A Comparison of the Simulation Results from Six International Trade Models

by

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Foreword

Predicting the impact of various exogenous shocks and alternative policy regimes on the agricultural sector is a task increasingly asked of economists. To perform this task economists often make use of formal mathematical representations, e.g. models of the agricultural sector. The accuracy of the economist's predictions then hinges on the ability of the mathematical model to capture the essential features of the real world economy. Unfortunately, different economic models often produce surprisingly different answers to the same question.

The purpose of this paper is to compare the predictions from several different models, to a common set of questions, to highlight where similarities and contradictions exist. As such, the results should be of interest to both model builders and model users.

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Introduction

The International Agricultural Trade Research Consortium invited a number of model builders to present simulation results from their models at the annual meeting of the Consortium held in Vancouver, British Columbia in December 1985. The model builders who accepted the invitation and their model names are: (a) the World Wheat Trade Model (WTM) of Dixit and Sharples; (b) the Food and Agricultural Policy Research Institute Model (FAPRI) of Meyers, Devadoss and Helmar; (c) the Michigan State University Model (MSU) presented by Shagam; (d) the USDA-Grain, Oilseeds and Livestock Model (GOL) presented by Liu and Roningen; and, (e) the International Institute for Applied Systems Analysis Model (IIASA) of the Food and Agricultural Program presented by Frohberg. Prior to this Workshop Mitchell provided results from simulating the World Bank Commodities Division Model (WB) and Meyers, Devadoss and Helmar resimulated their model under somewhat different assumptions. These results are incorporated in this discussion.

My task, at least as I interpret it, is to compare the simulation results from the models in such a way that similarities and perhaps contradictions among the models are highlighted. Before proceeding to this task it is important to note several characteristics of the models which may influence the results of the simulation exercises. Table 1 shows that the commodity and country coverage of the various models differs considerably. Commodity coverage varies from one (wheat) for WTM to 20 for GOL while the number of countries and regions covered varies from ten for soybeans in the FAPRI model to thirty-four in IIASA.

Table 1: Selected Characteristics of Six International Trade Models[a/]

Features	Wheat Trade Model	Iowa State-FAPRI	Michigan State	USDA-GOL	IIASA	World Bank
Commodities (Number & Type)	1: Wheat	3: Wheat, C.Grains, Soybeans	3: Wheat, C.Grains, Soybeans	20: Grains Oilseeds, Livestock	10: 9 Agri. Groups, 1 Non-Agri.	4: Wheat, Rice, Coarse Grains, Soybeans
Countries/ Regions	23: 6 Exporters, 17 Importers	Wheat: 8/7 C.Grains: 9/4 Soybeans: 7/3	6/5	16/9	20/14	15/9
Synthetic or Estimated	Synthetic	Estimated/ Synthetic[b/]	Estimated	Synthetic	Estimated	Estimated
Cross-Commodity Effects Allowed in Simulation	No	Model simulated both with and without cross-commodity effects	Yes	Yes	Yes	Yes

[a/] Partially adapated from a table prepared by Parveen Dixit and Walter Gardiner. For a comparison involving more detail see Schwartz.

[b/] Synthetic elasticities are used for regions not explicitly modeled.

Of perhaps more importance, for this exercise, simulations of the (WTM) allows for no cross-commodity effects while MSU and FAPRI allow for interaction among wheat, coarse grains and soybeans, but not with livestock. In the WB model cross-commodity effects are also restricted to crops (wheat, rice, coarse grains, soybeans) while GOL allows for interaction among grains, oilseeds and livestock. IIASA is the only model which incorporates interaction between the agricultural and nonagricultural sectors of the economy. These differences in the extent of cross-commodity interaction may result in significantly different results across the various models. In fact, Meyers, Devadoss and Helmar have simulated their model, both allowing for and excluding interaction among the various crop sectors. Their results show that the first year price impacts of a five percent United States yield reduction are approximately 20 percent larger for soybeans and corn, and six times larger for wheat, when cross-commodity effects are allowed than when they are ignored.

