FAPRI U.S. Crops
Model Documentation

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Introduction

The U.S. crops model is one component of the integrated modeling system developed and maintained by the Food and Agricultural Policy Research Institute (FAPRI), which operates as a joint program at Iowa State University and the University of Missouri-Columbia. The FAPRI system is used to generate medium-term projections of the agricultural economy and to conduct policy analysis. The U.S. crops model determines domestic supply, utilization, and prices for wheat, corn, sorghum, oats, barley, soybeans, soybean meal, soybean oil, rice, and cotton. Other components of the FAPRI system include world trade models for grains and oilseeds, domestic livestock models, and satellite models that determine U.S. net farm income and the government cost of agricultural programs.

The purposes of the U.S. crops model and its place in the FAPRI modeling system largely determine the characteristics of the model:

1. Because the model is used to prepare ten-year projections of both U.S. and world agricultural economies (e.g., FAPRI 1989), it must generate estimates of variables that are of interest to farmers, policymakers, and others involved with agriculture. The model must be sufficiently disaggregated to generate variables such as planted and idled acreage, ending stocks, and producer net returns. At the same time, it must be small enough to be calibrated to current market conditions quickly by a small staff.

2. Because the model is also used to conduct policy analyses, its structure must incorporate relevant policy instruments. Target prices, acreage

reduction programs, and government stocks of major commodities, for example, are some of the policy instruments significantly affecting commodity markets, producer returns, and government program costs. The model must reflect the various ways in which these and other policy variables affect outcomes of interest to the model's users.

3. As part of the FAPRI modeling system, the U.S. crops model must generate variable estimates needed for other models in the system. For example, the feed prices generated in the crops model must be used in the livestock models, and the livestock numbers and prices determined in the livestock models must be used in the crops model. Likewise, the commodity prices generated in the domestic crops model must be used in the world trade models, and the commodity exports determined in the world trade models must be used in the domestic crops model. This is achieved through an iterative process, as described in the Center for Agricultural and Rural Development (CARD 1989).

This report documents the U.S. crops model. After an introduction, the second section identifies previous modeling efforts contributing to the development of the FAPRI U.S. crops model. The third section discusses the theoretical framework for model specification. The fourth section presents the estimated equations in the model. The fifth section describes the results of a dynamic simulation of the U.S. crops model, including simulation statistics and graphs comparing key variables with their simulated values. The sixth section presents a summary of model elasticities and identifies strengths and weaknesses of the model.

Antecedents of the U.S. Crops Model

This section identifies past modeling efforts contributing to the development of the FAPRI U.S. crops model. After a brief overview of the history of agricultural commodity modeling, alternative approaches to dealing with important modeling problems will be reviewed.

Commodity modeling is not a new enterprise: the earliest models were formulated before 1920 (e.g., Moore 1919). The development of modeling over the next three decades is documented in work of Fox (1958). Under the auspices of the USDA, Meinken developed econometric models of the feed grain (1953) and wheat (1955) markets. These models are forerunners of the current commodity models.

By the 1970s, advances in economic and econometric theory and the increased availability of sophisticated computers stimulated the use of econometric commodity models for developing forecasts and conducting policy analyses. The Houck, Ryan, and Subotnik (1972) model of the market for soybeans and soybean products became the fundamental building block for commodity modeling in the Economic Research Service (ERS) of the USDA. Labys' classic book on dynamic commodity models was published in 1973.

Until the mid-1970s, iteration using impact multipliers among separate commodity models had been the primary method used to analyze cross-commodity effects. Through extensive modification of existing models, the Forecast Support Group of ERS (Teigen 1977) combined six livestock models with models of the wheat, soybean, and feed grain markets to create a simultaneous cross-commodity system. This was the precurser of the current Food and Agricultural Policy Simulation (FAPSIM) system in ERS.

As FAPRI developed its models in the early 1980s, it chose a modular system iterating among three major component models for U.S. crops, U.S. livestock, and world grain and soybean product trade. The current FAPRI U.S. crops model has roots in the USDA U.S. crops model developed by the Forecast Support Group of the ERS (Baumes and Meyers 1980). In this model, each component of supply and use appeared as an estimated equation, and prices were determined through market-clearing identities. The model consisted of three sub-models (feed grains, wheat, and soybeans); and each sub-model could be used separately, or the sub-models could be used in any combination. The model explicitly considered the effects on U.S. crop markets of both the macroeconomy and livestock and foreign markets. Exports were modeled with single equations representing net import demand from the rest of the world.

A variety of problems must be resolved by the analyst attempting to build a model of the U.S. crops sector. For example, the operation of government farm programs has greatly complicated the estimation of crop supply. The traditional approach to incorporating the influence of government program provisions on crop acreage employed "effective" support prices and payments. This approach was developed by Houck and Ryan (1972) and used by many subsequent researchers.

A step away from the traditional approach was taken by Gallagher (1978), who included price expectations in the acreage equation and noted that the influence of government price supports depended upon market prices. Lee and Helmberger (1985) highlighted the participation option in a farmer's acreage decisions by pointing out the fundamentally different natures of supply responses under farm programs and in competitive markets.

De Gorter and Paddock (1985) noted that the composite-variable approach to acreage response ignores the voluntary nature of commodity programs and imposes questionable restrictions on the effects of changing policy parameters. They pointed out that because the participation rate changes as government program parameters change, it is necessary to distinguish the supply response of participants from that of nonparticipants.

Skold and Westhoff (1988) built upon de Gorter and Paddock's approach by formulating a participation-rate equation that included a comparison of expected net returns to both participants and nonparticipants. Their model was able to analyze the effects of changes in farm program provisions on the participation rate, corn acreage planted by participants and nonparticipants, corn yields, corn production, and soybean planted acreage. The supply side of the FAPRI U.S. crops model has many unique features, but it is an outgrowth of the work done by de Gorter and Paddock, and Skold and Westhoff.

For the most part, the demand side of the FAPRI U.S. crops model is conventional, using specifications similar to those used in a variety of previous studies. Domestic use is disaggregated into several categories, with the specification of each depending on the commodity and demand component of interest. One innovation in the FAPRI model is the treatment of cotton mill demand as a derived demand from an endogenous textile market. This follows the approach taken by Yanagishima (1990).

According to a formulation originating with Gustafson (1958), there is a speculative motive for storing grain; the optimal storage level is determined by equating the difference between the current and expected price with the marginal cost of storage. Sharples and Holland (1981) showed that wheat stocks in the farmer-owned reserve (FOR) are a partial substitute for private stocks. Meyers, Jolly, and Ryan (1981) examined the factors influencing reserve participation and redemption decisions.

Schouten (1985) studied the relationships between different categories of grain stocks within a corn supply and demand model endogenizing the effects of models of government loan programs. He concluded that the reserve program stabilized prices and made total stocks more responsive to production shortfalls and that reserve stocks displaced private stocks to some degree. The FAPRI U.S. crops model incorporates the speculative motive for private stock holding and allows private and government stocks to be imperfect substitutes.

Most models of the U.S. crops sector have either exogenized U.S. exports or used a single-equation approach to estimating foreign demand for U.S. commodities. A variety of approaches have been used to estimate U.S. export demand (e.g., Bredahl, Womack, and Matthews 1978; Westhoff and Meyers 1985), but none of the single-equation approaches has been satisfactory. Because demand for U.S. exports depends upon all the factors affecting supply and demand in all other exporting and importing countries, it is very difficult to identify the set of independent variables to include in a single estimated equation.

The FAPRI U.S. crops model is operated as one component of a modeling system incorporating world trade models for grains and oilseeds. Strictly speaking, there is no need for an export equation in the domestic crops model because, in the iterated solution across the three FAPRI component models, U.S. exports must equal the difference between demand and supply by the rest of the world in the trade model. However, to facilitate the iteration process between the U.S. crops and world trade models (and to permit the independent operation of the U.S. crops model when domestic policy is being analyzed), reduced-form equations are derived that mimic the price responsiveness of the world trade model. The reduced-form equations incorporate the information contained in the FAPRI world trade models for wheat (Devadoss, Helmar, and Meyers 1990), feed grains (Helmar, Devadoss, and Meyers 1990), and the soybean sector (Meyers, Helmar, and Devadoss 1990).

Conceptual Framework

The FAPRI U.S. crops model is a simultaneous system of 171 equations that determines the supply, demand, and prices of 11 commodities. This section discusses the general structure of the model and explains the specifications of different types of equations.

The place of the U.S. crops model in the FAPRI modeling system is illustrated in Figure 1. Each of the FAPRI models is conditioned by assumptions about the general economy, agricultural policy, weather, and a number of other factors exogenous to the FAPRI models. The U.S. livestock, world trade, and U.S. crops models are linked by a limited number of key variables appearing in more than one model:

1. Corn and soybean meal prices determined in the U.S. crops model are used to represent feed costs in the U.S. livestock models.

2. Various measures of livestock numbers and prices generated by the U.S. livestock model influence feed demand in the U.S. crops model.

3. The U.S. commodity prices obtained in the U.S. crops model influence foreign commodity prices in the world trade model.

4. The U.S. commodity exports generated by the world trade models are used in the U.S. crops model.

A simultaneous solution of the FAPRI modeling system is obtained by iteration. As described below, reduced form export demand equations in the U.S. crops model facilitate the iteration process between the U.S. crops and world

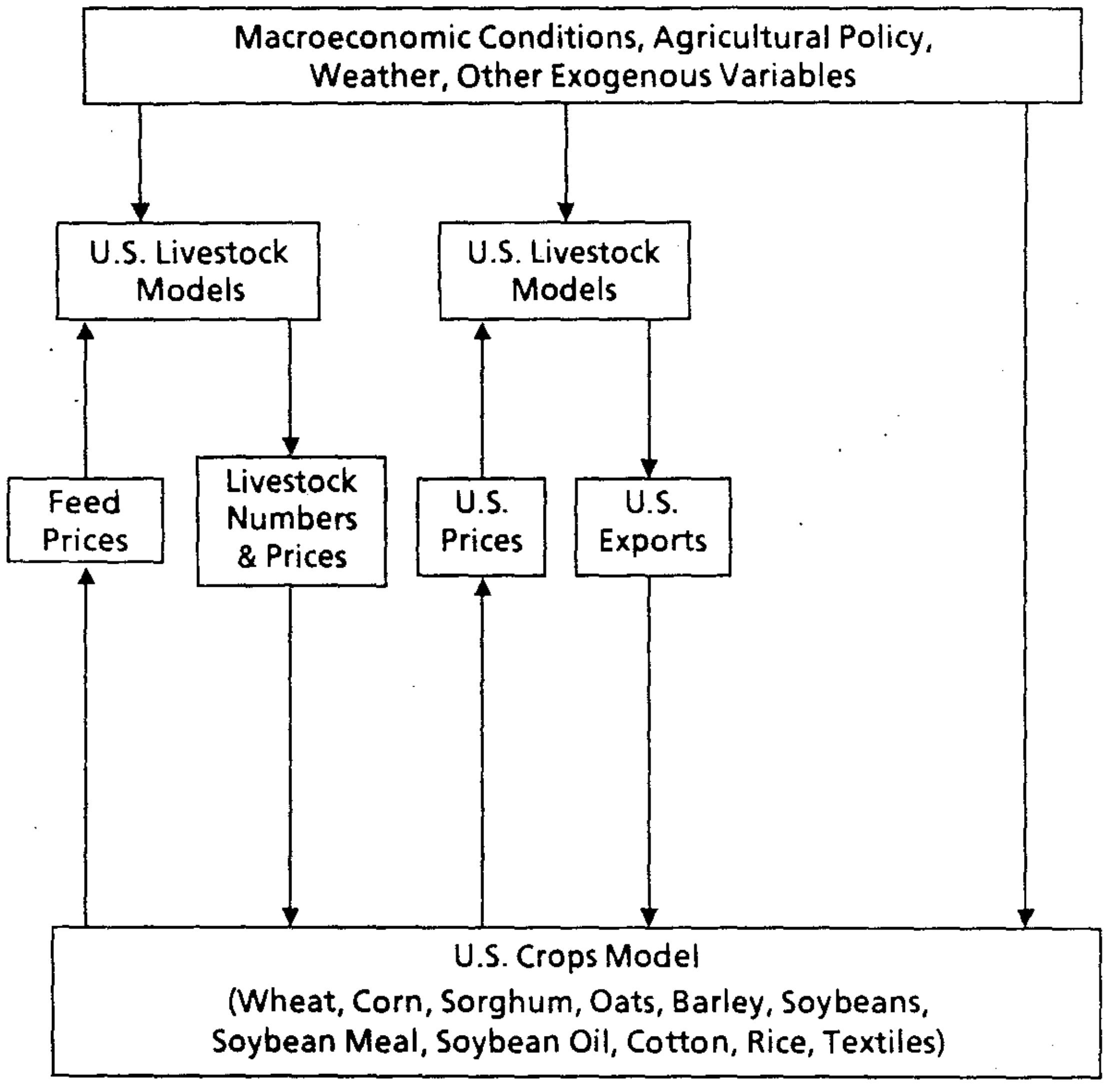


Figure 1. FAPRI model interactions

trade models. Similar reduced-form equations are also used to speed the iteration process between the U.S. crops and livestock models.

The scope of the FAPRI U.S. crops model is indicated in Table 1. Almost all major supply and demand categories for commodities are determined endogenously by the model. The only significant exception is government stocks of program commodities. In preparing projections and conducting policy analyses, the analyst adjusts government stocks to reflect market conditions, administrative stock management rules, and the likely behavior of producers and policymakers. Because imports are usually small relative to other supply and demand categories, U.S. imports of most commodities are also exogenous.

For all commodities, expected net returns to crop production are determined by formulas (identities) based on market prices, trend yields, production costs, and government program provisions. The rate of participation in government programs is estimated for all seven commodities in which farmers are required to idle part of their acreage to receive program benefits. Given the rate of participation and program provisions, the acreage planted and idled under government programs can be determined.

For wheat, corn, sorghum, and barley, the area planted by nonparticipants is estimated, and total planted area is determined by summing participant and nonparticipant areas. For other commodities, total planted area is estimated directly. The proportion of planted area that is harvested is an estimated equation for most commodities, so area harvested is determined by an identity. An exception is oats: oats area harvested is estimated directly, and planted area is estimated as a function of harvested area and other variables. Yields are estimated, so production is determined by an identity (yield times harvested

Table 1. Endogenous variables in the FAPRI U.S. crops model

	Wheat	Corn	Sorghum	Oats	Barley	Beans	Soymeal	Soyoil	Cotton	Rice	Textile
Exp. Part. Returns	I	I	I	I	I				I	I	
Exp. Nonp. Returns	I	I	I	I	I	I			I	I	
Participation Rate	E	E	E	E	E				E	E	
Part. Planted Area	I	I	I	I	I				I	I	
Program Idled Area	I	I	I	I	I				I	I	
Nonp. Planted Area	E	E	E	I	E				I	I	
Total Planted	I	I	I	E	I	E			E	E	
Harvested/ Planted	E	E	E		E	E			E		
Area Harvested	I	I	I	E	I	I			I	I	
Yield	E	E	E	E	E	E			E	E	
Production	I	I	I	I	I	I	I	I	I	I	E
Feed Use	E	E	E	E	E		E				
Food Use	E	E						E		E	
Other Uses[a]	E	E,E	E	E	E	E,E			E	E,E	E
Free Stocks	E	E	E	E	E	E			I	E	
CCC and FOR Stocks	A	A	A	A	A	A			A	A	
Total Stocks	I	I	I	I	I	I	E	E	E	I	
Exports	R	R	R		S	R	R	R	S	R	E
Imports				E							E
Prices[a]	I	I	I	I	I	I	I	I	I,E	I,E,E	I

[a]For some commodities, there is more than one endogenous variable in these categories.
A indicates the variable is adjusted based on market and policy factors.
E indicates that the variable is determined in the model by an estimated equation.
I indicates that the variable is determined by an identity.
R indicates the variable is determined by a reduced form of the trade model.
S indicates a synthetic equation.

area) for all eight crops. Soybean meal and oil production is determined by soybean crush.

On the demand side, all major categories of domestic demand are estimated. Textile market equations are included in the model because cotton mill demand is conditioned by textile production and prices. Free stocks are estimated for most commodities, and total carryover stocks are the sum of the endogenous free stocks and the exogenous (analyst-adjusted) government stocks. Total stocks equations are estimated directly for cotton, soybean meal, and soybean oil.

Exports of wheat, corn, sorghum, soybeans, soybean meal, soybean oil, and rice are determined by reduced-form equations mimicking the price responsiveness of the FAPRI world trade model. Synthetic equations determine barley and cotton exports, whereas oats exports are exogenous. Net imports of oats are estimated.

Equilibrium market prices are determined by iterating the model until supply equals demand in all markets. More than one price is used in both the cotton and rice models, and the different prices are linked by estimated price transmission equations.

Model specifications differ across commodities, but Figure 2 illustrates how the model determines the supply of a "typical" crop. Government policy parameters, lagged market prices, and production costs determine expected net returns to program participants. Expected nonparticipant net returns depend on lagged market prices and production costs. The difference between expected net returns to participants and to nonparticipants determines the rate of participation in the government program. Given the participation rate and program provisions, the area planted and idled by participants can be determined.

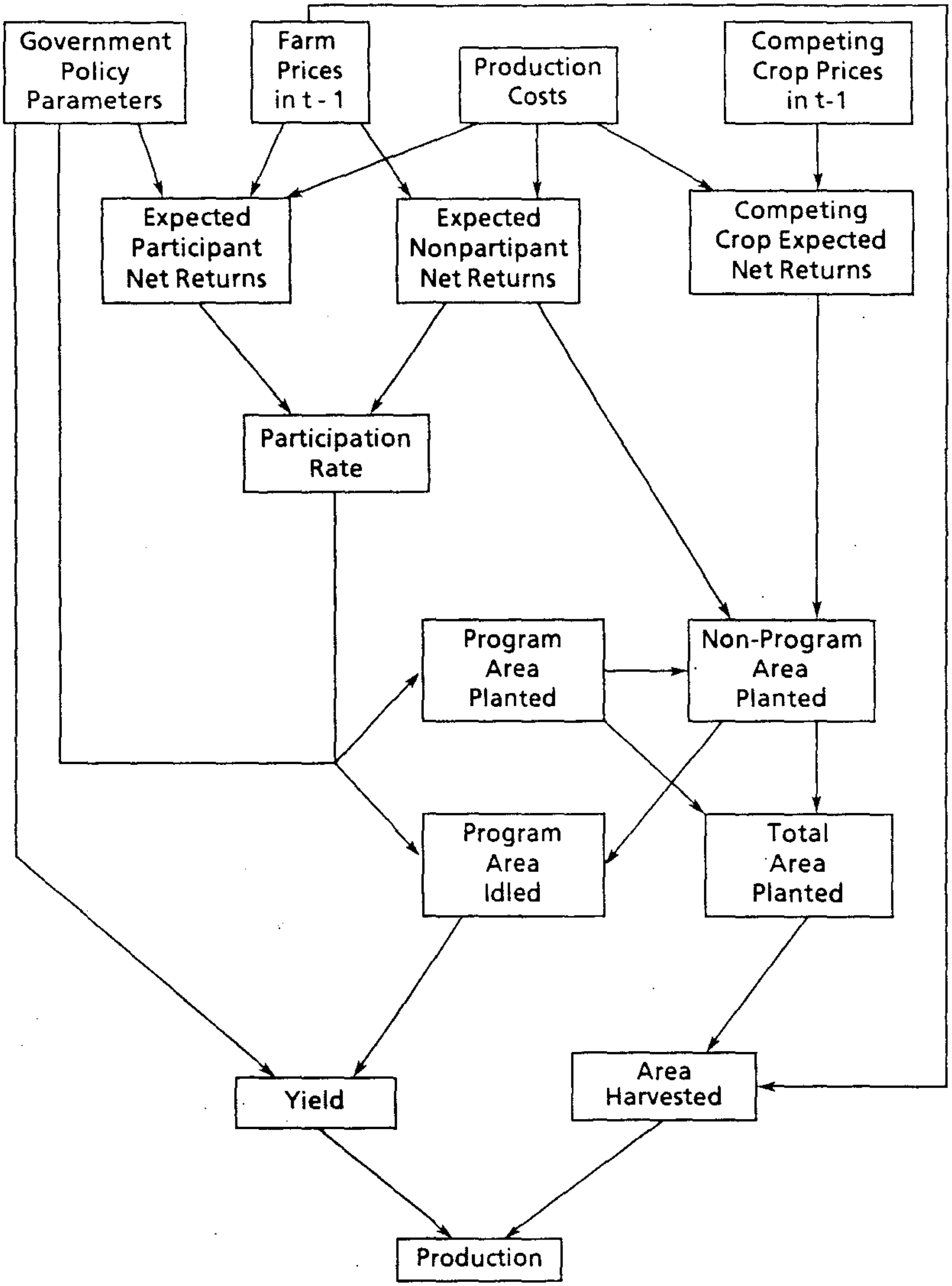


Figure 3.2. Supply determination for a typical crop

The area planted by nonparticipants is determined by a variety of factors. The area planted or idled under the program affects the amount of land available for production outside of the government program. Nonparticipant area is also affected by expected net returns for the crop in question and for one or more alternative crops. Total area planted is the sum of program and nonprogram acreage. Area harvested is primarily determined by the amount planted; but market prices and weather may also affect decisions to harvest, graze, or abandon marginal acreage.

Most of the annual changes in yields can be attributed to weather and changes in technology, both of which are exogenous to the model. Yields, however, are also determined by economic factors such as target prices. Changes in the area idled under government programs affect national average yields because idled acreage is usually less productive than acreage planted by program participants. Production is equal to the area harvested times the average yield.

The determination of both demand and equilibrium prices for a typical crop is shown in Figure 3. The market price of the commodity affects all demand categories except seed use. Livestock numbers and prices and the prices of alternative feedstuffs are additional determinants of feed use. Other crop prices affect exports, as do the hundreds of other factors explicit in the FAPRI world trade model and implicit in the intercept term of the reduced-form export equation included in the U.S. crops model. Food use is determined by commodity prices, consumer expenditures, and population. Stocks at the end of a marketing year are determined primarily by the size of the previous crop, the anticipated size of the crop about to be harvested, and the level of stocks in government programs. Seed use is linked to area planted.

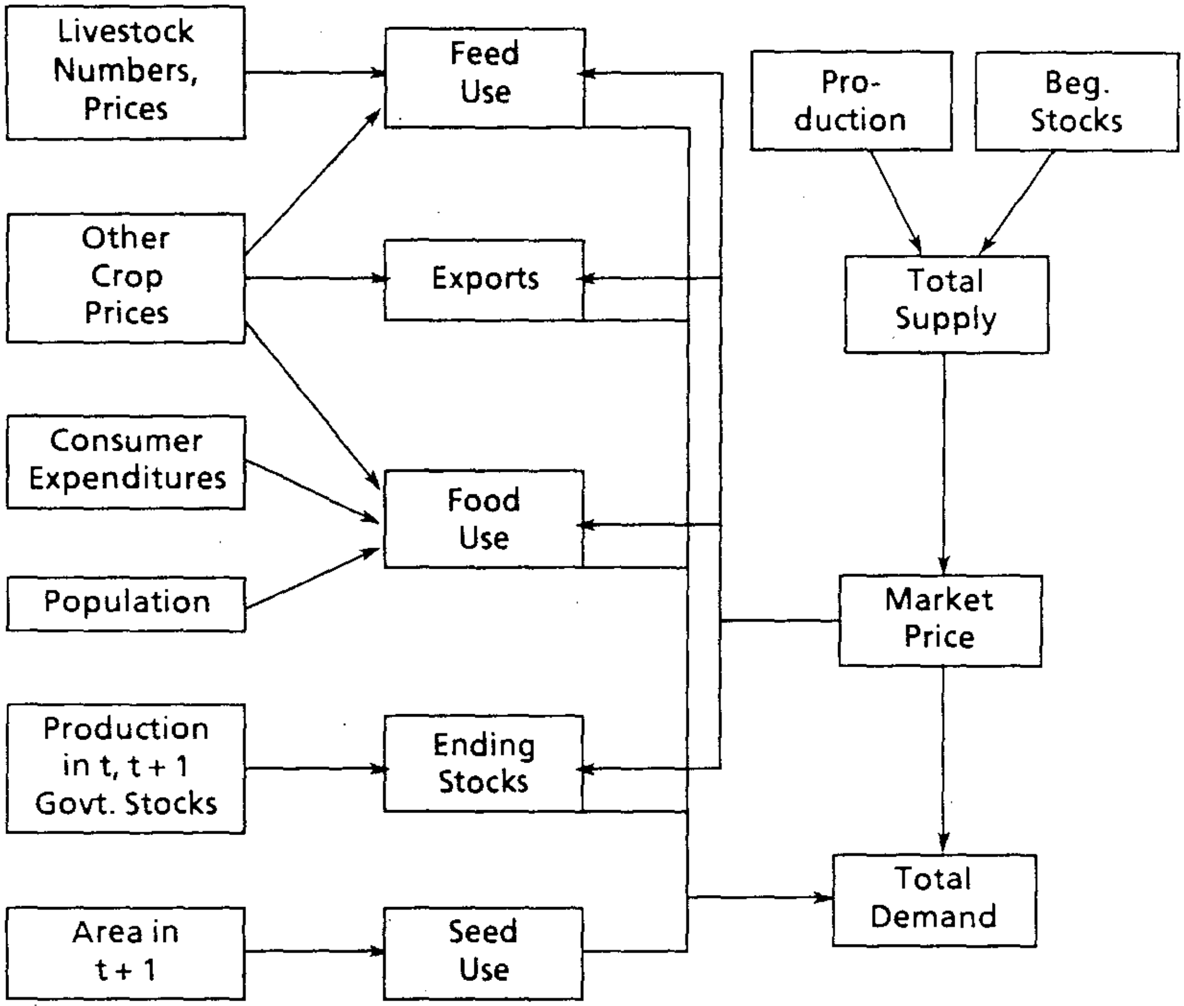


Figure 3. Demand and price determination for a typical crop

Equilibrium prices are determined by equating total supply and total demand in an iterative process. If the model were completely linear, and if there were no cross-price effects, equilibrium prices could be derived simply by computing the relationship between excess supplies and the necessary adjustment in market prices. Nonlinearities of the model, and cross-price effects, particularly, make the process more complicated; but procedures have been developed to speed convergence in a Lotus 1-2-3 spreadsheet.

The rest of this section explains the specification of different types of equations in the FAPRI U.S. crops model. The focus is on general specifications used across commodities. Idiosyncrasies of the specifications for particular commodities are discussed in the fourth section which presents the actual equations in the model.

Expected Net Returns

In the FAPRI U.S. crops model, it is assumed that farmers base their program participation and planting decisions on a comparison of expected net returns under various alternatives. This assumption makes it possible to incorporate a variety of factors that affect producer decisions, but that are omitted from models utilizing only market prices or aggregate measures such as Houck and Ryan's effective support rate.

Under existing commodity programs, farmers qualify for deficiency and diversion payments in exchange for idling a portion of their cropland. The model reflects this by expressing expected participant net returns in terms of dollars per base acre, rather than dollars per planted acre or dollars per unit of production. The components of participant net returns are shown below and elaborated on in equations 2 to 5:

Expected participant net returns = Expected deficiency payments (1)

+ Expected diversion payments + Expected market returns

- Variable costs of production.

