AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
http://ageconsearch.umn.edu
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

International Economics Division
Economic Research Service
United States Department of Agriculture

Staff Report # AGES861215
1987

Agricultural Trade Modeling – The State of Practice and Research Issues

Liu, K. and R. Seeley, eds.

Proceedings of a Meeting of the
International Agricultural Trade Research Consortium
December, 1985, Vancouver, British Columbia, Canada

THE MICHIGAN STATE UNIVERSITY AGRICULTURE MODEL

Shayle Shagam

High levels of agricultural production among exporting countries in recent years have resulted in increased competition for market share in international grain markets. It has been argued that the United States has been unfairly hampered by both misguided agricultural policies domestically and by unfair trading practices by competing exporters. The result is felt to be a cycle of continuously increasing levels of production and ending stocks as the United States loses market share by maintaining an unrealistic floor on world prices.

A number of policy options have been put forward as possible solutions to the problems of stock buildup and low prices. At the request of the Consortium for International Trade Research, the Michigan State University (M.S.U.) Agriculture Model attempted to explore the medium-term (5 years) effects of two options. The first option considered is effects of a one-time decrease of 5 percent in U.S. grain and oilseed production. The second scenario considered the effects of a more liberalized trade structure by the elimination of European Community (EC) support prices for grain, the variable levy, and export subsidies.

To understand how each scenario was run, a brief overview of the structure of the M.S.U. Agriculture Model is presented. The results are presented as deviations from a baseline.

Model Overview

The scenarios were run using the international component of the Agriculture Model. This component, with the capacity to be linked to a U.S. component model, divides the world into 11 regions, including a simplified U.S. region and solves simultaneously across wheat, coarse grains, and the soybean complex. The regions included are: the United States, Canada, Argentina, Australia, Brazil, China, the Soviet bloc (Eastern Europe and U.S.S.R.), the developed markets (EC, other Western Europe, Japan, and South Africa), newly industrialized countries (South Korea, Taiwan, Hong Kong, Singapore, and Malaysia), less developed oil exporters (LDO's), and the rest of the world in a catchall less developed countries (LDC's).

The regions are divided into four categories: (1) importers, (2) dumpers, (3) partial dumpers, and (4) the United States as the residual supplier. Importers included the LDO's, the newly industrialized countries (NIC's), the LDC's, the Soviet bloc, Brazil for wheat and coarse grains, China for wheat and coarse grains, and the developed markets for coarse grains and the soybean complex. For each region, equations for harvested area, yield, net imports, and ending stocks were estimated. Consumption is the residual identity that clears the regional market.

The dumpers include Argentina, Australia, and Brazil plus China for the soybean complex. These countries are assumed to fulfill domestic requirements and export the balance no matter what the price. For these countries,

---

Shayle Shagam is a research assistant with the Department of Agricultural Economics, Michigan State University, East Lansing. Vernon Sorenson reviewed the international market analysis, James Hilker reviewed the U.S. market analysis, and J. Roy Black gave general comments.

harvested area, yield, feed consumption, food/residual consumption, and ending stocks were estimated. Net exports is the residual identity that clears the market for a dumper.

Canada and the developed markets for wheat are classified as partial dumpers. Like the dumpers, equations are estimated for harvested area, yield, feed consumption, and food/residual consumption. However, partial dumpers are somewhat constrained in the quantities of grain they export. Therefore, net exports are estimated and ending stocks clear the regional market.

The United States is classified as the residual supplier to the world market. Harvested area, yield, feed use, and food/residual consumption are estimated equations. Net exports are the residual of imports and exports of all other regions, and thereby close the world market. Ending stocks are the residual that then close the U.S. market.

Demand for imports and consumption is estimated as a function of world prices, income, exchange rates, inflation rates, and domestic supplies. Government policies are, with the exception of the developed markets, implicit in the choice of variables and are included in the estimation of the equation. Interaction between wheat, coarse grains, and the soybean complex for imports and consumption is determined by own and cross price and supply elasticities. Interaction between imports of soybeans and soymeal is determined by the soybean crush margin and the supply elasticity of soybeans and exogenous other oilseed supply.

Crop production is the product of harvested area and yield. The area for each crop is estimated separately as a function of own and competing per hectare revenues where revenue is the previous year's price times a 4-year average of yield. Yields are estimated either as a time trend or as a function of a time trend and harvested area.

The structure of ending stocks is somewhat more complex and depends upon the regional class. For detailed description of this structure, see Appendix I.

Trade follows a hierarchy by which world import demand is filled first by dumpers. The residual pool is then shared by Canada and the United States.

5-Percent Production Drop

This scenario investigates the effects of a one-time 5-percent decline in production of U.S. grains and oilseeds in the 1986 crop year. Production and harvested area are projected as 5 percent less than baseline levels, assuming yields grow at historic trends. The results of the scenario are presented as absolute and percentage deviations from the baseline.