Two of the five models, WTM and GOL, are synthetic using "consensus" elasticity estimates for the simulations. In WTM dynamics are ignored and in both WTM and GOL stockholding behavior is incorporated implicitly in the domestic demand estimates. The FAPRI model is primarily a "descriptive" econometric model but synthetic excess demand elasticities are derived in order to endogenize the import demands of those regions not explicitly estimated. In 1985/86 these regions accounted for approximately 67, 47 and 7 percent of world imports of wheat, feed grains and soybeans, respectively.

Finally, it should be noted that the intellectual basis for all of the models is neoclassical microeconomic theory and at the most basic level the simulation results will reflect the reaction of supplies and demands, in the various models, to price changes.

Short-Run Effects of a Five Percent Decline in U.S. Grain Production

Each of the modellers was asked to simulate the effects, over five years, of a one-year five percent decline in U.S. grain production. The impacts of the production decline, in the year in which it occurred, are summarized in table 2 for wheat, coarse grains and soybeans.

The following tentative conclusions, based on the results from all of the models, seem to be in order.

1. The initial price increase resulting from a U.S. yield reduction would be greatest for soybeans (4 to 21 percent), followed by coarse grains (2 to 13 percent) and then wheat (1.5 to 5.5 percent). The very large price increase predicted by FAPRI for wheat seems inconsistent with the massive stocks held in the U.S. during the year of the production shock. However, in the simulations of FAPRI government stocks were held constant and as the authors note "this makes all price impacts larger than they would be under current conditions when government stock programs absorb much of the yield variation impact". The large price increase for wheat in FAPRI also results from the seemingly perverse response of feed wheat demand which increases with the price increase. This response must be due to cross-commodity effects because in the single-commodity simulations Meyers, et al. show wheat prices increasing by slightly less than three percent and feed wheat demand declining by four percent.

The WB model consistently predicts the smallest price increases while FAPRI predicts the largest price increase for wheat and coarse

Table 2: A Comparison of Price Changes and Selected Impact Elasticities, for the United States, from Six International Trade Models for Wheat, Coarse Grains and Soybeans

	WTM[a/]	FAPRI[b/]	MSU[b/]	GOL[b/]	IIASA[b/]	WB[b/]
Wheat						
Price change (percent)	5.5	17.1	1.5	4.6	3.6	1.5
Export demand elasticity	-1.0	-0.3	1.0	-1.7	-1.7	0.4
Stock demand elasticity	N.I.	-0.3	-6.5	N.I.	-1.0	-5.9
Domestic demand elasticity[c/]	N.I.	0.4	N.R.	-0.5	-0.3	0.1
Total demand elasticity	N.I.	-0.2	N.R.	-1.1	N.R.	-2.0
Coarse Grain[d/]						
Price Change (percent)	N.I.	12.9	7.9	7.8	9.2	2.3
Export demand elasticity	N.I.	-1.0	-0.2	-1.1	-1.2	-0.5
Stock demand elasticity	N.I.	-0.2	-1.3	N.I.	-1.8	-4.7
Domestic demand elasticity	N.I.	-0.2	N.R.	-0.4	Neg.	-0.1
Total demand elasticity	N.I.	-0.3	N.R.	-0.6	N.R.	-1.5
Soybeans[e/]						
Price change (percent)	N.I.	12.9	20.8	20.2	13.4	4.4
Export demand elasticity	N.I.	-0.4	-0.1	-0.5	-0.5	-0.1
Stock demand elasticity	N.I.	-0.3	N.R.	N.I.	-0.4	-8.5
Domestic demand elasticity	N.I.	-0.3	N.R.	-0.1	-0.2	-0.5
Total demand elasticity	N.I.	-0.3	N.R.	-0.3	N.R.	-1.1

N.I. = not included
N.R. = not reported

a/ Partial elasticities, no cross-commodity effects allowed.

b/ Total elasticities, cross-commodity effects included.

c/ For FAPRI feed wheat only.

d/ For GOL and FAPRI corn only.

e/ For the IIASA model the results for protein feeds are reported. The FAPRI WB and GOL models also include endogenous soybean oil and meal sectors while the MSU model includes an endogenous soybean meal sector.

grains but not for soybeans.

2. The export demand elasticity estimates from the various models are most consistent for the soybean market ranging from -0.1 to -0.5. There is general agreement that the short-run U.S. export demand elasticity for soybeans is inelastic with the MSU and WB models generating the smallest estimate (-0.1) and GOL and IIASA the largest (-0.5).

