reflecting payments.

### 3.3.2 Agricultural Land Balance

The agricultural land balance equations equate the pasture and cropland utilized for agriculture with the land supplied. The land equations are defined by region and land type. The land types are cropland and pasture land. The model assumes pasture land is permanent pasture not to be converted to cropland.

The coefficients in this equation include:

- < A positive land use by crops planted under the farm program variables. The coefficients here are one plus the set-aside rate adjusted for the participation rate.
- < A positive one under the nonprogram and nonparticipating production reflecting land use.
- < Positive crop and pasture land use by livestock.
- < A negative one under the land supply variable indicating that land is supplied.

### 3.3.3 AUM Grazing Balance

The AUM grazing balance equation links usage of AUM grazing with the supply from public and private sources by region and decade. The coefficients in this equation include

- < Positive AUM grazing use by livestock. The coefficients reflect the AUM grazing requirements as specified in the livestock data.
- < A negative one under the private land grazing supply activities reflecting AUM supply.
- < A negative one under the public land grazing supply activities reflecting AUM supply.

### 3.3.4 Maximum Public AUM Availability

Public AUMS are limited to their maximum availability by region and decade. The coefficients in this equation include

- < A positive AUM use by the public land AUM supply variables.
- < A positive the endowment of AUMS by subregion.

### 3.3.5 Maximum Land

The maximum amount of land that can be used is limited by region and land type. The coefficients as they enter the equations are as follows.

- < A positive entry for the participating production variables giving land use by crops planted under the farm program. The coefficients here are one plus the set aside rate adjusted for the participation rate.
- < A positive one for the non-program and nonparticipating production variables reflecting land use.
- < A positive entry for the livestock variables giving cropland, pasture usage.
- < A positive right-hand side entry giving the maximum amount of the land used in the past twenty years as an upper bound on land use by region.

### 3.3.6 Water Balance

Water supply and use is balanced by region. Coefficients appearing in this equation are:

- < A positive entry for irrigated crop production possibilities for both participating and nonparticipating possibilities giving water use.
- < A positive entry for livestock production reflecting water use.
- < A negative one under the fixed price water supply variables reflecting water supply .
- < A negative one under the variable price (pumped) water supply indicating water supply.

### 3.3.7 Maximum Fixed Price Water

The maximum amount of fixed price water is limited by region. These equations contain:

- < A positive entry under the fixed price water supply variable.
- < A right hand side giving the quantity available.

### 3.3.8 Labor Balance

Labor use from livestock and crop production is balanced with labor from hired and family sources.

The constraint is disaggregated by region. The coefficients are as follows.

- < A positive entry for the participating and nonparticipating crop production variables giving labor usage.
- < A positive entry for the livestock production variables giving labor usage.
- < A negative entry for the family labor supply variable indicating supply.
- < A negative one for the hired labor supply variable indicating supply.

### 3.3.9 Family Labor Limit

The maximum amount of family labor available is constrained to the amount available in each region.

These equations contain:

- < A plus one under the family labor supply variable.
- < A right hand side indicating the quantity of family labor available.

### 3.3.10 Hired Labor Limit

The maximum amount of hired labor that can be used in each region is bounded here. These equations contain:

- < A plus one under the hired labor supply variable.
- < A right hand side indicating the maximum quantity of hired labor available.

### 3.3.11 Primary Commodity Balance

A balance is struck between the primary commodities produced and the commodities consumed for each primary commodities. The entries in this equation are:

- < A negative entry under the participating farm program variables reflecting yield. The amount entered is that from the nonparticipating part of the activity (See Chang, et al.) plus the amount produced that is not subject to deficiency payments. Thus, the entries are the portion of the commodity yield which is not eligible for deficiency payments. The amount eligible for deficiency payments is recorded in a farm program row.
- < A negative entry for the nonparticipating production variables reflecting yield.
- < Both positive and negative entries under the processing variables depending on whether the primary commodities are being used or supplied by the processing activities. Generally, these are positive indicating use of the primary commodity.
- < Both positive and negative entries for the livestock production variables reflecting the usage of primary commodities as feedstuffs as well as production (negative) of livestock commodities.
- < A positive one under the primary domestic demand variables reflecting use of the primary commodity.
- < A negative one under the primary import variables indicating demand.
- < A positive one under the primary export variables indicating demand.
- < A negative one under the deficiency payment variables making participating production available to the market after the deficiency payment is paid.
- < A positive one under the CCC loan purchase variables indicating use.

### 3.3.12 Farm Program Production Balance

Commodity under the farm program that is eligible for deficiency payments is balanced with that amount receiving deficiency payments by commodity. The coefficients are:

- < A negative entry under the participating ceop production variables giving the maximum of the farm program yield and the actual yield times the participation fraction for the

participating production variables indicating the amount of production eligible for farm program payments.

- < A positive one under the deficiency payment variables indicating receipt of payments.

### 3.3.13 Secondary Balance

This balance is largely identical to the primary balance except that the farm program considerations are not entered. The entries are:

- < A positive entry for the livestock production variable indicating the usage of the secondary products (such as the usage of feed).
- < Both positive and negative entries under the processing variables indicating the usage and supply of secondary products.
- < A positive one for the CCC Loan variables reflecting the receipt of a CCC Loan on secondary commodities like butter.
- < A positive one for the domestic demand and export variables indicating the usage of the commodity in consumption.
- < A negative one for the import supply variables reflecting supply.

### 3.3.14 Crop Mix Balances

The crop mixes are controlled both by crop and region as well as in total in a region. The entries in these rows include:

- < A positive one under the production variables indicating the harvested acres of the crops produced.
- < Negative coefficients under the crop mix variables indicating the amount of the crop that appears in each of the crop mixes and the sum of acres in the total mix rows.
- < A positive one under the Tolerance activities.

### 3.3.15 National Mix Balances



The regional distribution of production of certain commodities is controlled so it falls in the pattern exhibited by historical mixes of those commodities among regions. The balances are present for the controlled commodities in each region.

- < A positive entry under the crop production variables reflecting the amount of the commodity being produced by the crop production activities in the region.
- < A positive entry for the livestock variables reflecting the amount of the primary commodities produced by livestock production.
- < A negative entry under the national mix variables reflecting the production of each of the controlled commodities observed in each of the representative years by region.

#### 3.3.16 Input Acquisitions Balance

Each input acquisition is balanced with its total usage. The entries are:

- < A positive entry under the crop and livestock production variables reflecting input use.
- < A positive entry under the processing variables reflecting input use.
- < A negative one under the input acquisition activities reflecting supply of inputs.

#### 3.3.17 50/92 Balance

The amount of production foregone by participation in the 50/92 program is balanced with an activity which pays for the 50/92 program. This is controlled by crop. The entries consist of:

- < A negative entry under the participating production variables giving the farm program yield times 92% of the production times the participation fraction times the amount of acreage that falls under 50/92.
- < A positive one under the 50/92 payment activities.

#### 3.3.18 Diverted Acres

This is similar in concept to the 50/92 row above where the foregone production on the acreage diverted is balanced with that receiving payments. This is controlled by crop.

### 3.3.19 Artificial Production

The amount of production that is eligible for deficiency payments but is not actually produced since production falls short of the farm program yield. This is balanced with the artificial payments and recorded by crop.

### 3.3.20 Unharvested Acres

Here, again, the amount of yield foregone on acreage enrolled in the unharvested acreage features of the farm program is balanced with payments for unharvested yield. This is done as in the above 50/92 balance.

## **4.0 SCOPE OF ASM**

The agricultural sector model is designed to simulate the effects of various changes in agricultural resource usage or resources available, in turn determining the implications for prices, quantities produced, consumers' and producers' welfare, exports, imports and food processing. In doing this the model considers production, processing, domestic consumption, imports, exports and input procurement. The model distinguishes between primary and secondary commodities with primary commodities being those directly produced by the farms and secondary commodities being those involving processing. For production purposes the U.S. is disaggregated into 63 geographical subregions. Each subregion possesses different endowments of land, labor and water as well as crop yields. Therefore, the disaggregate information is also an important feature in this model. The supply sector of the model works from these regional input markets and a set of regional budgets for a number

of primary crops and livestock and a set of national processing budgets which uses these inputs. There are also import supply functions from the rest of the world for a number of commodities. The demand sector of the model is constituted by the intermediate use of all the primary and secondary commodities, domestic consumption use and exports. Details on the items mentioned above follow.

#### **4.1 Primary Commodities**

There are 33 primary commodities in the model. These are listed in Table 1. The primary commodities are chosen so as to depict the majority of total agricultural production, land use and economic value. They can be grouped into crops and livestock.

Both supply and demand information (i.e., prices, quantities, slopes and/or elasticities) are required in the model. The total supply consists of domestic production from all agricultural regions and imports. Total demand is made up of domestic and foreign (or export) components. Domestic demand includes food consumption, CCC stock, livestock feed and processing. Transportation costs to the market are included in the supply budget. Livestock feed and processing demands are endogenously determined. The prices and quantity data came from Agricultural Statistics, Agricultural Prices Annual Summary, and Livestock and Meat Statistics Supplement. Elasticity, slope, and other information came from Baumes, Burton, Tanyeri-Abur and Bob House in the USDA.

#### **4.2 Secondary Commodities**

The model incorporates processing of the primary commodities. The production of primary commodities are regionally specified, but the processing of secondary commodities is done in the overall U.S. aggregate sector. Table 2 lists the 37 secondary commodities that are processed in the

model. These commodities are chosen based on their linkages to agriculture. Some primary commodities are inputs to the processing activities yielding these secondary commodities and certain secondary products (feeds and by-products) are in turn inputs to agriculture. The primary data sources were Agricultural Statistics, Agricultural Prices Annual Summary, Livestock and Meat Situation, and Livestock Slaughter Annual Summary.

### **4.3 National Inputs**

The model contains 24 national inputs. They are listed in Table 3. For the most part these are specified in dollar terms; for example, ten dollars worth of nitrogen, twenty dollars worth of repairing cost. In doing so, the input usage is converted into a homogeneous commodity. These inputs are usually assumed infinitely available at fixed prices and the prices are updated annually according to the paid-by-farmers index in Agricultural Statistics.

### **4.4 Regional Disaggregation**

The model operates with two levels of regional disaggregation. The fundamental unit of disaggregation is 63 state and/or substate areas. In addition, these smaller areas are grouped into larger regions for the purposes of land supply, and labor supply. A list of these two levels of disaggregated regions and areas are given in Table 4.

### **4.5 Regional Inputs**

There are two inputs that are available at the regional level; land and farm labor. Production of crops and livestock compete for these scarce resources in each state or region. Therefore, the price and quantities of these inputs are determined on a regional basis.

Three major types of land are specified. The first one (type 1) is land suitable for crop production. Depending on ASM version, crop land may be treated as a single type or in four erodibility classes. The second land type (type 2) is suitable for pasture or grazing. The availability on these two types of land by states or regions was derived from Agricultural Statistics. The regional prices of these land were derived from the information in Farm Real Estate Market Developments. Cash rental prices of land were used to reflect annual opportunity costs to the owners. The third land type is AUM grazing land. The AUM supply is divided into public and private grazing on the subregional level. Public grazing is available at a constant price while private grazing can be obtained by an upward-sloping supply schedule. Information on public grazing comes from the Grazing Statistical Summary by USDA Forest Service and Public Land Statistics by the Bureau of Land Management in the U.S. Department of the Interior. Private grazing information comes from the estimates in An Analysis of the Range Forage Situation in the United States: 1989-2040 by L.A. Joyce. Information on grazing fees originates from Estimating Forage Values for Grazing National Forest Lands by W.F. Hahn, et al. and the Bureau of Land Management.

The labor input also includes two components: family labor and hired labor. The model requires specification of a maximal amount of family labor available, and a reservation wage for family labor. The additional labor to be hired is based on an inducement wage rate which is higher than the

reservation wage. The regional information about the quantities and wages was obtained from Farm Labor.

The water input is also divided into fixed (or surface) and variable available (or pumped ground) water and is supplied at the subregion level. The fixed water is available for a constant price but the amount of variable water is provided according to a supply schedule where increasing amounts of water are available for higher prices. The information on water came from USDA and NASS sources who used the Farm and Ranch Irrigation Survey and other government sources in its formation.

#### **4.6 Regional Production Activities**

Currently more than 1200 production possibilities (budgets) are specified to represent agricultural production. These include major field crop production, livestock production, tree production and some miscellaneous transfer activities. Some field crop activities are also divided into irrigated and non-irrigated according to the irrigation facilities available in each state or area. Appendix A gives the information about the distribution of each production activity across various areas. Appendix B lists the production activities by area.

In some cases, the production possibilities produce more than one commodity. All commodities are produced by more than one production possibility. Most field crops (except rice) are produced by either irrigated or non-irrigated production practices. Livestock production is somewhat more complicated. Table 5 lists the main types of production activities and details the relationship between the production activities and primary commodities.

For each activity, information on yields, and usages of national and regional inputs or other commodities is required. The basic source of these information is the 1982 USDA FEDS budget. The irrigated/nonirrigated budget breakdown arose from the USDA water group who developed budgets based on the FEDS survey sources, the survey of irrigated acreage, extension budgets and SCS budget sets.<sup>1</sup> The yields in all the crop budgets were updated annually according to the Agricultural Statistics. The Livestock budgets came straight from the FEDS system 1982.<sup>2</sup> Some of their yields could also be updated by the information available in the Agricultural Statistics.

If the users are interested in examining the consequences of a technological change, the budgets for producing crops or livestock will need to be revised. The list in Appendix A can help the users acknowledge where the adjustments are most likely to be needed in the model.

#### **4.7 Processing Activities**

Basically, the secondary commodities are produced by a number of processing activities. They are soybean crushing, corn wet-milling, processing of potatoes, sweeteners, and timber, combining feed ingredients into various livestock and poultry feed, and the conversion of livestock and milk into consumable meat and dairy products. Processing cost of each commodity is calculated as the difference between its price and the costs of the primary commodity inputs. A list of all the processing activities currently included is given in Table 6.

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<sup>1</sup> Thanks to Bob House, Marcel Aillery, Glen Schaible and Terry Hickenbotham in the USDA/ERS Policy and Soil and Water Groups for making these data available.

<sup>2</sup> Thanks to Bob House and Terry Hickenbotham for making these data available.

Soybean crushing involves conversion of soybean meal and oil. Two soybean crushing activities are included so that the model can select the more profitable one. The meat processing includes conversion from culled animals to slaughter and from slaughter to meat. The dairy processing involves conversion of raw milk to five different dairy products. The conversion of feed and feed supplements always involves more than one processing activity so that the model can select the least cost combination of feed ingredients.

#### **4.8 Crop Mixes**

The sector model disaggregated into 63 "homogeneous" production areas. However, within each region, individual crop production was often represented by one budget. Such representation cannot capture the full factor-product substitution possibilities in each of those areas. In cases, this can lead to quite misleading results. This is avoided by requiring the crops in a region to fall within the mix of crops observed in the Agricultural Statistics historical cropping records. The model is constrained so that for each area the crop mix falls within one of those observed in the past 20 years.

### **5.0 GAMS FORMULATION OF ASM**

This section presents an outline of the ASM programmed in GAMS and a description of each component in the computer package. Due to the size and complexity of the ASM, we divided the GAMS program into many modules. According to their functions, these modules can be grouped into (a) data, (b) calculation, (c) model, (d) report writing, and (e) multiple funds. The following listing will present only the first few lines of the long data sets or modules to serve as an example; a complete listing of all items in every data set would run into several hundred pages.

#### **5.1 DATA**



### 5.1.1 SETS

This file contains all the sets defined in the model. These sets define various indices for the substantive variables and parameters listed as follows.

TABLE ?. LISTING OF SETS, PARAMETERS, AND SAMPLES OF DATA IN ASM

#### I. SETS

NAME	DEFINITION	CONTENT
ALLI	ALL BUDGET ITEMS	cotton, corn,
soybeans,	wheat,	sorghum, rice,
barley,	oats,	otherlives, culldairyc,
cullbeefco,	potatoes,	milk, silage,
hay, hogslaught,		feederpig, livecalf,
beefyearli, calfslaugh,		nonfedsla, fedbeefsla,
cullsow, poultry,		lambslaugh, lambfeerde,
cullewes, wool,		woolincpay, unshrnlamb,
sugarcane, sugarbeet,		soybeanmea, soybeanoil,
fluidmilk, feedgrain,		dairyprot1, highprotsw,
lowprotswi, lowprotcat,		fedbeef, veal,
nonfedbeef, pork,		highprotca, butter,
amcheese, otcheese,		icecream, nonfatdrym,
cottageche, skimilk,		cream, hfcs,
beverages, confection,		baking, canning,
refsugar, glutenfeed,		starch, canerefini,
cornoil, ethanol,		cosyrup, dextrose,
frozenpot, driedpot,		chippot, nitrogen, potassium
, phosporous,		limein, othervaria,
publicgraz, customoper,		chemicalco, seedcost, capital
, irrigation,		repaircost, vetandmedi,
marketing, insurance ,		

landtaxes, generalove,		machinery, management,
fuelandoth, cropinsur ,		noncashvar, mgt,
blank, laborinhou,		landrent , setaside,
aums, addland,		cropland , pasture,
complianc, validnum,		misccost, profit,
miscinput, maximum,		proccost, trancost,
labor, total,		minimum, water,
procs, obj		totalps, cs, grndtot, prodn,
ANIMAL NAMES OF LIVESTOCK BUDGETS		beefcows, cowcalf, sheep
, pigfin79a,		beeffeed, dairy, stocker
, feedlot79,		hogfarrow, feedpig, othlvstk
, poultry,		pigfinish, farfin79a, fdrpig79a
C FARM POGRAM CROPS		cotton, corn,
sorghum, rice,		soybeans, wheat,
barley, oats		
COST BUDGET COST ITEMS		misccost, proccost,
trancost, profit		
CROP CROPS		cotton, corn,
barley, oats,		
soybeans, wheat, silage, hay,		sugarbeet,
sorghum, rice, sugarcane,		potatoes
CRPMIXALT SUBREGIONAL CROP MIX ALTERNATIVES		1971*1990
CTECH CROP BUDGET ALTERNATIVES		base, nonpart, particip
FPTECH FARM PROGRAM CROP BUDGET ALTERNATIVES		nonpart, particip
INPUT NATIONAL INPUTS		nitrogen, potassium,
machinery, management,		othervaria, publicgraz,
phosporous, limein, landtaxes, generalove,		customoper, chemicalco,
noncashvar, mgt,		seedcost, capital,
fuelandoth, cropinsur,		
landrent, setaside,		

blank, laborinhou,

LANDTYPE LAND TYPES  
pasture, aums

LIVESTOCK LIVESTOCK PRODUCTS  
nonfedsla, fedbeefsla,

poultry,

lambslaugh, lambfeerde,

cullewes, wool,

woolincpay, unshrnlamb

LIVETECH LIVESTOCK TECHNOLOGY  
ALTERNATIVES

MAPPING ASSIGMENT OF SUBREGIONS TO  
,appalachia. kentucky ,  
REGIONS

,appalachia. northcarol,

,appalachia. tennessee ,

,appalachia. virginia ,

,appalachia. westvirgin,

,southeast. alabama ,

,southeast. florida ,

,southeast. georgia ,

,southeast. southcarol ,

,deltastate. arkansas ,

,deltastate. louisiana ,

,deltastate. mississipp,

,southplain. oklahoma ,

,southplain. hiplainstx,

,southplain. rolingpltx,

,southplain. cntblacktx,

,southplain. easttx ,

,southplain. edplattx ,

,southplain. texcoastbe,

repaircost, vetandmedi,

marketing, insurance, irrigation  
cropland,

otherlives, cullldairyc,

cullbeefco, cullsow,

milk, hogslaught,

feederpig, livecalf,

beefyearli, calfslaugh,

0\*10

northeast. conn

northeast. deleware

northeast. maine

northeast. maryland

northeast. mass

northeast. newhampshi

northeast. newjersey

northeast. newyork

northeast. pennsylvan

northeast. rhodeislan

northeast. vermont

lakestates. michigan

lakestates. minnesota

lakestates. wisconsin

cornbelt. nillinois

cornbelt. nindiana

cornbelt. wiowa

cornbelt. missouri

cornbelt. nwohio

,southplain. southtx ,  
 ,southplain. transpectx,  
 ,mountain. arizona ,  
 ,mountain. colorado ,  
 ,mountain. idaho ,  
 ,mountain. montana ,  
 ,mountain. nevada ,  
 ,mountain. newmexico ,  
 ,mountain. utah ,  
 northplain.northdakot ,mountain. wyoming ,  
 northplain. southdakot,pacific. ncaliforni ,  
 pacific. oregon ,  
 washington , pacific.  
 scal pacific.

MIXFEED FEED MIXING PROCESSING grain1 , catpro3,  
 catpro4 , ALTERNATIVES  
 grain2 , grain3, loproswn1 , loproswn2,  
 dairysup1 , dairysup2, hiproswn1 , catprohi,  
 dairysup3 , dairysup4, sowtopork , grain1a,  
 dairysup5 , dairysup6,  
 grain1b , grain1c  
 catpro1 , catpro2

NATMIXALT PRIMARY PRODUCT MIX ALTERNATIVES 1960\*1986  
 ACROSS REGIONS

NFPTECH NONFARM PROGRAM CROP BUDGET base  
 ALTERNATIVES

PRIMARY PRIMARY PRODUCTS cotton, corn,  
 feederpig, livecalf,  
 soybeans, wheat, beefyearli, calfslaugh,  
 sorghum, rice, nonfedsla, fedbeefsla,  
 barley, oats, cullcow, poultry,  
 potatoes, cullbeefco,  
 lambslaugh, lambfeerde,  
 otherlives, culldairyc, cullewes, wool,  
 milk, silage, woolincpay, unshrnlamb,  
 hay, hogslaught, sugarcane,  
 sugarbeet,

PROCESSALT	PROCESSING ALTERNATIVES	beverage2, beverage3,
dairysup1,	dairysup2,	beverage4, confectin2,
dairysup3,	dairysup4,	confectin3, confectin4,
dairysup5,	dairysup6,	canning2, canning3,
catpro1,	catpro2,	canning4, baking2,
catpro3,	catpro4,	baking3, baking4,
loproswn1,	loproswn2,	wetmill, gluttonsbm,
hiproswn1,	catprohi,	hfcs, csyrup,
sowtopork,	grain1a,	dextrose, ethanol,
grain1b,	grain1c,	beverages, confection,
butterpow,	fluidmlk1,	canning, baking,
fluidmlk2,	icecream1,	refsugar1, refsugar2,
icecream2,	amcheese,	canerrefine, soycrush1,
otcheese,	cottage,	soycrush2, hogtopork,
clcowsla,	bcafsla,	
nfslatonf,	fslatofbe,	dcowsla, bfhefsla,
	caftoveal,	grain1, dcafsla, frozen-pot,
	chip-pot	grain2, grain3,
dehydr-pot,		
REGION	REGIONS EXCLUDING TOTAL	northeast, lakestates,
cornbelt,	northplain,	appalachia, southeast,
deltastate,	southplain,	mountain, pacific
REGIONS	REGIONS INCLUDING TOTAL	northeast, lakestates,
cornbelt,	northplain,	appalachia, southeast,
deltastate,	southplain,	mountain, pacific, total
SDITEM	SUPPLY DEMAND CURVE PARAMETERS	price, quantity,
elasticity,	maxq, minq	
tfac,	constant1, constant2, constant3, box	
SECONDARY	PROCESSED PRODUCTS	soybeanmea, soybeanoil,
cottageche,	skimmilk,	
fluidmilk,	feedgrain, cream, hfcs,	
	dairyprot1, highprotsw, beverages, confection,	
	lowprotswi, lowprotcat, baking, canning,	
	fedbeef, veal,	

refsugar, glutenfeed,  
 nonfedbeef, pork, starch, canerefini,  
 highprotca, butter, cornoil, ethanol,  
 amcheese, otcheese, cosyrupe, dextrose,  
 icecream, nonfatdrym,  
 frozenpot, driepot,

CHIPPOT

SUBREG SUBREGIONS  
 nwohio, oklahoma,  
 oregon, pennsylvan,  
 rhodeislan, southcarol,  
 southdakot, tennessee,  
 utah,  
 vermont, virginia,  
 washington, westvirgin,  
 wisconsin, wyoming,  
 sindiana, centiowa,  
 neiowa, siowa,  
 sohio, neohio,  
 sillinois, hiplainstx,  
 rolingpltx, cntblacktx,  
 easttx, edplattx,  
 texcoastbe, southtx,  
 transpectx, scal

alabama, arizona,  
 arkansas, ncaliforni,  
 colorado, conn,  
 deleware, florida,  
 georgia, idaho,  
 nillinois, nindiana,  
 wiowa, kansas,  
 kentucky, louisiana,  
 maine, maryland,  
 mass, michigan,  
 minnesota, mississipp,  
 missouri, montana,  
 nebraska, nevada,  
 newhampshi, newjersey,  
 newmexico, newyork,  
 northcarol, northdakot,

TECH CROP TECHNOLOGY ALTERNATIVES

0\*10

WATERITEM WATER SUPPLY PARAMETERS  
 fixedprc,  
 pumpq

well, surface, fixedmax,  
 pumpprice, pumpmax, pumpelas,

WATER IRRIGATION WATER

water

WTECH IRRIGATION ALTERNATIVES

dryland, irrig

## II. PARAMETERS

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ITEM	DEFINITION
CBUDDATA	CROP BUDGET DATA
FARMPROD	FARM PROGRAM DATA
FPPART	FARM PROGRAM PARTICIPATION RATES
INPUTPRICE	NATIONAL INPUT PRICES
LABORSUP	REGIONAL LABOR SUPPLY
LANDAVAIL	MAXIMUM LAND AVAILABLE BY SUBREGION
LANDSUPPL	REGIONAL LAND SUPPLY DATA
LBUDDATA	LIVESTOCK BUDGET DATA
MIXDATA	PRIMARY PRODUCT MIX DATA (HISTORICAL HARVESTED ACRE BY SUBREGION)
NATMIXDATA	PRIMARY PRODUCT MIX DATA (HISTORICAL LIVESTOCK PRODUCTION BY SUBREGION)
PDEMAND	PRIMARY COMMODITY DOMESTIC DEMAND DATA
PEXPOR	PRIMARY COMMODITY EXPORT DEMAND DATA
PIMPORT	PRIMARY COMMODITY IMPORT DEMAND DATA
PROCBUD	PROCESSING BUDGET DATA
SCALE	OVERALL SCALING FACTORS
SCALLIVE	LIVESTOCK PRODUCTION SCALE
SCALMIX	MIX SCALING
SCALOBJ	OBJECTIVE FUNCTION SCALAR
SCALPROC	PROCESSING SCALE
SCALPROD	CROP PRODUCTION SCALE
SDEMAND	SECONDARY COMMODITY DOMESTIC DEMAND DATA
SEXPOR	SECONDARY COMMODITY EXPORT DEMAND DATA
SIMPORT	SECONDARY COMMODITY IMPORT DEMAND DATA
TUNE	TUNING FACTORS
WATERSUP	SUBREGIONAL WATER SUPPLY DATA

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### 5.1.2 DEMAND.DAT

This file supplies all the parameters of the demand and supply curves in the model which includes information on price, quantity, elasticity, any maximum and/or minimum restriction on the quantity if applicable. It also provides the input availability information on cropland, family labor, and water.

#### **\*\*\*\*\* 1990 DOMESTIC DEMAND, EXPORTS AND IMPORTS**

TABLE PDEMAND(PRIMARY,SDITEM) PRIMARY COMMODITY DOMESTIC DEMAND DATA

	PRICE	QUANTITY	ELASTICITY	MAXQ	MINQ	TFAC
cotton	325.44	8100.00	-.22	0.00	0.0	10.0

potatoes 6.15 185278.00 -.37 0.00 0.0 10.0;

TABLE PEXPORT(PRIMARY,SDITEM) PRIMARY COMMODITY EXPORT DEMAND DATA

	PRICE	QUANTITY	ELASTICITY	MAXQ	MINQ	TFAC
cotton	325.44	7600.00	-1.20	0.00	0.00	10.00
potatoes	6.15	350.00	-.10	0.00	0.00	10.00;

TABLE PIMPORT(PRIMARY,SDITEM) PRIMARY COMMODITY IMPORT DEMAND DATA

	PRICE	QUANTITY	ELASTICITY	MAXQ	MINQ	TFAC
cotton	.00	.00	.00	.00	0.00	0.00 10.00
potatoes	6.15	684.00	.20	.20	0.00	0.00 10.00;

TABLE SDEMAND(SECONDARY,SDITEM) SECONDARY COMMODITY DOMESTIC DEMAND DATA

	PRICE	QUANTITY	ELASTICITY	MAXQ	MINQ	TFAC
soybeanmea	8.25	.00	.00	.00	0.00	0.0 10.0
chippot	295.80	11486.00	-0.23	-0.23	0.00	0.0 10.0;

TABLE SEXPORT(SECONDARY,SDITEM) SECONDARY COMMODITY EXPORT DEMAND DATA

	PRICE	QUANTITY	ELASTICITY	MAXQ	MINQ	TFAC
soybeanmea	8.25	110000.00	-.37	-.37	0.00	0.00 10.00
chippot	295.80	47.00	-0.10	-0.10	0.00	0.0 10.00;

TABLE SIMPORT(SECONDARY,SDITEM) SECONDARY COMMODITY IMPORT DEMAND DATA

	PRICE	QUANTITY	ELASTICITY	MAXQ	MINQ	TFAC
soybeanmea	.00	.00	.00	.00	0.00	0.00 10.00
driedpot	86.30	128.00	0.20	0.20	0.00	0.0 10.00;

\*\*\*\*\* FACTOR SUPPLY: NATIONAL INPUTS, LAND, WATER, AND LABOR

PARAMETER INPUTPRICE(INPUT) NATIONAL INPUT PRICES

/ nitrogen 1.042  
irrigation .90 / ;

TABLE LANDAVAIL(SUBREG,LANDTYPE) MAXIMUM LAND AVAILABLE BY SUBREGION

	CROPLAND	PASTURE	AUMS
alabama	4338.00	10385.25	15000.00
arizona	1232.00	45413.00	15000.00;

TABLE LANDSUPPL(LANDTYPE,REGIONS,LANDITEM) REGIONAL LAND SUPPLY DATA



	PRICE	QUANTITY	ELASTICITY
cropland. northeast	45.63	10798.00	.30
cropland. lakestates	46.60	31695.00	.30
pasture. northeast	23.29	778.00	.60
pasture. lakestates	18.47	23300.00	.60
aums. northeast	8.98	1.00	0.00
aums. lakestates	8.98	1.00	0.00;

TABLE LABORSUP(REGIONS,LABORITEM) REGIONAL LABOR SUPPLY

	FAMILYMAX	FAMILYPRC	HIREQ	HIREP	HIREMAX	HIREELAS
northeast	44580.00	2.23	73875.00	4.45	0.00	1.90
lakestates	553907.00	2.06	66563.00	4.11	0.00	1.90;

TABLE WATERSUP(SUBREG,WATERITEM) SUBREGIONAL WATER SUPPLY DATA

	WELL	SURFACE	PUMPPRICE	PUMPELAS	FIXEDMAX	FIXEDPRC
alabama	7.3	17.6	17.3	1.50	0.8	11.1
arizona	1204.8	137.7	37.0	0.80	1730.0	20.2;

```

WATERSUP(SUBREG,"PUMPQ")= WATERSUP(SUBREG,"WELL");
WATERSUP(SUBREG,"FIXEDMAX")= WATERSUP(SUBREG,"FIXEDMAX")
+ WATERSUP(SUBREG,"SURFACE");

```

**\*\*\*\*\* POPULATION**

```

PARAMETER POPULATION(SUBREG) POPULATION BY SUBREGION FOR WELFARE ACCTING
/ alabama 4150.0
scal 16791.6 / ;

```

**\*\*\*\*\* INITIALIZE TUNING FACTORS FOR PROFIT CALCULATION**

```

PARAMETER TUNE(CROP) NEW TUNING FACTORS
/ cotton 0.0 / ;

```

### 5.1.3 TUNE.DAT

This file is used to calibrate the supply side (or the marginal cost curves) of the model by adding the following tuning factors into the net returns of each budget. The positive factors represent upward shifting of supply curves while the negative ones represent downward adjustments.

```

TUNE(CROP) = 0.0 ;
TUNE("COTTON") = 3.0 ;
TUNE("SORGHUM") = 8.0 ;
TUNE("OATS") = 5.0 ;

```

### 5.1.4 Fpdata.DAT

This file provides farm program information which includes target price, loan rate, marketing loan, diversion payment, set-aside requirement and cost, slippage ratio, national average yield on participating acres, participation rate by subregion, percentage of land in 0/92, 50/92, and acreage diversion program of each program crop. They are divided into two tables as follows:

**\*\*\*\*\* Defining the variables or items associated with farm program**

```
SETS  FARMPRO          FARM PROGRAM PARAMETERS
      /SLIPPAGE  , SETASIDE  ,
      SETASDCOST, DIVERSION , 50-92,
      UNHARVACR , PERCENTPAID, FPYIELD,AGSTATYLD,
      DIVERPAY  , MKTLOANY-N, TARGET  ,
      LOANRATE  , DEFIC    ,      MKTLOAN/
      FPSCENARIO(FARMPRO)  SETTING ALTERNATIVE FARM PROGRAM SCENARIOS
      /DIVERPAY  , MKTLOANY-N, TARGET  ,
      LOANRATE  , DEFIC    ,      MKTLOAN/ ;
```

**\*\*\*\*\* Specifying farm program parameters associated with each crop**

```
TABLE FARMPROD(FARMPRO,ALLI)  FARM PROGRAM DATA
```

	COTTON	CORN	WHEAT	SORGHUM	RICE	BARLEY	OATS
slippage	0.7	0.60	0.80	0.60	0.45	0.60	0.60
setaside	0.125	0.10	0.05	0.10	0.20	0.10	0.10
setasdcost	20.00	20.00	20.00	20.00	20.00	20.00	20.0
diversion	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50-92	0.058	0.008	0.027	0.051	0.047	0.012	0.082
unharvacr	0.021	0.000	0.000	0.000	0.038	0.024	0.00
percentpaid	1.000	0.967	0.897	0.806	1.000	1.000	0.502
fpyield	1.165	105.0	33.0	59.0	46.19	47.0	49.0
agstatyld	1.330	118.5	39.5	62.9	55.07	55.9	60.1
diverpay	0.000	0.730	1.601	0.650	0.000	0.570	0.360
mktloany-n	1.000	0.000	0.000	0.000	1.000	0.000	0.000
target	349.9	2.75	4.00	2.61	10.71	2.36	1.45
loanrate	241.3	1.57	1.95	1.49	6.50	1.32	0.85
defic	24.5	0.45	1.40	0.50	4.00	0.26	0.36
mktloan	0.0	0.00	0.0	0.00	0.00	0.0	0.0

  

```
+      SOYBEANS      BUTTER      AMCHEESE      NONFATDRYM
loanrate      4.480      1.010      1.150      0.850      ;
```

```
FARMPROD("FPYIELD",ALLI)$FARMPROD("AGSTATYLD",ALLI)
      =FARMPROD("FPYIELD",ALLI)/FARMPROD("AGSTATYLD",ALLI);
```

**\*\*\*\*\* Specifying farm program participating rate in each state by crop**

```
TABLE FPPART(SUBREG,ALLI)  FARM PROGRAM PARTICIPATION RATES
```

	COTTON	CORN	WHEAT	SORGHUM	RICE	BARLEY	OATS
alabama	0.95	0.58	0.76	0.59	0.00	0.17	0.39
arizona	0.95	0.57	0.54	0.30	0.00	0.21	0.76 ;

### 5.1.5 PROC.DAT

This file provides budget information of all processing activities in the model. Each budget is identified by a processing name code and a specific technological number code. The latter provides the model alternative possibilities of producing the same products. This is very typical, in particular, for the production of concentrate feed in the livestock sector. Here are some examples of these processing budgets:

TABLE PROCBUD(ALLI,PROCESSALT) PROCESSING BUDGET DATA

\*\*\*\*\* PROCESS PRIMARY COMMODITY INTO SECONDARY COMMODITY

	FROZEN-POT
proccost	4.60300
profit	9.40700
potatoes	2.00000
frozenpot	1.00000

\*\*\*\*\* PROCESS SECONDARY INTO ANOTHER SECONDARY COMMODITY

	HFCS
profit	112204.94531
starch	-1000.00000
hfcs	1047.62000

\*\*\*\*\* PROCESS PRIMARY INTO ANOTHER PRIMARY COMMODITY

	DCAFSLA
profit	1.39400
culldairyc	1.00000
calfslaugh	-1.00000 ;

5.1.6 LIVE.DAT

This file contains livestock production budgets. Each livestock budget is identified by 3 codes: location(subregion), livestock operation, and technology.

