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Report to the Honorable
J. Robert Kerrey, U.S. Senate

August 1991

USDA COMMODITY FORECASTS

Inaccuracies Found May Lead to Underestimates of Budget Outlays

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GAO

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Program Evaluation and
Methodology Division

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The Honorable J. Robert Kerrey
United States Senate

Dear Senator Kerrey:

In November 1989, you asked us to conduct a series of studies examining the accuracy of various price, production, and supply forecasts made by the U.S. Department of Agriculture (USDA). We provided you with the results of our first study in a May 1991 report that looked at cattle, hog, and poultry forecasts.[1] In this second report, we examine the USDA long-term commodity forecasts used in the President's budget process. After subsequent discussions with your staff, we focused our efforts on evaluating (1) the accuracy of those long-term supply and utilization forecasts referred to as baselines, and (2) the effect that inaccuracies in these forecasts could have on outlay estimates in the President's January 1990 budget submission.

We found that USDA baseline forecasts, particularly those made 3 to 5 years in advance, exhibit both large total error rates and consistent bias error components. Our results also show that if the bias error exhibited in long-term forecasts for crop years 1981-88 continued, and if the 1985 farm bill provisions had been extended, then costs for the commodity programs could have been $19.5 billion higher than estimated in the President's January 1990 budget submission. Such forecast errors could also affect farm policy decisions, which take into account long-term forecasts.

Results from our previous report indicate that USDA accepted our recommendations to improve forecast management. USDA has developed a comprehensive plan for monitoring and evaluating commodity forecasts. The plan was submitted to, and approved by, USDA's Assistant Secretary for Economics. Both USDA and we believe that these management efforts should improve forecast accuracy as they are implemented.

Background

USDA administers a multibillion dollar commodity program for wheat, corn, cotton, soybeans, and dairy products. Every fall, usually in November, USDA makes a baseline forecast for each of the next 5 years

[1] U.S. General Accounting Office, Short-Term Forecasting: Accuracy of USDA's Meat Forecasts and Estimates, GAO/PEMD-91-16 (Washington, D.C.: May 1991).

in order to prepare the President's budget forecast. Approximately every 5 years, these forecasts are also used to price out the initial farm bill proposal.

The World Agricultural Outlook Board has chief responsibility for preparing these baselines. USDA's forecasts are the result of an interagency committee process that involves representatives from other USDA agencies meeting to prepare consensus forecasts.

Analysis

We addressed two specific evaluation questions:

1. Are USDA's baseline price, production, export, domestic use, and stock forecasts for wheat, corn, cotton, soybeans, and dairy products "reasonably" accurate?

2. What are the implications of inaccurate forecasts with regard to outlay estimates in the President's January 1990 budget submission?

As in our prior report on cattle, hogs, and poultry, we examined accuracy by measuring both total and bias error in forecasts. Total error is the absolute amount that a forecast varies from the final actual amount and is composed of both random and bias error. Bias error is the systematic over- or underestimation of a series of forecasts.[2]

Because forecasting is based on incomplete knowledge concerning the future, it is to be expected that some level of error will occur. However, total and bias error measures by themselves do not provide a basis for evaluating what level of error in forecasts is "reasonable." To make this determination, it is also necessary to compare these measures to available "benchmark" forecasts as a way of determining whether smaller error rates are possible. In this context, "reasonable" would imply that both total and bias errors are small and that no better forecasts are readily available.

A benchmark forecast is another forecast for the same variable that can be used for comparison purposes. Two types of benchmarks are often used: competitive and naive. Competitive forecasts are those made by other individuals or groups. Naive forecasts use historical information and simplified models. We used naive forecasts for our benchmark analysis because, while some competitive forecasts do exist, we were not

[2]See appendix IX for discussion of these error measures.

able to obtain these in a form that allowed us to compare them with USDA forecasts.[3]

We concentrated most of our efforts on the accuracy of seasonal average price for wheat, corn, soybeans, and cotton because seasonal average price is the key variable in calculating deficiency payments.[4] Deficiency payments represent the major component of commodity program outlay estimates. For dairy products, we concentrated on the accuracy of production forecasts, since the costs for this program reflect USDA removals of excess dairy stocks at fixed prices.

The Office of Management and Budget (OMB) and the Congressional Budget Office (CBO) annually report reasons why budget estimates are incorrect. They group causes for the errors into three categories: (1) economic changes, (2) program changes, and (3) technical revisions. We identify and describe baseline forecast errors in this report; however, we do not evaluate specific causes of each error.

Findings

The accuracy of USDA's baseline forecasts is not yet what it should, and could, be. For the time period reviewed, the forecasts exhibit high bias error rates, and the benchmark forecasts with which we compared them present less bias error, particularly in the third through fifth years. The effect of this level of inaccuracy is that the January 1990 outlay estimate may have been underestimated by as much as $19.5 billion, if the conditions that caused the crop year 1981-88 bias error rate were to continue during the next 5 years and if program provisions implemented under the 1985 farm bill remain unchanged.

Accuracy of USDA's Baseline Forecasts

The total errors are measured by mean absolute percentage error (MAPE).[5] Production, exports, and price have MAPEs ranging from 6 percent for dairy production to 37 percent for cotton exports; domestic use has the lowest MAPE, which ranges from 2 to 17 percent. Ending stocks

[3]The term benchmark forecast as used throughout the remainder of this report refers to naive models.

[4]Deficiency payments are made to producers based on the difference between the target price and whichever is higher, the seasonal average price or the loan rate. As indicated in appendix X, deficiency payments represent over 90 percent of the estimated farm bill outlays.

[5]MAPE is the sum of absolute percentage error divided by the number of forecasts, and multiplied by 100.

have the highest error rates, ranging from 38 percent for cotton to 67 percent for corn.[6]

The bias errors, measured by mean percentage error (MPE), also have high error rates.[7] All price variables are overestimated by at least 10 percent. Dairy net removals, corn and cotton exports, and wheat ending stocks all have MPEs of greater than +/-20 percent. Variables such as domestic use (except wheat), ending stocks for corn and cotton, and cotton production all had MPEs of less than +/-5 percent. All other variables fell within the range of +/-5 to +/-20 percent.

Generally, the bias errors were larger for the out-year forecasts than for the current year forecasts. This was especially true for the price and dairy production variables, which had the greatest impact on outlay estimates. For example, average bias error for the 5-year price forecasts increased from -2.5 percent for the first year forecast, to -15.5 percent for the third year forecast, to -24.1 percent for the fifth year forecast. (See appendix III.)

Reasonableness Assessment

Our benchmarks demonstrate that forecasts with lower bias error and similar total error rates for these years are possible. USDA forecasts for the first 2 years tended to be more accurate than our benchmarks. Conversely, our benchmarks for the third through fifth years showed less bias error than the USDA forecasts. While benchmark forecasts cannot replace USDA's forecasting method, they can be helpful in identifying where improvements are needed. (See appendix IV.)

USDA includes data concerning historical drought impacts when forecasting future baselines. However, USDA has no documented methodology for analyzing expected crop yields, and they do not evaluate the accuracy of alternative methodologies.

[6]Since ending stocks are in effect the residuals of commodity supply and use, they can vary in percentage terms when only small errors occur in supply or use forecasts.

[7]MPE is the sum of the individual percentage errors divided by the number of forecasts, and multiplied by 100.

Implications for the Outlay Estimates of the January 1990 Budget Submission

As previously noted, if the historical bias error rate exhibited in the baseline forecasts for crop years 1981-88 continued, and if the farm program provisions in place at the start of 1990 had been extended for 5 more years, then the $47.1 billion outlay estimate used in the administration's January 1990 budget submission might have been underestimated by $19.5 billion. Table 1 shows that this $19.5 billion is primarily associated with corn, wheat, and dairy products.

Table 1: January 1990 Budget Outlay Estimates and Potential Dollar Changes, Assuming Historical Bias Error Continues[a]

Commodity	January 1990 budget estimate	Dollar change
Wheat	$11.6	$4.5
Corn	31.3	6.7
Soybeans	(0.1)	1.3
Cotton	2.3	2.8
Dairy products	1.9	4.2
Total[b]	**47.1**	**19.5**

[a]We used seasonal average price bias error except for dairy products, where we used production bias error. Dollar amounts are in billions.

[b]Totals may not add due to rounding.

A large proportion ($16.6 billion) of the estimated increased outlay would occur in the third through fifth out years (that is, fiscal years 1993-95). This effect is calculated using USDA policy simulation models and adjusting each out-year price forecast by the historical bias error rate for that year. (See appendix V.) Our work reflects the January 1990 outlay estimates in the administration's budget submission, which provided a baseline for initial debate on the 1990 farm bill. The farm bill actually passed into law—the Food, Agriculture, Conservation, and Trade (FACT) Act of 1990 (Public Law 101-624)—used slightly different baseline forecasts and incorporated different program provisions. Subsequently, the Omnibus Budget Reconciliation Act of 1990 (OBRA-90) (Public Law 101-508) cut outlay estimates by about 25 percent.

Recommendations

We believe that properly managing and evaluating the forecasting process will result in USDA making more accurate forecasts. In prior reports, we recommended improvements to USDA forecasts.[8] Furthermore, the FACT Act of 1990 uses these recommendations to suggest that the Secretary of Agriculture designate a single organization to manage the

[8]See USDA's Commodity Program: The Accuracy of Budget Forecasts, GAO/PEMD 88-8 (Washington, D.C.: April 21, 1988), pp. 75-6, and Short-Term Forecasting, pp. 55-9.

Department's commodity program forecasting and establish a quality control program to (1) systematically identify the source of forecasting errors, (2) maintain records of data used for supply and utilization forecasts, (3) document its forecasting methods, and (4) correct weaknesses in its various forecasting components.

We recommend that the Secretary of Agriculture specifically direct the World Agricultural Outlook Board to measure and report forecast accuracy of 5-year baselines, as well as develop and report on benchmark forecasts. (See appendix VI.)

Agency Comments

USDA fully agreed with our recommendations to improve forecast management and evaluation activities and accepted our main findings concerning forecasting errors. It is encouraging to note that USDA "acknowledges that the Department's long-term commodity forecasting can be improved and appreciates GAO's constructive critique." (See appendix XI.)

However, USDA was concerned that our analysis of budget impacts could be misleading. USDA noted that our analysis is based on the January 1990 budget submission, which assumes that the provisions of the 1985 farm bill would be extended for 5 years, and not on the actual 1990 farm bill. USDA updated the 5-year program data in the mid-session review, using available 1990 supply and demand data; and cost estimates of the 1990 farm bill were made based on those updates. We used the January 1990 budget submission since that was the only baseline available at the time we evaluated the accuracy of the commodity forecasts. In response to USDA's comment, we added further clarification to this report to indicate that our analysis is based on the administration's January 1990 budget submission, which was used in early deliberations on the 1990 farm bill, and not on the final farm bill that was enacted into law.

USDA officials also questioned the time frames used in our analysis. They felt that the time period was too short to prove long-term bias error in forecasts because the unusual economic and programmatic conditions that occurred during the 1980's made forecasting especially difficult for that period. We used the crop year 1981-88 forecasts because they were the only complete forecasts available at the time of our review. While some uncertainty is always associated with making forecasts, there is no reason to believe that the conditions that made forecasting difficult in the 1980's are significantly different from those that will be associated with making forecasts in other time periods, such as the 1990's.

Additional comments provided by USDA officials are incorporated, where appropriate, into the body of the report. USDA's formal comments are contained in appendix XI.

As agreed with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days from the date of this letter. At that time, we will send copies to interested parties and make copies available to others upon request.

If you have any questions or would like additional information, please call me at (202) 275-1854 or Kwai-Cheung Chan, Director of Program Evaluation in Physical Systems Areas, at (202) 275-3092. Other major contributors to this report are listed in appendix XII.

Sincerely yours,

Eleanor Chelimsky
Assistant Comptroller General

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Abbreviations

AMAPE	Adjusted mean absolute percentage error
CBO	Congressional Budget Office
CCC	Commodity Credit Corporation
ERS	Economic Research Service
FACT	Food, Agriculture, Conservation, and Trade (Act)
GAO	General Accounting Office
GATT	General Agreement on Tariffs and Trade
IPE	Individual percentage error
MAPE	Mean absolute percentage error
MPE	Mean percentage error
NASS	National Agricultural Statistics Service
OBRA-90	Omnibus Budget Reconciliation Act of 1990
OMB	Office of Management and Budget
RMSPE	Root mean squared percentage error
TMPE	Trimmed mean percentage error
USDA	U.S. Department of Agriculture
WMPE	Weighted mean percentage error

Objectives, Scope, and Methodology

Objectives

The following evaluation questions address Senator Kerrey's concerns about the accuracy of USDA's baseline forecasts of commodity supply and utilization variables.

1. Are USDA's baseline price, production, export, domestic use, and stock forecasts for wheat, corn, cotton, soybeans, and dairy products "reasonably" accurate?

2. What are the implications of inaccurate forecasts with regard to outlay estimates in the President's January 1990 budget submission?

As in our prior meat forecasting report, we discuss the importance and usefulness of USDA forecasts (appendix II), and how USDA can improve its forecasts (appendix IX).[1]

Scope

We limited the scope of our evaluation in the following ways:

1. We used the period of crop years 1981-88 for calculating summary error measures. We limited our analyses to this time frame for three reasons. First, according to USDA, out-year forecasts were not required before the Congressional Budget and Impoundment Control Act of 1974; therefore, out-year forecasts were not done prior to the fiscal year 1976 budget cycle.[2] Second, the board was created in 1977; therefore, forecasts made before this time were done differently. Third, the previous two farm bills are included in this time period.

2. We excluded one commodity variable (dairy exports) from our analysis because dairy export amounts were not forecasted. As a result, our forecast accuracy study included 24 commodity variables.

3. We did not report specific cotton price forecasts because 12 U.S.C. 1141j(d) prohibits the publication of cotton price forecasts. Error rate measures, however, do not divulge specific forecasts, and can therefore be reported.

[1]See U.S. General Accounting Office, Short-Term Forecasting: Accuracy of USDA's Meat Forecasts and Estimates, GAO/PEMD-91-16 (Washington, D.C.: May 6, 1991).

[2]Congressional Budget and Impoundment Control Act of 1974 (Public Law 93-344, Sec. 603, 31 U.S.C. 1105).

4. We only reviewed forecasts made for the President's budget submission. We did not evaluate the forecasts used for USDA's mid-session review, or any of the CBO forecasts.

5. We made no independent assessment of the seasonal average price determinations. Previously, we had expressed concern about how USDA calculated seasonal average prices.[3] USDA's Office of Inspector General has since issued a report that addressed USDA's seasonal average price calculations.[4] Further, the Omnibus Budget Reconciliation Act of 1990 (OBRA-90) specifies a new method of calculating the deficiency payments for grains in 1994.

6. We used USDA policy simulation models for the analysis. We conducted no independent assessment of these models.

7. We evaluated only the selected baseline forecasts for five commodities. Other economic and program-related factors that can affect outlays were not incorporated into our analysis of the effect of forecast errors on budget estimates. (See appendix V.)

Methodology

To understand the importance of USDA forecasts, we interviewed agency officials and experts who prepare and use them. We reviewed existing literature, primarily that published since 1980, which we identified through bibliographic searches and discussions with preparers and users. We also reviewed published USDA studies and internal working documents that discussed the forecasting process.

In order to evaluate the accuracy of variables, we obtained forecasts and actual values reported in the Agricultural Stabilization and Conservation Service budget submissions. When actual values were missing, we used those contained in USDA's 1989 Fact Book of Agriculture. We used crop years 1981-88 for five supply and utilization variables: (1) production, (2) use, (3) exports, (4) ending stocks, and (5) price.

Production, use, and exports are major components of supply and utilization. Supply is the total availability of a commodity and consists of

[3]U.S. General Accounting Office, Changes Are Needed to Assure Accurate And Valid Wheat Deficiency Payments, GAO/RCED-83-50 (Washington, D.C.: March 29, 1983).

[4]USDA, Office of the Inspector General, National Agricultural Statistics Service, Review of Data Used to Determine Deficiency Payment Rates for Upland Cotton, Audit Report No. 26600-1-At (Washington, D.C.: September 1990).

beginning stocks, production, and imports. Utilization consists of the amount of a commodity exported, the amount used domestically for livestock feed, and the amount used domestically for food, feed, other uses, and ending stocks. Ending stocks consist of farmer-owned reserve stocks, Commodity Credit Corporation (CCC) stocks, and free stocks of a commodity not used at the end of the crop year. Seasonal average price is the 12- month weighted average price of a commodity.

Seasonal average price is the most important variable when evaluating budget impacts. As shown in appendix X, $43.3 billion of the $47.1 billion outlays estimated in the January 1990 budget proposal is deficiency payments. Deficiency payments are based on target prices, loan rates, and the average market price for the months designated, times the program yield, times the acres eligible for payment. Since the loan rate and target price are set by law and the discretionary authority of the Secretary of Agriculture, the market price represents the most significant program crop variable from a forecasting standpoint.

Price is not as critical, however, for dairy product outlays. In general, the dairy program's outlays depend upon the degree to which milk production exceeds commercial use. The larger the surplus, the more dairy products the federal government purchases, and the greater its outlays. Dairy production forecasts are more important than price forecasts when considering total program outlays. Under the dairy price support program, USDA indirectly supports milk prices by purchasing storable surplus dairy products (butter, cheese, and nonfat dry milk) from dairy processors. Prices paid to the processors are set at a level that should permit processors to pay dairy farmers at least the federal support price for milk.

To measure the accuracy of USDA's baseline forecasts, we compared each forecast in the 5-year baseline with actual values, using an individual percentage error (IPE) and the summary error measures described here. We used two summary error rates: (1) total error and (2) bias error. We measured total error using mean absolute percentage error (MAPE), adjusted mean percentage error (AMAPE), and root mean squared percentage error (RMSPE). We measured bias error using mean percentage error (MPE), trimmed mean percentage error (TMPE), and weighted mean percentage error (WMPE). We use MPE for bias error and MAPE for total error throughout the report. The other measurement error rates are included in appendix VIII, and formulas used are discussed in appendix IX.

To determine the reasonableness of USDA baseline forecasts, we used benchmark forecasts. There are two types of benchmarks: competitive and naive. Competitive benchmarks are other forecasts that can be used to compare accuracy. Naive benchmarks use only historical data. We provided the World Agricultural Outlook Board with the naive models and results.

We developed four models for use as benchmarks—three naive forecasts and another model that uses the most recent USDA forecast for the first year and then holds that value constant for the remaining 4 years. Two of the naive forecasts use 3- and 5-year averages; the other uses a 5-year trimmed mean for the first-year forecast, and then keeps the next 4 years at that level.[5]

To determine if other forecasts could be used as benchmarks to compare against USDA's forecasts, we reviewed forecasts made by private sector institutions. We identified the other forecasts through our literature review and discussions with USDA and other users. However, we were not able to obtain any competitive forecasts in a form that could be used to make a comparison with USDA's.