Deficiency payments are made in several installments, but the total payment rate per unit of production is equal to the target price minus the higher of the loan rate or the season-average market price (no deficiency payments are made when market prices exceed the target price). Whereas loan rates and target prices are known before harvest, market prices are not. It is assumed that farmers use the market price of the previous year as the expected market price.

Payments are made on a level of production determined by land-idling requirements and program yields:

Expected deficiency payments = {max[Target price - max (2)

(Loan rate, Lagged market price)],0} * (1 - Model ARP rate

- Model PLD rate) * Program yield.

The model Acreage Reduction Program (ARP) and Paid Land Diversion (PLD) program rates are constructed so that a number of identities important to the model hold exactly, as will be described. The model ARP rate is, in essence, the proportion of base acreage all program participants are required to idle to qualify for deficiency payments. The model ARP rate is usually the same (or nearly the same) as the ARP rate announced each year.

The model PLD rate represents the average proportion of base acreage idled by program participants qualifying for diversion payments. For example, suppose there is an optional 10-percent PLD program, and suppose that 50 percent of all program participants (those complying with ARP program requirements) also choose to participate in the paid land diversion. The model PLD rate would be equal to 50 percent of 10 percent, or 5 percent. It is possible that no individual producer may be idling exactly 5 percent of his or her cropland, but 5 percent is the average (mean) amount idled by program participants.

The expected diversion payment is equal to the payment rate multiplied by the amount of idled production qualifying for payments. In years such as 1983, in which diversion payments were made in Payment-in-Kind certificates, a cash value is ascribed to the certificates:

Expected diversion payments = Diversion payment rate (3)
* Model PLD rate * Program yield.

Participants also have the option of placing their crop under loan, which effectively guarantees their receiving at least the loan rate as their market return. But farmers earn market returns on actual yields as well as on program yields used to determine deficiency and diversion payments. It is assumed that, at planting time, producers expect actual yields to equal yields projected by simple trend-yield equations:

Expected market returns = max(Lagged market price, Loan rate) (4)
* (1 - Model ARP rate - Model PLD rate)
* Trend yield.

For planted area, variable production costs are defined as the variable expenses reported by the USDA plus an allowance for family labor and interest on current expenses. Variable production costs are treated exogenously in the model. In reality, of course, production costs are determined simultaneously with planting and other production decisions. For idled acreage, it is assumed that the cost of maintaining cover, controlling weeds, etc., is 20 dollars per acre:

Variable costs of production = Variable costs/acre (5)

* (1 - Model ARP rate - Model PLD rate) + 20

* (Model ARP rate + Model PLD rate).

Expected nonparticipant net returns are simply equal to expected market returns minus variable production costs. Nonparticipants cannot place their crop under loan, so they are not assured of obtaining the loan rate on their sales. It has been argued that the loan rate serves as an effective floor on the market price, as market prices below the loan rate result in commodities being placed under loan until market prices rise to the loan rate. This is an arguable position over much of the estimation period, but the advent of generic certificates in the mid-1980s means that the loan rate is no longer a floor on market prices. For this reason, the lagged market price serves as an approximation of the expected price received by nonparticipants:

Expected nonparticipant net returns = Lagged market price (6)

* Trend yield - Variable costs/acre.

Participation Rate

In general, farmers can be expected to participate in government commodity programs if they expect to receive a net economic benefit. In terms of the model, this implies that farmers will participate if expected participant net returns are greater than expected nonparticipant net returns. If all farmers shared the same expectations and no other factors were involved in the participation decision, the participation rate in any given year should either be zero or 100 percent.

There are, of course, a variety of reasons why some farmers choose to participate in government programs and others do not. Yields and production costs vary among producers, thus affecting the relative returns of participation and nonparticipation. Producers may differ in both the mean and the distribution of their price expectations. Some may be more averse to risk than others. Some farmers may have an overly restrictive program base, or their program yields may be far below their actual yields. Noneconomic factors such as an ideological or moral opposition to receiving government subsidies may also come into play.

At any particular level of calculated participant and nonparticipant net returns, the net benefit of participating in the program will be greater for some than for others. The calculated values of expected participant and nonparticipant net returns are intended to approximate mean values of the actual distributions. An increase in expected participant net returns would, all else equal, increase the number of producers perceiving a net economic benefit from participation and could thus be expected to increase the participation rate. An increase in expected nonparticipant net returns would be expected to have the opposite effect.

In the model, the participation rate is modeled as a function of the difference between expected participant and nonparticipant net returns. Years during which no land-idling program was in effect are removed from the estimation by means of dummy variables, because it makes no sense to speak of program participation in those years:

Model participation rate = f(Real expected participant net returns - Real expected nonparticipant net returns, Dummy variables for nonprogram years). (7)

The model participation rate is defined as the sum of the area planted or idled in conformance with program provisions divided by the total base area. In general, this is quite close to the participation rate announced each year by the USDA. It differs slightly, however, because of underplanting (participants planting less than their permitted acreage) and a variety of other factors. Throughout the model, net returns and prices are deflated to remove the effects of inflation; the wholesale price index adjusted for the appropriate crop year is the deflator used.

Acreage

The model participation, ARP, and PLD rates are defined so that the area planted and idled by participants can be determined by identities:

Area planted by program participants = Model acreage * (1 - Model ARP rate - Model PLD rate) - (0-92/50-92 area idled). (8)

Area idled under the ARP and PLD programs = Model participation rate * Base acreage * (Model ARP rate + Model PLD rate). (9)

The specification implies that once a farmer decides to participate in the government program, the land use decision is automatic--the farmer will plant every acre permitted, and idle what is required. Strictly speaking, this is not true. Some farmers choose to plant less than their permitted acreage. Before the 0-92 and 50-92 programs were introduced, there were strong disincentives for underplanting. Any time a farmer planted less than the permitted acreage, his or her future base acreage eligible for program payments would be reduced. With the 0-92 and 50-92 programs, however, farmers can choose to underplant without any future base penalty and still receive 92 percent of their deficiency payments. The 0-92 and 50-92 programs were introduced under the 1985 Food Security Act, and at present they are treated exogenously in the model.

Another limitation of the specification is that it treats both base acreage and the model PLD rate as exogenous variables when both are, at least in some years, endogenous. Paid land diversion programs are often optional, so the model PLD rate thus depends on the percentage of ARP program participants choosing to participate in the PLD program. Until the 1985 Food Security Act, farmers easily increased their base acreage by not participating for one or more years and by planting more than their program base. Because the program base for each farm depended upon historic land use, this would increase their base acreage eligible for program benefits. Under the 1985 Food Security Act, it is much more difficult for producers to expand their base acreage; and thus it is more appropriate to treat base acreage as an exogenous variable.

In spite of these shortcomings, the program participation rate and program provisions are the main determinants of the area planted or idled by program participants. The model uses the information about participant area planted or idled to determine both the area planted by nonparticipants and the total area planted. For wheat, corn, sorghum, and barley, nonparticipant acreage is estimated and total planted acreage is determined by an identity. For cotton, rice, and oats, total acreage planted is estimated and nonparticipant acreage is determined by an identity. Soybean acreage is also estimated directly.

An acre planted or idled under government programs cannot be planted by nonparticipants, so it is important that the model reflect the substitution between participant and nonparticipant area planted. There are several reasons, however, why the substitution may not be acre for acre. Nonparticipants may choose to plant other crops or to leave idle land that can be used to grow the program crop profitably at the target price but cannot be used to grow the crop profitably at the market price. Land idled under government programs is typically marginal land, and some of it would not be planted even if ARP and PLD programs did not exist. For these reasons, one would expect that a one-acre increase in program planted or idled acreage would result in less than a one-acre decrease in nonprogram planted acreage.

In addition to program planted and idled acreage, the estimated nonparticipant acreage equations include terms representing expected net returns for nonparticipants planting the crop in question and other alternative crops:

Nonparticipant acreage planted (wheat, corn, sorghum, barley) (10)
= f(Participant planted area, Program idled area,
Real expected nonparticipant net returns, Real expected
nonparticipant net returns for competing crops).

Program idled area includes not only ARP and PLD acreage, but also land idled under the 0-92 program and the Conservation Reserve Program (CRP). The coefficients on the participant planted and idled acreage variables are expected to be between zero and negative one. Expected nonparticipant net returns is anticipated to be positively related to nonparticipant acreage, whereas competing crop net returns are expected to have a negative effect.

For the crops for which a nonparticipant acreage equation is estimated, total planted acreage is determined by the following identity:

Total planted acreage (wheat, corn, sorghum, barley) (11)
= Program planted acreage + Nonprogram planted acreage.

The cotton, rice, and oats programs assumed their current form in the 1980s. In the model, participation rates are defined only for the 1980s; and, by definition, nonparticipant acreage equaled total acreage in earlier years. For pragmatic reasons, then, it makes sense to estimate total planted acreage for these crops rather than nonparticipant acreage.

It is possible to incorporate in a total-acreage planted equation much of the same information used in a nonparticipant acreage equation. Idled area is included as an explanatory variable, and the estimated coefficient has the same interpretation as before. Likewise, nonparticipant net returns for the crop in question and for competing crops are included in the equation.

An additional concern is the need to incorporate the incentive effect of participant net returns, which is reflected in the nonparticipant acreage equations by the inclusion of the program planted acreage term. If included in a total acreage equation, the expected coefficient would have a value between zero and one, but attempts to estimate such an equation yield implausible coefficients for several different variables. Another approach would be to include expected participant net returns as a separate term. Given the nature of the data, however, this variable is closely correlated with expected nonparticipant net returns, and estimation results would thus be unsatisfactory.

The approach selected is to aggregate participant and nonparticipant net returns into a single term, using weights based on the participation rate:

Total planted acreage (cotton, rice) = f(Aggregated real expected participant and nonparticipant net returns, Program idled area, Real expected net returns for competing crops). (12)

Nonprogram planted acreage (cotton, rice, oats) = Total planted acreage - program planted acreage. (13)

Although the expected sign of the coefficient on the aggregated net return variable is positive, the expected signs of the other coefficients are negative.

Because much of the land planted to oats is planted as a cover crop on idled corn acreage and is never harvested for grain, total planted acreage for oats is derived as a function of oats area harvested and corn idled acreage. Oats harvested acreage is estimated using a specification similar to that used to determine cotton- and rice-planted acreage. Details of the oats model specification can be found in the fourth section of this report.

For soybeans, of course, there is no target price and no annual land-idling program, so there is no distinction between participant and nonparticipant acreage. Soybean area is strongly affected, however, by provisions of government programs affecting corn and other competing crops. The Conservation Reserve Program also idles land that might otherwise be planted to soybeans.

The soybean acreage equation treats corn as the relevant competing crop. Corn program acreage is included in the equation because acreage enrolled in the corn program is unavailable for soybean production. In years during which there is no government corn program, total corn acreage is included as a proxy for this substitution effect:

Total planted acreage (Soybeans) = f(Real expected soybean net returns, Real expected corn nonparticipant net returns, Corn program planted area, Corn program idled area, Total corn area planted when no corn program is in effect, Soybean CRP acreage). (14)

The coefficient on soybean net returns is expected to be positive, but the other coeffcients in the equation are all expected to be negative. The coefficients on the corn acreage terms are all expected to be between zero and negative one. The model restricts the coefficient of soybean CRP acreage to negative one.

For crops like wheat, corn, and sorghum, a significant amount of planted area is either hayed, grazed, made into silage, or abandoned. Especially for these commodities, economic variables may have an effect on the proportion of planted area harvested for grain. Higher market prices can encourage farmers to harvest more of their planted acreage. Increases in idled acreage mean that much marginal land that might otherwise be planted but not harvested is never planted in the first place. Weather problems, of course, can force the abandonment of planted acreage:

Proportion of planted area harvested = (15)

f(Real lagged market price, Program idled area,

Weather).

The same explanatory variables are not used in the equations for all commodities. No economic variables appear in the barley equation, and the rice proportion harvested is so stable that there is little reason to estimate it.

Except for oats, area harvested is determined by the following identity:

Harvested area = Total planted area * Proportion of (16)

planted area harvested.

Yields and Production

Economic theory suggests that crop yields per acre should depend on output and input prices and existing technology. It is very difficult to estimate yield equations, however, because most of the annual variation in observed yields is due to weather. In the model, the target price is used as the yield-inducing price, and the wholesale price index is used as a proxy for input prices. Simple linear or logarithmic trends are used to represent changes in technology. The same weather variable used in the area-harvested equations (described further in the fourth section) is used in the yield equations.

Also included in some of the equations are variables representing either area planted or area idled under government programs. An increase in planted area generally means that more marginal land is being utilized, so national average yields are likely to fall. Likewise, an increase in idled area means more marginal land is being removed from production, so national average yields are likely to increase:

Yield per harvested acre = f(Trend, Real target price, Program area idled or Total planted area, Weather). (17)

The coefficient on the trend variable is expected to be positive, as is the coefficient on program area idled. The coefficient on total planted area is expected to be negative.

If the target price is indeed the supply-inducing price, the expected sign of the coefficient on the real target price is positive. If, however, actual yields exceed program yields and program yields are frozen (as has been the case since 1985), then the marginal unit of production is produced at the market price, and the target price should have no effect on yield. Because program yields have always been adjusted by program administrators to reflect historical yields, many producers may not expect the current freeze to be permanent; and thus it may be appropriate to continue using the target price as a determinant of yields.

Total crop production is determined by the following identity:

Production = Area harvested * Yield per harvested acre. (18)

Feed Demand

The FAPRI U.S. crops model disaggregates domestic demand for most commodities into various categories. For feed grains and soybean meal, the largest single utilization category is use for feed. Biological requirements mean that total feed demand is closely linked to animal numbers. Both livestock and feed prices affect feeding rates per animal. Livestock producers substitute among different feedstuffs based on relative prices.

Different specifications are used for the various feed-use equations. Barley and oats feed demand, for example, are modeled simply as functions of feed prices, whereas the feed demand for corn incorporates a variety of other factors. In general terms, feed demand is modeled as follows:

Feed demand = f(Livestock numbers, Real price of the commodity, Real price [or quantities fed] of competing feedstuffs, Real price of livestock, Trend representing changing feeding technologies). (19)

Increases in livestock numbers are expected to increase feed demand. The expected sign of the coefficient on the real price of the commodity is negative, but the expected sign of the coefficients on competing crop prices and the real price of livestock are positive. Changes in the nature of livestock feeding are likely to affect livestock feeding rates in ways not easily explained by relative feed and livestock prices.

For corn, wheat, and soybean meal, livestock and poultry numbers are represented by composite variables (grain-consuming animal units for corn and wheat, high-protein animal units for soybean meal) that weight each type of animal by the amount of feed they typically consume. Cattle on feed numbers are used as a determinant of feed demand for both wheat and sorghum. For corn and soybean meal, feed demand is estimated on a per-animal unit basis although no such restriction is placed on the other feeds. Details of equation specifications can be found in the fourth section.

Soybean Crush

The vast majority of soybeans used domestically are crushed to produce meal and oil. The output of the domestic crushing industry is expected to be related to levels of profitability. A principal determinant of crusher profits is the difference in value between raw soybeans and soybean products, which is termed the crushing margin. Because plant capacities limit the amount that can be crushed in any given year, and because it takes time to build new plants, domestic crush is not likely to respond completely in the first year to a change in the crushing margin.

These features of the crushing industry are represented in the model, which makes domestic crush a function of the crushing margin and a lagged dependent variable. A trend variable is also included in the equation to help account for the phenomenal growth of the crushing industry in the 1960s and 1970s. The crushing margin is multiplied by the trend level of crush, so that the elasticity of crush demand with respect to the crushing margin does not fall as crush increases:

Crush = f(Lagged crush, Real crushing margin * trend crush, Trend). (20)

All of the coefficients in the equation are expected to have a positive sign. Soybean meal and soybean oil production are determined by crush and technical milling rates:

Soybean meal, oil production = Crush * Milling rate. (21)

Other Domestic Uses

Except for soybean meal and cotton, a significant portion of each of the commodities is used for food and industrial purposes. For wheat and soybean oil, these uses constitute the majority of domestic consumption. With the exception of sorghum (when nonfeed demand is negligible), food demand equations are estimated in per-capita terms:

Food demand = Per-capita food demand * Population. (22)

Per-capita food demand = f(Real price of the commodity, Real consumer expenditures per capita, Real prices [or quantities consumed] of other foods). (23)

The real price of the commodity is expected to be negatively related to food demand. The signs of the other two variables are ambiguous, because expenditure elasticities can be positive or negative, and other foods can be substitutes or complements.

Seed demand is modeled separately for wheat and corn, and seed use is a major part both of noncrush demand for soybeans and of nonfeed demand for oats. Seed demand is expected to be positively related to the next year's area planted:

Seed demand = f(Next year's planted area). (24)

Cotton mill use is treated as a derived demand from the textile industry. In addition to cotton prices, cotton mill demand is modeled as a function of textile prices and production. The relationship between textile production and cotton mill demand is clear. Textile prices may have an independent effect; if cotton is a preferred fiber, higher textile prices may encourage manufacturers to substitute cotton for synthetic fibers:

Cotton mill demand = f(Real cotton price, Real textile price, Textile production). (25)

The expected sign of the coefficient on the real cotton price is negative, whereas the expected signs of the coefficients on the other two variables in the equation are positive.

Other domestic use equaticns in the FAPRI U.S. crops model are detailed in the fourth section of this report.

Ending Stocks

Ending stocks of grains and soybeans are divided into two categories in the model: "free" stocks and government stocks. For wheat and corn, free stocks are defined as those stocks not in Commodity Credit Corporation (CCC) inventories, enrolled in the FOR, or placed under nine-month loan. For sorghum, oats, barley, soybeans, and rice, nine-month loan stocks are included with free stocks. Free stocks are usually more accessible to the marketplace than are other government program stocks. Farmers, elevator operators, millers, and exporters make decisions concerning the level of free stocks, whereas government actions and the rules of various government stocks programs are the major determinants of government stock levels.

The level of free stocks is determined by a variety of factors. Current market prices represent the opportunity cost of holding stocks. Next year's production serves as a proxy for expected future prices, e.g., speculative stockholders will hold more stocks when they expect production to decrease (prices to increase). (Through this relationship, factors affecting next year's production also affect this year's price.) Current production may also affect free stocks; this represents transactions demand and possibly also involuntary stockholding when producers are unable to market a large crop. Government stocks serve as an imperfect substitute for free stocks; and market participants know that government stocks are largely isolated from the market, but can be released under certain circumstances:

Free stocks = f(Real price of the commodity, Next year's production, Current production, Government stocks). (26)

The expected sign of the coefficients on the real price of the commodity, next year's production, and government stocks is negative. The expected sign of the coefficient on current production is positive. The absolute values of the coefficients on current production, future production, and government stocks are all expected to be between zero and one.

Government stock levels are not estimated in the model. This does not signify, however, that the analyst holds them constant while making projections or conducting policy analyses. The analyst adjusts government stock levels in response to changing market conditions reflecting administrative rules and the likely behavior of both government and private agents. Due to the many changes in operating rules, it is very difficult to estimate with historical data the structural equations representing government stock behavior. For grains and soybeans, then, the following identity determines total carryover stocks:

Total ending stocks (Wheat, feed grains, soybeans, rice) (27)

= Free stocks + Government stocks.

For cotton, soybean meal, and soybean oil, total ending stocks are estimated directly:

Total ending stocks (Cotton, Soybean meal, Soybean oil) (28)

= f(Real price of the commodity, Next year's production, Current production).

The expected signs of the coefficients are the same as those of the corresponding variables in the free stock equations for the other commodities.

Trade

U.S. exports of major commodities are determined by the FAPRI trade model when the FAPRI modeling system as a whole is operated. Strictly speaking, then, there is no need for export demand equations in the U.S. crops model. Including reduced-form equations for export demand, however, facilitates the iteration process and makes it possible to operate the U.S. crops model separately from the trade model in order to conduct U.S. policy analysis.

The reduced-form export equations in the U.S. crops model are expressed as functions of current and lagged commodity prices:

Exports = f(Current and lagged prices of the commodity, Current and lagged prices of other commodities, Shifter representing all nonprice effects). (29)

The reduced-form coefficients are determined by changing the prices in the trade model and observing what happens to U.S. exports. For example, to determine the coefficient on the wheat price in the wheat export demand equation, one would follow this procedure:

1. Pick a base year, and record baseline levels of wheat prices and U.S. wheat exports.
2. Change the U.S. wheat price by one unit.
3. Compute the change in U.S. exports and record this number as the coefficient on the wheat price in the wheat export equation.

Because the trade model is nonlinear, the computed reduced form coefficients must be considered approximations centered on particular years and particular values of endogenous and exogenous variables. In each historical year, the shift variable in each equation is set equal to the difference between actual exports and the sum of the computed price effects. For projections, the shift variable must be determined by assuming paths for prices and exogenous variables in the trade model and by solving for the shift variable representing nonprice effects.

Experience has shown that although the reduced-form equations are merely linear approximations of the behavior of the trade model, they are successful at imitating the responsiveness of the trade model to modest price changes. This reduces the time it takes to iterate between the U.S. crops and world trade model when the models are operated jointly--once the models are aligned for a given set of prices, a shock to the U.S. model that results in a change in prices will result in almost exactly the same level of U.S. exports in both models.

Reduced-form equations determine U.S. exports of wheat, corn, sorghum, soybeans, soybean meal, soybean oil, and rice. Barley and oats are not treated as separate commodities in the world feed-grain model, so U.S. exports of barley and imports of oats must be determined in the U.S. model. Oats imports are estimated and barley exports determined by a synthetic equation. Likewise, the FAPRI world trade model for cotton is still under development; until it is finished, a synthetic equation is used to determine U.S. cotton exports. The oats, barley, and cotton equations are each detailed in the fourth section.

Market-clearing Identities

Equilibrium is achieved when supply equals demand in each market:

Production + Beginning stocks + Imports (30)

= Domestic use + Exports + Ending stocks + Statistical discrepancy.

Textile Market

A textile market is estimated so that the textile prices and textile production used in the cotton mill demand equation are determined endogenously. A fiber price index is determined using a translog cost function:

Fiber price index = f(Cotton prices, Rayon prices, Polyester prices). (31)

Domestic textile production is modeled as a function of relative output and input prices, and expected demand:

Textile production = f(Lagged production, Textile price / fiber price, Change in real consumer expenditures). (32)

The lagged dependent variable is included in the equation to reflect a partial adjustment process. The expected sign of the coefficient on the textile/fiber price ratio is positive. When real consumer expenditures increase, so does the demand for textile products. A positive coefficient on the expenditures term in the equation indicates that textile manufacturers adjust production to meet expected demand, and not just in response to changing prices.

Per-capita domestic use of textiles is defined to include changes in inventories. Thus, the per-capita demand equation for textiles also includes textile production, as well as textile prices and the change in real consumer expenditures:

Textile consumption = Per-capita consumption * Population. (33)

Per-capita textile consumption = f(Real textile price, Textile production per capita, Change in real consumer expenditures per capita). (34)

The coefficient on the textile price term is expected to be negative, whereas the coefficients on the other two variables are expected to be positive.

Textile imports and exports are modeled separately, rather than simply as net trade, because different types of textile products are imported and exported. Moreover, policies to restrict textile imports have no direct effect on the level of textile exports. Textile import supply and export demand are both modeled as simple functions of the textile price:

Textile imports = f(Lagged imports, Real textile price). (35)

Textile exports = f(Real textile price, Trend). (36)

Real textile prices are expected to have a positive effect on textile imports and a negative effect on textile exports. Because the primary focus of the model is on the agricultural commodity markets, rather than on the textile market, all of the textile equations rely on simple specifications.

The textile market is closed using the following market-clearing equation:

Textile production + Textile imports = Textile consumption + Textile exports. (37)

Model Estimation

This section presents the estimated equations and identities of the FAPRI U.S. crops model. For most equations, the specifications are as described in the previous section, although there are some slight variations in the specifications for certain crops. Commentary is restricted to identifying and explaining these variations, and to assessing the estimated coefficients and associated statistics.

The equations reported here reflect the state of the model in the summer of 1989. Feed grain, wheat, and soybean equations were revised in the fall of 1988, and cotton and rice equations were revised in the summer of 1989. Most of the equations in the model are estimated over the period 1967/68-1986/87. Supply equations generally are extended through the 1987/88 crop year; data limitations and structural changes mean certain equations are estimated over a shorter time period.

All equations are estimated using ordinary least squares (OLS) and utilizing AREMOS, an econometric package developed by The WEFA Group. Given the simultaneity of the model and the nonlinearity of many of the modeled relationships, OLS is not the most appropriate estimation technique from a theoretical standpoint. However, OLS does make it easy to update or revise equations--an important characteristic for a model in constant revision.

For each estimated equation, t-statistics are presented in parentheses below the parameter estimates. Where appropriate, elasticities evaluated at the mean of the variables are reported in brackets. Also reported for each estimated equation are the estimation period, the R-squared, the adjusted R-squared, the standard error of the estimates, the Durbin-Watson statistic, and the mean of the dependent variable.

A complete list of variable names, definitions, and sources is provided at the end of this section. Variables are named, with some modifications, according to the Outlook and Situation Information System (OASIS) naming convention developed at ERS/USDA. In general, the first two characters of each variable name refer to a particular commodity or to some other general category (e.g "WH" indicates a wheat variable, and "DM" represents a dummy variable). The third through fifth characters refer to a particular category (e.g., "APA" refers to area planted, measured in acres; and "PFM" indicates a farm price. The sixth and seventh characters indicate the country (e.g., "U9" represents the United States). An "F" appears in the eighth position for variables that are forward shifted by one year (e.g., WHAPAU9F refers to wheat area planted for the next marketing year). A variable with the suffix ".1" is lagged one period.

Expected Participant Net Returns

For all program commodities, expected participant net returns are defined as expected deficiency payments, plus expected diversion payments, plus expected market returns, minus variable production costs, minus the cost (assumed to be 20 dollars per acre) of maintaining idled area (Table 2). For wheat, corn, cotton, and rice, all variables are shifted forward by one year so that next year's production can be determined in the current year, for use in stock equations. The stock equations for sorghum, oats, and barley do not include next year's production, so there is no need to shift supply-side variables for these commodities.

The other major difference among the equations is of relevance only when market prices fall below the loan rate. For wheat and feed grains, it is assumed that producers place their crop under loan, and are thus guaranteed the loan rate as their "market" return. For cotton and rice, it is assumed that the difference between the market price and the loan rate can only be recovered on program yields. This inconsistency is important only when program and trend yields are substantially different.

For wheat, payment provisions were quite different prior to 1973, so participant net returns are treated exogenously for those years. For cotton and rice, participant net returns are calculated only for the 1980s.

Expected Nonparticipant Net Returns

Expected nonparticipant net returns are defined in the same way for all commodities (Table 3). Forward-shifted variables are used in the wheat, corn, soybeans, cotton, and rice models, whereas current-year variables are used in the sorghum, oats, and barley models.