TABLE LBUDDATA(ALLI,SUBREG,ANIMAL,LIVETECH) LIVESTOCK BUDGET DATA

	ROLINGPLTX. BEEFCOWS . 0
labor	10.70200
aums	12.59200
profit	33.38100
maximum	544.59998
corn	-.80500
cullbeefco	.50100
silage	-.17600
hay	-.70700
livecalf	1.85700
beefyearli	2.04600
highprotca	.15300
othervaria	1.76700
capital	60.09400
repaircost	9.32700
vetandmedi	4.53500
marketing	8.83200
landtaxes	8.14700
generalove	5.27800
fuelandoth	9.87100 ;

### 5.1.7 MIX.DAT

This file contains historical harvested acreages for each crop by subregion from 1970 to 1990.

```
PARAMETER MIXDATA(CROP, SUBREG, CRPMIXALT)

/cotton .alabama .1971 558.00
cotton .alabama .1972 580.00
cotton .alabama .1973 510.00
cotton .alabama .1974 585.00
cotton .alabama .1975 370.00
.
.
.
cotton .alabama .1990 388.00 /;
```

### 5.1.8 NATMIX.DAT

This file has another type of historical data for primary commodities as follows

```
TABLE NATMIXDATA(SUBREG, PRIMARY, NATMIXALT) PRIMARY PRODUCT MIXDATA

          MILK.1960  MILK.1961  MILK.1962  MILK.1963  MILK.1964  MILK.1965

alabama   9610.00    9550.00    9340.00    9090.00    9040.00    9040.00
arizona   4610.00    4680.00    4780.00    5000.00    5290.00    5200.00

+         POULTRY.1980 POULTRY.1981 POULTRY.1982 POULTRY.1983 POULTRY.1984
alabama   18798.90    19732.90    19509.10    20113.40    21463.20
arizona    0.00         0.00         0.00         0.00         0.00

+         HOGSLAUGHT.1980 HOGSLAUGHT.1981 HOGSLAUGHT.1982 HOGSLAUGHT.1983
alabama   2138.00     2109.93     1595.18     1553.94
arizona    591.00     355.77     305.10     446.36

+         WOOL.1980 WOOL.1981 WOOL.1982 WOOL.1983 WOOL.1984 WOOL.1985 WOOL.1986
alabama    0.00         0.00         0.00         0.00         0.00         0.00         0.00
arizona   2329.00    2417.00    2368.00    2121.00    1840.00    1900.00    2000.00;
```

### 5.1.9 CROP.DAT

This file has all the crop production budgets. Each budget is in a per acre basis and contains information on yield, labor and water use in physical units, and all other variable costs in dollar terms.

The profit in each budget has to be recomputed later.

TABLE CBUDDATA (ALLI, SUBREG, CROP, WTECH, CTECH, TECH) CROP BUDGET DATA

```
CONN      . POTATOES  . DRYLAND.BASE.  0
labor      24.37300
cropland   1.00000
profit     296.10001
potatoes   248.00000
nitrogen   96.00000
potassium  16.00000
phosporous 48.00000
othervaria 4.76000
chemicalco 133.18001
seedcost   144.70000
capital    913.70001
repaircost 68.36000
insurance  12.67000
fuelandoth 82.78999 ;
```

## 5.2 CALCULATION

These are some computational tasks which can be taken care of before setting up the model.

These computation is divided into the two files: ASMCALRN and ASMCALSU.

### 5.2.1 ASMCALRN

The major purpose of ASMCALRN is to calculate part of the parameters used in computing the area under the demand curves. Since a Cobb-Douglas type of constant elasticity curve is used to represent the demand schedule of each commodity, the area under the curve is infinite. Therefore, an artificial truncation factor is chosen (i.e., TFAC=10) to avoid this problem of an infinite objective function value. In the calculation, "constant1" represents the rectangular area under the demand curve up to the truncation factor. "Constant2" computes part of the parameters in calculating the remaining area under the demand curve. The purpose of this term is to simplify the integration formulae later used in the model objective function.

```
***** Re-initialize the truncation factor to be equal to 10.00
```

```
PDEMAND(PRIMARY, "TFAC")=10 ;
PEXPORTR(PRIMARY, "TFAC")=10 ;
```

```
SDEMAND(SECONDARY,"TFAC")=10;  
SEXPORT(SECONDARY,"TFAC")=10;
```

**\*\*\*\*\* Re-compute the truncation factor so that it is either 10 or  $[1/(10 \times \text{elasticity})]$ , whichever is smaller.**

```
PDEMAND(PRIMARY, "TFAC")$(ABS(PDEMAND(PRIMARY, "ELASTICITY")) GT 0.05 AND
                                PDEMAND(PRIMARY, "QUANTITY") GT 0 AND
                                PDEMAND(PRIMARY, "PRICE" ) GT 0) =
MIN(PDEMAND(PRIMARY, "TFAC")$PDEMAND(PRIMARY, "TFAC"),10.,
    (1.0/(PDEMAND(PRIMARY, "TFAC")**PDEMAND(PRIMARY, "ELASTICITY"))) ) ;
```

```
PEXPORT(PRIMARY, "TFAC")$(ABS(PEXPORT(PRIMARY, "ELASTICITY")) GT 0.05 AND
                                PEXPORT(PRIMARY, "QUANTITY") GT 0 AND
                                PEXPORT(PRIMARY, "PRICE" ) GT 0) =
MIN(PEXPORT(PRIMARY, "TFAC")$PEXPORT(PRIMARY, "TFAC"),10.,
    (1.0/(PEXPORT(PRIMARY, "TFAC")**PEXPORT(PRIMARY, "ELASTICITY"))) ) ;
```

```
SDEMAND(SECONDARY, "TFAC")$(ABS(SDEMAND(SECONDARY, "ELASTICITY")) GT 0.05 AND
                                SDEMAND(SECONDARY, "QUANTITY") GT 0 AND
                                SDEMAND(SECONDARY, "PRICE" ) GT 0) =
MIN(SDEMAND(SECONDARY, "TFAC")$SDEMAND(SECONDARY, "TFAC"),10.,
    (1.0/(SDEMAND(SECONDARY, "TFAC")**SDEMAND(SECONDARY, "ELASTICITY"))) ) ;
```

```
SEXPORT(SECONDARY, "TFAC")$(ABS(SEXPORT(SECONDARY, "ELASTICITY")) GT 0.05 AND
                                SEXPORT(SECONDARY, "QUANTITY") GT 0 AND
                                SEXPORT(SECONDARY, "PRICE" ) GT 0) =
MIN(SEXPORT(SECONDARY, "TFAC")$SEXPORT(SECONDARY, "TFAC"),10.,
    (1.0/(SEXPORT(SECONDARY, "TFAC")**SEXPORT(SECONDARY, "ELASTICITY"))) ) ;
```

**\*\*\*\*\* Re-compute the MINQ using the re-computed truncation factor**

```
PDEMAND(PRIMARY, "MINQ")$PDEMAND(PRIMARY, "TFAC")= MAX(PDEMAND(PRIMARY, "MINQ"),
    PDEMAND(PRIMARY, "QUANTITY")
    /PDEMAND(PRIMARY, "TFAC"));
```

```
PEXPORT(PRIMARY, "MINQ")$PEXPORT(PRIMARY, "TFAC")= MAX(PEXPORT(PRIMARY, "MINQ"),
    PEXPORT(PRIMARY, "QUANTITY")
    /PEXPORT(PRIMARY, "TFAC"));
```

```
SDEMAND(SECONDARY, "MINQ")$SDEMAND(SECONDARY, "TFAC")=MAX(SDEMAND(SECONDARY, "MINQ"),
    SDEMAND(SECONDARY, "QUANTITY")
    /SDEMAND(SECONDARY, "TFAC"));
```

```
SEXPORT(SECONDARY, "MINQ")$SEXPORT(SECONDARY, "TFAC")=MAX(SEXPORT(SECONDARY, "MINQ"),
    SEXPORT(SECONDARY, "QUANTITY")
    /SEXPORT(SECONDARY, "TFAC"));
```

**\*\*\*\*\* Compute the area under the demand curve up to its truncation point**

```
PDEMAND(PRIMARY, "CONSTANT1")$(ABS(PDEMAND(PRIMARY, "ELASTICITY")) GT 0.05 AND
                                PDEMAND(PRIMARY, "QUANTITY") GT 0 AND
                                PDEMAND(PRIMARY, "PRICE" ) GT 0) =
    (1.0/PDEMAND(PRIMARY, "TFAC"))** (1.0/PDEMAND(PRIMARY, "ELASTICITY"))
/PDEMAND(PRIMARY, "TFAC")
*PDEMAND(PRIMARY, "QUANTITY")*PDEMAND(PRIMARY, "PRICE") ;
```

```
PEXPORT(PRIMARY, "CONSTANT1")$(ABS(PEXPORT(PRIMARY, "ELASTICITY")) GT 0.05 AND
                                PEXPORT(PRIMARY, "QUANTITY") GT 0 AND
                                PEXPORT(PRIMARY, "PRICE" ) GT 0) =
    (1.0/PEXPORT(PRIMARY, "TFAC"))** (1.0/PEXPORT(PRIMARY, "ELASTICITY"))
/PEXPORT(PRIMARY, "TFAC")
```



```

*PEXPORT(PRIMARY,"QUANTITY")*PEXPORT(PRIMARY,"PRICE") ;

SDEMAND(SECONDARY,"CONSTANT1")$(ABS(SDEMAND(SECONDARY,"ELASTICITY")) GT 0.05
AND SDEMAND(SECONDARY,"QUANTITY") GT 0 AND
SDEMAND(SECONDARY,"PRICE" ) GT 0 ) =
(1.0/SDEMAND(SECONDARY,"TFAC"))**(1.0/SDEMAND(SECONDARY,"ELASTICITY"))
/SDEMAND(SECONDARY,"TFAC")
*SDEMAND(SECONDARY,"QUANTITY")*SDEMAND(SECONDARY,"PRICE") ;

SEXPORT(SECONDARY,"CONSTANT1")$(ABS(SEXPORT(SECONDARY,"ELASTICITY")) GT 0.05
AND SEXPORT(SECONDARY,"QUANTITY") GT 0 AND
SEXPORT(SECONDARY,"PRICE" ) GT 0 ) =
(1.0/SEXPORT(SECONDARY,"TFAC"))**(1.0/SEXPORT(SECONDARY,"ELASTICITY"))
/SEXPORT(SECONDARY,"TFAC")
*SEXPORT(SECONDARY,"QUANTITY")*SEXPORT(SECONDARY,"PRICE") ;

**** Compute part of parameters used in the objective function to calculate the area
under demand curve

PDEMAND(PRIMARY,"CONSTANT2")$(ABS(PDEMAND(PRIMARY,"ELASTICITY")) GT 0.05 AND
PDEMAND(PRIMARY,"QUANTITY") GT 0 AND
PDEMAND(PRIMARY,"PRICE" ) GT 0 ) =
-(1.0/PDEMAND(PRIMARY,"TFAC"))*(1.0+1.0/PDEMAND(PRIMARY,"ELASTICITY"))
*PDEMAND(PRIMARY,"QUANTITY")*PDEMAND(PRIMARY,"PRICE")
/(1.0+(1.0/PDEMAND(PRIMARY,"ELASTICITY"))) ;

PEXPORT(PRIMARY,"CONSTANT2")$(ABS(PEXPORT(PRIMARY,"ELASTICITY")) GT 0.05 AND
PEXPORT(PRIMARY,"QUANTITY") GT 0 AND
PEXPORT(PRIMARY,"PRICE" ) GT 0 ) =
-(1.0/PEXPORT(PRIMARY,"TFAC"))*(1.0+1.0/PEXPORT(PRIMARY,"ELASTICITY"))
*PEXPORT(PRIMARY,"QUANTITY")*PEXPORT(PRIMARY,"PRICE")
/(1.0+(1.0/PEXPORT(PRIMARY,"ELASTICITY"))) ;

SDEMAND(SECONDARY,"CONSTANT2")$(ABS(SDEMAND(SECONDARY,"ELASTICITY")) GT 0.05
AND SDEMAND(SECONDARY,"QUANTITY") GT 0 AND
SDEMAND(SECONDARY,"PRICE" ) GT 0 ) =
-(1.0/SDEMAND(SECONDARY,"TFAC"))*(1.0+1.0/SDEMAND(SECONDARY,"ELASTICITY"))
*SDEMAND(SECONDARY,"QUANTITY")*SDEMAND(SECONDARY,"PRICE")
/(1.0+(1.0/SDEMAND(SECONDARY,"ELASTICITY"))) ;

SEXPORT(SECONDARY,"CONSTANT2")$(ABS(SEXPORT(SECONDARY,"ELASTICITY")) GT 0.05
AND SEXPORT(SECONDARY,"QUANTITY") GT 0 AND
SEXPORT(SECONDARY,"PRICE" ) GT 0 ) =
-(1.0/SEXPORT(SECONDARY,"TFAC"))*(1.0+1.0/SEXPORT(SECONDARY,"ELASTICITY"))
*SEXPORT(SECONDARY,"QUANTITY")*SEXPORT(SECONDARY,"PRICE")
/(1.0+(1.0/SEXPORT(SECONDARY,"ELASTICITY"))) ;

```

### 5.2.2 ASMCALSU

This calculation file is used to calculate the profit (or net returns) of each budget. This profit is later applied to the model objective function as the marketing margin associated with each budget to

account for the discrepancies between farm price and consumer price and other unaccounted production cost.

**\*\*\*\*\* Initialize profit parameter for crop budgets (PROFITC)**

SET REGION(REGIONS) ; REGION(REGIONS) = YES ; REGION("TOTAL") = NO;

PARAMETER PROFITC(SUBREG,CROP,WTECH,CTECH,TECH) ;

**\*\*\*\*\* Check market price and farm program payment of each commodity**

PDEMAND(PRIMARY,"PRICE")\$(FARMPROD("SLIPPAGE",PRIMARY) GT 0. AND  
 FARMPROD("MKTLOANY-N",PRIMARY) LE 0. AND PDEMAND(PRIMARY,"PRICE")  
 LT FARMPROD("LOANRATE",PRIMARY) )  
 =FARMPROD("LOANRATE",PRIMARY) ;

FARMPROD("DEFIC",PRIMARY)\$(FARMPROD("SLIPPAGE",PRIMARY) GT 0. AND  
 FARMPROD("LOANRATE",PRIMARY) LT PDEMAND(PRIMARY,"PRICE"))  
 = FARMPROD("TARGET",PRIMARY) - PDEMAND(PRIMARY,"PRICE") ;

FARMPROD("DEFIC",PRIMARY)\$(FARMPROD("SLIPPAGE",PRIMARY) GT 0. AND  
 FARMPROD("LOANRATE",PRIMARY) GE PDEMAND(PRIMARY,"PRICE"))  
 = FARMPROD("TARGET",PRIMARY) - FARMPROD("LOANRATE",PRIMARY) ;

FARMPROD("DEFIC",PRIMARY)\$(FARMPROD("SLIPPAGE",PRIMARY) GT 0. AND  
 FARMPROD("TARGET",PRIMARY) LE PDEMAND(PRIMARY,"PRICE")) =0.0 ;

**\*\*\*\*\* Calculate profit in each crop budget as the revenue minus all input cost**

CBUDDATA("PROFIT",SUBREG,CROP,WTECH,CTECH,TECH) = 0. ;

PROFITC(SUBREG,CROP,WTECH,CTECH,TECH) =  
 SUM(PRIMARY,PDEMAND(PRIMARY,"PRICE")  
 \*CBUDDATA(PRIMARY,SUBREG,CROP,WTECH,CTECH,TECH))  
 -SUM(SECONDARY,SDEMAND(SECONDARY,"PRICE")  
 \*CBUDDATA(SECONDARY,SUBREG,CROP,WTECH,CTECH,TECH))  
 -SUM(INPUT,INPUTPRICE(INPUT)  
 \*CBUDDATA(INPUT,SUBREG,CROP,WTECH,CTECH,TECH))  
 -SUM(COST,CBUDDATA(COST,SUBREG,CROP,WTECH,CTECH,TECH))  
 -WATERSUP(SUBREG,"PUMPPRICE")  
 \*CBUDDATA("WATER",SUBREG,CROP,WTECH,CTECH,TECH)  
 -SUM(REGION\$MAPPING(REGION,SUBREG),  
 SUM(LANDTYPE,LANDSUPPL(LANDTYPE,REGION,"PRICE")  
 \*CBUDDATA(LANDTYPE,SUBREG,CROP,WTECH,CTECH,TECH))  
 +LABORSUP(REGION,"HIREP")  
 \*CBUDDATA("LABOR",SUBREG,CROP,WTECH,CTECH,TECH) ) ;

CBUDDATA("PROFIT",SUBREG,CROP,WTECH,CTECH,TECH)\$PROFITC(SUBREG,CROP,WTECH,CTECH,TECH)

```

= PROFITC(SUBREG,CROP,WTECH,CTECH,TECH) ;

**** Initialize profit for all livestock budgets (PROFITL)
PARAMETER PROFITL(SUBREG,ANIMAL,LIVETECH) ;

LBUDDATA("PROFIT",SUBREG,ANIMAL,LIVETECH) = 0.;

**** Calculate profit for all livestock budgets

PROFITL(SUBREG,ANIMAL,LIVETECH) =
SUM(PRIMARY,PDEMAND(PRIMARY,"PRICE")
*LBUDDATA(PRIMARY,SUBREG,ANIMAL,LIVETECH))
-SUM(SECONDARY,SDEMAND(SECONDARY,"PRICE")
*LBUDDATA(SECONDARY,SUBREG,ANIMAL,LIVETECH))
-SUM(INPUT,INPUTPRICE(INPUT)
*LBUDDATA(INPUT,SUBREG,ANIMAL,LIVETECH))
-SUM(COST,LBUDDATA(COST,SUBREG,ANIMAL,LIVETECH))
-WATERSUP(SUBREG,"PUMPPRICE")
*LBUDDATA("WATER",SUBREG,ANIMAL,LIVETECH)
-SUM(REGION$MAPPING(REGION,SUBREG),
SUM(LANDTYPE,LANDSUPPL(LANDTYPE,REGION,"PRICE")
*LBUDDATA(LANDTYPE,SUBREG,ANIMAL,LIVETECH))
+LABORSUP(REGION,"HIREP")
*LBUDDATA("LABOR",SUBREG,ANIMAL,LIVETECH) ) ;

LBUDDATA("PROFIT",SUBREG,ANIMAL,LIVETECH) =
PROFITL(SUBREG,ANIMAL,LIVETECH) ;

**** Eliminate maximum constraint in some livestock budgets
LBUDDATA("maximum",SUBREG,ANIMAL,LIVETECH)=0.0 ;

**** Initialize profit for processing budget (PROFITR)
PARAMETER PROFITR(PROCESSALT);

PROCBUD("PROFIT",PROCESSALT) = 0.0;

**** Calculate profit for all processing budgets

PROFITR(PROCESSALT) =
-SUM(PRIMARY,PDEMAND(PRIMARY,"PRICE")
*PROCBUD(PRIMARY,PROCESSALT))
+SUM(SECONDARY,SDEMAND(SECONDARY,"PRICE")
*PROCBUD(SECONDARY,PROCESSALT))
-SUM(INPUT,INPUTPRICE(INPUT)
*PROCBUD(INPUT,PROCESSALT))
-SUM(COST,PROCBUD(COST,PROCESSALT)) ;

PROCBUD("PROFIT",PROCESSALT) = PROFITR(PROCESSALT) ;

**** In ASM, we assume all the crop budgets are weighted averages of participating and
non-participating **** budgets on a harvested basis. For farm program analysis, we
must distinguish between participating **** and non-participating production budgets.
Therefore, crop yield, land use, cost, and profit must be
**** adjusted to reflect the difference between these two budgets.

```

**\*\*\*\*\* Initialize participating and non-participating budgets equaling base budgets for farm program crops**

```
CBUDDATA(ALLI,SUBREG,CROP,WTECH,"PARTICIP",TECH)
  $(SUM(FARMPRO,ABS(FARMPROD(FARMPRO,CROP))))
= CBUDDATA(ALLI,SUBREG,CROP,WTECH,"BASE",TECH) ;
```

```
CBUDDATA(ALLI,SUBREG,CROP,WTECH,"NONPART",TECH)
  $(SUM(FARMPRO,ABS(FARMPROD(FARMPRO,CROP))))
= CBUDDATA(ALLI,SUBREG,CROP,WTECH,"BASE",TECH) ;
```

**\*\*\*\*\* Adjust yields for the non-participating budget for farm program crops**

```
CBUDDATA(CROP,SUBREG,CROP,WTECH,"NONPART",TECH) $FARMPROD("SLIPPAGE",CROP)
= CBUDDATA(CROP,SUBREG,CROP,WTECH,"BASE",TECH)
  * ( FPPART(SUBREG,CROP) * (1-FARMPROD("SETASIDE",CROP)
    -FARMPROD("DIVERSION",CROP)-FARMPROD("50-92",CROP))
    + (1-FPPART(SUBREG,CROP)) )
  / ( (1-FPPART(SUBREG,CROP)) +
    (1+(FARMPROD("SETASIDE",CROP)+FARMPROD("DIVERSION",CROP)
    +FARMPROD("50-92",CROP))* (1-FARMPROD("SLIPPAGE",CROP)))
    * FPPART(SUBREG,CROP) * (1-FARMPROD("SETASIDE",CROP)
    -FARMPROD("DIVERSION",CROP)-FARMPROD("50-92",CROP)) ) ;
```

**\*\*\*\*\* Adjust yields for the participating budget for farm program crops**

```
CBUDDATA(CROP,SUBREG,CROP,WTECH,"PARTICIP",TECH) $FARMPROD("SLIPPAGE",CROP)
= CBUDDATA(CROP,SUBREG,CROP,WTECH,"NONPART",TECH) *
  ( 1+(FARMPROD("SETASIDE",CROP)+FARMPROD("DIVERSION",CROP)
    +FARMPROD("50-92",CROP))* (1-FARMPROD("SLIPPAGE",CROP)) ) ;
```

**\*\*\*\*\* Due to the set-aside requirement in farm programs, for each acre harvested, there is a certain percentage being set-aside. Thus, we need to save the original land use in the budget and later use this number to compute the set-aside land required in the participating budget. This set-aside land must be added into the participating budget.**

**\*\*\*\*\* Save the original land use in each budget**

```
CBUDDATA("addLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH)=
  CBUDDATA("cropLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH) ;
```

**\*\*\*\*\* Compute total land use in participating budget including set-aside**

```
CBUDDATA("cropLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH)
  $FARMPROD("SLIPPAGE",CROP)
= CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"BASE",TECH)/(1.0 -
  (FARMPROD("SETASIDE",CROP)+FARMPROD("DIVERSION",CROP)
  +FARMPROD("50-92",CROP))*FPPART(SUBREG,CROP)) ;
```

**\*\*\*\*\* Compute the set-aside acre in each participating budget**

```
CBUDDATA("addLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH)=
  CBUDDATA("cropLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH)
  - CBUDDATA("addLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH) ;
```

**\*\*\*\*\* Compute the compliance cost associated with the set-aside acre**

```

CBUDDATA("COMPLIANC",SUBREG,CROP,WTECH,"PARTICIP",TECH)
    $FARMPROD("SLIPPAGE",CROP)
= CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH)
    *FPPART(SUBREG,CROP)
    *FARMPROD("SETASDCOST",CROP) * ( FARMPROD("SETASIDE",CROP)
    +FARMPROD("DIVERSION",CROP)+FARMPROD("50-92",CROP) ) ;

```

**\*\*\*\*\* Adjust profit by 1). subtracting the additional land cost,**  
**\*\*\*\*\* 2). subtracting the compliance cost, and**  
**\*\*\*\*\* 3). adding deficiency, diversion, 50/92 and marketing loan payment based on the**  
**farm program yield**

**\*\*\*\*\* For crops with marketing loan program**

```

CBUDDATA("PROFIT",SUBREG,CROP,WTECH,"PARTICIP",TECH)
    $(FARMPROD("SLIPPAGE",CROP)GT 0 AND FARMPROD("MKTLOANY-N",CROP) GT 0)
= CBUDDATA("PROFIT",SUBREG,CROP,WTECH,"BASE",TECH)
- SUM(REGION$MAPPING(REGION,SUBREG),
    LANDSUPPL("CROPLAND",REGION,"PRICE")
    *(CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH)-
    CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"BASE",TECH) ) )
- CBUDDATA("COMPLIANC",SUBREG,CROP,WTECH,"PARTICIP",TECH)
+ (FARMPROD("DEFIC",CROP) +
    max(0., (FARMPROD("LOANRATE",CROP)-PDEMAND(CROP,"PRICE"))) ) )
* CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH)
* FPPART(SUBREG,CROP)*(1-FARMPROD("SETASIDE",CROP)
    -FARMPROD("DIVERSION",CROP)-FARMPROD("50-92",CROP))
*FARMPROD("PERCNTPAID",CROP)
* MIN( CBUDDATA(CROP,SUBREG,CROP,WTECH,"PARTICIP",TECH) ,
    (FARMPROD("FPYIELD",CROP)
    *CBUDDATA(CROP,SUBREG,CROP,WTECH,"PARTICIP",TECH) ) )
+ FARMPROD("DEFIC",CROP)
*CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH)
*FPPART(SUBREG,CROP)*FARMPROD("50-92",CROP)
*FARMPROD("FPYIELD",CROP)
*CBUDDATA(CROP,SUBREG,CROP,WTECH,"PARTICIP",TECH)
*0.92
+ FARMPROD("DIVERPAY",CROP)
*CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH)
*FPPART(SUBREG,CROP)*FARMPROD("DIVERSION",CROP)
*FARMPROD("FPYIELD",CROP)
*CBUDDATA(CROP,SUBREG,CROP,WTECH,"PARTICIP",TECH)
+ FARMPROD("DEFIC",CROP)
*CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH)
*FPPART(SUBREG,CROP)
*(1-FARMPROD("SETASIDE",CROP)-FARMPROD("DIVERSION",CROP)
    -FARMPROD("50-92",CROP))*FARMPROD("PERCNTPAID",CROP)
*FARMPROD("UNHARVACR",CROP) *FARMPROD("FPYIELD",CROP)
*CBUDDATA(CROP,SUBREG,CROP,WTECH,"PARTICIP",TECH)
+ FARMPROD("DEFIC",CROP)
*CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH)
*FPPART(SUBREG,CROP)
*(1-FARMPROD("SETASIDE",CROP)-FARMPROD("DIVERSION",CROP)
    -FARMPROD("50-92",CROP))*FARMPROD("PERCNTPAID",CROP)
*MAX(0.0, (FARMPROD("FPYIELD",CROP)-1.0))
*CBUDDATA(CROP,SUBREG,CROP,WTECH,"PARTICIP",TECH) ;

```

**\*\*\*\*\* For crops without marketing loan program**

```

CBUDDATA("PROFIT",SUBREG,CROP,WTECH,"PARTICIP",TECH)
    $(FARMPROD("SLIPPAGE",CROP)
      GT 0 AND FARMPROD("MKTLOANY-N",CROP) LE 0)
= CBUDDATA("PROFIT",SUBREG,CROP,WTECH,"BASE",TECH)
- SUM(REGION$MAPPING(REGION,SUBREG),
      LANDSUPPL("CROPLAND",REGION,"PRICE")
      *(CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH)-
        CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"BASE",TECH) ) )
- CBUDDATA("COMPLIANC",SUBREG,CROP,WTECH,"PARTICIP",TECH)
+ FARMPROD("DEFIC",CROP)
  * CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH)
  * FPPART(SUBREG,CROP)*(1-FARMPROD("SETASIDE",CROP)
    -FARMPROD("DIVERSION",CROP)-FARMPROD("50-92",CROP))
  *FARMPROD("PERCENTPAID",CROP)
  * MIN( CBUDDATA(CROP,SUBREG,CROP,WTECH,"PARTICIP",TECH) ,
    (FARMPROD("FPYIELD",CROP)
      *CBUDDATA(CROP,SUBREG,CROP,WTECH,"PARTICIP",TECH)) )
+ FARMPROD("DEFIC",CROP)
  *CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH)
  *FPPART(SUBREG,CROP)*FARMPROD("50-92",CROP)
  *FARMPROD("FPYIELD",CROP)
  *CBUDDATA(CROP,SUBREG,CROP,WTECH,"PARTICIP",TECH)
  *0.92
+ FARMPROD("DIVERPAY",CROP)
  *CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH)
  *FPPART(SUBREG,CROP)*FARMPROD("DIVERSION",CROP)
  *FARMPROD("FPYIELD",CROP)
  *CBUDDATA(CROP,SUBREG,CROP,WTECH,"PARTICIP",TECH)
+ FARMPROD("DEFIC",CROP)
  *CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH)
  *FPPART(SUBREG,CROP)
  *(1-FARMPROD("SETASIDE",CROP)-FARMPROD("DIVERSION",CROP)
    -FARMPROD("50-92",CROP))*FARMPROD("PERCENTPAID",CROP)
  *FARMPROD("UNHARVACR",CROP)*FARMPROD("FPYIELD",CROP)
  *CBUDDATA(CROP,SUBREG,CROP,WTECH,"PARTICIP",TECH)
+ FARMPROD("DEFIC",CROP)
  *CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH)
  *FPPART(SUBREG,CROP)
  *(1-FARMPROD("SETASIDE",CROP)-FARMPROD("DIVERSION",CROP)
    -FARMPROD("50-92",CROP))*FARMPROD("PERCENTPAID",CROP)
  *MAX(0.0,(FARMPROD("FPYIELD",CROP)-1.0))
  *CBUDDATA(CROP,SUBREG,CROP,WTECH,"PARTICIP",TECH) ;

```

**\*\*\*\*\* Adjust profit for non-participating budgets using a proportional adjustment by crop yield**

```

CBUDDATA("PROFIT",SUBREG,CROP,WTECH,"NONPART",TECH)
  $(FARMPROD("SLIPPAGE",CROP)*CBUDDATA(CROP,SUBREG,CROP,WTECH,"BASE",TECH))
= ( CBUDDATA("PROFIT",SUBREG,CROP,WTECH,"PARTICIP",TECH) -
  CBUDDATA("COMPLIANC",SUBREG,CROP,WTECH,"PARTICIP",TECH) )
  * CBUDDATA(CROP,SUBREG,CROP,WTECH,"NONPART",TECH)
  / CBUDDATA(CROP,SUBREG,CROP,WTECH,"BASE",TECH) ;

```

## 5.3 MODEL

The main components (variables and equations) of the model are written in the file "ASMMODEL". Due to the endogenized price and deficiency payment, an iterative solving procedure is used and described in a separate file named "ASMSOLVE".