To estimate the effect of inaccurate forecasts, we used USDA budget and policy simulation models to evaluate the effect that bias errors can have on farm program outlay estimates.

To identify how forecasts might be improved, we reviewed available literature, including our previous evaluations, and interviewed forecasters to identify what constitutes good forecasting management techniques. We then compared those techniques to the forecasting process USDA currently employs.

We conducted our review in accordance with generally accepted government auditing standards during the period April 1990 through November 1990. USDA provided written comments on a draft of this report that are included in appendix XI; our responses are presented in appendixes III, IV, V, and VI.

[5]Trimmed means delete the smallest and largest values.

Background

USDA administers a multibillion dollar commodities program. We reviewed wheat, corn, cotton, soybean, and dairy products. In administering its commodities program, USDA makes 5-year supply and utilization forecasts, referred to as baselines, that are used in part to conduct policy analysis, prepare budget estimates, and implement programs.

USDA Forecasts

The World Agricultural Outlook Board has chief responsibility for coordinating and overseeing the preparation of USDA forecasts. Working with commodity experts in other USDA agencies, the Board develops both short-term and baseline forecasts. Short-term forecasts for the current or next crop year are published monthly in the USDA publication World Agricultural Supply and Demand Estimates. Every November, USDA makes a baseline forecast for the next 5 years.[1] The baseline forecasts are not routinely released to the public but are included with the administration's annual budget proposal. Office of Management and Budget (OMB) requirements generally restrict publication of 5-year baseline forecasts to those forecasts that apply to the current year only.

USDA's forecasts are the result of an interagency committee process involving representatives of the Board, Economic Research Service (ERS), Foreign Agricultural Service, Agricultural Stabilization and Conservation Service, and Agricultural Marketing Service. Representatives of other agencies are contacted as appropriate for input on specialized subjects. Representatives contribute the expertise and knowledge of their respective agency to the committee deliberations. The resulting forecasts represent a consensus about future supply and utilization. The Board serves as the USDA focal point for gathering, interpreting, and summarizing developments affecting domestic and world agriculture. ERS provides basic economic research to assist the Congress and USDA in developing, administering, and evaluating agricultural and rural policies and programs. The Foreign Agricultural Service promotes U.S. exports and gathers information about foreign agriculture through a network of about 100 U.S. agricultural specialists at 60 American embassies and consulates around the world. The Agricultural Stabilization and Conservation Service provides input on domestic production and use, government stocks, and farmers' participation in, and implementation of, USDA's commodity programs. The Agricultural Marketing Service collects

[1]Other 5-year forecasts are used in the farm bill deliberation process. CBO issued their first 5-year forecasts after the President's budget submission in April 1990. USDA issued a second forecast, called the mid-session review, for submission during the summer. CBO issued a second 5-year forecast about this time. During our review, we did not evaluate the accuracy of any of these other baselines.

and publishes daily information about market prices for grain and other commodities.

Each year, USDA devotes about 1,100 staff years to compiling basic agricultural statistics, forecasting, and policy analysis. About 130 staff years are for meat and animal products, while most of the rest are devoted to the budget-related commodities addressed in this report. Most of these staff years are devoted to National Agricultural Statistics Service (NASS) analysts who compile statistics; forecasting and policy analysis comprise a minor fraction of the total.

The basic objectives of present federal farm legislation, which have changed little since first formulated during the 1930's, include (1) providing farmers with a fair return on their investment, (2) stabilizing the agricultural economy, and (3) assuring consumers an abundant supply of farm products at reasonable prices. Conversely, the farm program details have undergone major changes, and outlays increased dramatically in nominal terms during the 1980's.

Commodity Program Outlay Levels and Forecast Errors

Outlays averaged $3.0 billion in the 1970's as compared to about $13.3 billion during the 1980's.[2] USDA forecasts of commodity program outlays, based on expected baseline conditions, erred considerably during both the 1970's and 1980's. Table II.1 shows errors ranging from as little as 7.6 percent in 1980 to as high as 169.9 percent in 1974.[3] USDA estimated budget outlays of $97.4 billion for fiscal years 1981 through 1989, while actual outlays totaled $130.0 billion.

[2]Outlays are reported as nominal prices.

[3]1974 was a drought year, and the actual result was a small net outlay.

Table II.1: USDA Commodity Budget Forecasts and Single Forecast Errors, Fiscal Years 1972-90[a]

	Net outlay[b]		Error[c]	
Fiscal year	Initial forecast[d]	Actual	Single forecast	Percentage[e]
1972	$3.6	$4.0	$0.4	9.0%
1973	4.3	3.6	(0.7)	(21.0)
1974	2.7	1.0	(1.7)	(169.9)
1975	0.9	0.6	(0.4)	(62.1)
1976	0.7	1.0	0.3	33.9
1977	0.8	3.8	3.0	78.2
1978	0.9	5.6	4.8	84.6
1979	4.3	3.6	(0.7)	(19.7)
1980	2.5	2.7	0.2	7.6
1981	0.9	4.0	3.1	77.6
1982	2.2	11.6	9.4	81.5
1983	6.7	18.8	12.1	64.4
1984	12.3	7.2	(5.1)	(71.3)
1985	10.7	17.6	6.9	39.3
1986	10.4	25.7	15.3	59.5
1987	16.5	22.3	5.8	25.9
1988	20.8	12.5	(8.3)	(67.1)
1989	17.0	10.4	(6.6)	(63.1)
1990	11.5	6.4	(5.1)	(80.3)

[a]Dollars are nominal prices for fiscal years in billions.

[b]Includes all USDA commodities.

[c]Errors in parentheses reflect overestimates.

[d]Initial forecast is the President's budget submission, generally released in January.

[e]Percentage errors were computed with exact numbers; calculated as actual less forecast, divided by actual.

Source: Agricultural Stabilization and Conservation Service budget documents

Major droughts in crop years 1983, 1988, and 1989 reduced dramatically USDA outlays for the commodities we evaluated. During droughts, prices tend to increase, thereby reducing deficiency payments.[4]

The two farm bill estimates prior to that of 1990 had dramatically different results. USDA initially estimated the 1981 farm bill to cost $11.0 billion, but actual outlays were $80.9 billion, or an 86.4 percent error. USDA initially estimated the 1985 farm bill outlays at $76.9 billion over 5 years, but the most recent outlay estimate is $77.7 billion, or a 1.0 percent error. Although the 1985 farm bill estimates were comparable to

[4]Crop years 1974 and 1980 were also drought years.

the actual outlays, error rates over the period ranged from about 26 to −80 percent per year.

There is concern that the cost of the FACT Act of 1990 will once again rise above the forecast because the baseline forecasts may be inaccurate. If commodity prices decline and the General Agreement on Tariffs and Trade (GATT) negotiations collapse, outlays may rise.[5]

Analysis of Budget Error Rates

OMB and CBO annually report reasons why budget forecasts and actual outlays differ. They group causes for the errors into three categories: (1) economic changes, (2) program changes, and (3) technical revisions. USDA also conducted an evaluation of budget errors in 1987, and discussed errors in 1-year supply and utilization forecasts.[6]

Unforeseen macroeconomic factors—such as exchange rates, interest rates, and economic growth rates—can affect outlays for commodity programs. The sharp decline in U.S. farm exports in the 1980's was strongly influenced by changes in macroeconomic and financial conditions. Farm exports continued to rise as the international exchange value of the dollar depreciated in the 1970's. However, when the relative value of the dollar rose substantially in the early 1980's, U.S. exports became less competitive in world markets. (Economic forecasts are made by the Council of Economic Advisers and OMB.)

Program changes involve both legislation, such as shifting deficiency payments from one fiscal year to the current year, and the Secretary's discretionary authority to modify programs, such as the amount of acreage held in conserving use through the acreage reduction program.

Technical revisions relate to the baseline (supply and utilization) forecasts. The production of many commodities is highly sensitive to weather and other biological factors. For example, corn yields per acre fluctuated from year to year over crop years 1980 to 1985 by an average amount of nearly 19 bushels per acre, or 18 percent of the average yield over the period.

[5]See U.S. General Accounting Office, Agricultural Trade Negotiations: Stalemate in the Uruguay Round, GAO/NSIAD-91-129 (Washington, D.C: February 1, 1991).

[6]USDA, "CCC Budget Estimates: An Overview and Preliminary Assessment," Interim report of staff working group on review of CCC estimates, Washington, D.C., June 8, 1987.

Importance of USDA Forecasts

USDA's baseline forecasts are important because the Congress uses them in enacting farm legislation, as it has generally done every 4 or 5 years since 1949, and in authorizing budgets to fund this legislation. The Secretary of Agriculture uses baselines in making those decisions necessary to implement the legislation, and USDA officials use them in administering programs authorized by the legislation. Internal USDA studies indicate that the 5-year (fiscal years 1991 through 1995) outlay estimate for five commodities (wheat, corn, cotton, soybeans, and dairy products) was $47.1 billion. This estimate, calculated for the President's January 1990 budget submission, was the first prepared as congressional debate on the 1990 farm bill got under way.[7] (See appendix X.)

Congressional Enactments

In enacting farm legislation, the Congress must choose from among many alternative proposals and ideas. Even though CBO is responsible for most of the official estimates used for budget purposes, USDA's baseline forecasts are critical to these deliberations because they are used as a reference point for evaluating the costs of various proposals and the farm legislation finally enacted. Any bias error in the baseline may affect decisions that the Congress makes in choosing between alternative program proposals. Pursuant to provisions in the FACT Act, USDA now uses forecasts more directly in setting acreage reduction programs and loan rates, as well as in determining provisions of the dairy cost containment legislation.

Recent budget summit actions emphasize the importance of 5-year forecasts. For example, OBRA-90 cut farm bill outlay estimates by $13 billion over 5 years.[8] OBRA-90 now requires the use of 5-year baselines for the program budget authorization process.

Secretary of Agriculture Decisions

The Secretary of Agriculture has discretionary authority in implementing some legislation. USDA analysts provide forecasts of alternative outlay estimates, for up to 3 years, for the Secretary's options and then, in regulatory impact statements, provide forecasts of the outlay estimates of the selected options.

[7]The President's budget submission was made in January 1990. In February 1990, the administration introduced a farm bill proposal; however, it did not include cost provisions. See USDA, Secretary of Agriculture, "1990 Farm Bill, Proposal of the Administration," Washington, D.C., February 1990.

[8]USDA, Economic Research Service, The 1990 Farm Act and the 1990 Budget Reconciliation Act: How U.S. Farm Policy Mechanisms Will Work Under the New Legislation (Washington, D.C.: November 1990).

Examples of secretarial options can include (1) determining the required acreage reduction percentages, (2) offering a paid land diversion program, (3) offering export enhancements, (4) selling or purchasing meats and grains to stabilize markets, and (5) offering deficiency payments in cash or in certificates redeemable for government held stocks.

Program Administration

USDA officials use baseline forecasts to administer programs. The Federal Crop Insurance Corporation and Farmer's Home Administration utilize baseline forecasts to implement programs they are required to carry out. For example, the Federal Crop Insurance Corporation offers crop insurance for 13 major commodities for which USDA forecasts prices. Federal Crop Insurance Corporation officials use these forecasts as input to determine the value at which farmers can insure their crops and to determine premiums for the insurance. Farmer's Home Administration officials use USDA baseline forecasts in calculating cash flow estimates used to make decisions affecting new loans, as well as in extending credit for existing loans.

The Omnibus Budget Reconciliation Act of 1990 and USDA's Commodity Programs

As previously stated, USDA's 5-year baseline forecasts are used by the Congress in the program budget authorization process. Because these forecasts are a factor in congressional decisions concerning the funding levels of the farm commodities program and other programs within the same appropriations category, their accuracy can affect the budget authorization and management process.

One aspect of OBRA-90 that broadens the influence of the commodities forecasts on government spending and budget enforcement is the requirement that the Congress be bound to achieve deficit targets for each fiscal year through 1995 by a budget resolution enacted in 1990. Previously, under the Balanced Budget and Emergency Deficit Control Act of 1985, USDA baseline forecasts would have affected the budget authorization process only for the current year. Now, however, when forecasts are more inaccurate for later years than for the current period, their effect will be greater on a system that uses a 5-year projection.

If the forecasts are inaccurate, then the deficit targets set under OBRA-90 for the later years are likely to be unrealistic, due to the fact that the targets have been set based on data concerning what outlays and income are expected to be over the 5 years. To the extent that the amounts needed for the commodity support program turn out to be greater than now anticipated, the deficit will be larger than anticipated.

Increases in spending within the farm commodities program that are attributable to economic or technical revisions, such as forecast errors, are not subject to the provisions in OBRA-90 that are designed to compel adherence to the deficit targets. Under OBRA-90, an unanticipated increase in costs in later years would not be permitted to increase the deficit. The target set by the law would still have to be achieved by decreases in other programs or revenue increases; if it were not, the sequestration procedure—triggering across-the-board cuts—would be invoked automatically. However, OBRA-90 permits the deficit to increase beyond the target when the increase is the result of technical or economic forecasting errors. Moreover, the commodities program falls within an exception from sequestration in OBRA-90 for so-called mandatory programs.

The total deficit can thus increase beyond the targets set under OBRA-90 as a result of increases in required commodity support programs that have not been anticipated. Conversely, if the forecasts of these payments are more accurate, the Congress may either have set the targets more realistically, planned for the necessary increased spending, or cut planned spending.

Causes of USDA Baseline Forecast Error

No formal studies are available explaining why USDA's 5-year baseline forecasts are in error. However, board analysts provided us with some general explanations about factors that contribute to forecast inaccuracy. In addition, a USDA working group did evaluate the USDA's 1-year forecasts.[9] This study concluded that weather, macroeconomic factors, and program and policy assumptions contribute to baseline forecast inaccuracy. The majority of these factors cannot be controlled or predicted but affect agricultural commodity supply, utilization, and prices.

Weather Conditions

Unpredictable weather leads to many inaccurate forecasts of crop production. Forecast inaccuracies due to weather occur because of factors such as droughts, freezes, and too much precipitation. Five-year forecasts are especially susceptible to uncertain weather conditions. For example, the 1983 drought caused some of the large overestimation errors in soybean ending-stocks.

[9]USDA, "CCC Budget Estimates: An Overview and Preliminary Assessment," Interim report of staff working group on review of CCC estimates, Washington, D.C., June 8, 1987.

According to the World Agricultural Outlook Board's chief meteorologist, the U.S. climate is returning to a period of more erratic variations in weather patterns.[10] Temperature variability increased greatly after about 1975. Along with this temperature variation, crop yield variations are also increasing. The temperature ranges for the late 1970's and the 1980's show a greater variability than that found in the previous two decades. It now appears that the temperature stability of the 1950's and 1960's was abnormal. This could mean that the 1990's will be a period of greater weather variability and of related variability in crop yields.

According to board officials, the combination of a return to increased weather pattern variability and the inherent difficulty of predicting the weather creates a very uncertain future for crop production forecasts.

Macroeconomic Conditions

Macroeconomic conditions also contribute to forecast inaccuracy. Currency exchange rates, economic (income) growth rates, international financial conditions, and foreign agricultural and trade policies affect agricultural commodity supply and utilization. For example, depressed growth rates reduced demand in the early 1980's, and the international debt crisis, fueled by rising real interest rates, curtailed import demand in foreign markets for U.S. farm products.

A World Bank analyst told us that, in general, assumptions concerning four sets of macroeconomic variables form the basis for forecasting most, if not all, international commodity market prices. These variables are gross national product growth rates, inflation rates, exchange rates among major partners, and interest rates. Any accurate assumption about their prospective levels must not only ensure global consistency but also must preserve the basic economic or behavioral relationships among them.

Program and Policy Assumptions

Forecast errors can also be attributable to changes in program and policy assumptions. Administrative discretion and legislative changes in the commodity programs have contributed greatly to forecast errors. For example, USDA implemented the payment-in-kind program differently than it assumed it would when some of the forecasts were made, and some of the forecasts were made prior to the time when a need for

[10]Norton D. Strommen, "A Global Perspective on Weather Trends—The Most Unpredictable and Least Controllable Nature Resource," Paper presented at the World Food Production Symposium, Rio De Janeiro, Brazil, November 6, 1989.

such a program was foreseen. Implementation of the dairy termination program also affected forecast accuracy. USDA dairy analysts indicated that they had no prior knowledge of such a program and therefore did not include it when they made their original forecasts.

Accuracy of USDA's Baseline Forecasts

In this appendix, we discuss the accuracy of USDA's baseline forecasts. We first show summary bias and total error rates, then disaggregate them by specific out-years. The longer the forecast period, the larger the error rates tend to be. For selected commodity variables, we graphically display yearly error rates.[1]

A major factor in analyzing production error rates is how droughts are considered. USDA analysts do not document their procedures for including drought information in forecasts, and we found little evidence that accuracy studies are conducted to assess the effect of the different procedures for including drought information on forecast accuracy.

Summary Statistics on Total Error

Total error (MAPE) measures for the 24 commodity variables exhibited widely varying error rates. Table III.1 shows the MAPE rates for the commodity variables. Ending stocks have the highest MAPEs, ranging from 38 to 67 percent; price, exports, and production have MAPEs ranging from 5.5 percent to 36.5 percent; and domestic use has MAPEs that range from 2.1 percent to 17.1 percent.[2]

Table III.1: MAPE Rates for Selected Commodities and Variables, Crop Years 1981-88

	Commodity				
Variable	Soybeans	Cotton	Corn	Wheat	Dairy products
Production	15.5%	21.6%	25.8%	18.6%	5.5%
Domestic use[a]	8.3	17.1	6.0	12.7	2.1
Exports	26.7	36.5	35.0	25.3	[b]
Ending stocks[c]	44.4	38.3	67.1	43.8	56.6
Price	27.4	23.2	24.2	24.6	18.6

[a]Mill use for cotton; commercial use for dairy products

[b]Excluded; no export forecasts

[c]Net removals for dairy products

[1]We measure error rates using the MPE and MAPE formulas discussed in appendix IX. The commodity variable summary measures each involve about 40 forecasts (8 years, with 5 out-year forecasts). Individual out-year forecasts involve 8 forecasts. Appendix VII identifies those instances where specific forecasts are not available.

[2]Ending stocks are, in effect, residuals of commodity supply and use. As a result, small forecast errors in commodity supply and use can lead to relatively large forecast errors in ending stocks.