Table 2. Structural parameter estimates of equations for expected participant net returns

Wheat

(2.1)
```
WHNRPU9F = (1 - DM1S73)WHNRPU9Z + DM1S73{max[WHPTGU9F -
max(WHPLNU9F, WHPFMU9), 0] * WHYHPU9F(1 - WHMARU9F -
WHMPLU9F) + WHDPRU9F * WHYHPU9F * WHMPLU9F + max(WHPLNU9F,
WHPFMU9) * WHYHTU9F(1 - WHMARU9F - WHMPLU9F) - WHVCAU9F(1 -
WHMARU9F - WHMPLU9F) - 20(WHMARU9F + WHMPLU9F)}
```

Corn

(2.2)
```
CONRPU9F = max[COPTGU9F - max(COPLNU9F, COPFMU9), 0]
* COYHPU9F(1 - COMARU9F - COMPLU9F) + CODPRU9F * COYHPU9F
* COMPLU9F + max(COPLNU9F, COPFMU9) * COYHTU9F(1 - COMARU9F
- COMPLU9F) - COVCAU9F(1 - COMARU9F - COMPLU9F)
- 20(COMARU9F + COMPLU9F)
```

Sorghum

(2.3)
```
SGNRPU9 = max[SGPTGU9 - max(SGPLNU9, SGPFMU9.1), 0]
* SGYHPU9(1 - SGMARU9 - SGMPLU9) + SGDPRU9 * SGYHPU9 * SGMPLU9
+ max(SGPLNU9, SGPFMU9.1) * SGYHTU9(1 - SGMARU9 - SGMPLU9)
- SGVCAU9(1 - SGMARU9 - SGMPLU9) - 20(SGMARU9 + SGMPLU9)
```

Oats

(2.4)
```
OANRPU9 = max[OAPTGU9 - max(OAPLNU9, OAPFMU9.1), 0]
* OAYHPU9(1 - OAMARU9 - OAMPLU9) + OADPRU9 * OAYHPU9 * OAMPLU9
+ max(OAPLNU9, OAPFMU9.1) * OAYHTU9(1 - OAMARU9 - OAMPLU9)
- OAVCAU9(1 - OAMARU9 - OAMPLU9) - 20(OAMARU9 + OAMPLU9)
```

Barley

(2.5)
```
BANRPU9 = max[BAPTGU9 - max(BAPLNU9, BAPFMU9.1), 0]
* BAYHPU9(1 - BAMARU9 - BAMPLU9) + BADPRU9 * BAYHPU9 * BAMPLU9
+ max(BAPLNU9, BAPFMU9.1) * BAYHTU9(1 - BAMARU9 - BAMPLU9)
- BAVCAU9(1 - BAMARU9 - BAMPLU9) - 20(BAMARU9 + BAMPLU9)
```

Cotton

(2.6)
```
CTNRPU9F = DM1S81[max(CTPTGU9F - CTPFMU9, 0)/100 * CTYHPU9F
(1 - CTMARU9F - CTMPLU9F) + CTDPRU9F/100 * CTYHPU9F * CTMPLU9F +
CTPFMU9/100 * CTYHTU9F(1 - CTMARU9F - CTMPLU9F) - CTVCAU9F
(1 - CTMARU9F - CTMPLU9F) - 20(CTMARU9F + CTMPLU9F)]
```

Rice

(2.7)
```
RINRPU9f = DM1S81[max(RIPTGU9F - RIPFMU9, 0) * RIYHPU9F/100 *
(1 - RIMARU9F - RIMPLU9F) + RIDPRU9F * RIYHPU9F/100 * RIMPLU9F +
RIPFMU9 * RIYHTU9F/100 * (1 - RIMARU9F - RIMPLU9F) - RIVCAU9F *
(1 - RIMARU9F - RIMPLU9F) - 20(RIMARU9F + RIMPLU9F)]
```

Table 3. Structural parameter estimates of equations for expected nonparticipant net returns

Wheat

(3.1) WHNRNU9F = WHPFMU9 * WHYHTU9F - WHVCAU9F
(3.2) WHNRNU9 = WHNRNU9F.1

Corn

(3.3) CONRNU9F = COPFMU9 * COYHTU9F - COVCAU9F
(3.4) CONRNU9 = CONRNU9F.1

Sorghum

(3.5) SGNRNU9F = SGPFMU9 * SGYHTU9F - SGVCAU9F
(3.6) SGNRNU9 = SGNRNU9F.1

Oats

(3.7) OANRNU9 = OAPFMU9.1 * OAYHTU9 - OAVCAU9

Barley

(3.8) BANRNU9F = BAPFMU9 * BAYHTU9F - BAVCAU9F
(3.9) BANRNU9 = BANRNU9F.1

Soybeans

(3.10) SBNRNU9F = SBPFMU9 * SBYHTU9F - SBVCAU9F
(3.11) SBNRNU9 = SBNRNU9F.1

Cotton

(3.12) CTNRNU9F = CTPFMU9/100 * CTYHTU9F - CTVCAU9F

Rice

(3.13) RINRNU9F = RIPFMU9 * RIYHTU9F/100 - RIVCAU9F

Model Participation Rate

For each of the program commodities, the estimated coefficients indicate that the participation rate increases with expected participant net returns and decreases with expected nonparticipant net returns (Table 4). Dummy variables are used in the estimation to remove years in which there were no set-aside programs (1974/75-1977/78 and 1980/81-1981/82 for wheat, corn, sorghum, and barley) in which the structure of commodity programs was substantially different from that of current programs (years prior to 1982/83 for cotton, rice, and oats).

For corn, it is assumed that nonparticipants can choose to plant either corn or soybeans. The weights assigned to corn and soybeans are arbitrary, but reflect base acreage provisions and other institutional factors encouraging corn farmers opting out of the program to plant corn rather than soybeans. Attempts to derive the weights empirically yielded implausible results--the net effect of the estimated weights was that an increase in soybean prices would actually increase the total corn area planted. Given the assumed weights and the other estimated parameters of the model, higher soybean prices reduce corn area.

The sorghum and barley equations include additional explanatory variables to improve model behavior. Each equation includes a trend variable with an estimated negative coefficient, which indicates that participation rates are falling over time, all else equal. Each equation also includes a dummy variable for a year in which the participation rate was substantially different from that predicted by other variables in the equation.

Table 4. Structural parameter estimates of equations for model participation rates

Wheat

(4.1)

$$\underset{(6.32)}{WHMPRU9F = 2.933}(WHNRPU9F - WHNRNU9F)/PWJMU9$$

$$- \underset{(6.28)}{0.5758}\ DM173 - \underset{(6.28)}{0.5758}\ DM174 - \underset{(6.28)}{0.5758}\ DM175 - \underset{(7.53)}{0.6609}\ DM176$$

$$- \underset{(6.28)}{0.5758}\ DM179 - \underset{(6.28)}{0.5758}\ DM180 + \underset{(14.71)}{0.5758}$$

Fit over:	1967-1986	Std Error	= 0.0829
R Sq	= 0.9717	D.W.(1)	= 2.1313
Adj R Sq	= 0.9552	LHS Mean	= 0.5457

Corn

(4.2)

$$COMPRU9F = \underset{(2.58)}{0.7695}[CONRPU9F - (0.8\ CONRNU9F + 0.2\ SBNRNU9F)]/PWSAU9$$

$$- \underset{(3.83)}{0.5944}\ DM173 - \underset{(3.86)}{0.6004}\ DM174 - \underset{(3.89)}{0.6052}\ DM175$$

$$- \underset{(3.45)}{0.5352}\ DM176 - \underset{(3.61)}{0.5594}\ DM179 - \underset{(3.67)}{0.5683}\ DM180 + \underset{(14.04)}{0.5610}$$

Fit over:	1967-1986	Std Error	= 0.1495
R Sq	= 0.8471	D.W.(1)	= 1.6495
Adj R Sq	= 0.7579	LHS Mean	= 0.3948

Sorghum

(4.3)

$$SGMPRU9 = \underset{(1.87)}{1.153}(SGNRPU9 - SGNRNU9)/PWSAU9 - \underset{(1.65)}{0.0132}\ TREND$$

$$+ \underset{(2.41)}{0.3143}\ DM172 - \underset{(4.62)}{0.5994}\ DM174 - \underset{(4.55)}{0.5862}\ DM175 - \underset{(4.47)}{0.5730}\ DM176$$

$$- \underset{(4.78)}{0.6352}\ DM177 - \underset{(4.31)}{0.5547}\ DM180 - \underset{(3.82)}{0.5069}\ DM181 + \underset{(1.68)}{26.6854}$$

Fit over:	1967-1987	Std Error	= 0.1236
R Sq	= 0.9066	D.W.(1)	= 1.6651
Adj R Sq	= 0.8303	LHS Mean	= 0.4206

Table 4. Continued

Oats

(4.4)

```
OAMPRU9 = 5.215(OANRPU9 - OANRNU9)/PWJMU9 * DM1S82
         (4.96)

+ 0.2019 DM1S82 + 0.00000
 (9.00)          (0.00)

Fit over:     1967-1987         Std Error = 0.0443
R Sq          = 0.8279          D.W.(1)   = 2.2190
Adj R Sq      = 0.8088          LHS Mean  = 0.0481
```

Barley

(4.5)

```
BAMPRU9 = 3.455(BANRPU9 - BANRNU9)/PWJMU9 - 0.8246 DM171
         (3.08)                              (4.57)

- 0.7199 DM174 - 0.6896 DM175 - 0.6612 DM176 - 0.6344 DM177
 (4.68)         (4.65)         (4.57)         (4.47)

- 0.7329 DM180 - 0.5402 DM181 - 0.4691 LOG(TREND - 1959) + 1.9903
 (4.94)         (3.80)         (2.08)                     (2.95)

Fit over:     1969-1987          Std Error = 0.1347
R Sq          = 0.9101           D.W.(1)   = 1.7467
Adj R Sq      = 0.8202           LHS Mean  = 0.3620
```

Cotton

(4.6)

```
CTMPRU9F = 1.147 DM1S81(CTNRPU9F - CTNRNU9F)/PWAJU9
          (4.04)

+ 0.5022 DM1S81 + 0.0000
 (6.66)          (0.00)

Fit over:     1970-1986          Std Error = 0.0480
R Sq          = 0.9871           D.W.(1)   = 2.5171
Adj R Sq      = 0.9852           LHS Mean  = 0.2789
```

Rice

(4.7)

```
RIMPRU9F = 0.2438 DM1S81(RINRPU9F - RINRNU9F)/PWAJU9
          (4.52)

+ 0.7311 DM1S81 + 0.0000
(25.52)          (0.00)

Fit over:     1967-1986          Std Error = 0.0325
R Sq          = 0.9940           D.W.(1)   = 3.0804
Adj R Sq      = 0.9933           LHS Mean  = 0.2517
```

Area Planted by Program Participants

At the time the model was estimated, information concerning 0-92 and 50-92 program idled acreage was not readily available for all commodities. Model participation, and ARP and PLD rates for all crops were constructed such that the indicated identities would hold. Few feed grain acres were enrolled in the 0-92 and 50-92 programs during the estimation period. Information about 0-92 and 50-92 acreage is used in developing projections for all commodities (Table 5).

Area Idled under the ARP and PLD Programs

For cotton, the current type of set-aside program did not exist prior to the 1980s, so model participation, and ARP and PLD rates are used to estimate program idled acreage only in the 1980s (Table 6). Other types of set-aside programs that existed in previous years for cotton are represented by the variable CTAIZU9F and are treated exogenously. For all commodities, variables are constructed so that the identities hold exactly during the estimation period.

Area Planted by Nonparticipants

Estimated equations determine the area planted by nonparticipants for wheat, corn, sorghum, and barley. For all four crops, estimated coefficients are consistent with expectations. For oats, soybeans, cotton, and rice, total area planted is estimated directly, so that nonprogram acreage is determined by an identity (Table 7).

In the wheat equation, the weights on sorghum and barley net returns reflect the mean level of net returns for each commodity during the estimation period. Thus, each commodity, on average, is given an equal weight in

Table 5. Structural parameter estimates of equations for area planted by program participants

Wheat

(5.1) WHAPPU9F = WHMPRU9F * WHABAU9F(1 - WHMARU9F - WHMPLU9F) - WH092U9F

Corn

(5.2) COAPPU9F = COMPRU9F * COABAU9F(1 - COMARU9F - COMPLU9F)

Sorghum

(5.3) SGAPPU9 = SGMPRU9 * SGABAU9(1 - SGMARU9 - SGMPLU9)

Oats

(5.4) OAAPPU9 = OAMPRU9 * OAABAU9(1 - OAMARU9 - OAMPLU9)

Barley

(5.5) BAAPPU9 = BAMPRU9 * BAABAU9(1 - BAMARU9 - BAMPLU9)

Cotton

(5.6) CTAPPU9F = CTMPRU9F * CTABAU9F(1 - CTMARU9F - CTMPLU9F) - CT092U9F

Rice

(5.7) RIAPPU9F = RIMPRU9F * RIABAU9F(1 - RIMARU9F - RIMPLU9F) - RI092U9F

Table 6. Structural parameter estimates of equations for area idled under the the ARP and PLD programs

Wheat

(6.1) WHAIAU9F = WHABAU9F * WHMPRU9F(WHMARU9F + WHMPLU9F)

Corn

(6.2) COAIAU9F = COABAU9F * COMPRU9F(COMARU9F + COMPLU9F)

Sorghum

(6.3) SGAIAU9 = SGABAU9 * SGMPRU9(SGMARU9 + SGMPLU9)

Oats

(6.4) OAAIAU9 = OAABAU9 * OAMPRU9(OAMARU9 + OAMPLU9)

Barley

(6.5) BAAIAU9 = BAABAU9 * BAMPRU9(BAMARU9 + BAMPLU9)

Cotton

(6.6) CTAIAU9F = CTABAU9F * CTMPRU9F(CTMARU9F + CTMPLU9F) + CTAIZU9F

Rice

(6.7) RIAIAU9F = RIABAU9F * RIMPRU9F(RIMARU9F + RIMPLU9F)

Table 7. Structural parameter estimates of equations for area planted by nonparticipants

Wheat

(7.1)

```
WHAPNU9F = 29.39 WHNRNU9F/PWJMU9
           (1.56)
           [0.16]

- 531.6(SGNRNU9F/53 + BANRNU9F/44)/PWJMU9
   (0.94)
  [-0.11]

- 0.9290(WHAPPU9F + WHAIAU9F + WHCRPU9F + WH092U9F)
(14.39)
[-0.64]

+ 11.12 DM171 + 11.92 DM1S74 + 17.79 DM1S80
  (2.32)        (4.69)         (5.94)

- 4.52 DM1S84 + 62.13
 (1.23)        (12.21)

Fit over:    1967-1986      Std Error =   4.2230
R Sq         = 0.9810       D.W.(1)   =   2.0863
Adj R Sq     = 0.9699       LHS Mean  =  47.604
```

Corn

(7.2)

```
COAPNU9F = -0.9633 COAPPU9F - 0.7432(COAIAU9F + COCRPU9F)
           (48.13)            (22.31)
           [-0.43]            [-0.15]

+ 5.049 CONRNU9F/PWSAU9 - 2.815 SBNRNU9F/PWSAU9
 (2.04)                   (0.78)
 [0.05]                  [-0.03]

- 7.828 DM17274 + 82.74
 (6.23)          (38.99)

Fit over:    1967-1986     Std Error =   1.1896
R Sq         = 0.9980      D.W.(1)   =   2.3518
Adj R Sq     = 0.9973      LHS Mean  =  52.515
```

Table 7. Continued

Sorghum

(7.3) SGAPNU9 = 8.691 SGNRNU9/PWSAU9 - 1.096 WHNRNU9/PWSAU9
(3.42) (0.43)
[0.20] [-0.02]

- 0.8679 SGAPPU9 - 0.7475(SGAIAU9 + SGCRPU9) - 5.557 DM1S74
(17.90) (8.66) (11.07)
[-0.47] [-0.19]

- 2.852 DM173 + 2.071 DM185 + 19.78
(4.10) (3.53) (20.03)

Fit over:	1967-1987	Std Error	= 0.5370
R Sq	= 0.9911	D.W.(1)	= 2.3545
Adj R Sq	= 0.9864	LHS Mean	= 10.829

Oats

(7.4) OAAPNU9 = OAAPAU9 - OAAPPU9

Barley

(7.5) BAAPNU9 = 12.08 BANRNU9/PWJMU9 - 0.9082 BAAPPU9
(1.68) (10.95)
[0.35] [-0.39]

- 0.5526 DM1S74(BAAIAU9 + BACRPU9) + 2.707 DM1S84
(2.07) (4.27)
[-0.04]

- 411.3(WHNRNU9/49 + OANRNU9/27 * 0.5)/PWJMU9 + 10.30
(1.86) (15.20)
[-0.42]

Fit over:	1967-1987	Std Error	= 0.7937
R Sq	= 0.9347	D.W.(1)	= 1.4048
Adj R Sq	= 0.9129	LHS Mean	= 7.2429

Cotton

(7.6) CTAPNU9F = CTAPAU9F - CTAPPU9F

Rice

(7.7) RIAPNU9F = RIAPAU9F - RIAPPU9F

determining the competing crop return variable. In the barley equation, a similar approach is used, but wheat net returns are given twice the weight of oats net returns. Because net returns tend to be correlated across commodities, it is very difficult to estimate directly a number of cross-commodity effects. The weights used are based on prior information about common cropping patterns.

Each of the estimated nonparticipant acreage equations utilizes shift and dummy variables. This is not desirable, but it is necessary to obtain reasonable coefficient estimates for the variables of primary interest. Some of the problems resulting when shift and dummy variables are omitted include negative own-price elasticities, positive cross-price elasticities with competing crops, and implausible degrees of substitution between program and nonprogram uses of land.

Total Planted Area

Total planted area for wheat, corn, sorghum, and barley is simply equal to the sum of participant and nonparticipant planted area; for the other crops, the estimated coefficnts are consistent with expectations (Table 8).

Oats area planted is estimated as a function of area harvested. Because oats is often used as a cover crop on acreage idled under government programs, the planted acreage of oats has been much larger than the area harvested for grain in recent years. Estimated parameters indicate that oats area planted is positively correlated both with oats area harvested and with corn acreage idled under annual government programs.

In the case of soybeans, it is very difficult to determine the effects of the CRP on planted acreage because there is no reported base reduction for soybeans, as there is for other crops. An exogenous assumption is made

Table 8. Structural parameter estimates of equations for total planted area

Wheat

(8.1) WHAPAU9F = WHAPPU9F + WHAPNU9F

Corn

(8.2) COAPAU9F = COAPPU9F + COAPNU9F

Sorghum

(8.3) SGAPAU9 = SGAPPU9 + SGAPNU9

Oats

```
(8.4)   OAAPAU9 = 0.6666 OAAHAU9 + 0.1638 COAIAU9 - 6.823 DM183
                   (9.64)            (6.58)            (5.73)
                   [0.47]            [0.10]

                + 7.783
                (10.08)

        Fit over:  1967-1987      Std Error  =  0.9417
        R Sq       = 0.9484       D.W.(1)    =  1.3458
        Adj R Sq   = 0.9393       LHS Mean   = 17.248
```

Barley

(8.5) BAAPAU9 = BAAPPU9 + BAAPNU9

Soybeans

```
(8.6)   SBAPJU9F = 0.5383 SBAPJU9F.1 + 26.15 SBNRNU9F/PWSAU9
                    (3.00)               (4.43)
                    [0.22]

        - 16.92 CONRNU9F/PWSAU9 + 24.39 DM1S77
          (4.13)                  (1.81)
         [-0.15]

        + 7.378(1 - DM1S77) * LOG(TREND - 1959)
         (1.62)

        - 0.2018(COAIAU9F + COCRPU9F) - 0.1186 COAPPU9F
         (3.09)                          (2.42)
        [-0.04]                         [-0.05]

        - 0.0894 DM1NPRGF * COAPAU9F + 8.760
         (3.46)                        (0.96)
        [-0.04]

        Fit over:   1967-1986      Std Error =  1.7286
        R Sq        = 0.9830       D.W.(1)   =  2.8939
        Adj R Sq    = 0.9706       LHS Mean  = 57.525
```

Table 8. Continued

```
(8.7)   SBAPAU9F = SBAPJU9F-SBCRPU9F
```

Cotton

```
(8.8)   CTAPAU9F = 2.465 {(1 - DM1S81) CTNRNU9F/PWAJU9 + DM1S81
                   (1.77)
                   [0.08]

        * (CTNRNU9F(1 - CTMPRU9F/2) + CTNRPU9F * [CTMPRU9F/2]/PWAJU9}

        - 0.7046(CTAIAU9F + CT092U9F + CTCRPU9F)
          (3.64)
         [-0.10]

        - 354.3(SBNRNU9F/109 + SGNRNU9F/58)/PWAJU9
            (4.28)
           [-0.28]

        - 1.572 DM175 - 2.175 DM1S81 + 16.47
          (1.70)        (2.76)         (15.37)

        Fit over:  1970-1986          Std Error =  0.8584
        R Sq       = 0.8648           D.W. (1)  =  2.3954
        Adj R Sq   = 0.8033           LHS Mean  = 12.063
```

Rice

```
(8.9)   RIAPAU9F = 0.3398 RIAPAU9F.1 + 2018 RIALTU9F
                   (2.62)               (5.19)

        + 310.4 {(1 - DM1S81) RINRNU9F/PWAJU9 + DM1S81
            (2.67)
            [0.12]

        * [RINRNU9F(1 - RIMRPU9F/2) + RINRPU9F * RIMPRU9F/2]/PWAJU9}

        - 0.7356(RIAIAU9F + RI092U9F) - 773.1 DM17576 + 337.9 DM1S81
          (3.24)                        (3.89)          (1.13)
         [-0.10]

        - 43.44
           (0.14)

        Fit over: 1967-1986          Std Error =  228.13
        R Sq      = 0.8779           D.W. (1)  =    2.2369
        Adj R Sq  = 0.8216           LHS Mean  = 2547.6
```

concerning the effect of the CRP on soybean acreage, and the dependent variable in the estimated equation is the sum of soybean planted acreage and CRP acreage from soybeans. The estimated parameters in the equation indicate that soybeans and corn are substitutes in production, and that an increase in corn acreage enrolled in government programs results in a reduction in soybean planted area. A logarithmic trend term for years prior to 1977 is included to reflect the adoption process.

Cotton and rice acreage equations utilize a weighted average of participant and nonparticipant expected net returns. Nonparticipant returns are given twice the weight indicated by the participation rate. This fact reflects the notion that base acreage restrictions limit the degree to which program participants can increase acreage in response to program provisions. Soybeans and sorghum are competing crops in the cotton acreage equation, with weights determined similarly to those in the nonparticipant wheat acreage equation. The rice acreage equation includes a lagged dependent variable and a variable representing rice acreage allotments.

Area Harvested as a Proportion of Area Planted

Market prices are one determinant of the proportion of planted area harvested for wheat, soybeans, and cotton. The weather variables used in the estimated yield equations are included in the corn, sorghum, soybean, and cotton equations. For corn, an increase in the area idled by government programs increases the proportion of planted area to be harvested. Trend terms are included in the corn, sorghum, and cotton equations. For both corn and sorghum, the trend term represents a secular reduction in the amount of silage harvested (Table 9).

Table 9. Structural parameter estimates of equations for area harvested as a proportion of area planted

Wheat:

(9.1)

$$\mathrm{WHAHPU9F} = \underset{\substack{(3.11)\\ [0.04]}}{2.634}\ \mathrm{WHPFMU9/PWJMU9} - \underset{(2.74)}{0.0479}\ \mathrm{DM182}$$

$$- \underset{(3.03)}{0.0296}\ \mathrm{DM1S82} + \underset{(63.00)}{0.8510}$$

Fit over:	1967-1986	Std Error	= 0.0156
R Sq	= 0.7826	D.W.(1)	= 2.0499
Adj R Sq	= 0.7418	LHS Mean	= 0.8780

Corn

(9.2)

$$\mathrm{COAHPU9F} = - \underset{(3.67)}{0.0434}\ \mathrm{DM182} + \underset{(1.85)}{0.0195}\ \mathrm{LOG(TREND - 1959)}$$

$$+ \underset{(1.76)}{0.0071}\ \mathrm{DMCOYU9F} + \underset{(4.10)}{0.0276}\ \mathrm{DM1S77}$$

$$+ \underset{\substack{(2.36)\\ [0.01]}}{0.0340}(\mathrm{COAIAU9F} + \mathrm{COCRPU9F})/\mathrm{COAPAU9F} + \underset{(28.75)}{0.7992}$$

Fit over:	1967-1986	Std Error	= 0.0076
R Sq	= 0.8973	D.W.(1)	= 2.3246
Adj R Sq	= 0.8606	LHS Mean	= 0.8703

Sorghum

(9.3)

$$\mathrm{SGAHPU9} = \underset{(2.36)}{0.0232}\ \mathrm{DMSGYU9} + \underset{(7.34)}{0.1029}\ \mathrm{LOG(TREND - 1959)} + \underset{(13.62)}{0.5437}$$

Fit over:	1967-1987	Std Error	= 0.0236
R Sq	= 0.7626	D.W.(1)	= 1.5583
Adj R Sq	= 0.7362	LHS Mean	= 0.8323

Table 9. Continued

Barley

(9.4) BAAHPU9 = - 0.0374 DM180 + 0.0347 DM18183
(2.99) (4.53)

- 0.0382 DM185 + 0.9170
(3.04) (301.6)

Fit over:	1967-1987	Std Error	= 0.0122
R Sq	= 0.7188	D.W.(1)	= 1.6670
Adj R Sq	= 0.6692	LHS Mean	= 0.9183

Soybeans

(9.5) SBAHPU9F = 0.0023 DMSBYU9F + 0.3258 SBPFMU9/PWSAU9 + 0.970
(1.19) (1.92) (215.3)
[0.01]

Fit over:	1967-1986	Std Error	= 0.0049
R Sq	= 0.2166	D.W.(1)	= 2.5338
Adj R Sq	= 0.1244	LHS Mean	= 0.9785

Cotton

(9.6) CTAHPU9F = 0.0211 DMCTYU9F + 0.1584 CTPFMU9/PWAJU9
(2.46) (1.28)
[0.04]

- 0.0766 DM181 - 0.1000 DM185 + 0.002022 TREND - 3.1004
(4.01) (5.12) (1.88) (1.45)

Fit over:	1970-1986	Std Error	= 0.0173
R Sq	= 0.8280	D.W.(1)	= 2.4565
Adj R Sq	= 0.7498	LHS Mean	= 0.9277

Total Area Harvested

For all commodities except oats, area harvested is equal to area planted multiplied by the proportion harvested (Table 10). For oats, harvested area is determined by a behavioral equation specified much like the planted area equations for cotton and rice. The only significant difference is that participant net returns are not assumed to have a direct effect on oats acreage (although participant net returns do affect program participation, which determines program idled acreage). Corn, barley, and soybeans are competing crops in the oats equation.

Yield Per Harvested Acre

Estimated coefficients in the yield equations are consistent with expectations regarding yield per harvested acre (Table 11). In each equation, a trend term serves as a proxy for technological progress. A linear trend is used in all equations other than that of corn, in which a logarithmic trend is utilized. For corn, this implies that yields are increasing at a decreasing rate, all else equal. The target price is included in the wheat, corn, sorghum, barley, and cotton equations. No relationship was found between target prices and yields for oats and rice, commodities for which the current system of target prices is relatively new.