### 5.3.1 ASMMODEL

```
#####
* DEMAND CURVES SPECIFICATIONS IN ASM INCLUDE THE FOLLOWING 4 CASES:
* (1) NO FINAL DEMAND: P NE 0.0; Q EQ 0.0; ELAS EQ 0.0
* (2) REGULAR DEMAND: P NE 0.0; Q NE 0.0; ELAS LE -0.05
* (3) HORIZONATAL DEMAND:P NE 0.0; Q NE 0.0; ELAS EQ 0.0 (FIXED PRICE DEMAND)
* (4) VERTICAL DEMAND: P NE 0.0; Q NE 0.0; W/ MINQ GT 0.0
* THESE SPEICIFICATIONS ALSO APPLY TO THE IMPORT ANS INPUT SUPPLY CURVES.
#####
```

#### \*\*\* Defining variables and equations

```
POSITIVE VARIABLES

CROPBUDGET(SUBREG,CROP,WTECH,CTECH,TECH) CROP BUDGETS
LVSTBUDGET(SUBREG,ANIMAL,LIVETECH) LIVESTOCK BUDGETS
LANDSUPPLY(REGIONS,LANDTYPE) REGIONAL LAND SUPPLY
PROCESS(PROCESSALT) PROCESSING BUDGETS
WATERFIX(SUBREG) FIXED PRICE - FIXED WATER SUPPLY
WATERVAR(SUBREG) VARIABLE COST - PUMPED WATER
SUPPLY
FAMILY(REGIONS) FAMILY LABOR SUPPLY
HIRED(REGIONS) HIRED LABOR SUPPLY
DEMANDP(PRIMARY) PRIMARY PRODUCT DOMESTIC
DEMAND
IMPORTP(PRIMARY) PRIMARY PRODUCT IMPORTS
EXPORTP(PRIMARY) PRIMARY PRODUCT EXPORTS
DEMANDS(SECONDARY) SECONDARY PRODUCT DOMESTIC
DEMAND
IMPORTS(SECONDARY) SECONDARY PRODUCT IMPORTS
EXPORTS(SECONDARY) SECONDARY PRODUCT EXPORTS
MIXR(SUBREG,CRPMIXALT) CROP MIXES BY REGION
NATMIX(PRIMARY,NATMIXALT) PRIMARY PRODUCT MIXES ACROSS
REGIONS
BUYINPUT(INPUT) INPUT PURCHASES
CCCLOANP(PRIMARY) PRIMARY PRODUCT CCC LOAN
DEMAND
CCCLOANS(SECONDARY) SECONDARY PRODUCT CCC LOAN
DEMAND
```

DEFPRODN(ALLI)	PRODUCTION RECEIVE DEFIC PYMT
PRDN5092(ALLI)	PRODUCTION RECEIVE 5092 PYMT
DIVPRODN(ALLI)	PRODUCTION RECEIVE DIVERSION PYMT
ARTIF(ALLI)	ARTIFICIAL PRODUCTION
UNHARV(ALLI)	UNHARVESTED PRODUCTION

VARIABLES

CSPS	
TOLR(PRIMARY, SUBREG)	NATIONAL CROP MIX TOLERANCE
TWID(CROP, SUBREG)	CROP MIXES TOLERANCE

EQUATIONS

OBJT	
MAXLAND(SUBREG, LANDTYPE)	MAXIMUM LAND AVAILABLE IN A
SUBREG	
MINLAND(SUBREG)	MINIMUM CROPLAND USE IN A SUBREG
LAND(REGIONS, LANDTYPE)	REGIONAL LAND BALANCE
WATERR(SUBREG)	SUBREGIONAL WATER BALANCE
FIX(SUBREG)	SUBREGIONAL MAXIMUM FIXED PRICE WATER
LABOR(REGIONS)	REGIONAL LABOR BALANCE
FAMILYLIM(REGIONS)	MAXIMUM FAMILY LABOR
HIRELIM(REGIONS)	MAXIMUM HIRED LABOR
PRIMARYBAL(PRIMARY)	PRIMARY PRODUCT BALANCE
SECONDBAL(SECONDARY)	SECONDARY PRODUCT BALANCE
MIXREG(CROP, SUBREG)	CROP MIX CONSTRAINTS BY ACREAGE IN
SUBREGION	
MIXREGTOT(SUBREG)	TOTAL ACRES IN A CROP MIX
MIXNAT(PRIMARY, SUBREG)	PRIMARY PRODUCT DISTRIBUTION
ACROSS REGIONS	
INPUTBAL(INPUT)	NATIONAL INPUT BALANCES
FRMPROG(CROP)	TOTAL FARM PROGRAM PRODUCTION
P5092(CROP)	TOTAL 5092 ACREAGE PRODUCTION
DIVERT(CROP)	TOTAL VOLUNTARY DIVERSION PRODUCTION
ARTIFICIAL(CROP)	ARTIFICIAL FARM PROGRAM PRODUCTION
UNHARVEST(CROP)	PAID BUT UNHARVESTED FARM PROGRAM
PRODUCITON	;

\*\*\*\* Objective Function

OBJT.. CSPPS =E=

\*\*\*\* Summation of all areas under domestic and export demand curves for primary commodities.

```
( SUM(PRIMARY$(PDEMAND(PRIMARY,"QUANTITY") GT 0 AND
PDEMAND(PRIMARY,"PRICE") GT 0 AND
PDEMAND(PRIMARY,"ELASTICITY") LT -0.05 ),
(DEMANDP(PRIMARY)*SCALE(PRIMARY)/PDEMAND(PRIMARY,"QUANTITY"))
** (1./PDEMAND(PRIMARY,"ELASTICITY"))
* DEMANDP(PRIMARY)*SCALE(PRIMARY)
* PDEMAND(PRIMARY,"PRICE")
* PDEMAND(PRIMARY,"ELASTICITY")
/ (1.+PDEMAND(PRIMARY,"ELASTICITY"))
+PDEMAND(PRIMARY,"CONSTANT1")
+PDEMAND(PRIMARY,"CONSTANT2") )
+SUM(PRIMARY$(PDEMAND(PRIMARY,"PRICE") GT 0 AND
```



```

        PDEMAND(PRIMARY,"ELASTICITY") GE -0.05
        and pdemand(primary,"quantity") ne 0    ),
PDEMAND(PRIMARY,"PRICE") *DEMANDP(PRIMARY)*SCALE(PRIMARY))

+SUM(PRIMARY$(PEXPORT(PRIMARY,"QUANTITY")    GT 0 AND
              PEXPORT(PRIMARY,"PRICE")      GT 0 AND
              PEXPORT(PRIMARY,"ELASTICITY")  LT -0.05    ),
(EXPORTP(PRIMARY)*SCALE(PRIMARY)/PEXPORT(PRIMARY,"QUANTITY"))
              *(1./PEXPORT(PRIMARY,"ELASTICITY"))
* EXPORTP(PRIMARY)*SCALE(PRIMARY)
* PEXPORT(PRIMARY,"PRICE")
* PEXPORT(PRIMARY,"ELASTICITY")
/ (1.+PEXPORT(PRIMARY,"ELASTICITY"))
+PEXPORT(PRIMARY,"CONSTANT1")
+PEXPORT(PRIMARY,"CONSTANT2")    )

+SUM(PRIMARY$(PEXPORT(PRIMARY,"PRICE")      GT 0 AND
              PEXPORT(PRIMARY,"ELASTICITY") GE -0.05
              and pexport(primary,"quantity") ne 0    ),
PEXPORT(PRIMARY,"PRICE")*EXPORTP(PRIMARY)
*SCALE(PRIMARY))

**** Subtracting areas under import supply curves for primary commodities
-SUM(PRIMARY$(PIMPORT(PRIMARY,"PRICE")      GT 0 AND
              PIMPORT(PRIMARY,"QUANTITY")   GT 0 AND
              PIMPORT(PRIMARY,"ELASTICITY") GT 0.05    ),
+PIMPORT(PRIMARY,"ELASTICITY")
              /(1.+PIMPORT(PRIMARY,"ELASTICITY"))
*(PIMPORT(PRIMARY,"PRICE")
*(IMPORTP(PRIMARY)*SCALE(PRIMARY)/PIMPORT(PRIMARY,"QUANTITY"))**
  (1./PIMPORT(PRIMARY,"ELASTICITY"))
  * IMPORTP(PRIMARY)*SCALE(PRIMARY)    ) )

-SUM(PRIMARY$(PIMPORT(PRIMARY,"PRICE")      GT 0 AND
              PIMPORT(PRIMARY,"ELASTICITY") LE 0.05
              and pimport(primary,"quantity") ne 0    ),
PIMPORT(PRIMARY,"PRICE")*IMPORTP(PRIMARY)*SCALE(PRIMARY))

**** Summation of all areas under domestic and export demand curves for secondary commodities.
+SUM(SECONDARY$(SDEMAND(SECONDARY,"QUANTITY") GT 0 AND
               SDEMAND(SECONDARY,"PRICE")     GT 0 AND
               SDEMAND(SECONDARY,"ELASTICITY") LT -0.05    ),

(DEMANDS(SECONDARY)*SCALE(SECONDARY)/SDEMAND(SECONDARY,"QUANTITY"))
               *(1./SDEMAND(SECONDARY,"ELASTICITY"))
* DEMANDS(SECONDARY)*SCALE(SECONDARY)
* SDEMAND(SECONDARY,"PRICE")
* SDEMAND(SECONDARY,"ELASTICITY")
/ (1.+SDEMAND(SECONDARY,"ELASTICITY"))
+SDEMAND(SECONDARY,"CONSTANT1")
+SDEMAND(SECONDARY,"CONSTANT2")    )

+SUM(SECONDARY$(SDEMAND(SECONDARY,"PRICE")   GT 0 AND
               SDEMAND(SECONDARY,"ELASTICITY") GE -0.05
               and sdemand(secondary,"quantity") ne 0    ),
(SECONDARY,"PRICE") *DEMANDS(SECONDARY)*SCALE(SECONDARY))

```

```

+SUM(SECONDARY$(SEXPORT(SECONDARY,"QUANTITY") GT 0 AND
          SEXPORT(SECONDARY,"PRICE") GT 0 AND
          SEXPORT(SECONDARY,"ELASTICITY") LT -0.05 ),
(EXPORTS(SECONDARY)*SCALE(SECONDARY)/SEXPORT(SECONDARY,"QUANTITY"))
          *(1./SEXPORT(SECONDARY,"ELASTICITY"))
* EXPORTS(SECONDARY)*SCALE(SECONDARY)
* SEXPORT(SECONDARY,"PRICE")
* SEXPORT(SECONDARY,"ELASTICITY")
/ (1.+SEXPORT(SECONDARY,"ELASTICITY"))
+SEXPORT(SECONDARY,"CONSTANT1")
+SEXPORT(SECONDARY,"CONSTANT2")

+SUM(SECONDARY$(SEXPORT(SECONDARY,"PRICE") GT 0 AND
          SEXPORT(SECONDARY,"ELASTICITY") GE -0.05
          and sexport(secondary,"quantity") ne 0 ),
SEXPORT(SECONDARY,"PRICE")*EXPORTS(SECONDARY)*SCALE(SECONDARY))

**** Subtracting areas under import supply curves for secondary commodities
-SUM(SECONDARY$(SIMPORT(SECONDARY,"QUANTITY") GT 0 AND
          SIMPORT(SECONDARY,"PRICE") GT 0 AND
          SIMPORT(SECONDARY,"ELASTICITY") GT 0.05 ),
+SIMPORT(SECONDARY,"ELASTICITY")/(1.+SIMPORT(SECONDARY,"ELASTICITY"))
          *SIMPORT(SECONDARY,"PRICE")*
          (IMPORTS(SECONDARY)*SCALE(SECONDARY)
          /SIMPORT(SECONDARY,"QUANTITY"))
          *(1./SIMPORT(SECONDARY,"ELASTICITY"))
          * IMPORTS(SECONDARY)*SCALE(SECONDARY)

-SUM(SECONDARY$(SIMPORT(SECONDARY,"PRICE") GT 0 AND
          SIMPORT(SECONDARY,"ELASTICITY") LE 0.05
          and simport(secondary,"quantity") ne 0 ),
SIMPORT(SECONDARY,"PRICE")*IMPORTS(SECONDARY)*SCALE(SECONDARY))

**** Subtracting areas under the regional land supply curves
-SUM((REGION, LANDTYPE)$ (LANDSUPPL(LANDTYPE, REGION, "QUANTITY") GT
0 AND LANDSUPPL(LANDTYPE, REGION, "PRICE") GT 0 AND
LANDSUPPL(LANDTYPE, REGION, "ELASTICITY") GT 0.05 ),
+LANDSUPPL(LANDTYPE, REGION, "ELASTICITY")
/ (1.+LANDSUPPL(LANDTYPE, REGION, "ELASTICITY"))
*LANDSUPPL(LANDTYPE, REGION, "PRICE")*
(LANDSUPPLY(REGION, LANDTYPE)*SCALE(LANDTYPE)
/LANDSUPPL(LANDTYPE, REGION, "QUANTITY"))
*(1./LANDSUPPL(LANDTYPE, REGION, "ELASTICITY"))
* LANDSUPPLY(REGION, LANDTYPE)*SCALE(LANDTYPE)

-SUM((REGION, LANDTYPE)$ (LANDSUPPL(LANDTYPE, REGION, "PRICE") GT 0 AND
LANDSUPPL(LANDTYPE, REGION, "ELASTICITY") LE 0.05 AND
LANDSUPPL(LANDTYPE, REGION, "quantity") ne 0.0 ),
LANDSUPPL(LANDTYPE, REGION, "PRICE")*
LANDSUPPLY(REGION, LANDTYPE)*SCALE(LANDTYPE))

**** Subtracting areas under the subregional water supply curves
-SUM(SUBREG$(WATERSUP(SUBREG, "PUMPO") GT 0 AND
WATERSUP(SUBREG, "PUMPPRICE") GT 0 AND
WATERSUP(SUBREG, "PUMPELAS") GT 0.05 ),
WATERSUP(SUBREG, "PUMPELAS")

```

```

/ (1.+WATERSUP (SUBREG, "PUMPELAS" ) )
*WATERSUP (SUBREG, "PUMPPRICE" ) *
(WATERVAR (SUBREG) *SCALE ( "WATER" )
/WATERSUP (SUBREG, "PUMPQ" ) )
** (1./WATERSUP (SUBREG, "PUMPELAS" ) )
* WATERVAR (SUBREG) *SCALE ( "WATER" ) )

-SUM (SUBREG$ (WATERSUP (SUBREG, "PUMPPRICE" ) GT 0 AND
WATERSUP (SUBREG, "PUMPELAS" ) LE 0.05 AND
WATERSUP (SUBREG, "PUMPQ" ) NE 0.0 ),
WATERSUP (SUBREG, "PUMPPRICE" ) *
WATERVAR (SUBREG) *SCALE ( "WATER" ) )

**** Subtracting areas under regional labor supply curves
-SUM (REGION$ (LABORSUP (REGION, "HIREQ" ) GT 0 AND
LABORSUP (REGION, "HIREP" ) GT 0 AND
LABORSUP (REGION, "HIREELAS" ) GT 0.05 ),
LABORSUP (REGION, "HIREELAS" ) / (1.+LABORSUP (REGION, "HIREELAS" ) )
*LABORSUP (REGION, "HIREP" ) *
(HIRED (REGION) *SCALE ( "LABOR" ) /LABORSUP (REGION, "HIREQ" ) ) **
(1./LABORSUP (REGION, "HIREELAS" ) )
* HIRED (REGION) *SCALE ( "LABOR" ) )

- SUM (REGION$ (LABORSUP (REGION, "HIREQ" ) LE 0 AND
LABORSUP (REGION, "HIREP" ) GT 0 AND
LABORSUP (REGION, "HIREELAS" ) LE 0.05 AND
LABORSUP (REGION, "HIREQ" ) NE 0.0 ),
LABORSUP (REGION, "HIREP" ) *
HIRED (REGION) *SCALE ( "LABOR" ) )

**** Subtracting net production cost (or profits) of crop, livestock and processing
budgets
- SUM ( (SUBREG, CROP, WTECH, TECH) $ (FARMPROD ( "SLIPPAGE" , CROP) gt 0.0 and
CBUDDATA (crop, SUBREG, CROP, WTECH, "PARTICIP" , TECH) gt 0.0 ),
(tune (crop) +SUM (COST, CBUDDATA (COST, SUBREG, CROP, WTECH, "PARTICIP" , TECH) ) )
*CROPBUDGET (SUBREG, CROP, WTECH, "PARTICIP" , TECH) *SCALPROD

+ (tune (crop) +SUM (COST, CBUDDATA (COST, SUBREG, CROP, WTECH, "NONPART" , TECH) ) )
*CROPBUDGET (SUBREG, CROP, WTECH, "NONPART" , TECH) *SCALPROD

- SUM ( (SUBREG, CROP, WTECH, TECH) $ (FARMPROD ( "SLIPPAGE" , CROP) LE 0.0 and
CBUDDATA (crop, SUBREG, CROP, WTECH, "base" , TECH) gt 0.0 ),
+ (tune (crop) +SUM (COST, CBUDDATA (COST, SUBREG, CROP, WTECH, "BASE" , TECH) ) )
*CROPBUDGET (SUBREG, CROP, WTECH, "BASE" , TECH) *SCALPROD )

- SUM ( (SUBREG, ANIMAL, LIVETECH) ,
(SUM (COST, LBUDDATA (COST, SUBREG, ANIMAL, LIVETECH) ) )
* LVSTBUDGET (SUBREG, ANIMAL, LIVETECH) ) *SCALLIVE

- SUM (PROCESSALT, PROCESS (PROCESSALT) *SCALPROC*
(SUM (COST, PROCBUD (COST, PROCESSALT) ) ) )

**** Subtracting family labor cost
- SUM (REGION, FAMILY (REGION) * LABORSUP (REGION, "FAMILYPRC" ) *SCALE ( "LABOR" ) )

**** Subtracting national input cost
- SUM (INPUT, INPUTPRICE (INPUT) *BUYINPUT (INPUT) *SCALE (INPUT) )

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```

**** Subtracting fixed-price water cost
- SUM(SUBREG,WATERFIX(SUBREG)* WATERSUP(SUBREG,"FIXEDPRC")*SCALE("WATER"))

**** Adding deficiency and maketing loan receipts for crops with target price and
marketing loan
+ SUM(CROP$(FARMPROD("TARGET",CROP) GT 0 AND
           FARMPROD("SLIPPAGE",CROP) GT 0 AND
           FARMPROD("MKTLOANY-N",CROP) GT 0),
      (FARMPROD("DEFIC",CROP)+FARMPROD("MKTLOANY-N",CROP)*FARMPROD("MKTLOAN",CROP))
      *DEFPRODN(CROP) *SCALE(CROP) )

**** Adding deficiency receipts for crops with target price only
+ SUM(CROP$(FARMPROD("TARGET",CROP) GT 0 AND
           FARMPROD("SLIPPAGE",CROP) GT 0 AND
           FARMPROD("MKTLOANY-N",CROP) LE 0),
      (FARMPROD("DEFIC",CROP)*DEFPRODN(CROP) *SCALE(CROP) ) )

**** Adding deficiency receipts for 50/92
+ SUM(CROP$(FARMPROD("TARGET",CROP), FARMPROD("DEFIC",CROP)*PRDN5092(CROP) *SCALE(CROP))

**** Adding diversion receipts
+ SUM(CROP$(FARMPROD("TARGET",CROP), FARMPROD("DIVERPAY",CROP)*DIVPRODN(CROP)
*SCALE(CROP) )

**** Adding deficiency receipts for production below farm program yield
+ SUM(CROP$(FARMPROD("TARGET",CROP) gt 0 and
           FARMPROD("FPYIELD",CROP) GT 1.0), FARMPROD("DEFIC",CROP)*ARTIF(CROP)
*SCALE(CROP) )

**** Adding deficiency receipts for crops not actually harvested
+ SUM(CROP$(FARMPROD("TARGET",CROP) GT 0 AND
           FARMPROD("UNHARVACR",CROP) GT 0), FARMPROD("DEFIC",CROP)*UNHARV(CROP)
*SCALE(CROP) )

**** Adding CCC loan payment
+ SUM(PRIMARY$(FARMPROD("LOANRATE",PRIMARY) GT 0 AND
              FARMPROD("MKTLOANY-N",PRIMARY) LT 1.0),
      FARMPROD("LOANRATE",PRIMARY)*CCCLOANP(PRIMARY)*SCALE(PRIMARY))

+ SUM(SECONDARY$(FARMPROD("LOANRATE",SECONDARY) GT 0 AND
                FARMPROD("MKTLOANY-N",SECONDARY) LT 1.0),
      FARMPROD("LOANRATE",SECONDARY)*CCCLOANS(SECONDARY)*SCALE(SECONDARY) ) ) /SCALOBJ
;

**** Primary Commodity Supply and Demand Balance Equation
PRIMARYBAL(PRIMARY)..
**** Supply from farm program crop production
- SUM(SUBREG,
      SUM((CROP,WTECH,TECH)$FARMPROD("SLIPPAGE",CROP),
          CROPBUDGET(SUBREG,CROP,WTECH,"NONPART",TECH)
          *SCALPROD
          *CBUDDATA(PRIMARY,SUBREG,CROP,WTECH,"NONPART",TECH)
          *CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"NONPART",TECH)
      + CROPBUDGET(SUBREG,CROP,WTECH,"PARTICIP",TECH)
      *SCALPROD
      *CBUDDATA(PRIMARY,SUBREG,CROP,WTECH,"NONPART",TECH)
      *CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH)

```

```

* (1.0-FPPART(SUBREG,CROP))
+ CROPBUDGET(SUBREG,CROP,WTECH,"PARTICIP",TECH)
*SCALPROD
*CBUDDATA(PRIMARY,SUBREG,CROP,WTECH,"PARTICIP",TECH)
*CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH)
*FPPART(SUBREG,CROP) * (1.0-FARMPROD("SETASIDE",CROP)
-FARMPROD("DIVERSION",CROP)-FARMPROD("50-92",CROP))
* (1.0-FARMPROD("PERCENTPAID",CROP))
/SCALE(PRIMARY)
+ SUM((CROP,WTECH,TECH)$ (FARMPROD("SLIPPAGE",CROP) GT 0.0 AND
FARMPROD("FPYIELD",CROP) LE 1.0),
CROPBUDGET(SUBREG,CROP,WTECH,"PARTICIP",TECH)
*SCALPROD
*CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH)
*FPPART(SUBREG,CROP) * (1.0-FARMPROD("SETASIDE",CROP)
-FARMPROD("DIVERSION",CROP)-FARMPROD("50-92",CROP))
* FARMPROD("PERCENTPAID",CROP)
/SCALE(PRIMARY)
*CBUDDATA(PRIMARY,SUBREG,CROP,WTECH,"PARTICIP",TECH)
*(1.0-FARMPROD("FPYIELD",CROP))
**** Supply from non-farm program crop production
+ SUM((CROP,WTECH,TECH)$ (FARMPROD("SLIPPAGE",CROP) LE 0.),
CROPBUDGET(SUBREG,CROP,WTECH,"BASE",TECH)
*SCALPROD
*CBUDDATA(PRIMARY,SUBREG,CROP,WTECH,"BASE",TECH) )
/SCALE(PRIMARY)
**** Demand from livestock feed usages
+ SUM((ANIMAL,LIVETECH),
LVSTBUDGET(SUBREG,ANIMAL,LIVETECH)
*SCALLIVE
*LBUDDATA(PRIMARY,SUBREG,ANIMAL,LIVETECH))
/SCALE(PRIMARY) )

**** Supply from participating production
-DEFPROD(PRIMARY)$ (FARMPROD("SLIPPAGE",PRIMARY) gt 0 and
FARMPROD("target",PRIMARY) GT 0 )
+DEMANDP(PRIMARY)$PDEMAND(PRIMARY,"quantity")
-IMPORTP(PRIMARY)$PIMPORT(PRIMARY,"quantity")
+EXPORTP(PRIMARY)$PEXPOR(PRIMARY,"quantity")

+SUM(PROCESSALT,PROCESS(PROCESSALT)*PROCBUD(PRIMARY,PROCESSALT))
/SCALE(PRIMARY)*SCALPROC
+CCCLOANP(PRIMARY)$ (FARMPROD("LOANRATE",PRIMARY) GT 0 AND
FARMPROD("MKTLOAN-N",PRIMARY) LT 1.0) =L= 0. ;

**** Total Participating Produciton Eligible for Deficiency Payment

FRMPROG(CROP)$FARMPROD("TARGET",CROP)..
- SUM((SUBREG,WTECH,TECH),
CROPBUDGET(SUBREG,CROP,WTECH,"PARTICIP",TECH)
*SCALPROD
* ( CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH)
*FPPART(SUBREG,CROP) * (1.0-FARMPROD("SETASIDE",CROP)
-FARMPROD("DIVERSION",CROP)-FARMPROD("50-92",CROP))
*FARMPROD("PERCENTPAID",CROP) )
* MIN( CBUDDATA(CROP,SUBREG,CROP,WTECH,"PARTICIP",TECH) ,
(FARMPROD("FPYIELD",CROP)
*CBUDDATA(CROP,SUBREG,CROP,WTECH,"PARTICIP",TECH))) )

```

/SCALE(CROP)  
+DEFPROD(CROP) =L= 0. ;

**\*\*\*\* Total Participating Production Eligible for 50/92 Payment**

P5092(CROP)\$FARMPROD("TARGET",CROP)..  
- SUM( (SUBREG,WTECH,TECH),  
CROPBUDGET(SUBREG,CROP,WTECH,"PARTICIP",TECH)  
\*SCALPROD  
\*CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH)  
\*FPPART(SUBREG,CROP)\*FARMPROD("50-92",CROP)  
\*FARMPROD("FPYIELD",CROP)  
/SCALE(CROP)  
\*CBUDDATA(CROP,SUBREG,CROP,WTECH,"PARTICIP",TECH) )  
\*0.92  
+PRDN5092(CROP) =L= 0. ;

**\*\*\*\* Total Participating Production Eligible for Diversion Payment**

DIVERT(CROP)\$FARMPROD("TARGET",CROP)..  
- SUM( (SUBREG,WTECH,TECH),  
CROPBUDGET(SUBREG,CROP,WTECH,"PARTICIP",TECH)  
\*SCALPROD  
\*CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH)  
\*FPPART(SUBREG,CROP)\*FARMPROD("DIVERSION",CROP)  
\*FARMPROD("FPYIELD",CROP)  
\*CBUDDATA(CROP,SUBREG,CROP,WTECH,"PARTICIP",TECH) )  
/SCALE(CROP)  
+ DIVPROD(CROP) =L= 0. ;

**\*\*\*\* Total Participating but Unharvested Production Eligible for Deficiency Payment**

UNHARVEST(CROP)\$ (FARMPROD("TARGET",CROP) GT 0 AND  
FARMPROD("UNHARVACR",CROP) GT 0)..  
- SUM( (SUBREG,WTECH,TECH),  
CROPBUDGET(SUBREG,CROP,WTECH,"PARTICIP",TECH)  
\*SCALPROD  
\*CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH)  
\*FPPART(SUBREG,CROP)  
\*(1.0-FARMPROD("SETASIDE",CROP)-FARMPROD("DIVERSION",CROP)  
-FARMPROD("50-92",CROP))\*FARMPROD("PERCENTPAID",CROP)  
\*FARMPROD("UNHARVACR",CROP)\*FARMPROD("FPYIELD",CROP)  
\*CBUDDATA(CROP,SUBREG,CROP,WTECH,"PARTICIP",TECH) )  
/SCALE(CROP)  
+UNHARV(CROP) =L= 0. ;

**\*\*\*\* Total Participating but Below Famr program Yield Eligible for Deficiency Payment**

ARTIFICIAL(CROP)\$ (FARMPROD("TARGET",CROP) GT 0 AND  
FARMPROD("FPYIELD",CROP) GT 1.0)..  
- SUM( (SUBREG,WTECH,TECH),  
CROPBUDGET(SUBREG,CROP,WTECH,"PARTICIP",TECH)  
\*SCALPROD  
\*CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH)  
\*FPPART(SUBREG,CROP)  
\*(1.0-FARMPROD("SETASIDE",CROP)-FARMPROD("DIVERSION",CROP)  
-FARMPROD("50-92",CROP))\*FARMPROD("PERCENTPAID",CROP)  
\*(FARMPROD("FPYIELD",CROP)-1.0)

```

      *CBUDDATA(CROP, SUBREG, CROP, WTECH, "PARTICIP", TECH) ) /SCALE(CROP)
+ARTIF(CROP)          =L= 0. ;

**** Secondary Commodity Supply and Demand Balance Equation
SECONDBAL( SECONDARY) . .
    +SUM( SUBREG,
        SUM( (CROP, WTECH, CTECH, TECH) $FARMPROD( "SLIPPAGE", CROP),
            CROPBUDGET( SUBREG, CROP, WTECH, "PARTICIP", TECH)
            *SCALPROD

*CBUDDATA( SECONDARY, SUBREG, CROP, WTECH, "PARTICIP", TECH) +
    CROPBUDGET( SUBREG, CROP, WTECH, "NONPART", TECH)
    *SCALPROD
    *CBUDDATA( SECONDARY, SUBREG, CROP, WTECH, "NONPART", TECH) )
    /SCALE( SECONDARY)
+SUM( (CROP, WTECH, CTECH, TECH) $ ( FARMPROD( "SLIPPAGE", CROP) LE 0.0 ),
    CROPBUDGET( SUBREG, CROP, WTECH, "BASE", TECH)
    *SCALPROD
    *CBUDDATA( SECONDARY, SUBREG, CROP, WTECH, "BASE", TECH) )
    /SCALE( SECONDARY)
+SUM( (ANIMAL, LIVETECH),
    LVSTBUDGET( SUBREG, ANIMAL, LIVETECH)
    *SCALLIVE
    *LBUDDATA( SECONDARY, SUBREG, ANIMAL, LIVETECH) )
    /SCALE( SECONDARY) )
+DEMANDS( SECONDARY) $SDEMAND( SECONDARY, "quantity" )
-IMPORTS( SECONDARY) $SIMPORT( SECONDARY, "quantity" )
+EXPORTS( SECONDARY) $SEXPORT( SECONDARY, "quantity" )

-SUM( PROCESSALT, PROCESS( PROCESSALT) *PROCBUD( SECONDARY, PROCESSALT)
/SCALE( SECONDARY) ) *SCALPROC
    +CCCLOANS( SECONDARY) $ ( FARMPROD( "LOANRATE", SECONDARY) GT 0 AND
FARMPROD( "MKTLOANY-N", SECONDARY) LT 1.0 )
    =L= 0. ;

**** Maximum Land Use Constraint
MAXLAND( SUBREG, LANDTYPE) $LANDAVAIL( SUBREG, LANDTYPE) . .
    SUM( (CROP, WTECH, TECH) $FARMPROD( "SLIPPAGE", CROP),
        CROPBUDGET( SUBREG, CROP, WTECH, "PARTICIP", TECH)
    *SCALPROD
    *CBUDDATA( LANDTYPE, SUBREG, CROP, WTECH, "PARTICIP", TECH)
    /SCALE( LANDTYPE)
    + CROPBUDGET( SUBREG, CROP, WTECH, "NONPART", TECH)
    *SCALPROD
    *CBUDDATA( LANDTYPE, SUBREG, CROP, WTECH, "NONPART", TECH)
    /SCALE( LANDTYPE) ) +
    SUM( (CROP, WTECH, TECH) $ ( FARMPROD( "SLIPPAGE", CROP) LE 0. ),
        CROPBUDGET( SUBREG, CROP, WTECH, "BASE", TECH)
    *SCALPROD
    *CBUDDATA( LANDTYPE, SUBREG, CROP, WTECH, "BASE", TECH)
    /SCALE( LANDTYPE) ) +
    SUM( (ANIMAL, LIVETECH),
        LVSTBUDGET( SUBREG, ANIMAL, LIVETECH)
    *SCALLIVE
    *LBUDDATA( LANDTYPE, SUBREG, ANIMAL, LIVETECH)
    /SCALE( LANDTYPE) )
=L= LANDAVAIL( SUBREG, LANDTYPE) /SCALE( LANDTYPE) ;

```

**\*\*\*\* Minimum Land Use Constraint (They are zero currently)**

```

MINLAND(SUBREG)$LANDAVAIL(SUBREG,"CROPLAND")..
  ( SUM((CROP,WTECH,TECH)$FARMPROD("SLIPPAGE",CROP),
    CROPBUDGET(SUBREG,CROP,WTECH,"PARTICIP",TECH)
    *SCALPROD
    *CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH)+
    CROPBUDGET(SUBREG,CROP,WTECH,"NONPART",TECH)
    *SCALPROD
    *CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"NONPART",TECH) )
+
  SUM((CROP,WTECH,TECH)$ (FARMPROD("SLIPPAGE",CROP) LE 0.),
    CROPBUDGET(SUBREG,CROP,WTECH,"BASE",TECH)
    *SCALPROD
    *CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"BASE",TECH) )
+
  SUM((ANIMAL,LIVETECH),
    LVSTBUDGET(SUBREG,ANIMAL,LIVETECH)
    *SCALLIVE
    *LBUDDATA("CROPLAND",SUBREG,ANIMAL,LIVETECH))
  /SCALE("CROPLAND")
= G =      0.0 * LANDAVAIL(SUBREG,"CROPLAND") /SCALE("CROPLAND") ;

```

**\*\*\*\* Land supply and demand Balance Equaiton**

```

LAND(REGION,LANDTYPE)..
  ( SUM(SUBREG$MAPPING(REGION,SUBREG),
    SUM((CROP,WTECH,TECH)$FARMPROD("SLIPPAGE",CROP),
    CROPBUDGET(SUBREG,CROP,WTECH,"PARTICIP",TECH)
    *SCALPROD
    *CBUDDATA(LANDTYPE,SUBREG,CROP,WTECH,"PARTICIP",TECH)+
    CROPBUDGET(SUBREG,CROP,WTECH,"NONPART",TECH)
    *SCALPROD
    *CBUDDATA(LANDTYPE,SUBREG,CROP,WTECH,"NONPART",TECH) )
+
    SUM((CROP,WTECH,TECH)$ (FARMPROD("SLIPPAGE",CROP) LE 0.0),
    CROPBUDGET(SUBREG,CROP,WTECH,"BASE",TECH)
    *SCALPROD
    *CBUDDATA(LANDTYPE,SUBREG,CROP,WTECH,"BASE",TECH) ) +
    SUM((ANIMAL,LIVETECH),
    LVSTBUDGET(SUBREG,ANIMAL,LIVETECH)
    *SCALLIVE
    *LBUDDATA(LANDTYPE,SUBREG,ANIMAL,LIVETECH)))
  /SCALE(LANDTYPE)
-LANDSUPPLY(REGION,LANDTYPE)      =L= 0. ;

```

**\*\*\*\* Water Supply and Demand Balance Equation**

```

WATERR(SUBREG)$ (WATERSUP(SUBREG,"FIXEDMAX")+WATERSUP(SUBREG,"P
UMPQ")+
  WATERSUP(SUBREG,"PUMPMAX"))..
  (SUM((CROP,TECH)$FARMPROD("SLIPPAGE",CROP),
    CROPBUDGET(SUBREG,CROP,"IRRIG","PARTICIP",TECH)
    *SCALPROD
    *CBUDDATA("WATER",SUBREG,CROP,"IRRIG","PARTICIP",TECH)+
    CROPBUDGET(SUBREG,CROP,"IRRIG","NONPART",TECH)
    *SCALPROD
    *CBUDDATA("WATER",SUBREG,CROP,"IRRIG","NONPART",TECH) )
+

```



```

SUM( (CROP, TECH) $( FARMPROD( "SLIPPAGE", CROP) LE 0.0),
      CROPBUDGET( SUBREG, CROP, "IRRIG", "BASE", TECH)
      *SCALPROD
      *CBUDDATA( "WATER", SUBREG, CROP, "IRRIG", "BASE", TECH) ) +
SUM( (ANIMAL, LIVETECH),
      LVSTBUDGET( SUBREG, ANIMAL, LIVETECH)
      *SCALLIVE
      *LBUDDATA( "WATER", SUBREG, ANIMAL, LIVETECH) ) ) / SCALE( "WATER" )
- WATERFIX( SUBREG) - WATERVAR( SUBREG) =L= 0;

**** Maximum Fixed-Price Water Availability Constraint
FIX( SUBREG) ..
      WATERFIX( SUBREG)
      =L= WATERSUP( SUBREG, "FIXEDMAX" ) / SCALE( "WATER" );

**** Labor Supply and Demand Balance Equaiton

LABOR( REGION) ..
      ( SUM( SUBREG$MAPPING( REGION, SUBREG),
            SUM( (CROP, WTECH, TECH) $FARMPROD( "SLIPPAGE", CROP),
                  CROPBUDGET( SUBREG, CROP, WTECH, "PARTICIP", TECH)
                  *SCALPROD
                  *CBUDDATA( "LABOR", SUBREG, CROP, WTECH, "PARTICIP", TECH) +
                  CROPBUDGET( SUBREG, CROP, WTECH, "NONPART", TECH)
                  *SCALPROD
                  *CBUDDATA( "LABOR", SUBREG, CROP, WTECH, "NONPART", TECH) )
            +
            SUM( (CROP, WTECH, TECH) $( FARMPROD( "SLIPPAGE", CROP) LE 0.0),
                  CROPBUDGET( SUBREG, CROP, WTECH, "BASE", TECH)
                  *SCALPROD
                  *CBUDDATA( "LABOR", SUBREG, CROP, WTECH, "BASE", TECH) ) +
            SUM( (ANIMAL, LIVETECH),
                  LVSTBUDGET( SUBREG, ANIMAL, LIVETECH)
                  *SCALLIVE *LBUDDATA( "LABOR", SUBREG, ANIMAL, LIVETECH) ) ) ) / SCALE( "LABOR" )
      - FAMILY( REGION) - HIRED( REGION) =L= 0;

**** Maximum Family Labor Availability Constraint

FAMILYLIM( REGION) $LABORSUP( REGION, "familyMAX" ) ..
      FAMILY( REGION) =L= LABORSUP( REGION, "FAMILYMAX" ) / SCALE( "LABOR" );

**** Maximum Hired Labor Availability Constraint

HIRELIM( REGION) $LABORSUP( REGION, "HIREMAX" ) ..
      HIRED( REGION) =L= LABORSUP( REGION, "HIREMAX" ) / SCALE( "LABOR" );

**** Total National Input Use Equation

INPUTBAL( INPUT) ..
      +SUM( SUBREG,
            SUM( (CROP, WTECH, TECH) $FARMPROD( "SLIPPAGE", CROP),
                  CROPBUDGET( SUBREG, CROP, WTECH, "PARTICIP", TECH)
                  *SCALPROD / SCALE( INPUT)
                  *CBUDDATA( INPUT, SUBREG, CROP, WTECH, "PARTICIP", TECH) +
                  CROPBUDGET( SUBREG, CROP, WTECH, "NONPART", TECH)
                  *SCALPROD / SCALE( INPUT)
                  *CBUDDATA( INPUT, SUBREG, CROP, WTECH, "NONPART", TECH) )
            +SUM( (CROP, WTECH, TECH) $( FARMPROD( "SLIPPAGE", CROP) LE 0.0),