Summary Statistics on Bias Error

Bias error (MPE) measures for the 24 commodity variables also exhibited widely varying error rates. Table III.2 shows the MPE rates for the commodity variables. All price variables are overestimated by at least 10 percent. Dairy net removals, corn and cotton exports, and wheat ending-stocks all have MPEs of over +/-20 percent. Variables such as domestic use (except wheat), ending stocks for corn and cotton, and cotton production all had MPEs of less than +/-5 percent. All other variables fell into the range of +/-5 to 20 percent. (Complete tables of all individual forecasts and actual events can be found in appendix VII. Error measures by commodity, variable, and out-year forecast can be found in appendix VIII.)

Table III.2: MPE Rates for Selected Commodities and Variables, Crop Years 1981-88

	Commodity				
Variable	Soybeans	Cotton	Corn	Wheat	Dairy products
Production	−9.8%	−0.5%	−17.2%	−6.1%	5.5%
Domestic use	−4.1	−1.3	−2.0	10.3	1.0
Exports	−18.0	−21.2	−31.4	−11.1	[a]
Ending stocks	−15.1	1.5	1.0	−21.9	50.3
Price	−14.2	−13.7	−11.0	−12.9	−16.3

[a]Excluded; no dairy export forecasts available

Seasonal Average Price Bias Error for 5 Out-Years

Table III.3 shows that seasonal average price bias error rates tend to be larger for the latter years. The third, fourth, and fifth out-year forecasts tend to exhibit the highest bias error rates.

Table III.3: Seasonal Average Price MPE Rates for 5-Year Forecasts, Crop Years 1981-88[a]

	Bias Error Rate					
Commodity	Year 1	Year 2	Year 3	Year 4	Year 5	Overall
Soybeans	−6.1%	−9.8%	−14.9%	−14.5%	−29.3%	−14.2%
Corn	−4.1	−11.3	−14.7	−18.0	−14.4	−11.0
Wheat	0.8	−7.3	−14.2	−19.4	−24.4	−12.9
Dairy products	−1.2	−7.9	−18.9	−27.9	−31.9	−16.3
Cotton	−2.1	−12.3	−14.9	−19.0	−20.6	−13.7
Average[a]	−2.5	−6.5	−15.5	−19.9	−24.1	−13.6

[a]Weighted averages for all five commodities. We analyzed 182 separate forecasts; 18 forecasts were not available.

Long-term bias errors are a concern, but the previous summary analysis tends to mask even higher individual errors and trends. The next section

of our report addresses individual percentage error (IPE) for selected commodity variables.

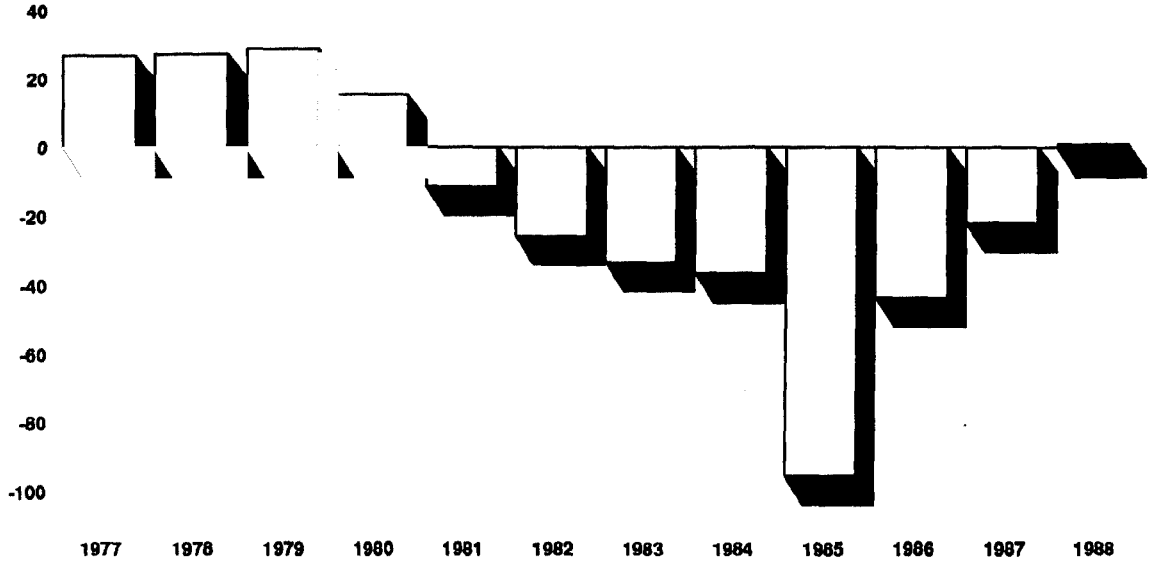
Analysis of Individual Forecast Errors

We graphed IPEs for crop years 1981-88 for three commodities to demonstrate trends, consistent over- or underestimation, and other factors (such as drought) that lead to forecast errors.

Long-Term Trends in Corn Exports

Certain commodity variables exhibit long-term trends. Figure III.1 shows that corn export forecasts tended to be underestimated during the late 1970's, then overestimated during the 1980's. According to USDA analysts, this cycle reflected the change in overall export levels. Exports rose during the 1970's, peaked, and then tended to fall. For this period, USDA failed to accurately forecast the change, so the out-year forecasts for several years were inaccurate. Other commodity variables that exhibited similar trends include (1) wheat seasonal average price, (2) cotton mill use, and (3) soybean production.

Figure III.1: Corn Export IPE Average Rates for 1-Through 5-Year Forecasts, Crop Years 1977-88[a]

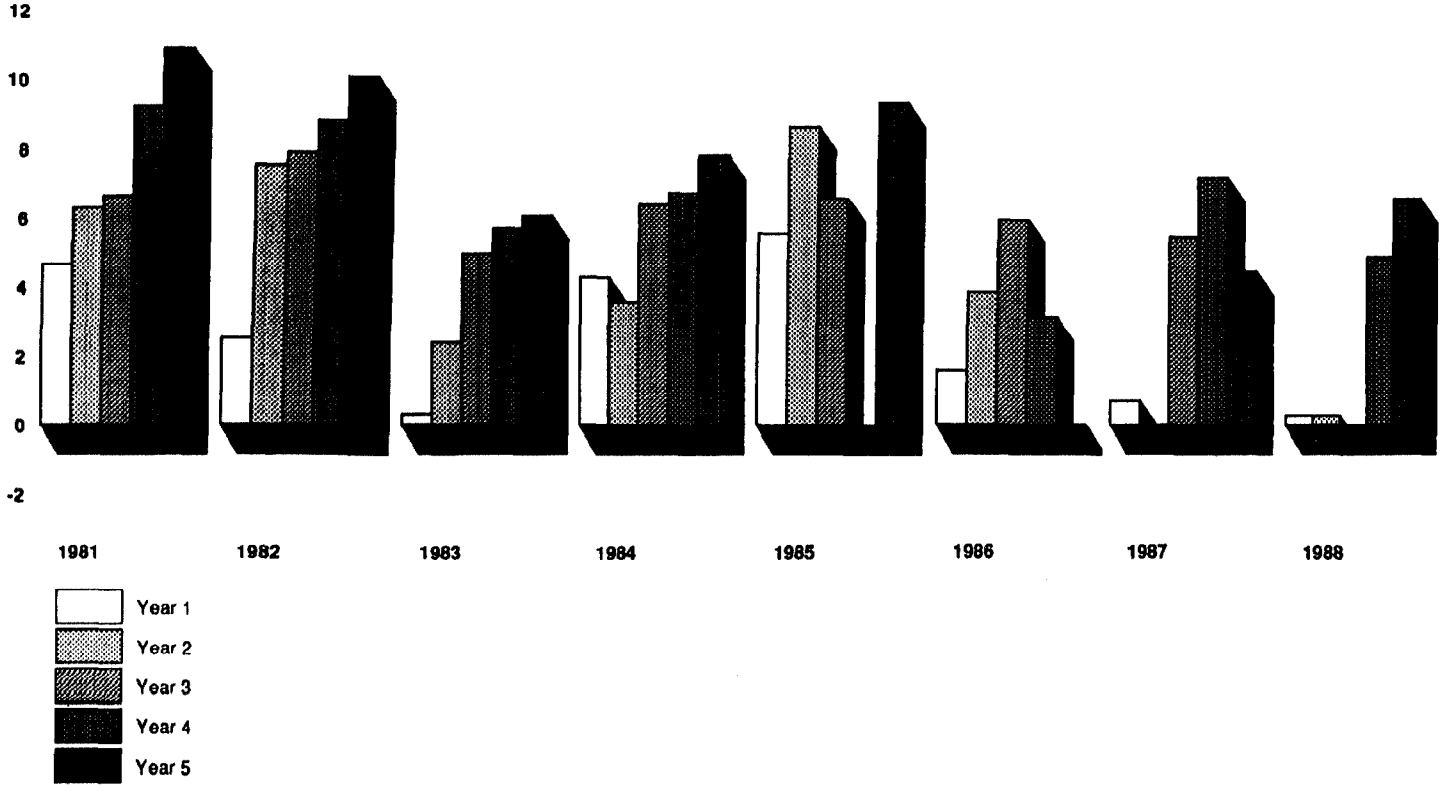


[a]Where bars are not shown, data were not available.

Consistent Bias Error in Dairy Production Forecasts

Figure III.2 shows that USDA has consistently underestimated dairy production from 1981 through 1988. If the errors were in fact random, then the IPEs would largely cancel out one another. However, from 1981 through 1988, bias and total error are equal at 5.5 percent. According to USDA analysts, almost yearly legislative changes to the dairy program are responsible for much of this underestimation. Forecasts of dairy production were made prior to much of this legislation, and anticipated production did not occur because of the changes in legislation. We believe that over a sufficient time period, regardless of circumstances, bias error should approach zero.

Figure III.2: Dairy Production Long-Term IPE Rates for 1- Through 5-Year Forecasts, Crop Years 1981-88[a]



[a]Where bars are not shown, data were not available.

How Droughts Contributed to Production Forecast Error

The two droughts that occurred during our evaluation period were a major source of production forecast error. Major droughts occurred during crop years 1983 and 1988. The 1983 drought affected corn, soybeans, and cotton. The 1988 drought affected corn, soybeans, and spring wheat.[3] Board officials believe these droughts and other weather-induced production variations reflect the return to the greater weather variability of the historical periods before the 1950's. Indeed, the "relative calm" of the 1950-70 period appears to be the real anomaly with regard to weather patterns.[4]

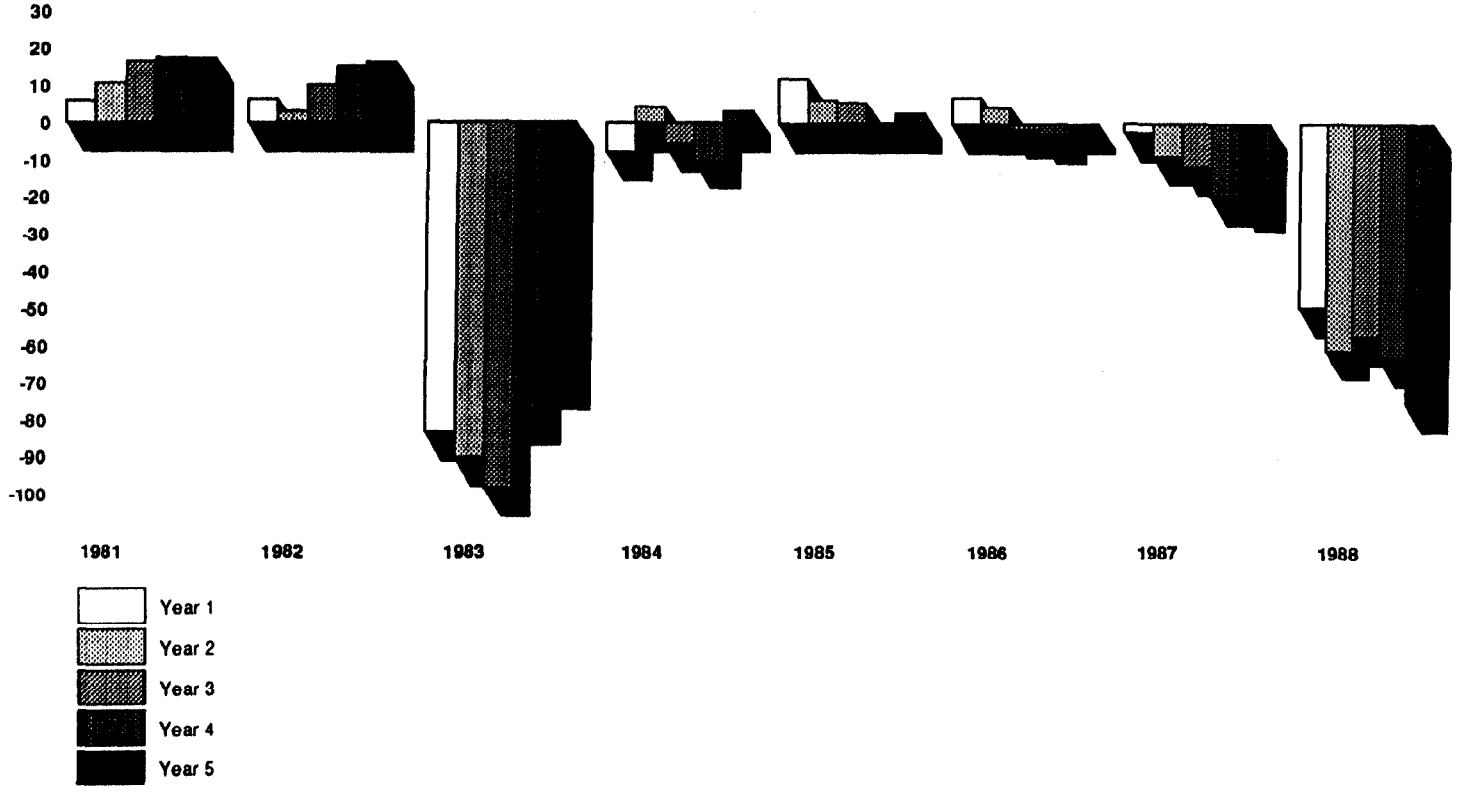
How Droughts Affected Corn Production

During the 1980's, droughts dramatically affected corn production. Figure III.3 illustrates corn production IPE. Individual error rates in 1983 ranged from -69.5 to -98.4 percent, while rates for crop year 1988 ranged from -49.4 to -75.4 percent. These error rates are more than twice any other individual error rates.

[3]See U.S. General Accounting Office, Crop Production: Outlook for Post-Drought Recovery During 1989, GAO/RCED-89-161BR (Washington, D.C: June 6, 1989).

[4]Norton D. Strommen, "A Global Perspective on Weather Trends—The Most Unpredictable and Least Controllable Nature Resource," Paper presented at the World Food Production Symposium, Rio De Janeiro, Brazil, November 6, 1989, pp. 4-5.

Figure III.3: Corn Production Long-Term IPE Rates for 1- Through 5-Year Forecasts, Crop Years 1981-88[a]



[a]Where bars are not shown, data were not available.

Conflicting and Undocumented Procedures for Including Droughts

According to USDA analysts, baseline forecasts assume historical weather trends, which include some drought years. Board commodity subcommittees use different methods to calculate long-term yields, a major component of production. Analysts responsible for their long-term forecasts defended the methodologies they chose, saying each commodity may need a different forecast methodology to account for drought. For example, drought can affect winter and summer wheat differently than corn since these crops are grown in different parts of the country. The board's analyst for wheat stated that long-term trend yield growth for wheat is not the same as that for corn. Further, droughts affecting summer and/or winter wheat may affect corn differently. This occurred in 1989 when a heavy drought cut wheat yields, but corn yields remained high. We recognize that differing long-term commodity yield

trends and the different drought effects may necessitate alternative methodologies for calculating production.

USDA analysts, however, do not consistently document their methodologies for calculating yields and production. Further, we found little evidence that systematic studies are conducted to evaluate the relative accuracy of alternative yield or production forecasts.

Agency Comments and Our Evaluation

USDA accepted our numerical results of the calculations pertaining to differences between forecasts and final results. However, USDA commented that we did not select an appropriate time period within which to analyze the long-term forecasts. They suggested that bias error rates would differ if the period of the 1970's was included in the analysis. We included crop years 1981-88 in our analysis because they were the only available 5-year forecasts. USDA either did not document earlier 5-year forecasts or did not make them.

USDA officials also thought we should emphasize that the period of the 1980's, because of variable weather and unanticipated program changes, was an unusual forecasting period in comparison to the 1970's, which had less variability in such factors. Since forecast data for the 1970's are not available, there is no way to assess whether forecast accuracy was any better during this time period. Furthermore, there is no evidence available to suggest that the period of the 1970's was any more typical of conditions likely to occur in the 1990's.

USDA also felt that we placed undue emphasis on percentage error of stocks estimates. While our report demonstrates that ending stocks do not have a substantial impact on budgetary outlays, the accuracy of these forecasts is nonetheless important to the implementation of the farm programs. The FACT Act ties future acreage-reduction-program percentages and loan rates to the estimated ending-stocks forecast. (See appendix XI for USDA's comments in their entirety.)

Reasonableness of USDA Baseline Forecasts

In this appendix, we respond to evaluation question 1, "Are USDA's baseline price, production, export, domestic use, and stock forecasts for wheat, corn, cotton, soybeans, and dairy products reasonably accurate?" We first define the concept of "reasonableness." Since this definition requires comparing forecasts to benchmarks, we constructed naive models for comparison purposes. (See appendix I for a description of the naive models used.) Overall, our naive models exhibited lower bias and total error for the seasonal average price and exports, but showed mixed results for the other variables. USDA's first and second year forecasts, however, tended to be more accurate than ours; conversely, our third through fifth year forecasts were better than USDA's longer term forecasts.

"Reasonableness" Defined

Because forecasting is based on incomplete knowledge concerning the future, it is to be expected that some level of error will occur. However, total and bias error measures by themselves do not provide a basis for evaluating what level of error in forecasts is "reasonable." To make this determination, it is also necessary to compare these measures to other available "benchmarks" in order to determine whether smaller error rates are possible. "Reasonable" would imply both small total and bias errors and that no better forecasts are readily available.

Table IV.1 shows that our 5-year benchmark forecasts exhibit less average bias error than USDA's 5-year forecasts of seasonal average price for crop years 1981-88.

