United States General Accounting Office

GAO

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

May 1991

SHORT-TERM FORECASTING

Accuracy of USDA's Meat Forecasts and Estimates

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GAO

United States
General Accounting Office
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Program Evaluation and
Methodology Division

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May 6, 1991

The Honorable J. Robert Kerrey
United States Senate

Dear Senator Kerrey:

This report responds to your November 30, 1989, letter and subsequent discussions with your staff regarding the accuracy of U.S. Department of Agriculture (USDA) short-term forecasts and estimates of meat production, prices, and inventories. Within USDA, the World Agricultural Outlook Board chairs interagency committees that make short-term forecasts of production and prices for meat products. The interagency committees, with representatives from several USDA agencies, meet and agree on consensus forecasts. For each year, these forecasts are first published in August of the preceding year and then updated monthly through March of the following year, for a 20-month cycle. The National Agricultural Statistics Service (NASS) estimates current inventory and production, based on surveys of actual conditions. NASS publishes its estimates immediately after the month or quarter they are conducted and updates them in the following month or quarter and again after the end of the year.

Our judgment is that the USDA forecasts and estimates, when looked at over 1983-89, are reasonably accurate. Comparisons of forecasts and estimates to actual production and price figures resulted in total error rates of less than 6 percent. We also found that USDA forecasts and estimates compared well to other available forecasts produced in the private sector. We did find, however, that when forecasts were assessed month by month, larger error rates were evident, particularly during the early months of the USDA forecast cycle. In addition, although overall error rates were small, we found they did have a consistent bias error component. We believe that USDA can improve on these high error rates and especially on their consistent bias error.

In conjunction with your staff, we developed the following evaluation questions to address your concerns about the accuracy of USDA short-term forecasts and estimates of meat production, prices, and inventories.

1. Who uses USDA forecasts and estimates?

2. How can the accuracy of forecasts and estimates be measured?

3. How accurate are USDA's short-term production and price forecasts for cattle, hogs, and broilers?

4. How accurate are NASS's cattle-on-feed and hogs inventory and broiler production estimates?

5. What other forecasts and estimates are available for use as benchmarks against which to evaluate the board forecasts and NASS estimates?

6. What are the implications of forecast, estimate, and bias error on U.S. government policy, program, and budget decisions?

7. How can USDA improve its forecasts and estimates?

To answer these questions, we interviewed preparers and users of forecasts and estimates, reviewed relevant literature, measured the accuracy of the USDA forecasts and estimates, compared these errors with other available nongovernment forecasts, and examined the effect of errors on U.S. government decisions. (See appendixes I and II.)

Who Uses USDA Forecasts and Estimates

USDA forecasts and estimates are used by a number of different audiences. Farmers and agriculture-related businesses use them to help make decisions about when to expand or reduce production and when to market products. Policymakers use them to evaluate policy options and make farm-related policy decisions. USDA and other federal executive agencies use them to administer their programs. In addition, private sector analysts use them to make their own forecasts and estimates and to conduct analyses of farm sector activities. These analyses, in turn, are often used by federal decisionmakers. (See appendix III.)

It is important that decisionmakers have accurate forecasts and estimates. Inaccuracies can have financial consequences for users. Errors, for example, can lead farmers to misinterpret market signals and overcapitalize their operations or prematurely change inventories when prices are moving in a direction different from what is projected. Similarly, errors can adversely affect USDA and private sector decisionmaking. For example, USDA analysts used meat forecasts in preparing their regulatory impact analysis for the dairy termination program. The impact analysis used price forecasts for evaluating the effect of the program on cattle prices.

Forecast and Estimate Accuracy Measurement

To determine forecast and estimate accuracy retrospectively, it is necessary to measure the magnitude of total error and identify bias error (that is, systematic over- or underestimation). These error measures are derived by comparing forecasts and estimates with actual production and price figures. Theoretically, the total error in a single forecast has two components: a random part and a bias part. Random error results from truly uncertain events, such as weather, and cannot be totally eliminated. Random error, which may be unavoidable, averages out to zero over time but bias error does not. However, bias error can be reduced if it results from problems in design, methodology, measurement instruments, input data, or subjectivity (conscious or unconscious) on the part of the analyst. (See appendix IV.)

Because forecasting is based on incomplete knowledge about 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 or estimates is "reasonable." To determine this, it is also necessary to compare them to other available "benchmarks" (that is, competitive forecasts) as a way of determining whether smaller error rates are possible. "Reasonable" would imply both small total and bias errors and that no better forecasts are readily available.