The effects of the 5-percent production decline are greatest in the soybean complex. A large percentage reduction in U.S. soybean stocks increases soymeal prices and encourages Argentina and Brazil to expand soybean production, increasing their exports at the expense of the United States. Higher coarse grain prices relative to wheat prices in the first period encourage U.S. and Canadian producers to shift production to coarse grains in the second period and bring about an increase in wheat prices as ending stocks in these countries are drawn down. An increase in difference in the price of wheat between the baseline and the scenario and decreases in the difference in

the prices for soybeans and coarse grains reverse the decline in wheat production and narrow the shortfall in wheat ending stocks.

Prices of all crops approach baseline levels toward the end of the period with the fastest decline appearing in soybeans as U.S. ending stocks increase.

Effects of Reduction on Wheat Supply and Trade

The initial impacts of a reduction in U.S. production are minimized by the large levels of ending stocks held by the major exporters, primarily the United States (table 1). U.S. ending stocks in the baseline are 40.7 million metric tons in 1986; therefore, the 3.6-million-metric-ton decline in U.S. wheat production is covered mostly by a 10-percent reduction in U.S. wheat ending stocks and by a smaller release of ending stocks in Canada. Net trade in wheat increases slightly in the 1986 crop year as coarse grain prices rise relative to wheat and encourage an increase in Chinese imports.

The modest increases in wheat prices relative to soybean and coarse grain prices cause a major shift in production patterns in the next period. The model projects harvested area as a function of lagged harvested area and expectations of own and competing revenue per hectare, where the revenues are based upon prices in the previous period. Therefore, there is a shift into competing crops. Wheat production in 1987 declines in all regions but China.

Argentina and Australia are classified as "dumpers"; hence, the majority of production declines in those countries manifest themselves as export declines. Lower wheat production in importing regions increases demand for imported wheat concurrently. The shortfall in trade left by a 16-percent decline in Argentine exports, a 2-percent decline in Australian exports, and higher import demand is filled by the United States, Canada, and the developed markets. This reduces stock levels further and drives wheat prices 6.7 percent above baseline levels in 1987.

In later periods, a reduction in the difference between wheat prices relative to coarse grain and soybean complex prices and government policy encourages production in the United States and Canada. Increased production reduces the shortfall between scenario stocks and baseline stocks. The United States and Canada gain market share in wheat exports at the expense of Australia and Argentina, although there is some erosion by the end of the period. Prices decline steadily from their peak deviation in 1987 and are 2.3 percent above baseline levels by the end of the forecast period.

Effects of Reduction on Coarse Grain Supply and Trade

The effects of a 5-percent reduction in coarse grain production are more immediate than those for wheat (table 2). The United States has a far larger share of world coarse grain production and ending stock relative to wheat. Ending stocks held by competing exporters have less of a cushion. Therefore, while a 5-percent decline in U.S. wheat production reduced wheat ending stocks held by exporters to 6 percent, a 5-percent reduction in U.S. coarse grain production results in an 11-percent decline in ending stocks held by exporters. Substantially higher prices in coarse grains relative to wheat reduce demand for coarse grain imports in almost all regions. The LDC's that are more reliant on corn for human consumption do not change the level of their imports, and the developed markets increase coarse grain imports at the expense of cassava to offset higher soymeal prices in cassava/soymeal animal rations.

Table 1--Effects of a 5-percent decline in U.S. crop production on world wheat supply and trade deviations from baseline

Item	1986/87	1987/88	1988/89	1989/90	1990/91
		Dollars per metric ton 1/			
World price	1.58	6.88	5.55	3.63	2.15
	(1.5)	(6.7)	(5.5)	(3.7)	(2.3)
		Million metric tons 1/			
Net exports:					
Canada	.2	.6	.3	.2	.2
	(1.0)	(2.9)	(1.4)	(1.0)	(1.0)
Australia	0	-.3	-.4	-.4	-.3
	(0)	(-2.1)	(-2.6)	(-2.5)	(-1.8)
Argentina	-.1	-.9	-.6	-.1	0
	(-1.5)	(-15.8)	(-11.3)	(-1.8)	(0)
Developed markets	.1	.4	.1	0	0
	(1.9)	(7.1)	(1.5)	(0)	(0)
United States	.5	2.0	1.5	1.1	.7
	(1.5)	(5.8)	(4.3)	(3.2)	(2.0)
Net imports:					
Soviet bloc	0	-.1	.2	-.2	-.1
	(0)	(-.5)	(1.0)	(-.9)	(-4.4)
Less developed countries	0	1.3	.9	.8	.7
	(0)	(5.9)	(4.0)	(3.6)	(3.1)
China	.5	.3	.2	.1	.1
	(3.9)	(2.1)	(1.4)	(0.6)	(0.6)
Middle income countries 2/	0	.1	.1	0	0
	(0)	(.4)	(.1)	(0)	(0)
Production:					
Canada	0	-.4	.1	.5	.5
	(0)	(-1.4)	(.4)	(1.9)	(1.9)
Australia	0	-.2	-.3	-.3	-.3
	(0)	(-1.1)	(-1.6)	(-1.5)	(-1.4)
Argentina	0	-.8	-.5	-.1	0
	(0)	(-7.4)	(-4.8)	(-.9)	(0)
United States	-3.6	-.1	2.1	2.6	2.4
	(-5.0)	(-.2)	(3.2)	(3.9)	(3.4)
Soviet bloc	0	.2	0	0	0
	(0)	(.1)	(0)	(0)	(0)
Developed markets	0	0	0	0	0
	(0)	(.0)	(0)	(0)	(0)
Less developed countries	0	-.4	-.7	-.8	-1.0
	(0)	(-.4)	(-.7)	(-.7)	(-.9)
China	0	.1	.6	.6	.5
	(0)	(.1)	(.8)	(.8)	(.6)
Middle income countries 2/	0	-.2	-.1	-.1	-.1
	(0)	(-1.6)	(-.8)	(-.8)	(-.8)
Ending stocks (exporters):					
Canada	-.2	-1.1	-1.1	-.8	-.4
	(-1.3)	(-6.6)	(-6.9)	(-5.2)	(-2.8)
Australia	0	0	0	0	0
	(0)	(0)	(0)	(0)	(0)
Argentina	0	0	0	0	0
	(0)	(0)	(0)	(0)	(0)
Developed markets	0	-.1	-.1	0	0
	(0)	(-.8)	(-.7)	(0)	(0)
United States	-4.0	-6.0	-4.8	-2.7	-.8
	(-9.8)	(-16.0)	(-15.4)	(-11.0)	(-3.5)