```

```

        CROPBUDGET ( SUBREG , CROP , WTECH , "BASE" , TECH )
        * SCALPROD / SCALE ( INPUT )
        * CBUDDATA ( INPUT , SUBREG , CROP , WTECH , "BASE" , TECH )
    +SUM ( ( ANIMAL , LIVETECH ) ,
        LVSTBUDGET ( SUBREG , ANIMAL , LIVETECH )
        * SCALLIVE / SCALE ( INPUT )
        * LBUDDATA ( INPUT , SUBREG , ANIMAL , LIVETECH ) )
+SUM ( PROCESSALT , PROCESS ( PROCESSALT ) * PROCBUD ( INPUT , PROCESSALT ) )
    * SCALPROC / SCALE ( INPUT )
    -BUYINPUT ( INPUT )           =L= 0. ;

```

**\*\*\*\* Crop Mixes Constraint by Crop and Subregion**

```

MIXREG ( CROP , SUBREG ) $SUM ( CRPMIXALT , MIXDATA ( CROP , SUBREG , CRPMIXALT
) ) . .
    SUM ( ( WTECH , TECH ) $FARMPROD ( "SLIPPAGE" , CROP ) ,
        CROPBUDGET ( SUBREG , CROP , WTECH , "PARTICIP" , TECH )
        * SCALPROD / scalmix
        * ( CBUDDATA ( "cropland" , SUBREG , CROP , WTECH , "PARTICIP" , TECH )
          -CBUDDATA ( "addLAND" , SUBREG , CROP , WTECH , "PARTICIP" , TECH ) )
    + CROPBUDGET ( SUBREG , CROP , WTECH , "NONPART" , TECH )
        * SCALPROD / scalmix
        * CBUDDATA ( "cropland" , SUBREG , CROP , WTECH , "NONPART" , TECH ) )
+SUM ( ( WTECH , TECH ) $ ( FARMPROD ( "SLIPPAGE" , CROP ) LE 0.0 ) ,
        CROPBUDGET ( SUBREG , CROP , WTECH , "BASE" , TECH )
        * SCALPROD / scalmix
        * CBUDDATA ( "cropland" , SUBREG , CROP , WTECH , "BASE" , TECH ) )
-SUM ( CRPMIXALT
    , MIXDATA ( CROP , SUBREG , CRPMIXALT ) * MIXR ( SUBREG , CRPMIXALT ) )
    / scalmix
+ TWID ( CROP , SUBREG )           =E= 0.0 ;

```

**\*\*\*\* Total Crop Mixes Within Each Subregion**

```

MIXREGTOT ( SUBREG )
    $SUM ( CRPMIXALT , SUM ( CROP , MIXDATA ( CROP , SUBREG , CRPMIXALT ) ) ) . .
    SUM ( ( CROP , WTECH , TECH ) $FARMPROD ( "SLIPPAGE" , CROP ) ,
        CROPBUDGET ( SUBREG , CROP , WTECH , "PARTICIP" , TECH )
        * SCALPROD / SCALMIX
        * ( CBUDDATA ( "cropland" , SUBREG , CROP , WTECH , "PARTICIP" , TECH )
          -CBUDDATA ( "addLAND" , SUBREG , CROP , WTECH , "PARTICIP" , TECH ) )
    + CROPBUDGET ( SUBREG , CROP , WTECH , "NONPART" , TECH )
        * SCALPROD / SCALMIX
        * CBUDDATA ( "cropland" , SUBREG , CROP , WTECH , "NONPART" , TECH ) )
+SUM ( ( CROP , WTECH , TECH ) $ ( FARMPROD ( "SLIPPAGE" , CROP ) LE 0.0 ) ,
        CROPBUDGET ( SUBREG , CROP , WTECH , "BASE" , TECH )
        * SCALPROD / SCALMIX
        * CBUDDATA ( "cropland" , SUBREG , CROP , WTECH , "BASE" , TECH ) )
- SUM ( CRPMIXALT , SUM ( CROP ,
    MIXDATA ( CROP , SUBREG , CRPMIXALT ) ) * MIXR ( SUBREG , CRPMIXALT ) )
    / scalmix
=E= 0. ;

```

**\*\*\*\* Mixes Constraint for Subregional Distribution by Commodity**

```

MIXNAT ( PRIMARY , SUBREG )
    $SUM ( NATMIXALT , NATMIXDATA ( SUBREG , PRIMARY , NATMIXALT ) ) . .
    SUM ( ( CROP , WTECH , TECH )

```

```

$(FARMPROD("SLIPPAGE",CROP)
  *cbuddata(primary,subreg,crop,wtech,"particip",TECH),
  CROPBUDGET(SUBREG,CROP,WTECH,"PARTICIP",TECH)
  *SCALPROD/SCALMIX
  *(CBUDDATA("cropland",SUBREG,CROP,WTECH,"PARTICIP",TECH)
  -CBUDDATA("addLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH))
+  CROPBUDGET(SUBREG,CROP,WTECH,"NONPART",TECH)
  *SCALPROD/SCALMIX
  *CBUDDATA(primary,SUBREG,CROP,WTECH,"NONPART",TECH) )
+SUM((CROP,WTECH,TECH)$ (FARMPROD("SLIPPAGE",CROP) LE 0.0 and
  cbuddata(primary,subreg,crop,wtech,"base",TECH) gt 0),
  CROPBUDGET(SUBREG,CROP,WTECH,"BASE",TECH)
  *SCALPROD/SCALMIX
  *CBUDDATA(primary,SUBREG,CROP,WTECH,"BASE",TECH) )

+SUM((ANIMAL,LIVETECH)$LBUDDATA(PRIMARY,SUBREG,ANIMAL,LIVETECH)
,
  LVSTBUDGET(SUBREG,ANIMAL,LIVETECH)
  *SCALLIVE/SCALMIX
  *LBUDDATA(PRIMARY,SUBREG,ANIMAL,LIVETECH))
- SUM(NATMIXALT,
NATMIXDATA(SUBREG,PRIMARY,NATMIXALT)*NATMIX(PRIMARY,NATMIXALT))
  /scalmix + tolr(PRIMARY,SUBREG) =E= 0.;

**** BOUNDS

TWID.LO(CROP,SUBREG)$SUM(CRPMIXALT,MIXDATA(CROP,SUBREG,CRPMIXALT))
  = -0.001*mixdata(crop,subreg,"1989")/scalmix;
TWID.UP(CROP,SUBREG)$SUM(CRPMIXALT,MIXDATA(CROP,SUBREG,CRPMIXALT))
  = 0.001*mixdata(crop,subreg,"1989")/scalmix;
tolr.LO(PRIMARY,SUBREG)$SUM(NATMIXALT,NATMIXDATA(SUBREG,PRIMARY,NATMIXALT))
  = -0.001*NATMIXDATA(SUBREG,PRIMARY,"1986")/SCALMIX;
tolr.UP(PRIMARY,SUBREG)$SUM(NATMIXALT,NATMIXDATA(SUBREG,PRIMARY,NATMIXALT))
  = 0.001*NATMIXDATA(SUBREG,PRIMARY,"1986")/SCALMIX ;
IMPORTP.UP(PRIMARY)$ (PIMPORT(PRIMARY,"MAXQ") GT 0) = PIMPORT(PRIMARY,"MAXQ")
/SCALE(PRIMARY) ;
IMPORTP.LO(PRIMARY)$ (PIMPORT(PRIMARY,"MINQ") GT 0 OR PIMPORT(PRIMARY,"ELASTICITY") GT
0)
  = MAX(1.,PIMPORT(PRIMARY,"MINQ")) /SCALE(PRIMARY) ;
EXPORTP.UP(PRIMARY)$ (PEXPOR(T(PRIMARY,"MAXQ") GT 0)
  = PEXPORT(PRIMARY,"MAXQ") /SCALE(PRIMARY) ;
EXPORTP.LO(PRIMARY)$ (PEXPOR(T(PRIMARY,"MINQ") GT 0 OR PEXPORT(PRIMARY,"ELASTICITY") GT
0)
  = MAX(1.,PEXPOR(T(PRIMARY,"MINQ")) /SCALE(PRIMARY) ;
DEMANDP.UP(PRIMARY)$ (PDEMAND(PRIMARY,"MAXQ") GT 0)
  = PDEMAND(PRIMARY,"MAXQ") /SCALE(PRIMARY) ;
DEMANDP.LO(PRIMARY)$ (PDEMAND(PRIMARY,"MINQ") GT 0 OR PDEMAND(PRIMARY,"ELASTICITY") GT
0)
  = MAX(1.,PDEMAND(PRIMARY,"MINQ")) /SCALE(PRIMARY) ;
IMPORTS.UP(SECONDARY)$ (SIMPORT(SECONDARY,"MAXQ") GT 0)
  = SIMPORT(SECONDARY,"MAXQ") /SCALE(SECONDARY);
IMPORTS.LO(SECONDARY)$ (SIMPORT(SECONDARY,"MINQ") GT 0 OR
SIMPORT(SECONDARY,"ELASTICITY") GT 0)
  = MAX(1.,SIMPORT(SECONDARY,"MINQ")) /SCALE(SECONDARY);
EXPORTS.UP(SECONDARY)$ (SEXPOR(T(SECONDARY,"MAXQ") GT 0)
  = SEXPOR(T(SECONDARY,"MAXQ") /SCALE(SECONDARY);
EXPORTS.LO(SECONDARY)$ (SEXPOR(T(SECONDARY,"MINQ") GT 0 OR
SEXPOR(T(SECONDARY,"ELASTICITY") GT 0)

```

```

= MAX(1.,SEXPORT(SECONDARY,"MINQ")) /SCALE(SECONDARY);
DEMANDS.UP(SECONDARY)$(SDEMAND(SECONDARY,"MAXQ") GT 0)
= SDEMAND(SECONDARY,"MAXQ") /SCALE(SECONDARY);
DEMANDS.LO(SECONDARY)$(SDEMAND(SECONDARY,"MINQ") GT 0 OR
SDEMAND(SECONDARY,"ELASTICITY") GT 0)
= MAX(1.,SDEMAND(SECONDARY,"MINQ")) /SCALE(SECONDARY);
LANDSUPPLY.LO(REGION,LANDTYPE)$LANDSUPPL(LANDTYPE,REGION,"ELASTICITY") = 1.
/SCALE(LANDTYPE);
WATERVAR.LO(SUBREG)$WATERSUP(SUBREG,"PUMPELAS") = 1. /SCALE("WATER");
HIRED.LO(REGION)$LABORSUP(REGION,"HIREELAS") = 1. /SCALE("LABOR");

CROPBUDGET.LO(SUBREG,CROP,WTECH,CTECH,TECH)$CBUDDATA("MINIMUM",SUBREG,CROP,WTECH,CTECH,TECH) =
CBUDDATA("MINIMUM",SUBREG,CROP,WTECH,CTECH,TECH)/SCALPROD;

CROPBUDGET.UP(SUBREG,CROP,WTECH,CTECH,TECH)$CBUDDATA("MAXIMUM",SUBREG,CROP,WTECH,CTECH,TECH) =
CBUDDATA("MAXIMUM",SUBREG,CROP,WTECH,CTECH,TECH)/SCALPROD;
LVSTBUDGET.LO(SUBREG,ANIMAL,LIVETECH)$LBUDDATA("MINIMUM",SUBREG,ANIMAL,LIVETECH)
= LBUDDATA("MINIMUM",SUBREG,ANIMAL,LIVETECH);
LVSTBUDGET.UP(SUBREG,ANIMAL,LIVETECH)$LBUDDATA("MAXIMUM",SUBREG,ANIMAL,LIVETECH)
= LBUDDATA("MAXIMUM",SUBREG,ANIMAL,LIVETECH)/SCALLIVE;
PROCESS.LO(PROCESSALT)$PROCBUD("MINIMUM",PROCESSALT)
=PROCBUD("MINIMUM",PROCESSALT)/SCALPROC;
PROCESS.UP(PROCESSALT)$PROCBUD("MAXIMUM",PROCESSALT)
=PROCBUD("MAXIMUM",PROCESSALT)/SCALPROC;

**** INITIAL VALUES FOR NONLINEAR VARIABLES

IMPORTP.L(PRIMARY)$(PIMPORT(PRIMARY,"QUANTITY") GT 0 OR
PIMPORT(PRIMARY,"ELASTICITY") GT 0)
= PIMPORT(PRIMARY,"QUANTITY")
/SCALE(PRIMARY);
EXPORTP.L(PRIMARY)$(PEXPOR(T)T(PRIMARY,"QUANTITY") GT 0 OR
PEXPOR(T)T(PRIMARY,"ELASTICITY") GT 0)
= PEXPOR(T)T(PRIMARY,"QUANTITY")
/SCALE(PRIMARY);
DEMANDP.L(PRIMARY)$(PDEMAND(PRIMARY,"QUANTITY") GT 0 OR
PDEMAND(PRIMARY,"ELASTICITY") GT 0)
= PDEMAND(PRIMARY,"QUANTITY")
/SCALE(PRIMARY);
IMPORTS.L(SECONDARY)$(SIMPORT(SECONDARY,"QUANTITY") GT 0 OR
SIMPORT(SECONDARY,"ELASTICITY") GT 0)
= SIMPORT(SECONDARY,"QUANTITY")
/SCALE(SECONDARY);
EXPORTS.L(SECONDARY)$(SEXPORT(SECONDARY,"QUANTITY") GT 0 OR
SEXPORT(SECONDARY,"ELASTICITY") GT 0)
= SEXPORT(SECONDARY,"QUANTITY")
/SCALE(SECONDARY);
DEMANDS.L(SECONDARY)$(SDEMAND(SECONDARY,"QUANTITY") GT 0 OR
SDEMAND(SECONDARY,"ELASTICITY") GT 0)
= SDEMAND(SECONDARY,"QUANTITY")
/SCALE(SECONDARY);
LANDSUPPLY.L(REGION,LANDTYPE)$LANDSUPPL(LANDTYPE,REGION,"ELASTICITY")
= LANDSUPPL(LANDTYPE,REGION,"QUANTITY")
/SCALE(LANDTYPE);
WATERVAR.L(SUBREG)$WATERSUP(SUBREG,"PUMPELAS")
= WATERSUP(SUBREG,"PUMPQ")/SCALE("WATER");

```

```

HIRED.L(REGION) $LABORSUP(REGION,"HIREELAS")
      = LABORSUP(REGION,"HIREQ")/SCALE("LABOR") ;

```

```

MODEL SECTOR /ALL/;

```

### 5.3.2 ASMSOLVE

```

option solveopt=replace;
#####
* ITERATIVE SOLVING PROCEDURE USING LOOP
#####
$offsymlist offsymxref
OPTION SOLPRINT = OFF;
option limrow = 00
option limcol = 00
option iterlim = 50000;
OPTION RESLIM = 20000;

TOL = 0.0015;
CONVERGE = 1;

*#####

LOOP(ITER$(CONVERGE GT 0 ),

      SOLVE SECTOR USING NLP MAXIMIZING CSPTS ;

*   ABORT$(SUM(C,(FARMPROD("TARGET",C)+FARMPROD("LOANRATE",C))) LE 0)
*       "NON-FARM PROGRAM SCENARIO";

FARMPROD("TARGET",C)$FARMPROD("TARGET",C) LE 0 AND
      FARMPROD("MKTLOANY-N",C) GT 0)
      =FARMPROD("LOANRATE",C) ;

TOLER(C) = TOL*FARMPROD("TARGET",C) ;

RESULT(C,ITER+1,'PRICE')$FARMPROD("TARGET",C) = PRIMARYBAL.M(C)*scalobj
                                                /scale(c) ;
RESULT(C,ITER+1,'TRIAL')$FARMPROD("TARGET",C) = FRMPROG.M(C)*scalobj
                                                /scale(c);
RESULT(C,ITER+1,'TARGET')$FARMPROD("TARGET",C) = FARMPROD("TARGET",C);
RESULT(C,ITER+1,'DEFIC')$FARMPROD("TARGET",C) = FARMPROD("DEFIC",C);

DISPLAY RESULT;

FARMPROD("DEFIC",C)$FARMPROD("TARGET",C)
      = MAX(0, FARMPROD("DEFIC",C)+(FARMPROD("TARGET",C)-FRMPROG.M(C)*scalobj
      /scale(c))*0.90 );

CONVERGE=SUM(C,1$(ABS(FARMPROD("DEFIC",C)-RESULT(C,ITER+1,'DEFIC'))
      -TOLER(C) GT 0 ));

display converge;
) ;
option solprint= on ;
SOLVE SECTOR USING NLP MAXIMIZING CSPTS ;

```

## 5.4 REPORT WRITING

A considerable amount of output is generated by the model. The output consists of supply-demand disappearance tables for both the primary and secondary commodities including the price, production, and disposition.

The social welfare accounting is given by region and component. The first component is the benefit attributed to agricultural producers arising from labor, the two land types, water, and grazing animal unit months. The second component of the benefit is attributed to domestic and foreign consumers and is listed by commodities. The third component is the government program payment and CCC loan cost. The net social welfare is the sum of domestic and foreign welfare to producers and consumers minus the government deficiency payments and marketing loan payments. CCC loan costs are not accounted because the net cost depends on receipts when government disposes of the commodity.

Regional labor, water and land reports are reported in separate tables. The labor report includes the reservation wage and quantity utilized of family labor, as well as the equilibrium wage and quantity of hired labor in each region. The water report lists the amount used and equilibrium prices as well as the total values of fixed and purchased water. The land report presents the quantities of land utilized by types and rental value of land in each region. The distribution of irrigated and nonirrigated (dry) land among field crop production is listed in the harvest acreage report.

National input usages in the production and processing activities are reported by the name of the input. A revenue statement is given which lists the gross incomes received from commodity sales

including government payments. Sub-regional reports are also given which includes input usage welfare account, crop and livestock production.

The GAMS program for the report is called "ASMREPT" and listed as follows:

```
#####
*   Primary Commodity Price, Supply and Disappearance
#####
NONFEED(PROCESSALT) = YES; NONFEED(MIXFEED)=NO;

BALANCEP(PRIMARY, "PRODUCTION") =
    SUM(SUBREG,
        SUM((CROP, WTECH, TECH)$FARMPROD("SLIPPAGE", CROP),
            CROPBUDGET.L(SUBREG, CROP, WTECH, "NONPART", TECH)
        *SCALPROD
        *CBUDDATA(PRIMARY, SUBREG, CROP, WTECH, "NONPART", TECH)
        *CBUDDATA("CROPLAND", SUBREG, CROP, WTECH, "NONPART", TECH)$
            (CBUDDATA(PRIMARY, SUBREG, CROP, WTECH, "NONPART", TECH) GT 0)
        + CROPBUDGET.L(SUBREG, CROP, WTECH, "PARTICIP", TECH)
        *SCALPROD
        *CBUDDATA(PRIMARY, SUBREG, CROP, WTECH, "NONPART", TECH)
        *CBUDDATA("CROPLAND", SUBREG, CROP, WTECH, "PARTICIP", TECH)
        *(1.0-FPPART(SUBREG, CROP))$
            (CBUDDATA(PRIMARY, SUBREG, CROP, WTECH, "NONPART", TECH) GT 0)
        + CROPBUDGET.L(SUBREG, CROP, WTECH, "PARTICIP", TECH)
        *SCALPROD
        *CBUDDATA(PRIMARY, SUBREG, CROP, WTECH, "PARTICIP", TECH)
        *CBUDDATA("CROPLAND", SUBREG, CROP, WTECH, "PARTICIP", TECH)
        *FPPART(SUBREG, CROP) * (1-FARMPROD("SETASIDE", CROP)
            -FARMPROD("DIVERSION", CROP)-FARMPROD("50-92", CROP))
        * (1-FARMPROD("PERCENTPAID", CROP))$
            (CBUDDATA(PRIMARY, SUBREG, CROP, WTECH, "PARTICIP", TECH) GT 0) )
        + SUM((CROP, WTECH, TECH)$ (FARMPROD("SLIPPAGE", CROP) GT 0.0 AND
            FARMPROD("FPYIELD", CROP) LE 1.0),
            CROPBUDGET.L(SUBREG, CROP, WTECH, "PARTICIP", TECH)
        *SCALPROD
        *CBUDDATA("CROPLAND", SUBREG, CROP, WTECH, "PARTICIP", TECH)
        *FPPART(SUBREG, CROP) * (1-FARMPROD("SETASIDE", CROP)
            -FARMPROD("DIVERSION", CROP)-FARMPROD("50-92", CROP))
        * FARMPROD("PERCENTPAID", CROP)
        *CBUDDATA(PRIMARY, SUBREG, CROP, WTECH, "PARTICIP", TECH)
        *(1.0-FARMPROD("FPYIELD", CROP))$
            (CBUDDATA(PRIMARY, SUBREG, CROP, WTECH, "PARTICIP", TECH) GT 0) )
        + SUM((CROP, WTECH, TECH)$ (FARMPROD("SLIPPAGE", CROP) LE 0.),
            CROPBUDGET.L(SUBREG, CROP, WTECH, "BASE", TECH)
        *SCALPROD
        *CBUDDATA(PRIMARY, SUBREG, CROP, WTECH, "BASE", TECH)$
            (CBUDDATA(PRIMARY, SUBREG, CROP, WTECH, "BASE", TECH) GT 0) )
        + SUM((ANIMAL, LIVETECH),
            LVSTBUDGET.L(SUBREG, ANIMAL, LIVETECH)
        *SCALLIVE
        *LBUDDATA(PRIMARY, SUBREG, ANIMAL, LIVETECH)$
```

```

(LBUDDATA(PRIMARY, SUBREG, ANIMAL, LIVETECH) GT 0) ) )

- SUM(NONFEED$(PROCBUD(PRIMARY, NONFEED) LT 0. AND
    PROCESS.L(NONFEED) GT 0 ),
    PROCESS.L(NONFEED)
    *PROCBUD(PRIMARY, NONFEED) )
    *SCALPROC

+DEFPROD.N.L(PRIMARY)$FARMPROD("SLIPPAGE", PRIMARY) *SCALE(PRIMARY) ;

BALANCEP(PRIMARY, "IMPORT") = IMPORTP.L(PRIMARY) *SCALE(PRIMARY) ;

BALANCEP(PRIMARY, "PROD-USE") =
-SUM(SUBREG,
    SUM((CROP, WTECH, CTECH, TECH),
        CROPBUDGET.L(SUBREG, CROP, WTECH, CTECH, TECH)
        *SCALPROD
        *CBUDDATA(PRIMARY, SUBREG, CROP, WTECH, CTECH, TECH)$
        (CBUDDATA(PRIMARY, SUBREG, CROP, WTECH, CTECH, TECH) LT 0))
    +SUM((ANIMAL, LIVETECH),
        LVSTBUDGET.L(SUBREG, ANIMAL, LIVETECH)
        *SCALLIVE
        *LBUDDATA(PRIMARY, SUBREG, ANIMAL, LIVETECH)$
        (LBUDDATA(PRIMARY, SUBREG, ANIMAL, LIVETECH) LT 0) )) ;

* NONFEED(PROCESSALT) = YES; NONFEED(MIXFEED)=NO;

BALANCEP(PRIMARY, "FEEDMIXUSE") =
    +SUM(MIXFEED, PROCESS.L(MIXFEED)*SCALPROC*PROCBUD(PRIMARY, MIXFEED)) ;

BALANCEP(PRIMARY, "PROC-USE") =
    +SUM(NONFEED$(PROCBUD(PRIMARY, NONFEED) GT 0),
        PROCESS.L(NONFEED)*SCALPROC*PROCBUD(PRIMARY, NONFEED)) ;

BALANCEP(PRIMARY, "DOM-DEMAND") = DEMANDP.L(PRIMARY)*SCALE(PRIMARY) ;

BALANCEP(PRIMARY, "EXPORT") = EXPORTP.L(PRIMARY)*SCALE(PRIMARY) ;

BALANCEP(PRIMARY, "PRICEx100") = PRIMARYBAL.M(PRIMARY) * 100.
    /SCALE(PRIMARY)*SCALOBJ;

BALANCEP(PRIMARY, "CCCLOANSTK") = CCCLOANP.L(PRIMARY)*SCALE(PRIMARY) ;

OPTION DECIMALS = 0 ;

DISPLAY BALANCEP;

#####
* Secondary Commodity Price, Supply and Disappearance
#####

BALANCES(SECONDARY, "PROC-YLD") =
    +SUM(PROCESSALT, PROCESS.L(PROCESSALT)*PROCBUD(SECONDARY, PROCESSALT)
    *SCALPROC
    $(PROCBUD(SECONDARY, PROCESSALT) GT 0)) ;

BALANCES(SECONDARY, "IMPORT") = IMPORTS.L(SECONDARY)*SCALE(SECONDARY) ;

```



```

BALANCES (SECONDARY, "PROD-USE") =
  +SUM (SUBREG,
    SUM ( (CROP, WTECH, CTECH, TECH) $FARMPROD ("SLIPPAGE", CROP),
      CROPBUDGET.L (SUBREG, CROP, WTECH, "PARTICIP", TECH)
    *SCALPROD
      *CBUDDATA (SECONDARY, SUBREG, CROP, WTECH, "PARTICIP", TECH) +
      CROPBUDGET.L (SUBREG, CROP, WTECH, "NONPART", TECH)
    *SCALPROD
      *CBUDDATA (SECONDARY, SUBREG, CROP, WTECH, "NONPART", TECH) )
  +SUM ( (CROP, WTECH, CTECH, TECH) $ (FARMPROD ("SLIPPAGE", CROP) LE 0.0),
    CROPBUDGET.L (SUBREG, CROP, WTECH, "BASE", TECH)
  *SCALPROD
    *CBUDDATA (SECONDARY, SUBREG, CROP, WTECH, "BASE", TECH) )
  +SUM ( (ANIMAL, LIVETECH),
    LVSTBUDGET.L (SUBREG, ANIMAL, LIVETECH)
  *SCALLIVE
    *LBUDDATA (SECONDARY, SUBREG, ANIMAL, LIVETECH) ) ) ;

BALANCES (SECONDARY, "FEEDMIXUSE") =
-SUM (MIXFEED, PROCESS.L (MIXFEED) *SCALPROC*PROCBUD (SECONDARY, MIXFEED)
  $ (PROCBUD (SECONDARY, MIXFEED) LT 0) ) ;

BALANCES (SECONDARY, "PROC-USE") =
  -SUM (NONFEED, PROCESS.L (NONFEED) *SCALPROC*PROCBUD (SECONDARY, NONFEED)
  $ (PROCBUD (SECONDARY, NONFEED) LT 0) ) ;
BALANCES (SECONDARY, "DOM-DEMAND") = DEMANDS.L (SECONDARY) *SCALE (SECONDARY) ;

BALANCES (SECONDARY, "EXPORT") = EXPORTS.L (SECONDARY) *SCALE (SECONDARY) ;

BALANCES (SECONDARY, "PRICEx100") = SECONDBAL.M (SECONDARY) *
  100./SCALE (SECONDARY) *SCALOBJ ;

BALANCES (SECONDARY, "CCCLOANSTK") = CCCLOANS.L (SECONDARY)
  *SCALE (SECONDARY) ;

OPTION DECIMALS = 0 ;

DISPLAY BALANCES ;

#####
* Consumer Expenditures and Surplus by Commodity
#####

PCONSUR (PRIMARY, "PRICEx100") = PRIMARYBAL.M (PRIMARY) *100.
  /SCALE (PRIMARY) *SCALOBJ ;

PCONSUR (PRIMARY, "QUANTITY")
  = BALANCEP (PRIMARY, "DOM-DEMAND") ;

PCONSUR (PRIMARY, "EXPEND")
  = PRIMARYBAL.M (PRIMARY) /SCALE (PRIMARY) *BALANCEP (PRIMARY, "DOM-DEMAND")
  *SCALOBJ ;

PCONSUR (PRIMARY, "DOMEST-CS")
  $ (PDEMAND (PRIMARY, "QUANTITY") GT 0 AND
    PDEMAND (PRIMARY, "PRICE") GT 0 AND
    PDEMAND (PRIMARY, "ELASTICITY") LT -0.05 )
  = ( (DEMANDP.L (PRIMARY) *SCALE (PRIMARY) /PDEMAND (PRIMARY, "QUANTITY")) **

```

```

(1/PDEMAND(PRIMARY,"ELASTICITY")) )
*DEMANDP.L(PRIMARY)*SCALE(PRIMARY)
*PDEMAND(PRIMARY,"PRICE")/(1+1/PDEMAND(PRIMARY,"ELASTICITY"))
+PDEMAND(PRIMARY,"CONSTANT1")
+PDEMAND(PRIMARY,"CONSTANT2")
-PRIMARYBAL.M(PRIMARY)*BALANCEP(PRIMARY,"DOM-DEMAND")
/SCALE(PRIMARY)*SCALOBJ ;

PCONSUR(PRIMARY,"MIN-REQ")
$ ( DEMANDP.L(PRIMARY)*SCALE(PRIMARY) EQ PDEMAND(PRIMARY,"MINQ") )
= PDEMAND(PRIMARY,"MINQ") * DEMANDP.M(PRIMARY)
/SCALE(PRIMARY)*SCALOBJ ;

PCONSUR(PRIMARY,"TOTCS")
*$SUM(PRIM, PCONSUR(PRIM,"MIN-REQ"))
= (PCONSUR(PRIMARY,"MIN-REQ") + PCONSUR(PRIMARY,"DOMEST-CS")) ;

PCONSUR(SECONDARY,"PRICEx100") = SECONDBAL.M(SECONDARY) *100.
/SCALE(SECONDARY)*SCALOBJ ;

PCONSUR(SECONDARY,"QUANTITY")
= BALANCES(SECONDARY,"DOM-DEMAND") ;

PCONSUR(SECONDARY,"EXPEND")
= SECONDBAL.M(SECONDARY)/SCALE(SECONDARY)*SCALOBJ
* BALANCES(SECONDARY,"DOM-DEMAND") ;

PCONSUR(SECONDARY,"DOMEST-CS")
$ (SDEMAND(SECONDARY,"QUANTITY") GT 0 AND
SDEMAND(SECONDARY,"PRICE") GT 0 AND
SDEMAND(SECONDARY,"ELASTICITY") LT -0.05 )
= (DEMANDS.L(SECONDARY)*SCALE(SECONDARY)
/SDEMAND(SECONDARY,"QUANTITY"))**
(1/SDEMAND(SECONDARY,"ELASTICITY"))
*DEMANDS.L(SECONDARY)*SCALE(SECONDARY)
*SDEMAND(SECONDARY,"PRICE")/(1+1/SDEMAND(SECONDARY,"ELASTICITY"))
+SDEMAND(SECONDARY,"CONSTANT1")
+SDEMAND(SECONDARY,"CONSTANT2")
-SECONDBAL.M(SECONDARY)/SCALE(SECONDARY)*SCALOBJ*
BALANCES(SECONDARY,"DOM-DEMAND") ;

PCONSUR(SECONDARY,"MIN-REQ")
$ ( DEMANDS.L(SECONDARY)*SCALE(SECONDARY)
EQ SDEMAND(SECONDARY,"MINQ") )
= SDEMAND(SECONDARY,"MINQ") * DEMANDS.M(SECONDARY)
/SCALE(SECONDARY)*SCALOBJ ;

PCONSUR(SECONDARY,"TOTCS")
*$SUM(SECOND, PCONSUR(SECOND,"MIN-REQ"))
= PCONSUR(SECONDARY,"MIN-REQ") + PCONSUR(SECONDARY,"DOMEST-CS") ;

PCONSUR("TOTAL",ITEMCS) = SUM(PRIMARY,PCONSUR(PRIMARY,ITEMCS))
+ SUM(SECONDARY,PCONSUR(SECONDARY,ITEMCS)) ;

#####
* Foreign Welfare by Commodity
#####