Table IV.1: Seasonal Average Price Bias Error Benchmarks, Crop Years 1981-88

Crop forecast/ benchmark	Seasonal average price bias error					
	Year 1	Year 2	Year 3	Year 4	Year 5	Overall
Corn						
USDA actuals	−4.1%	−11.3%	−14.7%	−18.0%	−14.4%	−11.0%
GAO 3-year average	−14.5	−14.9	−12.8	−10.4	−0.7	−7.9
GAO 5-year average	−13.3	−13.2	−11.5	−8.4	3.5	−7.0
GAO 5-year trimmed	−11.9	−11.1	−9.4	−7.0	4.1	−5.6
GAO 1-year fixed	−4.1	−10.3	−13.5	−13.9	−4.8	−6.8
Soybeans						
USDA actuals	−6.1	−9.8	−14.9	−14.5	−29.3	−14.2
GAO 3-year average	−7.5	−8.9	−6.1	0.9	−0.4	−4.8
GAO 5-year average	−8.1	−8.2	−5.7	2.4	4.1	−3.6
GAO 5-year trimmed	−6.3	−7.7	−5.7	1.6	2.8	−3.5
GAO 1-year fixed	−6.1	−9.7	−9.2	−3.7	−5.2	−6.9
Wheat						
USDA actuals	0.8	−7.3	−14.2	−19.4	−24.4	−12.9
GAO 3-year average	−8.7	−8.1	−6.7	−6.6	−6.9	−7.4
GAO 5-year average	−7.6	−7.6	−6.9	−4.9	−1.5	−5.7
GAO 5-year trimmed	−9.0	−8.3	−7.9	−6.8	−3.9	−7.2
GAO 1-year fixed	0.8	−4.3	−8.2	−8.4	−6.8	−5.4
Cotton						
USDA actuals	−2.1	−12.3	−14.9	−19.0	−20.6	−13.7
GAO 3-year average	−5.6	−5.4	−4.6	−1.0	4.1	−2.6
GAO 5-year average	−4.8	−3.6	−1.9	3.1	10.8	0.5
GAO 5-year trimmed	−3.1	−2.1	−0.1	4.6	12.0	2.1
GAO 1-year fixed	−2.1	−3.2	−3.9	−4.0	−3.5	−3.3

We conducted tests to assess whether there were statistically significant differences between USDA's forecasts and our benchmarks. This testing produced mixed results. In some cases, such as cotton prices, significant differences exist between USDA forecasts and our benchmarks, both for all 5 years and for the third through fifth out-year forecasts. Other commodities, however, did not exhibit significant differences, at least at the 90-percent level of confidence. This was due to the wide variation in forecast error rates. The standard deviations for the forecasts were in many cases twice the means.

Table IV.2 shows that overall error rates for seasonal average price benchmark forecasts are also lower than USDA's rates, but not by as much as bias error.

Table IV.2: Seasonal Average Price Total Error Benchmarks, Crop Years 1981-88

	Seasonal average price total error					
Crop forecast/ benchmark	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Overall**
Corn						
USDA actuals	20.6%	23.5%	21.6%	24.3%	31.8%	24.2%
GAO 3-year average	25.7	27.1	28.0	28.7	16.0	23.9
GAO 5-year average	24.7	25.6	23.9	23.3	13.2	21.7
GAO 5-year trimmed	24.4	25.6	23.9	22.4	12.5	21.5
GAO 1-year fixed	20.6	24.2	22.7	30.4	24.9	23.6
Soybeans						
USDA actuals	22.7	27.8	22.6	27.5	38.7	27.4
GAO 3-year average	18.6	16.9	15.9	8.7	14.2	15.2
GAO 5-year average	17.6	17.4	15.0	9.4	13.7	14.9
GAO 5-year trimmed	17.5	18.0	14.8	9.2	14.9	15.1
GAO 1-year fixed	22.7	29.1	18.4	25.0	24.1	23.8
Wheat						
USDA actuals	10.6	18.0	27.4	34.2	45.0	24.6
GAO 3-year average	18.0	21.0	23.3	22.4	18.0	18.3
GAO 5-year average	19.4	19.5	17.9	14.9	13.4	16.8
GAO 5-year trimmed	18.7	19.7	18.7	15.4	12.5	16.3
GAO 1-year fixed	10.6	15.0	20.6	23.5	28.8	17.7
Cotton						
USDA actuals	21.9	21.2	22.4	23.7	27.1	23.2
GAO 3-year average	8.2	7.6	9.9	7.8	8.2	8.2
GAO 5-year average	9.6	6.7	9.4	11.8	14.1	10.5
GAO 5-year trimmed	9.1	5.9	8.6	11.8	14.5	10.3
GAO 1-year fixed	21.9	18.2	14.5	12.5	18.9	17.9

Benchmark Error Rates Differ Dramatically for Out-Years

Bias error rates for our benchmark forecasts are lower than USDA's actual bias error rates. These overall averages, however, mask individual out-year differences. USDA first and second out-year forecasts tend to be more accurate than our benchmarks. Table IV.1 shows that USDA's bias error rates were usually more accurate for the first year. Conversely, our benchmark third-, fourth-, and fifth-year forecasts show less bias error than USDA's forecasts. It is these out-year forecast improvements that make the averages for all 5 years superior for the naive model results.

All of the benchmarks demonstrate total error improvement over that exhibited in the USDA total error, when the averages for all 5 years are

considered. USDA forecasts again demonstrated greater accuracy for the first year, and generally for the second year.

GAO's analysis of export benchmarks found a lower bias error with similar accuracy rates, in particular for forecasts of the third, fourth, and fifth "out-years." Production, ending stocks, and domestic use showed mixed results. Some better forecasts could have been made by using one or a combination of our naive models for the current year and the out-years. Conversely, other naive models did not show improvement in the forecasts.

Agency Comments and Our Evaluation

USDA commented that we overstate the usefulness of the naive models presented in this report and that such models could not replace USDA's current forecasting method. Our recommendation is not that USDA replace its forecasting methods with naive models. Instead, we emphasize that naive models can be useful in highlighting areas where improvements in forecast accuracy are needed and that benchmarks should be used at the time forecasts are made. Forecasters, as well as policy makers, need benchmark information to assess forecast accuracy. (See appendix XI for USDA's comments in their entirety.)

Budgetary Implications

In this appendix, we address evaluation question 2, "What are the implications of inaccurate forecasts with regard to outlay estimates in the administration's January 1990 budget submission?"

If the historical bias error rates exhibited in the baseline forecasts for crop years 1981-88 were to continue, and if the farm program provisions in place at the beginning of 1990 were extended for 5 more years, then the $47.1 billion outlay estimate used in the administration's January 1990 budget submission may have been underestimated by $19.5 billion.[1]

Without a major drought during the 5-year forecast period, such as those experienced in crop years 1983 and 1988, outlays could increase even more; conversely, if yields are below trend for the period, outlays could decline. Sensitivity analysis indicates that a sizable range of possible multibillion dollar outlay impacts exist. Should commodity prices fall, outlays could rise greatly due to increases in deficiency payments. On the other hand, should droughts occur and prices rise, outlays may decline.

Caution Needed in Evaluating Outlay Estimates

Farm program outlays, especially for 5 years into the future, are difficult to forecast accurately. Actual outlays for the 1981 farm bill were underestimated by 86.4 percent, while outlays for the 1985 farm bill were underestimated by 1.0 percent.[2] It is with this dramatically different experience in mind that we offer comments on the implications of potential baseline forecast bias error.

The following series of assumptions affected our outlay estimates:

1. The President's January 1990 budget submission outlay estimates that we evaluated assumed that the program provisions of the 1985 farm bill would continue through 1995. The outlay estimates are listed in appendix X. The actual 1990 farm bill (the FACT Act of 1990) legislatively mandated changes that will affect future outlays. One such change allowed base acre planting flexibility. Other cost containment changes included the dairy program cost limitation provision and the mandatory acreage-reduction-program and loan rate changes.

[1]We used seasonal average price for all commodities except dairy products, where we used production.

[2]The low 5-year error rate for the 1985 farm bill is in part due to substantial overestimates in fiscal years 1988-90, as indicated in table II.1.

2. While we only evaluated the baseline forecasts, policy or economic changes other than those anticipated at the time of the President's budget submission could affect outlays.

3. We used the MPE bias error measure when adjusting for the forecast prices and dairy production. Other bias error measures, such as those shown in appendix IX, would affect outlay estimates differently.

4. The baseline forecasts used for the FACT Act of 1990 were updated prior to the legislation's being approved. USDA produced forecasts for the mid-session review, and CBO produced two additional 5-year baselines between the January 1990 USDA baseline and the enactment of the FACT Act of 1990.

5. OBRA-90 mandated about a 25-percent reduction in total FACT Act of 1990 spending. Spending reductions come mainly from price support and income support programs.

6. Future legislative changes to the farm program may also change outlays.

7. Long-term export forecasts could be affected by a GATT agreement. Failure to reach a GATT agreement could lead to changes in policy and farm programs in the United States and abroad.[3]

Effect on Accuracy of January 1990 Outlay Estimates

Table V.1 shows that the outlay estimates for commodity programs provided in the January 1990 budget submission could have been underestimated by as much as $19.5 billion—if the conditions that led to the crop year 1981-88 historical bias error rate continued over the next 5 years, and if the 1985 farm bill provisions were extended.

[3]See U.S. General Accounting Office, Agricultural Trade Negotiations: Stalemate in the Uruguay Round, GAO/NSIAD-91-129 (Washington, D.C.: February 1, 1991).

Table V.1: Effect on the January 1990 Budget Submission Outlay Estimate Using Historical Price Bias Error, Fiscal Years 1991-95[a]

Commodity	January 1990 budget estimate	Dollar change
Wheat	$11.6	$4.5
Corn	31.3	6.7
Soybeans	(0.1)[b]	1.3
Cotton	2.3	2.8
Dairy products	1.9	4.2
Total[c]	**47.1**	**19.5**

[a]We used seasonal average price bias error except for dairy products, where we used production bias error. Dollar amounts are in billions.

[b]Indicates a net receipt (excess of repayments or other receipts over gross outlays of funds).

[c]Totals may not add due to rounding.

Table V.2 shows the individual year effect of the historical bias errors at $19.5 billion, with 85 percent of this effect occurring in fiscal years 1993 to 1995. This effect is calculated using USDA policy simulation models, and adjusting each out-year price forecast by the historical bias error rate for that year. (See table VIII.1 for the historical bias error.)

Table V.2: Estimates of Additional Farm Program Outlays If Historical Bias Error Rates Continue, Fiscal Years 1991- 95[a]

Commodity	1991	1992	1993	1994	1995	Total
Corn	$0.3	$0.6	$1.3	$1.8	$2.7	**$6.7**
Wheat	0.1	0.6	1.0	1.3	1.5	**4.5**
Soybean	0.0	0.1	0.1	0.0	1.1	**1.3**
Cotton	0.1	0.4	0.7	0.8	0.9	**2.8**
Dairy products	0.2	0.5	0.9	1.1	1.4	**4.2**
Total[b]	**0.6**	**2.1**	**4.0**	**5.0**	**7.6**	**19.5**

[a]We used seasonal average price bias error except for dairy products, where we used production bias error. Dollar amounts are in billions.

[b]Totals may not add due to rounding.

Sensitivity Analysis

Sensitivity analysis demonstrates that production and export bias error exhibited high budget impacts, but that the ending stocks exhibited a relatively neutral impact. This means that price has the primary impact on proposed farm program spending.[4] To conduct this analysis, we first used the historical bias error rates for individual commodity variables. Additional analysis indicated that corn forecasts, excluding the two

[4]Sensitivity analysis is an approach to problem solving based upon the repeated solution of the problem using varying inputs and/or changes in the simulation model.

drought years, resulted in higher budgetary impacts. Virtually any bias error adjustment can affect outlay estimates.

Table V.3 shows that production and export variables demonstrate large individual impacts. Production bias error occurs on account of the droughts and results in overestimating outlay estimates by as much as $30 billion. Export bias error occurs when anticipated exports are not realized and results in underestimating outlay estimates by approximately $21 billion. Domestic use and ending stocks, however, do not greatly affect outlay estimates. Ending stock bias error, the net impact of all supply and utilization variables, shows that outlay estimates could be $4 billion less. Thus, with offsetting impacts for individual supply and utilization variables, analysis of the seasonal average price bias becomes even more important.

Table V.3: Outlay Estimate Impact Using Historical Bias Error, All Commodities, and Selected Variables, Fiscal Years 1991-95

	Dollar change[a]			
Commodity	Production	Domestic use	Exports	Stocks
Wheat	$(3.8)	$(2.3)	$5.2	$(2.8)
Corn	(30.1)	2.2	11.6	(2.3)
Soybeans	(0.3)	0.1	1.3	0.0
Cotton	(0.3)	(0.1)	2.7	0.1
Dairy products	4.2	(0.7)	[b]	1.0
Total[c]	**(30.3)**	**(0.9)**	**20.7**	**(4.0)**

[a]Dollar amounts are in billions. Amounts in parentheses are overestimates; the rest are underestimates.

[b]Excluded

[c]Totals may not add due to rounding.

Again, most of the estimated outlay impact occurs in the third, fourth, and fifth out-years.

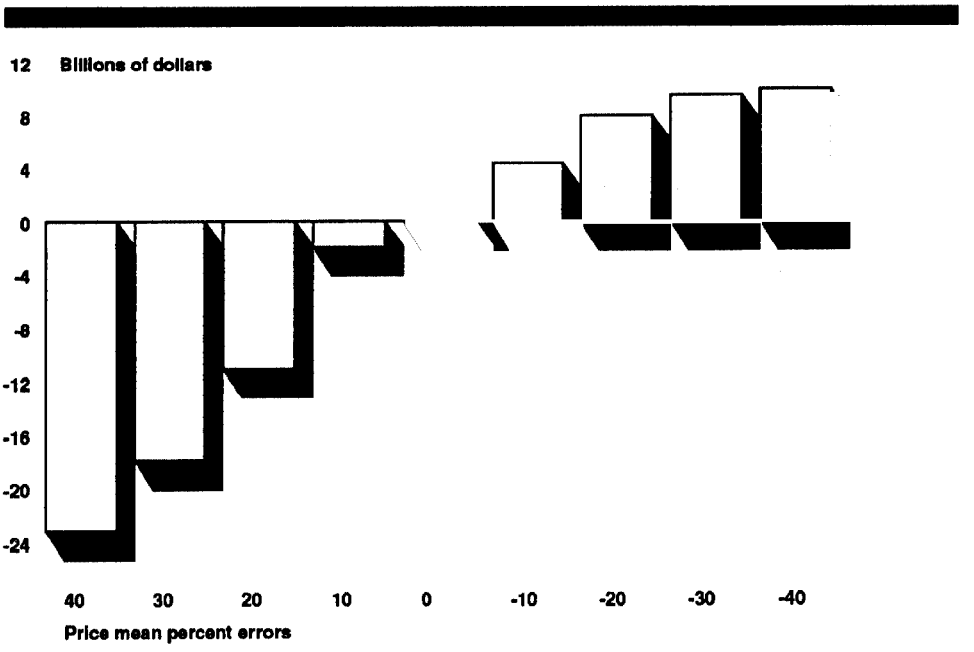
Corn Production Drought Sensitivity Analysis

USDA's budget outlays are sensitive to weather variability. Thus, if one uses the bias error rates for corn over the 1981-88 period, excluding drought years 1983 and 1988, the results for corn shown in table V.2 would increase from $6.7 to $9.1 billion. This means that unless drought conditions such as those of crop years 1983 and 1988 reoccur, outlays could rise even further than shown.

Corn Price Arbitrary Change Sensitivity Analysis

We arbitrarily changed corn prices to look at the impact on outlay estimates. We found that, for corn, any changes in price forecasts have a dramatic impact on the 5-year, $31.3 billion outlay estimate. Figure V.1 shows sensitivity analysis for corn seasonal average price under alternative bias error rates. As figure V.1 demonstrates, corn prices can have a significant impact on outlay estimates.

Figure V.1: Estimated Corn Outlays Assuming Selected Error Rates for Seasonal Average Price, Fiscal Years 1991-95



Agency Comments and Our Evaluation

USDA emphasized that we did not review the cost estimate for the 1990 farm bill, but rather relied on an earlier forecast that assumed that the program provisions of the 1985 farm bill would not change. We used the January 1990 budget proposal because USDA's baseline represents the beginning of the farm bill deliberations and was the most current one available at the time of our analysis. The subsequent program provision changes, which were incorporated into the final farm bill, resulted in a different budget outlay estimate. However, we believe that our analysis demonstrates that a bias error rate does exist, which could lead to underestimates of budget outlays. We also recognize that not all of the differences are due solely to misestimates of supply and utilization. We agree that determining how much of the inaccuracy is respectively due to program changes, technical assumptions, or supply and utilization

misestimates is a very complex task. (See appendix XI for USDA's comments in their entirety.)

Improving USDA's Forecast Management Process

This appendix contains information on how USDA can improve its baseline forecasts.

USDA can improve the accuracy of its forecasts through improved management. The elements of a successful management program were identified in our earlier reports on USDA forecast accuracy,[1] and codified in the FACT Act of 1990.[2] Forecast accuracy should improve if these steps are properly implemented. These elements include

- systematically identifying the source of forecasting errors by assessing the reasonableness of USDA's forecasts by measuring and reporting accuracy, and comparing this accuracy to that of benchmarks;
- maintaining records of data used for supply and utilization forecasts, including a data base of forecasts, special events, and input data;
- documenting forecasting methods for subsequent analysis, including the methodologies used, all major assumptions, the forecasts made, and other information necessary to an understanding of how they were made; and
- correcting weaknesses in USDA's various forecasting components, including the establishment of a quality control program.

We recognize that when many different factors—such as weather, changes in farm legislation, farmers' participation, and domestic and world economic conditions—have a bearing on the trend being forecasted, forecast accuracy becomes problematic. However, Ascher points to the plausible connections between accuracy and the characteristics of a forecasting technique or of forecasters and their behavior.[3] We believe that when forecasting errors exceeding benchmark levels are isolated, and component forecasts that include bias error are systematically identified, evaluators can associate the forecasting errors with specific

[1]U.S. General Accounting Office, Short-Term Forecasting: Accuracy of USDA's Meat Forecasts and Estimates, GAO/PEMD-91-16 (Washington, D.C.: May 1991), pp. 55-59, and USDA's Commodity Program: The Accuracy of Budget Forecasts, GAO/PEMD 88-8 (Washington, D.C.: April 1988), pp. 59-73. Our comments in those reports are based on a review of available research pertinent to managing a forecasting process. See U.S. General Accounting Office, Guidelines for Model Evaluation, PAD-79-17 (Washington, D.C.: 1979); S.I. Gass, Computer Model Documentation: A Review and an Approach (Washington, D.C: U.S. Government Printing Office, 1979); William Ascher, Forecasting: An Appraisal for Policymakers and Planners (Baltimore: Johns Hopkins University Press, 1978); J. Scott Armstrong, Long-Range Forecasting: From Crystal Ball to Computer, 2nd ed. (New York: John Wiley and Sons, 1985); Stuart Bretschneider, "Forecasting: Some New Realities," Metropolitan Studies Program, Syracuse University, Syracuse, New York, December 1985; Office of Management and Budget, Statistical Policy Directive on Compilation, Research and Evaluation of Principal Federal Economic Indicators (Washington, D.C: 1985).