Yields are negatively related to planted area in the soybean and rice equations. Increasing planted area means more marginal land is brought into production, resulting in lower average yields. Likewise, yields are positively related to the number of acres idled under government programs in the wheat and corn equations. Except for that of rice, each equation includes a dummy variable taking the values one when yields are more than one standard deviation

Table 10. Structural parameter estimates of equations for total area harvested

Wheat

(10.1) WHAHAU9F = WHAPAU9F * WHAHPU9F

Corn

(10.2) COAHAU9F = COAPAU9F * COAHPU9F

Sorghum

(10.3) SGAHAU9 = SGAPAU9 * SGAHPU9

Oats

(10.4) OAAHAU9 = 0.1953 OAAHAU9.1 + 18.84 OANRNU9/PWJMU9
(0.87) (2.76)
[0.22]

- 230.1(CONRNU9/101 + SBNRNU9/96 + BANRNU9/43)/PWJMU9
(2.75)
[-0.26]

- 0.4792(OAAIAU9 + OACRPU9) - 0.4346 TRND7186 + 13.56
(0.84) (2.95) (3.22)
[-0.01]

Fit over:	1967-1987	Std Error =	0.9832
R Sq	= 0.9458	D.W.(1) =	1.9994
Adj R Sq	= 0.9277	LHS Mean =	12.033

Barley

(10.5) BAAHAU9 = BAAPAU9 * BAAHPU9

Soybeans

(10.6) SBAHAU9F = SBAPAU9F * SBAHPU9F

Cotton

(10.7) CTAHAU9F = CTAPAU9F * CTAHPU9F

Rice

(10.8) RIAHAU9F = RIAPAU9F * RIAHPU9F

Table 11. Structural parameter estimates of equations for yield per harvested acre

Wheat:

```
(11.1)  WHYHAU9F = 0.5024 TREND + 94.85 WHPTGU9F/PWJMU9
                   (5.70)          (1.13)

                   [0.05]

        + 0.0293(WHAIAU9F + WHCRPU9F + WH092U9F) + 2.4486 DMWHYU9F
         (0.82)                                    (6.19)
         [0.05]

        - 961.83                                   (5.48)
         (5.48)

        Fit over:  1967-1986             Std Error =  0.9136
        R Sq       = 0.9419              D.W.(1)   =  2.1740
        Adj R Sq   = 0.9263              LHS Mean  = 33.203
```

Corn

```
(11.2)  COYHAU9F = 2134 COPTGU9F/PWSAU9 + 83.27 LOG(TREND - 1945)
                   (1.46)                 (9.45)
                   [0.23]

        + 0.0921(COAIAU9F + COCRPU9F) + 10.60 DMCOYU9F - 20.80 DM182 - 211.40
         (0.50)                         (3.95)           (2.63)        (5.20)
         [0.01]
```

Sorghum

```
(11.3)  SGYHAU9 = 0.7177 TREND + 806.7 SGPTGU9/PWSAU9
                  (4.56)          (0.95)
                  [0.14]

        + 8.422 DMSGYU9 - 1369.81
         (4.95)            (4.33)

        Fit over:  1967-1987             Std Error =  3.6148
        R Sq       = 0.7849              D.W.(1)   =  2.6378
        Adj R Sq   = 0.7470              LHS Mean  = 56.020
```

Oats

```
(11.4)  OAYHAU9 = 0.5012 TREND + 5.269 DMOAYU9 - 938.11
                  (7.12)          (7.11)          (6.74)

        Fit over:  1967-1987             Std Error =  1.8723
        R Sq       = 0.8137              D.W.(1)   =  2.9115
        Adj R Sq   = 0.7930              LHS Mean  = 53.085
```

Table 11. Continued

Barley

```
(11.5)  BAYHAU9 = 0.7954 TREND + 4.504 DMBAYU9
                  (9.76)         (5.21)

        + 424.5 BAPTGU9/PWJMU9 + 2.653 DM171 - 1528.97
          (1.03)                 (0.60)           (9.48)
          [0.07]

        Fit over:  1969-1987            Std Error =  1.8500
        R Sq       = 0.8972             D.W.(1)   =  2.1489
        Adj R Sq   = 0.8678             LHS Mean  = 47.878
```

Soybeans

```
(11.6)  SBYHAU9F = 0.3871 TREND - 0.0531 SBAPAU9F + 3.460 DMSBYU9F
                   (7.35)         (1.72)              (10.49)
                  [-0.11]

        - 732.60
          (7.13)

        Fit over:  1967-1986            Std Error =  0.8429
        R Sq       = 0.9272             D.W.(1)   =  2.5210
        Adj R Sq   = 0 .9185            LHS Mean  = 28.917
```

Cotton

```
(11.7)  CTYHAU9F = 12.45 TREND + 331.8 CTPTGU9F/PWAJU9
                   (7.65)        (1.04)
                   [0.17]

        + 85.09 DMCTYU9F - 24193.2
          (5.74)            (7.43)

        Fit over:  1969-1986             Std Error =  31.114
        R Sq       = 0.8776              D.W.(1)   =   2.8402
        Adj R Sq   = 0.8513              LHS Mean  = 515.77
```

Rice

```
(11.8)  RIYHAU9F = 60.24 TREND - 0.2980 RIAPAU9F - 113597
                   (5.63)        (2.54)              (5.40)

        Fit over:  1967-1986             Std Error =  246.25
        R Sq       = 0.6507              D.W.(1)   =    1.4250
        Adj R Sq   = 0.6096              LHS Mean  = 4716.1
```

above trend, negative one when yields are more than one standard deviation below trend, and zero in all other instances. The dummy variable is intended to serve as a proxy for weather effects.

Production

For each commodity, production is simply equal to area harvested times yield (Table 12). For cotton, yields are expressed in pounds per acre, so it is necessary to divide by 480 to obtain bales. Likewise, rice yields are also reported in pounds per acre, so it is necessary to divide by 100 to obtain hundredweight.

Feed Use

Each of the feed use equations incorporates both own-price and cross-commodity effects (Table 13). To avoid problems with multicollinear prices, cross-commodity effects in corn are captured using a quantity variable rather than the prices of competing feedstuffs. For corn and soybean meal, the model is structured such that feed use changes proportionately with livestock numbers, all else equal. Animal numbers also appear in the wheat and sorghum equations, but without restrictions. Livestock prices appear in the corn and soybean meal equations. Trends and shift variables account for changes in feeding patterns that cannot be explained by changes in prices or aggregate livestock numbers. All coefficient estimates are consistent with expectations.

Soybean Crush

As expected, soybean crush increases with the crushing margin (Table 14). The estimated coefficient on the lagged dependent variable is consistent with the notion that it takes time to adjust crushing capacity. Dummy variables for

Table 12. Structural parameter estimates of equations for production

Wheat

(12.1) WHSPRU9F = WHAHAU9F * WHYHAU9F

Corn

(12.2) COSPRU9F = COAHAU9F * COYHAU9F

Sorghum

(12.3) SGSPRU9 = SGAHAU9 * SGYHAU9

Oats

(12.4) OASPRU9 = OAAHAU9 * OAYHAU9

Barley

(12.5) BASPRU9 = BAAHAU9 * BAYHAU9

Soybeans

(12.6) SBSPRU9F = SBAHAU9F * SBYHAU9F

Cotton

(12.7) CTSPRU9F = CTAHAU9F * CTYHAU9F/480

Rice

(12.8) RISPRU9F = RIAHAU9F * RIYHAU9F/100

Table 13. Structural parameter estimates of equations for feed use

Wheat

```
(13.1)  WHUFEU9 = 35.33(CATN3U9 + GCAUU9/10) - 12778 WHPFMU9/PWJMU9
                  (3.11)                      (2.01)
                  [2.96]                      [-1.00]

        + 5788 COPFMU9/PWJMU9 + 200.9 DM18387 - 275.6
         (0.57)                 (6.11)          (1.63)
         [0.35]

        Fit over:  1967-1986          Std Error =  50.935
        R Sq       = 0.8497           D.W.(1)   =   2.4820
        Adj R Sq   = 0.8096           LHS Mean  = 179.60
```

Corn

```
(13.2)  COUFEU9 = COUFEU9G * GCAUU9

(13.3)  COUFEU9G = -1750 COPFMU9/PWSAU9 + 2374 LVPIU9/PWSAU9
                   (5.91)                (2.04)
                  [-0.29]                [0.29]

        - 0.4298(60 WHUFEU9/56 + SGUFEU9 + 48 BAUFEU9/56 + 32 OAUFEU9/56)/GCAUU9
         (2.22)
        [-0.14]

        + 10.23 LOG(TREND - 1959) + 4.941 SMPFMU9/PWSAU9
          (4.13)                   (1.28)
          [0.06]

        + 14.43 DM173 - 6.735 DM17677 + 40.50
          (4.72)        (3.46)          (3.18)

        Fit over 1967-1986            Std Error =  2.3561
        R Sq     = 0.8866             D.W.(1)   =  3.0808
        Adj R Sq = 0.8204             LHS Mean  = 64.736
```

Sorghum

```
(13.4)  SGUFEU9 = -115318 SGPFMU9/PWSAU9 + 60406 COPFMU9/PWSAU9
                   (2.59)                  (1.49)
                  [-2.08]                  [1.21]

        + 17994 WHPFMU9/PWSAU9 + 38.73 CATNFU9 - 15.95 TRND6783 + 568
         (1.67)                  (1.68)          (3.99)           (2.43)
         [0.47]                  [0.65]
```

Table 13. Continued

Fit over 1967-1986	Std Error = 75.330
R Sq = 0.6605	D.W.(1) = 1.6377
Adj R Sq = 0.5393	LHS Mean = 532.40

Oats

(13.5)
$$\begin{array}{l} OAUFEU9 = \underset{\substack{(8.91)\\ [-0.52]}}{-49237}\ OAPFMU9/PWJMU9 + \underset{\substack{(5.25)\\ [0.27]}}{14174}\ COPFMU9/PWJMU9 \\ \quad - \underset{(24.15)}{21.79}\ TRND7186 - \underset{(6.41)}{65.39}\ DM17780 + \underset{(37.90)}{868.8} \end{array}$$

Fit over 1967-1986	Std Error = 17.698
R Sq = 0.9849	D.W.(1) = 2.4736
Adj R Sq = 0.9809	LHS Mean = 564.50

Barley

(13.6)
$$\begin{array}{l} BAUFEU9 = \underset{\substack{(6.59)\\ [-0.66]}}{0.6383}\ BAUFEU9.1 - \underset{(2.93)}{16247}\ BAPFMU9/PWJMU9 \\ \quad + \underset{\substack{(2.31)\\ [0.43]}}{9326}\ COPFMU9/PWJMU9 + \underset{\substack{(0.39)\\ [0.06]}}{1069}\ WHPFMU9/PWJMU9 \\ \quad + \underset{(2.85)}{31.71}\ DM18285 + \underset{(3.80)}{120.6} \end{array}$$

Fit over: 1967-1986	Std Error = 17.597
R Sq = 0.9014	D.W.(1) = 2.3201
Adj R Sq = 0.8661	LHS Mean = 234.60

Soybean Meal

(13.7)
$$SMUDTU9 = SMUDTU9H * HPAUU9$$

(13.8)
$$\begin{array}{l} SMUDTU9H = \underset{\substack{(3.23)\\ [-0.16]}}{-70.24}\ SMPFMU9/PWSAU9 + \underset{\substack{(1.81)\\ [0.27]}}{11105}\ LVPIU9/PWSAU9 \\ \quad + \underset{\substack{(0.64)\\ [0.03]}}{1056}\ COPFMU9/PWSAU9 - \underset{(2.52)}{48.54}\ DM174 - \underset{(1.93)}{29.27}\ DM183 \\ \quad + \underset{(9.62)}{145.01}\ LOG(TREND - 1959) - \underset{(1.52)}{116.18} \end{array}$$

Fit over: 1967-1986	Std Error = 13.946
R Sq = 0.9483	D.W.(1) = 2.1312
Adj R Sq = 0.9245	LHS Mean = 332.31

Table 14. Structural parameter estimates of equations for soybean crush

Crush

```
(14.1)  SBUFEU9 = 0.5816 SBUFEU9.1 + 195.4 LOG(TREND - 1959)
                  (3.33)             (2.36)

        + 43.43 SBUFTU9(SMPFMU9 * SMYCBU9/1000 + SOPFMU9 * SOYCBU9/100
          (5.29)
          [0.14]

        - SBPFMU9)/PWSAU9 - 617.1 DM172 - 154.6 DM173 - 246.7
                            (5.32)        (2.69)        (2.40)

        Fit over: 1967-1986          Std Error  =  45.162
        R Sq      = 0.9541           D.W.(1)    =   2.2251
        Adj R Sq  = 0.9377           LHS Mean   = 888.50
```

Soybean Meal Production

(14.2) SMSPRU9 = SBUFEU9 * SMYCBU9

Soybean Oil Production

(14.3) SOSPRU9 = SBUFEU9 * SOYCBU9

1972 and 1973 reflect the effects of the Nixon price freeze at a time when world oilseed and oilseed product prices behaved erratically. Meal and oil production are linked to crush by means of technical milling rates that do not vary significantly over time.

Other Domestic Uses

Food demand is expressed in per-capita terms for wheat, corn, oats, barley, soybean oil, and rice. The own-price elasticity is negative in all the food demand equations, and elasticity with respect to real per-capita consumer expenditures is positive, except for oats (Table 15). The corn-food demand equation includes cross-price elasticities with wheat (a substitute for corn used in baking) and sugar (a substitute for corn sweeteners). Consumer expenditure for corn food demand is found to be less elastic after 1982 than in earlier years. Soybean oil demand is negatively related to demand for other oils (palm oil, cottonseed oil, butter, and lard). The demand for these other oils is positively related to soybean oil prices. As expected, wheat is found to be a substitute for rice in food demand.

Wheat-, corn-, and rice-seed demand equations result in expected relationships between seed demand and acreage planted. Likewise, the food, seed, and industrial use equation for oats and the noncrush demand equation for soybeans also incorporate planted area variables. As expected, corn gasohol demand is found to depend in part on the ratio of corn and fuel prices, but trend and shift variables are needed to account for the expansion of the industry in the 1980s. Barley is found to be a substitute for rice in brewing. Cotton mill use is modeled as a derived demand from the textile industry, and

Table 15. Structural parameter estimates of equations for other domestic uses

Wheat Food Use

(15.1) $\mathrm{WHUOFU9 = WHUOFU9C * DEPOPU9}$

(15.2) $\mathrm{WHUOFU9C = -5.038\ WHPFMU9/PWJMU9 - 0.0924\ DM17072}$
(2.86) (4.20)
[-0.03]

$\mathrm{+\ 0.3516\ LOG(CEJMU9/DEPOPU9) + 0.1245\ DM175 + 0.1258\ DM1S85}$
(4.19) (3.71) (4.35)
[0.13]

$+\ 1.967$
(10.59)

Fit over:	1967-1986	Std Error	= 0.0312
R Sq	= 0.9273	D.W.(1)	= 1.9224
Adj R Sq	= 0.9014	LHS Mean	= 2.6494

Wheat Seed Use

(15.3) $\mathrm{WHUSDU9 = 1.332\ WHAPAU9F + 0.4414\ TREND - 879.9}$
(45.84) (7.88) (8.05)
[1.09]

Fit over:	1967-1986	Std Error	= 1.0719
R Sq	= 0.9965	D.W.(1)	= 1.3415
Adj R Sq	= 0.9961	LHS Mean	= 85.515

Wheat Food, Seed, and Industrial Use

(15.4) $\mathrm{WHUFOU9 = WHUOFU9 + WHUSDU9}$

Corn Food Use

(15.5) $\mathrm{COUOFU9 = COUOFU9C * DEPOPU9}$

(15.6) $\mathrm{COUOFU9C = -0.3367\ COPFMU9/(WHPFMU9/2.763 + SUPRTU9/25.8)}$
(2.12)
[-0.14]

$\mathrm{+\ 4.072\ LOG(CESAU9/DEPOPU9) - 2.531\ DM1S82 * LOG(CESAU9/DEPOPU9)}$
(16.82) (1.85)
[1.59] [-0.99]

$\mathrm{+\ 0.3450\ DM1S80 + 5.901\ DM1S83 - 5.901}$
(5.88) (1.89) (10.40)

Fit over:	1967-1986	Std Error	= 0.0688
R Sq	= 0.9921	D.W.(1)	= 1.7900
Adj R Sq	= 0.9893	LHS Mean	= 2.5658

Table 15. Continued

Corn Gasohol Use

```
(15.7)  COUGAU9 = -4773 DM1S80 * COPFMU9/PWFSAU9 + 12.87 TRND8184
                   (2.67)                           (2.20)
                  [-0.11]

        + 602.7 DM1S79 * LOG(TREND - 1965) - 1581 DM1S79 + 0.0000
           (8.12)                            (8.01)        (0.00)

        Fit over: 1967-1986              Std Error  =  6.4611
        R Sq      = 0.9966               D.W.(1)    =  2.7647
        Adj R Sq  = 0.9958               LHS Mean   = 60.500
```

Corn Seed Use

```
(15.8)  COUSDU9 = 0.2787 COAPAU9F + 0.1481 TREND - 296.3
                 (13.88)           (5.39)          (5.51)
                  [1.20]

        Fit over: 1967-1986              Std Error  =  0.6658
        R Sq      = 0.9478               D.W.(1)    =  1.7181
        Adj R Sq  = 0.9417               LHS Mean   = 17.593
```

Corn Food, Seed, and Industrial Use

```
(15.9)  COUFOU9 = COUOFU9 + COUGAU9 + COUSDU9
```

Sorghum Food, Seed, and Industrial Use

```
(15.10) SGUFOU9 = -1858 SGPFMU9/PWSAU9 + 949.1 BAPFMU9/PWSAU9
                   (1.29)                 (1.48)
                  [-1.42]                 [0.71]

        + 567.4 COPFMU9/PWSAU9 + 14.65 DM185 + 14.80
           (0.57)               (6.61)        (7.84)
           [0.48]

        Fit over: 1967-1986              Std Error =  1.9976
        R Sq      = 0.8168               D.W.(1)   =  2.0373
        Adj R Sq  = 0.7680               LHS Mean  = 12.600
```

Oats Food, Seed, and Industrial Use

```
(15.11) OAUFOU9 = OAUFOU9C * DEPOPU9
```

Table 15. Continued

```
(15.12) OAUFOU9C = -2.920 OAPFMU9/PWJMU9 + 1.224 OAAPAU9F/DEPOPU9
                    (0.91)                (3.27)
                   [-0.04]                [0.24]

        - 0.3762 LOG(CEJMU9/DEPOPU9) + 1.116
         (4.71)                       (5.34)
        [-0.95]

        Fit over: 1967-1986              Std Error = 0.0155
        R Sq      = 0.9560               D.W.(1)   = 1.8668
        Adj R Sq  = 0.9478               LHS Mean  = 0.3948
```

Barley Food, Seed, and Industrial Use

```
(15.13) 06/22/90 = BAUFOU9C * DEPOPU9

(15.14) BAUFOU9C = -1.234 BAPFMU9/PWJMU9 + 0.2205 LOG(CEJMU9/DEPOPU9)
                    (1.20)                (5.30)
                   [-0.02]                [0.31]

        + 0.0491 DM1S78 - 0.0169 TRND8185 + 0.2432
         (6.06)          (8.15)            (2.97)

        Fit over: 1967-1986              Std Error = 0.0091
        R Sq      = 0.9453               D.W.(1)   = 2.1638
        Adj R Sq  = 0.9307               LHS Mean  = 0.7053
```

Soybean Noncrush Domestic Use

```
(15.15) SBUFOU9 = 0.5326 SBAPAU9F + 1.313 TREND - 2547
                 (2.08)            (3.01)        (3.00)
                 [0.39]

        Fit over: 1967-1986              Std Error =  6.9793
        R Sq      = 0.7798               D.W.(1)   =  2.1780
        Adj R Sq  = 0.7539               LHS Mean  = 78.950
```

Soybean Oil Domestic Use

```
(15.16) SOUDTU9 = SOUDTU9C * DEPOPU9

(15.17) SOUDTU9C = -38.58 SOPFMU9/PWSAU9 + 18.42 LOG(CESAU9/DEPOPU9)
                    (3.74)                (2.83)
                   [-0.11]                [0.51]

        - 0.9770 OOUDTU9/DEPOPU9 + 5.147 DM173 + 15.62
         (4.23)                   (3.23)        (0.89)
        [-0.41]

        Fit over: 1967-1986           Std Error  =  1.1729
        R Sq      = 0.9631            D.W.(1)    =  1.9690
        Adj R Sq  = 0.9533            LHS Mean   = 36.377
```

Table 15. Continued

Other Oils Domestic Use

```
(15.18) OOUDTU9 = 1095(SOPFMU9/PWSAU9 + SOPFMU9.1/PWSAU9.1)
                  (1.42)
                  [0.07]

        - 1673 LOG(TREND - 1959) + 2656.9 DM1S78 * LOG(TREND - 1959)
         (7.91)                      (4.77)

        - 7883 DM1S78 + 7567
         (4.79)        (16.56)

        Fit over: 1967-1986           Std Error  =  145.65
        R Sq      = 0.9218            D.W.(1)    =    2.1302
        Adj R Sq  = 0.9009            LHS Mean   = 3301.6
```

Cotton Mill Use:

```
(15.19) CTUMDU9 = -2.217 CTPMKU9/PWAJU9 + 10.76 TXPMIU9/PWAJU9
                   (1.26)                  (7.72)
                  [-0.09]                  [1.22]

        + 0.000495 TXSPRU9 - 1.243 DM174 + 1.137 DM175 - 6.252
         (3.06)              (2.89)        (2.35)        (2.67)
         [0.81]

        Fit over: 1970-1986             Std Error = 0.4037
        R Sq        = 0.8747            D.W. (1)  = 1.8729
        Adj R Sq    = 0.8177            LHS Mean  = 6.6363
```

Rice Food Use:

```
(15.20) RIUOFU9 = RIUOFU9C * DEPOPU9

(15.21) RIUOFU9C = 0.4106 RIUOFU9C.1 - 0.3084 RIPWHU9/PWAJU9
                   (1.86)               (1.41)
                                        [-0.19]

        + 1.934 WHPFMU9/PWAJU9 + 0.00546 CEAJU9/DEPOPU9
         (1.27)                  (0.96)
         [0.19]                  [0.32]

        + 0.0384 DM1S85 + 0.0380
         (2.66)          (0.77)

        Fit over: 1967-1986          Std Error  = 0.0152
        R Sq        = 0.7913         D.W. (1)   = 1.9353
        Adj R Sq    = 0.7168         LHS Mean   = 0.1440
```

Rice Brewing Use

```
(15.22) RIUBRU9 = RIUBRU9C * DEPOPU9
```

Table 15. Continued

```
(15.23) RIUBRU9C = 0.3754 RIUBRU9C.1 - 0.0312 RIPWHU9/PWAJU9
                  (1.61)              (1.14)
                                     [-0.06]

        + 0.2401 BAPFMU9/PWAJU9 + 0.00641 CEAJU9/DEPOPU9 - 0.0249
         (0.71)                  (2.46)                   (1.84)
         [0.05]                  [1.20]

        Fit over: 1967-1986      Std Error = 0.0026
        R Sq      = 0.9520       D.W. (1)  = 2.3116
        Adj R Sq  = 0.9392       LHS Mean  = 0.0452
```

Rice Seed Use

```
(15.24) RIUSDU9 = 0.00137 RIAPAU9F - 0.6946 DM1S83 + 0.0626
                 (27.58)            (10.61)         (0.48)
                  [1.02]

        Fit over: 1967-1986      Std Error  = 0.1171
        R Sq      = 0.9812       D.W. (1)   = 1.2043
        Adj R Sq  = 0.9790       LHS Mean   = 3.4188
```

estimated coefficients indicate that increases in textile production and textile prices result in increases in cotton mill demand.

Free Stock Equations

For wheat and corn, nine-month loan stocks are treated as a type of government stock substituting imperfectly for free stocks. For the other commodities, free and nine-month loan stocks are aggregated, which implies that they are perfect substitutes for one another. This is done primarily because of data limitations--nine-month loan stocks for some commodities were unavailable when the model was estimated.

Next year's production is one determinant of free stocks in the wheat, corn, soybean, and rice equations. As expected, estimated coefficients indicate that producers and others reduce stockholdings when they anticipate a large crop (Table 16). Sorghum, oats, and barley equations do not incorporate expected production, so there is no need to shift forward by one year the supply portions of those sub-models.

For all commodities, prices and current production have the expected effect on stock demand. Across the board, government stocks are found to be imperfect substitutes for free stocks. The displacement of free stocks ranged from 0.63 bushels of free stocks per bushel of government program stocks of barley to a low of 0.20 to one for oats.