```

```

FWELFARE(PRIMARY, "PRICEx100") = PRIMARYBAL.M(PRIMARY) *100.
                                /SCALE(PRIMARY)*SCALOBJ;

FWELFARE(PRIMARY, "EXPQUANT") = BALANCEP(PRIMARY, "EXPORT");

FWELFARE(PRIMARY, "EXPORT-CS")
$    (PEXPOR(T PRIMARY, "QUANTITY")  GT 0 AND
      PEXPOR(T PRIMARY, "PRICE")      GT 0 AND
      PEXPOR(T PRIMARY, "ELASTICITY") LT -0.05      )
=    (EXPORTP.L(PRIMARY)*SCALE(PRIMARY)/PEXPOR(T PRIMARY, "QUANTITY"))**
      (1/PEXPOR(T PRIMARY, "ELASTICITY"))
      *EXPORTP.L(PRIMARY)*SCALE(PRIMARY)
      *PEXPOR(T PRIMARY, "PRICE")/(1+1/PEXPOR(T PRIMARY, "ELASTICITY"))
      +PEXPOR(T PRIMARY, "CONSTANT1")
      +PEXPOR(T PRIMARY, "CONSTANT2")
      -PRIMARYBAL.M(PRIMARY)/SCALE(PRIMARY)*SCALOBJ
      * BALANCEP(PRIMARY, "EXPORT") ;

FWELFARE(PRIMARY, "IMPQUANT") = BALANCEP(PRIMARY, "IMPORT") ;

FWELFARE(PRIMARY, "IMPORT-PS")
$    (PIMPORT(PRIMARY, "QUANTITY")  GT 0 AND
      PIMPORT(PRIMARY, "PRICE")      GT 0 AND
      PIMPORT(PRIMARY, "ELASTICITY") GT 0.05      )
=    BALANCEP(PRIMARY, "IMPORT") * PRIMARYBAL.M(PRIMARY)
      /SCALE(PRIMARY)*SCALOBJ
      -(IMPORTP.L(PRIMARY)*SCALE(PRIMARY)/PIMPORT(PRIMARY, "QUANTITY"))
      ** (1./PIMPORT(PRIMARY, "ELASTICITY"))
      * IMPORTP.L(PRIMARY)*SCALE(PRIMARY)
      * PIMPORT(PRIMARY, "PRICE")
      * PIMPORT(PRIMARY, "ELASTICITY")
      / (1.+PIMPORT(PRIMARY, "ELASTICITY")) ;

FWELFARE(PRIMARY, "MIN-REQ")
$    ( IMPORTP.L(PRIMARY)*SCALE(PRIMARY) EQ PIMPORT(PRIMARY, "MINQ") )
=    PIMPORT(PRIMARY, "MINQ") * IMPORTP.M(PRIMARY)
      /SCALE(PRIMARY)*SCALOBJ
      $(IMPORTP.L(PRIMARY)*SCALE(PRIMARY) EQ PIMPORT(PRIMARY, "MINQ"))
      + PEXPOR(T PRIMARY, "MINQ") * EXPORTP.M(PRIMARY)
      *SCALE(PRIMARY)*SCALOBJ
      $(EXPORTP.L(PRIMARY)*SCALE(PRIMARY) EQ PEXPOR(T PRIMARY, "MINQ")) ;

FWELFARE(SECONDARY, "PRICEx100") = SECONDBAL.M(SECONDARY) *100.
                                /SCALE(SECONDARY)*SCALOBJ;

FWELFARE(SECONDARY, "EXPQUANT") = BALANCES(SECONDARY, "EXPORT");

FWELFARE(SECONDARY, "EXPORT-CS")
$    (SEXPOR(T SECONDARY, "QUANTITY")  GT 0 AND
      SEXPOR(T SECONDARY, "PRICE")      GT 0 AND
      SEXPOR(T SECONDARY, "ELASTICITY") LT -0.05      )
=    (EXPORTS.L(SECONDARY)*SCALE(SECONDARY)/SEXPOR(T SECONDARY, "QUANTITY"))**
      (1/SEXPOR(T SECONDARY, "ELASTICITY"))
      *EXPORTS.L(SECONDARY)*SCALE(SECONDARY)
      *SEXPOR(T SECONDARY, "PRICE")/(1+1/SEXPOR(T SECONDARY, "ELASTICITY"))
      +SEXPOR(T SECONDARY, "CONSTANT1")
      +SEXPOR(T SECONDARY, "CONSTANT2")
      -SECONDBAL.M(SECONDARY)

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/SCALE(SECONDARY)*SCALOBJ* BALANCES(SECONDARY,"EXPORT") ;

FWELFARE(SECONDARY,"IMPQUANT") = BALANCES(SECONDARY,"IMPORT") ;

FWELFARE(SECONDARY,"IMPORT-PS")
$ (SIMPORT(SECONDARY,"QUANTITY") GT 0 AND
SIMPORT(SECONDARY,"PRICE") GT 0 AND
SIMPORT(SECONDARY,"ELASTICITY") GT 0.05 )
= BALANCES(SECONDARY,"IMPORT") * SECONDBAL.M(SECONDARY)
/SCALE(SECONDARY) *SCALOBJ
- (IMPORTS.L(SECONDARY)*SCALE(SECONDARY)
/SIMPORT(SECONDARY,"QUANTITY"))
** (1./SIMPORT(SECONDARY,"ELASTICITY"))
* IMPORTS.L(SECONDARY) * SCALE(SECONDARY)
* SIMPORT(SECONDARY,"PRICE")
* SIMPORT(SECONDARY,"ELASTICITY")
/ (1.+
SIMPORT(SECONDARY,"ELASTICITY")) ;

FWELFARE(ALLI,"PS+CS") = FWELFARE(ALLI,"IMPORT-PS")
+ FWELFARE(ALLI,"EXPORT-CS") ;

FWELFARE(SECONDARY,"MIN-REQ")
$ ( IMPORTS.L(SECONDARY)*SCALE(SECONDARY)
EQ SIMPORT(SECONDARY,"MINQ"))
= SIMPORT(SECONDARY,"MINQ") * IMPORTS.M(SECONDARY)
/SCALE(SECONDARY)*SCALOBJ
$(IMPORTS.L(SECONDARY)*SCALE(SECONDARY)
EQ SIMPORT(SECONDARY,"MINQ"))
+ SEXPOR(TSECONDARY,"MINQ") * EXPORTS.M(SECONDARY)
/SCALE(SECONDARY)*SCALOBJ
$(EXPORTS.L(SECONDARY)*SCALE(SECONDARY)
EQ SEXPOR(TSECONDARY,"MINQ")) ;

FWELFARE(ALLI,"TOTWEL")
* $(SUM(PRIM,FWELFARE(PRIM,"MIN-REQ"))
+SUM(SECOND,FWELFARE(SECOND,"MIN-REQ")))
= FWELFARE(ALLI,"MIN-REQ") + FWELFARE(ALLI,"PS+CS") ;

FWELFARE("TOTAL",ITEMFOR) = SUM(PRIMARY,FWELFARE(PRIMARY,ITEMFOR))
+ SUM(SECONDARY,FWELFARE(SECONDARY,ITEMFOR)) ;

OPTION DECIMALS = 0 ;

DISPLAY PCONSUR;

DISPLAY FWELFARE;

#####
* Producer Surplus by Region and Input Type
#####

REGWELFAR(REGION,LANDTYPE) =
SUM(SUBREG$MAPPING(REGION,SUBREG),
MAXLAND.M(SUBREG,LANDTYPE)*SCALOBJ
*MAXLAND.UP(SUBREG,LANDTYPE))+
( (LAND.M(REGION,LANDTYPE)* LANDSUPPLY.L(REGION,LANDTYPE)*SCALOBJ )
-LANDSUPPL(LANDTYPE,REGION,"ELASTICITY")

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/ (1.+LANDSUPPL(LANDTYPE,REGION,"ELASTICITY"))
*LANDSUPPL(LANDTYPE,REGION,"PRICE")*
(LANDSUPPLY.L(REGION,LANDTYPE)*SCALE(LANDTYPE)
/LANDSUPPL(LANDTYPE,REGION,"QUANTITY"))
**(1./LANDSUPPL(LANDTYPE,REGION,"ELASTICITY"))
* LANDSUPPLY.L(REGION,LANDTYPE)*SCALE(LANDTYPE) ) $
(LANDSUPPL(LANDTYPE,REGION,"QUANTITY") GT 0 AND
LANDSUPPL(LANDTYPE,REGION,"PRICE") GT 0 AND
LANDSUPPL(LANDTYPE,REGION,"ELASTICITY") GT 0.05 ) ;

REGWELFAR(REGION,"WATER")
= SUM(SUBREG$MAPPING(REGION,SUBREG),
FIX.M(SUBREG)*FIX.UP(SUBREG)*SCALOBJ
+( WATERR.M(SUBREG)*WATERVAR.L(SUBREG) *SCALOBJ
- ( WATERSUP(SUBREG,"PUMPELAS")
/(1.+WATERSUP(SUBREG,"PUMPELAS"))
*WATERSUP(SUBREG,"PUMPPRICE")*
(WATERVAR.L(SUBREG)*SCALE("WATER")
/WATERSUP(SUBREG,"PUMPQ"))
**(1./WATERSUP(SUBREG,"PUMPELAS"))
* WATERVAR.L(SUBREG) ) *SCALE("WATER"))$
(WATERSUP(SUBREG,"PUMPQ")*WATERSUP(SUBREG,"PUMPELAS") ne 0));

REGWELFAR(REGION,"LABOR") =
FAMILYLIM.M(REGION)* FAMILYLIM.UP(REGION)*SCALOBJ+
HIRELIM.M(REGION)* HIRELIM.UP(REGION)*SCALOBJ+
LABOR.M(REGION)*HIRED.L(REGION)*SCALOBJ
-LABORSUP(REGION,"HIREELAS")/(1.+LABORSUP(REGION,"HIREELAS"))
*LABORSUP(REGION,"HIREP")*
(HIRED.L(REGION)*SCALE("LABOR")
/LABORSUP(REGION,"HIREQ"))** (1./LABORSUP(REGION,"HIREELAS"))
* HIRED.L(REGION)*SCALE("LABOR") ;

REGWELFAR(REGION,"TOTALPS") = SUM(LANDTYPE,REGWELFAR(REGION,LANDTYPE))+
REGWELFAR(REGION,"LABOR") + REGWELFAR(REGION,"WATER");

REGWELFAR(REGION,"CS") = PCONSUR("TOTAL","DOMEST-CS") *
SUM(SUBREG$MAPPING(REGION,SUBREG),POPULATION(SUBREG))/
SUM(SUBREG,POPULATION(SUBREG)) ;

REGWELFAR(REGION,"GRNDTOT") = REGWELFAR(REGION,"CS") +
REGWELFAR(REGION,"TOTALPS") ;

REGWELFAR("TOTAL",ALLI) = SUM(REGION,REGWELFAR(REGION,ALLI)) ;

DISPLAY REGWELFAR;

#####
* Government Program Payment by Commodity
#####

GOVDEF(PRIMARY,"DEFRATE")$(FARMPROD("TARGET",PRIMARY) GT 0
AND FARMPROD("MKTLOANY-N",PRIMARY) LE 0)
= MAX(0.0, (FARMPROD("TARGET",PRIMARY)-
MAX(FARMPROD("LOANRATE",PRIMARY),PRIMARYBAL.M(PRIMARY)
/SCALE(PRIMARY)*SCALOBJ) ) ) ;

GOVDEF(PRIMARY,"DEFRATE")$(FARMPROD("TARGET",PRIMARY) GT 0

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AND FARMPROD("MKTLOANY-N", PRIMARY) GT 0)
= FARMPROD("TARGET", PRIMARY) - FARMPROD("LOANRATE", PRIMARY) ;

GOVDEF(PRIMARY, "DEFPYMT") $FARMPROD("TARGET", PRIMARY)
= GOVDEF(PRIMARY, "DEFRATE") * DEFPRODN.L(PRIMARY) * SCALE(PRIMARY) ;

GOVDEF(PRIMARY, "5092PYMT") $FARMPROD("TARGET", PRIMARY)
= GOVDEF(PRIMARY, "DEFRATE") * PRDN5092.L(PRIMARY) * SCALE(PRIMARY) * 0.92 ;

GOVDEF(PRIMARY, "DIVPYMT") $FARMPROD("TARGET", PRIMARY)
= FARMPROD("DIVERPAY", PRIMARY) * DIVPRODN.L(PRIMARY) * SCALE(PRIMARY) ;

GOVDEF(PRIMARY, "UNHARVPYMT") $FARMPROD("TARGET", PRIMARY)
= GOVDEF(PRIMARY, "DEFRATE") * UNHARV.L(PRIMARY) * SCALE(PRIMARY) ;

GOVDEF(PRIMARY, "ARTIFPYMT") $FARMPROD("TARGET", PRIMARY)
= GOVDEF(PRIMARY, "DEFRATE") * ARTIF.L(PRIMARY) * SCALE(PRIMARY) ;

GOVDEF(PRIMARY, "TOTDEFPYMT") $FARMPROD("TARGET", PRIMARY)
= GOVDEF(PRIMARY, "DEFPYMT") + GOVDEF(PRIMARY, "5092PYMT")
+ GOVDEF(PRIMARY, "DIVPYMT") + GOVDEF(PRIMARY, "UNHARVPYMT")
+ GOVDEF(PRIMARY, "ARTIFPYMT") ;

GOVDEF(PRIMARY, "MKTRATE") $( FARMPROD("MKTLOANY-N", PRIMARY) GT 0
AND FARMPROD("LOANRATE", PRIMARY) GT PRIMARYBAL.M(PRIMARY)
/ SCALE(PRIMARY) * SCALOBJ )
= FARMPROD("LOANRATE", PRIMARY) - PRIMARYBAL.M(PRIMARY)
/ SCALE(PRIMARY) * SCALOBJ ;

GOVDEF(PRIMARY, "MKTPYMT") $( FARMPROD("MKTLOANY-N", PRIMARY) GT 0
AND FARMPROD("LOANRATE", PRIMARY) GT PRIMARYBAL.M(PRIMARY)
/ SCALE(PRIMARY) * SCALOBJ )
= GOVDEF(PRIMARY, "MKTRATE") * DEFPRODN.L(PRIMARY) * SCALE(PRIMARY) ;

GOVDEF(PRIMARY, "DEF+MKT") $( FARMPROD("TARGET", PRIMARY) GT 0 OR
FARMPROD("MKTLOANY-N", PRIMARY) GT 0 )
= GOVDEF(PRIMARY, "TOTDEFPYMT") + GOVDEF(PRIMARY, "MKTPYMT") ;

GOVDEF("TOTAL", IDEF)
= SUM(PRIMARY, GOVDEF(PRIMARY, IDEF)) ;

GOVCCC(PRIMARY, "CCCSTK") $( FARMPROD("LOANRATE", PRIMARY) GT 0 AND
FARMPROD("MKTLOANY-N", PRIMARY) LE 0 )
= CCCLOANP.L(PRIMARY) * SCALE(PRIMARY) ;

GOVCCC(PRIMARY, "CCCRATE") $( FARMPROD("LOANRATE", PRIMARY) GT 0 AND
FARMPROD("MKTLOANY-N", PRIMARY) LE 0 )
= FARMPROD("LOANRATE", PRIMARY) ;

GOVCCC(PRIMARY, "CCCLOANCST") $( FARMPROD("LOANRATE", PRIMARY) GT 0 AND
FARMPROD("MKTLOANY-N", PRIMARY) LE 0 )
= GOVCCC(PRIMARY, "CCCRATE") * GOVCCC(PRIMARY, "CCCSTK") ;

GOVCCC(SECONDARY, "CCCSTK") $( FARMPROD("LOANRATE", SECONDARY) GT 0 AND
FARMPROD("MKTLOANY-N", SECONDARY) LE 0 )
= CCCLOANS.L(SECONDARY) * SCALE(SECONDARY) ;

GOVCCC(SECONDARY, "CCCRATE") $( FARMPROD("LOANRATE", SECONDARY) GT 0 AND

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                FARMPROD("MKTLOANY-N",SECONDARY) LE 0 )
    = FARMPROD("LOANRATE",SECONDARY);

GOVCCC(SECONDARY,"CCCLOANCST")$(FARMPROD("LOANRATE",SECONDARY) GT 0 AND
    FARMPROD("MKTLOANY-N",SECONDARY) LE 0 )
    = GOVCCC(SECONDARY,"CCCRATE") * GOVCCC(SECONDARY,"CCSTK");

GOVCCC("TOTAL",ICCC)
    = SUM(PRIMARY,GOVCCC(PRIMARY,ICCC))
      + SUM(SECONDARY,GOVCCC(SECONDARY,ICCC));

OPTION DECIMALS=3;

DISPLAY GOVDEF;
DISPLAY GOVCCC;

#####
*   Welfare Summary Report
#####

WELSUM("DOM-CONSUM")= PCONSUR("TOTAL","DOMEST-CS");
WELSUM("DOM-PRODUC")= REGWELFAR("TOTAL","TOTALPS");
WELSUM("DOM-TOTAL")= WELSUM("DOM-CONSUM") + WELSUM("DOM-PRODUC");
WELSUM("FOR-EXPORT")= FWELFARE("TOTAL","EXPORT-CS");
WELSUM("FOR-IMPORT")= FWELFARE("TOTAL","IMPORT-PS");
WELSUM("FOR-TOTAL")= WELSUM("FOR-EXPORT")+WELSUM("FOR-IMPORT");
WELSUM("TOT-SOCIAL")=WELSUM("DOM-TOTAL") + WELSUM("FOR-TOTAL");
WELSUM("GOV-DEFPMT")= GOVDEF("TOTAL","TOTDEFPYMT");
WELSUM("GOV-MKTLN")= GOVDEF("TOTAL","MKTPYMT");
WELSUM("GOV-TOTPM")= GOVDEF("TOTAL","TOTDEFPYMT")+GOVDEF("TOTAL","MKTPYMT");
WELSUM("NET-SOCIAL")=WELSUM("TOT-SOCIAL") - WELSUM("GOV-TOTPM");
WELSUM("NET-DOMEST")=WELSUM("NET-SOCIAL") - WELSUM("FOR-TOTAL");

OPTION WELSUM:0:0:1; DISPLAY WELSUM;

#####
*   Regional Labor Use and Wage Report
#####

LABORSUM(REGION,"FAMILY") = FAMILY.L(REGION)*SCALE("LABOR");
LABORSUM(REGION,"REWAG") = LABORSUP(REGION,"FAMILYPRC");
LABORSUM(REGION,"VALUE") =
    LABORSUM(REGION,"FAMILY") * LABORSUM(REGION,"REWAG");
LABORSUM(REGION,"HIRED") = HIRED.L(REGION)*SCALE("LABOR");
LABORSUM(REGION,"WAGE") = LABOR.M(REGION)*SCALOBJ/SCALE("LABOR");
LABORSUM(REGION,"VALU") =
    LABORSUM(REGION,"HIRED") * LABORSUM(REGION,"WAGE");
LABORSUM(REGION,"TOTALLABR") =
    LABORSUM(REGION,"FAMILY") + LABORSUM(REGION,"HIRED");
LABORSUM(REGION,"TOTVALU") =
    LABORSUM(REGION,"VALUE") + LABORSUM(REGION,"VALU");
LABORSUM("TOTAL",LABRITEM) = SUM(REGION,LABORSUM(REGION,LABRITEM));

DISPLAY LABORSUM;

#####
*   Regional Water Use and Price Report
#####

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WATERSUM( REGION, "FIXED" )
  = SUM( SUBREG$MAPPING( REGION, SUBREG ) ,
        WATERFIX.L( SUBREG ) * SCALE( "WATER" ) ) ;

WATERSUM( REGION, "FVALUE" )
  = SUM( SUBREG$MAPPING( REGION, SUBREG ) ,
        WATERFIX.L( SUBREG ) * SCALE( "WATER" ) * WATERSUP( SUBREG, "FIXEDPRC" ) ) ;

WATERSUM( REGION, "FIXPRC" ) $ WATERSUM( REGION, "FIXED" ) =
  WATERSUM( REGION, "FVALUE" ) / WATERSUM( REGION, "FIXED" ) ;

WATERSUM( REGION, "PUMPED" )
  = SUM( SUBREG$MAPPING( REGION, SUBREG ) ,
        WATERVAR.L( SUBREG ) * SCALE( "WATER" ) ) ;

WATERSUM( REGION, "PVALUE" )
  = SUM( SUBREG$MAPPING( REGION, SUBREG ) ,
        WATERVAR.L( SUBREG ) * SCALE( "WATER" ) * WATERR.M( SUBREG ) ) ;

WATERSUM( REGION, "PUMPPRICE" ) $ WATERSUM( REGION, "PUMPED" ) =
  WATERSUM( REGION, "PVALUE" ) / WATERSUM( REGION, "PUMPED" ) ;

WATERSUM( REGION, "TOTALWATER" ) =
  WATERSUM( REGION, "FIXED" ) + WATERSUM( REGION, "PUMPED" ) ;
WATERSUM( REGION, "TOTWVAL" ) =
  WATERSUM( REGION, "FVALUE" ) + WATERSUM( REGION, "PVALUE" ) ;

WATERSUM( "TOTAL", WATRITEM ) = SUM( REGION, WATERSUM( REGION, WATRITEM ) ) ;

WATERSUM( "TOTAL", "PUMPPRICE" ) $ WATERSUM( "TOTAL", "PUMPED" ) =
  WATERSUM( "TOTAL", "PVALUE" ) / WATERSUM( "TOTAL", "PUMPED" ) ;

WATERSUM( "TOTAL", "FIXPRC" ) $ WATERSUM( "TOTAL", "FIXED" ) =
  WATERSUM( "TOTAL", "FVALUE" ) / WATERSUM( "TOTAL", "FIXED" ) ;

DISPLAY WATERSUM;

#####
*   Processing Activity Report
#####

PROCSUM( PROCESSALT, "LEVEL" ) = PROCESS.L( PROCESSALT ) * SCALPROC ;
PROCSUM( PROCESSALT, "RED-COST" ) = PROCESS.M( PROCESSALT ) * SCALOBJ / SCALPROC ;

DISPLAY PROCSUM;

#####
*   National and Regional Harvest and Set-Aside Acre Report by Crop
#####

OPTION DECIMALS = 2 ;

HARVEST( CROP, "DRYHARV" ) = SUM( SUBREG, SUM( ( WTECH, CTECH, TECH ) ,
        CROPBUDGET.L( SUBREG, CROP, WTECH, CTECH, TECH )
        * SCALPROD
        $( CBUDDATA( "WATER" , SUBREG, CROP, WTECH, CTECH, TECH ) EQ 0 ) )
        ) ;

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HARVEST(CROP, "IRRHARV") = SUM(SUBREG, SUM( (WTECH, CTECH, TECH) ,
      CROPBUDGET.L(SUBREG, CROP, WTECH, CTECH, TECH)
      *SCALPROD
      $CBUDDATA( "WATER" , SUBREG, CROP, WTECH, CTECH, TECH) )
      ) ;

HARVEST(CROP, "TOT-HARV")=HARVEST(CROP, "DRYHARV") + HARVEST(CROP, "IRRHARV") ;

harvest(crop, "DIVERTLAND") =SUM(SUBREG, SUM( (WTECH, TECH) ,
      CROPBUDGET.L(SUBREG, CROP, WTECH, "PARTICIP" , TECH)
      *SCALPROD
      *CBUDDATA( "CROPLAND" , SUBREG, CROP, WTECH, "PARTICIP" , TECH)
      *FPPART(SUBREG, CROP) * ( FARMPROD( "SETASIDE" , CROP)
      +FARMPROD( "DIVERSION" , CROP)+FARMPROD( "50-92" , CROP) )
      $CROPBUDGET.L(SUBREG, CROP, WTECH, "PARTICIP" , TECH) )
      ) ;

HARVEST(CROP, "TOT-ACRE") = HARVEST(CROP, "DIVERTLAND")
      + HARVEST(CROP, "TOT-HARV") ;

HARVEST(CROP, "AVG-YIELD") = 0.0 ;

HARVEST(CROP, "AVG-YIELD")$HARVEST(CROP, "TOT-HARV")
      = BALANCEP(CROP, "PRODUCTION") / HARVEST(CROP, "TOT-HARV") ;

DISPLAY HARVEST ;

HARVESTREG(CROP, REGION, "DRYHARV") =
      SUM(SUBREG$MAPPING(REGION, SUBREG) ,
      SUM( (WTECH, CTECH, TECH) ,
      CROPBUDGET.L(SUBREG, CROP, WTECH, CTECH, TECH)
      *SCALPROD
      $(CBUDDATA( "WATER" , SUBREG, CROP, WTECH, CTECH, TECH) EQ 0) )
      ) ;

HARVESTREG(CROP, REGION, "IRRHARV") =
      SUM(SUBREG$MAPPING(REGION, SUBREG) ,
      SUM( (WTECH, CTECH, TECH) ,
      CROPBUDGET.L(SUBREG, CROP, WTECH, CTECH, TECH)
      *SCALPROD
      $CBUDDATA( "WATER" , SUBREG, CROP, WTECH, CTECH, TECH) )
      ) ;

HARVESTREG(CROP, REGION, "TOT-HARV")=HARVESTREG(CROP, REGION, "DRYHARV")
      + HARVESTREG(CROP, REGION, "IRRHARV") ;

harvestreg(crop, region, "DIVERTLAND") =
      sum(subreg$mapping(region, subreg) ,
      SUM( (WTECH, TECH) ,
      CROPBUDGET.L(SUBREG, CROP, WTECH, "PARTICIP" , TECH)
      *SCALPROD
      *CBUDDATA( "CROPLAND" , SUBREG, CROP, WTECH, "PARTICIP" , TECH)
      *FPPART(SUBREG, CROP) * ( FARMPROD( "SETASIDE" , CROP)
      +FARMPROD( "DIVERSION" , CROP)+FARMPROD( "50-92" , CROP) )
      $CROPBUDGET.L(SUBREG, CROP, WTECH, "PARTICIP" , TECH) ) ) ;

HARVESTREG(CROP, REGION, "TOT-ACRE")=HARVESTREG(CROP, REGION, "TOT-HARV")
      + HARVESTREG(CROP, REGION, "DIVERTLAND") ;

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harvestreg(crop,"TOTAL",HARVLAND) = SUM(REGION,harvestreg(crop,region,HARVLAND));

DISPLAY HARVESTREG;

#####
*   Regional Land Use and Rent Report
#####

OPTION DECIMALS = 2 ;

LANDSUM(REGION,LANDTYPE,"USE") = LANDSUPPLY.L(REGION,LANDTYPE)
                                *SCALE(LANDTYPE);
LANDSUM(REGION,LANDTYPE,"RENTALRATE") = LAND.M(REGION,LANDTYPE)
                                *SCALOBJ/SCALE(LANDTYPE);
LANDSUM("TOTAL",LANDTYPE,"USE")=SUM(REGION, LANDSUM(REGION,LANDTYPE,"USE"));

DISPLAY LANDSUM;

#####
*   Subregional Cropland Report by Crop
#####
option decimals = 0;
solcrop(subreg,crop)
=sum((wtech,ctech,tech),CROPBUDGET.L(SUBREG,CROP,WTECH,ctech,TECH))*1000.;

totcrop(crop)
  =sum(subreg,solcrop(subreg,crop));

Display solcrop;
Display totcrop;

#####
*   Subregional Crop Production Report
#####

CROPSUBREG(SUBREG,CROP)=
  SUM((WTECH,TECH)$FARMPROD("SLIPPAGE",CROP),
    CROPBUDGET.L(SUBREG,CROP,WTECH,"NONPART",TECH)
    *SCALPROD
    *CBUDDATA(CROP,SUBREG,CROP,WTECH,"NONPART",TECH)
    *CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"NONPART",TECH)$
      (CBUDDATA(CROP,SUBREG,CROP,WTECH,"NONPART",TECH) GT 0)
  + CROPBUDGET.L(SUBREG,CROP,WTECH,"PARTICIP",TECH)
    *SCALPROD
    *CBUDDATA(CROP,SUBREG,CROP,WTECH,"NONPART",TECH)
    *CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH)
    *(1.0-FPPART(SUBREG,CROP))$
      (CBUDDATA(CROP,SUBREG,CROP,WTECH,"NONPART",TECH) GT 0)
  + CROPBUDGET.L(SUBREG,CROP,WTECH,"PARTICIP",TECH)
    *SCALPROD
    *CBUDDATA(CROP,SUBREG,CROP,WTECH,"PARTICIP",TECH)
    *CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH)
    *FPPART(SUBREG,CROP) * (1-FARMPROD("SETASIDE",CROP)
      -FARMPROD("DIVERSION",CROP)-FARMPROD("50-92",CROP))
    * (1-FARMPROD("PERCENTPAID",CROP))$
      (CBUDDATA(CROP,SUBREG,CROP,WTECH,"PARTICIP",TECH) GT 0) )

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+ SUM((WTECH,TECH)$ (FARMPROD("SLIPPAGE",CROP) GT 0.0 AND
      FARMPROD("FPYIELD",CROP) LE 1.0),
      CROPBUDGET.L(SUBREG,CROP,WTECH,"PARTICIP",TECH)
      *SCALPROD
      *CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH)
      *FPPART(SUBREG,CROP) * (1-FARMPROD("SETASIDE",CROP)
        -FARMPROD("DIVERSION",CROP)-FARMPROD("50-92",CROP))
      * FARMPROD("PERCENTPAID",CROP)
      *CBUDDATA(CROP,SUBREG,CROP,WTECH,"PARTICIP",TECH)
      *(1.0-FARMPROD("FPYIELD",CROP))$
      (CBUDDATA(CROP,SUBREG,CROP,WTECH,"PARTICIP",TECH) GT 0))
+ SUM((WTECH,TECH)$ (FARMPROD("SLIPPAGE",CROP) LE 0.),
      CROPBUDGET.L(SUBREG,CROP,WTECH,"BASE",TECH)
      *SCALPROD
      *CBUDDATA(CROP,SUBREG,CROP,WTECH,"BASE",TECH)
      *CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"BASE",TECH)$
      (CBUDDATA(CROP,SUBREG,CROP,WTECH,"BASE",TECH) GT 0))
+ SUM((WTECH,TECH),
      CROPBUDGET.L(SUBREG,CROP,WTECH,"PARTICIP",TECH)
      *SCALPROD
      * ( CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH)
        *FPPART(SUBREG,CROP)*(1.0-FARMPROD("SETASIDE",CROP)
          -FARMPROD("DIVERSION",CROP)-FARMPROD("50-92",CROP))
        *FARMPROD("PERCENTPAID",CROP) )
      * MIN(CBUDDATA(CROP,SUBREG,CROP,WTECH,"PARTICIP",TECH),
        (FARMPROD("FPYIELD",CROP)
        *CBUDDATA(CROP,SUBREG,CROP,WTECH,"PARTICIP",TECH)))
      )
;

DISPLAY CROPSUBREG;

#####
* Subregional Livestock Production Report
#####

LIVESUBREG(SUBREG,LIVESTOCK)=
  SUM((ANIMAL,LIVETECH),
    LVSTBUDGET.L(SUBREG,ANIMAL,LIVETECH)
    *SCALLIVE
    *LBUDDATA(LIVESTOCK,SUBREG,ANIMAL,LIVETECH)$
    (LBUDDATA(LIVESTOCK,SUBREG,ANIMAL,LIVETECH) GT 0) );

DISPLAY LIVESUBREG;

#####
* Subregional Input Use and Producer Surplus Report
#####

USPOPU= SUM(SUBREG,POPULATION(SUBREG));

SUBREPORT(SUBREG,"CROPLAND") =
  SUM((CROP,WTECH,CTECH,TECH),CROPBUDGET.L(SUBREG,CROP,WTECH,CTECH,TECH)
    *SCALPROD)
  + SUM((CROP,WTECH,TECH),CROPBUDGET.L(SUBREG,CROP,WTECH,"PARTICIP",TECH)
    *SCALPROD
    *CBUDDATA("CROPLAND",SUBREG,CROP,WTECH,"PARTICIP",TECH)
    *FPPART(SUBREG,CROP)*(FARMPROD("SETASIDE",CROP)

```

```

+FARMPROD("DIVERSION",CROP)+FARMPROD("50-92",CROP))
  $CROPBUDGET.L(SUBREG,CROP,WTECH,"PARTICIP",TECH) ;

SUBREPORT(SUBREG,"PASTURE")=
SUM((ANIMAL,LIVETECH),
  LVSTBUDGET.L(SUBREG,ANIMAL,LIVETECH)
  *SCALLIVE
  *LBUDDATA("PASTURE",SUBREG,ANIMAL,LIVETECH));

SUBREPORT(SUBREG,"AUMS")=
SUM((ANIMAL,LIVETECH),
  LVSTBUDGET.L(SUBREG,ANIMAL,LIVETECH)
  *SCALLIVE
  *LBUDDATA("AUMS",SUBREG,ANIMAL,LIVETECH));

SUBREPORT(SUBREG,"WATER") =
SUM((CROP,WTECH,CTECH,TECH),CROPBUDGET.L(SUBREG,CROP,WTECH,CTECH,TECH)
  *SCALPROD
  *CBUDDATA("WATER",SUBREG,CROP,WTECH,CTECH,TECH))
+ SUM((ANIMAL,LIVETECH),
  LVSTBUDGET.L(SUBREG,ANIMAL,LIVETECH)
  *SCALLIVE
  *LBUDDATA("WATER",SUBREG,ANIMAL,LIVETECH))
+ SUM(PROCESSALT,
  PROCESS.L(PROCESSALT)
  *PROCBUD("WATER",PROCESSALT)
  *SCALPROC);

SUBREPORT(SUBREG,"LABOR")=
SUM((CROP,WTECH,CTECH,TECH),CROPBUDGET.L(SUBREG,CROP,WTECH,CTECH,TECH)
  *SCALPROD
  *CBUDDATA("LABOR",SUBREG,CROP,WTECH,CTECH,TECH))
+ SUM((ANIMAL,LIVETECH),
  LVSTBUDGET.L(SUBREG,ANIMAL,LIVETECH)
  *SCALLIVE
  *LBUDDATA("LABOR",SUBREG,ANIMAL,LIVETECH))
+ SUM(PROCESSALT,
  PROCESS.L(PROCESSALT)
  *PROCBUD("LABOR",PROCESSALT)
  *SCALPROC);

SUBREPORT("TOTAL",LANDTYPE) = SUM(SUBREG,SUBREPORT(SUBREG,LANDTYPE));
SUBREPORT("TOTAL","WATER") = SUM(SUBREG,SUBREPORT(SUBREG,"WATER"));
SUBREPORT("TOTAL","LABOR") = SUM(SUBREG,SUBREPORT(SUBREG,"LABOR"));

SUBREPORT(SUBREG,"SURP-LAND") =
SUM(LANDTYPE$SUBREPORT("TOTAL",LANDTYPE),
  SUM(REGION,REGWELFAR(REGION,LANDTYPE))
  *SUBREPORT(SUBREG,LANDTYPE)
  /SUBREPORT("TOTAL",LANDTYPE));

SUBREPORT(SUBREG,"SURP-WATER")
= FIX.M(SUBREG)*FIX.UP(SUBREG)*SCALOBJ
+ (WATERR.M(SUBREG)*WATERVAR.L(SUBREG)*SCALOBJ
  - (WATERSUP(SUBREG,"PUMPELAS")
  / (1.+WATERSUP(SUBREG,"PUMPELAS")))
  *WATERSUP(SUBREG,"PUMPPRICE")*
  (WATERVAR.L(SUBREG)*SCALE("WATER"))

```

```

/WATERSUP(SUBREG,"PUMPQ"))
** (1./WATERSUP(SUBREG,"PUMPELAS"))
* WATERVAR.L(SUBREG) ) *SCALE("WATER"))$
(WATERSUP(SUBREG,"PUMPQ")*WATERSUP(SUBREG,"PUMPELAS") ne 0) ;

SUBREPORT(SUBREG,"SURP-LABOR") =
SUM(REGION,REGWELFAR(REGION,"LABOR") )
*SUBREPORT(SUBREG,"LABOR")
/SUBREPORT("TOTAL","LABOR") ;

SUBREPORT(SUBREG,"TOTALPS") = SUBREPORT(SUBREG,"SURP-LAND")+
SUBREPORT(SUBREG,"SURP-LABOR") + SUBREPORT(SUBREG,"SURP-WATER");

SUBREPORT(SUBREG,"CS") = PCONSUR("TOTAL","DOMEST-CS") *
POPULATION(SUBREG)/ USPOPU;

SUBREPORT(SUBREG,"GRNDTOT") = SUBREPORT(SUBREG,"CS") +
SUBREPORT(SUBREG,"TOTALPS") ;

SUBREPORT("TOTAL",ALLI) = SUM(SUBREG,SUBREPORT(SUBREG,ALLI)) ;
SUBREPORT("TOTAL","SURP-LAND") = SUM(SUBREG,SUBREPORT(SUBREG,"SURP-LAND")) ;
SUBREPORT("TOTAL","SURP-WATER") = SUM(SUBREG,SUBREPORT(SUBREG,"SURP-WATER")) ;
SUBREPORT("TOTAL","SURP-LABOR") = SUM(SUBREG,SUBREPORT(SUBREG,"SURP-LABOR")) ;

DISPLAY SUBREPORT;

#####
* Texas Input Use and Producer Surplus Report
#####

TXREPORT(ALLI)=SUM(TEXAS,SUBREPORT(TEXAS,ALLI));
TXREPORT("SURP-LAND")=SUM(TEXAS,SUBREPORT(TEXAS,"SURP-LAND"));
TXREPORT("SURP-WATER")=SUM(TEXAS,SUBREPORT(TEXAS,"SURP-WATER"));
TXREPORT("SURP-LABOR")=SUM(TEXAS,SUBREPORT(TEXAS,"SURP-LABOR"));

DISPLAY TXREPORT;

#####
* Gross Revenue Report by Commodity
#####

GROSSREV(PRIMARY,"PRODUCTION")= BALANCEP(PRIMARY,"PRODUCTION") ;
GROSSREV(PRIMARY,"PRICE")= BALANCEP(PRIMARY,"PRICEX100") /100.;
GROSSREV(PRIMARY,"DEFPYMT")= GOVDEF(PRIMARY,"DEF+MKT") ;
GROSSREV(PRIMARY,"TOTAL-REV")= GROSSREV(PRIMARY,"PRODUCTION")*
GROSSREV(PRIMARY,"PRICE") + GROSSREV(PRIMARY,"DEFPYMT");

GROSSREV(SECONDARY,"PRODUCTION")= BALANCES(SECONDARY,"PROC-YLD") ;
GROSSREV(SECONDARY,"PRICE")= BALANCES(SECONDARY,"PRICEX100") /100.;
GROSSREV(SECONDARY,"TOTAL-REV")= GROSSREV(SECONDARY,"PRODUCTION")*
GROSSREV(SECONDARY,"PRICE") ;

DISPLAY GROSSREV;

#####

```

```

*   National Input Use Report by Input Type
#####

NATINPUSE(INPUT)=  INPUTPRICE(INPUT) *
  ( SUM((SUBREG,CROP,WTECH,TECH)$FARMPROD("SLIPPAGE",CROP),
        CROPBUDGET.L(SUBREG,CROP,WTECH,"PARTICIP",TECH)
        *SCALPROD
        *CBUDDATA(INPUT,SUBREG,CROP,WTECH,"PARTICIP",TECH)
  +  CROPBUDGET.L(SUBREG,CROP,WTECH,"NONPART",TECH)
        *SCALPROD
        *CBUDDATA(INPUT,SUBREG,CROP,WTECH,"NONPART",TECH)

  +  SUM((SUBREG,CROP,WTECH,TECH)$ (FARMPROD("SLIPPAGE",CROP) LE 0.),
        CROPBUDGET.L(SUBREG,CROP,WTECH,"BASE",TECH)
        *SCALPROD
        *CBUDDATA(INPUT,SUBREG,CROP,WTECH,"BASE",TECH))
  +  SUM((SUBREG,ANIMAL,LIVETECH),
        LVSTBUDGET.L(SUBREG,ANIMAL,LIVETECH)
        *SCALLIVE
        *LBUDDATA(INPUT,SUBREG,ANIMAL,LIVETECH) ) ) ;

```

```

DISPLAY NATINPUSE;

```

```

#####
*   Subregional AUMS Use Report
#####

```

```

PARAMETER AUMSSUBREG(SUBREG);

```

```

AUMSSUBREG(SUBREG)=
  SUM((ANIMAL,LIVETECH),
        LVSTBUDGET.L(SUBREG,ANIMAL,LIVETECH)
        *SCALLIVE
        *LBUDDATA(LANDTYPE,SUBREG,ANIMAL,LIVETECH))
  *SCALE("AUMS");

```

```

DISPLAY AUMSSUBREG;

```

## 5.5 MULTIPLE RUNS

To conduct a sensitivity analysis with multiple runs, the model have to be solved many times.