[2]FACT Act of 1990, Section 2512. See later section in this appendix for a discussion of Section 2512.

[3]Ascher, Forecasting: An Appraisal for Policymakers and Planners, p. 8.

methodologies or individual forecasters. As a result, management should know where to allocate resources to try to improve accuracy.

We generally did not question the type of forecasting methodology USDA analysts and officials chose to use. However, according to Bretschneider, after a methodology is chosen, good practices should be followed to ensure that the results are timely, accurate, and appropriate at a minimum cost.[4]

While USDA has corrected some of the forecasting problems identified in our previous work, and has implemented some of our recommendations, we believe improvements are still possible.

Identifying the Source of Forecasting Errors

We believe USDA should measure the accuracy of their 5-year commodity baseline forecasts and report the results. This is particularly important if error rates are relatively high or bias error is clearly indicated. Forecast users should know what type of reliability the forecasts historically have exhibited.

Needed Improvements

Forecasting methodologies similar to the committees' forecasting methodologies are described in the literature as a panel or round-table process. Levin found that a panel process using several experts can arrive at a better forecast than can one person.[5] In this regard, USDA's organizations have placed priority on assigning to the committees highly qualified analysts with the necessary program knowledge. Levin found that unless a panel is properly structured, the forecasts may not be as accurate and unbiased as possible. In other research, Ascher found that forecast accuracy is affected by the goals and objectives of the forecaster's institutional bias and training.[6]

We compared the committee process to the research by the forecasting experts cited above and identified several weaknesses with the forecasting methodology that the committees use to forecast baselines. We found that the World Agricultural Outlook Board does not systematically or formally

[4]Bretschneider, "Forecasting: Some New Realities," p. 15.

[5]Richard L. Levin, et al., Quantitative Approaches to Management (New York: McGraw-Hill, 1982).

[6]Ascher, Forecasting: An Appraisal for Policymakers and Planners, pp. 12-13.

- measure the accuracy of its baseline forecasts;
- measure the forecast's accuracy for individual committee members;
- compare its baseline forecasts to benchmarks;[7]
- validate existing forecasting methods using such techniques as peer group review by USDA and outside experts, as well as benchmarks.

We found in our review of forecasting evaluation literature and discussions with USDA officials and outside experts, that there has been little evaluation work conducted on the accuracy of long- term commodity forecasts.

Improvements That Are Occurring

A World Agricultural Outlook Board analyst has conducted some preliminary studies comparing the seasonal average price forecasts with naive model benchmarks. This work specified baseline and benchmark forecast error rates. The analyst found that benchmarks exhibited greater accuracy, in some cases, than USDA's 5-year forecasts. This information, however, has not yet been reported to the baseline forecast users.

Maintaining Data Records

Data associated with a forecasting process includes the input data, the forecast results, and information explaining historical events or actions that describe input data that influenced prior forecasts. The major weaknesses of forecasting, according to Bretschneider, is that the world sometimes changes in unexpected ways.[8] Special events directly influence the development and use of forecasting data, but often no adequate records are maintained. Bretschneider proposes standards for data management to ensure that the lessons of history are available. Along this line, Bretschneider recommends that the analyst and agency store forecasts, as one would store data, and maintain records of special events or actions, including estimates of their effects on the historical data maintained for use in building a forecasting model.

[7]While the individual analysts informally compare USDA forecasts to other private-sector forecasts, there is no formal process for constructing consensus forecasts and systematically comparing forecast accuracy. Such information is needed for USDA management forecast review. Private forecasters—such as the WEFA Group, the Food and Agricultural Policy Research Institute, Texas A&M University, and the World Bank—make forecasts that USDA could use for benchmark purposes.

[8]Bretschneider, "Forecasting: Some New Realities," p. 17.

Needed Improvements

We found that the World Agricultural Outlook Board has not

- maintained a data base of all forecasts, as well as of actual subsequent events, such as that shown in appendix VII of this report;
- kept records of individual analysts' forecasts now used as input into the committee process—which would enable USDA to hold individual analysts accountable for their forecasts;
- recorded special events that affect the input data or the forecast results—for example, by using an events register to describe the effects of droughts, program changes, or political events such as wars and trade sanctions[9] —or
- maintained a record of input data such as program assumptions, economic assumptions, yield trends, and other pertinent data in developing their input for the committee meetings. (Historically, until recent years, the Board committees had not published or maintained a record of the supply and utilization forecasts they make for the President's budget. The only record of these baseline forecasts until recently had been the Commodity Credit Corporation estimates book, maintained by the Agricultural Stabilization and Conservation Service Budget Division.)

Improvements That Are Occurring

USDA now prepares a semiannual baseline estimate book that documents their forecasts. This restricted publication includes information about the assumptions used for the baseline forecasts.[10] We provided the Board with a complete data base of past forecasts, which USDA analysts said they would update.

Documenting USDA's Forecasting Methods

The fact that individual components of the forecasting methodology do not meet best documentation practices can mean that systematic evaluation is precluded, replicating the process is difficult, and knowledge is lost when employees leave. If the forecast results do not disclose assumptions and limitations and show measures of uncertainty, the data have limited value for users in their decision making.

The adequacy of forecast documentation and reporting is assessed by checking to see if the documentation on methodology supports the user's needs. The forecasting process should be documented so that the results

[9]A method for developing an events register is discussed by W. L. Gorr, "Use of Special Event Data in Government Information Systems," Public Administration Review, 46 (November 1986), pp. 532-39.

[10]The USDA baseline publication is an internal document summarizing forecasts used for preparing budgets and policy simulations. It is not releasable to the public.

can be replicated for evaluation. The forecasting results should disclose the assumptions and limitations of the methodology, and they should contain measures of uncertainty or ranges to explain the expected accuracy.

Needed Improvements

USDA maintains a record of assumptions used in the baseline forecasts but could improve documentation by preparing a manual of the forecasting methodologies used, including all major assumptions and other information necessary. Such a manual would be similar to that developed and used in NASS.[11] This would allow forecasts to be replicated and fully understood in future years when the analysts who made the forecasts are no longer available. It should also encourage consistency among analysts in their treatment of such factors as droughts when calculating yields. The Board chairperson stated that there is no standard methodology. The Board relies on each analyst's professional expertise to ensure that the forecasting methodology is appropriate and correct. Since much of USDA's forecasting methodology is not documented and cannot be replicated, USDA management is limited in its ability to share the strengths of its forecasting processes with other analysts and in evaluating the quality of forecasts. Without full documentation, peer review is not possible.

Improvements That Are Occurring

USDA, in its comments on our meat forecasting report, agreed to develop a manual that will describe operating procedures, document USDA forecasting performance, discuss methodologies, and outline major assumptions.

Organizational Weaknesses and Quality Control

The basic objective of a forecasting process, according to Bretschneider, is to produce timely, accurate, and appropriate forecasts at minimum cost.[12] We emphasized throughout this report that the ultimate test of a forecasting methodology is the accuracy of its forecasts. If a forecast is not as accurate as it could be, causes for error should be identified. A quality control program helps management select forecasting techniques, develop measures of uncertainty, identify areas for improvements, and produce better forecasts.

[11]See USDA, National Agricultural Statistics Service, Scope and Methods of the Statistical Reporting Service, Miscellaneous Publication No. 1308 (Washington, D.C.: September 1983).

[12]Bretschneider, "Forecasting: Some New Realities," p. 15.

We previously expressed concern over the fact that accountability for the many disparate parts of forecasts has been spread out among so many officials that none seems quite sure how weaknesses affect the outlay estimates as a whole. In fact, no single management organization could eliminate the weaknesses that they identify.[13]

Needed Improvements

USDA does not have a structured quality control program or agency regulations setting standards for the evaluation of methodology and results, data management, and documentation and reporting. USDA's quality control program is carried out primarily through the use of professional staff and normal supervisory review. For several years, USDA has proposed adding Board staff who will be responsible for evaluating the agency's forecasting program. This program evaluation effort would help USDA to implement existing proposals for improvement. The additional appropriations requests, however, were not authorized.

Improvements That Are Occurring

New regulations consolidated responsibility at the World Agricultural Outlook Board for budget-related baseline forecasts. In its fiscal year 1992 budget submission, the Board requested funding to establish and support a "forecast evaluation coordinator" position for the purpose of monitoring and evaluating USDA estimates, forecasts, and projections. As an independent analyst without direct responsibility for developing commodity estimates, the coordinator will subject all forecasts to unbiased review. The coordinator will develop an analytical framework and implement a standard operating procedure for evaluating and documenting USDA forecasting performance on a continuous basis.

[13]See U.S. General Accounting Office, USDA's Commodity Program, pp. 4-5. The organizational improvements discussed in this previous report are beyond the scope of our present report. This report only addresses the World Agricultural Outlook Board's baseline forecasts. We did not address the policy simulation analysis conducted by the Agricultural Stabilization and Conservation Service Commodity Analysis Division, or the budget preparation work conducted by the Budget Division.

Legislation Suggests Secretary of Agriculture Modify Forecasting Procedures

In response to our previous report, the FACT Act of 1990 suggests that the Secretary of Agriculture should implement new forecasting practices.[14] Specifically, Section 2512 states

"Improving the Accuracy of Commodity Program Budget Forecasts.—Congress finds that, to improve the accuracy of commodity program benefit forecasts, the Secretary of Agriculture should designate a single organization to manage its commodity program forecasting and establish a quality control program to--(1) systematically identify the source of forecasting errors; (2) maintain records of data used for supply and utilization forecasts; (3) document its forecasting methods; and (4) correct weaknesses in its various forecasting components."

Recommendations

We believe that properly managing and evaluating the forecasting process will result in USDA's making more accurate forecasts. Our prior reports recommended improvements for USDA forecasts.[15] Furthermore, the FACT Act of 1990 uses these recommendations to suggest that the Secretary of Agriculture designate a single organization to manage its commodity program forecasting and establish a quality control program to (1) systematically identify the source of forecasting errors, (2) maintain records of data used for supply and utilization forecasts, (3) document its forecasting methods, and (4) correct weaknesses in its various forecasting components.

We recommend that the Secretary of Agriculture specifically direct the World Agricultural Outlook Board to measure and report forecast accuracy of 5-year baselines, as well as to develop and report benchmark forecasts.

[14]U.S. General Accounting Office, USDA's Commodity Program, p. 5.

[15]U.S. General Accounting Office, USDA's Commodity Program, pp. 75-76, and U.S. General Accounting Office, Short-Term Forecasting, pp. 55-59.

Costs and Benefits of Implementing Recommendations

If implemented, our recommendations should increase forecast accuracy. Since annual commodity program expenditures are in the multibillion dollar range, and the 5-year forecasts are used for budget deficit management, the effect on future spending could be considerable. This report demonstrates that the benefits associated with improved forecasting could also be considerable. Armstrong also provides a methodology for assessing the value of improved forecasting accuracy.[16]

Some costs will be incurred. Additional staff resources will be required to conduct evaluations. The World Agricultural Outlook Board chairperson estimated that at least one staff year will be needed for establishing a routine evaluation program for all of the long- and short-term forecasts.

Research into long-term commodity forecasting would entail some expense. We found little available information evaluating the accuracy of long-term commodity forecasting. Encouraging such research could entail the expenditure of some USDA analyst resources and, potentially, grants to private sector researchers.

Agency Comments and Our Evaluation

USDA has stated that long-term forecasting accuracy evaluation may not be easy or inexpensive to carry out. Since small forecasting errors can have budget outlay impacts, we believe that it would be cost-effective to work towards improving forecasting accuracy. This is particularly true now that OBRA-90 places greater emphasis on 5-year forecasts for budgeting. (See appendix XI for USDA's comments in their entirety.)

[16]Armstrong, Long-Range Forecasting: From Crystal Ball to Computer, pp. 452-58.

USDA Long-Term Budget-Related Commodity Forecasts, by Crop Year

This appendix contains USDA's crop years 1975-88, 5-year baseline forecasts for the five commodities we studied. We included these forecasts in this report for use in further forecast evaluation research. Many of these forecasts are not available outside USDA.

USDA makes forecasts for the following crop year, plus the next four crop years. For example, USDA's baseline soybean forecasts made in December 1979 include forecasts for crop years 1980-84. We recapped the USDA baseline forecasts by listing the five forecasts and the actual yield. The out-year represents the number of years in the past a forecast was made for the crop year. For example, the soybean export forecast for crop year 1988 made 5 years prior (1983) is 1,070,000 bushels, while the forecast made 1 year prior (1987) is 745,000 bushels.

We obtained the forecasts from the President's budget submissions for USDA/Agricultural Stabilization and Conservation Service. We used the subsequent year's "actual" as reported in the budget documents. When the actual was not available, we obtained actual information from the Fact Book of Agriculture, 1989. (See tables VII.1 through VII.5.)

Table VII.1: Forecast and Actual Commodity-Export Data, Crop Years 1975-88

Commodity	Crop year	Year 5	Year 4	Year 3	Year 2	Year 1	Actual
Soybeans[a]	1975	[b]	[b]	[b]	[b]	570,000	555,094
	1976	[b]	[b]	[b]	600,000	500,000	564,072
	1977	[b]	[b]	630,000	525,000	545,000	700,452
	1978	[b]	655,000	550,000	565,000	635,000	739,154
	1979	[b]	570,000	590,000	685,000	750,000	875,173
	1980	[b]	610,000	705,000	760,000	810,000	724,201
	1981	625,000	710,000	780,000	820,000	875,000	929,080
	1982	710,000	800,000	830,000	900,000	860,000	905,158
	1983	810,000	840,000	925,000	875,000	960,000	742,760
	1984	850,000	950,000	890,000	[b]	900,000	598,174
	1985	975,000	[b]	[b]	950,000	811,000	740,672
	1986	[b]	[b]	990,000	843,000	735,000	757,000
	1987	[b]	1,030,000	878,000	765,000	780,000	802,000
	1988	1,070,000	920,000	790,000	800,000	745,000	530,000
Cotton[c]	1975	[b]	[b]	[b]	[b]	5,000	3,300
	1976	[b]	[b]	[b]	4,800	4,500	4,779
	1977	[b]	[b]	5,000	4,200	4,500	5,459
	1978	[b]	4,800	4,700	4,300	5,100	6,150

(continued)

Commodity	Crop year	Year 5	Year 4	Year 3	Year 2	Year 1	Actual
	1979	[b]	4,500	4,600	4,600	5,500	9,177
	1980	[b]	4,700	4,400	5,000	6,400	5,893
	1981	4,400	4,700	5,000	6,000	6,700	6,555
	1982	4,400	5,200	5,500	7,000	7,500	5,194
	1983	5,200	5,200	7,000	7,400	6,300	6,750
	1984	5,000	7,000	7,300	6,400	5,000	6,125
	1985	6,800	[b]	6,500	5,200	5,800	1,855
	1986	[b]	6,800	5,400	5,400	5,500	6,570
	1987	7,000	5,400	5,700	6,000	6,400	6,345
	1988	5,400	6,000	6,500	6,600	6,600	5,946
Corn[a]	1975	[b]	[b]	[b]	[b]	1,150,000	1,711,000
	1976	[b]	[b]	[b]	1,275,000	1,400,000	1,684,000
	1977	[b]	[b]	1,400,000	1,475,000	1,400,000	1,948,000
	1978	[b]	1,525,000	1,600,000	1,500,000	1,575,000	2,133,000
	1979	[b]	1,725,000	1,600,000	1,625,000	1,975,000	2,433,000
	1980	[b]	1,700,000	1,725,000	2,075,000	2,475,000	2,355,000
	1981	1,800,000	1,800,000	2,150,000	2,475,000	2,700,000	1,967,000
	1982	1,875,000	2,250,000	2,525,000	2,800,000	2,300,000	1,870,000
	1983	2,325,000	2,575,000	2,900,000	2,400,000	2,225,000	1,865,000
	1984	2,650,000	3,025,000	2,600,000	2,300,000	2,150,000	1,865,000
	1985	3,175,000	[b]	2,400,000	2,235,000	1,900,000	1,241,000
	1986	[b]	2,450,000	2,350,000	1,950,000	1,875,000	1,504,000
	1987	2,525,000	2,450,000	2,000,000	2,075,000	1,500,000	1,732,000
	1988	2,550,000	2,050,000	2,250,000	1,600,000	1,750,000	2,060,000
Wheat[a]	1975	[b]	[b]	[b]	[b]	1,100,000	1,173,000
	1976	[b]	[b]	[b]	1,125,000	1,200,000	950,000
	1977	[b]	[b]	1,150,000	1,225,000	1,225,000	1,124,000
	1978	[b]	1,175,000	1,250,000	1,250,000	1,050,000	1,194,000
	1979	[b]	1,275,000	1,275,000	1,065,000	1,130,000	1,375,000
	1980	[b]	1,300,000	1,100,000	1,175,000	1,300,000	1,514,000
	1981	1,325,000	1,140,000	1,175,000	1,325,000	1,580,000	1,771,000
	1982	1,175,000	1,215,000	1,375,000	1,615,000	1,725,000	1,509,000
	1983	1,215,000	1,400,000	1,650,000	1,725,000	1,525,000	1,429,000
	1984	1,450,000	1,690,000	1,755,000	1,560,000	1,500,000	1,424,000
	1985	1,690,000	1,790,000	1,600,000	1,550,000	1,350,000	915,000
	1986	[b]	1,635,000	1,600,000	1,350,000	1,200,000	1,004,000
	1987	1,675,000	1,650,000	1,375,000	1,400,000	1,100,000	1,592,000
	1988	1,700,000	1,400,000	1,550,000	1,200,000	1,350,000	1,424,000

[a]Thousands of bushels

[b]Forecast data not available or no forecast made

[c]Thousands of bales

Table VII.2: Forecast and Actual Price Data, Crop Years 1975-88[a]