1/ Number in parentheses are percentages.

2/ Includes Brazil, newly industrialized countries, and less developed oil exporters.

Table 2--Effects of a 5-percent decline in U.S. crop production on coarse grain supply and trade deviations from baseline

Item	1986/87	1987/88	1988/89	1989/90	1990/91
		Dollars per metric ton 1/			
World price	7.51	6.61	5.61	4.09	1.64
	(7.9)	(6.6)	(5.5)	(3.8)	(1.4)
		Million metric tons 1/			
Net exports:					
Canada	0	.1	.1	.1	.1
	(0)	(2.0)	(1.9)	(1.9)	(1.9)
Australia	-.1	0	0	.1	-.1
	(-2.0)	(0)	(0)	(1.4)	(-1.3)
Argentina	.1	.2	.1	.1	.1
	(.8)	(1.6)	(.7)	(.7)	(.6)
United States	-.2	-.5	-.8	-.8	-.6
	(1.5)	(-.8)	(-1.3)	(-1.4)	(-1.0)
Net imports:					
Soviet bloc	-.4	0	-.1	-.1	0
	(-1.6)	(0)	(-.4)	(-.4)	(0)
Developed markets	.9	.3	.1	.1	.1
	(3.2)	(1.0)	(.4)	(.4)	(.4)
Less developed countries	0	-.1	0	0	.1
	(0)	(-.9)	(0)	(0)	(.0)
China	-.3	-.1	0	0	.1
	(-9.6)	(-3.0)	(-2.7)	(-2.5)	(-2.2)
Middle income countries 2/	-.3	-.3	-.4	-.5	-.4
	(-1.3)	(-1.3)	(-1.7)	(-2.1)	(-1.6)
Production:					
Canada	0	.4	.4	.3	.2
	(0)	(1.6)	(1.6)	(1.2)	(.8)
Australia	0	.1	0	0	.1
	(0)	(1.1)	(0)	(0)	(.9)
Argentina	0	.3	.1	.1	.1
	(0)	(1.4)	(.4)	(.4)	(.4)
United States	-11.6	1.7	1.9	1.8	1.6
	(-5.0)	(.7)	(.8)	(.7)	(.6)
Soviet bloc	0	-.2	0	0	0
	(0)	(-.1)	(0)	(0)	(0)
Developed markets	0	0	0	0	0
	(0)	(0)	(0)	(0)	(0)
Less developed countries	0	.5	.4	.3	.3
	(0)	(.4)	(.3)	(.3)	(.2)
China	0	1.1	.8	.6	.5
	(0)	(1.3)	(.9)	(.7)	(.5)
Middle income countries 2/	0	-.2	-.2	.8	.7
	(0)	(-.5)	(-.5)	(1.9)	(1.6)
Ending stocks (exporters):					
Canada	-.1	.2	.2	.1	.2
	(-1.8)	(3.5)	(3.4)	(1.7)	(3.0)
Australia	0	0	0	0	0
	(0)	(0)	(0)	(0)	(0)
Argentina	0	0	0	0	0
	(0)	(0)	(0)	(0)	(0)
United States	-9.6	-8.6	-7.5	-5.6	-3.1
	(-10.5)	(-9.5)	(-7.7)	(-5.5)	(-2.9)

1/ Numbers in parentheses are percentages.
2/ Includes Brazil, newly industrialized countries, and less developed oil exporters.