USDA Short-Term Production and Price Forecast Accuracy

Overall, bias error was less than 3 percent for all the USDA's short-term cattle, hog, and broiler production and price forecasts for the period 1983-89. Total error was less than 6 percent for these forecasts. The largest production forecast bias error and total error were for cattle (2.6 and 2.7 percent, respectively), followed by hogs (1.1 and 1.8 percent), and then broilers (0.6 and 1.0 percent). The largest price forecast bias error and total error were for broilers (2.6 and 5.8 percent), followed by hogs (−2.1 and 5.3 percent) and then cattle (−2.2 and 3.4 percent).

Error rates were considerably higher and more varied when forecast accuracy was evaluated on an annual or individual monthly level instead of over a multiyear period. Error rates on an annual basis ranged from as large as 12.4 percent to as low as 0.2 percent. Annual error rates did not exhibit any discernible trend during 1983-89. Maximum monthly price forecast errors varied from a 23.6-percent underestimate for broiler prices to an overestimate of 29.6 percent for cattle prices. Maximum monthly production forecast errors ranged from as much as an 11.4-percent underestimate for hogs to a 4.3-percent overestimate, also for hogs. As might be expected, error rates were largest

during the first several months of the 20-month forecast cycle period, when data were limited, and smallest during the later months, when much of the actual information is already available. Error rates generally declined to about 1 to 2 percent by the middle of the forecast year.

The relationships between bias error and total error generally followed the monthly improvement in forecast errors. However, the monthly and annual error rates included individual errors that were both larger and smaller than those reflected in the overall trends. Although error rates varied with respect to size, the USDA forecasts showed a consistent bias error for 1983-89 with respect to the direction of error. For example, analysts consistently underestimated beef production figures. An underestimation bias error was also evident for broiler price forecasts; however, cattle and hog price forecasts were overestimated.

USDA officials cited a number of factors that affected their ability to forecast accurately from year to year during 1983-89. These include, among other unanticipated factors, two major droughts, increased consumer demand for broilers, and the federal payment-in-kind, dairy diversion, and dairy termination programs. (See appendix V.)

NASS Inventory and Production Estimate Accuracy

Bias errors and total errors were relatively small for NASS estimates of cattle and hog inventories and broiler production during the 1980's. Cattle inventory estimate errors, generally 1 percent or less through 1985 and 3 to 4 percent after 1985, were largest. Broiler production estimate errors, generally from 1 to 2 percent, were next. Hog inventory estimate errors, generally 1 percent or less, were smallest. Bias errors for cattle-on-feed and broiler production estimate errors are approximately equal to total errors: that is, the 1980-89 cattle-on-feed bias error and total error each averaged 1.6 percent. The 1980-89 broiler production bias and total error each averaged 1.4 percent. Although these errors are small overall, users have expressed concern about some individual errors, and NASS has taken or is taking action to improve these estimates. (See appendix VI.)

Benchmark Forecasts and Estimates

Two types of benchmarks are useful for comparative purposes: competitive and naive. Competitive benchmarks are simply other forecasts or estimates used as a basis for comparison. Naive forecasts or estimates are benchmarks based on historical information with little or no judgment and assume the future will closely resemble the past.

We found in our work that some reconstruction was required in using other forecasts or estimates as benchmarks for comparison and analysis. For the most part, this was because historical information for other forecasts and estimates had not been retained in an easily accessible format. We were able to reconstruct the annual American Agricultural Economics Association (AAEA) forecasts of production and prices, as well as the Knight-Ridder Financial News Service predictions of cattle and hog inventories.

In July of each year, AAEA consolidates member economists' forecasts of production and prices into consensus forecasts for the next year and the current year. The AAEA consensus forecasts for the next year were slightly more accurate than USDA forecasts of cattle production and cattle, hog, and broiler prices. However, it is also true that USDA's forecasts for the current year were more accurate than AAEA's forecasts for hog and broiler production and cattle and hog prices.

The Knight-Ridder Financial News Service publishes private sector analysts' predictions of the number of cattle-on-feed by month and hogs and pigs by quarter. The Knight-Ridder predictions were about the same as the NASS estimates.

Benchmarks can be used as a management tool to identify whether or not improved forecast accuracy may be possible. Our findings using available benchmarks indicate the potential to improve some of USDA's forecasts. For example, the AAEA forecasts show that 1-year cattle production and prices can be improved. Of course, benchmarks also show that in some cases improvements are not needed. For example, we found NASS forecasts to be similar in accuracy to the benchmarks we used. (See appendix VII.)

Although benchmarks can show when improvement is needed, they do not in themselves indicate what should be done. Improving forecasts requires an ongoing evaluation effort that considers not only why past errors occurred and how sizable they are but also what their implications are for policy.