Commodity	Crop year	Year 5	Year 4	Year 3	Year 2	Year 1	Actual
Soybeans[b]	1975	[c]	[c]	[c]	[c]	$7.00	$5.00
	1976	[c]	[c]	[c]	$6.00	4.25	6.81
	1977	[c]	[c]	$5.00	4.25	5.50	5.88
	1978	[c]	$5.00	4.50	5.25	4.30	6.66
	1979	[c]	4.75	5.00	4.60	6.10	6.28
	1980	[c]	5.25	5.00	6.10	6.35	7.57
	1981	$5.35	5.00	6.10	6.75	9.00	6.04
	1982	7.00	6.25	7.50	9.65	6.50	5.69
	1983	6.50	8.00	10.30	6.60	6.00	7.81
	1984	8.25	11.00	7.25	[c]	7.25	5.78
	1985	11.75	[c]	[c]	6.50	6.15	5.05
	1986	[c]	[c]	6.65	5.80	5.00	4.78
	1987	[c]	7.25	6.00	5.20	4.70	5.88
	1988	7.75	5.75	5.35	4.70	5.65	7.35
Corn[b]	1975	[c]	[c]	[c]	[c]	3.00	2.55
	1976	[c]	[c]	[c]	2.25	2.25	2.15
	1977	[c]	[c]	2.00	2.00	2.20	2.02
	1978	[c]	2.00	1.90	2.05	2.00	2.25
	1979	[c]	1.95	1.90	2.10	2.20	2.52
	1980	[c]	1.95	2.20	2.30	2.60	3.11
	1981	2.00	2.25	2.35	2.75	3.60	2.50
	1982	2.35	2.40	2.95	3.80	2.60	2.68
	1983	2.50	3.20	4.00	2.75	2.60	3.25
	1984	3.40	4.30	2.90	2.65	2.75	2.62
	1985	4.65	[c]	2.45	2.58	2.60	2.23
	1986	[c]	2.40	2.40	2.55	2.00	1.50
	1987	2.40	2.40	2.55	1.95	1.65	1.94
	1988	2.40	2.55	2.00	1.70	1.83	2.54
Wheat[b]	1975	[c]	[c]	[c]	[c]	3.50	3.52
	1976	[c]	[c]	[c]	2.75	3.25	2.73
	1977	[c]	[c]	2.75	2.90	2.60	2.33
	1978	[c]	2.50	2.65	2.50	2.45	2.98
	1979	[c]	2.55	2.40	2.60	2.98	3.78
	1980	[c]	2.50	2.65	2.92	3.60	3.91
	1981	2.60	2.65	2.83	3.85	4.40	3.65
	1982	2.60	2.86	4.00	4.85	3.70	3.55
	1983	2.89	4.25	5.35	3.90	3.60	3.53
	1984	4.50	5.80	4.10	3.55	3.25	3.38
	1985	6.35	4.35	3.45	3.30	3.30	3.08

(continued)

Commodity	Crop year	Year 5	Year 4	Year 3	Year 2	Year 1	Actual
	1986	4.65	3.60	3.35	3.30	2.55	2.42
	1987	3.75	3.40	3.35	2.45	2.20	2.57
	1988	3.40	3.25	2.60	2.30	2.70	3.72
Dairy	1975	[c]	[c]	[c]	[c]	8.60	9.16
products[d]	1976	[c]	[c]	[c]	9.15	9.00	9.63
	1977	[c]	[c]	9.45	9.00	9.50	10.23
	1978	[c]	9.70	9.45	9.75	10.65	11.74
	1979	[c]	10.10	10.40	11.00	12.10	12.76
	1980	[c]	11.15	11.75	12.70	14.45	13.74
	1981	11.85	13.15	13.75	15.70	15.15	13.62
	1982	13.60	15.30	17.55	16.95	13.85	13.58
	1983	16.05	19.55	19.50	14.75	13.65	13.38
	1984	21.80	21.75	15.50	14.75	13.35	13.11
	1985	23.75	[c]	15.90	12.75	12.49	12.31
	1986	[c]	17.00	13.20	12.65	12.85	12.63
	1987	18.20	13.50	12.65	[c]	12.10	12.08
	1988	13.75	12.65	[c]	11.50	11.50	12.95

[a]We did not report specific cotton price forecasts because 12 U.S.C. 1141j(d) prohibits forecast publication. Error rate measures, however, do not divulge specific forecasts and can therefore be reported.

[b]Price per bushel

[c]Forecast not available or no forecast made

[d]Price per pound of milk equivalent

Table VII.3: Forecast and Actual Production Data, Crop Years 1975-88

Commodity	Crop year	Year 5	Year 4	Year 3	Year 2	Year 1	Actual
Soybeans[a]	1975	[b]	[b]	[b]	[b]	1,510,000	1,521,370
	1976	[b]	[b]	[b]	1,580,000	1,400,000	1,287,560
	1977	[b]	[b]	1,625,000	1,410,000	1,525,000	1,761,755
	1978	[b]	1,670,000	1,425,000	1,570,000	1,655,000	1,870,181
	1979	[b]	1,470,000	1,580,000	1,650,000	1,880,000	2,267,901
	1980	[b]	1,595,000	1,665,000	1,880,000	2,005,000	1,792,062
	1981	1,640,000	1,665,000	1,910,000	1,975,000	2,100,000	2,000,145
	1982	1,680,000	1,920,000	2,000,000	2,150,000	2,080,000	2,190,297
	1983	1,980,000	2,045,000	2,180,000	2,075,000	2,110,000	1,635,772
	1984	2,150,000	2,215,000	2,070,000	[b]	2,225,000	1,860,863
	1985	2,255,000	[b]	[b]	2,282,000	2,060,000	2,098,531
	1986	[b]	[b]	2,275,000	2,061,000	1,880,000	1,940,000
	1987	[b]	2,266,000	2,031,000	1,925,000	1,915,000	1,923,000
	1988	2,340,000	2,063,000	1,970,000	1,950,000	1,900,000	1,548,000
Cotton[c]	1975	[b]	[b]	[b]	[b]	11,444	8,247
	1976	[b]	[b]	[b]	11,650	11,200	10,517
	1977	[b]	[b]	10,750	11,200	11,700	14,277
	1978	[b]	11,450	10,800	11,000	11,700	10,762
	1979	[b]	11,200	11,200	10,800	12,900	14,531
	1980	[b]	11,500	11,200	11,800	12,800	11,018
	1981	11,500	11,200	11,200	12,900	13,200	15,566
	1982	11,200	11,400	12,000	13,600	11,900	11,864
	1983	11,500	11,200	13,500	13,300	12,500	7,677
	1984	11,400	13,600	13,500	10,400	11,500	12,852
	1985	13,100	[b]	12,700	10,900	11,100	13,277
	1986	[b]	12,800	11,200	10,800	11,400	9,525
	1987	12,900	11,100	10,500	11,700	11,700	14,475
	1988	11,100	10,600	11,900	13,300	13,800	15,077
Corn[a]	1975	[b]	[b]	[b]	[b]	6,394,000	5,767,000
	1976	[b]	[b]	[b]	6,596,000	6,348,000	6,266,000
	1977	[b]	[b]	6,667,000	6,486,000	6,300,000	6,425,000
	1978	[b]	6,801,000	6,672,000	6,437,000	6,302,000	7,087,000
	1979	[b]	6,790,000	6,542,000	6,112,000	6,336,000	7,939,000
	1980	[b]	6,674,000	6,592,000	6,743,000	7,130,000	6,645,000
	1981	6,814,000	6,793,000	6,872,000	7,334,000	7,725,000	8,202,000
	1982	6,912,000	7,003,000	7,410,000	8,008,000	7,723,000	8,235,000
	1983	7,078,000	7,486,000	8,282,000	7,948,000	7,659,000	4,175,000
	1984	7,437,000	8,439,000	8,096,000	7,347,000	8,270,000	7,674,000
	1985	8,651,000	[b]	8,389,000	8,327,000	7,810,000	8,877,000

(continued)

Commodity	Crop year	Year 5	Year 4	Year 3	Year 2	Year 1	Actual
	1986	[b]	8,468,000	8,343,000	7,875,000	7,661,000	8,250,000
	1987	8,544,000	8,451,000	7,878,000	7,689,000	7,230,000	7,072,000
	1988	8,630,000	8,015,000	7,735,000	7,915,000	7,350,000	4,921,000
Wheat[a]	1975	[b]	[b]	[b]	[b]	2,115,000	2,134,000
	1976	[b]	[b]	[b]	2,138,000	2,155,000	2,142,000
	1977	[b]	[b]	2,086,000	2,143,000	2,200,000	2,036,000
	1978	[b]	2,061,000	2,160,000	2,193,000	1,900,000	1,798,000
	1979	[b]	2,168,000	2,191,000	1,680,000	1,865,000	2,134,000
	1980	[b]	2,172,000	1,740,000	2,000,000	2,229,000	2,374,000
	1981	2,175,000	1,856,000	2,030,000	2,255,000	2,554,000	2,799,000
	1982	1,918,000	1,985,000	2,300,000	2,527,000	2,630,000	2,765,000
	1983	1,990,000	2,338,000	2,570,000	2,630,000	2,380,000	2,420,000
	1984	2,308,000	2,617,000	2,635,000	2,395,000	2,820,000	2,595,000
	1985	2,670,000	2,645,000	2,710,000	2,825,000	2,550,000	2,425,000
	1986	[b]	2,715,000	2,793,000	2,658,000	2,504,000	2,092,000
	1987	2,755,000	2,710,000	2,702,000	2,460,000	2,292,000	2,107,000
	1988	2,700,000	2,747,000	2,424,000	2,345,000	2,100,000	1,811,000
Dairy	1975	[b]	[b]	[b]	[b]	115,300	116,300
products[d]	1976	[b]	[b]	[b]	116,000	116,900	122,500
	1977	[b]	[b]	117,000	117,600	120,900	122,000
	1978	[b]	118,000	118,200	121,200	123,800	122,600
	1979	[b]	118,600	121,000	123,000	124,000	127,300
	1980	[b]	120,000	122,000	125,500	125,000	131,700
	1981	120,300	122,500	126,000	126,500	128,700	135,000
	1982	125,000	126,700	128,000	128,500	135,500	139,000
	1983	128,500	129,000	130,000	133,500	136,400	136,800
	1984	129,500	131,000	131,500	135,500	134,500	140,500
	1985	132,000	[b]	136,000	133,000	137,500	145,600
	1986	[b]	137,000	133,000	136,000	139,200	141,400
	1987	138,500	134,500	137,000	[b]	143,900	144,900
	1988	136,000	138,500	[b]	146,000	146,000	145,600

[a]Thousands of bushels

[b]Forecast not available or no forecast made

[c]Thousands of bales

[d]Millions of pounds of milk equivalent

Table VII.4: Forecast and Actual Ending-Stock Data, Crop Years 1975-88

Commodity	Crop year	Year 5	Year 4	Year 3	Year 2	Year 1	Actual
Soybeans[a]	1975	[b]	[b]	[b]	[b]	85,000	243,546
	1976	[b]	[b]	[b]	115,000	385,000	102,916
	1977	[b]	[b]	130,000	360,000	130,000	161,044
	1978	[b]	140,000	305,000	175,000	305,000	174,402
	1979	[b]	255,000	170,000	285,000	205,000	358,768
	1980	[b]	145,000	235,000	210,000	410,000	318,305
	1981	125,000	160,000	205,000	350,000	215,000	266,173
	1982	80,000	170,000	275,000	245,000	380,000	344,634
	1983	165,000	205,000	265,000	365,000	360,000	175,696
	1984	210,000	275,000	305,000	[b]	285,000	316,057
	1985	265,000	[b]	[b]	394,000	341,000	536,365
	1986	[b]	[b]	419,000	419,000	525,000	436,000
	1987	[b]	372,000	408,000	450,000	565,000	302,000
	1988	332,000	352,000	370,000	515,000	205,000	182,000
Cotton[c]	1975	[b]	[b]	[b]	[b]	5,500	3,615
	1976	[b]	[b]	[b]	5,800	3,900	2,879
	1977	[b]	[b]	5,000	4,200	3,800	5,278
	1978	[b]	5,300	3,800	3,900	5,700	3,905
	1979	[b]	4,100	3,700	4,700	5,400	2,962
	1980	[b]	3,800	4,600	6,100	5,200	2,614
	1981	4,100	4,200	6,100	5,700	3,100	6,567
	1982	4,400	6,000	5,800	3,600	4,400	7,844
	1983	5,900	5,300	3,800	4,100	8,600	2,693
	1984	5,200	4,100	4,100	4,200	4,700	4,024
	1985	4,100	[b]	4,600	4,700	5,100	9,289
	1986	[b]	4,800	4,900	5,400	8,600	4,942
	1987	4,900	5,100	5,300	7,700	3,800	5,718
	1988	5,400	5,200	6,300	3,700	4,200	7,027
Corn[a]	1975	[b]	[b]	[b]	[b]	760,000	399,000
	1976	[b]	[b]	[b]	1,162,000	1,078,000	884,000
	1977	[b]	[b]	1,340,000	1,290,000	954,000	1,104,000
	1978	[b]	1,367,000	1,363,000	1,152,000	1,445,000	1,286,000
	1979	[b]	1,294,000	1,215,000	1,233,000	1,257,000	1,617,000
	1980	[b]	1,190,000	1,201,000	1,216,000	1,178,000	1,034,000
	1981	1,145,000	1,145,000	1,109,000	1,058,000	535,000	2,286,000
	1982	1,033,000	963,000	894,000	579,000	2,325,000	3,120,000
	1983	747,000	686,000	612,000	2,559,000	3,647,000	723,000
	1984	534,000	577,000	2,591,000	2,482,000	1,503,000	1,648,000
	1985	594,000	[b]	2,847,000	2,171,000	1,676,000	4,040,000

(continued)

Commodity	Crop year	Year 5	Year 4	Year 3	Year 2	Year 1	Actual
	1986	[b]	3,091,000	2,490,000	2,037,000	3,259,000	4,882,000
	1987	3,211,000	2,542,000	2,251,000	3,111,000	5,890,000	4,259,000
	1988	2,623,000	2,457,000	2,722,000	6,646,000	3,826,000	1,930,000
Wheat[a]	1975	[b]	[b]	[b]	[b]	427,000	664,000
	1976	[b]	[b]	[b]	578,000	537,000	1,112,000
	1977	[b]	[b]	648,000	629,000	1,103,000	1,177,000
	1978	[b]	663,000	703,000	1,200,000	1,277,000	925,000
	1979	[b]	749,000	1,249,000	1,140,000	1,009,000	902,000
	1980	[b]	1,242,000	1,025,000	1,050,000	958,000	989,000
	1981	1,200,000	1,003,000	1,107,000	1,048,000	1,017,000	1,164,000
	1982	1,005,000	1,080,000	1,112,000	1,061,000	1,073,000	1,515,000
	1983	1,059,000	1,163,000	1,109,000	1,131,000	1,506,000	1,399,000
	1984	1,124,000	1,159,000	1,165,000	1,483,000	1,760,000	1,425,000
	1985	1,257,000	1,174,000	1,712,000	2,038,000	1,609,000	1,905,000
	1986	[b]	1,884,000	2,244,000	1,940,000	1,903,000	1,821,000
	1987	2,061,000	2,317,000	2,265,000	1,869,000	1,938,000	1,261,000
	1988	2,325,000	2,580,000	1,661,000	1,999,000	995,000	698,000
Dairy	1975	[b]	[b]	[b]	[b]	2,200	900
products[d]	1976	[b]	[b]	[b]	1,700	2,100	6,900
	1977	[b]	[b]	2,100	3,100	3,500	3,200
	1978	[b]	2,400	3,300	3,500	5,800	1,100
	1979	[b]	3,300	2,600	3,700	2,500	8,200
	1980	[b]	1,500	1,600	3,500	2,300	12,700
	1981	1,400	1,000	2,900	2,500	5,500	13,800
	1982	3,000	1,500	2,800	4,400	11,300	16,600
	1983	2,800	2,700	4,100	7,800	10,200	10,400
	1984	2,100	3,900	4,400	9,200	7,700	11,500
	1985	3,400	[b]	8,600	3,400	8,000	12,300
	1986	[b]	8,400	1,600	6,600	7,300	5,400
	1987	7,800	1,900	5,700	[b]	5,700	9,700
	1988	2,200	5,600	[b]	6,200	4,600	9,200

[a]Thousands of bushels

[b]Forecast not available or no forecast made

[c]Thousands of bales

[d]Millions of pounds of milk equivalent

Table VII.5: Forecast and Actual Domestic-Use Data, Crop Years 1975-88

Commodity	Crop year	Year 5	Year 4	Year 3	Year 2	Year 1	Actual
Soybeans[a]	1975	[b]	[b]	[b]	[b]	915,000	907,766
	1976	[b]	[b]	[b]	950,000	890,000	865,503
	1977	[b]	[b]	980,000	910,000	935,000	1,003,175
	1978	[b]	1,005,000	930,000	960,000	965,000	1,117,669
	1979	[b]	950,000	995,000	985,000	1,090,000	1,208,048
	1980	[b]	1,010,000	1,010,000	1,115,000	1,185,000	1,108,324
	1981	1,035,000	1,030,000	1,135,000	1,215,000	1,190,000	1,123,197
	1982	1,050,000	1,155,000	1,245,000	1,220,000	1,190,000	1,206,678
	1983	1,175,000	1,275,000	1,235,000	1,215,000	1,220,000	1,061,950
	1984	1,295,000	1,255,000	1,240,000	[b]	1,180,000	1,122,828
	1985	1,290,000	[b]	[b]	1,223,000	1,123,000	1,137,551
	1986	[b]	[b]	1,260,000	1,140,000	1,200,000	1,283,000
	1987	[b]	1,283,000	1,164,000	1,235,000	1,185,000	1,255,000
	1988	1,310,000	1,196,000	1,260,000	1,200,000	1,285,000	1,138,000
Cotton[c]	1975	[b]	[b]	[b]	[b]	6,400	7,160
	1976	[b]	[b]	[b]	6,600	6,900	6,595
	1977	[b]	[b]	6,600	6,900	6,500	6,442
	1978	[b]	6,400	6,700	6,800	7,300	6,286
	1979	[b]	6,600	7,000	7,400	6,200	6,441
	1980	[b]	6,900	7,100	6,300	6,500	5,828
	1981	7,000	7,100	6,400	6,500	6,100	5,214
	1982	6,800	6,500	6,500	6,200	6,000	5,457
	1983	6,600	6,600	6,400	6,300	5,600	5,861
	1984	6,600	6,400	6,300	5,800	5,830	5,491
	1985	6,400	[b]	5,900	5,800	4,900	6,338
	1986	[b]	5,900	5,700	5,200	6,300	7,385
	1987	5,900	5,600	5,000	6,700	7,000	7,565
	1988	5,500	4,800	6,900	6,900	7,400	7,721
Corn[a]	1975	[b]	[b]	[b]	[b]	4,760,000	4,018,000
	1976	[b]	[b]	[b]	4,920,000	4,545,000	4,100,000
	1977	[b]	[b]	5,090,000	4,800,000	4,525,000	4,260,000
	1978	[b]	5,250,000	5,000,000	4,740,000	4,525,000	4,773,000
	1979	[b]	5,135,000	4,880,000	4,700,000	4,640,000	5,194,000
	1980	[b]	5,000,000	4,900,000	4,710,000	4,910,000	4,874,000
	1981	5,060,000	5,050,000	4,830,000	4,980,000	5,035,000	4,984,000
	1982	5,150,000	4,900,000	5,050,000	5,165,000	5,125,000	5,420,000
	1983	4,970,000	5,120,000	5,350,000	5,315,000	5,285,000	4,709,000
	1984	4,940,000	5,450,000	5,465,000	5,450,000	5,130,000	5,171,000
	1985	5,460,000	[b]	5,625,000	5,425,000	5,360,000	5,255,000