Total Stocks

Total ending stocks are simply the sum of the endogenous free stocks and the exogenous government stocks for wheat, corn, sorghum, barley, oats, soybeans, and rice. Soybean meal stocks are insignificant; and the estimated

Table 16. Structural parameter estimates of equations for free stocks

Wheat Free Stocks

(16.1) WHFREU9 = -16733 WHPFMU9/PWJMU9 - 0.2763 WHSPRU9F
(3.57) (3.52)
[-0.79] [-1.89]

+ 0.2252 WHSPRU9F.1 - 0.4576(WHCCCU9 + WHFORU9 + WH9LNU9)
(2.75) (9.16)
[1.54] [-1.13]

+ 291.2 DM1S74 + 790.9
(5.54) (6.58)

Fit over:	1967-1986	Std Error	= 61.749
R Sq	= 0.9110	D.W.(1)	= 2.3092
Adj R Sq	= 0.8792	LHS Mean	= 297.68

Corn Free Stocks

(16.2) COFREU9 = -31056 COPFMU9/PWSAU9 - 0.0527 COSPRU9F
(1.89) (1.74)
[-0.64] [-0.66]

+ 0.1473 COSPRU9F.1 + 231.2 DM1S75
(3.92) (2.12)
[1.83]

- 0.3126(CO9LNU9 + COCCCU9 + COFORU9) + 465.7
(7.46) (1.47)
[-0.68]

Fit over:	1967-1986	Std Error	= 133.41
R Sq	= 0.8490	D.W.(1)	= 1.9372
Adj R Sq	= 0.7951	LHS Mean	= 512.90

Sorghum Free and Nine-Month Loan Stocks

(16.3) SGF9LNU9 = 0.3956 SGF9LNU9.1 - 14295 SGPFMU9/PWSAU9
(2.02) (1.92)
[-1.51]

+ 0.2301 SGSPRU9 - 0.2341(SGCCCU9 + SGFORU9) + 51.68
(2.31) (2.02) (0.40)
[1.97] [-0.38]

Fit over:	1967-1986	Std Error	= 54.056
R Sq	= 0.6041	D.W.(1)	= 1.6978
Adj R Sq	= 0.4985	LHS Mean	= 91.300

Table 16. Continued

Oats Free and Nine-Month Loan Stocks

(16.4)
$$\text{OAF9LU9} = \underset{(2.91)}{0.3822}\ \text{OAF9LU9.1} - \underset{\substack{(4.38)\\ [-0.35]}}{14471}\ \text{OAPFMU9/PWJMU9}$$

$$+ \underset{\substack{(12.49)\\ [1.16]}}{0.4403}\ \text{OASPRU9} - \underset{\substack{(0.94)\\ [-0.04]}}{0.2029}(\text{OACCCU9} + \text{OAFORU9}) - \underset{(1.10)}{38.84}$$

Fit over:	1967-1986	Std Error	= 19.127
R Sq	= 0.9722	D.W.(1)	= 1.7625
Adj R Sq	= 0.9647	LHS Mean	= 245.25

Barley Free and Nine-Month Loan Stocks

(16.5)
$$\text{BAF9LU9} = \underset{\substack{(2.10)\\ [-0.48]}}{0.3493}\ \text{BAF9LU9.1} - \underset{(2.43)}{7601}\ \text{BAPFMU9/PWJMU9}$$

$$+ \underset{\substack{(1.72)\\ [0.89]}}{0.2997}\ \text{BASPRU9} - \underset{\substack{(2.94)\\ [-0.20]}}{0.6323}(\text{BACCCU9} + \text{BAFORU9})$$

$$- \underset{(3.04)}{48.10}\ \text{DM18183} + \underset{(0.69)}{72.53}$$

Fit over:	1967-1986	Std Error	= 22.565
R Sq	= 0.7303	D.W.(1)	= 2.1165
Adj R Sq	= 0.6339	LHS Mean	= 149.75

Soybean Free and Nine-Month Loan Stocks

(16.6)
$$\text{SBF9LU9} = \underset{\substack{(1.64)\\ [-0.66]}}{-5063}\ \text{SBPFMU9/PWSAU9} - \underset{\substack{(1.22)\\ [-0.54]}}{0.0651}\ \text{SBSPRU9F}$$

$$+ \underset{\substack{(4.18)\\ [-1.89]}}{0.2291}\ \text{SBSPRU9F.1} + \underset{(1.98)}{133.4}\ \text{DM174} - \underset{\substack{(1.05)\\ [-0.05]}}{0.2405}\ \text{SBCCCU9} + \underset{(0.58)}{74.54}$$

Fit over:	1967-1986	Std Error	= 56.775
R Sq	= 0.7660	D.W.(1)	= 1.7288
Adj R Sq	= 0.6824	LHS Mean	= 198.60

Rice Free and Nine-Month Loan Stocks

(16.7)
$$\text{RIF9LU9} = \underset{\substack{(1.55)\\ [-0.39]}}{-177.8}\ \text{RIPFMU9/PWAJU9} - \underset{\substack{(1.78)\\ [-0.74]}}{0.1183}\ \text{RISPRU9F/1000}$$

Table 16. Continued

$$+\ 0.3335\ RISPRU9F.1/1000 - 0.3165\ RICCCU9 + 15.76\ DM1S82$$
$$\underset{[2.05]}{(4.44)} \qquad \underset{[-0.21]}{(2.20)} \qquad (3.31)$$

$$+\ 1.552$$
$$(0.15)$$

Fit over:	1967-1986	Std Error	= 5.6560
R Sq	= 0.8458	D.W. (1)	= 1.9497
Adj R Sq	= 0.7907	LHS Mean	= 19.018

equation includes only beginning stocks, a price term, and dummy variables. Soybean oil stocks are more important. The price responsiveness of soybean oil stocks is relatively weak, but stocks are responsive to changes in soybean oil production and exports. The estimated negative coefficient on SBSPRU9F, though insignificant, is consistent with the hypothesis that the prospect of larger soybean supplies should discourage the holding of soybean and soybean-product stocks.

In the case of cotton, total stocks are estimated rather than free stocks because attempts to estimate alternative specifications indicate that there is little practical benefit in separating free from government stocks. The cotton stocks equation is specified much like the free stocks equations are for major grains and soybeans (Table 17).

Trade

U.S. export demand for wheat, corn, sorghum, soybeans, soybean meal, soybean oil, and rice are determined by reduced form equations mimicking the price responsiveness of the FAPRI trade models. Net import demand for oats is estimated as a function of the oats/corn price ratio. Synthetic equations for barley and cotton export demand are used in the current version of the model. When the FAPRI world cotton model is operational, a reduced-form equation will be used to determine U.S. cotton exports. Similarly, when barley is disaggregated in the world feed grains model, U.S. barley exports will also be determined by a reduced form equation. See Table 18 for the equations used to determine total exports.

Table 17. Structural parameter estimates of equations for total stocks

Wheat

(17.1) WHCOTU9 = WHFREU9 + WH9LNU9 + WHFORU9 + WHCCCU9

Corn

(17.2) COCOTU9 = COFREU9 + CO9LNU9 + COFORU9 + COCCCU9

Sorghum

(17.3) SGCOTU9 = SGCCCU9 + SGFORU9 + SGF9LU9

Oats

(17.4) OACOTU9 = OACCCU9 + OAFORU9 + OAF9LU9

Barley

(17.5) BACOTU9 = BAF9LU9 + BACCCU9 + BAFORU9

Soybeans

(17.6) SBCOTU9 = SBF9LU9 + SBCCCU9

Soybean Meal

```
(17.7)  SMCOTU9 = 0.4295 SMCOTU9.1 - 29.70 SMPFMU9/PWSAU9
                  (3.26)              (0.55)
                                     [-0.09]

        + 319.2 DM173 + 279.4 DM182 + 137.9
           (4.90)        (4.26)        (2.33)

        Fit over: 1967-1985          Std Error  =  62.043
        R Sq      = 0.7601           D.W.(1)    =   2.5547
        Adj R Sq  = 0.6916           LHS Mean   = 253.16
```

Soybean Oil

```
(17.8)  SOCOTU9 = -1672 SOPFMU9/PWSAU9 + 0.2198 SOSPRU9
                   (1.41)                (6.09)
                  [-0.19]                [2.39]

        - 0.1349 SBSPRU9F - 0.3156 SOUXTU9 - 543.4 DM18385 - 272.5
          (0.76)             (2.82)            (4.28)           (0.93)
         [-0.25]            [-0.55]
```

Table 17. Continued

```
        Fit over: 1967-1986            Std Error = 178.29
        R Sq      = 0.8370             D.W.(1)   =   1.8853
        Adj R Sq  = 0.7788             LHS Mean  = 889.45
```

Cotton

```
(17.9)  CTCOTU9 = 0.3381 CTCOTU9.1 - 0.3541 CTSPRU9F
                  (2.79)             (5.09)
                                    [-0.93]

        + 0.4776 CTSPRU9F.1 - 6.006 CTPMKU9/PWAJU9 + 2.838 DM185
         (4.33)              (2.47)                   (4.40)
         [1.25]             [-0.35]

        - 3.045 DM179 + 3.342
         (4.64)        (1.37)

        Fit over:  1971-1986              Std Error = 0.5743
        R Sq       = 0.9472               D.W. (1)  = 2.0353
        Adj R Sq   = 0.9120               LHS Mean  = 4.6498
```

Rice

```
(17.10) RICOTU9 = RIF9LU9 + RICCCU9
```

Table 18. Structural parameter estimates of equations for trade

Wheat Exports

(18.1) WHUXTU9 = -153 WHPFMU9 - 124 WHPFMU9.1 - 116 WHPFMU9.2

- 89 WHPFMU9.3 + 34 COPFMU9 + 59 COPFMU9.1 + 54 COPFMU9.2

+ 32 COPFMU9.3 + 31 SGPFMU9.1 + 20 SGPFMU9.2 + 10 SGPFMU9.3

+ 11 BAPFMU9 + 16 SBPFMU9.1 + 9 SBPFMU9.2 + 4 SBPFMU9.3

+ 0.2 SMPFMU9 + 8.7 RIPXETH + 1.6 RIPXETH.1 + 1.3 RIPXETH.2

+ 1.0 RIPXETH.3 + WHUXEU9

Corn Exports

(18.2) COUXTU9 = -230 COPFMU9 - 108 COPFMU9.1 - 72 COPFMU9.2

- 46 COPFMU9.3 + 33 WHPFMU9 + 39 WHPFMU9.1 + 30 WHPFMU9.2

+ 23 WHPFMU9.3 + 39 SGPFMU9 - 123 BAPMFU9 - 55 BAPFMU9.1

- 46 BAPFMU9.2 - 26 BAPFMU9.3 + 26 SBPFMU9.1 + 18 SBPFMU9.2

+ 9 SBPFMU9.3 + 0.4 SMPFMU9 - 0.86 BAUXTU9 + 0.68 OASMTU9

+ COUXEU9

Sorghum Exports

(18.3) SGUXTU9 = -182 SGPFMU9 - 52 SGPFMU9.1 - 33 SGPFMU9.2

- 19 SGPFMU9.3 + 157 COPFMU9 + 29 WHPFMU9.1 + 16 WHPFMU9.2

+ 8 WHPFMU9.3 + 5 BAPFMU9.1 + 5 BAPFMU9.2 + 4 BAPFMU9.3

Oats Total Imports

(18.4) OASMTU9 = OASMNU9 + OAUXTU9

Oats Net Imports

(18.5) $$\text{OASMNU9} = \underset{(1.68)}{22.84}\ \text{OAPFMU9/COPFMU9} + \underset{(12.11)}{37.84}\ \text{DM1S83}$$

$$- \underset{(7.82)}{44.72}\ \text{DM173} - \underset{(2.92)}{22.85}$$

Table 18. Continued

Fit over: 1967-1986	Std Error = 5.3670
R Sq = 0.9445	D.W.(1) = 1.5777
Adj R Sq = 0.9340	LHS Mean = -4.450

Barley Exports

(18.6) BAUXTU9 = -200 BAPFMU9 + 100 COPFMU9 + 40 WHPFMU9 + BAUXEU9

Soybean Exports

(18.7) SBUXTU9 = -80.48 SBPFMU9 - 46.51 SBPFMU9.1

- 24.09 SBPFMU9.2 - 11.59 SBPFMU9.3 + 1.96 SMPFMU9

+ 0.90 SMPFMU9.1 + 0.46 SMPFMU9.2 + 0.23 SMPFMU9.3

+ 9.40 SOPFMU9 + 4.36 SOPFMU9.1 + 2.24 SOPFMU9.2

+ 1.20 SOPFMU9.3 + SBUXEU9

Soybean Meal Exports

(18.8) SMUXTU9 = -34.10 SMPFMU9 - 11.23 SMPFMU9.1 - 6.33 SMPFMU9.2

- 3.60 SMPFMU9.3 - 102.15 SOPFMU9 - 58.85 SOPFMU9.1

- 35.91 SOPFMU9.2 - 21.81 SOPFMU9.3 + 833.56 SBPFMU9

+ 334.60 SBPFMU9.1 + 91.18 SBPFMU9.2 + 7.57 SBPFMU9.3

+ SMUXEU9

Soybean Oil Exports

(18.9) SOUXTU9 = -123.45 SOPFMU9 - 36.20 SOPFMU9.1

- 20.63 SOPFMU9.2 - 11.67 SOPFMU9.3 - 14.31 SMPFMU9

- 7.52 SMPFMU9.1 - 4.10 SMPFMU9.2 - 2.20 SMPFMU9.3

+ 586.89 SBPFMU9 + 264.92 SBPFMU9.1 + 101.12 SBPFMU9.2

+ 30.91 SBPFMU9.3 + SOUXEU9

Cotton Net Exports

(18.10) CTUXNU9 = -0.12 CTPFMU9 + CTUXEU9

Table 18. Continued

Rice Exports

(18.11) RIUXTU9 = -12.334 RIPXETH - 0.624 RIPXETH.1

- 1.929 RIPXETH.2 - 1.254 RIPXETH.3 + 5.718 WHPFMU9

+ 0.856 WHPFMU9.1 + 0.951 WHPFMU9.2 + 0.767 WHPFMU9.3

+ RIUXEU9

Price Linkages

For all commodities, the principal market price is determined by an iteration process equating supply with demand. For cotton and rice, the model utilizes more than one price (Table 19). The cotton market is solved for the market price, and the rice market is solved for the Thai export price. Simple price transmission equations link these prices to other cotton and rice prices used in the model. In all cases, estimated price transmission elasticities are close to one, as expected.

Market-clearing Identities

The market-clearing identities require supply to equal demand in each market. The residual term in each equation accounts for statistical discrepancies in the historical data and is equal to zero in most years, for most commodities. Imports of each commodity except oats are exogenous. All other variables included in the market-clearing identities are determined endogenously in the model (Table 20).

Textile Market

The textile market is included in the model so that the textile price index and the textile production variable used in the cotton model can be determined endogenously (Table 21). The fiber price index (a composite of cotton, rayon, and polyester prices) is derived from a translog cost function estimated by Yanagishima 1990. The estimated coefficients in the textile equations are consistent with expectations.

Table 19. Structural parameter estimates of equations for price linkages

Cotton Farm Price

(19.1) CTPFMU9 = 0.9120 CTPMKU9 - 16.52 DM173 + 2.775 DM1S84
(20.64) (5.82) (1.60)
[1.01]

- 0.07395
(0.03)

Fit over:	1970-1986	Std Error	= 2.6971
R Sq	= 0.9713	D.W. (1)	= 1.8947
Adj R Sq	= 0.9646	LHS Mean	= 51.52

Rice Export Price

(19.2) RIPXEU9 = 1.192 RIPXETH + 4.923 DM18285 - 0.2195
(19.29) (6.17) (0.23)
[0.95]

Fit over:	1967-1986	Std Error	= 1.4017
R Sq	= 0.9570	D.W. (1)	= 2.0887
Adj R Sq	= 0.9520	LHS Mean	= 16.948

Rice Wholesale Price

(19.3) RIPWHU9 = RIPXEU9 + RIPSBU9

Rice Farm Price

(19.4) RIPFMU9 = 0.4389 RIPWHU9 - 1.121 DM1S82 + 0.5536
(21.05) (3.98) (1.43)
[0.97]

Fit over:	1967-1986	Std Error	= 0.5447
R Sq	= 0.9645	D.W. (1)	= 2.2447
Adj R Sq	= 0.9603	LHS Mean	= 7.8665

Table 20. Specification of market-clearing identities

Wheat

(20.1) WHSPRU9F.1 + WHCOTU9.1 + WHSMTU9 = WHUFEU9 + WHUFOU9 + WHUXTU9 + WHCOTU9 + WHURSU9

Corn

(20.2) COSPRU9F.1 + COCOTU9.1 + COSMTU9 = COUFEU9 + COUFOU9 + COUXTU9 + COCOTU9 + COURSU9

Sorghum

(20.3) SGSPRU9 + SGCOTU9.1 + SGSMTU9 = SGUFEU9 + SGUFOU9 + SGUXTU9 + SGCOTU9 + SGURSU9

Oats

(20.4) OASPRU9 + OACOTU9.1 + OASMTU9 = OAUFEU9 + OAUFOU9 + OAUXTU9 + OACOTU9 + OAURSU9

Barley

(20.5) BASPRU9 + BACOTU9.1 + BASMTU9 = BAUFEU9 + BAUFOU9 + BAUXTU9 + BACOTU9 + BAURSU9

Soybeans

(20.6) SBSPRU9F.1 + SBCOTU9.1 = SBUFEU9 + SBUFOU9 + SBUXTU9 + SBCOTU9 + SBURSU9

Soybean Meal

(20.7) SMSPRU9 + SMCOTU9.1 = SMUDTU9 + SMUXTU9 + SMCOTU9 + SMURSU9

Soybean Oil

(20.8) SOSPRU9 + SOCOTU9.1 + SOSMTU9 = SOUDTU9 + SOUXTU9 + SOCOTU9 + SOURSU9

Cotton

(20.9) CTSPRU9F.1 + CTCOTU9.1 = CTUMDU9 + CTUXNU9 + CTCOTU9 + CTURSU9

Rice

(20.10) RISPRU9F.1/1000 + RICOTU9.1 + RISMTU9 = RIUOFU9 + RIUBRU9 + RIUSDU9 + RIUXTU9 + RICOTU9 + RIURSU9

Table 21. Structural parameter estimates of equations for the textile market

Fiber Price Index

(21.1)

$$
\begin{aligned}
\text{FBPMIU9} = \text{EXP}\Big[&0.3017\ \text{LOG}(9.385 + 0.9225\ \text{CTPMKU9}) \\
&+ 0.09162\ \text{LNPFRAY} + 0.6066\ \text{LNPFPOL} + 0.5\Big(0.2444\{[\text{LOG}(9.385 \\
&+ 0.9225\ \text{CTPMKU9})]\ {**}\ 2\} - 0.1173(\text{LNPFRAY}\ {**}\ 2) \\
&- 0.2139(\text{LNPFPOL}\ {**}\ 2)\Big) - 0.17038\ \text{LOG}(9.385 + 0.9225\ \text{CTPMKU9}) \\
&* \text{LNPFRAY} - 0.07399\ \text{LOG}(9.385 + 0.9225\ \text{CTPMKU9})\ \text{LNPFPOL} \\
&+ 0.28768\ \text{LNPFPOL} * \text{LNPFRAY}\Big]
\end{aligned}
$$

Textile Production

(21.2)

$$
\begin{array}{llll}
\text{TXSPRU9} = & 0.8162\ \text{TXSPRU9.1} & + 17.59(\text{CEU9} - \text{CEU9.1}) & \\
 & (5.18) & (4.08) & \\
 & + 837.2\ \text{TXPMIU9.1/FBPMIU9.1} & - 1060\ \text{DM18485} & - 1043 \\
 & (1.74) & (2.43) & (0.50) \\
 & [0.21] & &
\end{array}
$$

Fit over:	1971-1987	Std Error	= 490.77
R Sq	= 0.7725	D.W. (1)	= 2.7555
Adj R Sq	= 0.6966	LHS Mean	= 11050

Domestic Use

(21.3)

$$\text{TXUDTU9} = \text{TXUDTU9C} * \text{DEPOPU9}$$

(21.4)

$$
\begin{array}{llll}
\text{TXUDTU9C} = & -5.778\ \text{TXPMIU9/PW} & + 0.6561\ \text{TXSPRU9/DEPOPU9} & \\
 & (1.74) & (6.44) & \\
 & [-0.09] & [0.60] & \\
 & + 11.81(\text{CEU9} - \text{CEU9.1})/\text{DEPOPU9} & + 4.909\ \text{TRND8587} & + 21.68 \\
 & (5.05) & (6.96) & (4.50)
\end{array}
$$

Fit over:	1970-1986	Std Error	= 1.3497
R Sq	= 0.9445	D.W. (1)	= 1.5165
Adj R Sq	= 0.9260	LHS Mean	= 52.900

Table 21. Continued

Imports

(21.5) TXSMTU9 = 0.4941 TXSMTU9.1 + 8453 TXPMIU9/PW
(1.79) (3.15)
[3.62]

+ 281.9 TREND - 563297
(3.23) (3.23)

Fit over:	1971-1986	Std Error	= 212.63
R Sq	= 0.9654	D.W. (1)	= 2.2426
Adj R Sq	= 0.9567	LHS Mean	= 1803.0

Exports

(21.6) TXUXTU9 = -1076 TXPMIU9/PW + 33.91 TREND - 459.9 DM1S82
(1.68) (1.86) (5.20)
[-1.15]

- 65355
(1.79)

Fit over:	1970-1986	Std Error	= 79.433
R Sq	= 0.8831	D.W. (1)	= 2.2038
Adj R Sq	= 0.8562	LHS Mean	= 732.99

Market-clearing Identity

(21.7) TXSPRU9 + TXSMTU9 = TXUDTU9 + TXUXTU9

Model Validation

A variety of methods can be used to validate an econometric model. One common method is to conduct a dynamic simulation of the model over a historical period, and compare the solution values of important variables to their actual values. This provides a way of testing the internal consistency and dynamic stability of the model. This section presents the results of a dynamic simulation of the FAPRI U.S. crops model.

Most of the equations of the model were estimated over the 1967-1986 period, but the estimation period begins in 1971 for some variables. Therefore, the model is simulated over the 1971-1986 period. The simulation is dynamic, which means that the model sets any lagged endogenous variable equal to its solution value rather than to its actual value.

For purposes of simulation, the effects of random weather on crop yields have been removed. This was accomplished by adding to each yield equation an adjustment term equal to the difference between the actual yield and the predicted value of the OLS equation. Thus, at actual levels of all endogenous variables, simulated yields equal actual yields; but if the values of endogenous variables do not reflect their actual levels, the simulated yields will also differ from actual yields. Thus, the economic behavior represented in the yield equation is preserved, but the large amount of random error introduced into the model by the effects of weather shocks on crop yields is excluded.

Table 22 presents several key simulation statistics for 145 important endogenous variables (certain minor variables, such as the percentage of planted area harvested, are omitted). The first column reports the mean of the variable to make it easier to interpret the root mean squared error reported in

Table 22. Dynamic simulation of the U.S. crops model over the 1971-86 period: Simulation statistics

		Mean	Root Mean Squared Error	Root Mean Squared % Error	Theil Statistics UM	UR	UD
Exp. Participant Net Returns							
Wheat	WHNRPU9F	65.74	4.89	6.47	0.100	0.012	0.888
Corn	CONRPU9F	130.25	16.21	13.17	0.046	0.092	0.862
Sorghum	SGNRPU9	67.51	5.69	8.56	0.005	0.001	0.994
Oats	OANRPU9	29.17	7.71	27.62	0.011	0.169	0.820
Barley	BANRPU9	52.51	3.68	6.10	0.004	0.004	0.993
Cotton	CTNRPU9F	60.34	0.62	0.79	0.159	0.133	0.708
Rice	RINRPU9F	79.37	0.47	0.40	0.061	0.068	0.871
Exp. Nonpart. Net Returns							
Wheat	WHNRNU9F	57.97	11.09	24.16	0.002	0.131	0.868
Corn	CONRNU9F	118.58	30.10	36.20	0.003	0.261	0.737
Sorghum	SGNRNU9	60.55	15.31	31.23	0.006	0.269	0.725
Oats	OANRNU9	30.13	9.18	33.56	0.001	0.280	0.720
Barley	BANRNU9	49.70	8.73	19.58	0.002	0.111	0.887
Soybeans	SBNRNU9F	112.93	40.98	38.13	0.022	0.656	0.322
Cotton	CTNRNU9F	85.33	25.97	46.55	0.001	0.199	0.801
Rice	RINRNU9F	173.45	26.78	17.81	0.002	0.053	0.945
Model Participation Rates							
Wheat	WHMPRU9F	0.460	0.149	21.23	0.007	0.010	0.982
Corn	COMPRU9F	0.358	0.145	55.30	0.035	0.006	0.959
Sorghum	SGMPRU9	0.369	0.098	19.01	0.005	0.012	0.983
Oats	OAMPRU9	0.037	0.025	35.44	0.143	0.097	0.760
Barley	BAMPRU9	0.325	0.153	31.59	0.014	0.025	0.961
Cotton	CTMPRU9F	0.296	0.057	14.20	0.050	0.001	0.949
Rice	RIMPRU9F	0.315	0.031	5.87	0.003	0.009	0.988
Participant Planted Area							
Wheat	WHAPPU9F	20.57	6.48	21.54	0.000	0.036	0.964
Corn	COAPPU9F	22.57	9.99	55.30	0.055	0.050	0.895
Sorghum	SGAPPU9	5.39	1.36	19.01	0.026	0.013	0.961
Oats	OAAPPU9	0.30	0.19	35.44	0.145	0.092	0.763
Barley	BAAPPU9	3.16	1.65	31.59	0.015	0.091	0.894
Cotton	CTAPPU9F	3.14	0.67	14.26	0.061	0.019	0.920
Rice	RIAPPU9F	0.88	0.08	5.87	0.001	0.024	0.975
Annual Program Idled Area							
Wheat	WHAIAU9F	9.96	2.44	21.23	0.000	0.159	0.841
Corn	COAIAU9F	7.36	2.95	55.30	0.006	0.029	0.965
Sorghum	SGAIAU9	1.63	0.21	19.01	0.000	0.018	0.981
Oats	OAAIAU9	0.06	0.05	35.44	0.115	0.115	0.770
Barley	BAAIAU9	0.77	0.63	31.59	0.019	0.141	0.840
Cotton	CTAIAU9F	1.45	0.22	12.30	0.028	0.034	0.938
Rice	RIAIAU9F	0.42	0.05	5.87	0.032	0.224	0.743

Table 22. Continued

		Mean	Root Mean Squared Error	Root Mean Squared % Error	Theil Statistics		
					UM	UR	UD
Nonparticipant Planted Area							
Wheat	WHAPNU9F	53.03	9.99	46.27	0.001	0.101	0.898
Corn	COAPNU9F	55.21	11.00	33.40	0.037	0.010	0.953
Sorghum	SGAPNU9	11.40	1.75	26.30	0.020	0.019	0.961
Oats	OAAPNU9	15.46	0.94	6.54	0.035	0.097	0.869
Barley	BAAPNU9	7.14	2.05	66.36	0.002	0.331	0.667
Cotton	CTAPNU9F	8.90	1.19	108.65	0.025	0.014	0.961
Rice	RIAPNU9F	1.80	0.24	51.97	0.001	0.002	0.997
Total Planted Area							
Wheat	WHAPAU9F	73.61	4.57	6.44	0.003	0.309	0.688
Corn	COAPAU9F	77.78	2.20	3.10	0.010	0.017	0.973
Sorghum	SGAPAU9	16.79	0.62	3.87	0.002	0.023	0.975
Oats	OAAPAU9	15.76	0.87	5.62	0.014	0.051	0.935
Barley	BAAPAU9	10.29	0.98	9.79	0.012	0.028	0.961
Soybeans	SBAPAU9F	61.04	4.64	7.90	0.000	0.103	0.897
Cotton	CTAPAU9F	12.04	1.00	8.37	0.001	0.078	0.921
Rice	RIAPAU9F	2.67	0.21	7.58	0.001	0.005	0.994
Total Harvested Area							
Wheat	WHAHAU9F	64.51	3.83	6.44	0.002	0.269	0.730
Corn	COAHAU9F	67.95	2.05	3.31	0.015	0.006	0.979
Sorghum	SGAHAU9	14.08	0.77	5.55	0.001	0.005	0.994
Oats	OAAHAU9	10.96	1.01	9.86	0.010	0.111	0.879
Barley	BAAHAU9	9.44	0.92	9.97	0.012	0.023	0.965
Soybeans	SBAHAU9F	59.74	4.71	8.22	0.000	0.116	0.884
Cotton	CTAHAU9F	11.19	0.90	8.26	0.002	0.067	0.932
Rice	RIAHAU9F	2.65	0.21	7.58	0.001	0.005	0.994
Yield per Harvested Acre							
Wheat	WHYHAU9F	33.75	0.07	0.20	0.000	0.065	0.935
Corn	COYHAU9F	99.60	0.27	0.28	0.006	0.002	0.992
Sorghum	SGYHAU9	56.18	0.00	0.00	0.999	0.000	0.001
Oats	OAYHAU9	53.42	0.00	0.00	0.145	0.206	0.650
Barley	BAYHAU9	48.10	0.00	0.00	1.000	0.000	0.000
Soybeans	SBYHAU9F	29.37	0.24	0.84	0.000	0.048	0.952
Cotton	CTYHAU9F	525.43	0.00	0.00	0.995	0.002	0.003
Rice	RIYHAU9F	4765.25	63.09	1.36	0.001	0.143	0.856
Production							
Wheat	WHSPRU9F	2177.4	129.40	6.29	0.005	0.095	0.899
Corn	COSPRU9F	6801.0	195.5	3.10	0.015	0.004	0.981
Sorghum	SGSPRU9	793.8	47.7	5.55	0.000	0.002	0.998
Oats	OASPRU9	580.6	52.7	9.86	0.005	0.051	0.945
Barley	BASPRU9	455.6	45.5	9.97	0.012	0.025	0.964
Soybeans	SBSPRU9F	1761.6	126.7	7.39	0.002	0.095	0.904
Cotton	CTSPRU9F	12.1	1.0	8.27	0.000	0.014	0.986
Rice	RISPRU9F	126.1	8.0	6.23	0.004	0.019	0.977