3. In the wheat market three models show U.S. export demand to be elastic while in FAPRI it is quite inelastic (-0.3). In the MSU and WB models wheat exports are forecast to increase in the face of a production decline, and price increase, because of the larger price increase in the coarse grain market _i.e._ cross price effects offset the direct price effect.

It is worth focusing some attention on the wheat export demand elasticity of -1.0 from the WTM because it is a partial demand elasticity and illustrates the fairly general result that econometrically estimated export demand elasticities tend to be much smaller than estimates derived indirectly. In the WTM synthetic excess supply and demand elasticities are used. In eight of the 17 importing regions, accounting for 31 percent of total imports, the excess demand curve is assumed to be _totally inelastic_ and the weighted excess demand elasticity for the remaining price responsive importers is about -0.50. Two of the five exporters (excluding the United States), accounting for 37.5 percent of the non-U.S. exports, are also assumed to be totally unresponsive to price changes, while the weighted average excess supply elasticity of the price responsive exporters is 0.33. Yet, even with these rather conservative estimates the excess demand elasticity facing the U.S. is found to be -1.0. Consequently, any model which includes an inelastic excess demand curve for U.S. wheat is implicitly assuming that more than one-third of the world's importing and non-U.S. exporting nations are completely unresponsive to prices, or that a large number of countries have excess demand elasticities of less than -0.5 and/or excess supply elasticities of less than 0.3. Nonetheless, a perusal of the survey of export demand elasticities compiled by Gardiner and Dixit shows that of the nine econometric estimates of U.S. short-run excess demand elasticities, for wheat, eight are below -0.45 and most fall in the range of -0.14 to -0.26. The implications of these estimates in terms of price responsiveness throughout the world, as illustrated above, seems highly doubtful and simply illustrates the well known difficulty of estimating excess demand and supply parameters econometrically (Thompson). At least for wheat it appears that the method used to generate excess demand elasticities largely predetermines the size of the elasticity that will be found.

4. Although perhaps not readily apparent from table 2 the elasticity of stock demand in the U.S. plays a major role in determining short-run price variations. Unfortunately, stock demand changes are incorporated into domestic demand in the WTM and GOL models and was not reported for the MSU soybean model. In the soybean market both the FAPRI and IIASA models incorporate a stock demand elasticity near -0.4. In the coarse grain market stockholding is elastic in the MSU and IIASA models, very elastic in the WB model and very inelastic in the FAPRI model. For wheat the MSU and WB models both incorporate very elastic stockholding functions while in FAPRI it is again quite inelastic.

Based on the information in table 2 the ranking of models in terms of the size of price changes (from smallest to largest) is almost exactly the same as a ranking of models in terms of the absolute value of the elasticity of stock demand (from largest to smallest). Hence, the inventory demand elasticity may be more important in determining short-run price behavior than different assumptions with regard to the excess demand elasticity. This is particularly true under current conditions where 1985/86 closing stocks of wheat will be twice as large, and in the feed grain market more than three times as large, as 1985/86 exports.

Dynamic Effects of a Five Percent Decline in U.S. Grain Production

Table 3 shows the impact of the U.S. production shock on U.S. prices, production and net exports in the year of the shock (yr. 1), the following year (yr. 2) and the fifth year (yr. 5). By the fifth year the values of most of the variables in all of the models appear to be returning to their baseline levels. Nonetheless there are some differences in the degree of dampening of dynamic effects across the models and also some subtle differences across commodities.

The GOL model appears to return to baseline values most quickly with only small differences appearing in the year following the production shock. The FAPRI and WB models also dampen fairly quickly with prices, production and exports returning to within one percent of the baseline values by the fifth year of the simulation.

Dynamics appear more pronounced in the MSU model than in FAPRI, WB or GOL. In several cases second year impacts are nearly as large, or larger, than the first year impacts. Even in the fourth year after the shock about one-half of the variables shown in table 3 differ from their baseline values by more than two percent.

As in the MSU model dynamic effects in the IIASA model appear more pronounced than in the other models, even though only first and fifth year results were reported. Although not shown in table 3 cross-commodity effects outside the grain sector also appear significant in the IIASA model, particularly in the short-run, whereas they are negligible in GOL and ignored in the other models.