For convenience, ASM results can be saved into GAMS for each scenario and later listed in a composite comparison report where all the percentage and absolute changes are computed. This procedure requires the following 3 additional files: ASMRUNS, ASMCOMPR, and ASMEND.

### 5.5.1 ASMRUNS

This file contains the GAMS for setting up the multiple runs.



This file saves the selected results from each scenario using a Loop statement for each run. The program is listed as follows.

```

LOOP (RUN,
  SURCOMP ("CONSURPLUS", RUN) = PCONSUR ("TOTAL", "TOTCS" );
  SURCOMP ("PROSURPLUS", RUN) = REGWELFAR ("TOTAL", "TOTALPS" );
  SURCOMP ("FORSURPLUS", RUN) = FWELFARE ("TOTAL", "TOTWEL" );
  SURCOMP ("GOVCOST", RUN) = GOVDEF ("TOTAL", "DEF+MKT" );
  SURCOMP ("TOTDOMSURP", RUN) = SURCOMP ("CONSURPLUS", RUN) +
    SURCOMP ("PROSURPLUS", RUN) ;
  SURCOMP ("TOTSURPLUS", RUN) = SURCOMP ("TOTDOMSURP", RUN) +
    SURCOMP ("FORSURPLUS", RUN) ;
  SURCOMP ("NETSURPLUS", RUN) = SURCOMP ("TOTSURPLUS", RUN) -
    SURCOMP ("GOVCOST", RUN) ;

  INPCOMP ("CROPLAND", RUN) = LANDSUM ("TOTAL", "CROPLAND", "USE" );
  INPCOMP ("HARVESTIRR", RUN) = SUM (CROP, HARVEST (CROP, "IRRHARV" )) ;
  INPCOMP ("HARVESTDRY", RUN) = SUM (CROP, HARVEST (CROP, "DRYHARV" )) ;
  INPCOMP ("HARVESTTOT", RUN) = SUM (CROP, HARVEST (CROP, "TOT-HARV" )) ;
  INPCOMP ("SET-ASIDE", RUN) = SUM (CROP, HARVEST (CROP, "DIVERTLAND" )) ;
  INPCOMP ("PASTURE", RUN) = LANDSUM ("TOTAL", "PASTURE", "USE" );
  INPCOMP ("AUMS", RUN) = LANDSUM ("TOTAL", "AUMS", "USE" );
  INPCOMP ("WATER", RUN) = WATERSUM ("TOTAL", "TOTALWATER" );
  INPCOMP ("LABOR", RUN) = LABORSUM ("TOTAL", "TOTALLABR" );

  PRICECOMP (PRIMARY, RUN) = BALANCEP (PRIMARY, "PRICEX100" ) / 100.0 ;
  PRICECOMP (SECONDARY, RUN) = BALANCES (SECONDARY, "PRICEX100" ) / 100.0 ;

  PRODNCOMP (PRIMARY, RUN) = BALANCEP (PRIMARY, "PRODUCTION" );
  PRODNCOMP (SECONDARY, RUN) = BALANCES (SECONDARY, "PROC-YLD" );

  USCROPCOMP (CROP, RUN) = HARVEST (CROP, "TOT-HARV" );

  NATINPCOMP (INPUT, RUN) = NATINPUSE (INPUT) ;

  REVCOMP (ALLI, RUN) = GROSSREV (ALLI, "TOTAL-REV" );

  REGCOMP ("CROPLAND", REGIONS, RUN) = LANDSUM (REGIONS, "CROPLAND", "USE" );
  REGCOMP ("HARVESTIRR", REGIONS, RUN) = SUM (CROP, HARVESTREG (CROP, REGIONS, "IRRHARV" )) ;
  REGCOMP ("HARVESTDRY", REGIONS, RUN) = SUM (CROP, HARVESTREG (CROP, REGIONS, "DRYHARV" )) ;
  REGCOMP ("HARVESTTOT", REGIONS, RUN) = SUM (CROP, HARVESTREG (CROP, REGIONS, "TOT-HARV" )) ;
  REGCOMP ("SET-ASIDE", REGIONS, RUN) = SUM (CROP, HARVESTREG (CROP, REGIONS, "divertland" )) ;
  REGCOMP ("PASTURE", REGIONS, RUN) = LANDSUM (REGIONS, "PASTURE", "USE" );
  REGCOMP ("AUMS", REGIONS, RUN) = LANDSUM (REGIONS, "AUMS", "USE" );
  REGCOMP ("WATER", REGIONS, RUN) = WATERSUM (REGIONS, "TOTALWATER" );
  REGCOMP ("LABOR", REGIONS, RUN) = LABORSUM (REGIONS, "TOTALLABR" );
  REGCOMP ("PRODSUR", REGIONS, RUN) = REGWELFAR (REGIONS, "TOTALPS" );
  REGCOMP ("CONSUR", REGIONS, RUN) = REGWELFAR (REGIONS, "CS" );
  REGCOMP ("TOTSURP", REGIONS, RUN) = REGWELFAR (REGIONS, "GRNDTOT" );

  ACRECOMP (CROP, REGION, RUN) = HARVESTREG (CROP, REGION, "TOT-HARV" );
  ACRECOMP (CROP, "TOTAL", RUN) = SUM (REGION, ACRECOMP (CROP, REGION, RUN) );

  CROPPRCOMP (CROP, REGION, RUN) =
SUM (SUBREG$MAPPING (REGION, SUBREG), CROPSUBREG (SUBREG, CROP) );
  CROPPRCOMP (CROP, "TOTAL", RUN) = SUM (REGION, CROPPRCOMP (CROP, REGION, RUN) );

```



```

LIVECOMP(LIVESTOCK,REGION,RUN)=SUM(SUBREG$MAPPING(REGION,SUBREG),
                                     LIVESUBREG(SUBREG,LIVESTOCK));
LIVECOMP(LIVESTOCK,"TOTAL",RUN)=SUM(REGION,LIVECOMP(LIVESTOCK,REGION,RUN));
) ;

```

### 5.5.3 ASMEND

This file is used after all the alternative scenarios are done and reports are saved.

It will display all the results associated with each scenario and their percentage and absolute changes

from the base run. The program is as follows.

```

**** Define Alternative Runs

SET ALTRUN(RUNS)      /SCENARIO1, SCENARIO2/;

PARAMETERS

SURABS(SURITEM,RUNS)      ABSOLUTE CHANGE IN NATIONAL WELFARE
INPABS(INPITEM,RUNS)      ABSOLUTE CHANGE IN INPUT USE
NATINPABS(INPUT,RUNS)     ABSOLUTE CHANGE IN NATIONAL INPUT USE
PRICEABS(ALLI,RUNS)       ABSOLUTE CHANGE IN COMMODITY PRICE
PRODNABS(ALLI,RUNS)       ABSOLUTE CHANGE IN COMMODITY PRODUCTION
USCROPABS(CROP,RUNS)      ABSOLUTE CHANGE IN CROP HARVEST ACREAGE
REVABS(ALLI,RUNS)         ABSOLUTE CHANGE IN NATIONAL GROSS REVENUE
REGABS(REGITEM,REGIONS,RUNS) ABSOLUTE CHANGE IN REGIONAL INPUT USE AND WELFARE
ACREABS(CROP,REGIONS,RUNS) ABSOLUTE CHANGE IN REGIONAL CROP HARVEST ACRE
CROPPRABS(CROP,REGIONS,RUNS) ABSOLUTE CHANGE IN REGIONAL CROP PRODUCTION
LIVEABS(LIVESTOCK,REGIONS,RUNS) ABSOLUTE CHANGE IN REGIONAL LIVESTOCK PRODUCITON

SURPCNT(SURITEM,RUNS)     PERCENTAGE CHANGE IN NATIONAL WELFARE
INPPCNT(INPITEM,RUNS)     PERCENTAGE CHANGE IN INPUT USE
NATINPPCNT(INPUT,RUNS)    PERCENTAGE CHANGE IN NATIONAL INPUT USE
PRICEPCNT(ALLI,RUNS)      PERCENTAGE CHANGE IN COMMODITY PRICE
PRODNP CNT(ALLI,RUNS)     PERCENTAGE CHANGE IN COMMODITY PRODUCTION
USCROPPCNT(CROP,RUNS)    PERCENTAGE CHANGE IN CROP HARVEST ACREAGE
REVPCNT(ALLI,RUNS)        PERCENTAGE CHANGE IN NATIONAL GROSS REVENUE
REGPCNT(REGITEM,REGIONS,RUNS) PERCENTAGE CHANGE IN REGIONAL INPUT USE AND WELFARE
ACREPCNT(CROP,REGIONS,RUNS) PERCENTAGE CHANGE IN REGIONAL CROP HARVEST ACRE
CROPPRPCNT(CROP,REGIONS,RUNS) PERCENTAGE CHANGE IN REGIONAL CROP PRODUCTION
LIVEPCNT(LIVESTOCK,REGIONS,RUNS) PERCENTAGE CHANGE IN REGIONAL LIVESTOCK PRODUCITON
;

SURABS(SURITEM,"BASE90") = 0.00;
SURABS(SURITEM,ALTRUN)$SURCOMP(SURITEM,"BASE90")
= SURCOMP(SURITEM,ALTRUN)-SURCOMP(SURITEM,"BASE90");
SURABS(SURITEM,ALTRUN)$ (NOT SURCOMP(SURITEM,"BASE90")) = NA ;

INPABS(INPITEM,"BASE90") = 0.00;
INPABS(INPITEM,ALTRUN)$INPCOMP(INPITEM,"BASE90")
= INPCOMP(INPITEM,ALTRUN)-INPCOMP(INPITEM,"BASE90");
INPABS(INPITEM,ALTRUN)$ (NOT INPCOMP(INPITEM,"BASE90"))
and INPCOMP(INPITEM,ALTRUN) ne 0.) = NA ;

```

```

NATINPABS(INPUT,"BASE90") = 0.00;
NATINPABS(INPUT,ALTRUN)$NATINPCOMP(INPUT,"BASE90")
  = NATINPCOMP(INPUT,ALTRUN)-NATINPCOMP(INPUT,"BASE90");
NATINPABS(INPUT,ALTRUN)$ (NOT NATINPCOMP(INPUT,"BASE90")
  and NATINPCOMP(INPUT,ALTRUN) ne 0.) = NA ;

PRICEABS(ALLI,"BASE90") = 0.00;
PRICEABS(ALLI,ALTRUN)$PRICECOMP(ALLI,"BASE90")
  = PRICECOMP(ALLI,ALTRUN)-PRICECOMP(ALLI,"BASE90");
PRICEABS(ALLI,ALTRUN)$ (not PRICECOMP(ALLI,"BASE90")
  and PRICECOMP(ALLI,ALTRUN) ne 0.) = NA;

PRODNABS(ALLI,"BASE90") = 0.00;
PRODNABS(ALLI,ALTRUN)$PRODNCOMP(ALLI,"BASE90")
  = PRODNCOMP(ALLI,ALTRUN)-PRODNCOMP(ALLI,"BASE90");
PRODNABS(ALLI,ALTRUN)$ (not PRODNCOMP(ALLI,"BASE90")
  and PRODNCOMP(ALLI,ALTRUN) ne 0.) = NA;

USCROPABS(CROP,"BASE90") = 0.00;
USCROPABS(CROP,ALTRUN)$USCROPCOMP(CROP,"BASE90")
  = USCROPCOMP(CROP,ALTRUN)-
    USCROPCOMP(CROP,"BASE90");
USCROPABS(CROP,ALTRUN)$ (not USCROPCOMP(CROP,"BASE90")
  and USCROPCOMP(CROP,ALTRUN) ne 0.) = NA ;

REVABS(ALLI,"BASE90") = 0.00;
REVABS(ALLI,ALTRUN)$REVCOMP(ALLI,"BASE90")
  = REVCOMP(ALLI,ALTRUN)-REVCOMP(ALLI,"BASE90");
REVABS(ALLI,ALTRUN)$ (not REVCOMP(ALLI,"BASE90")
  and REVCOMP(ALLI,ALTRUN) ne 0.) = NA;

REGABS(REGITEM,REGIONS,"BASE90") = 0.00;
REGABS(REGITEM,REGIONS,ALTRUN)$REGCOMP(REGITEM,REGIONS,"BASE90")
  = REGCOMP(REGITEM,REGIONS,ALTRUN)-REGCOMP(REGITEM,REGIONS,"BASE90");
REGABS(REGITEM,REGIONS,ALTRUN)$ (NOT REGCOMP(REGITEM,REGIONS,"BASE90")
  and REGCOMP(REGITEM,REGIONS,ALTRUN) ne 0.) = NA ;

ACREABS(CROP,REGIONS,"BASE90") = 0.00;
ACREABS(CROP,REGIONS,ALTRUN)$ACRECOMP(CROP,REGIONS,"BASE90")
  = ACRECOMP(CROP,REGIONS,ALTRUN)-
    ACRECOMP(CROP,REGIONS,"BASE90");
ACREABS(CROP,REGIONS,ALTRUN)$ (not ACRECOMP(CROP,REGIONS,"BASE90")
  and ACRECOMP(CROP,REGIONS,ALTRUN) ne 0.) = NA ;

CROPPRABS(CROP,REGIONS,"BASE90") = 0.00;
CROPPRABS(CROP,REGIONS,ALTRUN)$CROPPRCOMP(CROP,REGIONS,"BASE90")
  = CROPPRCOMP(CROP,REGIONS,ALTRUN)-
    CROPPRCOMP(CROP,REGIONS,"BASE90");
CROPPRABS(CROP,REGIONS,ALTRUN)$ (not CROPPRCOMP(CROP,REGIONS,"BASE90")
  and CROPPRCOMP(CROP,REGIONS,ALTRUN) ne 0.) = NA ;

LIVEABS(LIVESTOCK,REGIONS,"BASE90") = 0.00;
LIVEABS(LIVESTOCK,REGIONS,ALTRUN)$LIVECOMP(LIVESTOCK,REGIONS,"BASE90")
  = LIVECOMP(LIVESTOCK,REGIONS,ALTRUN)-
    LIVECOMP(LIVESTOCK,REGIONS,"BASE90");
LIVEABS(LIVESTOCK,REGIONS,ALTRUN)$ (not LIVECOMP(LIVESTOCK,REGIONS,"BASE90")
  and LIVECOMP(LIVESTOCK,REGIONS,ALTRUN) ne 0.) = NA ;

```

##### PERCENTAGE CHANGE #####

```
SURPCNT(SURITEM,"BASE90") = 0.00;
SURPCNT(SURITEM,ALTRUN)$SURCOMP(SURITEM,"BASE90")
  = (SURCOMP(SURITEM,ALTRUN)-SURCOMP(SURITEM,"BASE90"))/
    SURCOMP(SURITEM,"BASE90")*100.0;
SURPCNT(SURITEM,ALTRUN)$ (NOT SURCOMP(SURITEM,"BASE90")) = NA ;
```

```
INPPCNT(INPITEM,"BASE90") = 0.00;
INPPCNT(INPITEM,ALTRUN)$INPCOMP(INPITEM,"BASE90")
  = (INPCOMP(INPITEM,ALTRUN)-INPCOMP(INPITEM,"BASE90"))/
    INPCOMP(INPITEM,"BASE90")*100.0;
INPPCNT(INPITEM,ALTRUN)$ (NOT INPCOMP(INPITEM,"BASE90")
  and INPCOMP(INPITEM,ALTRUN) ne 0.) = NA ;
```

```
NATINPPCNT(INPUT,"BASE90") = 0.00;
NATINPPCNT(INPUT,ALTRUN)$NATINPCOMP(INPUT,"BASE90")
  = (NATINPCOMP(INPUT,ALTRUN)-NATINPCOMP(INPUT,"BASE90"))/
    NATINPCOMP(INPUT,"BASE90")*100.0;
NATINPPCNT(INPUT,ALTRUN)$ (NOT NATINPCOMP(INPUT,"BASE90")
  and NATINPCOMP(INPUT,ALTRUN) ne 0.) = NA ;
```

```
PRICEPCNT(ALLI,"BASE90") = 0.00;
PRICEPCNT(ALLI,ALTRUN)$PRICECOMP(ALLI,"BASE90")
  = (PRICECOMP(ALLI,ALTRUN)-
    PRICECOMP(ALLI,"BASE90"))/
    PRICECOMP(ALLI,"BASE90")*100.0;
PRICEPCNT(ALLI,ALTRUN)$ (not PRICECOMP(ALLI,"BASE90")
  and PRICECOMP(ALLI,ALTRUN) ne 0.) = NA;
```

```
PRODNPCNT(ALLI,"BASE90") = 0.00;
PRODNPCNT(ALLI,ALTRUN)$PRODNCOMP(ALLI,"BASE90")
  = (PRODNCOMP(ALLI,ALTRUN)- PRODNCOMP(ALLI,"BASE90"))/
    PRODNCOMP(ALLI,"BASE90")*100.0;
PRODNPCNT(ALLI,ALTRUN)$ (not PRODNCOMP(ALLI,"BASE90")
  and PRODNCOMP(ALLI,ALTRUN) ne 0.) = NA;
```

```
USCROPPCNT(CROP,"BASE90") = 0.00;
USCROPPCNT(CROP,ALTRUN)$USCROPCOMP(CROP,"BASE90")
  = ((USCROPCOMP(CROP,ALTRUN)-
    USCROPCOMP(CROP,"BASE90"))/
    USCROPCOMP(CROP,"BASE90")*100.0);
USCROPPCNT(CROP,ALTRUN)$ (not USCROPCOMP(CROP,"BASE90")
  and USCROPCOMP(CROP,ALTRUN) ne 0.) = NA ;
```

```
REVPCNT(ALLI,"BASE90") = 0.00;
REVPCNT(ALLI,ALTRUN)$REVCOMP(ALLI,"BASE90")
  = (REVCOMP(ALLI,ALTRUN)- REVCOMP(ALLI,"BASE90"))/
    REVCOMP(ALLI,"BASE90")*100.0;
REVPCNT(ALLI,ALTRUN)$ (not REVCOMP(ALLI,"BASE90")
  and REVCOMP(ALLI,ALTRUN) ne 0.) = NA;
```

```
REGPCNT(REGITEM,REGIONS,"BASE90") = 0.00;
REGPCNT(REGITEM,REGIONS,ALTRUN)$REGCOMP(REGITEM,REGIONS,"BASE90")
  = (REGCOMP(REGITEM,REGIONS,ALTRUN)-REGCOMP(REGITEM,REGIONS,"BASE90"))/
    REGCOMP(REGITEM,REGIONS,"BASE90")*100.0;
REGPCNT(REGITEM,REGIONS,ALTRUN)$ (NOT REGCOMP(REGITEM,REGIONS,"BASE90")
```

```

and REGCOMP(REGITEM,REGIONS,ALTRUN) ne 0.) = NA ;

ACREPCNT(CROP,REGIONS,"BASE90") = 0.00;
ACREPCNT(CROP,REGIONS,ALTRUN)$ACRECOMP(CROP,REGIONS,"BASE90")
= ((ACRECOMP(CROP,REGIONS,ALTRUN)-
ACRECOMP(CROP,REGIONS,"BASE90"))/
ACRECOMP(CROP,REGIONS,"BASE90")*100.0);
ACREPCNT(CROP,REGIONS,ALTRUN)$(not ACRECOMP(CROP,REGIONS,"BASE90")
and ACRECOMP(CROP,REGIONS,ALTRUN) ne 0.) = NA ;

CROPPRPCNT(CROP,REGIONS,"BASE90") = 0.00;
CROPPRPCNT(CROP,REGIONS,ALTRUN)$CROPPRCOMP(CROP,REGIONS,"BASE90")
= ((CROPPRCOMP(CROP,REGIONS,ALTRUN)-
CROPPRCOMP(CROP,REGIONS,"BASE90"))/
CROPPRCOMP(CROP,REGIONS,"BASE90")*100.0);
CROPPRPCNT(CROP,REGIONS,ALTRUN)$(not CROPPRCOMP(CROP,REGIONS,"BASE90")
and CROPPRCOMP(CROP,REGIONS,ALTRUN) ne 0.) = NA ;

LIVEPCNT(LIVESTOCK,REGIONS,"BASE90") = 0.00;
LIVEPCNT(LIVESTOCK,REGIONS,ALTRUN)$LIVECOMP(LIVESTOCK,REGIONS,"BASE90")
= ((LIVECOMP(LIVESTOCK,REGIONS,ALTRUN)-
LIVECOMP(LIVESTOCK,REGIONS,"BASE90"))/
LIVECOMP(LIVESTOCK,REGIONS,"BASE90")*100.0);
LIVEPCNT(LIVESTOCK,REGIONS,ALTRUN)$(not LIVECOMP(LIVESTOCK,REGIONS,"BASE90")
and LIVECOMP(LIVESTOCK,REGIONS,ALTRUN) ne 0.) = NA ;

##### ROUNDING THE COMPARISON REPORT #####
SURPCNT(SURITEM,RUNS)=ROUND(SURPCNT(SURITEM,RUNS),2);
INPPCNT(INPITEM,RUNS)=ROUND(INPPCNT(INPITEM,RUNS),2);
NATINPPCNT(INPUT,RUNS)=ROUND(NATINPPCNT(INPUT,RUNS),2);
PRICEPCNT(ALLI,RUNS)=ROUND(PRICEPCNT(ALLI,RUNS),2);
PRODNPCNT(ALLI,RUNS)=ROUND(PRODNPCNT(ALLI,RUNS),2);
USCROPPCNT(CROP,RUNS)=ROUND(USCROPPCNT(CROP,RUNS),2);
REVPcnt(ALLI,RUNS)=ROUND(REVPcnt(ALLI,RUNS),2);
REGPCNT(REGITEM,REGIONS,RUNS)=ROUND(REGPCNT(REGITEM,REGIONS,RUNS),2);
ACREPCNT(CROP,REGIONS,RUNS)=ROUND(ACREPCNT(CROP,REGIONS,RUNS),2);
CROPPRPCNT(CROP,REGIONS,RUNS)=ROUND(CROPPRPCNT(CROP,REGIONS,RUNS),2);
LIVEPCNT(LIVESTOCK,REGIONS,RUNS)=ROUND(LIVEPCNT(LIVESTOCK,REGIONS,RUNS),2);

SURABS(SURITEM,RUNS)=ROUND(SURABS(SURITEM,RUNS),0);
INPABS(INPITEM,RUNS)=ROUND(INPABS(INPITEM,RUNS),0);
NATINPABS(INPUT,RUNS)=ROUND(NATINPABS(INPUT,RUNS),0);
PRICEABS(ALLI,RUNS)=ROUND(PRICEABS(ALLI,RUNS),2);
PRODNABS(ALLI,RUNS)=ROUND(PRODNABS(ALLI,RUNS),2);
USCROPABS(CROP,RUNS)=ROUND(USCROPABS(CROP,RUNS),0);
REVABS(ALLI,RUNS)=ROUND(REVABS(ALLI,RUNS),0);
REGABS(REGITEM,REGIONS,RUNS)=ROUND(REGABS(REGITEM,REGIONS,RUNS),0);
ACREABS(CROP,REGIONS,RUNS)=ROUND(ACREABS(CROP,REGIONS,RUNS),0);
CROPPRABS(CROP,REGIONS,RUNS)=ROUND(CROPPRABS(CROP,REGIONS,RUNS),0);
LIVEABS(LIVESTOCK,REGIONS,RUNS)=ROUND(LIVEABS(LIVESTOCK,REGIONS,RUNS),0);

##### DISPLAY THE COMPARISON REPORT #####
OPTION SURCOMP:0:1:1; DISPLAY SURCOMP;
OPTION SURPCNT:2:1:1; DISPLAY SURPCNT;
OPTION SURABS:0:1:1; DISPLAY SURABS;
OPTION INPCOMP:0:1:1; DISPLAY INPCOMP;
OPTION INPPCNT:2:1:1; DISPLAY INPPCNT;
OPTION INPABS:0:1:1; DISPLAY INPABS;

```

```

OPTION NATINPCOMP:0:1:1; DISPLAY NATINPCOMP;
OPTION NATINPPCNT:2:1:1; DISPLAY NATINPPCNT;
OPTION NATINPABS:0:1:1; DISPLAY NATINPABS;
OPTION PRICECOMP:2:1:1; DISPLAY PRICECOMP;
OPTION PRICEPCNT:2:1:1; DISPLAY PRICEPCNT;
OPTION PRICEABS:2:1:1; DISPLAY PRICEABS;
OPTION PRODNCOMP:2:1:1; DISPLAY PRODNCOMP;
OPTION PRODNPCNT:2:1:1; DISPLAY PRODNPCNT;
OPTION PRODNABS:2:1:1; DISPLAY PRODNABS;
OPTION USCROPCOMP:0:1:1; DISPLAY USCROPCOMP;
OPTION USCROPPCNT:2:1:1; DISPLAY USCROPPCNT;
OPTION USCROPABS:0:1:1; DISPLAY USCROPABS;
OPTION REVCOMP:0:1:1; DISPLAY REVCOMP;
OPTION REVPCNT:2:1:1; DISPLAY REVPCNT;
OPTION REVABS:0:1:1; DISPLAY REVABS;
OPTION REGCOMP:0:2:1; DISPLAY REGCOMP;
OPTION REGPCNT:2:2:1; DISPLAY REGPCNT;
OPTION REGABS:0:2:1; DISPLAY REGABS;
OPTION ACRECOMP:0:2:1; DISPLAY ACRECOMP;
OPTION ACREPCNT:2:2:1; DISPLAY ACREPCNT;
OPTION ACREABS:0:2:1; DISPLAY ACREABS;
OPTION CROPPRCOMP:0:2:1; DISPLAY CROPPRCOMP;
OPTION CROPPRPCNT:2:2:1; DISPLAY CROPPRPCNT;
OPTION CROPPRABS:0:2:1; DISPLAY CROPPRABS;
OPTION LIVECOMP:0:2:1; DISPLAY LIVECOMP;
OPTION LIVEPCNT:2:2:1; DISPLAY LIVEPCNT;
OPTION LIVEABS:0:2:1; DISPLAY LIVEABS;

```

## 5.6 HOW TO SET UP THE RUNS IN GAMS?

To run the model, we can use the -r and -s feature in GAMS to execute all the files sequentially. In doing so, it is easy to identify the problem files and debug the program. During the execution process, GAMS will produce an output file (\*.LST) for each executed input file. For example, the output file for "SETS" is called "SETS.LST". All the error statement and result displaying can be found in these \*.LST files.

To do these sequential runs, the user should also set up a batch job -- ASM.BAT. Under the DOS system, this batch job should contain the following commands:

```

COMMAND /C GAMS SETS          s=c:\gams\asm\temp\1
COMMAND /C GAMS DEMAND.DAT    r=c:\gams\asm\temp\1 s=c:\gams\asm\temp\2
COMMAND /C GAMS Fpdata.DAT    r=c:\gams\asm\temp\2 s=c:\gams\asm\temp\1
COMMAND /C GAMS PROC.DAT      r=c:\gams\asm\temp\1 s=c:\gams\asm\temp\2
COMMAND /C GAMS CROP.DAT      r=c:\gams\asm\temp\2 s=c:\gams\asm\temp\1
COMMAND /C GAMS LIVE.DAT      r=c:\gams\asm\temp\1 s=c:\gams\asm\temp\2
COMMAND /C GAMS MIX.DAT       r=c:\gams\asm\temp\2 s=c:\gams\asm\temp\1

```



public land grazing fees/reduced grazing availability, and the impacts of the 1993 summer floods in the Midwest. Utilization of ASM for these analyses required incorporation of additional resource and environmental management detail.

Prior to SCS adaption ASM, crop production enterprise budgets in ASM represented average conditions for each subregion and crop, with no additional differentiation for soil types or production technologies. Modeling soil and water policy with ASM required dividing the cropland base in each subarea into several classes based on erodibility and other characteristics (see Table 1), and specifying additional alternative management practices for each of these classes of cropland, depending on the requirements of the specific evaluation (see Table 2). Additional crop enterprise budgets were developed by applying proportional change factors from other data sources to components of the original ASM budgets. The final ASM budget set then includes a baseline budget, representing average production practices, and alternative budgets representing conservation practices. Alternatives budgets include conservation and zero tillage practices, strip cropping, contouring, and terrace conservation practices, and growing row crops in rotation with small grains or hay.

The original and the additional crop budgets were then augmented with coefficients for water and wind erosion. The erosion coefficients for the "average" budgets are average erosion by subregion, crop, and cropland class calculated from the 1987 National Resources Inventory (87NRI) (USDA, 1989). Also added to ASM were summer fallow/wheat rotation crop activities, separate supply for public and private grazing land, irrigation water supply at the 63 subarea level, and sediment transport ratios.

The two primary sources of information used in adapting ASM for soil and water conservation policy analysis were the 87NRI and the data system developed for the 2nd Resource Conservation Act (2ndRCA) Appraisal (English, et al., 1989; Robertson, et al., 1987; USDA, 1989). The 87NRI contains landuse, management, and soil attribute for approximately 350,000 survey points in the U.S. Statistical acreage expansion factors for each 87NRI survey point enable regional totals and acreage weighted averages of the survey data to be calculated. The 2ndRCA data consists of indices that can be applied to area-average-baseline production costs, yields, erosion, fertilizer use, and erosion impacts to generate enterprise budgets for specific subareas, land classes and production technologies. The 2ndRCA data is delineated by one of two regional definitions, either Major Land Resource Areas (MLRAs) (USDA, 1981) which are physiographic areas or Production Areas (PAs) (English et al., 1989) which are approximately river basins, eight cropland classes, 18 crops (with one-year crop after crop yield effects), four tillage and four conservation practices. Utilization of the 2ndRCA data with ASM required developing correspondences between the 2ndRCA and ASM regions, cropland classes, crops, and management practice definitions. In some cases the correspondence is by way of direct assignment of a dominant associated entity (region, soil, or crop) and its characteristics while in other cases it was by the use of an acreage weighted average of the characteristics of all associated entities.

### **Cropland Classes**

Cropland in each subarea is available according to a supply function. The cropland supply function for each subarea includes an area wide base rent and base total usage, and the maximum



available cropland in each of the four classes (calculated from the 87NRI). Division of cropland in each subarea into the four classes is based on provisions in the 1985 Food Security Act (85FSA) and the 1990 Food, Agricultural, Conservation and Trade Act (90FACTA) (Cohen, et al. 1990; Pollack and Lynch, 1991) (see Table 1). The maximum cropland available in each class is the sum of the 87NRI acreages of all ASM crops "other cropland not planted", with the following exceptions: in the 87NRI the following occur: there is no distinction between crops planted versus crops harvested, there are various 87NRI hay types which we added together, only total corn acreage (grain and silage) is reported, and sugar cane is not distinguished from other minor miscellaneous crops.

The four cropland classes are defined as follows. First, all cropland with USDA Land Capability Class III to VIII having a subclass of "w", i.e., a wetness limitation for cropping, was grouped and labeled "w3-8". The remaining cropland was divided into three groups according to its erodibility index (ei). The ei is either RKLS/T from the Universal Soil Loss Equation (USLE) (Wischmeier and Smith, 1978) or WEQ/T from the Wind Erosion Equation, depending on whether wind or water erosion gives the larger ei ("T", the soil loss tolerance level, is the maximum allowable erosion for sustained crop production. The three ei groups are:  $ei < 8.0$  in "loei";  $8.0 \leq ei < 20.0$  in "mdei"; and  $ei \geq 20.0$  in "svei".

The maximum cropland available in ASM according to the 87NRI is 390 million acres (see Table 1 for detail). However, the ASM calibrated to USDA 1990 statistics uses about 310 million acres of cropland. The 87NRI crop definitions differ from those in USDA statistics, i.e., "corn", for example, includes all acres thought to have been planted to corn, even if the corn was not harvested. The 87NRI

also does not include current Conservation Reserve (CRP) enrollment levels and does not distinguish various categories of land idled through government commodity programs.

Conservation Reserve Program (CRP) acres, signups 1 through 9, were subtracted from the ASM cropland base by subarea and cropland class in the model specification stage. Available CRP data did not allow a direct allocation of enrolled acres by ASM cropland classes (Osborn et al., 1992). However, analysis of the available data provided guidelines for allocation of the CRP by ASM cropland classes. The general rule used in a computer algorithm is as follows:

"About 25 percent of the CRP enrollment has went into non-highly erodible land ( $ei < 8.0$ ) and so in ASM the CRP proportion in svei and mdei could not exceed 75 percent; likewise, restrict for each subarea that only 75 percent of svei and mdei could be in the CRP. First, CRP was allocated into svei and mdei, proportional to their occurrence in total land, until either 75 percent of the CRP was allocated or 75 percent of svei and mdei devoted to CRP. Then, put the remainder of CRP into loei and w3-8 proportionate to their occurrence in total acres."

### **Regional Links Between ASM and the 2ndRCA Data**

The 87NRI data indicated that within each ASM subarea, the cropland class definitions were nearly analogous to additional subregional delineation rather than strictly corresponding to standard soil mapping characteristics. A large number of counties have a large portion of their cropland in only one cropland class: 503 counties had 95 percent or more of their cropland in one class; 1077 counties had 80 percent or more; and 2356 had 50 percent or more. This resulted in MLRA or PA parts of ASM subareas containing predominately only one of the four ASM soil classes. Therefore, in some cases data from different MLRAs or PAs were used for each ASM cropland class within a given ASM subarea. And, in some cases the dominant

MLRA and PA were used, while in other cases the acreage weighted average of all associated MLRAs and PAs were calculated.