Table 22. Continued

		Mean	Root Mean Squared Error	Root Mean Squared % Error	Theil Statistics UM	UR	UD
Feed Use							
Wheat	WHUFEU9	188.7	48.2	41.54	0.001	0.001	0.998
Corn	COUFEU9	4054.8	120.2	3.03	0.001	0.008	0.991
Sorghum	SGUFEU9	511.6	49.5	11.39	0.008	0.005	0.987
Oats	OAUFEU9	522.1	24.6	5.17	0.010	0.195	0.795
Barley	BAUFEU9	232.9	16.6	8.50	0.179	0.014	0.807
Soymeal	SMUDTU9	16608.6	592.7	3.67	0.000	0.028	0.972
Soybean Crush							
Bean Crush	SBUFEU9	943.2	36.4	3.84	0.006	0.084	0.911
Meal Production	SMSPRU9	22427.2	865.4	3.84	0.006	0.096	0.898
Oil Production	SOSPRU9	10294.8	391.1	3.84	0.005	0.060	0.935
Other Domestic Use							
Wheat Food	WHUOFU9	599.7	5.7	0.94	0.001	0.000	0.998
Wheat Seed	WHUSDU9	91.3	5.9	7.00	0.001	0.188	0.811
Corn Food	COUOFU9	627.6	14.3	2.95	0.004	0.088	0.908
Corn Gasohol	COUGAU9	75.6	5.4	6.93	0.005	0.005	0.990
Corn Seed	COUSDU9	18.6	0.9	4.77	0.004	0.090	0.906
Sorghum FSI	SGUFOU9	12.8	1.9	13.39	0.011	0.052	0.937
Oats FSI	OAUFOU9	82.4	3.7	4.63	0.000	0.000	1.000
Barley FSI	BAUFOU9	160.6	1.7	1.08	0.008	0.050	0.943
Soybean FSI	SBUFOU9	84.1	7.3	8.37	0.005	0.062	0.933
Soy Oil Use	SOUDTU9	8612.6	211.1	2.42	0.000	0.073	0.927
Other Oil Use	OOUDTU9	3137.5	119.0	3.61	0.010	0.272	0.718
Cotton Mill	CTUMDU9	6.5	0.5	7.76	0.004	0.289	0.707
Rice Food	RIUOFU9	33.7	3.5	11.24	0.001	0.000	0.999
Rice Brewing	RIUBRU9	11.0	0.5	4.21	0.012	0.007	0.982
Rice Seed	RIUSDU9	3.6	0.3	6.79	0.011	0.013	0.976
"Free" Stocks							
Wheat	WHFREU9	320.9	75.4	31.56	0.002	0.007	0.992
Corn	COFREU9	543.6	131.3	32.34	0.004	0.028	0.969
Sorghum	SGF9LU9	96.6	63.4	96.47	0.007	0.000	0.993
Oats	OAF9LU9	210.1	31.3	16.25	0.000	0.126	0.874
Barley	BAF9LU9	140.1	24.1	19.56	0.082	0.260	0.657
Soybeans	SBF9LU9	218.9	82.2	70.59	0.000	0.125	0.875
Rice	RIFREU9	21.5	5.8	47.75	0.011	0.011	0.978
Total Stocks							
Wheat	WHCOTU9	1084.4	75.4	7.97	0.002	0.020	0.978
Corn	COCOTU9	1790.0	131.3	10.91	0.004	0.023	0.973
Sorghum	SGCOTU9	242.6	63.4	50.77	0.007	0.020	0.973
Oats	OACOTU9	251.1	31.3	14.74	0.000	0.123	0.876
Barley	BACOTU9	192.8	24.1	15.62	0.082	0.010	0.907
Soybeans	SBCOTU9	244.4	82.2	69.89	0.000	0.115	0.885
Soymeal	SMCOTU9	279.1	49.8	16.85	0.109	0.021	0.870
Soy Oil	SOCOTU9	969.9	192.6	22.53	0.002	0.011	0.987
Cotton	CTCOTU9	4.6	0.7	16.73	0.001	0.023	0.976
Rice	RICOTU9	35.7	5.8	42.06	0.011	0.000	0.989

Table 22. Continued

		Mean	Root Mean Squared Error	Root Mean Squared % Error	Theil Statistics UM	UR	UD
Trade							
Wheat Exports	WHUXTU9	1210.1	43.5	3.98	0.001	0.003	0.995
Corn Exports	COUXTU9	1687.1	61.2	3.74	0.013	0.001	0.986
Sorghum Exports	SGUXTU9	230.7	28.8	14.19	0.011	0.057	0.932
Oats Imports	OASMTU9	9.1	4.1	238.91	0.014	0.044	0.943
Barley Exports	BAUXTU9	64.1	25.3	42.12	0.002	0.142	0.856
Soybean Exports	SBUXTU9	667.8	14.3	2.13	0.105	0.000	0.895
Soymeal Exports	SMUXTU9	5812.7	437.2	7.14	0.023	0.001	0.976
Soy Oil Exports	SOUXTU9	1625.4	239.9	13.53	0.012	0.065	0.923
Cotton Exports	CTUXNU9	5.4	0.6	11.50	0.001	0.073	0.926
Rice Exports	RIUXTU9	68.8	6.8	11.11	0.001	0.193	0.807
Prices							
Wheat Farm	WHPFMU9	3.13	0.32	11.56	0.002	0.070	0.928
Corn Farm	COPFMU9	2.34	0.30	14.30	0.001	0.219	0.781
Sorghum Farm	SGPFMU9	2.12	0.26	13.89	0.000	0.144	0.857
Oats Farm	OAPFMU9	1.34	0.17	11.93	0.001	0.288	0.711
Barley Farm	BAPFMU9	2.10	0.20	9.97	0.002	0.070	0.928
Soybean Farm	SBPFMU9	5.82	1.40	24.69	0.019	0.560	0.421
Soymeal Market	SMPFMU9	168.70	34.58	20.08	0.014	0.337	0.650
Soy Oil Market	SOFPMU9	22.74	4.82	21.65	0.018	0.231	0.752
Cotton Market	CTPMKU9	59.08	5.20	8.68	0.001	0.084	0.915
Cotton Farm	CTPFMU9	53.31	4.87	9.73	0.001	0.075	0.924
Rice Thai.	RIPXEU9	14.89	0.63	4.55	0.000	0.078	0.922
Rice Market	RIPWHU9	19.14	1.30	7.00	0.008	0.007	0.986
Rice Farm	RIPFMU9	8.58	0.56	8.52	0.002	0.090	0.908
Textile Market							
Production	TXSPRU9	10929	371	3.54	0.037	0.104	0.859
Domestic Use	TXUDTU9	11976	413	3.71	0.012	0.000	0.988
Imports	TXSMTU9	1803	196	13.37	0.018	0.001	0.981
Exports	TXUXTU9	757	58	7.65	0.000	0.008	0.992
Textile Price	TXPMIU9	167.4	7.5	4.43	0.006	0.008	0.986
Fiber Price	FBPMIU9	60.6	1.4	2.22	0.001	0.059	0.940

the second column. The root mean squared percent error is reported in the third column. The Theil decomposition of the root mean squared error is reported in the final three columns.

Simulation statistics must be interpreted with care. For example, a small absolute simulation error in a variable having a value near zero in some year results in a large root mean squared percent error. Although it is always desirable that UM and UR be near zero and UD close to one, large values for UM or UR may not be particularly problematic if the average error is very small. Moreover, the simulation statistics for a particular variable may be unsatisfactory, not because of a problem with the equation determining that variable, but because of a problem elsewhere in the model.

In general, the simulation statistics indicate that the model behaves in a satisfactory manner. Considering the inelasticity of most of the markets represented in the model, it is not surprising that the poorest results were for prices and variables sensitive to absolute and relative prices.

For example, expected nonparticipant net returns are very sensitive to prices, and participation rates are very sensitive to the relationship between participant and nonparticipant net returns. The participation rate determines program area planted and idled, and both nonparticipant returns and program acreage have an important effect on nonprogram acreage. Because the root mean squared percent errors for market prices are generally high, so are those for expected nonparticipant net returns, the participation rate, program planted and idled area, and nonparticipant area planted.

On the other hand, most of the statistics are encouraging for the major components of supply and demand. The root mean squared percent error is less than 10 percent for all of the total area planted and for the production variables (this phenomenon occurs because, given the structure of the model, errors in participant and nonparticipant acreage tend to offset one another). Except for wheat and sorghum feed use, sorghum food, seed and industrial use, and rice food demand, the root mean squared percent error is also less than 10 percent for all major components of domestic demand. By construction, the errors in simulated export levels are due strictly to errors in simulated prices.

The free stocks equations behave less satisfactorily than do most of the other equations in the model. Stocks are more price sensitive than most other supply and demand categories, and thus errors in simulated prices account for part of the problem. Free stocks are also more variable than most of the other categories. The fact remains, however, that the stock equations do not perform as well as do many other equations in the model. This is confirmed by out-of-sample solutions of the model--when the model is used operationally to develop projections, large adjustments are needed in some of the free stocks equations to align the model with actual data for years after 1986.

Examining plots of actual and simulated values of endogenous variables is often more revealing than is a close examination of simulation statistics. Figures 4 to 17 illustrate actual and solution values of 14 key variables, including market prices for all commodities and planted area for wheat, corn, and soybeans.

Most of the price graphs (Figures 4 to 14) indicate that the model does a fair job of replicating historical price movements. The largest problems occur in the soybean sector. For beans, meal, and oil, simulated market prices tend to gyrate dramatically from year to year. The average errors are large because