Looking at the results in table 3 across commodities the coarse grains market seems to be the most stable, while the soybean and wheat markets encompass more dynamic effects.

Trade Liberalization

The model builders were given considerable latitude in modeling trade liberalization and they made full use of this leeway.[1] The most complete trade liberalization scenario was performed with the IIASA model by removiong border protection, for all agricultural commodities, in all regions (excluding China and the CMEA countries). In FAPRI trade liberalization was "evaluated by removing existing policies that inhibiit the transmission of world market price variability to domestic markets" in the countries included explicitly in the model (excluding the CPEs), for grains only. In the MSU model trade is liberalized only for the developed markets region (EC, Japan, other Western Europe and South Africa) and again only for grains. The WTM liberalized wheat trade in the U.S., Japan and European Community (EC).

Even though the trade liberalization scenarios in these models are quite different there is some evidence that EC trade policies for wheat

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[1] The Japan component of the GOL model was used to analyze alternative beef import policies in Japan. Mitchell did not simulate trade liberalization using the WB model.

Table 3: A Comparison of Selected Dynamic Effects for the United States from Five International Trade Models for Wheat, Coarse Grains and Soybeans

	FAPRI			MSU			GOL			IIASA[a/]		WB		
	yr.1	yr.2	yr.5	yr.1	yr.2	yr.5	yr.1	yr.2	yr.5	yr.1	yr.5	yr.1	yr.2	yr.5
				(percentage changes from base run)										
Wheat														
Price	17.1	13.0	-0.5	1.5	1.5	2.3	4.6	-1.2	-0.0	3.6	-1.8	1.5	1.6	0.1
Production	-5.0	1.2	-0.1	-5.0	-0.2	3.4	-5.0	N.R.	N.R.	-5.0	1.2	-5.0	0.0	0.0
Exports	-4.7	-3.4	0.3	1.5	5.8	2.0	-7.8	0.4	-0.3	-6.0	0.0	0.6	-0.5	-0.5
Coarse Grain[b/]														
Price	12.9	2.3	0.0	7.9	6.6	1.4	7.8	-1.4	-0.2	9.2	-2.5	2.3	0.2	0.0
Production	-5.0	-0.3	-0.0	-5.0	0.7	0.6	-5.0	N.R.	N.R.	-5.0	0.5	-5.0	4.6	0.0
Exports	-16.2	-6.9	-0.0	-1.5	-0.8	-1.0	-8.3	-1.0	-0.2	-10.7	1.2	-1.1	-0.3	0.0
Soybeans[c/]														
Price	12.9	0.3	0.4	20.8	8.5	0.0	20.2	1.5	0.5	13.4	2.2	4.4	0.7	-0.7
Production	-5.0	0.2	-0.4	-5.0	-1.2	-1.3	-5.0	N.R.	N.R.	-5.0	-1.1	-5.1	2.0	0.2
Exports	-4.8	-2.0	-1.1	-1.3	-3.1	-5.0	-9.1	2.3	0.0	6.8	-1.3	-0.3	-0.5	0.2

N.R. = not reported

a/ Results were only reported for the first and fifth years of the simulation.

b/ For GOL and FAPRI corn only.

c/ For the IIASA model the results for protein feeds are reported. The FAPRI, WB and GOL models also include endogenous soybean oil and meal sectors while the MSU model includes an endogenous soybean meal sector.

and coarse grains are responsible for much of the "policy induced" price depression in the world wheat and coarse grain markets (Anderson and Tyers). Consequently, a comparison of the results of trade liberalization from the FAPRI, MSU, WTM and IIASA models, particularly in terms of world price impacts and production and trade effects in the EC, may be of some interest. These results are reported in Table 4 for the fifth year following trade liberalization.

In the wheat market the predicted impacts of trade liberalization on U.S. wheat prices cover an impressive range, from an increase of 4.1 percent in WTM to 44.2 percent in FAPRI. The wide variation in estimated price effects contrasts with the very similar prediction, from three of the models, of the effect on EC exports (roughly a decline of 75-80 percent).

The predicted price changes in the coarse grain market are just as variable across models, as in the wheat market, except that in all cases they show less response to trade liberalization. The MSU and IIASA models both predict an increase in EC coarse grain production as a result of the decline in EC wheat prices relative to coarse grain prices. All of the models predict a decline in EC coarse grain exports ranging from insignificant in the MSU model (-0.5 mmt) to sizable (-7.1 mmt) in FAPRI.