Coarse grain production in 1987 increases as higher prices relative to wheat encourage an expansion of harvested area. Although the middle income countries appear to decline, this is a result of an increase in soybean area in Brazil. As soymeal prices fall relative to coarse grains later in the period, coarse grain production increases in the middle income region.

Given higher levels of production and higher prices relative to the baseline, imports are lower in the scenario than in the baseline. The shortfall in ending stocks for exporters declines in 1987, a trend that continues through the entire forecast period.

For the remainder of the period, U.S. exports are slightly more than 1 percent below baseline levels. This is a result of decreased import demand overall and increased pressure from the end of the forecast period coarse grain prices are only 1.4 percent above baseline levels.

Effect of Reduction on Soybean Complex Supply and Trade

The greatest impact of the 5-percent reduction occurred in the soybean section (tables 3 and 4). Soybean prices are a function of soymeal prices and exogenously determined soyoil prices. A 5-percent decline in U.S. soybean production resulted in a 27-percent decline in soybean ending stocks in 1986. Therefore, a 27-percent difference in soybean stock levels raised soymeal price 32 percent above baseline levels and raised the ratio of soybean stocks to soymeal equivalent disappearance (feed, seed, and exports) in the United States.

Higher prices reduced import demand for oilseeds among higher income regions that feed livestock. In developed markets that crush domestically, the reduction was greater in whole beans; in the NIC's, where a greater percentage of meal equivalent is imported as meal, soymeal net imports absorbed most of the burden of adjustment. As the residual supplier to the world market, the United States absorbed the entire shortfall in trade.

Higher prices in 1986 provided incentives for both Argentina and Brazil to increase soybean production in 1987. Argentina increased production by 7.6 percent and Brazil increased production by 4 percent. The United States absorbed this increase in competing exports by exporting 3 percent less soybeans and 12 percent less soymeal than in the baseline forecast. This resulted in higher U.S. soybean ending stocks and a narrowing of the gap between baseline and scenario soybean complex prices.

As the difference between scenario and baseline prices narrows, the spread between scenario and baseline production for Argentina and Brazil narrows as well. Brazil increases both soymeal and whole bean exports throughout the remainder of the forecast period. Argentina increases exports of soybeans at a greater rate than production increases, causing a shortfall in soymeal exports relative to the baseline. 1/

1/ This decline in Argentine soymeal exports is most likely the result of an overreaction of the equation that estimates the share of soymeal equivalent exports exported as soymeal. The equation is specified with a negative coefficient on soybean supply; that is, as soybean supply increases, there may be insufficient crush capacity and a greater percentage of soymeal equivalent exports will be as soybeans. The rapid increase in production triggers the export of a larger percentage of beans than is warranted by the production increase.

Conclusions

The effect of a 5-percent reduction in grain and oilseed production is greatest in the oilseed sector. High prices in the initial period encourage rapid expansion of production by competing exporters. As a result, the United States loses market share in the soybean sector.

Price movements are moderated by high stock levels in the grain sectors. The amount of ending stocks held by competing exporters in the wheat sector resulted in lower increases in wheat prices in 1986, while the effect of the lower stocks in the United States caused a larger price increase in coarse grains during the same time period.

Table 3--Effects of a 5-percent decline in U.S. crop production on world soybean supply and trade deviations from baseline

Item	1986/87	1987/88	1988/89	1989/90	1990/91
		Dollars per metric ton 1/			
World price	48.48	20.93	3.41	1.50	0.14
	(20.8)	(8.5)	(1.7)	(.8)	(0)
		Million metric tons 1/			
Net exports:					
United States	-.3	-.7	-.7	-1.0	-1.1
	(-1.3)	(-3.1)	(-4.2)	(-4.5)	(-5.0)
Argentina	0	.3	.4	.8	1.0
	(0)	(15.0)	(11.5)	(7.6)	(4.2)
Brazil	0	.3	.3	.2	.1
	(0)	(15.0)	(11.5)	(7.6)	(4.2)
China	0	0	0	0	0
	(0)	(0)	(0)	(0)	(0)
Net imports:					
Developed markets	-.2	-.1	0	-.1	0
	(-.9)	(-.4)	(0)	(-.4)	(0)
Less developed countries	-.1	0	0	0	0
	(-7.7)	(0)	(0)	(0)	(0)
Middle income countries 2/	-.1	0	0	0	0
	(-4.6)	(0)	(0)	(0)	(0)
Soviet bloc	0	-.1	0	0	0
	(0)	(-.5)	(1.0)	(-.9)	(-4.4)
Production (exporters):					
United States	-2.4	-.6	-.2	-.6	-.7
	(-5.0)	(-1.2)	(-.4)	(-1.1)	(-1.3)
Argentina	0	.7	.6	.3	.3
	(0)	(7.6)	(5.4)	(2.5)	(2.4)
Brazil	0	.7	1.0	.9	.7
	(0)	(3.9)	(4.8)	(4.0)	(3.0)
China	0	0	-.1	-.1	-.1
	(0)	(0)	(-1.0)	(-1.0)	(-1.0)

1/ Numbers in parentheses are percentages.
2/ Includes newly industrialized countries and less developed oil exporters.