Fig. 4. U.S. wheat farm prices

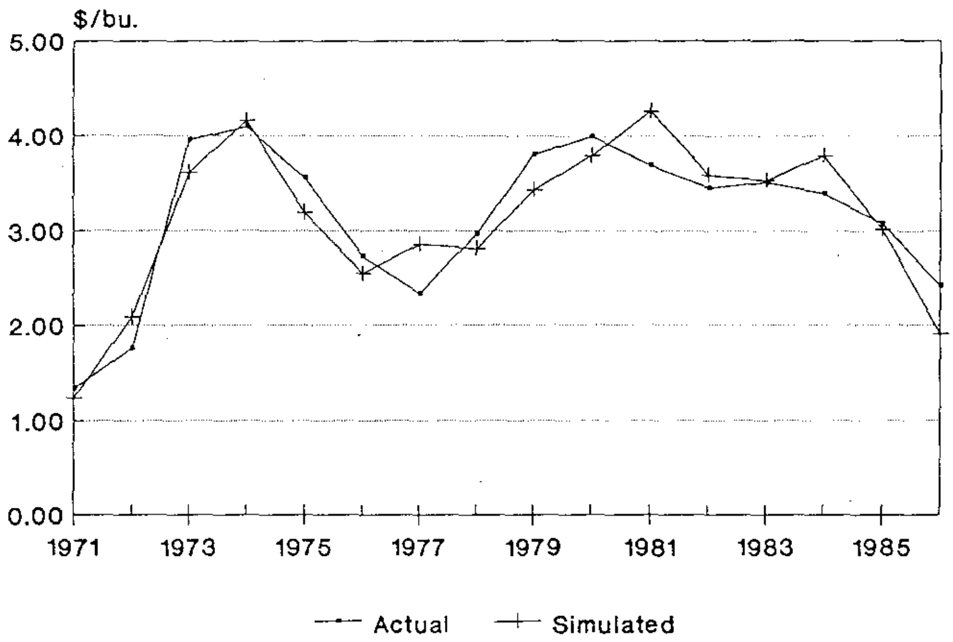


Fig. 5. U.S. corn farm prices

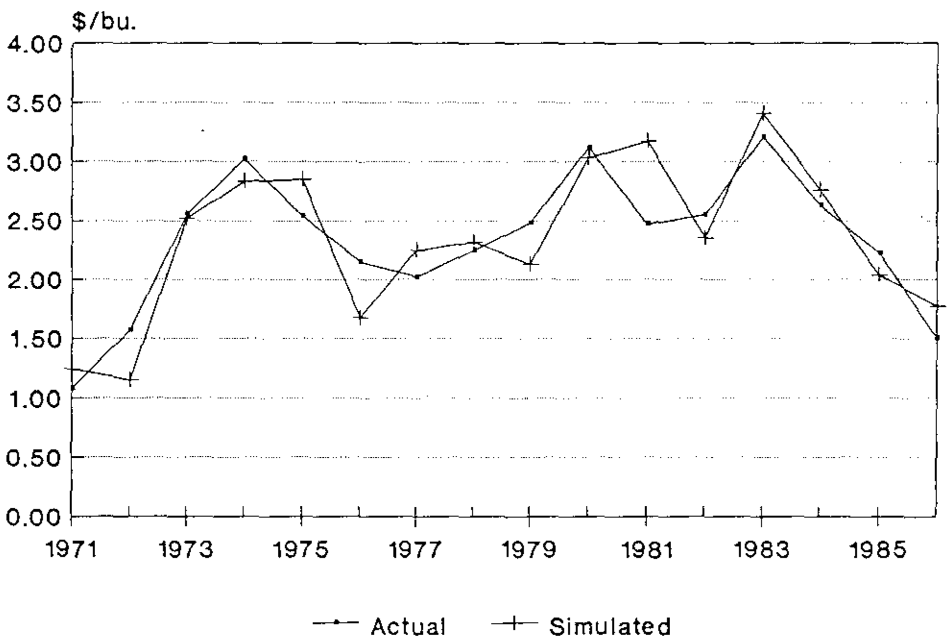


Fig. 6. U.S. sorghum farm prices

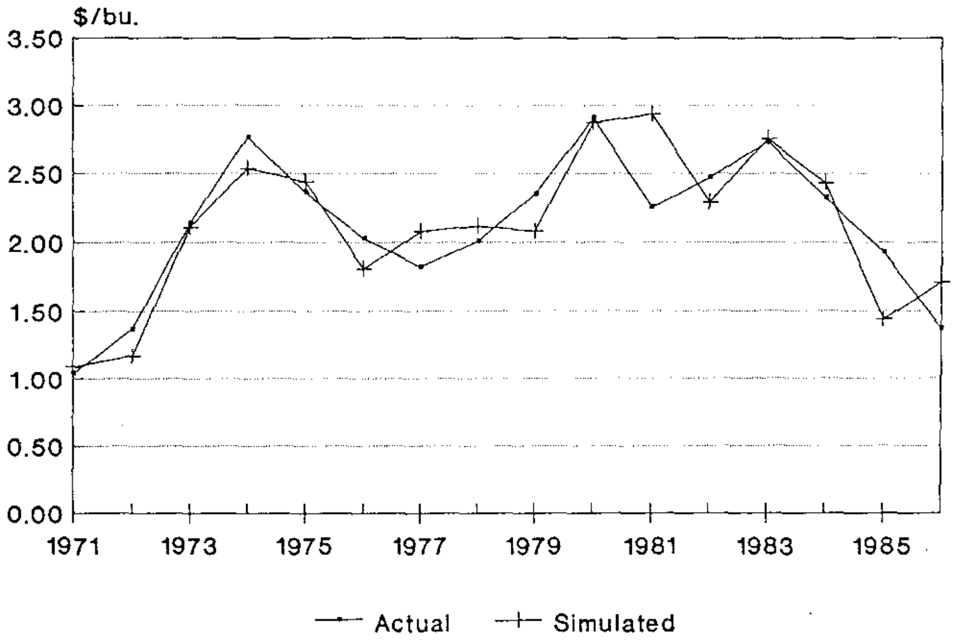


Fig. 7. U.S. oats farm prices

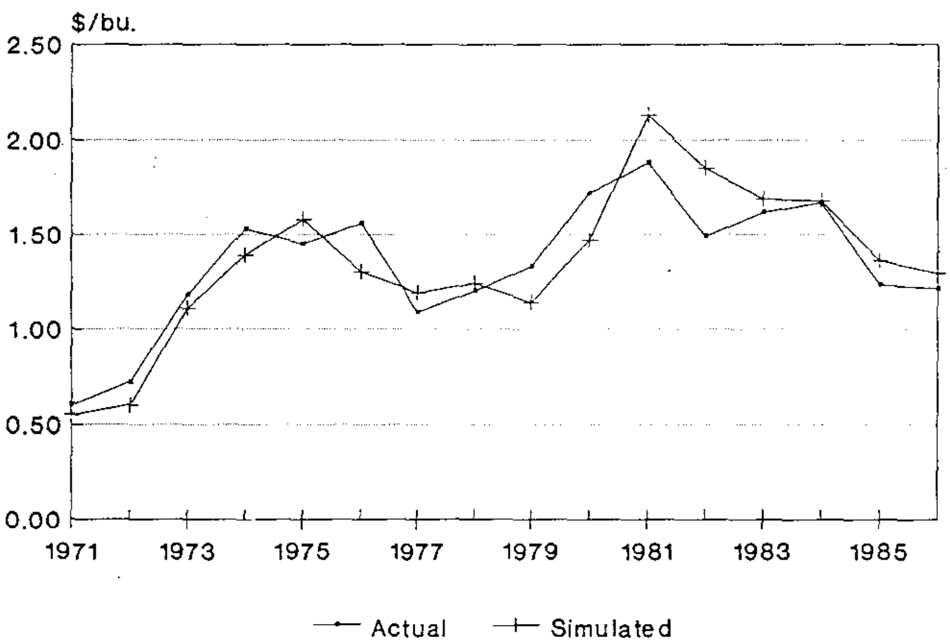


Fig. 8. U.S. barley farm prices

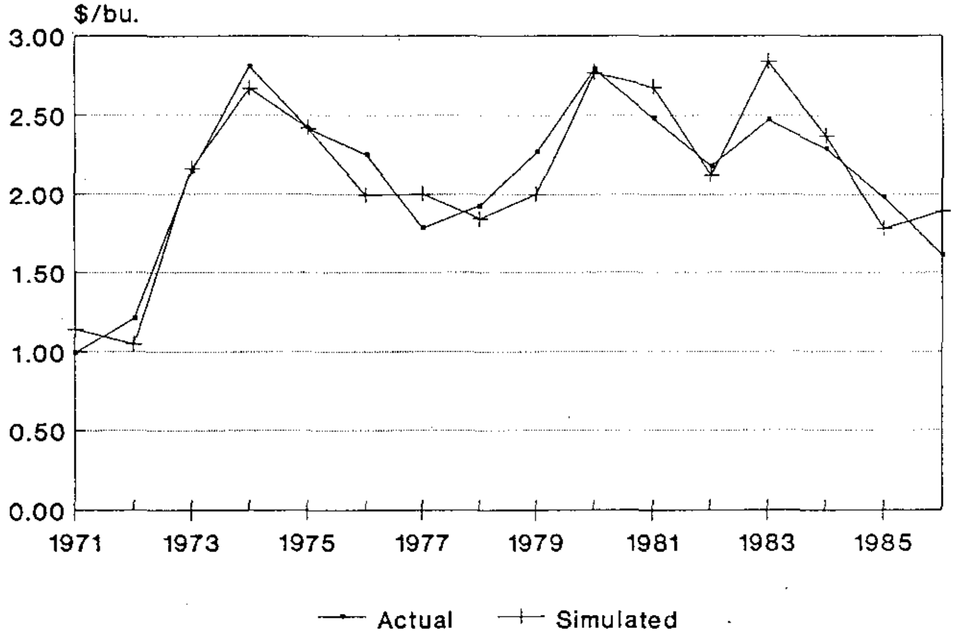


Fig. 9. U.S. soybean farm prices

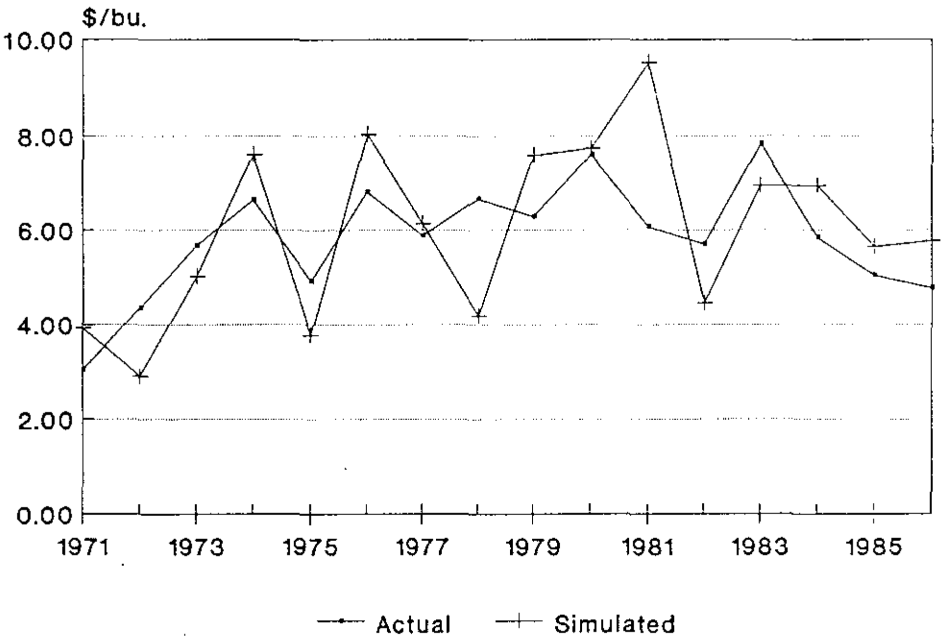


Fig. 10. U.S. soybean meal mkt prices

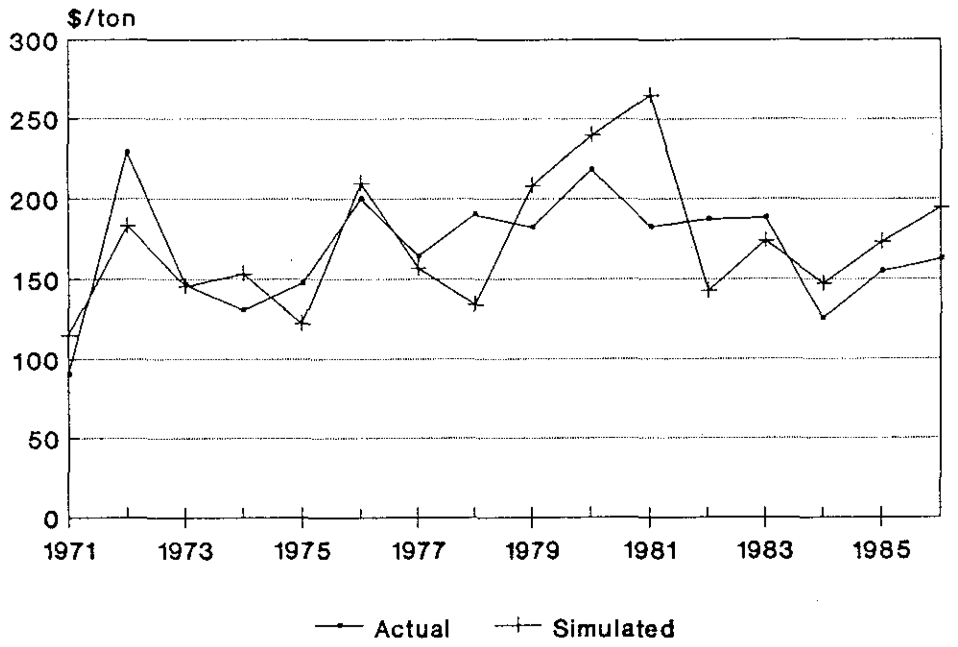


Fig. 11. U.S. soybean oil market prices

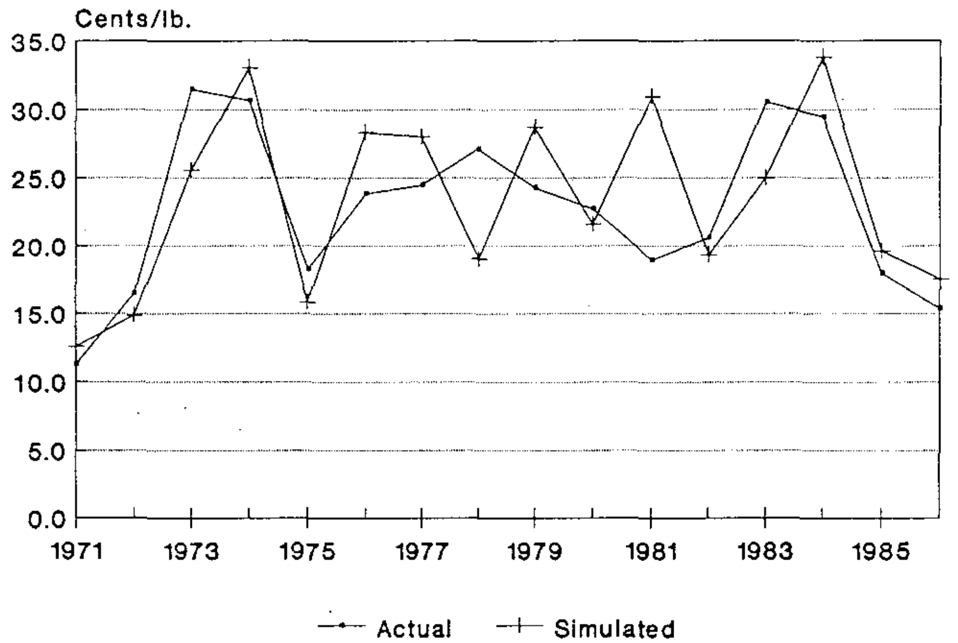


Fig. 12. U.S. cotton farm prices

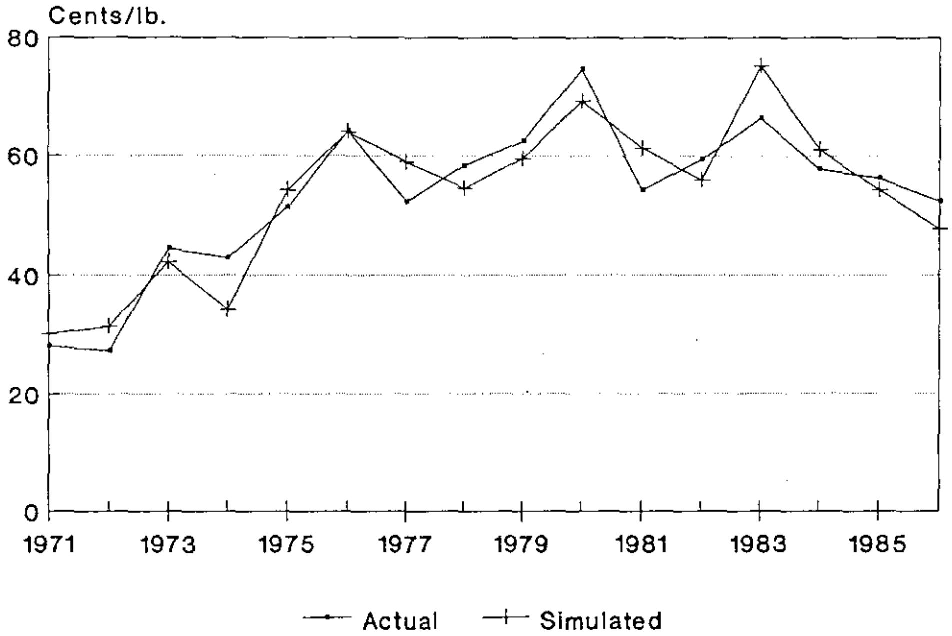


Fig. 13. U.S. rice farm prices

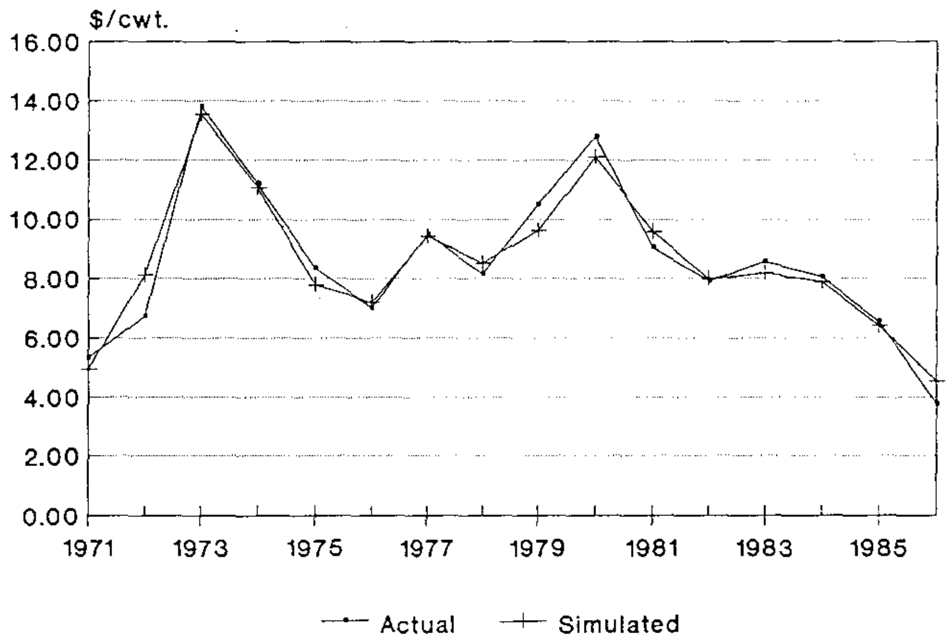


Fig. 14. U.S. textile price index

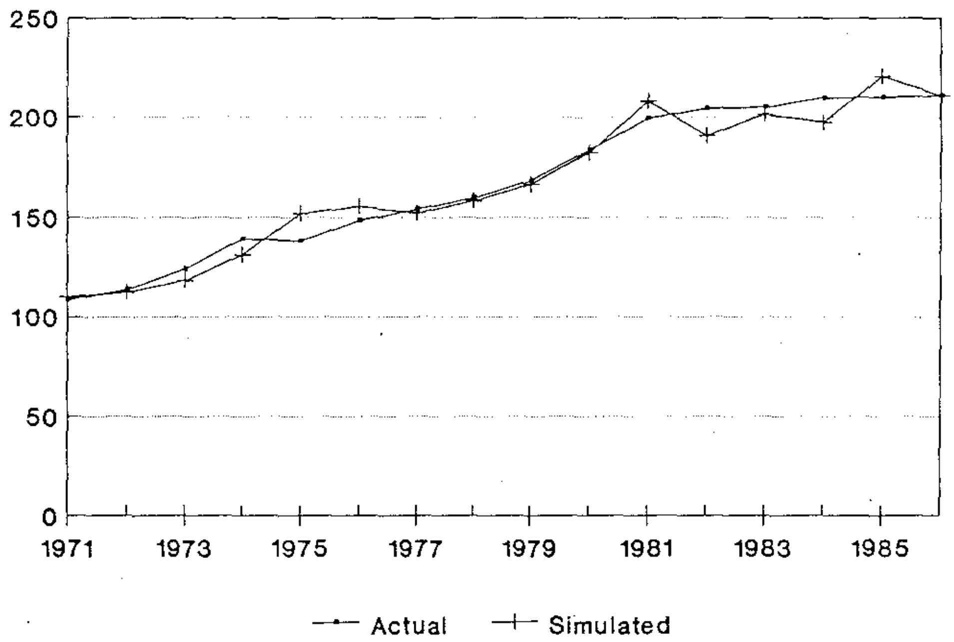


Fig. 15. U.S. wheat area planted

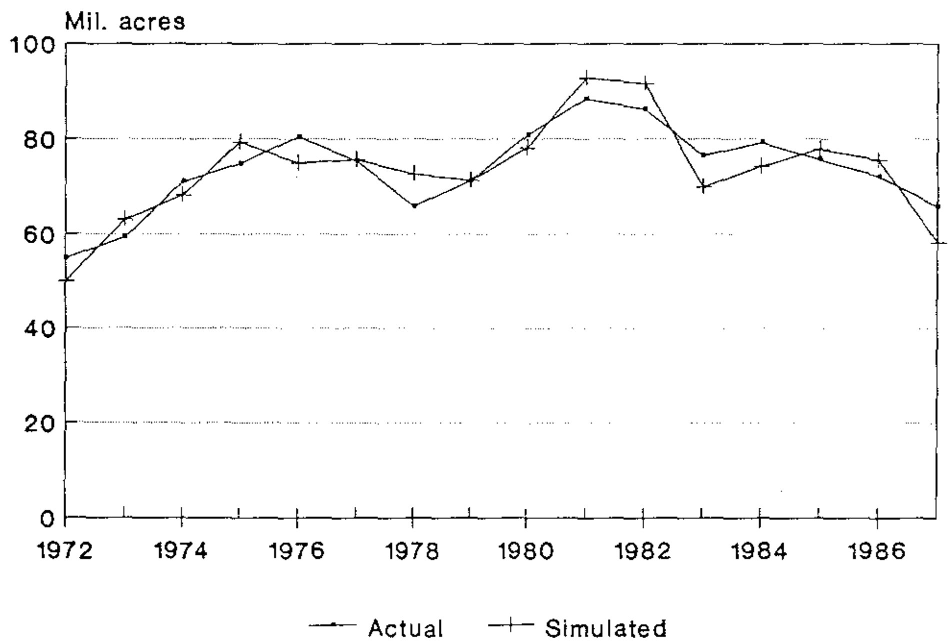


Fig. 16. U.S. corn area planted

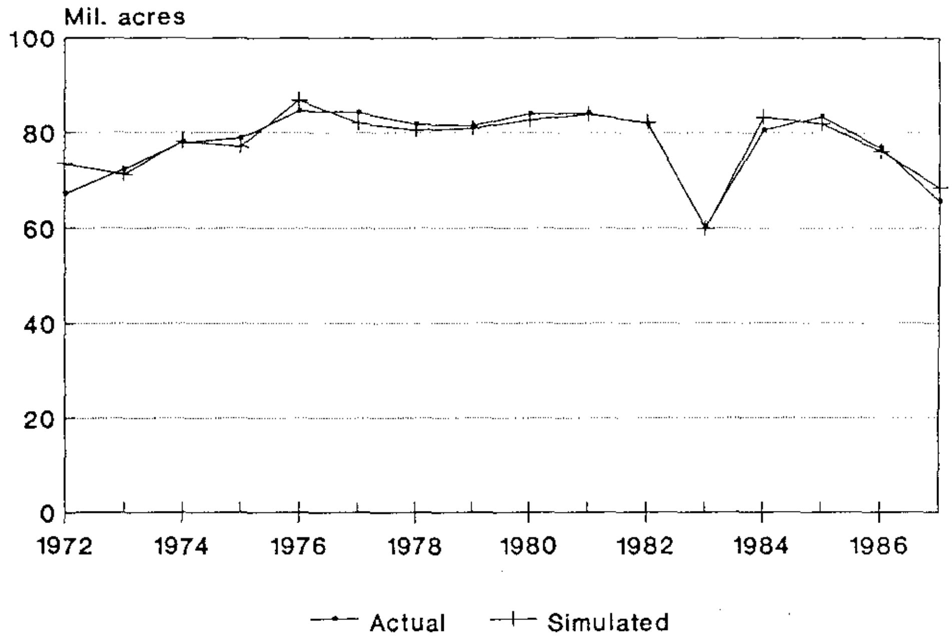
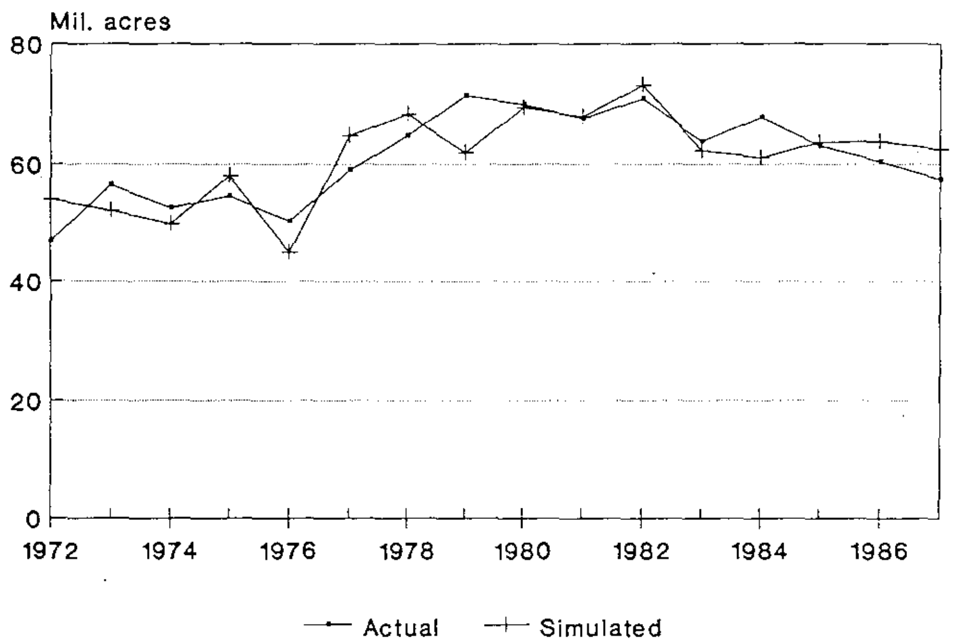


Fig. 17. U.S. soybean area planted



the soybean market as modeled is very inelastic when all soybean sector prices move in the same direction.

Suppose, for example, that the model overestimates soybean production in a given year. To make supply equal to demand, simulated domestic crush, exports, or ending stocks must exceed actual levels. A lower soybean price increases demand in each of these categories, but it also has other effects. The increased crush that results from larger crushing margins results in increased meal and oil production, which in turn reduces prices for meal and oil. Thus, a one-cent change in the soybean price results in much less than a one-cent change in the crushing margin. To obtain a particular increase in crush demand, soybean market prices must fall much more when meal and oil prices are allowed to adjust than would be necessary if meal and oil prices were exogenous. A similar situation occurs in the export market.

The fact that simulated soybean prices are more variable than actual prices indicates that the model is probably too price inelastic. Because soybeans are a substitute for corn and other commodities in both supply and demand, some of the errors in other commodity prices are due to the errors in soybean market prices.

The area planted graphs (Figures 15 to 17) indicate that the model is fairly successful at replicating historical changes in area for the three major crops. The fit on corn is particularly good; errors made in estimating participant or nonparticipant area tend to balance out. The errors in simulating soybean area can largely be attributed to the errors in soybean prices.

Although not shown here, graphs of most other key variables are also satisfactory. Prices and area are chosen for presentation because they represent the variables depending on the greatest number of interrelationships in the model. In general, if the performance of the model in terms of prices and area is satisfactory, it is unlikely that significant problems in variables representing key components of supply and demand exist.

Model Elasticities and Revisions

The simulation results presented in the previous section represent one common approach to model validation. If a model is to be used for projections and forward-looking policy analyses, it is not sufficient to evaluate the ability of the model to replicate historical data. The ability of the model to provide defensible answers to the questions it addresses also must be assessed.

Elasticities

Examining model elasticities is one way to assess the plausibility of the model's behavior. The fourth section reported single-equation elasticities evaluated at the means of all variables. Because of the model's numerous interactions, how the model behaves when all equations are operating simultaneously should be considered. Tables 23-29 provide estimates of model elasticities obtained by shocking a particular variable and allowing the effects to feed through all equations in the model. To reflect current conditions, these elasticities are evaluated in 1988/89 for demand variables and in 1989/90 for supply variables.

As shown in Table 23, participation rates are positively related to target prices and to the proportion of base acreage a participant is permitted to plant

Table 23. Participation rate elasticities (percentage change in 1989/90 participation rates resulting from a 1-percent increase in 1988/89 prices or 1989/90 program levels)

	Price Elasticity								All 8 Commodities	Own Target Price	Permitted Area[a]
	Wheat	Corn	Sorghum	Oats	Barley	Soybeans	Cotton	Rice			
Wheat	-1.70								-1.70	1.68	1.36
Corn		-0.66				-0.16			-0.82	0.86	0.56
Sorghum			-0.66						-0.66	0.70	0.47
Oats				-0.46					-0.46	0.00	6.70
Barley					-0.32				-0.32	0.00	2.09
Cotton							-1.13	-0.38	-1.13	1.28	0.64
Rice									-0.38	0.47	0.22

[a]Proportion of base acreage a participant can plant (1 - ARP Rate).

Table 24. Planted area elasticities (percentage change in 1989/90 planted area resulting from a 1-percent increase in 1988/89 prices or 1989/90 program levels)

	Price Elasticity								All 8 Commodities	Own Target Price	Permitted Area[a]
	Wheat	Corn	Sorghum	Oats	Barley	Soybeans	Cotton	Rice			
Wheat	0.21		-0.06		-0.08				0.07	-0.04	0.71
Corn		0.08					-0.02		0.06	-0.03	0.55
Sorghum	-0.04		0.27						0.24	0.03	0.68
Oats		-0.14		0.40	-0.12	-0.09			0.05	0.00	0.04
Barley	-0.33			-0.32	0.53				-0.13	0.00	0.44
Soybeans[b]		-0.17				0.34			0.17	-0.11	0.00
Cotton			-0.28			-0.14	0.27		-0.14	-0.18	0.63
Rice								0.16	0.16	-0.01	0.62
8 Crops	0.04	-0.02	-0.01	0.01	-0.01	0.06	0.01	0.00	0.08	-0.05	0.41

[a]Proportion of base acreage a participant can plant (1 - ARP Rate).
[b]For soybeans, reported target price and permitted acreage elasticities are with respect to the corresponding variables for corn.

Table 25. Production elasticities (percentage change in 1989/90 production resulting from a 1-percent increase in 1988/89 prices or 1989/90 program levels)

	Price Elasticity								All 8 Commodities	Own Target Price	Permitted Area[a]
	Wheat	Corn	Sorghum	Oats	Barley	Soybeans	Cotton	Rice			
Wheat	0.24		-0.06		-0.08				0.10	0.00	0.67
Corn		0.08				-0.02			0.05	0.13	0.48
Sorghum	-0.04		0.27						0.24	0.13	0.68
Oats		-0.25		1.05	-0.31	-0.21			0.28	0.00	0.08
Barley	-0.33			-0.32	0.53				-0.13	0.06	0.44
Soybeans[b]		-0.15				0.31			0.16	-0.10	0.00
Cotton			-0.28			-0.14	0.30		-0.12	-0.06	0.63
Rice								0.13	0.13	-0.01	0.51

[a]Proportion of base acreage a participant can plant (1 - ARP Rate).
[b]For soybeans, reported target price and permitted acreage elasticities are with respect to the corresponding variables for corn.

Table 26. Domestic demand elasticities, 10 commodities (percentage change in 1988/89 demand resulting from a 1-percent increase in prices over baseline levels in 1988/89)

	Price Elasticity										All 10
	Wheat	Corn	Sorghum	Oats	Barley	Soybeans	Soymeal	Soy oil	Cotton	Rice	Commodities
Wheat											
Feed	-0.62	0.19									-0.42
Food	-0.02										-0.02
Free Stk.	-3.89		0.45		0.59						-2.85
Corn											
Feed	-0.01	-0.26	0.08	0.02	0.01		0.05				-0.10
Food	0.04	-0.09									-0.04
Gasohol		-0.12									-0.12
Free Stk.		-0.67				0.02					-0.65
Sorghum											
Feed	0.39	0.89	-1.54								-0.27
Other		0.22	-0.67		0.42						-0.02
Free Stk.			-2.35								-2.35
Oats											
Feed		0.50		-1.83							-1.32
Other		-0.03		0.01	-0.02	-0.02					-0.06
Free Stk.				-1.36							-1.36
Barley											
Feed	0.05	0.31			-0.60						-0.24
Other					-0.02						-0.02
Free Stk.					-0.91						-0.91
Soybeans											
Crush						-1.17	0.91	0.38			0.12
Other		-0.06				0.11					0.06
Free Stk.		0.15				-2.00					-1.85
Soymeal											
Use		0.02					-0.14				-0.12
End. Stk.							-0.08				-0.08
Soy Oil											
Use								-0.06			-0.06
End. Stk.		0.03				-3.06	2.36	1.17			0.51
Cotton											
Mill									-0.05		-0.05
End. Stk.			0.13			0.07			-0.25		-0.05
Rice											
Food	0.10									-0.07	0.03
Brewing					0.03					-0.02	0.01
Free Stk.										-0.19	-0.19

Table 27. Domestic demand elasticities, five areas (percentage change in 1988/89 demand resulting from a 1-percent increase in the variable interest rate in 1988/89)

		Elasticity				
		Live-stock Numbers	Live-stock Prices	Real Consumer Expend.	Sugar Price	Textile Price
Wheat	Feed	2.32				
	Food			0.11		
Corn	Feed	1.02	0.23			
	Food			0.40	0.04	
Sorghum	Feed	0.66				
Barley	Other			0.30		
Oats	Other			-1.03		
Soymeal	Use	1.00	0.19			
Soy Oil	Use			0.39		
Cotton	Mill					1.02
Rice	Food			0.26		
	Brewing			1.03		

Table 28. Short-run U.S. export demand elasticities (percentage change in 1988/89 exports resulting from a 1-percent increase in prices over baseline levels in 1988/89)

	Price Elasticity										
	Wheat	Corn	Sorghum	Oats	Barley	Soybeans	Soymeal	Soy Oil	Cotton	Rice	All 10 Commodities
Wheat	-0.38	0.06			0.02		0.03			0.08	-0.19
Corn	0.00	-0.42	0.05	0.01	0.07		0.05				-0.25
Sorghum		1.42	-1.49								-0.08
Barley	2.94	5.04			-11.28						-3.30
Soybeans						-1.07	0.86	0.37			0.15
Soy Meal						1.40	-1.88	-0.50			-0.98
Soy Oil						3.35	-2.69	-2.07			-1.40
Cotton											-1.09
Rice	0.28										-1.99
Beans and									-1.09	-2.27	
Products[a]						-0.44	0.20	0.12			-0.12
Oats Imports		-0.36		0.39							0.00

[a]Simple sum of soybeans, soybean meal, and soybean oil, all measured in metric tons.

Table 29. Long-run U.S. export demand elasticities (percentage change in 1991/92 exports resulting from a 1-percent increase in prices over baseline levels in every year between 1988/89 and 1991/92)

	Price Elasticity										
	Wheat	Corn	Sorghum	Oats	Barley	Soybeans	Soymeal	Soy Oil	Cotton	Rice	All 10 Commodities
Wheat	-1.12	0.28	0.09		0.02	0.12	0.03			0.08	-0.52
Corn	0.17	-0.65	0.04	0.01	-0.11	0.17	0.04				-0.32
Sorghum	0.79	1.46	-2.60		0.17						-0.20
Barley					-3.71						-0.64
Soybeans						-1.44	0.98	0.53			0.08
Soy Meal						1.25	-1.73	-0.76			-1.24
Soy Oil						3.35	-3.02	-2.30			-1.98
Cotton									-0.85		-0.85
Rice										-2.57	-2.26
Beans and Products[a]						-0.69	0.25	0.15			-0.28
Oats Imports			-0.50	0.55							0.00

[a]Simple sum of soybeans, soybean meal, and soybean oil, all measured in metric tons.

and are negatively related to market prices. The lack of a reported relationship between barley and oats participation rates and their respective target prices occurs because 1988/89 market prices for the two commodities exceed the target prices. In the model, this means that a small change in the target price has no effect on expected participant net returns (given naive price expectations), and thus no effect on the participation rate.

The planted area elasticities reported in Table 24 represent the net effect of all the equations directly or indirectly affecting planted area in the model. In general, the results are consistent with expectations. Own-price elasticities are positive for all crops, and all crops but rice have at least one negative cross-price elasticity. If the prices of all commodities are increased by one percent, the planted area for all crops but barley and cotton increases slightly.

Given the specification of the model, the net effect of target price changes on planted area is ambiguous. An increase in target prices results in an increase in participation rates, which means that participant planted area increases and nonparticipant planted area decreases. The net effect on total planted area depends on acreage-idling requirements and on the amount of slippage implied in the nonparticipant area equation.

If the ARP rate is high, an increase in participation rates may actually result in a reduction in total area planted. Outside the program, farmer planting decisions are unrestricted. Participants, on the other hand, are required to idle land to receive program benefits. If enough land is idled by new participants when target prices are increased, the supply incentive effect of higher target prices can actually be outweighed, causing planted area to decrease. On the other hand, at low set-aside rates, it is more likely that total planted acreage will increase as the incentive effect dominates.

At 1989/90 levels of program provisions, an increase in the target price would increase total planted area for sorghum, have no effect on oats and barley area, and reduce the planted area for all other commodities. This includes soybeans, for an increase in corn target prices would draw more land into the corn program and away from soybean production. Not only the magnitude of the effect, but even the direction of the target price effect on planted acreage of most crops is dependent on program provisions. Results are unambiguous only for soybeans and oats: soybean acreage cannot increase in response to an increase in corn target prices, and oats area cannot increase in response to an increase in oats target prices.

For all commodities, a 1-percent change in the area that participants are allowed to plant has less than a 1-percent effect on planted area. This is expected because of participation being less that 100 percent, and because of slippage. The results indicate, for example, that more than a 10-percent ARP rate is required to obtain a 10 percent reduction in area planted for each of the program crops.

A final check on the internal consistency of the acreage equations is provided by examining the effect on the total area planted of all eight crops combined in response to changes in commodity prices and other variables. When all crop prices increase one percent, the total area planted ;increases by 0.08 percent. That the total area planted to all crops should be very inelastic with respect to a change in all commodity prices is consistent with expectations.

A minor problem with the model is evident in the calculated effect of increasing corn, sorghum, or barley prices. Higher corn prices, for example, result in a larger absolute reduction in oats and soybean area than that directly tied to the increase in corn area. There is no reason to expect that higher market prices would actually reduce the total area planted, so this computed effect highlights one of the shortcomings of a model whose supply side is not estimated as a system. Nevertheless, in no case does a higher commodity price result in a large decline in total area planted.

Production elasticities reported in Table 25 generally are similar to the planted area elasticities. The major exception is the response to changes in target prices. Even though planted area decreases for wheat and corn when target prices increase, production increases. This is because the increase in yields more than offsets the decline in area planted. As suggested earlier, if producers believe that program yields are frozen forever, yields should not respond to changes in target prices. The marginal unit of production would be produced at the market price, even for program participants.

Domestic demand elasticities are reported in Tables 26 and 27. With three minor exceptions, all own-price elasticities are negative, even when all model equations interact. Two exceptions are soybean and oats variables that include seed demand, hence a positive own-price effect is plausible. The third exception is soybean oil stocks. All other prices held constant, an increase in soybean oil prices increases crush, and the effect of higher soybean oil production outweighs the price effect in the soybean oil stocks equation.

Most of the other demand elasticities in the model are also consistent with expectations. An unimportant exception is corn feed demand. An increase in wheat prices results in an increase in corn feed use because model parameters imply (counterintuitively) that an increase in wheat prices increases sorghum feed use more than it reduces wheat feed use, so that aggregate competitive feed use increases. When all commodity prices increase, own-price effects dominate cross-price effects, except in rice food and brewing uses.

Tables 28 and 29 report short- and long-run U.S. export demand elasticities. For commodities other than barley, oats, and cotton, these elasticities are based on the reduced-form equations calculated from the FAPRI trade model. All own-price elasticities are negative, and short-run elasticities are generally smaller than long-run elasticities. The only negative cross-price effects are in the soybean sector (where meal and oil are expected to be complements because of the effects on crush of changing meal or oil prices and the corn sector, where the long-run elasticity of corn exports with respect to barley prices is negative (this occurs because barley and corn are treated as a single commodity in the FAPRI trade models).

When all 10 commodity prices change simultaneously, the effect on U.S. exports is quite interesting. Wheat, corn, and soybean sector export demands are all inelastic, even in the long run, when all commodity prices change by the same proportion. The cotton export demand elasticity is approximately negative one (by assumption--cotton exports are determined by a synthetic equation), whereas U.S. rice export demand is elastic, even when all prices change together.

Revisions

The FAPRI U.S. crops model should be evaluated as a model under development. The model undergoes frequent revision to deal with perceived problems, so this document should be regarded as a snapshot of a work in progress, rather than as a report of a completed effort. Some of the shortcomings of the model have been pointed out, and efforts will be made to correct these shortcomings in the months and years to come.

Revisions to the model should recognize the strengths of the model. In its present form, the model makes it possible to examine a variety of issues important in policy analysis and market outlooks. For the most part, the model behaves in an internally consistent and intuitively appealing way. Although it may be desirable to impose more structure on the model and to use more appropriate estimation techniques, the current strengths of the model should not be sacrificed unnecessarily in the process.

APPENDIX

Variable Definitions and Sources

The following list identifies the variables included in the FAPRI U.S. crops model. For each variable, a definition and a data source are provided. Data sources are identified by number:

1. Commodity Fact Sheets prepared by the Agricultural Stabilization and Conservation Service (types of data: crop supply, demand, and prices).
2. Agricultural Outlook, from the USDA (program provisions).
3. Publications and data tapes prepared by The WEFA Group (macroeconomic data).
4. Agricultural Statistics, published by the Statistical Reporting Service of USDA (miscellaneous supply, demand, and price information).
5. Various situation and outlook reports published by the Economic Research Service of USDA, including <u>Feed Situation and Outlook, Oil Crops Situation and Outlook, Cotton and Wool Situation and Outlook, Rice Situation and Outlook, and Livestock and Poultry Situation and Outlook</u> (commodity-specific supply, demand, and price data).
6. <u>Selected Speeches and News Releases</u>, from the USDA (CRP and 0-92 data).
7. FAPRI data set, from the University of Missouri (variable production costs).
8. Calculated.