Conclusions

I had hoped by the end of this review to be able to draw five or six solid conclusions from the exercises that could be incorporated into our thinking as representing conventional wisdom. However, it appears that this is not possible. Several general tendencies of the models were

Table 4: A Comparison of Trade Liberalization Results Five Years After Liberalization for Wheat and Coarse Grains

		FAPRI		MSU[a/]		IIASA		WTM[b/]	
	Units	Unit	%	Unit	%	Unit	%	Unit	%
Wheat									
U.S. price	$/mt	38.5	44.2	8.5	9.2	N.R.	17.3	6.0	4.1
EC price	$/mt	N.R.	-36.5	N.R.	N.R.	N.R.	-35.3	44.0	-22.0
EC production	mmt	-23.3	-33.2	-4.1	-4.9	-14.0	-21.8	N.I.	N.I.
EC exports	mmt	-12.0	-74.9	-3.0	-32.3	-16.1	-79.4	-11.6	-77.3
Coarse Grains									
U.S. price	$/mt	14.4	19.3	1.4	1.3	N.R.	17.3	N.I.	N.I.
EC price	$/mt	N.R.	-57.2	N.R.	N.R.	N.R.	-20.0	N.I.	N.I.
EC production	mmt	-5.6	-8.2	2.0	1.8	3.5	4.5	N.I.	N.I.
EC exports	mmt	-7.1	-93.3	-0.5	-1.9	-5.4	-43.0	N.I.	N.I.

N.R. = not reported
N.I. = not included

a/ Changes reported for the EC are for the region defined as developed markets in the MSU model.

b/ Long-run results.

identified but the models differ so much in terms of commodity coverage and cross-commodity effects that it is difficult to know if the "economic truth" has been discovered or just some random similarities.

Two issues, however, seem worthy of discussion. First, even though there is no reason to suppose that the priors of a single agricultural economist should carry more weight than the results from a set of carefully constructed econometric models, the current period price impacts emanating from several of the models, as a result of a five percent U.S. yield decline, seem very large given current supply/demand conditions. This point is illustrated in table 5 which shows the 1985/86 United States values for beginning supplies, utilization, ending stocks and stock/utilization ratios for wheat, coarse grains and soybeans. As is well known there is a fairly consistent relationship between the stock/use ratio and U.S. price levels (Meilke; Van Meir). To calculate the stock/utilization ratio given in the last column of table 5 the U.S. production figures were reduced by five percent and the stock/utilization ratio recalculated assuming no change in the level of utilization. These new ratios of 0.90, 0.55 and 0.22 for wheat, coarse grains and soybeans are either the largest or second largest ratios, for these commodities, over at least the past 25 years. Given this it is difficult to believe that a five percent production cut could raise prices more than marginally from baseline levels. Clearly, the short-run responsiveness of prices depends crucially on U.S. government stock-holding policies, and these policies would appear to deserve added emphasis in our modeling efforts.

Second, the simulation results of Meyers et al., illustrate the importance of distinguishing between structural (partial) and total

Table 5: United States 1985/86 Supply and Demand Conditions for Wheat, Coarse Grains and Soybeans

Commodity	Beginning Supplies (mmt)	Utilization (mmt)	Ending Stock (mmt)	Stock/ Utilization (percent)	Stock/ Utilization[a/] (percent)
Wheat	105.2	53.5	51.7	0.97	0.90
Coarse Grains	332.0	206.2	125.8	0.61	0.55
Soybeans	65.7	51.7	14.0	0.27	0.22

a/ Stock/Utilization ratio calculated assuming 1985/86 production had been five percent lower and utilization constant.

Source: U.S. Department of Agriculture. Agricultural Outlook, AO-122 (August, 1986) and Feed Situation and Outlook Report, Fds-300 (August, 1986).

elasticities. It is quite possible that the partial excess demand elasticity faced by the United States is elastic for wheat, coarse grains and soybeans considered individually, but that the total elasticity of excess demand for each good is inelastic. This distinction becomes exceedingly important in the current policy environment where decision makers are interested in what will happen to U.S. exports given a decline in loan rates (price levels) for all grains and soybeans, rather than what would happen under ceteris paribus conditions. The moral of this story is that the separability assumptions in our models and the way we state our results need very close scrutiny.