Higher coarse grain and soybean prices encouraged competing exporters to shift out of wheat in 1987. This resulted in a substantial draw down of ending stocks among wheat exporters and significantly higher prices in 1987. It also permitted the United States to increase its market share early in the period. Although there was some erosion of this position later as prices realigned, U.S. wheat exports remained above baseline levels for the entire forecast period.

The shift of exporters and most importers into coarse grains resulted in the loss of market share by the United States as competing exporters fought for a smaller import market. Later in the period, U.S. coarse grain exports regain some lost ground; however, they remain below baseline levels throughout the entire forecast period.

Trade Liberalization Scenario

The M.S.U. Agriculture Model does not have an explicit policy variable included in equations for most regions. Tariffs, subsidies, and other taxes are implicit in the price elasticities for all regions but one. The Common Agricultural Policy (CAP) of the EC has a profound effect on the economic

Table 4--Effects of a 5-percent decline in U.S. crop production on world soymeal supply and trade deviations from baseline

Item	1986/87	1987/88	1988/89	1989/90	1990/91
		Dollars per metric ton 1/			
World price	61.01	29.39	4.46	1.91	0.15
	(32.2)	(16.7)	(3.2)	(1.7)	(.2)
		Million metric tons 1/			
Net exports:					
United States	-.2	-.5	-.2	.1	.2
	(-4.8)	(-11.9)	(-6.2)	(3.3)	(6.7)
Argentina	0	3.4	1.3	-.5	-.7
	(0)	(9.7)	(3.6)	(-13.9)	(-20.0)
Brazil	0	.3	.4	.4	.5
	(0)	(3.2)	(3.8)	(3.4)	(4.0)
China	0	0	0	0	0
	(0)	(0)	(0)	(0)	(0)
Net imports:					
Developed markets	-.1	0	0	0	0
	(-1.2)	(0)	(0)	(.4)	(0)
Less developed countries	0	0	0	0	0
	(0)	(0)	(0)	(0)	(0)
Middle income countries 2/	-.2	0	0	0	0
	(-8.0)	(0)	(0)	(0)	(0)
Soviet bloc	0	0	0	0	0
	(0)	(0)	(0)	(0)	(0)

1/ Numbers in parentheses are percentages.
2/ Includes newly industrialized countries and less developed oil exporters.

structure of European agriculture. Prices are political as opposed to economic and have been responsible for a rapid expansion in grain production since the early seventies. Therefore, it was felt that equations for the developed markets should use these policy prices as opposed to world prices.

EC intervention prices were found to be highly correlated among commodities so EC producer prices (although not perfect) were used to determine per hectare gross revenue. These exogenous prices were forecast by assuming that since the CAP provides the floor, a forecast of the intervention plus a historical margin could provide a reasonable approximation of producer prices.

The structure of the equations for EC harvested area of the major crops also required a slightly different specification from that for other regions. If the same Nerlovian partial adjustment structure is used, the elasticity of expansion is very high for the late seventies. Given the lack of alternatives for agricultural production, it is not expected that harvested area will contract as rapidly as it expanded. Therefore, harvested area for the developed market was estimated following the Nerlovian partial model, but the ratio of own to competing crop revenue was used instead of using each as an independent variable.

The developed markets was the only region modified for the free trade scenario. Beginning in 1986, real EC producer prices were set equal to real border prices. This lowered the price paid to producers and the subsidy paid on exports in 1986 and affected revenue assumptions for 1987 and beyond.

The effects of free trade on the wheat market are summarized in table 5. Being no longer constrained by the subsidy costs, the developed markets increase wheat exports by 1.1 million tons over the baseline forecast. However, the low price elasticities of imports kept total trade at about the same level; therefore, exports from Canada and the United States declined. This reduced ending stocks in the developed markets and increased stocks in the United States and Canada.

Lower price in 1987 translated into lower wheat revenues in all regions. Production was slightly lower in most importing regions. The additional import demand was met by the developed markets and further reduced their stocks. An increase in coarse grain revenue relative to wheat in the developed markets in 1987 began a shift away from wheat product in 1988 and as domestic supply began to fall, so too did exports. This continued through the end of the period, although the developed markets remained wheat exporters, production, exports, and stocks were lower than in the baseline. The United States and Canada both benefited from the decline in exports by the developed markets during the latter part of the period. Exports are projected to increase above the baseline in 1989 and by 1990 to be approximately 600,000 metric tons higher for Canada and 1.5 million tons higher for the United States.

Lower ending stocks are reflected in higher prices. Prices are $3.50 per metric ton higher in 1989 and $8.50 higher in 1990.