### **2ndRCA and ASM Cropland Classes**

Where use of the 2ndRCA data required a choice of a 2ndRCA landgroup, either the following assignments were used or 87NRI acreage weighted averages of the data for several landgroups were utilized: for "w3-8" the 2ndRCA landgroup "7" (wet soils: IIw, IIIw, and IVw) was used; for "loei" the 2ndRCA landgroup "2" (IIe) was used; for "mdei" the 2ndRCA "3" (IIIe) was used; and for "svei" the 2ndRCA "4" (IVe) was used (see Table 1).

### **2ndRCA and ASM Crops**

For some ASM crops, a special assignment of 2ndRCA crop data was needed. 2ndRCA corn silage was used for ASM silage. For ASM hay, the 2ndRCA legume hay and non-legume hay coefficients were averaged. For ASM wheat, 2ndRCA spring and winter wheat coefficients were averaged. The averaging of legume and non-legume hay, and spring and winter wheat was generally not so meaningful, since in the 2ndRCA data typically only the dominant crop type was represented.

No 2ndRCA coefficients were available for rice, potatoes, sugarbeets, and sugarcane. For these crops erosion and cost coefficients were developed from the 87NRI and other SCS data for an average technology and conservation practices of strip cropping, contouring and

terracing where crop specific information was not required. No additional alternative conservation technologies were specified.

### **Crop Yield Differentials by ASM Cropland Class**

As noted in the introduction, a large number of counties have a large portion of their cropland in only one cropland class, a fact which enabled use of historical county level crop statistics to be used to factor subarea average yields into cropland class yields within subareas. County crop production statistics (NASS, 1992) were assigned to cropland classes within ASM subareas. The average of production divided by harvested acreage over the years within 1972 to 1991 for which data was reported were then calculated for each cropland class in each ASM subarea. In some cases the NASS data was deficient at the subarea/landclass level of detail. Missing subarea yields were filled in by repeating the averaging procedure for the ten USDA Farm Production Regions instead of the 63 ASM subareas, and assigning the results as needed.

### **Production Cost Differentials for Alternative Technologies**

Production cost information from the 2ndRCA data was used to develop additional budgets in ASM for alternative technologies. Since the 2ndRCA data was applicable for 1982, a production cost index (12 percent) was used to index costs to reflect 1990 in ASM.

For conservation and zero tillage, the 2ndRCA cost difference between conventional and these tillages was added to the ASM original budget. The 2ndRCA tillage cost data included two categories: variable costs excluding pesticides and pesticides. The variable costs were by

MLRA and tillage type, with no distinction for irrigation or landgroups. The 2nd RCA pesticide costs were functions consisting of six variables for each MLRA and crop: dry and irrigated intercepts, coefficients for spring conventional, fall conventional, conservation and zero tillage types, and a proportional reduction coefficient for grass (and non-legume) hay. Differentials between conventional and reduced tillage were assumed equal to zero where they were missing from the 2ndRCA data.

Terrace costs consist of annualized establishment cost and annual maintenance cost. Strip cropping and contouring involved increases (percentage) in the labor and machine time components of the enterprise budgets.

### **Water Erosion**

Water (sheet and rill) erosion for ASM production technologies was calculated differently for the original and alternative technologies. For the original technologies the average Universal Soil Loss Estimates (USLE) (Wischmeier and Smith, 1978) were calculated from the 87NRI by subarea, cropland class, and crop. There were 45 cases where ASM contained production budgets and neither the 87NRI nor the 82NRI reported the particular crop. For these cases erosion estimates from adjacent situations were used, with an adjustment for differing RKLS factors.

For the alternative technologies, the 2ndRCA erosion data was used. The 2ndRCA USLE estimates were divided by the 2ndRCA representative soil RKLS factors and by the appropriate P factors to produce C factors. These C factors were combined with 2ndRCA P

factors and used with average 87NRI RKLS by subarea and cropland class. In six cases this procedure produced C factors greater than 1.0, which were reduced to 0.95 based on a comparison to similar situations. For sveiland in Alabama, MLRA 129 had been chosen while for the other Alabama cropland classes MLRA 136 had been used. That resulted in some inconsistency so MLRA 136 was used for all of Alabama.

### **Wind Erosion**

The 2ndRCA EPIC wind erosion estimates were combined with SCS wind erosion adjustments developed for use in evaluating conservation compliance options and acres by tillage type from the 1990 Conservation Tillage Survey (Becherer, 1991) and from the 87NRI to develop wind erosion estimates. Wind erosion was not consistently reported in the 87NRI so rates for the original technologies were assumed to be the result of the applying acreage mix information to EPIC per acre estimates. For each ASM region, cropland class, and crop the corresponding EPIC estimates were averaged across the associated 2ndRCA regions, soils, and crops. Where EPIC estimates were missing an attempt was made to fill in using, first, 87NRI average by ASM subarea, crop, and cropland class, and secondly, 82NRI average by ASM subarea, crop, and cropland class, and finally either the 87NRI or 82NRI average by Land Resource Region, ASM cropland class and soil. The few remaining missing values were filled in by assuming, for example, that potatoes have the same rate as sugarbeets, etc. Finally, the Conservation Compliance study adjustments were applied as appropriate. The same

procedure was followed for alternative technologies, except that rates were not averaged across tillages or management practices.

### **Sediment Delivery Ratios**

Sediment delivery ratios were included in ASM at the subarea level. These ratios were developed by SCS (Clark, 1990) for the 2ndRCA PAs, which are essentially river basins. The ratios we used are those defined as applicable to the threshold drainage area, which is the estimated size that supports a "significant" stream, which in turn, is defined as a water body adequate for a defined beneficial use (Clark, 1990). The ratios are the proportion of water (sheet and rill) erosion that becomes sediment. For each ASM subarea we calculated a weighted average of the sediment ratio across corresponding PAs.

### **SCS Adaptation of ASM for Specific Analyses**

#### **Erosion Control Policy in Coastal Zone**

In 1990 the U.S. Congress passed the Coastal Zone Management Act Reauthorization Amendments (Godschalk, 1992; Federal Register, 1991). The U.S. Environmental Protection Agency (EPA), in accordance with the law, published "Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters" in May of 1991 (USEPA, 1991). Various agencies, including the SCS participated in writing the EPA document. EPA published final guidance in May 1993 (EPA, 1993), and states that fail to

develop implementation programs incorporating the guidance could face reductions in federal funding for state water quality programs beginning in fiscal year 1996.

The May 1991 EPA document included a measure for cropland erosion and sedimentation requiring that producers limit erosion to the lesser of the "soil loss tolerance" (T), or that occurring with conservation tillage. In the period of October 1991 to February 1992 the modeling system described in this paper was applied to analyze the "T or Conservation Tillage" erosion standard, and alternative standards of T, Conservation Tillage, two times T, and the level occurring with approved Alternative Conservation Systems (ACS) associated with Conservation Compliance planning (Chang et al., 1993). Based on this analysis and input from other studies and interest groups, the final guidance (USEPA, 1993) for erosion and sediment requires that producers either used approved SCS systems (essentially the ACS alternative) or have the ability to capture sediments and pollutant runoff from storms of intensity of up to a 10-year, 24 hour frequency.

This study targeted the 624 counties having at least 15 percent of their area in a coastal drainage basin as determined by National Oceanic and Atmospheric Administration (NOAA) and EPA (Farrow, 1991). For our modeling system this required dividing 27 states (of which 6 surround the Great Lakes) into coastal and non-coastal portions. The 1987 National Resources Inventory (NRI87) (USDA 1989) was used to determine that the coastal zone area included 16.7 million acres of field crops and hay, of which 6.0 million acres either reported erosion in excess of T or were not using conservation tillage. However, 1.3 million of the 6.0 million had an erosion index greater than 8.0 and were subject to the Farm Bill Conservation



Compliance provisions, leaving just 4.7 million acres likely to be directly impacted by the proposed erosion measures (of course, additional acreage will have indirect impacts as farmers make adjustments). Corn, soybeans, acres unplanted, hay, and wheat together accounted for 88 percent of the 6.0 million acres with high erosion and/or not using conservation tillage.

Application of these models required utilization of the system database for characterization of farmers' technological alternatives for response to the erosion policy within the coastal zone. First, the NRI87 was used to divide cropland into two groups: USDA Land Use Capability Classes III to VIII with a wetness hazard (subclass w) and otherwise. Land not in this wetness hazard group was divided into three groups according to its erosion index (ei) value (which is the inherent erodibility, either for water or wind induced erosion, depending on which is the larger, divided by the soil loss tolerance level): ei less than eight, ei between 8 and 20 and ei equal to 20 or greater. It was assumed that the farmer choices for a given type of land were limited to tillage options (NRI87 average mix, reduced and zero), conservation practices (NRI87 average mix, contouring, strip cropping, and terracing), and rotation choice (NRI87 average mix, after one year of small grain, and after three years of hay). The NRI87 average mix was considered a production technology because the available economic data represented area averages. Our method was to apply cost, yield, and erosion differentials from the 2nd RCA Appraisal study (USDA, 1989) to the average technologies to develop alternative technologies. Integration in the database of various Census of Agriculture, USDA, and NRI87 data enabled us to link the disparate spatial and temporal data elements of the coastal zone and 2nd RCA studies.

Table 3 shows selected aggregate impacts of the proposed erosion limits, as well as alternative limits. The utility of the modeling system is illustrated by the finding in Table that for the most highly erodible land the "T or Cons.Till" erosion limit achieves only 10 percent more erosion control than the "ACS" limit, but costs nearly twice as much and takes nearly twice as much coastal cropland out of production. For the coastal zone as a whole, the "T or Cons.Till" limit achieves 25 percent more erosion control than the "ACS" limit but takes three times as much coastal cropland out of production. It also reduces producer net income 2.4 percent while the ACS limit slightly increases income. These aggregate income, erosion, and cropland use impacts are consistent with the farm level impacts also estimated with the modeling and data system (Bryant et al., 1993).

### **Salmon Protection in the Pacific Northwest**

Several species of salmon in the Pacific Northwest Snake River and Salmon River drainages were declared endangered in 1991 and the U.S. Dept. of Agric. was asked to evaluate several salmon recovery measures that were either proposed or being implemented (Aillery et al., 1993). The Economic Research Service was given lead responsibility for a task force to evaluate the salmon issues, and the modeling/analysis tasks were assigned to SCS. The ASM model was then used to estimate agricultural sector impacts.

The proposed measures target both reducing the travel time for young fish to migrate from the spawning area to the ocean and the quality of the spawning areas. Two levels of reduction in public land grazing (in terms of Animal Unit Months (AUMs)) were the proposed

measures for improving the spawning area. The lower level of AUM reduction is accompanied by expenditures for damage mitigation or reduction. The largest reduction in public AUMs were generally less than five percent of baseline public AUM use for Idaho and Oregon.

Migration travel time for the young salmon could be reduced by increasing the velocity of water flow through reservoirs while maintaining reservoir storage (protecting hydro electric power) and reducing irrigation. Alternatively, reservoirs could be drawn down while irrigation capacity is maintained if electrical power production was reduced. Lower reservoir levels also limit barge transportation. These aspects of the policy were simulated by alternative levels of irrigation water reduction, electrical power increases, and transportation cost increases. In addition, with the drawdowns, some Washington irrigated acreage was assumed to revert to dryland due to reservoir levels dropping below economical pumping lifts. In developing the policy alternatives it was determined that nine northern counties of Idaho would have significantly different impacts than would southern Idaho. Various Census of Agriculture, resource inventory and SCS data sets were utilized to modify ASM to reflect the Idaho subregional delineation and the policy impositions.

Table 4 gives the farm net income and cropland use impacts of the policies for Idaho. The impacts in Washington and Oregon were less than 2.4 percent. Other results in Aillery et al, but not given in Table 4, further illustrate the usefulness of this modeling approach. Government commodity program payment savings offset essentially all other income losses in all scenarios. The \$0.03 increase in wheat price also induces changes in production of wheat and cotton in the Delta and Southern Plains States that are as large in percentage terms as the

changes occurring in the Pacific Northwest. Cotton has the largest price increase, up to 5.6 percent, while wheat, rice, and barley also have price increases of over 1.0 percent in some scenarios.

Though national (and even Washington and Oregon) impacts are small, cropped acres decrease by up to 53 percent in N. Idaho, reducing N. Idaho net farm income by up to 25 percent. S. Idaho income increases for scenarios other than where irrigation water is restricted, with the largest percentage changes being 11 percent for income and 9 percent (increase) for cropland. The relative mix of crops (crop rotations) in both parts of Idaho is unchanged though the overall scale of cropping is shifted up or down and the choice of which crops are irrigated does change.

In summary, the wheat and barley producers of the nine counties of Northern Idaho have the largest impact, essentially a 50 percent decrease in cropping leading to a 25 percent decrease in farm income. This large impact is apparently due mostly to the increased shipping costs. To the extent that the wheat and barley of this region is more specialized, and so faces more rigid demand than the national crop markets, or to the extent that increases in shipping/storage costs have been overstated, the large impacts would be mitigated.

### **Crop Subsidy Reduction and Erosion Control Alternatives**

The 1985 and 1990 Farm Bills require that farmers with highly erodible land (HEL) implement approved erosion control practices by 1995 or else lose all government payments. As 1995 approaches policy makers are interested in knowing how the level of crop commodity subsidies and the cost of the erosion control practices will affect participation in commodity

programs. In addition, there have been discussions of reductions in the levels of subsidy payments, and it is likely that the Reauthorization of the Clean Water Act which is due in the next few years will impose national erosion limits of the type now established for the Coastal Zone. For this analysis we extended the ASM coastal zone erosion control modifications to the entire national ASM, as described in Chapter 6, Section1.

Tables 5 shows that we compared 19 scenarios to a baseline. The scenarios involve combinations of three levels of erosion control for HEL and participating farmers, the same three levels of erosion applied to all cropland, and 10, 50 and 100 percent reductions in crop subsidies. The reductions are made by reducing target prices, loan rates, and diversion payments by a percentage of the baseline deficiency payments.

The evaluation accounts for the decision of some farmers (representing up to 12 million HEL acres) to drop out of the commodity programs rather than apply conservation treatment. The evaluation also accounts for market effects, i.e., as many farmers apply costly treatments, commodity supply is reduced, prices increase, and government payments and program participation decline. In all scenarios, the savings in government payments to producers are large than the losses incurred by producers and consumers (domestic and foreign) implying that national welfare would increase with lower crop subsidies. For all scenarios consumers would pay higher prices but erosion would be lower and increased farm prices offset at least two-thirds of the farmers' loss of government subsidies.



**Table 1.** Distribution of ASM Cropland Classes by USDA Land Capability Class and Subclass and Link to Landgroups Used in 2ndRCA (1000 acres).

USDA LCC Class/ Subclass	2ndRCA <sup>b</sup> land group	ASM Cropland Classes <sup>a</sup>			
		loei	mdei	svei	w3-8
1	1		2700.	339.6	
2C	5	13967.60	1500.	27.7	
2E	2	67390.50	15134	2078.3	
2S	6	14194.20	1785.	112.4	
2W	1,7 <sup>c</sup>	59720.10	1583.	164.4	
3C	5	1048.40	2246.	154.3	
3E	3	37467.60	34489	9755.0	
3S	6	7671.00	1210.	363.2	
4C	5	201.20	27.5	1.7	
4E	4	6385.60	15229	8412.0	
4S	6	3927.70	1132.	345.5	
5S	8	24.30	2.1	3.0	
6C	8	168.80	177.4	22.5	
6E	8	1546.40	3697.	4568.3	
6S	8	1705.30	1087.	548.6	
7C	8	68.40	28.5	28.6	
7E	8	268.30	303.7	1249.6	
7S	8	366.80	339.0	419.3	
8E	8	4.30	0.0	0.0	
8S	8	21.40	0.0	4.4	
3W	7			30129.4	
4W	7			6070.9	
5W	8				2704.5
6W	8				1156.9
7W	8				202.2
8W	8				51.3
<b>Totals</b>		<b>239193.10</b>	<b>82675</b>	<b>28598.4</b>	<b>40315.2</b>

SOURCE: 1987 National Source Inventory (USDA, 1989).

<sup>a</sup>The classes are first, all cropland in LCC III to VIII with subclass "w" is in "w3-8"; then, remainder is divided according to erosion index (ei) class, less than 8.0, 8.0 up to less than 20.0, and 20.0 and above.

<sup>b</sup>The 2nd Resource Conservation Act Appraisal (USDA, 1989).

<sup>c</sup>Put in "1" if the wetness problem was adequately treated.

**Table 2.** Elements Defining the Baseline and 35 Possible Alternative Management Technologies in ASM.<sup>a</sup>

Tillage	Conservation Practice	Cropping Sequence
87NRI mix	87NRI mix	87NRI mix
Conservation	Contouring	after 1 year small grain
Zero	Strip cropping <sup>b</sup>	after 3 years hay
	Terracing	

<sup>a</sup>In ASM for each subarea, each cropland class, dry or irrigated, and commodity program participant or not management practices consist of tillage, conservation practice, and cropping sequence.

The technology consisting of "87NRI mix" is assumed to be equal to the original area average technologies in ASM, particularly for purposes of erosion calculations.

<sup>b</sup>In areas where wind is the dominant erosion problem, strip cropping is defined for wind erosion control rather than for water erosion control.



**Table 3.** Impacts of Alternative Cropland Erosion Restrictions in the Coastal Zone.

Scenarios <sup>a</sup>	Coastal Zone Cropland Classes <sup>b</sup>					Non- Coastal Total
	w3-8	loei	mdei	hie	all	
---percentage change from baseline---						
Sheet and Rill Erosion:						
T or Cons. Till	8.8	-9.5	-63.6	-82.8	-28.4	NA
T	8.9	-7.0	-63.7	-83.3	-27.3	NA
2T	7.1	-4.3	-44.2	-75.0	-20.8	NA
Cons. Till	5.8	-8.1	-19.2	23.1	-4.0	NA
ACS	7.1	-5.4	-49.3	-75.3	-22.6	NA
Producer Net Income						
T or Cons. Till	-0.1	-0.7	-13.6	-27.6	-2.4	0.1
T	1.1	0.9	-9.9	-20.2	-0.5	0.1
2T	0.5	1.1	-5.6	-13.3	0.1	0.0
Cons. Till	-1.2	-1.4	-8.8	-8.7	-2.2	0.2
ACS	0.8	1.2	-5.8	-14.9	0.1	0.0
Cropland Use:						
T or Cons. Till	0.6	-1.9	-8.8	-22.3	-2.6	0.6
T	0.5	-0.2	-7.8	-15.6	-1.2	0.3
2T	0.1	0.1	-7.5	-12.1	-0.9	0.2
Cons. Till	0.1	-1.6	-7.2	-8.6	-2.0	0.5
ACS	0.1	0.1	-7.0	-11.2	-0.9	0.2

Source: Chang, et al. (1993).

<sup>a</sup>Originally EPA had proposed that soil erosion in the Coastal Zone be reduced to the lower of either T (soil loss tolerance) or that occurring with Conservation Tillage systems. The 1990 Farm Bill defines Alternative Conservation Systems (ACS) that farmers may use and remain in compliance with erosion control regulations of the commodity programs; we evaluated the implied maximum erosion allowed with the ACSs.

<sup>b</sup>Cropland in the Coastal Drainage portions of 32 state production areas were divided into first, land with USDA Land Class III-VIII where wetness was the hazard; remaining cropland was divided by erosion index (ei),  $ei < 8.0$ ,  $8.0 \leq ei < 20.0$ , and  $ei \geq 20.0$ . The Coastal Drainage total cropland acreage was about 40 million acres.

**Table 4.** Impact of Salmon Protection Strategies on Pacific Northwest Agricultural net income and cropland use<sup>a</sup>.

Scenario <sup>b</sup>	Net Income			Cropland Use
	S. Idaho	N. Idaho	S. Idaho	N. Idaho
Baseline (1000s)	112,424	14,187	3057	663
	--percentage change from baseline--			
Flow aug. 1	+*	-*	0.0	-0.1
Flow aug. 2	-3.5	-1.7	1.4	-5.5
Flow aug. 3	-10.7	-7.0	4.3	-16.2
Drawdown 4	2.4	-10.8	4.8	-26.1
Drawdown 5	2.3	-11.1	4.7	-27.3
Draw RID 6	-1.3	-11.4	4.6	-27.8
Draw RID 7	-1.2	-12.0	4.6	-28.0
Draw RID 8	-1.3	-11.4	4.6	-28.0
Draw RID 9	-9.5	-11.5	4.6	-26.7
High Cost 10	4.4	-25.1	8.7	-53.3
High Cost 11	-7.4	-25.4	9.1	-53.2

SOURCE: Aillery, et al. (1993).

<sup>a</sup>All changes for Oregon and Washington were less than 2.4 percent and Northern Idaho includes the counties of Benewah, Bonner, Boundary, Clearwater, Idaho, Kootenai, Latah, Lewis, and Nez Perce.

<sup>b</sup>Scenarios involve lower public grazing and agricultural irrigation water and higher electrical power and barge transportation costs. Flow augmentation alone impacts electrical power and Idaho irrigation water while drawdown only impacts electrical power, barge transportation, and some irrigation availability in Washington. The "Draw RID" scenarios have drawdown features along with reduced Idaho irrigation diversions while "High Cost" scenarios have larger impacts all around. Public land grazing reductions are only up to 5 percent and so have small impacts only.

**Table 5.** National Subsidy Reduction and Erosion Limit Impacts.

	Subsidy <sup>a</sup> Level	Erosion Limit <sup>b</sup>			
		None	T	ACS	2*T
-million change from Base/Non-					
Ag. Net Income	Base	15,101	390	143	54
	-10%	-560	-7	-342	-447
	-50%	-2,149	-2,002	-2,034	-2,038
	-100%	-2,139			
	U.S. ero limit		7,156	2,682	592
Gov. Ag. Payments	Base	6,583	-863	-446	-381
	-10%	1,494	-2,265	-1,730	-1,730
	-50	-6,364	-6,425	-6,449	-6,451
	-100%	-6,853			
	U.S. ero limit		-6,816	-5,230	-1,169
Partic. Acreage	Base	-10	-9	-7	-5
	-10%	-3	-8	-7	-5
	-50%	-74	-75	-72	
	-100	-151			
	U.S. ero limit		-10	-5	-1
Water Erosion	Base	976	-239	-213	-195
	-10%	-46	-245	-219	-201
	-50%	-58	-114	-131	-136
	-100%	-33			
	U.S. ero limit		-408	-314	-248
Wind Erosion	Base	804	-5	-10	-45
	-10%	-13	-2	-4	-40
	-50%	-3	-19	-19	-19
	-100%	-3			
	U.S. ero limit		-322	-322	-87

<sup>a</sup>Target price, loan rate, and diversion payments are reduced by a percentage of the baseline deficiency payment for each crop.

<sup>b</sup>Tons/acre/year for water erosion (wind limits are double these) on Highly Erodible participating acreage (and soybeans), except that the "U.S. ero limit" controls erosion on all cropland. "T" is the soil loss tolerance level and "ACS" is the limit implied by approved SCS Alternative Conservation Systems.

## 6.1 Sets

New variables and parameters are defined here to incorporate the soil and water conservation feature.

```
LANDTYPE      ALL LAND TYPES
               / W3-8LAND, SVEILAND, MDEILAND, LOEILAND, CROPLAND, PASTURE, AUMS/

LANDTWO       LAND TYPES WITHOUT CROPLAND
               / W3-8LAND, SVEILAND, MDEILAND, LOEILAND, PASTURE, AUMS/

STECH         SOIL TYPES
               / W3-8LAND, LOEILAND, MDEILAND, SVEILAND/

SSTECH        SOIL TYPE AND TOTAL
               / CROPLAND, W3-8LAND, LOEILAND, MDEILAND, SVEILAND/

TLTECH        TILLAGE TYPES
               / VENT, CONS, ZERO/

PRTECH        PRACTICE TYPES
               / CONT, STIP, TERR, NONE/

SQTECH        CROP SEQUENCE TYPES
               / HY, SG, ND /

VITEM         ITEMS IN CONSERVATION DATA
               / USLE-WATER, USLE-WIND, TLCDRY, TLCIRR, PRTIME, TLSQY, TERCST/

ROWCROP       ROW CROPS
               / CORN, SILAGE, COTTON, SORGHUM, SOYBEANS/

SMG           SMALL GRAINS
               / WHEAT, BARLEY, OATS /

LANDMAP(LANDTYPE, LANDTYPE)
             /CROPLAND. (CROPLAND, W3-8LAND, LOEILAND, MDEILAND, SVEILAND),
             PASTURE . PASTURE,
             AUMS . AUMS /

AUMSITEM -- AUMS SUPPLY PARAMETERS
             /PUBLICMAX, PUBLICPRC, PRIVATEQ,
             PRIVATEP, PRIVATEMAX, PRIVATELAS/

AUMSIT -- AUMS ITEMS FOR REPORTS
             /PUBLIC, PUBPRC, PUBVALUE, PRIVATE,
             PRIVPRC, PRIVVALUE, TOTALAUMS, TOTAUMVAL/
```

## 6.2 Demand

New soil type availability by subregion and AUMS supply information are added into the DEMAND file.

TABLE LANDAVAIL(SUBREG, LANDTYPE)						
	CROPLAND	PASTURE	W3-8LAND	SVEILAND	MDEILAND	LOEILAND
ALABAMA	3462.0	10385.2	308.3	255.0	709.4	2189.3
ARIZONA	1145.1	45413.0	6.2	410.0	384.7	344.2

TABLE LANDSUPPL(LANDTYPE, REGIONS, LANDITEM) REGIONAL LAND SUPPLY DATA			
	PRICE	QUANTITY	ELASTICITY
CROPLAND.NORTHEAST	45.63	10798.00	0.30
CROPLAND.LAKESTATES	46.60	31695.00	0.30
w3-8land. northeast	45.63	.00	.00
w3-8land. lakestates	46.60	.00	.00
sveiland. northeast	45.63	.00	.00
sveiland. lakestates	46.60	.00	.00
mdeiland. northeast	45.63	.00	.00
mdeiland. lakestates	46.60	.00	.00
loeiland. northeast	45.63	.00	.00
loeiland. lakestates	46.60	.00	.00
PASTURE. northeast	23.29	778.00	.60
PASTURE. lakestates	18.47	23300.00	.60

TABLE AUMSSUP(SUBREG, AUMSITEM) SUBREGIONAL AUMS SUPPLY					
	PUBLICMAX	PUBLICPRC	PRIVATEQ	PRIVATEP	PRIVATELAS
ALABAMA	0.4	1.81	2.0	3.92	0.60
ARIZONA	2958.4	1.81	18500.0	3.92	0.60

### 6.3 CRPLAND

This file has CRP acreage by soil type and subregion.

```

PARAMETER CRPLAND(SUBREG, STECH)
/
alabama .loeiland 113.8
alabama .mdeiland 198.4
alabama .sveiland 191.3
alabama .w3-8land 16.0
arkansas .loeiland 22.5
arkansas .mdeiland 111.3
arkansas .sveiland 57.7
arkansas .w3-8land 33.8 /;

LANDAVAIL(SUBREG, STECH) =
LANDAVAIL(SUBREG, STECH) - CRPLAND(SUBREG, STECH);

```

### 6.4 CROP

The crop budget variable "cbuddata" is renamed into "cccbuddata".

TABLE CCCBUDDATA(ALLI, SUBREG, CROP, WTECH, CTECH, TECH) CROP BUDGET DATA			
	conn	. POTATOES	. DRYLAND.BASE. 0
LABOR		24.37300	
CROPLAND		1.00000	
PROFIT		296.10001	
POTATOES		248.00000	

## 6.5. YLDDATA

This new file provides yield differentials among 4 soil type by subregion, irrigation, and crop.

```

SET YLDITEM /BASEYLD, W3-8LAND, LOEILAND, MDEILAND, SVEILAND/
WID /ALA,IRR,DRY/;

TABLE YLDADJ(SUBREG,CROP,WID,YLDITEM)
                                BASEYLD  W3-8LAND  LOEILAND  MDEILAND  SVEILAND
alabama .wheat .ala 32.326 1.005 0.997 1.005 1.002
alabama .corn .ala 53.454 0.949 1.020 0.979 0.945

*%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
* ASSIGN YIELD ADJUSTMENT (FIPSYD.DAT) DATA TO MISSING STATES, CROPS
* AND WTECH ACCORDING TO THE CROSS-EXAM WITH ASM BUDGET.
*%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

YLDADJ(subreg,"silage",WID,YLDITEM)$ (YLDADJ(subreg,"silage",WID,"baseyld")
LE 0.0 and YLDADJ(subreg,"corn",WID,"BASEYLD") GT 0.0)
= YLDADJ(subreg,"corn",WID,YLDITEM);

YLDADJ("newyork","soybeans",WID,YLDITEM)
= YLDADJ("newjersey","soybeans",WID,YLDITEM);

YLDADJ("deleware","oats",WID,YLDITEM)
= YLDADJ("newyork","oats",WID,YLDITEM);

YLDADJ("newjersey","oats",WID,YLDITEM)
= YLDADJ("newyork","oats",WID,YLDITEM);

YLDADJ("kentucky","oats",WID,YLDITEM)
= YLDADJ("northcarol","oats",WID,YLDITEM);

YLDADJ("nevada","oats",WID,YLDITEM)
= YLDADJ("wyoming","oats",WID,YLDITEM);

YLDADJ("tennessee","oats",WID,YLDITEM)
= YLDADJ("northcarol","oats",WID,YLDITEM);

YLDADJ("louisiana","HAY",WID,YLDITEM)
= YLDADJ("mississipp","HAY",WID,YLDITEM);

YLDADJ("MICHIGAN","HAY",WID,YLDITEM)
= YLDADJ("minnesota","HAY",WID,YLDITEM);

YLDADJ("NEVADA","POTATOES",WID,YLDITEM)
= YLDADJ("newmexico","POTATOES",WID,YLDITEM);

YLDADJ("HIPLAINSTX","POTATOES",WID,YLDITEM)
= YLDADJ("rolingpltx","POTATOES",WID,YLDITEM);

YLDADJ("sohio","sugarbeet",WID,YLDITEM)
= YLDADJ("nwohio","sugarbeet",WID,YLDITEM);

YLDADJ("neohio","sugarbeet",WID,YLDITEM)
= YLDADJ("nwohio","sugarbeet",WID,YLDITEM);

YLDADJ(subreg,CROP,"DRY",YLDITEM)$ (YLDADJ(subreg,CROP,"DRY", "baseyld")

```

```

LE 0.0 and YLDADJ(subreg,CROP,"ALA","BASEYLD") GT 0.0
AND CCCBUDDATA(crop,SUBREG,CROP,"DRYLAND","base","0") GT 0.0)
= YLDADJ(subreg,CROP,"ALA",YLDITEM);

YLDADJ(subreg,CROP,"IRR",YLDITEM)$ (YLDADJ(subreg,CROP,"IRR","baseyld")
LE 0.0 and YLDADJ(subreg,CROP,"ALA","BASEYLD") GT 0.0
AND CCCBUDDATA(crop,SUBREG,CROP,"IRRIG","base","0") GT 0.0)
= YLDADJ(subreg,CROP,"ALA",YLDITEM);

PARAMETER ADJUST(subreg,CROP,WTECH,STECH);

ADJUST(subreg,CROP,"DRYLAND","W3-8LAND")= YLDADJ(subreg,CROP,"DRY","W3-8LAND");
ADJUST(subreg,CROP,"DRYLAND","LOEILAND")= YLDADJ(subreg,CROP,"DRY","LOEILAND");
ADJUST(subreg,CROP,"DRYLAND","MDEILAND")= YLDADJ(subreg,CROP,"DRY","MDEILAND");
ADJUST(subreg,CROP,"DRYLAND","SVEILAND")= YLDADJ(subreg,CROP,"DRY","SVEILAND");
ADJUST(subreg,CROP,"IRRIG","W3-8LAND")= YLDADJ(subreg,CROP,"IRR","W3-8LAND");
ADJUST(subreg,CROP,"IRRIG","LOEILAND")= YLDADJ(subreg,CROP,"IRR","LOEILAND");
ADJUST(subreg,CROP,"IRRIG","MDEILAND")= YLDADJ(subreg,CROP,"IRR","MDEILAND");
ADJUST(subreg,CROP,"IRRIG","SVEILAND")= YLDADJ(subreg,CROP,"IRR","SVEILAND");

```

## 6.6 BASEUSLE

This new file provides water and wind erosion data by soil type, crop and subregion.

```

SET IDLEITEM / IDLE, FALO/
USLEITEM / WATERUSLE, WINDUSLE/ ;

TABLE BASEUSLE(subreg,STECH,CROP,USLEITEM)

                                WATERUSLE  WINDUSLE
alabama   .loeiland   .corn           5.24      0.00
alabama   .loeiland   .silage          5.24      0.00

BASEUSLE("NEVADA",STECH,"COTTON",USLEITEM) =
BASEUSLE("NCALIFORNI",STECH,"COTTON",USLEITEM) ;

BASEUSLE("NINDIANA",STECH,"BARLEY",USLEITEM) =
BASEUSLE("NINDIANA",STECH,"OATS",USLEITEM) ;

BASEUSLE("southdakot",STECH,"POTATOES",USLEITEM) =
BASEUSLE("NEBRASKA",STECH,"POTATOES",USLEITEM) ;

```

## 6.7 COVER

This new file constructs dryland cover crop budgets allowing conversion of cropland into pasture.