BAABAU9: Barley program acreage base, mil. ac. (1)
BAAHAU9: Barley area harvested, mil. ac. (1)
BAAHPU9: Barley harvested area/planted area (8)
BAAIAU9: Barley area idled by ARP, PLD programs, mil. ac. (1)
BAAPAU9: Barley area planted, mil. ac. (1)
BAAPNU9: Barley area planted by nonparticipants, mil. ac. (1)
BAAPPU9: Barley area planted by participants, mil. ac. (1)
BACCCU9: Barley CCC stocks, mil. bu. (1)
BACOTU9: Barley total ending stocks, mil. bu. (1)
BACRPU9: Barley program base enrolled in the CRP, mil. ac. (6)
BADPRU9: Barley diversion payment rate, $/bu. (1,2)
BAFORU9: Barley FOR stocks, mil. bu. (1)
BAF9LU9: Barley free and nine-month loan stocks, mil. bu. (1)
BAMARU9: Barley model ARP rate, equals ARP area/(ARP + PLD + program planted area) (8)
BAMPLU9: Barley model PLD rate, equals PLD area/(ARP + PLD + program planted area) (8)
BAMPRU9: Barley model participation rate, equals (ARP + PLD + program planted area)/program base (8)

BANRNU9: Barley expected net returns to nonparticipants, $/ac. (8)
BANRNU9F: Barley expected nonparticipant net returns, next year, $/ac. (8)
BANRPU9: Barley expected net returns to program participants, $/base ac. (8)
BAPFMU9: Barley farm market price, $/bu. (1)
BAPLNU9: Barley loan rate, $/bu. (1)
BAPTGU9: Barley target price, $/bu. (1)
BASMTU9: Barley imports, mil. bu. (1)
BASPRU9: Barley production, mil. bu. (1)
BAUFEU9: Barley feed use, mil. bu. (1)
BAUFOU9: Barley food, seed, and industrial use, mil. bu. (1)
BAUFOU9C: Barley per-capita food, seed, and industrial use, bu./capita (8)
BAURSU9: Barley statistical discrepancy, mil. bu. (8)
BAUXEU9: Barley export demand shifter, mil. bu. (8)
BAUXTU9: Barley exports, mil. bu. (1)
BAVCAU9: Barley variable production costs--includes family labor and interest on variable expenses, $/ac. (7)
BAVCAU9F: Barley variable production costs, next year, $/ac. (8)
BAYHAU9: Barley yield per harvested acre, bu./ac. (1)
BAYHPU9: Barley program yield, bu./ac. (1)
BAYHTU9: Barley trend yield, bu./ac. (8)
BAYHTU9F: Barley trend yield, next year, bu./ac. (8)
CATNFU9: Cattle on feed, 13 states, average of third quarter this year and next (8)
CATN3U9: Cattle on feed, 13 states, third quarter (5)
CEAJU9: U.S. real personal consumption expenditures, Aug.-July year, billion 1982 dollars (8)
CEJMU9: U.S. real personal consumption expenditures, June-May year, billion 1982 dollars (8)
CESAU9: U.S. real personal consumption expenditures, Sept.-Aug. year, billion 1982 dollars (8)
CEU9: U.S. real personal consumption expenditures, calendar year, billion 1982 dollars (3)
CO9LNU9: Corn nine-month loan stocks, mil. bu. (1)
COABAU9F: Corn program acreage base, next year, mil. ac. (1)
COAHAU9F: Corn area harvested, next year, mil. ac. (1)
COAHPU9F: Corn harvested area/planted area, next year (8)
COAIAU9: Corn acreage idled by ARP, PLD programs, mil. ac. (1)
COAIAU9F: Corn acreage idled by ARP, PLD programs, next year, mil. ac. (1)
COAPAU9F: Corn area planted, next year, mil. ac. (1)
COAPNU9F: Corn area planted by nonparticipants, next year, mil. ac. (1)
COAPPU9F: Corn area planted by participants, next year, mil. ac. (1)
COCCCU9: Corn CCC stocks, mil. bu. (1)
COCOTU9: Corn total ending stocks, mil. bu. (1)
COCRPU9F: Corn program base enrolled in the CRP, next year, mil. ac. (6)
CODPRU9F: Corn diversion payment rate, next year, $/bu. (1,2)
COFORU9: Corn FOR stocks, mil. bu. (1)
COFREU9: Corn free stocks, mil. bu. (1)
COMARU9F: Corn model ARP rate, equals ARP area/(ARP + PLD + program planted area), next year (8)

COMPLU9F: Corn model PLD rate, equals PLD area/(ARP + PLD + program planted area), next year (8)
COMPRU9F: Corn model participation rate, equals (ARP + PLD + program planted area)/program base, next year (8)
CONRNU9F: Corn expected net returns to non-participants, next year, $/ac. (8)
CONRNU9: Corn expected nonparticipant net returns, $/ac. (8)
CONRPU9F: Corn expected net returns to participants, next year, $/base ac. (8)
COPFMU9: Corn farm market price, $/bu. (1)
COPLNU9F: Corn loan rate, next year, $/bu. (1)
COPTGU9F: Corn target price, next year, $/bu. (1)
COSMTU9: Corn imports, mil. bu. (1)
COSPRU9F: Corn production, next year, mil. bu. (1)
COUFEU9: Corn feed use, mil. bu. (1)
COUFEU9G: Corn feed use per GCAU, bu./GCAU (8)
COUFOU9: Corn food, seed and industrial use, mil. bu. (1)
COUGAU9: Corn gasohol use, mil. bu. (5)
COUOFU9: Corn food (nonfeed, nongasohol, nonseed) use, mil. bu. (8)
COUOFU9C: Corn food use per capita, bu./capita (8)
COURSU9: Corn statistical discrepancy (includes 1975 crop year change), mil. bu. (8)
COUSDU9: Corn seed use, mil. bu. (5)
COUXEU9: Corn export demand shifter, mil. bu. (8)
COUXTU9: Corn exports, mil. bu. (1)
COVCAU9F: Corn variable production costs--includes family labor and interest on variable expenses, next year, $/ac. (7)
COYHAU9F: Corn yield per harvested acre, next year, bu./ac. (1)
COYHPU9F: Corn program yield, next year, bu./ac. (1)
COYHTU9F: Corn trend yield, next year, bu./ac. (8)
CT092U9F: Cotton 0-92 and 50-92 area, next year, mil. ac. (1)
CTABAU9F: Cotton program acreage base, next year, mil. ac. (1)
CTAHAU9F: Cotton area harvested, next year, mil. ac. (5)
CTAHPU9F: Cotton harvested area/planted area, next year (8)
CTAIAU9F: Cotton area idled under annual programs, mil. ac. (1,5)
CTAIZU9F: Cotton area idled under programs before 1982, mil ac. (1,5)
CTAPAU9F: Cotton area planted, next year, mil. ac. (1,5)
CTAPNU9F: Cotton area planted by nonparticipants, next year, mil. ac. (1)
CTAPPU9F: Cotton area planted by participants, next year, mil. ac. (1)
CTCOTU9: Cotton ending stocks, mil. bales. (1,5)
CTCRPU9F: Cotton program base enrolled in the CRP, next year, mil. ac. (6)
CTDPRU9F: Cotton diversion payment rate, next year, cents/lb. (2)
CTMARU9F: Cotton model ARP rate, equals ARP area/(ARP + PLD + 0-92 + program planted area), next year (8)
CTMPLU9F: Cotton model PLD rate, equals PLD area/(ARP + PLD + 0-92 + program planted area), next year (8)
CTMPRU9F: Cotton model participation rate, equals (ARP + PLD + 0-92 + program planted area)/program base, next year (8)
CTNRNU9F: Cotton expected nonparticipant net returns, next year, $/ac. (8)

CTNRPU9F: Cotton expected participant net returns, next year, $/base ac. (8)
CTPFMU9: Cotton farm price, cents/lb. (5)
CTPMKU9: Cotton market price, cents/lb. (5)
CTPTGU9F: Cotton target price, next year, cents/lb. (1)
CTSPRU9F: Cotton production, next year, mil. bales (1,5)
CTUMDU9: Cotton mill demand, mil. bales (1,5)
CTURSU9: Cotton residual use, mil. bales (8)
CTUXEU9: Cotton export demand shifter, mil. bales (8)
CTUXNU9: Cotton net exports, mil. bales (1,5)
CTVCAU9F: Cotton variable production costs--includes family labor and interest on variable expenses, next year, $/ac. (7)
CTYHAU9F: Cotton yield per harvested acre, next year, lbs./ac. (1,5)
CTYHPU9F: Cotton program yield, next year, lbs./ac. (1)
CTYHTU9F: Cotton trend yield, next year, lbs./ac. (8)
DEPOPU9: U.S. population including overseas armed forces, July 1 (3)
DM17072: 1 from 1970-1972; 0 otherwise (8)
DM171: 1 in 1971; 0 otherwise (8)
DM172: 1 in 1972; 0 otherwise (8)
DM17274: 1 from 1972-1974; 0 otherwise (8)
DM173: 1 in 1973; 0 otherwise (8)
DM174: 1 in 1974; 0 otherwise (8)
DM175: 1 in 1975; 0 otherwise (8)
DM17576: 1 in 1975 and 1976; 0 otherwise (8)
DM176: 1 in 1976; 0 otherwise (8)
DM17677: 1 in 1976 and 1977; 0 otherwise (8)
DM177: 1 in 1976; 0 otherwise (8)
DM17780: 1 from 1977-1980; 0 otherwise (8)
DM179: 1 in 1979; 0 otherwise (8)
DM180: 1 in 1980; 0 otherwise (8)
DM181: 1 in 1981; 0 otherwise (8)
DM18183: 1 from 1981-1983; 0 otherwise (8)
DM182: 1 in 1982; 0 otherwise (8)
DM18285: 1 from 1982-1985; 0 otherwise (8)
DM183: 1 in 1983; 0 otherwise (8)
DM18385: 1 from 1983-1985; 0 otherwise (8)
DM18387: 1 from 1983-1987; 0 otherwise (8)
DM18485: 1 in 1984 and 1985; 0 otherwise (8)
DM185: 1 in 1985; 0 otherwise (8)
DM1NPRGF: 1 when no program in the next year: 1973-1976, 1979-1980; 0 otherwise (8)
DM1S73: 1 beginning in 1973; 0 otherwise (8)
DM1S74: 1 beginning in 1974; 0 otherwise (8)
DM1S75: 1 beginning in 1975; 0 otherwise (8)
DM1S77: 1 beginning in 1977; 0 otherwise (8)
DM1S78: 1 beginning in 1978; 0 otherwise (8)
DM1S79: 1 beginning in 1979; 0 otherwise (8)
DM1S80: 1 beginning in 1980; 0 otherwise (8)
DM1S81: 1 beginning in 1981; 0 otherwise (8)
DM1S82: 1 beginning in 1982; 0 otherwise (8)

DM1S83: 1 beginning in 1983; 0 otherwise (8)
DM1S84: 1 beginning in 1984; 0 otherwise (8)
DM1S85: 1 beginning in 1985; 0 otherwise (8)
DMBAYU9: Barley yield dummy: 1 if 1 s.d. above trend; -1 if 1 s.d. below; 0 otherwise (8)
DMCOYU9F: Corn yield dummy, next year: 1 if 1 s.d. above trend; -1 if 1 s.d. below; 0 otherwise (8)
DMCTYU9F: Cotton yield dummy, next year: 1 if 1 s.d. above trend; -1 if 1 s.d. below; 0 otherwise (8)
DMOAYU9: Oats yield dummy: 1 if 1 s.d. above trend; -1 if 1 s.d. below; 0 otherwise (8)
DMSBYU9F: Soybean yield dummy, next year: 1 if 1 s.d. above trend; -1 if 1 s.d. below; 0 otherwise (8)
DMSGYU9: Sorghum yield dummy: 1 if 1 s.d. above trend; -1 if 1 s.d. below; 0 otherwise (8)
DMWHYU9F: Wheat yield dummy, next year: 1 if 1 s.d. above trend; -1 if 1 s.d. below; 0 otherwise (8)
FBPMIU9: Fiber price index (Yanagishima)
GCAUU9: Grain-consuming animal units, crop year basis (8)
HPAUU9: High-protein animal units, crop year basis (8)
LNPFPOL: Log of the polyester price index (Yanagishima)
LNPFRAY: Log of the rayon price index (Yanagishima)
LVPIU9: Livestock price index, crop year basis (8)
OAABAU9: Oats program acreage base, mil. ac. (1)
OAAHAU9: Oats area harvested, mil. ac. (1)
OAAIAU9: Oats area idled by ARP, PLD programs, mil. ac. (1)
OAAPAU9: Oats area planted, mil. ac. (1)
OAAPAU9F: Oats area planted, next year, mil. ac. (1)
OAAPNU9: Oats area planted by nonparticipants, mil. ac. (1)
OAAPPU9: Oats area planted by participants, mil. ac. (1)
OACCCU9: Oats CCC stocks, mil. bu. (1)
OACOTU9: Oats total ending stocks, mil. bu. (1)
OACRPU9: Oats program base enrolled in the CRP, mil. ac. (6)
OADPRU9: Oats diversion payment rate, $/bu. (2)
OAF9LU9: Oats free and nine-month loan stocks, mil. bu. (1)
OAFORU9: Oats FOR stocks, mil. bu. (1)
OAMARU9: Oats model ARP rate, equals ARP area/(ARP + PLD + program planted area) (8)
OAMPLU9: Oats model PLD rate, equals PLD area/(ARP + PLD + program planted area) (8)
OAMPRU9: Oats model participation rate, equals (ARP + PLD + program planted area)/program base (8)
OANRNU9: Oats expected net returns to nonparticipants, $/ac. (8)
OANRPU9: Oats expected net returns to participants, $/base ac. (8)
OAPFMU9: Oats farm market price, $/bu. (1)
OAPLNU9: Oats loan rate, $/bu. (1)
OAPTGU9: Oats target price, $/bu. (1)
OASMNU9: Oats net imports, mil. bu. (8)
OASMTU9: Oats total imports, mil. bu. (1)
OASPRU9: Oats production, mil. bu. (1)

OAUFEU9: Oats feed use, mil. bu. (1)
OAUFOU9: Oats food, seed, and industrial use, mil. bu. (1)
OAUFOU9C: Oats per-capita food, seed, and industrial use, bu./capita (8)
OAURSU9: Oats statistical discrepancy, mil. bu. (8)
OAUXTU9: Oats total exports, mil. bu. (1)
OAVCAU9: Oats variable production costs--includes family labor and interest on variable expenses, $/ac. (7)
OAYHAU9: Oats yield per harvested acre, bu./ac. (1)
OAYHPU9: Oats program yield, bu./ac. (1)
OAYHTU9: Oats trend yield, bu./ac. (8)
OOUDTU9: Cotton oil, palm oil, butter, and lard use, mil. lbs. (5)
PW: U.S. wholesale price index, 1967=100 (3)
PWAJU9: U.S. wholesale price index, Aug.-July year, cal. 1967=100 (8)
PWFSAU9: Producer price index for fuels, etc, Sept.-Aug. year, cal. 1967=100 (3)
PWJMU9: U.S. wholesale price index, June-May year, cal. 1967=100 (8)
PWSAU9: U.S. wholesale price index, Sept.-Aug. year, cal. 1967=100 (8)
RI092U9F: Rice 0-92 and 50-92 area, next year, mil. ac. (1)
RIABAU9F: Rice program acreage base, next year, mil. ac. (1)
RIAHAU9F: Rice area harvested, next year, 1000 ac. (4)
RIAHPU9F: Rice harvested area/planted area (8)
RIAIAU9F: Rice area idled by ARP, PLD programs, next year, 1000 ac. (1)
RIALTU9F: Rice allotment proportion, next year (5)
RIAPAU9F: Rice area planted, next year, 1000 ac. (4)
RIAPNU9F: Rice area planted by nonparticipants, next year, 1000 ac. (8)
RIAPPU9F: Rice area planted by participants, next year, 1000 ac. (1)
RICCCU9: Rice CCC stocks, mil. cwt. (4,5)
RICOTU9: Rice total ending stocks, mil. cwt. (4,5)
RIDPRU9F: Rice diversion payment rate, $/cwt. (2)
RIF9LU9: Rice free and nine-month loan stocks, mil. cwt. (4,5)
RIMARU9F: Rice model ARP rate, equals ARP area/(ARP + PLD + 0-92 + program planted area), next year (8)
RIMPLU9F: Rice model PLD rate, equals PLD area/(ARP + PLD + 0-92 + program planted area), next year (8)
RIMPRU9F: Rice model participation rate, equals (ARP + PLD + 0-92 + program planted area)/program base, next year (8)
RINRNU9F: Rice expected nonparticipant net returns, next year, $/ac. (8)
RINRPU9F: Rice expected participant net returns, next year, $/base ac. (8)
RIPFMU9: Rice farm price, $/cwt. (4,5)
RIPSBU9: Rice export subsidy, $/cwt. (8)
RIPTGU9F: Rice target price, next year, $/cwt. (1)
RIPWHU9: Rice mill price, no. 2 long grain, fob Houston, $/cwt. (5)
RIPXETH: Rice, Thailand export price, 100% no. 2 white, fob Bangkok, $/cwt. (5)
RIPXEU9: Rice, US export price, no.2 long grain rice, fob Houston, $/cwt. (5)
RISMTU9: Rice imports, mil. cwt. (5)
RISPRU9F: Rice production, next year, 1000 cwt. (4,5)
RIUBRU9: Rice brewing and other industrial use, mil. cwt. (4,5)
RIUBRU9C: Rice per-capita brewing and other industrial use, cwt./capita (8)

RIUOFU9: Rice food use, mil. cwt. (4,5)
RIUOFU9C: Rice food use per capita, cwt./capita (8)
RIURSU9: Rice residual use, mil. cwt. (8)
RIUSDU9: Rice seed use, mil. cwt. (4,5)
RIUXEU9: Rice export demand shifter, mil. cwt. (8)
RIUXTU9: Rice exports, mil. cwt. (4,5)
RIVCAU9F: Rice variable production costs--includes family labor and interest on variable expenses, next year \$/ac. (7)
RIYHAU9F: Rice yield per harvested acre, next year, lbs./ac. (4,5)
RIYHPU9F: Rice program yield, next year, lbs./ac. (1)
RIYHTU9F: Rice trend yield, next year, lbs./ac. (8)
SBAHAU9F: Soybean area harvested, next year, mil. ac. (1)
SBAHPU9F: Soybean harvested area/planted area, next year (8)
SBAPAU9F: Soybean area planted, next year, mil. ac. (1)
SBAPJU9F: Soybean area planted plus CRP area, next year, mil. ac. (8)
SBCCCU9: Soybean CCC stocks, mil. bu. (1)
SBCOTU9: Soybean total ending stocks, mil. bu. (1)
SBCRPU9F: Soybean area in the CRP, next year, mil. ac. (est.)
SBF9LU9: Soybean free and nine-month loan stocks, mil. bu. (1)
SBNRNU9: Soybean expected net returns, \$/ac. (8)
SBNRNU9F: Soybean expected net returns, next year, \$/ac. (8)
SBPFMU9: Soybean farm market price, \$/bu. (1)
SBSPRU9F: Soybean production, next year, mil. bu. (1)
SBUFEU9: Soybean crush, mil. bu. (1)
SBUFOU9: Soybean seed, feed, and residual use, mil. bu. (1)
SBUFTU9: Soybean trend crush, mil. bu. (8)
SBURSU9: Soybean statistical discrepancy, mil. bu. (8)
SBUXEU9: Soybean export demand shifter, mil. bu. (8)
SBUXTU9: Soybean exports, mil. bu. (1)
SBVCAU9F: Soybean variable production costs--includes family labor and interest on variable expenses, next year \$/ac. (7)
SBYHAU9F: Soybean yield per harvested acre, next year, bu./ac. (1)
SBYHTU9F: Soybean trend yield, next year, bu./ac. (8)
SGABAU9: Sorghum program acreage base, mil. ac. (1)
SGAHAU9: Sorghum area harvested, mil. ac. (1)
SGAHPU9: Sorghum harvested area/sorghum planted area (8)
SGAIAU9: Sorghum acreage idled by ARP, PLD programs, mil. ac. (1)
SGAPAU9: Sorghum area planted, mil. ac. (1)
SGAPNU9: Sorghum area planted by nonparticipants, mil. ac. (1)
SGAPPU9: Sorghum area planted by participants, mil. ac. (1)
SGCCCU9: Sorghum CCC stocks, mil. bu. (1)
SGCOTU9: Sorghum total ending stocks, mil. bu. (1)
SGCRPU9: Sorghum program base enrolled in the CRP, mil. ac. (6)
SGDPRU9: Sorghum diversion payment rate, \$/bu. (2)
SGF9LU9: Sorghum free and nine-month loan stocks, mil. bu. (1)
SGFORU9: Sorghum FOR stocks, mil. bu. (1)
SGMARU9: Sorghum model ARP rate, equals ARP area/(ARP + PLD + program planted area) (8)
SGMPLU9: Sorghum model PLD rate, equals PLD area/(ARP + PLD + program planted area) (8)

SGMPRU9: Sorghum model participation rate, equals (ARP + PLD + program planted area)/program base (8)
SGNRNU9: Sorghum expected net returns to nonparticipants, $/ac. (8)
SGNRPU9: Sorghum expected net returns to participants, $/base ac. (8)
SGPFMU9: Sorghum farm market price, $/bu. (1)
SGPLNU9: Sorghum loan rate, $/bu. (1)
SGPTGU9: Sorghum target price, $/bu. (1)
SGSMTU9: Sorghum imports, mil. bu. (1)
SGSPRU9: Sorghum production, mil. bu. (1)
SGUFEU9: Sorghum feed use, mil. bu. (1)
SGUFOU9: Sorghum food, seed, and industrial use, mil. bu. (1)
SGURSU9: Sorghum statistical discrepancy, mil. bu. (8)
SGUXEU9: Sorghum export demand shifter, mil. bu. (8)
SGUXTU9: Sorghum exports, mil. bu. (1)
SGVCAU9: Sorghum variable production costs--includes family labor and interest on variable expenses, $/ac. (7)
SGVCAU9F: Sorghum production costs, next year, $/ac. (7)
SGYHAU9: Sorghum yield per harvested acre, bu./ac. (1)
SGYHPU9: Sorghum program yield, bu./ac. (1)
SGYHTU9: Sorghum trend yield, bu./ac. (8)
SGYHTU9F: Sorghum trend yield, next year, bu./ac. (8)
SMCOTU9: Soybean meal total ending stocks, 1000 tons (5)
SMPFMU9: Soybean meal market price, 44% protein, Decatur, $/ton (4,5)
SMSPRU9: Soybean meal production, 1000 tons (5)
SMUDTU9: Soybean meal domestic use, 1000 tons (5)
SMUDTU9H: Soybean meal domestic use per HPAU, tons/1000 HPAU (8)
SMURSU9: Soybean meal statistical discrepancy, 1000 tons (8)
SMUXEU9: Soybean meal export demand shifter, 1000 tons (8)
SMUXTU9: Soybean meal exports, 1000 tons (5)
SMYCBU9: Soybean meal crushing yield, tons/1000 bu. (8)
SOCOTU9: Soybean oil total ending stocks, mil. lbs. (5)
SOPFMU9: Soybean oil market price, crude, Decatur, cents/lb. (4,5)
SOSMTU9: Soybean oil imports, mil. lbs. (5)
SOSPRU9: Soybean oil production, mil. lbs. (5)
SOUDTU9: Soybean oil domestic use, mil. lbs. (5)
SOUDTU9C: Soybean oil domestic use per capita, lbs./capita (8)
SOURSU9: Soybean oil statistical discrepancy, mil. lbs. (8)
SOUXEU9: Soybean oil export demand shifter, mil. lbs. (8)
SOUXTU9: Soybean oil exports, mil. lbs. (5)
SOYCBU9: Soybean oil crushing yield, lbs./bu. (8)
SUPRTU9: Granulated sugar retail price, cents/lb. (4)
TREND: Calendar year
TRND6783: Trend from 1967-1983: 1 in 1967, 2 in 1968,..., 17 in 1983 and after
TRND7186: Trend from 1971-1986: 0 until 1970, 1 in 1971, 2 in 1972,..., 16 in 1986 and after
TRND8184: Trend from 1981-1984; 0 until 1980; 1 in 1981, 2 in 1982,..., 4 in 1984 and after
TRND8185: Trend from 1981-1985; 0 until 1980; 1 in 1981, 2 in 1982,..., 5 in 1985 and after

TRND8587: Trend from 1985-1987; 0 until 1984; 1 in 1985, 2 in 1986, 3 in 1987 and after (8)
TXPMIU9: Textile price index (Statistical Abstract of the U.S.)
TXSMTU9: Textile imports, mil. lbs. (5)
TXSPRU9: Textile production, mil. lbs. (5)
TXUDTU9: Textile domestic use, mil. lbs. (5)
TXUDTU9C: Textile domestic use per capita, lbs./cap. (8)
TXUXTU9: Textile exports, mil. lbs. (5)
WH092U9F: Wheat 50-92 and 0-92 idled acres, next year, mil. ac. (1)
WH9LNU9: Wheat nine-month loan stocks, mil. bu. (1)
WHABAU9F: Wheat program acreage base, next year, mil. ac. (1)
WHAHAU9F: Wheat area harvested, next year, mil. ac. (1)
WHAHPU9F: Wheat harvested area/wheat planted area, next year (8)
WHAIAU9F: Wheat acreage idled by ARP, PLD programs, next year, mil. ac. (1)
WHAPAU9F: Wheat area planted, next year, mil. ac. (1)
WHAPNU9F: Wheat area planted by nonparticipants, next year, mil. ac. (1)
WHAPPU9F: Wheat area planted by participants, next year, mil. ac. (1)
WHCCCU9: Wheat CCC stocks, mil. bu. (1)
WHCOTU9: Wheat total ending stocks, mil. bu. (1)
WHCRPU9F: Wheat program base enrolled in the CRP, next year, mil. ac. (6)
WHDPRU9F: Wheat diversion payment rate, next year, $/bu. (1,2)
WHFREU9: Wheat free stocks, mil. bu. (1)
WHFORU9: Wheat FOR stocks, mil. bu. (1)
WHMARU9F: Wheat model ARP rate, equals ARP area/(ARP + PLD + 0-92 + program planted area), next year (8)
WHMPLU9F: Wheat model PLD rate, equals PLD area/(ARP + PLD + 0-92 + program planted area), next year (8)
WHMPRU9F: Wheat model participation rate, equals (ARP + PLD + 0-92 + program planted area)/program base, next year (8)
WHNRNU9F: Wheat expected net returns to nonparticipants, next year, $/ac. (8)
WHNRPU9F: Wheat expected participant net returns, next year, $/base ac. (8)
WHNRPU9Z: Wheat exogenous participant net returns for years prior to 1973, next year, $/base ac. (8)
WHPFMU9: Wheat farm market price, $/bu. (1)
WHPLNU9F: Wheat loan rate, next year, $/bu. (1)
WHPTGU9F: Wheat target price, next year, $/bu. (1)
WHSMTU9: Wheat imports, mil. bu. (1)
WHSPRU9F: Wheat production, next year, mil. bu. (1)
WHUFEU9: Wheat feed use, mil. bu. (1)
WHUFOU9: Wheat food, seed and industrial use, mil. bu. (1)
WHUOFU9: Wheat food and industrial use, mil. bu. (1)
WHUOFU9C: Wheat food and industrial use per capita, bu./capita. (8)
WHURSU9: Wheat statistical discrepancy, mil. bu. (8)
WHUSDU9: Wheat seed use, mil. bu. (1)
WHUXEU9: Wheat export demand shifter, mil. bu. (8)
WHUXTU9: Wheat exports, mil. bu.
WHVCAU9F: Wheat variable production costs--includes family labor and interest on variable expenses, next year, $/ac. (7)
WHYHAU9F: Wheat yield per harvested acre, next year, bu./ac. (1)
WHYHPU9F: Wheat program yield, next year, bu./ac. (1)
WHYHTU9F: Wheat trend yield, next year, bu./ac. (8)

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