Effects of Liberalization on Coarse Grain Supply and Trade

Coarse grain production and trade are affected very little by a movement toward freer trade (table 6). Large stocks of wheat in the developed markets and low soymeal prices initially encourage continued levels of wheat feeding.

Total world trade in coarse grains decline by a small amount and ending stocks held by the major exporters do not increase appreciably. Therefore, in 1986, coarse grain prices do not decline from the baseline by as much as the wheat prices.

A greater decline in wheat prices improves grain revenue relative to wheat in all regions except the developed markets and Australia where a return to trend yield growth keeps revenues fairly constant. An expansion of harvested area

Table 5--World wheat production and trade under free trade: Deviation from baseline forecast

Item	1985	1986	1987	1988	1989	1990
			Dollar per metric ton 1/			
World price	0	-3.32	-0.78	0.56	3.48	8.50
			Million metric tons 1/			
Net exports:						
Canada	0	-.2	0	0	.2	.6
Australia	0	.1	0	0	0	.1
Argentina	0	0	-.1	.1	.2	.2
Developed markets	0	1.1	.5	-.2	-1.4	-3.0
United States	0	-.7	0	0	.7	1.5
Net imports:						
Soviet Bloc	0	0	.1	.1	0	-.1
Less developed countries	0	0	.2	.1	-.2	-.3
China	0	0	0	-.1	0	-.3
Middle income countries 2/	0	0	.1	0	-.1	-.1
Production:						
Canada	0	0	-.3	-.1	0	.1
Australia	0	0	0	0	.1	.1
Argentina	0	0	-.1	.2	.2	.2
United States	0	0	-.4	-.3	-.1	.4
Soviet bloc	0	0	.1	.1	0	0
Developed markets	0	0	0	-.8	-2.1	-4.1
Less developed countries	0	0	-.1	.2	0	.1
China	0	0	-.3	0	0	0
Middle income countries 2/	0	0	-.1	-.2	0	0
Ending stocks (exporters):						
Canada	0	.2	.1	0	-.2	-.6
Australia	0	0	0	0	0	0
Argentina	0	0	0	0	0	0
Developed markets	0	-1.1	-1.6	-2.1	-2.9	-4.0
United States	0	.6	.3	0	-.7	-1.6

1/ Deviations may not net to 0 due to rounding errors.
2/ Includes Brazil, newly industrialized countries, and less developed oil exporters.

in coarse grains in all but these two regions results in higher levels of production than those found in the baseline. Higher levels of production in the United States result in higher stocks as the coarse grain trade remains soft.

Tighter domestic supplies of wheat relative to coarse grains in the EC encourage more coarse grain feeding later in the period. In addition, more favorable coarse grain revenues encourage a production shift toward coarse

Table 6--World coarse grain production and trade under free trade: Deviation from baseline forecast

Item	1985	1986	1987	1988	1989	1990
			Dollar per metric ton 1/			
World price	0	-0.34	-1.03	-0.54	0.20	1.44
			Million metric tons 1/			
Net exports:						
Canada	0	-.2	0	0	0	.1
Australia	0	0	.1	.1	0	.1
Argentina	0	0	.2	0	0	.1
United States	0	-.3	-.3	-.1	.1	.2
Net imports:						
Developed markets	0	0	0	-.1	-.2	.5
Soviet bloc	0	-.1	0	.1	.3	.3
Less developed countries	0	0	0	.1	0	.1
China	0	-.1	0	0	0	0
Middle income countries 2/	0	-.2	-.1	-.1	.1	.1
Production:						
Canada	0	0	.1		-.1	.1
Australia	0	0	0		0	.0
Argentina	0	0	.1	.1	0	-.1
United States	0	0	.7	-.2	-.5	-1.0
Soviet bloc	0	0	-.1	0	.1	.2
Developed markets	0	0	0	.8	2.0	2.0
Less developed countries	0	0	.2	0	-.1	-.3
China	0	0	.7	.6	.3	-.5
Middle income countries 2/	0	0	.2	.2	0	-.2
Ending stocks (exporters):						
Canada	0	.1	0	0	0	-.1
Australia	0	0	0	0	0	.0
Argentina	0	0	0	0	0	.0
Developed market	0	.3	1.2	.9	0	-1.3
United States	0	0	0	.1	.3	.6

1/ Deviations may not net to 0 due to rounding errors.
2/ Includes Brazil, newly industrialized countries, and less developed oil exporters.

grains. After an initial decline, coarse grain imports by the developed markets increase above baseline projections by the end of the period.

Increased import demand coupled with a shift back into wheat in the United States raises coarse grain prices in 1989 and into 1990. The increase in coarse grain prices is rather modest, only $1.44 per metric ton over the baseline by 1990. These world prices, although higher than the baseline, are low relative to the former EC producer prices. Beginning in 1990, total cropland in the developed markets begins to deviate slightly from the baseline as land is abandoned.