The major cost in these budgets are assumed to be the same as the amortized establishment plus maintenance cost of pasture land. Wind and water erosion levels are also assigned according to those occurring in pasture land.

```

PARAMETERS COVER(ALLI) COVERCROP BUDGETS

/ CROPLAND          1.00
  PASTURE           -1.00
  PROFIT            0.00
  COVERCROP         1.00  /;

PARAMETER COVERINP(ALLI, SUBREG, WTECH, CTECH);

COVERINP(ALLI, SUBREG, "DRYLAND", "BASE")
=COVER(ALLI);

SET PASTITEM /WATER-PAST, COVER-EST, COVER-MNT, WIND-PAST/;

TABLE COSTPASTUR(subreg, STECH, PASTITEM)

                WATER-PAST  COVER-EST  COVER-MNT  WIND-PAST
alabama .loeiland    0.20     12.43     8.40     0.00
alabama .mdeiland    0.66     10.09     8.40     0.00
alabama .sveiland    0.90     10.09     8.40     0.00
alabama .w3-8land    0.16     12.43     8.40     0.00
;

PARAMETER COVERBUD(ALLI, subreg, crop, WTECH, CTECH, LANDTYPE);

COVERBUD(ALLI, subreg, CROP, WTECH, "base", STECH)$
  (ccbuddata(crop, subreg, crop, wtech, "base", stech) gt 0.0
  and SUM(CRPMIXALT, MIXDATA(CROP, SUBREG, CRPMIXALT)) gt 0.0)
= COVERINP(ALLI, subreg, WTECH, "base");

COVERBUD("profit", subreg, CROP, "DRYLAND", "BASE", STECH)$
  COVERBUD("cropland", subreg, CROP, "DRYLAND", "BASE", STECH)
= COSTPASTUR(SUBREG, STECH, "COVER-EST")
+ COSTPASTUR(SUBREG, STECH, "COVER-MNT");

COVERBUD("USLE-WATER", subreg, CROP, "DRYLAND", "base", STECH)$
  COVERBUD("cropland", subreg, CROP, "DRYLAND", "base", STECH)
= COSTPASTUR(SUBREG, STECH, "WATER-PAST");

COVERBUD("USLE-WIND", subreg, CROP, "DRYLAND", "base", STECH)$
  COVERBUD("cropland", subreg, CROP, "DRYLAND", "base", STECH)
= COSTPASTUR(SUBREG, STECH, "WIND-PAST");

```

## 6.8 FALLOW

This new file contains acreages of wheat in summer fallow by soil type and subregion and corresponding wind and water erosion information for the fallow acre.

```

PARAMETER WHEAFALLOW(SUBREG, STECH) PERCENT OF WHEAT ACRES WITH SUMMER FALLOW
/
colorado .loeiland 80.6
colorado .mdeiland 69.0
colorado .sveiland 71.1
colorado .w3-8land 23.5/;

PARAMETER WATRFALLOW(SUBREG, STECH, TLTECH, PRTECH, SQTECH) WATER EROSION LEVEL
IN WHEAT FALLOW

```



```

/
idaho .loeiland .vent .none .sg 7.12
idaho .loeiland .vent .stri .sg 5.00
idaho .mdeiland .vent .stri .sg 0.10
idaho .mdeiland .vent .terr .sg 1.32
idaho .sveiland .vent .none .sg 33.23
idaho .sveiland .vent .terr .sg 2.51
idaho .w3-8land .vent .stri .sg 1.00
idaho .w3-8land .vent .terr .sg 1.00/;

```

PARAMETER WINDFALLOW(SUBREG,STECH,TLTECH,PRTECH,SQTECH) WIND EROSION LEVEL IN WHEAT FALLOW

```

/
idaho .loeiland .vent .none .sg 3.39
idaho .loeiland .vent .stri .sg 5.00
idaho .mdeiland .vent .stri .sg 5.00
idaho .mdeiland .vent .terr .sg 13.88
idaho .sveiland .vent .none .sg 2.42
idaho .sveiland .vent .stri .sg 5.00
idaho .w3-8land .vent .stri .sg 5.00
idaho .w3-8land .vent .terr .sg 15.43/;

```

## 6.9 CONSV

This new file provides yield and cost adjustment for different types of tillage, conservation practices, and sequences by crop, subregion, and soil type.

```

TABLE ALTDATA(SUBREG,STECH,CROP,TLTECH,PRTECH,SQTECH,VITEM)
                                usle-water tlcdry tlcirr
prtime  tlsxq  tercst
alabama .loeiland .corn .zero .none.hy 1.34 26.46 18.72
1.00 0.999 0.00
alabama .loeiland .corn .zero .none.nd 1.68 26.46 18.72
1.00 0.999 0.00
alabama .loeiland .cotton .zero .none.hy 1.34 334.42 334.42
1.00 1.023 0.00
alabama .loeiland .cotton .zero .none.nd 2.02 334.42 334.42
1.00 1.005 0.00
alabama .mdeiland .corn .zero .cont.hy 0.97 26.46 18.72
1.15 0.999 0.00
alabama .mdeiland .corn .zero .cont.nd 1.20 26.46 18.72
1.15 0.999 0.00
alabama .mdeiland .cotton .cons .none.nd 33.71 208.59 216.36
1.00 0.985 0.00
alabama .mdeiland .cotton .zero .cont.hy 0.96 334.42 334.42
1.15 1.023 0.00/;

```

## 6.10 ASMWIND

This new file contains the wind erosion data by crop, subregion, soil type, and cropping method.

```

PARAMETER WINDDATA(SUBREG,STECH,CROP,TLTECH,PRTECH,SQTECH)
/

```

alabama	.loeiland	.corn	.vent	.none	.nd	0.97
alabama	.loeiland	.corn	.zero	.none	.hy	0.97
alabama	.loeiland	.cotton	.cons	.none	.hy	0.97
alabama	.loeiland	.cotton	.vent	.none	.nd	0.97 / ;





```

ccbuddata("addLAND2",SUBREG,CROP,WTECH,"PARTICIP",STECH)=
  ccbuddata(STECH,SUBREG,CROP,WTECH,"PARTICIP",STECH) ;

ccbuddata(STECH,SUBREG,CROP,WTECH,"PARTICIP",STECH)
  $FARMPROD("SLIPPAGE",CROP)
  = ccbuddata(STECH,SUBREG,CROP,WTECH,"BASE",STECH)/(1.0 -
    (FARMPROD("SETASIDE",CROP)+FARMPROD("DIVERSION",CROP)
    +FARMPROD("50-92",CROP))*FPPART(SUBREG,CROP)) ;

ccbuddata("addLAND2",SUBREG,CROP,WTECH,"PARTICIP",STECH)=
  ccbuddata(STECH,SUBREG,CROP,WTECH,"PARTICIP",STECH)
  - ccbuddata("addLAND2",SUBREG,CROP,WTECH,"PARTICIP",STECH) ;

```

## 6.14 ASMFILT1

This is a new GAMS program to first add a number of adjustment data on yields and costs of alternative practices and then to perform a pre-screening for those with lower yield, higher cost, and higher erosion level before the conservation alternatives are included.

```

#####
* 1. assigning corn cost & yield adjustment data to silage, ..., etc,
*   according to the checkcon.gam result
#####

ALTDATA(subreg,STECH,"SILAGE",TLTECH,PRTECH,SQTECH,VITEM)$
  (ALTDATA(subreg,STECH,"SILAGE",TLTECH,PRTECH,SQTECH,"usle-water") le 0.
  AND ALTDATA(subreg,STECH,"CORN",TLTECH,PRTECH,SQTECH,"USLE-WATER") GT 0.)
= ALTDATA(subreg,STECH,"CORN",TLTECH,PRTECH,SQTECH,VITEM) ;

ALTDATA(subreg,STECH,"SORGHUM",TLTECH,PRTECH,SQTECH,VITEM)$
  (ALTDATA(subreg,STECH,"SORGHUM",TLTECH,PRTECH,SQTECH,"usle-water") le 0.
  AND ALTDATA(subreg,STECH,"CORN",TLTECH,PRTECH,SQTECH,"USLE-WATER") GT 0.)
= ALTDATA(subreg,STECH,"CORN",TLTECH,PRTECH,SQTECH,VITEM) ;

ALTDATA(subreg,STECH,"CORN",TLTECH,PRTECH,SQTECH,VITEM)$
  (ALTDATA(subreg,STECH,"CORN",TLTECH,PRTECH,SQTECH,"usle-water") le 0.
  AND ALTDATA(subreg,STECH,"SILAGE",TLTECH,PRTECH,SQTECH,"USLE-WATER") GT 0.)
= ALTDATA(subreg,STECH,"SILAGE",TLTECH,PRTECH,SQTECH,VITEM) ;

ALTDATA(subreg,STECH,"CORN",TLTECH,PRTECH,SQTECH,VITEM)$
  (ALTDATA(subreg,STECH,"CORN",TLTECH,PRTECH,SQTECH,"usle-water") le 0.
  AND ALTDATA(subreg,STECH,"SORGHUM",TLTECH,PRTECH,SQTECH,"USLE-WATER") GT 0.)
= ALTDATA(subreg,STECH,"SORGHUM",TLTECH,PRTECH,SQTECH,VITEM) ;

ALTDATA(subreg,STECH,"BARLEY",TLTECH,PRTECH,SQTECH,VITEM)$
  (ALTDATA(subreg,STECH,"BARLEY",TLTECH,PRTECH,SQTECH,"usle-water") le 0.
  AND ALTDATA(subreg,STECH,"OATS",TLTECH,PRTECH,SQTECH,"USLE-WATER") GT 0.)
= ALTDATA(subreg,STECH,"OATS",TLTECH,PRTECH,SQTECH,VITEM) ;

ALTDATA(subreg,STECH,"OATS",TLTECH,PRTECH,SQTECH,VITEM)$
  (ALTDATA(subreg,STECH,"OATS",TLTECH,PRTECH,SQTECH,"usle-water") le 0.
  AND ALTDATA(subreg,STECH,"BARLEY",TLTECH,PRTECH,SQTECH,"USLE-WATER") GT 0.)
= ALTDATA(subreg,STECH,"BARLEY",TLTECH,PRTECH,SQTECH,VITEM) ;

ALTDATA(subreg,STECH,"BARLEY",TLTECH,PRTECH,SQTECH,VITEM)$
  (ALTDATA(subreg,STECH,"BARLEY",TLTECH,PRTECH,SQTECH,"usle-water") le 0.
  AND ALTDATA(subreg,STECH,"WHEAT",TLTECH,PRTECH,SQTECH,"USLE-WATER") GT 0.)

```

```

= ALTDATA(subreg,STECH,"WHEAT",TLTECH,PRTECH,SQTECH,VITEM) ;

ALTDATA(subreg,STECH,"OATS",TLTECH,PRTECH,SQTECH,VITEM)$
  (ALTDATA(subreg,STECH,"OATS",TLTECH,PRTECH,SQTECH,"usle-water") le 0.
  AND ALTDATA(subreg,STECH,"WHEAT",TLTECH,PRTECH,SQTECH,"USLE-WATER") GT 0.)
= ALTDATA(subreg,STECH,"WHEAT",TLTECH,PRTECH,SQTECH,VITEM) ;

ALTDATA(subreg,STECH,"WHEAT",TLTECH,PRTECH,SQTECH,VITEM)$
  (ALTDATA(subreg,STECH,"WHEAT",TLTECH,PRTECH,SQTECH,"usle-water") le 0.
  AND ALTDATA(subreg,STECH,"OATS",TLTECH,PRTECH,SQTECH,"USLE-WATER") GT 0.)
= ALTDATA(subreg,STECH,"OATS",TLTECH,PRTECH,SQTECH,VITEM) ;

ALTDATA("KANSAS",STECH,"SOYBEANS",TLTECH,PRTECH,SQTECH,VITEM)$
  (ALTDATA("KANSAS",STECH,"SOYBEANS",TLTECH,PRTECH,SQTECH,"usle-water") le 0.
  AND ALTDATA("NEBRASKA",STECH,"SOYBEANS",TLTECH,PRTECH,SQTECH,"USLE-WATER") GT
0.)
= ALTDATA("NEBRASKA",STECH,"SOYBEANS",TLTECH,PRTECH,SQTECH,VITEM) ;

ALTDATA("SOUTHDAKOT",STECH,"SOYBEANS",TLTECH,PRTECH,SQTECH,VITEM)$
  (ALTDATA("SOUTHDAKOT",STECH,"SOYBEANS",TLTECH,PRTECH,SQTECH,"usle-water") le
0.
  AND ALTDATA("NEBRASKA",STECH,"SOYBEANS",TLTECH,PRTECH,SQTECH,"USLE-WATER") GT
0.)
= ALTDATA("NEBRASKA",STECH,"SOYBEANS",TLTECH,PRTECH,SQTECH,VITEM) ;

ALTDATA("WISCONSIN",STECH,"SOYBEANS",TLTECH,PRTECH,SQTECH,VITEM)$
  (ALTDATA("WISCONSIN",STECH,"SOYBEANS",TLTECH,PRTECH,SQTECH,"usle-water") le 0.
  AND ALTDATA("minnesota",STECH,"SOYBEANS",TLTECH,PRTECH,SQTECH,"USLE-WATER") GT
0.)
= ALTDATA("minnesota",STECH,"SOYBEANS",TLTECH,PRTECH,SQTECH,VITEM) ;

ALTDATA("NORTHDAKOT",STECH,"SOYBEANS",TLTECH,PRTECH,SQTECH,VITEM)$
  (ALTDATA("NORTHDAKOT",STECH,"SOYBEANS",TLTECH,PRTECH,SQTECH,"usle-water") le
0.
  AND ALTDATA("MINNESOTA",STECH,"SOYBEANS",TLTECH,PRTECH,SQTECH,"USLE-WATER") GT
0.)
= ALTDATA("MINNESOTA",STECH,"SOYBEANS",TLTECH,PRTECH,SQTECH,VITEM) ;

ALTDATA("CNTBLACKTX",STECH,"SOYBEANS",TLTECH,PRTECH,SQTECH,VITEM)$
  (ALTDATA("CNTBLACKTX",STECH,"SOYBEANS",TLTECH,PRTECH,SQTECH,"usle-water") le
0.
  AND ALTDATA("EASTTX",STECH,"SOYBEANS",TLTECH,PRTECH,SQTECH,"USLE-WATER") GT
0.)
= ALTDATA("EASTTX",STECH,"SOYBEANS",TLTECH,PRTECH,SQTECH,VITEM) ;

#####
* 2. eliminate undesirable conservation adjustment information on
* "stri-nd" and yield adjustment on all "nd" alternatives.
#####

ALTDATA(subreg,STECH,CROP,TLTECH,"STRI","ND",VITEM)= 0.0 ;

ALTDATA(subreg,STECH,CROP,TLTECH,PRTECH,"ND","tlsqy")$(
  (ALTDATA(subreg,STECH,CROP,TLTECH,PRTECH,"ND","tlsqy") ne 1.00)AND
  (ALTDATA(subreg,STECH,CROP,TLTECH,PRTECH,"ND","USLE-water") GT 0.0))
  = 1.00 ;

#####
* 3. filter out consv data with low yield, high cost and high erosion level
* using the flag variable -- isalt
#####

set ISALT(SUBREG,crop,wtech,stech,tltech,prtech,sqtech) ;

```







```

        ISALT(subreg,crop,wtech,stech,tltech,prtech,sqtech)
= ALTDATA(subreg,STECH,CROP,TLTECH,PRTECH,SQTECH,"usle-water")$
  cbuddata(crop,subreg,crop,wtech,ctech,stech,"VENT","NONE","ND");

```

## 6.16 ASMFILT2

This is a GAMS program to filter out budgets with higher net cost and higher erosion level after the conservation alternatives are included before the model is solved.

```

#####
**   FILTER OUT BUDGETS WITH LOWEST YIELD AND HIGHEST COST           **
**   USING THE "NETCOST" VARIABLE                                   **
#####

PARAMETERS  NETCOST(subreg,CROP,WTECH,STECH,CCTECH,TLTECH,PRTECH,SQTECH)
            TOLCST(subreg)
            ELIMIN(subreg,CROP,WTECH,CTECH,landtype,TLTECH,PRTECH,SQTECH);

#####
*   CALCULATE NETCOST = COST INCREASE - YIELD CHANGES
#####

NETCOST(subreg,CROP,"DRYLAND",STECH,CCTECH,TLTECH,PRTECH,SQTECH)$
  altdata(subreg,stech,crop,tltech,prtech,sqtech,"USLE-water")
= altdata(subreg,stech,crop,tltech,prtech,sqtech,"tercst")
+ altdata(subreg,stech,crop,tltech,prtech,sqtech,"tlcdry")
+ (1.0-1.0/altdata(subreg,stech,crop,tltech,prtech,sqtech,"prtime"))*1.2847
  * cbuddata("labor",subreg,crop,"dryland",cctech,stech,tltech,prtech,sqtech)
  * (sum(region$mapping(region,subreg),laborsup(region,"hirep")))
+ (1.0-1.0/altdata(subreg,stech,crop,tltech,prtech,sqtech,"prtime"))*0.9005
  *cbuddata("fuelandoth",subreg,crop,"dryland",cctech,stech,tltech,prtech,sqtech)
- (1.0-1.0/altdata(subreg,stech,crop,tltech,prtech,sqtech,"tlsqy"))
  *cbuddata(crop,subreg,crop,"DRYLAND",cctech,stech,tltech,prtech,sqtech)
  *pdemand(crop,"price")
;

NETCOST(subreg,CROP,"IRRIG",STECH,CCTECH,TLTECH,PRTECH,SQTECH)$
  altdata(subreg,stech,crop,tltech,prtech,sqtech,"USLE-WATER")
= altdata(subreg,stech,crop,tltech,prtech,sqtech,"tercst")
+ altdata(subreg,stech,crop,tltech,prtech,sqtech,"tlcIRR")
+ (1.0-1.0/altdata(subreg,stech,crop,tltech,prtech,sqtech,"prtime"))*1.2847
  * cbuddata("labor",subreg,crop,"IRRIG",cctech,stech,tltech,prtech,sqtech)
  * (sum(region$mapping(region,subreg),laborsup(region,"hirep")))
+ (1.0-1.0/altdata(subreg,stech,crop,tltech,prtech,sqtech,"prtime"))*0.9005
  *cbuddata("fuelandoth",subreg,crop,"IRRIG",cctech,stech,tltech,prtech,sqtech)
- (1.0-1.0/altdata(subreg,stech,crop,tltech,prtech,sqtech,"tlsqy"))
  *cbuddata(crop,subreg,crop,"IRRIG",cctech,stech,tltech,prtech,sqtech)
  *pdemand(crop,"price")
;

#####
**   CALCULATE TOLERANCE LEVEL BASED ON REGIONAL LAND VALUES
#####

TOLCST(subreg) = sum(region$mapping(region,subreg),
  LANDSUPPL("CROPLAND",REGION,"PRICE")) * 0.10 ;

#####
**   FILTER BUDGETS USING THE SIGNAL VARIABLE ELIMIN(...)
#####

```

```

ALIAS (TLTECH, TLTECHP);
ALIAS (PRTECH, PRTECHP);
ALIAS (SQTECH, SQTECHP);

ELIMIN(subreg, CROP, WTECH, CTECH, STECH, TLTECH, PRTECH, SQTECH) = 0.00;

#####
* FILTER A: ELIMINATE BUDGETS WITH HIGHER NETCOST AND USLE
#####

loop((crop, subreg, wtech, cctech, stech, tltech, prtech, sqtech)$ (
  CBUDDATA("USLE-WATER", subreg, CROP, WTECH, CCTECH, STECH, TLTECH, PRTECH, SQTECH) gt
  0.0
  and ELIMIN(subreg, CROP, WTECH, CCTECH, STECH, TLTECH, PRTECH, SQTECH) lt 1.0),
  LOOP((TLTECHP, PRTECHP, SQTECHP)$ (
    (ELIMIN(subreg, CROP, WTECH, CCTECH, STECH, TLTECHP, PRTECHP, SQTECHP) lt 1.0)
    and ((ORD(TLTECHP) NE ORD(TLTECH)) or
          (ORD(PRTECHP) NE ORD(PRTECH)) or
          (ORD(SQTECHP) NE ORD(SQTECH))
         )),

    ELIMIN(subreg, CROP, WTECH, CCTECH, STECH, TLTECHP, PRTECHP, SQTECHP)
    = 1.00$((NETCOST(subreg, CROP, WTECH, STECH, CCTECH, TLTECHP, PRTECHP, SQTECHP)
              -NETCOST(subreg, CROP, WTECH, STECH, CCTECH, TLTECH, PRTECH, SQTECH))
            GT TOLCST(subreg))
    AND
    (CBUDDATA("USLE-WATER", subreg, CROP, WTECH, CCTECH, STECH, TLTECHP, PRTECHP, SQTECHP)
    GT
    0.98*(CBUDDATA("USLE-WATER", subreg, CROP, WTECH, CCTECH, STECH, TLTECH, PRTECH, SQTECH))
    ));
  );
);

parameter IT1 NUMBER OF ELIMINATED BUDGETS DUE TO HIGHER COST AND USLE;

IT1 = sum((subreg, CROP, WTECH, CCTECH, STECH, TLTECHP, PRTECHP, SQTECHP),
  ELIMIN(subreg, CROP, WTECH, CCTECH, STECH, TLTECHP, PRTECHP, SQTECHP));

display IT1;

```

## 6.17 ASMMODEL

The model has the following major modifications:

- 1) All the crop budgets are extended to include the soil type and conservation dimensions: STECH, TLTECH, PRTECH, and SQTECH.
- 2) All the crop budgets are subject to a "NOT ELIMIN" condition due to the pre-screening process performed in ASMFILT2.
- 3) "Addland" is changed into "Addland 2" to account for the set-aside acre in the participating budgets.

- 4) "Addland 2" is subtracted from land use in each crop budget to account for the summer fallow activity. Currently, this is only valid for wheat.
- 5) All the AUMS supply and demand are modified into the subregional level. Public AUMS is a fixed-price supply similar to the family labor while private AUMS is modeled as the variable-price supply.

## **6.18 ASMREPT**

The revised report incorporates all the changes from ASMMODEL as listed above. There are also new additions of regional and subregional tables summarizing soil and water erosion levels and land usages by alternative tillage methods, practices, and crop sequences.

## **7.0 USING THE MODEL**

There are many ways that the model as described above has been used originally. Baumes developed the model which was used to study import quotas for beef and wheat. Subsequently, the model was used by Burton to study the impacts of banning various herbicides. Then, McCarl and others, under an OTA sponsored project studied the effect of making ethanol from agricultural byproducts and agricultural products. This was followed by Chattin who re-examined the ethanol situation. Subsequently, the model has been used in air pollution evaluations by McCarl and Associates involving ozone (Adams, Hamilton, and McCarl) acid rain (Adams, Calloway and McCarl) and more recently ultraviolet radiation and global climate change. Simultaneously, the model has also been used for a number of years at the USDA for policy assessment and has been used by the Western Regional Water Groups to examine water questions. The University of Minnesota has also used the model in technology assessment. Many of the uses of the model have involved expansion of model scope to

include new primary or secondary commodities (i.e. as in Tanyeri-Abur where sugarcane, sugarbeets, corn wet-milled, and other sweetener related commodities are added to study the impact of sugar import quota removal). Additional production activities have also been added and there have been modifications to the yields of current production activities. In this section we wish to present some brief notes on two issues regarding using the model. The first involves adding new commodities. The second involves preparing input for using the model in technological appraisal. Before discussing these we will introduce a short section on model flexibility.

### **7.1 Model Flexibility**

The original design of the model and the subsequent versions of the model have all attempted to maintain flexibility in the model structure making it easy to add commodities, sources of export, import sources of domestic demand, additional production activities, etc. This is facilitated through use of GAMS. Those wishing to utilize the model will find it simple to add desirable features. However, certain changes such as disaggregation of an input category into several may require extensive respecification since more than 1200 production activities are involved.

### **7.2 Adding a New Commodity**

Model use may require addition of a new commodity. Suppose, for example, one wished to use the model to study vegetable policy questions and wished to add production of onions and tomatoes, as well as tomato processing. In order to do this several modifications have to be done. First, one would need to develop production budgets for tomatoes and onions. Second, one would need to respecify the crop mixes to reflect the presence of tomatoes and onions. This would involve going through the historical USDA statistics and finding out how much of each of these were produced in each of the 63 areas and then augmenting the crop mixes with this information. Third, one would then need to develop

processing budgets for processing tomatoes into whatever products were needed to be modeled.

Fourth, one would have to develop data on domestic demand, export demand and import supply relationships for tomatoes, processed tomato products and onions.

All things considered, then adding a new commodity to the model as in the above illustration embodies consideration of new production activities, crop mixes, demand, processing, and foreign trade.

### **7.3 Using ASM on a Technological Appraisal**

Alternative production processes which make use of new technology, better management, etc. can be specified into the model. Fundamentally, the model has facilities for changing technical coefficients or resource endowments. As such, new technology or management practice may alter the technical coefficients in terms of land, labor, water use, national input use and primary product yields.

The use of the model to do a technological appraisal requires consideration of several things. First, the user has to identify what regions will be affected by the technological change. This can be specified on a now and later basis but should include all regions that would be effected. When a technology is being developed, it will be contained to a particular region only for the first few years. Therefore, one must also specify where (and when) the eventual adoption of this technology will take place.

Second, once the regions have been identified, one needs to develop budget alterations for each region. In altering the budgets, one of the following two assumptions has to be made. Namely, one has to identify whether or not this new budget is an alternative production pattern or a replacement production pattern. If, for example, one anticipates that this technology is potentially an improved way of growing corn but is not sure that it is always dominant, then it should be entered as an alternative

production budget. On the other hand, if one anticipates this technology is indeed a dominant way of growing corn (i.e., in which all of the production costs are either reduced or unchanged), then one should indicate that it is a substitute and the production budget can be replaced by the new one.

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**Table 1. Primary Commodities**

<b>Crop Commodities</b>		<b>Units</b>		<b>Livestock Commodities</b>	<b>Units</b>
1	Cotton	Bales	21	Cull Dairy Cows	Head
2	Corn	Bushel	22	Cull Dairy Calves	Head
3	Soybeans	Bushel	23	Cull Beef Cows	Cwt, LW
4	Wheat	Bushel	24	Calves	Cwt, LW
5	Sorghum	Bushel	25	Yearlings	Cwt, LW
6	Rice	Cwt	26	Non-Fed Beef	Cwt, LW
7	Barley	Bushel	27	Fed Beef	Cwt, LW
8	Oats	Bushel	28	Veal Calves	Cwt, LW
9	Silage	Ton	29	Cull Sows	Cwt, LW
10	Hay	Ton	30	Hogs	Cwt, LW
11	Sugar Cane	1000 lbs	31	Feeder Pigs	Cwt, LW
12	Sugar Beets	1000 lbs	32	Cull Ewvs	Cwt, LW
13	Potatoes	Cwt	33	Wool	Cwt
14	Fresh Tomatoes	25 lb. boxes	34	Feeder Lambs	Cwt, LW
15	Processed Tomatoes	Tons	35	Slaughter Lambs	Cwt, LW
16	Fresh Oranges	90 lb. boxes	36	Unshorn Lambs	Cwt, LW
17	Processed Oranges	Tons	37	Wool Subsidy	\$
18	Fresh Grapefruits	85 lb. boxes	38	Other Livestock	GCAU
19	Processed Grapefruits	85 lb. boxes	39	Broilers	Cwt, LW
20	Milk	Cwt	40	Turketys	Cwt, LW
			41	Eggs	Thous. dozen

Note: LW indicates live weight  
GCAU is grain consuming animal unit.

**Table 2. Secondary Commodities**

<b>Crop Commodities</b>		<b>Units</b>		<b>Livestock Commodities</b>		<b>Units</b>
1	Soybean Meal	Cwt	25	Sheep Protein Feed		Cwt
2	Soybean Oil	1000 lbs	26	Egg Protein Feed		lb
3	Raw Sugar	1000 lbs	27	Broiler Protein Feed		lb
4	Refined Sugar	1000 lbs	28	Turkey Protein Feed		lb
5	Corn Starch	1000 lbs	29	Fluid Milk		lb
6	Corn Gluten Feed	1000 lbs	30	Skim Milk		lb
7	Corn Oil	1000 lbs	31	Non Fat Dry Milk		lb
8	Ethanol	1000 lbs	32	Cream		lb
9	HFCS	1000 lbs	33	Butter		lb
10	Corn Syrup	1000 lbs	34	Ice Cream		Cwt,CW
11	Dextrose	1000 lbs	35	American Cheese		Cwt,CW
12	Confectioneries	1000 lbs	36	Other Cheese		Cwt,CW
13	Beverages	1000 lbs	37	Cottage Cheese		Cwt,CW
14	Baked Goods	1000 lbs	38	Fed Beef		Cwt,CW
15	Canned Goods	1000 lbs	39	Non Fed Beef		Cwt,CW
16	Dried Potatoes	Cwt	40	Veal		Cwt,CW
17	Chipped Potatoes	Cwt	41	Pork		Cwt,CW
18	Frozen Potatoes	Cwt	42	Chicken		Cwt,DW
19	Feed Grains	1000 lbs	43	Whole Turkeys		Cwt,DW
20	Dairy Concentrate	1000 lbs	44	Orange Juice		1000gals
21	Swine Protein Feed	1000 lbs	45	Grapefruit Juice		1000gals
22	Cattle Protein Feed	1000 lbs				
23	Range Cubes	1000 lbs				
24	Cow Protein Feed	1000 lbs				

Note: Cw mean carcass weight.

**Table 3. National Inputs**

<b>Lists of Inputs</b>	<b>Units</b>
1. Nitrogen	\$
2. Potassium	\$
3. Phosphorous	\$
4. Lime	\$
5. Other Chemicals	\$
6. Custom Operation	\$
7. Seed Costs	\$
8. Fuel and Energy Costs	\$
9. Interest on Operating Capital	\$
10. Irrigation Energy Cost	\$
11. Repair Costs	\$
12. Vet and Medical Costs	\$
13. Marketing/Storage Costs	\$
14. Insurance (Except Crop)	\$
15. Machinery	\$
16. Management	\$
17. Land Taxes	\$
18. General Overhead Costs	\$
19. Non-Cash Variable Costs	\$
20. Crop Insurance	\$
21. Land Rent	\$
22. Set-Aside (Conservation Cost)	\$
23. Processing Labor	\$
24. Other Variable Costs	\$

**Table 3. National Inputs (continued)**

<b>Lists of Inputs</b>	<b>Units</b>
25. Crop Residue	\$
26. Livestock Hauling	\$
27. Bedding	\$
28. Manure Credit	\$
29. Capital Replacement	\$
30. Operating Capital	\$
31. Other Nonland Capital	\$
32. Grower Payment	\$
33. Services	\$
34. Feed Supplements	\$
35. Commission	\$
36. Pullet Cost	\$
37. Artificial Insemination	\$
38. Dairy Herd Improvement	\$
39. Dairy Assesment	\$
40. Shearing and Tagging	\$
41. Poult Cost	\$
42. Starter Fertilizer	\$
43. Picking, Packing, Hauling	\$
44. Anhydrous	\$
45. Drip Irrigation	\$
46. Stakes	\$
47. Strings	\$
48. Baskets	\$
49. Pruning	\$

**Table 4.** Regional and Subregional Disaggregation in the Sector Model

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<u>NORTHEAST</u>	<u>CORNBELT</u>	<u>SOUTHERN PLAINS</u>	
Connecticut	North Illinois	Oklahoma	
Delaware	South Illinois	Texas Central Blacklands	Maine
	North Indiana	Texas Coast Bend	
Maryland	South Indiana	Texas East	
Massachusetts	North East Iowa	Texas Edwards Plateau	
New Hampshire	Central Iowa	Texas High Plains	
New Jersey	South Iowa	Texas Rolling Plains	
New York	West Iowa	Texas South	
Pennsylvania	Missouri	Texas Trans Pecos	
Rhode Island	North East Ohio		
Vermont	North West Ohio		
	South Ohio		
<u>MOUNTAIN</u>	<u>LAKE STATES</u>	<u>SOUTHEAST</u>	
Arizona	Michigan	Alabama	
Colorado	Minnesota	Florida	
Idaho	Wisconsin	Georgia	
Montana		South Carolina	
New Mexico			
Utah			
Wyoming			
Nevada			
<u>NORTHERN PLAINS</u>	<u>DELTA STATES</u>	<u>PACIFIC</u>	
Kansas	Arkansas	North California	
Nebraska	Louisiana	South California	
North Dakota	Mississippi	Oregon	
South Dakota		Washington	
<u>APPALACHIAN</u>			
Kentucky			
North Carolina			
Tennessee			
Virginia			
West Virginia			

(I). Crop Production

Production Activities	Primary Commodities
Cotton Cotton Irrigated	Cotton
Corn Corn Irrigated	Corn
Soybeans Soybeans Irrigated	Soybeans
Wheat Wheat Irrigated	Wheat
Sorghum Sorghum Irrigated	Sorghum
Rice Irrigated	Rice
Barley Barley Irrigated	Barley
Oats Oats Irrigated	Oats
Silage Silage Irrigated	Silage
Hay Hay Irrigated	Hay
Sugar Cane Sugar Can Irrigated	Sugar Cane
Sugar Beets Sugar Beets Irrigated	Sugar Beets



Potatoes Potatoes Irrigated	Potatoes
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(II). Livestock Production

Production Activities	Primary Commodities
Beef Cow	Cull Beef Cows, Beef Feeder Yearlings, Live Calves
Beef Feed	Slaughtered Fed Beef Cows
Cow Calf	Cull Beef Cows, Live Calves, Beef Feeder Yearlings
Dairy	Milk, Cull Dairy Cows, Live Calves
Farrow Finishing	Hogs for Slaughter, Cull Sows
Feeder Pig	Feeder Pigs, Cull Sows
Feedlot	Slaughtered Fed Beef Cows
Hog Farrow	Hogs for Slaughter, Cull Sows
Pig Finishing	Hogs for Slaughter
Other Livestock	Other Livestock (Primary Horses)
Poultry	Poultry
Sheep	Slaughtered Lambs, Feeder Lambs, Culled Ewes, Wool, Wool Incentive Payments, Unshorn Lamb Payments
Stocker	Live (Beef Feeder) Calves, Slaughtered Nonfed Beef

Table 6. Processing Activities

Processing Activities	Number of Activities
Soybean Crushing	
Soybean to soybean meal and oil	2
Livestock to Meat and Dairy Products:	
Culled Beef Cow to Nonfed Slaughter	1
Culled Dairy Cow to Nonfed Slaughter	1
Beef Feeder Yearling to Nonfed Slaughter	1
Nonfed Slaughter to Nonfed Beef	1
Live Calf to Calf Slaughter	1
Culled Dairy Calf to Calf Slaughter	1
Calf Slaughter to Veal	1
Fed Slaughter to Fed Beef	1
Hog Slaughter to Pork	1
Sow Slaughter to Pork	1
Raw Milk to Skim Milk and Cream	1
Raw Milk to Fluid Milk and Cream	1
Raw Milk to Butter and Nonfat Dry Milk	1
Cream and Skim Milk to American Cheese	1
Cream and Skim Milk to Other Cheese	1
Cream and Skim Milk to Ice Cream	1
Cream and Nonfat Dry Milk to Ice Cream	1
Cream and Skim Milk to Cottage Cheese	1
Livestock Feed Mixing:	
Feed Grain	6
Dairy Protein Feed	6
High Protein Swine Feed	1

Low Protein Swine Feed 2

Table 6. Continued

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High Protein Cattle Feed 1

Low Protein Cattle Feed 4

Potato Processing:

Potatoes to Frozen Potatoes 1

Potatoes to Potato Chips 1

Potatoes to Dehydrated Potatoes 1

Corn Wetmilling:

Corn to Corn-oil, Gluten feed, and Starch 1

Gluten Feed to Soybean Meal 1

Starch to HFCS 1

Starch to Corn Syrup 1

Starch to Dextrose 1

Starch to Ethanol 1

Sweetener Processing:

HFCS and Refined Sugar to Beverages 1

HFCS and Refined Sugar to Confectioners 1

HFCS and Refined Sugar to Canned Good 1

HFCS and Refined Sugar to Baked Good 1

Sugar Cane to Cane-Refining 1

Cane-Refining to Refined Sugar 1

Sugar Beets to Refined Sugar 1

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Figure 1. ASM for a Single Region

	Program Crop Production	Non-Program Crop Production	Livestock Production	Crop Mix	Live Mix	Land Supply	AUM Supply	Water Supply	Labor Supply	Input Purchase	Process	Demand	Export Demand	Import Supply	CCC Loan	Deficiency Payment	Other FP Payments
Objective	-	-	-			-		-	-	-	-	+	+	-	+	+	+
Crop Land	+	+1				-1											# 0
Max Crop						+											# +
Pasture Land			+			-											# 0
Max Pasture						+											# +
AUM Grazing			+				-										# 0
Max Pub AUM							+										# +
Water	+	+	+					-1									# 0
Fixed Water								+1									# +
Labor	+	+	+						-								# 0
Family Labor									+1								# +
Ag Inputs	+	+	+							-	+						# 0
Primary Products	-	-	+/-								+/-	+1	+1	-1	+1	-1	# 0
Secondary Products			+								+/-	+1	+1	-1	+1		# 0
Farm Program Products	-															+	# 0
Other Farm Programs	-																+ # 0
Crop Mix	+1	+1		-													= 0
Livestock Mix			+		-												= 0