(continued)

Commodity	Crop year	Year 5	Year 4	Year 3	Year 2	Year 1	Actual
	1986	[b]	5,775,000	5,675,000	5,565,000	5,580,000	5,906,000
	1987	5,900,000	5,950,000	5,665,000	5,740,000	5,455,000	5,967,000
	1988	6,000,000	5,760,000	5,875,000	5,560,000	6,100,000	5,195,000
Wheat[a]	1975	[b]	[b]	[b]	[b]	815,000	729,000
	1976	[b]	[b]	[b]	863,000	817,000	748,000
	1977	[b]	[b]	867,000	827,000	821,000	849,000
	1978	[b]	872,000	837,000	847,000	757,000	857,000
	1979	[b]	848,000	868,000	754,000	765,000	783,000
	1980	[b]	880,000	757,000	786,000	824,000	776,000
	1981	893,000	740,000	800,000	842,000	866,000	856,000
	1982	743,000	799,000	863,000	870,000	867,000	908,000
	1983	798,000	889,000	874,000	849,000	860,000	1,111,000
	1984	899,000	879,000	848,000	860,000	1,037,000	1,154,000
	1985	884,000	848,000	883,000	1,000,000	975,000	1,046,000
	1986	[b]	910,000	990,000	980,000	1,148,000	1,193,000
	1987	905,000	990,000	1,005,000	1,099,000	1,095,000	1,092,000
	1988	995,000	1,035,000	1,087,000	1,089,000	1,057,000	973,000
Dairy	1975	[b]	[b]	[b]	[b]	112,400	114,700
products[d]	1976	[b]	[b]	[b]	113,600	113,000	115,400
	1977	[b]	[b]	114,400	113,400	116,200	118,900
	1978	[b]	115,200	113,900	116,500	117,200	120,000
	1979	[b]	114,400	117,300	118,500	120,700	119,300
	1980	[b]	117,500	119,700	121,500	122,900	119,800
	1981	118,000	120,900	122,700	124,100	123,100	122,000
	1982	121,500	124,900	125,300	124,300	124,100	122,100
	1983	125,500	126,600	126,200	126,000	125,800	126,300
	1984	127,900	127,500	127,500	126,400	127,000	129,300
	1985	129,100	[b]	127,700	129,800	129,500	133,400
	1986	[b]	129,000	131,700	129,500	132,400	136,100
	1987	130,700	133,000	131,500	[b]	138,700	136,000
	1988	134,300	133,200	[b]	140,500	141,500	136,100

[a]Thousands of bushels

[b]Forecast not available or no forecast made

[c]Thousands of bales

[d]Millions of pounds of milk equivalent

Baseline Error Rates by Commodity and by Supply and Utilization Variables

This appendix contains crop year 1981-88 forecast error statistical measures for supply and utilization forecasts. We use three bias error measures: mean percentage error (MPE), trimmed mean percentage error (TMPE), and the weighted mean percentage error (WMPE). We use three total error measures: mean absolute percentage error (MAPE), adjusted mean absolute percentage error (AMAPE), and root mean squared percentage error (RMSPE). (See appendix IX for a discussion of these measures.)

Table VIII.1: MPE Rates by Out-Year, Crop Years 1981-88

Commodity	Variable	Year 1	Year 2	Year 3	Year 4	Year 5	Overall
Soybeans	Exports	−14.16%	−13.06%	−19.75%	−23.12%	−21.73%	−18.00%
	Price	−6.09	−9.76	−14.87	−14.48	−29.28	−14.22
	Production	−8.24	−9.26	−11.64	−11.01	−8.98	−9.77
	Ending stocks	−21.23	−44.55	−19.81	−4.95	22.94	−15.07
	Domestic use	−3.02	−3.42	−4.66	−4.43	−5.61	−4.14
Cotton	Exports	−28.73	−26.06	−29.60	6.76	−25.46	−21.21
	Price	−2.05	−12.27	−14.88	−18.99	−20.56	−13.74
	Production	−1.63	−2.02	−2.34	−0.16	4.54	−0.45
	Ending stocks	−11.82	7.94	7.39	0.08	3.78	1.45
	Mill use	2.54	1.09	1.06	−0.08	−5.98	−0.13
Corn	Exports	−18.02	−29.35	−39.20	−30.85	−40.56	−31.38
	Price	−4.13	−11.34	−14.74	−18.03	−14.44	−11.01
	Production	−13.95	−16.45	−17.73	−20.31	−18.16	−17.22
	Ending stocks	−42.29	−35.28	20.70	34.12	36.44	1.03
	Domestic use	−1.54	−1.77	−2.57	−2.03	−2.27	−2.03
Wheat	Exports	−5.82	−11.02	−15.70	−15.25	−6.98	−11.05
	Price	0.80	−7.28	−14.22	−19.35	−24.39	−12.89
	Production	−5.37	−7.84	−8.85	−6.84	−1.17	−6.14
	Ending stocks	−9.32	−24.14	−20.03	−30.05	−26.65	−21.92
	Domestic use	4.72	8.07	11.02	14.37	13.50	10.26
Dairy products	All milk prices	−1.16	−7.91	18.94	−27.93	−31.88	−16.27
	Production	2.41	4.57	6.28	6.53	7.89	5.45
	Net removals	27.26	43.85	60.87	55.40	70.66	50.27
	Domestic use	−0.08	0.17	0.80	1.33	1.99	0.97

Table VIII.2: TMPE Rates by Out-Year, Crop Years 1981-88[a]

Commodity	Variable	Year 1	Year 2	Year 3	Year 4	Year 5	Overall
Soybeans	Exports	−11.45%	−10.45%	−21.05%	−22.18%	−15.31%	−16.97%
	Price	−3.81	−6.95	−18.43	−4.59	−14.94	−12.09
	Production	−6.99	−7.96	−11.38	−12.39	−6.51	−9.51
	Ending stocks	−16.89	−31.56	−11.67	3.26	35.82	−12.69
	Domestic use	−2.62	−4.13	−4.72	−3.70	−7.83	−4.18
Cotton	Exports	−5.92	−7.66	−1.69	6.67	11.10	−21.21
	Price	1.86	−13.37	−15.10	−13.85	−14.24	−12.68
	Production	5.10	6.31	4.85	3.01	11.05	0.91
	Ending stocks	11.99	10.27	8.30	12.26	17.94	4.85
	Mill use	2.44	0.64	−0.45	−0.44	−7.28	−1.56
Corn	Exports	−17.69	−29.50	−35.16	−32.31	−27.32	−29.42
	Price	−2.83	−8.96	−13.19	−14.51	−3.13	−10.93
	Production	−6.70	−8.63	−9.95	−16.00	−13.73	−17.48
	Ending stocks	−1.75	−18.29	25.25	39.40	41.14	9.93
	Domestic use	−0.58	−1.18	−2.29	−2.59	−1.08	−1.88
Wheat	Exports	−4.98	−7.33	−14.07	−10.33	2.14	−10.03
	Price	−0.08	−9.97	−15.38	−18.44	−19.62	−11.78
	Production	−5.34	−8.78	−10.74	−6.12	2.05	−4.62
	Ending stocks	−8.34	−6.11	−8.14	−1.52	2.51	−18.65
	Domestic use	3.96	8.50	12.23	16.25	14.12	8.84
Dairy products	All milk prices	−1.53	−8.35	−17.17	−26.28	−28.65	−14.87
	Production	2.33	4.73	6.21	6.67	7.98	5.46
	Net removals	32.18	50.87	62.58	70.13	77.04	52.13
	Commercial use	0.06	−0.15	1.49	1.28	1.91	0.99

[a]TMPE is used in USDA programs for calculating yields for program payment purposes. When using TMPE calculations for forecast evaluation, it is possible that two large errors, one positive and one negative, will be deleted. This produces a different intended effect, however, when exclusively positive values are used.

Table VIII.3: WMPE Rates by Out-Year, Crop Years 1981-88

Commodity	Variable	Year 1	Year 2	Year 3	Year 4	Year 5	Overall
Soybeans	Exports	−11.01%	−10.10%	−15.55%	−16.48%	−13.36%	−13.12%
	Price	−3.87	−6.10	−13.43	−12.19	−23.54	−11.34
	Production	−7.06	−8.12	−10.21	−9.10	−6.28	−8.14
	Ending stocks	−12.39	−22.08	−11.10	3.31	35.36	−3.32
	Domestic use	−2.62	−2.96	−4.25	−4.15	−5.37	−3.77
Cotton	Exports	−9.84	−10.28	−7.85	7.32	1.47	−4.09
	Price	−1.32	−11.81	−15.25	−18.31	−19.46	−13.25
	Production	3.20	3.40	3.80	5.90	8.91	4.94
	Ending stocks	11.65	18.72	14.98	10.60	21.23	15.51
	Domestic use	3.73	3.20	3.79	4.01	−2.64	2.53
Corn	Exports	−16.28	−26.45	−35.95	−29.05	−34.13	−28.23
	Price	−1.92	−7.63	−12.15	−14.50	−10.92	−9.28
	Production	−7.01	−8.77	−9.75	−12.62	−9.99	−9.52
	Ending stocks	0.99	9.81	32.21	39.19	45.09	24.02
	Domestic use	−1.09	−1.39	−2.18	−1.75	−2.12	−1.69
Wheat	Exports	−2.37	−5.94	−9.14	−7.70	−1.65	−5.43
	Price	0.77	−6.18	−12.08	−16.45	−11.12	−8.97
	Production	−4.29	−5.69	−6.05	−3.15	2.40	−3.48
	Ending stocks	−5.48	−12.34	−10.61	−10.48	−7.09	−9.27
	Domestic use	5.14	8.93	11.80	14.92	14.33	10.92
Dairy products	All milk prices	−1.23	−8.16	−19.12	−23.59	−30.73	−12.26
	Production	2.40	4.56	6.28	6.51	7.86	5.43
	Net removals	32.17	49.37	62.23	67.36	72.81	58.23
	Domestic use	−0.08	0.52	1.39	1.41	2.01	1.02

Table VIII.4: MAPE Rates by Out-Year, Crop Years 1981-88

Commodity	Variable	Year 1	Year 2	Year 3	Year 4	Year 5	Overall
Soybeans	Exports	18.28%	17.90%	26.71%	34.85%	39.83%	26.66%
	Price	22.68	27.79	22.64	27.48	38.68	27.39
	Production	10.83	10.14	15.41	20.71	22.75	15.48
	Ending stocks	37.60	61.51	34.26	39.47	50.41	44.42
	Domestic use	6.69	7.06	7.25	8.62	12.56	8.26
Cotton	Exports	39.06	33.99	42.52	12.14	53.65	36.45
	Price	21.90	21.18	22.44	23.67	27.05	23.16
	Production	19.07	23.29	22.57	24.44	18.77	21.63
	Ending stocks	65.72	33.08	18.14	28.28	46.16	38.33
	Mill use	10.82	13.94	17.51	24.05	20.49	17.10
Corn	Exports	25.13	34.93	39.20	33.42	42.99	34.97
	Price	20.60	23.45	21.55	24.32	31.84	24.21
	Production	21.75	23.53	25.66	29.49	29.19	25.75
	Ending stocks	92.95	101.94	45.26	41.92	47.65	67.06
	Domestic use	6.63	5.36	7.29	5.49	5.29	6.04
Wheat	Exports	17.54	24.27	29.74	29.95	24.77	25.27
	Price	10.62	17.99	27.36	34.22	44.95	24.59
	Production	9.19	16.78	19.92	23.16	24.53	18.57
	Ending stocks	23.65	38.91	40.18	59.16	58.96	43.79
	Domestic use	7.24	11.21	13.95	15.97	15.38	12.68
Dairy products	All milk prices	3.95	11.11	18.94	29.08	35.59	18.55
	Production	2.48	4.65	6.28	6.94	7.89	5.48
	Net removals	36.05	46.80	60.87	73.39	70.66	56.55
	Commercial use	2.04	2.42	2.21	2.05	1.99	2.14

Table VIII.5: AMAPE Rates by Out-Year, Crop Years 1981-88

Commodity	Variable	Year 1	Year 2	Year 3	Year 4	Year 5	Overall
Soybeans	Exports	15.68%	15.75%	23.19%	29.25%	33.59%	22.79%
	Prices	21.75	25.74	20.68	23.02	28.56	23.78
	Production	9.88	9.19	14.03	19.33	21.26	14.27
	Ending stocks	30.72	42.93	27.78	38.57	61.59	39.46
	Domestic use	6.48	6.91	6.95	8.26	12.17	7.98
Cotton	Exports	24.72	22.80	25.52	13.26	33.68	24.02
	Price	21.49	19.84	20.06	19.65	21.88	20.53
	Production	17.69	21.63	21.21	24.31	18.70	20.66
	Ending stocks	56.38	37.51	20.02	25.99	45.97	37.23
	Mill use	11.14	14.29	18.17	24.87	20.10	17.46
Corn	Exports	22.30	29.36	30.73	27.06	30.28	27.91
	Price	19.84	21.05	19.14	19.91	26.37	21.36
	Production	17.59	18.33	20.19	24.21	23.84	20.66
	Ending stocks	64.62	80.83	54.58	56.16	68.52	65.08
	Domestic use	6.45	5.25	7.09	5.41	5.13	5.90
Wheat	Exports	16.82	21.79	26.04	25.23	21.99	22.38
	Price	11.01	17.60	25.35	29.90	36.45	22.72
	Production	8.78	15.89	18.91	22.29	24.02	17.82
	Ending stocks	21.84	27.41	31.12	39.02	41.66	31.97
	Domestic use	7.67	12.23	15.14	17.54	17.09	13.85
Dairy products	All milk prices	3.95	10.47	16.41	20.77	27.41	15.47
	Production	2.53	4.80	6.49	6.78	8.24	5.68
	Net removals	44.55	68.28	92.13	111.81	116.17	85.42
	Commercial use	2.04	2.41	2.24	2.08	2.02	2.15

Table VIII.6: RMSPE Rates by Out-Year, Crop Years 1981-88

Commodity	Variable	Year 1	Year 2	Year 3	Year 4	Year 5	Overall
Soybeans	Exports	20.82%	19.26%	26.30%	34.22%	40.67%	28.59%
	Price	26.40	33.03	26.72	36.57	48.19	35.42
	Production	13.27	12.63	16.73	20.37	24.11	17.38
	Ending stocks	43.46	53.56	32.98	43.15	59.78	44.85
	Domestic use	7.82	8.16	8.48	9.93	12.88	9.37
Cotton	Exports	30.53	25.85	32.79	16.73	39.86	30.08
	Price	25.02	25.20	26.54	32.83	39.58	30.71
	Production	19.59	22.89	25.60	26.22	21.02	23.25
	Ending stocks	59.33	44.41	31.29	30.13	47.42	44.05
	Mill use	12.31	16.61	20.53	26.88	23.07	20.14
Corn	Exports	25.80	35.39	41.30	38.11	49.09	38.94
	Price	23.82	27.47	22.07	31.02	41.12	30.99
	Production	22.25	24.60	26.22	28.10	28.55	25.61
	Ending stocks	63.91	84.88	53.93	51.65	66.29	63.86
	Domestic use	8.45	6.08	7.86	6.56	6.82	7.22
Wheat	Exports	19.35	24.59	30.44	33.55	26.82	27.59
	Price	14.85	23.80	30.05	37.46	49.84	32.32
	Production	9.80	17.13	21.73	26.53	25.42	21.00
	Ending stocks	25.05	39.07	39.72	59.49	57.71	45.15
	Domestic use	10.33	15.84	16.74	18.08	18.65	16.05
Dairy products	All milk prices	5.93	13.72	24.83	33.91	46.39	28.52
	Production	3.17	5.42	6.34	6.79	8.13	6.11
	Net removals	41.57	64.97	69.91	84.02	78.68	70.36
	Commercial use	2.37	2.83	2.71	2.61	2.42	2.58

Formulas for Measuring Forecast Accuracy

In this appendix, we address how the accuracy of forecasts can be measured, and we discuss formulas for measuring forecast accuracy. The concepts and formulas are drawn from the work of forecasting experts such as Armstrong, Ascher, Makridakis, and Bretschneider, as well as from our previous forecast evaluations.[1] As discussed in the following sections of our report, we use a series of summary error measures to indicate the magnitude of total error and to identify bias error.

The Concept of Error

For a single forecast, the difference between the forecast (F) and the actual (A) value is the error (E); that is, E = A - F. The single forecast error may be positive or negative. It does not have much value for gauging the quality of a forecasting model; however, multiple forecasts made at varied times can be used to show how accurately a forecasting procedure is working. Calculated in this way, negative errors are overestimates, while positive errors are underestimates.

To analyze forecasting methods, the single forecast error can be separated into two parts. One part is called "random error," and it varies unsystematically from one forecast to the next. The other part is called "bias error," and it remains constant for any particular forecasting procedure. For complex models, bias error can come from any of the input variables or component forecasts, and it generally varies with each single forecast in a time series.

The length of the time series or the number of data points affects the statistical validity of the measurements. According to a USDA official, the minimum time period needed for evaluating forecast accuracy may very well be 20 years. However, we do not believe that the evaluation of forecasts can always be put off until there is sufficient time to make statistically accurate measurements. Timely evaluations are needed to improve the forecasts' credibility and to ensure that decision makers get the information they need.

In analyzing error in multiple forecasts, we concentrated on absolute error measures and bias error measures. We refer to the absolute error measures as "total error," which is the sum of random and bias error. It

[1] J. Scott Armstrong, Long-Range Forecasting: From Crystal Ball to Computer, 2nd ed. (New York: John Wiley and Sons, 1985); William Ascher, Forecasting: An Appraisal for Policymakers and Planners (Baltimore: John Hopkins University Press, 1978); Spyros Makridakis, et al., The Forecasting Accuracy of Major Time-Series Methods (New York: John Wiley and Sons, 1984); Stuart Bretschneider, personal communication, and "Forecasting: Some New Realities," Metropolitan Studies Program, Syracuse University, Syracuse, New York, December 1985.

is important to measure bias error because research has shown that its causes can frequently be isolated and corrected.