Effect of Liberalization on Soybean Complex Supply and Trade

Soybean and soymeal prices remain somewhat lower as some producers in the developed markets increase production of oilseeds. An early increase of 300,000 metric tons in soybean production occurs as a result of higher returns from unprotected soybean prices relative to the lower wheat and coarse grain prices. This, coupled with weaker demand for soybeans as coarse grain prices fall relative to the price cassava/soymeal mix, lowers demand for soybeans by approximately 1 million tons by the end of the period. It can be assumed, although not covered by this model, that if the trade liberalization carried over to the livestock and dairy sector, herd size would decline in the EC. This decline in herd size would cause soybean complex imports to be even lower than those in the baseline.

Appendix

The structure of the equations for harvested area, yield, and either feed and food consumption for exporters or net imports for importers follows a generic format that is modified to take economic policies into account. Equations for exports and ending stocks differ depending upon a regional category. The structures that follow in this appendix are the generic structures. For a more complete analysis of the individual equations, a complete documentation of the M.S.U. Agriculture Model is forthcoming.

Harvested area for a given crop is estimated as a Nerlovian partial adjustment model where producers adjust last period's acreage (HA^i) by revenue expectations for own (REV^i) and competing (REV^j) crops and relevant government policies. Revenue per hectare is assumed to be last period's real border price times a 4-year moving average of yield. 1/ In the developed markets, the EC producer price is substituted for real border prices. To model policy, lagged ending stocks (ES^i_{t-1}) are used as a proxy for government allotment decisions and lagged net imports (NI^i_{t-1}) as a proxy for policies of self-sufficiency for importers:

$$HA^i_t = f(HA^i_{t-1}, REV^i_{t-1}, REV^j_{t-1}, ES^i_{t-1}, NI^i_{t-1})$$

1/ Real border price is defined as world prices times exchange rate divided by the Consumer Price Index.

Yield is estimated either as a time trend or as a function of time and harvested area, where the coefficient on harvested area is expected to be negative:

$$YLD^{i}_{t} = f(TIME, HA^{i}_{t-1})$$

Production is defined as harvested area times yield:

$$PROD^{i}_{t} = HA^{i}_{t} * YLD^{i}_{t}$$

Production is summed with lagged ending stocks to determine domestic supply (DS^{i}_{t}):

$$DS^{i}_{t} = PROD^{i}_{t} + ES^{i}_{t}$$

Net imports ($PCNI^{i}_{t}$) are estimated on a per capita basis and have the same structure for all regions. Net imports are also estimated as functions of real per capita income ($PCRDGP_{t}$), real border prices of the own (P^{i}_{t}), competing (P^{j}_{t}) and substitute (P^{k}_{t}) crops, and domestic supplies of the own ($PCDS^{i}_{t}$) and competing ($PCDS^{j}_{t}$) crops. However, in the case of coarse grains used as a livestock feed, the livestock cycle often requires that lagged prices and income be included as independent variables:

$$PCNI^{i}_{t} = f(PRGDP_{t}, PRGDP_{t-1}, Pi_{t}, P^{j}_{t}, Pit_{-t}, P^{j}_{t-1}, P^{k}_{t}, PCDS^{i}_{t}, PCDS^{j}_{t})$$

The equations for feed consumption ($PCFED^{i}_{t}$) and food/residual consumption ($PCFOD^{i}_{t}$) are estimated only for exporters. Both per capita feed consumption and per capita food consumption use a ratio of own and competing supplies to measure relative availability of grains. Although feed consumption uses lagged income and prices to represent the livestock cycle, the lag structure and the prices of complementary crops are dropped from the equation that estimates per capita food consumption:

$$PCFED^{i}_{t} = f(PCRDP_{t}, P^{i}_{t}, P^{j}_{t}, PCRDP_{t-1}, Pit_{-t}, P^{j}_{t-1}, P^{k}_{t}, DS^{i}_{t}/DS^{j}_{t})$$

$$PCFOD^{i}_{t} = f(PCRDP_{t}, P^{i}_{t}, P^{j}_{t}, DS^{i}_{t}/DS^{j}_{t})$$

Total consumption for exporting regions is defined as the sum of food and feed consumption:

$$CONS^{i}_{T} = PCFED^{i}_{t} + PCFOD^{i}_{t}$$

For importing regions, consumption is a definitional equation that clears the market:

$$CONS^{i}_{t} = ES^{i}_{t-1} + PROD^{i}_{t} + NI^{i}_{t} - ES^{i}_{t}$$

The two equations with the greatest variation in structure are net exports and ending stocks. Their structures are highly dependent upon the category to which a region conforms.