The trade liberalization results, reported above, illustrate a difficulty in handling this question by these modelers and more generally I believe by our profession. Constructing policy models for countries other than the EC, Japan, United States, Canada and Australia is extraordinarily difficult because of an inadequate information base. Where do we turn as a profession to find a time series of (a) effective consumer prices, (b) effective producer prices, and (c) a listing of the important policy variables, and their values, used in most countries for most agricultural commodities? Until we can obtain this type of information we will not make much progress in comprehensive policy evaluations; and, we will have to continue to rely on fundamentally flawed summary measures such as "consumer subsidy equivalents" and "producer subsidy equivalents" (de Gorter and McClatchy). It is worth noting that in addition to the above listing of factual data McCalla and Houck suggest that the analyst also needs "an understanding of the goals of domestic policy, the constraints under which it operates, and the policy instruments actually or potentially available". This is a tall order for a small team of policy analysts attempting to build a comprehensive, multi-commodity, multi-country agricultural model using currently available information sources.

As an aside, and concluding comment, it is interesting to note that although four of the five models participating in the liberalization experiment are based in the United States only WTM and IIASA attempted to "liberalize" U.S. grain policy; and in both of these cases the U.S. acreage reduction programs were handled using ad hoc calculations carried on outside the modeling framework.

References

Anderson, K. and R. Tyers. "European Community Grain and Meat Policies: Effects on International Prices, Trade and Welfare". Eur. Rev. of Agr. Econ. 11(4):367-94.

de Gorter, H. and D. McClatchy. Mathematical Representation of Agricultural Support Measures in a World Trade Model. International Trade Policy Division, Agriculture Canada, Ottawa, 1984.

Dixit, P. M. and J. A. Sharples. "The World Wheat Trade Model". Consortium on Trade Research, Agricultural Trade Modeling: The State of Practice and Research Issues. USDA/ERS/IED (forthcoming).

Frohberg, K. "A Brief Description of Three Scenario Runs Obtained with the Basic Linked System of IIASA". Consortium on Trade Research, Agricultural Trade Modeling: The State of Practice and Research Issues. USDA/ERS/IED (forthcoming).

Gardiner, W. H. and P. M. Dixit. Price Elasticity of Export Demand: Concepts and Estimates. ERS Staff Rpt. AGES860408, International Economics Division, U.S. Dept. of Agriculture, 1986.

Liu, K. and V. O. Roningen. "Analysis with USDA-GOL Model". Consortium on Trade Research, Agricultural Trade Modeling: The State of Practice and Research Issues. USDA/ERS/IED (forthcoming).

McCalla, A. and J. P. Houck. "Government Policy and Agricultural Trade Models". AAEA Post-conference workshop on Modeling for Analysis of International Trade, Reno, 1986.

Meilke, K. D. An Economic Profile of the Ontario Corn Industry. Research Bulletin AEEE/84/8, Dept. of Ag. Econ. and Business, University of Guelph, 1984.

Meyers, W. H., S. Devadoss and M. D. Helmar. "The U.S. Export Response to Price and the Impacts of Trade Liberalization: A Regional Trade Model Analysis", AAEA Post-conference workshop on Modeling for Analysis of International Trade, Reno, 1986.

Mitchell, D. "World Bank's Grain and Soybean Model". Private communication, July, 1986.

Schwartz, N. "Structural Differences Among International Agricultural Trade Models: A Comparison of Five Models". AAEA Post-conference workshop on Modeling for Analysis of International Trade, Reno, 1986.

Shagam, S. "M.S.U. Agricultural Model Scenario Analysis". Consortium on Trade Research, Agricultural Trade Modeling: The State of Practice and Research Issues. USDA/ERS/USDA (forthcoming).

Thompson, R. L. A Survey of Recent U.S. Developments in International Agricultural Trade Models. Bibliographies and Literature of Agriculture No. 21, Economic Research Service, U.S. Dept. of Agriculture, 1981.

Van Meir, L. W. "Relationship Among Ending Stocks, Prices and Loan Rates for Corn". Feed Outlook and Situation Report, Fds-290, U.S. Dept. of Agriculture, 1983.