Measures of Single Forecast Error

The basic error measurements are for one forecast at a time. These measurements stress identifying the deviation between the actual data and the forecast. In all cases, the actual serves as the base, the forecast being deducted. To reiterate, the error (E) is defined as E = A - F, or the difference between A and F.

Individual percentage error (IPE) is defined as IPE = (E/A) X 100, and is the product of the error divided by the actual, multiplied by 100. The measure shows whether the error is negative or positive. The percentage error measurement favors forecasts that are less than the actual, or underestimates. If the forecast is less than the actual, the error cannot exceed 100 percent; however, the percentage error for overestimates has no limits.

Summary Error Measures

The sum of the two components of forecast error—random and bias error—is "total error." Total error is measured with absolute measures (that is, negative and positive signs are not considered). Measurement of the random and bias error components, however, does involve consideration of the negative and positive signs of single errors over time. These two partially offset each other, thus canceling out random error, which is unavoidable, and identifying bias error, which can be reduced. Research has shown that the causes of bias error can frequently be isolated and corrected. Bias error can result from many factors, including problems of design, methodology, measurement instruments, input data, or subjectivity (conscious or unconscious) on the part of the analyst.

In analyzing error in multiple forecasts, we concentrated on total (absolute) error and bias error measures. The first step in developing summary error measures is to subtract the individual forecast from the actual. The difference is the error. For single instances of error, the bias error component cannot be separated from the random component. However, multiple instances of error over time can be used to identify bias error.

To measure total and bias error, we used percentage error measures that express the error (actual minus the forecast) as a percent of actual. Percentage error measures allow comparisons between forecasts of different quantities, such as production and price, as well as comparisons

of forecasts of price over time. Analysis using percent error allows us to give each observation an equal weight. This is important since USDA uses similar forecasting methodology from one year to the next. (Averages calculated using other units, such as dollars or bushels, give greater weight to those years where the units are larger.)

Measures of Total Error

Absolute measures over multiple forecasts show total error. Total, or absolute, error measures over a time series of forecasts ($F_1, F_2, \ldots, F_n$) divided by actual observations ($A_1, A_2, \ldots, A_n$) is referred to as the mean absolute percentage error (MAPE).

MAPE is defined as

$$\text{MAPE} = \left(\frac{\sum_{i=1}^{n} \frac{|E_i|}{A_i}}{n} \right) \times 100$$

or the sum of the absolute percentage errors (absolute error for each forecast divided by actual observations) divided by the number of forecasts. The result is multiplied by 100. MAPE is dimensionless and useful for comparing forecasts from different situations. The measurement favors forecasts that are less than the actual in the sense that a low forecast can never be wrong by more than 100 percent, whereas the percentage error on the high side has no limit.

Adjusted mean absolute percentage error (AMAPE) is defined as

$$\text{AMAPE} = \left[\frac{\sum_{i=1}^{n} \frac{|A_i - F_i|}{\frac{1}{2}(A_i + F_i)}}{n} \right] \times 100$$

Although similar to MAPE, AMAPE does not favor low forecasts. The sum of the absolute error for each period is divided by half the actual plus the forecast. This sum is then divided by the number of periods. The result is multiplied by 100. AMAPE is also less sensitive to measurement error in actual data.

Root mean squared percentage error (RMSPE) is defined as

$$\text{RMSPE} = \left(\frac{\sqrt{\frac{\sum_{i=1}^{n} E_i^2}{n}}}{\frac{\sum_{i=1}^{n} A_i}{n}} \right) \times 100$$

RMSPE is calculated by first taking the square root of the sum of the actual minus the forecast squared divided by the number of observations. This result is then divided by the sum of the actual divided by the number of observations, and the whole is then multiplied by 100.

Measures of Bias Error

Bias error measures identify consistent underestimates and overestimates. It is important to identify bias error because it happens when factors other than the random events are influencing the forecasts. It thus may be possible to make changes in the forecasting process that lessen bias error. However, bias error must be measured over several observations to avoid mistaking it for random error. Bias error measures include mean percentage error, trimmed mean percentage error, and weighted mean percentage error.

Mean percentage error (MPE) is defined as

$$\text{MPE} = \left(\frac{\sum_{i=1}^{n} \frac{E_i}{A_i}}{n} \right) \times 100$$

MPE is the sum of the percentage errors, whether underestimates or overestimates, divided by the number of forecasts and multiplied by 100. The MPE measure favors estimates that are less than the actual. An underestimate can never be wrong by more than 100 percent (when the forecast is not less than 0); however, the percentage error on the high side has no limit.

Trimmed mean percentage error (TMPE) is defined as

$$TMPE = \left(\frac{\sum_{i=1}^{n} \frac{E_i}{A_i}}{n-2} \right) \times 100$$

where the largest and smallest errors are dropped. TMPE is calculated by summing all single-forecast errors, deducting the highest and lowest values, and dividing by the number of forecasts less 2. The product is then multiplied by 100 to arrive at the percentage.

Weighted mean percentage error (WMPE) is defined as

$$WMPE = \left(\frac{\sum_{i=1}^{n} E_i}{\sum_{i=1}^{n} A_i} \right) \times 100$$

WMPE is the sum of the errors, divided by the sum of the actuals, multiplied by 100. WMPE weights each yearly forecast and actual observation by the unit value. This removes some of the bias error inherent in the MPE formula, by reducing the effect of high individual percentage errors on bias error.

USDA January 1990 Budget Submission Outlay Estimates

Net CCC outlay estimate[a]	Fiscal year 1991	1992	1993	1994	1995	January 1990 budget total
Corn						
Deficiency payments	$4,673.6	$6,191.2	$6,627.3	$6,049.1	$5,804.2	$29,345.4
Diversion payments	0.0	0.0	0.0	0.0	0.0	0.0
Storage payments	26.5	123.2	120.6	119.2	116.6	506.1
Net lending	439.5	112.9	(117.4)	(111.1)	21.0	344.9
Other	240.8	253.1	228.4	212.6	200.3	1,135.2
Total	**5,380.4**	**6,680.4**	**6,858.9**	**6,269.8**	**6,142.1**	**31,331.6**
Soybeans						
Deficiency payments	0.0	0.0	0.0	0.0	0.0	0.0
Diversion payments	0.0	0.0	0.0	0.0	0.0	0.0
Loan deficit payments	0.0	0.0	0.0	0.0	0.0	0.0
CCC storage	0.0	0.0	0.0	0.0	0.0	0.0
Net lending	51.7	13.4	(26.9)	(58.2)	(67.3)	(87.3)
Other	0.0	0.0	0.0	0.0	0.0	0.0
Total	**51.7**	**13.4**	**(26.9)**	**(58.2)**	**(67.3)**	**(87.3)**
Wheat						
Deficiency payments	1,984.0	2,524.0	2,502.0	2,442.0	2,401.0	11,852.0
Diversion payments	0.0	0.0	0.0	0.0	0.0	0.0
Storage payments	0.0	0.0	0.0	0.0	0.0	0.0
Net lending	(12.0)	(48.0)	(89.0)	(127.0)	(155.0)	(431.0)
Other	51.0	47.0	36.0	24.0	13.0	171.0
Total	**2,023.0**	**2,523.0**	**2,449.0**	**2,339.0**	**2,259.0**	**11,592.0**
Upland cotton						
Deficiency payments	538.4	544.4	452.2	348.5	255.4	2,138.9
Diversion payments	0.0	0.0	0.0	0.0	0.0	0.0
Storage payments	0.0	0.0	0.0	0.0	0.0	0.0
Net lending	171.5	19.8	(11.6)	6.1	9.9	195.8
Other	0.0	0.0	0.0	0.0	0.0	0.0
Total	**709.9**	**564.3**	**440.7**	**354.6**	**265.3**	**2,334.7**

(continued)

Net CCC outlay estimate[a]	Fiscal year 1991	1992	1993	1994	1995	January 1990 budget total
Total dairy product net expenditures	**617.0**	**487.0**	**317.0**	**226.0**	**298.0**	**1,945.0**
Five program totals						
Deficiency payments	7,196.0	9,259.6	9,581.5	8,839.6	8,460.6	43,337.3
Diversion payments	0.0	0.0	0.0	0.0	0.0	0.0
Storage	26.5	123.2	120.6	119.2	116.6	506.1
Net lending	650.7	98.1	(244.9)	(290.2)	(191.4)	22.3
Other	291.8	300.1	264.4	236.6	213.3	1,305.4
Dairy product net expenditures	**617.0**	**487.0**	**317.0**	**226.0**	**298.0**	**1,945.0**
Total	**8,782.0**	**10,268.0**	**10,038.7**	**9,131.2**	**8,897.1**	**47,116.0**

[a]Parentheses around numbers indicate a net receipt (excess of repayments or other receipts over gross outlays of funds). Totals may not add due to rounding.

Source: USDA policy simulation models from its Office of Economic Analysis (corn, wheat, cotton, and soybeans) and Agricultural Stabilization and Conservation Service Commodity Analysis Division (dairy products)

Comments From USDA

United States Department of Agriculture
World Agricultural Outlook Board
Washington, D.C. 20250-3800

June 10, 1991

SUBJECT: USDA Review of GAO Report Entitled "USDA Commodity Forecasts: Inaccuracies Found May Lead to Underestimates of Budget Outlays"

TO: Eleanor Chelimsky
Assistant Controller General
Program Evaluation and Methodology Division
U.S. General Accounting Office

Thank you for the opportunity to review and comment on the subject draft report. This memorandum summarizes our general comments. A marked-up copy of the draft report which consolidates more detailed comments by ASCS, ERS, EAS, and WAOB has been provided to GAO under separate cover.

The GAO report, requested by Senator Kerrey, examines USDA's long-term commodity forecasts used in the President's Budget. The report states that the analysis focused particularly on two issues: (1) The accuracy of long-term commodity supply and utilization forecasts, and (2) The effect that inaccuracies in these forecasts could have on outlay estimates of the President's January 1990 budget submission.

In summary, the GAO analysis provides useful insights on the difficulties caused by the wide variations in commodity supply and use conditions, and we agree that there are possible approaches which may help improve the commodity forecasts. However, we do not agree that unusual forecasting problems in the early to mid-1980's should be interpreted to suggest either the presence of long-term bias or that commodity program costs were seriously understated in the President's January 1990 budget submission.

With regard to the first issue, we fully agree with the report's broad thrust, that USDA should follow a regular and more formal evaluation program for long-term commodity forecasts. We also accept the finding of the report that "The accuracy of USDA's baseline forecasts is not yet what it should and could be." In fact, the report corroborates USDA's concerns about the difficulties of projections beyond the first 2 years. However, some clarifications and corrections are needed.

USDA accepts the calculations pertaining to differences between forecasts and final results. However, we strongly disagree that the results indicate either USDA bias or poor analysis, as implied in the report. The data evaluated are from 1981-1988, a period when the Department and others had unusual difficulty in commodity forecasting. It is a period heavily weighted by years of severe world-wide economic recession and huge debts in developing countries which undercut export demand. At the same time, a very strong U.S. dollar plus high and inflexible commodity support prices meant that prices for many U.S. products were not competitive in world markets. All these factors caused the long-term forecasts to differ from actual outcomes.

Further, other information presented in the report would suggest different conclusions relative to forecast accuracy and bias. For example, the single-year commodity budget forecasts for 1972-1990, in Table II.1, show underestimates in 11 years and overestimates in 8 years. Also, the report indicates that, while estimates of farm program costs were seriously underestimated in the early 1980's, the estimate for the 1985 Farm Bill was within 1.0 percent of the actual.

The GAO use of naive models provides a helpful focus on the problem of inaccuracy in the out-years, but the usefulness of this type of model appears to be overstated. For example, in Appendix IV the report states that "... better forecasts could have been made using one or a combination of our naive models..." In practice, there are at least three reasons why naive models cannot replace USDA's current forecasting method. First, the basic USDA forecasting method proved to always be more accurate in the first year and generally more accurate in the second year. The early years are usually of greatest interest in the budget process and in program analysis. Second, model selection based simply on the degree of accuracy over a few past years does not offer much confidence about results in the future. Third, and importantly, forecast models for each element of supply and use would lead to inconsistent results. During each period, supply must equal use; and this identity would not hold if independent forecasting methods were used.

USDA feels the GAO conclusion on the second issue, that outlay estimates for the January 1990 Budget Submission may be underestimated as much as $19.5 billion over 5 years, is neither properly justified nor meaningful. The commodity forecasts and budget estimates prepared for the President's Budget, and updated in the Mid-Session Review, are not the only numbers used in estimating the cost of new farm legislation; and they are not used for other farm program and policy decisions when more up-to-date information is available. The estimates used in these decisions are made as needed and incorporate any new legislation or program changes as well as the latest supply and demand information. Formal budget scorekeeping conventions used by the Congress and OMB to cost out legislation usually have required use of a specific baseline such as the President's Budget or the Mid-Session Review.

The $47.1 billion outlay estimate which GAO reviewed is the estimated cost of the 1985 Farm Bill extended over 5 years for corn, soybeans, wheat, cotton, and dairy as submitted in January 1990 with the President's Fiscal Year 1991 Budget. The GAO results show that if the 1985 Farm Bill provisions had been extended for 5 years, and if the unusual commodity forecasting problems of the early to mid-1980's were repeated, then costs for the five commodity programs could be $19.5 billion higher than shown in the President's Fiscal Year 1991 Budget.

While the GAO analysis demonstrates the sensitivity of program costs to commodity supply and use conditions, it says nothing directly about USDA estimates of 1990 Farm Bill costs. The analysis also is likely to be misleading with regard to the potential size of errors of program cost estimates, since it fails to account for provisions of the 1990 Farm Bill which alter the relation between supply and use conditions and program costs.

There appears to be a tendency to overstate the role of the World Agricultural Outlook Board. Readers of the report should understand that the Board's role is to coordinate an interagency process and clear the results of analysis. Thus, the results of this process are properly attributable to USDA, rather than the Board.

Several of the points reviewed in this report are the same or similar to those in earlier GAO reports PEMD 88-8 and PEMD 91-16. We note that USDA has already implemented or initiated work on most of the previous GAO recommendations as a part of continuing efforts to strengthen analytical support for the Department's policy and budget responsibilities.

The Department concurs with GAO's principal recommendation, specifically that USDA should "... measure and report forecast accuracy of 5-year baselines, as well as develop and report on benchmark forecasts." We have initiated work on such an evaluation effort, and plan to expand that activity. Our plans build on the Secretary's Memorandum of January 28, 1988, charging the Board to coordinate the development of long-run commodity and non-commodity projections. Full implementation of our plans for a review and evaluation effort will require some increase in budget. The needed increase is being addressed in the FY 1992 budget process. We are confident that these ongoing and planned efforts will help to improve our long-term commodity forecasts.

In closing, USDA acknowledges that the Department's long-term commodity forecasting can be improved and appreciates GAO's constructive critique.

James R. Donald
JAMES R. DONALD
Chairperson

Bruce L. Gardner
Assistant Secretary for Economics

5-30-91
Date

for Alan C. Raul
General Counsel

6/4/91
Date

Stephen B. Dewhurst
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6-7-91
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Glossary

Accuracy	Measures the difference between an actual subsequent event and an initial estimate, or forecast.
Baseline Forecast	Baseline forecasts are 5-year supply, utilization, and price forecasts that are viewed as the underlying forecasts for budget process and program analysis. Use of those forecasts past the current crop year is generally restricted to within USDA.
Benchmark	An alternative forecast used to compare to accuracy of the original forecast. Benchmark forecasts should be low-cost, simple alternatives.
Beginning Stocks	The supply or inventory of the farmer-owned reserve stocks, CCC stocks, and free stocks of a commodity still not used at the end of the previous marketing year.
Bias Error	A forecast evaluation term used to describe consistent underestimation or overestimation of the actual indicator.
Competitive Forecast	Competitive forecasts or estimates are simply other forecasts or estimates used for comparison purposes. Several forecasts or estimates may be averaged for comparison purposes.
Crop/Marketing Year	The year in which a crop is harvested and marketed. For wheat, the crop/marketing year is from June 1 to May 31. For corn and soybeans, the crop/marketing year is from September 1 to August 31. For cotton, it is from August 1 to July 31. The dairy product marketing year is from October 1 to September 30.
Data Base	A collection of one or more files that may be integrated to retrieve specific information.
Deficiency Payment	A direct payment made to a farmer when farm prices are below target levels. It is calculated by subtracting from the target price the loan rate or the national average price of a commodity during the first 5 months of the marketing year, whichever is higher. In general, the government

	makes deficiency payments to farmers who qualify for the portion of their production that is specified in the farm program.
Ending Stocks	The supply or inventory of the farmer-owned reserve stocks, CCC stocks, and free stocks of a commodity still not used at the end of the marketing year.
Error	The forecast or estimate subtracted from the actual result.
Forecast	The prediction of what will happen in the future, given some continuation or modification of present trends.
Loan Rate	The price per unit at which the government will provide loans to farmers who participate in the commodity programs, to enable them to hold their crops for later sale.
Model	The representation of an object, system, activity, or situation and its elements (or variables), as well as the relationships between the elements that govern their interaction. The representation may be theoretical, mathematical, or physical, or a combination of these.
Naive Forecast	A forecast based on historical information, with little or no judgment, that assumes the future will closely resemble the past.
Out-Year Forecast	Those forecasted years beyond the current budget year. For this report, out-year forecasts refer to USDA's 2- through 5-year forecasts.
Percentage Error	The result of the forecast or estimate subtracted from the actual result, which is then divided by actual result. The result is then multiplied by 100.
Random Error	The difference between total error and bias error. Random error is unavoidable and represents the minimum possible error.

Reasonable Error	"Reasonable" implies that both total and bias errors are small and that no better forecasts are readily available.
Seasonal Average Price	The national, weighted average market price of a commodity during the 12 months of a marketing year.
Sensitivity Analysis	An approach to problem solving based on the repeated solution of the problem using varying inputs and/or changes in the simulation model.
Supply and Utilization	Supply is the total availability of a commodity and consists of beginning stocks, production, and imports. Forecasts for supply are prepared for both U.S. and worldwide production. Utilization is the total of the amount exported, the amount used domestically for livestock feed, and the amount used domestically for food products and other uses, as well as ending stocks.
Target Price	A price, determined by law, sometimes called "guaranteed price level." The target price becomes the income support price. The government bolsters farm income by making deficiency payments to farmers who qualify for them when national average market prices fall below the target. (Also see Deficiency Payment.)
Total Error	The sum of bias and random error.

Related GAO Products

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International Trade: Export Enhancement Program's Recent Changes and Future Role (GAO/NSIAD-90-204, June 14, 1990).

1990 Farm Bill: Opportunities for Change (GAO/RCED-90-142, Apr. 10, 1990).

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