Net importing regions are assumed to establish ending stocks as a policy decision dependent upon prices, available supplies, and the size of the pipeline. During periods of low prices (denoting abundant supplies), importers tend to maintain low stock levels but seek to buffer themselves by increasing stock levels if world supplies as measured for the size of the pipeline, a positive sign is expected; if a lagged stock-to-use ratio is used as a measure, a negative sign is expected:

$$ES^{i}_{t} = f(P^{i}_{t}, DS^{i}_{t}, NI^{i}_{t}, ES^{i}_{t-1}/CON^{i}_{t-1}, RGDP_{t})$$

The exporters classified as dumpers are assumed to establish a minimum pipeline level of stocks and then to export all surplus grain after meeting domestic demand. The simplest structural form for a per capita ending stock equation assumes a constant level of stock with involuntary accumulation during periods of large production when marketing channels become clogged:

$$PCES^{i}_{t} = f(PCDS^{i}_{t})$$

The second form used in estimating dumper ending stocks attempts to determine the size of the pipeline by testing for a negative coefficient on a lagged stock-to-consumption ratio ($ES^{i}_{t-1}/CON^{i}_{t-1}$) or a positive coefficient on current period per capita real income ($PCRGDP_{t}$). Once the pipeline has been established, the dumper will attempt to export the balance subject to involuntary accumulation:

$$PCES^{i}_{t} = f(ES^{i}_{t-1}/CON^{i}_{t-1}, PCRGDP_{t}, PCDS^{i}_{t})$$

Since ending stocks are estimated for a dumper, net exports become the residual equation, which closes the system for a region:

$$NE^{i}_{t} = ES^{i}_{t-1} + PROD^{i}_{t} - CONS^{i}_{t} - ES^{i}_{t}$$

A second class of exporters are those designated as partial dumpers. They are exporters who seek to sell available supplies but hold stocks during periods of low prices. The developed markets, led by the EC, is treated as an exporter of wheat that would like to be a dumper but is constrained in its exports by the subsidy it must pay to make its supplies competitive on the world market. Net exports are estimated as a function of the difference between the EC producer price per metric ton and the border price per ton ($SUBSID_{t}$) and domestic supply (DS_{t}). The subsidy represents a cost of exporting and has a negative coefficient, while domestic supply reflects the pressure for implementation of government policies favoring exports and is positively signed:

$$NE^{Dev\ Mkts}_{t} = f(SUBSID_{t}, DS_{t})$$

Canada is treated as a game-playing oligopolist. The residual pool of world import demand after dumping (RES^{i}_{t}) is shared by Canada at the highest possible prices, the Canadian Wheat Board will store grain in an attempt to influence price. However, through its actions in the early seventies, Canada has shown that there are limits to the amount of grain it is prepared to store. If ending stocks become large, Canada will begin to resemble a dumper, undertaking an aggressive marketing program to gain market share. Therefore, net exports can be specified as:

$$NE^{C\ a\ n}{}_t = f(RES_t, P^i{}_t, DS^i{}_t)$$

In both Canada and the developed markets, ending stocks are the definitional equation that clears the market:

$$ES^i{}_t = ES^i{}_{t-1} + PROD^i{}_t - CONS^i{}_t - NE^i{}_t$$

However, if ending stocks fall to a low level, they are fixed at that level and net exports become a residual.

The United States fills the role of the residual claimant to import demand from the rest of the world. Therefore, net exports are a residual of supply and demand in the rest of the world:

$$NE^{U.S.}{}_t = NI^{importers}{}_t - NE^{exporters}{}_t$$

Ending stocks in the United States are a residual that clears the market as in Canada and the developed markets. However, an additional set of equations was added to proxy the Farmer Owned Reserve (FOR) and the Commodity Credit Corporation (CCC) storage programs. The structure of these equations was kept as simple as possible. Additions to and release of policy stocks are a function of the supply of grain ($DS^i{}_t$) and the differential between the real gulf price and the real loan rate ($MARG^i{}_t$):

$$FOR^i{}_t = f(FOR^i{}_{t-1}, DS^i{}_t, MARG^i{}_t)$$

$$CCC^i{}_t = f\ (CC^i{}_{t-1}, DS^i{}_t, MARG^i{}_t)$$

The U.S. Government holds FOR and CCC stocks in an attempt to maintain price at or above a politically acceptable level. The relevant stock quantity for price determination theoretically should be $Freestocks^i{}_t = ES^I{}_t - FOR^i{}_t - CCC^i{}_t$ since the stocks held under CCC and FOR will not be released until prices reach preset levels. However, the market recognizes that FOR and CCC stocks exist and will be released. Therefore, there is an implicit discount on the effectiveness of policy stocks to support price. Under the current specification, the M.S.U. Agriculture Model discounts FOR by 50 percent in establishing freestocks:

$$Freestocks^i{}_t = ES^i{}_t - 0.5*FOR^i{}_t - CCC^i{}_t$$

As the largest exporter, the United States sets a floor price that will also be the floor for other exporters. The mechanism for determining world price is a ratio of U.S. export (gulf) price to the loan rate and is estimated as a function of stocks to use for exporters and a weighted exchange rate (XR_t):

$$WP^i{}_t/LR^i{}_t = f(\geq ES^i{}_t/CON^i{}_t, XR_t)$$

Prices are then fed back through the model in nominal form and are adjusted by the consumer price indexes and exchange rates for each region to derive a real border price. Transportation costs are assumed to be constant.