Implications of Forecast or Estimate Errors

We believe that forecast errors, particularly those with bias error, can have implications for U.S. government policies, programs, and budget decisions. An example of such implications involves USDA's implementation of the Meat Import Act of 1979 (Public Law 96-177). USDA uses forecasts to establish the maximum imports allowed by the act and to limit

imports to that maximum. We estimate that during 1983-89, excess meat imports totaled 135.6 million pounds, in part because USDA used biased forecasts that underestimated actual production and imports. (See appendix VIII for meat imports and appendix III for other users.)

How USDA Can Improve Its Meat Forecasts and Estimates

Our analysis of the forecast and estimate errors as well as of the benchmarks allows us to draw some conclusions about their reasonableness and accuracy. The benchmarks indicate that the 1-year meat prices as well as cattle production forecasts can be improved. Accuracy for the 1-year forecasts, such as those made during the early months of the forecast cycle, show the highest error rates. And although the NASS estimates appear reasonable from a benchmark standpoint, the cattle-on-feed and broiler production estimates do exhibit consistent bias error rates. This again indicates the potential for improvement.

Although the foundation has been laid for a sound forecasting and estimating system, we think certain changes can be made. We believe USDA should improve the documentation of its forecasting efforts by constructing a data base of past forecasts and by preparing a manual to accompany current forecasts that explains the methodologies used (including all major assumptions and other information necessary to understand how the forecasts were developed).

USDA can also improve its accuracy measurement and reporting, first, by conducting measurement studies for its major meat forecasts and estimates and, then, by reporting the results. It is particularly important to report results if error rates are relatively high or if bias error is clearly indicated.

USDA should also assess the reasonableness of its own forecasts and estimates by comparing them to other benchmarks. These benchmarks can be the forecasts or estimates of other analysts, or they can be internally constructed such as naive models.

Further, to ensure ongoing progress, it is critical that USDA's evaluation efforts should determine the causes of identified errors. Such causes should be documented. Once it is understood why an error has occurred, efforts should be made to improve the methodology used.

Finally, it is important to continually assess the concerns of forecast and estimate users. Taking the steps outlined above should help not only to improve the forecasts and estimates themselves but also the clarity of

their reporting and their usefulness to potential users. (See appendix IX.)

The Food, Agriculture, Conservation, and Trade Act of 1990 (Public Law 101-624) provides that recommendations in our 1988 report should be implemented to improve the budget-related commodity forecasts.[1] The board chairperson said they were addressing these legislative mandates. (See appendix IX.)

Recommendation

To improve meat production and price forecasts and estimates, we recommend that the secretary of USDA direct the board and NASS to develop a process to more clearly identify, report, and correct bias errors when they occur and to provide better documentation of their procedures and assumptions.

Agency Comments

USDA's official written response to a draft of this report concurred with our recommendation and generally agreed with our main findings about forecast accuracy and our conclusion that there is room for improvement. (See appendix VIII.) USDA reported that actions are currently under way to improve documentation, measurement and reporting, the use of benchmarks and naive models, and consultation with the user community. USDA emphasized that our study provides a constructive and useful reference for establishing forecast evaluation methods. In addition, USDA provided several specific suggestions for improving the report and these have been incorporated throughout.

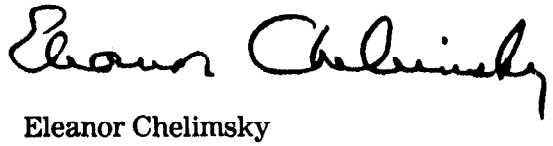
As we agreed with your office, unless you announce the contents of this report earlier, we plan no further distribution of it until 30 days from its date. We will then send copies to the secretary of USDA. In addition, we will make copies available to interested organizations, as appropriate, and to others upon request.

If you have any questions or would like additional information, please call me at (202) 275-1854 or Mr. Kwai-Cheung Chan, Director of

[1]U.S. General Accounting Office, USDA's Commodity Program: The Accuracy of Budget Forecasts, GAO/PEMD-88-8 (Washington, D.C.: April 21, 1988).

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

AAEA	American Agricultural Economics Association
AMS	Agricultural Marketing Service
CPI	Consumer Price Index
ERS	Economic Research Service
FAS	Foreign Agricultural Service
FSIS	Food Safety and Inspection Service
GAO	General Accounting Office
GNP	Gross national product
HRI	Hotel, restaurant, and institution
NASS	National Agricultural Statistics Service
USDA	U.S. Department of Agriculture
WASDE	World Agricultural Supply and Demand Estimates

Objectives, Scope, and Methodology

Meat production is one of the nation's largest industries, accounting for as much as 9 percent of the gross national product (GNP) and 37 percent (about $50 billion) of the $136 billion cash receipts to U.S. farmers in 1988.[1] Cattle, hog, and broiler production accounts for 85 percent of all meat consumption.[2]

The federal government does not provide direct subsidies to cattle, hog, or broiler producers, but it does support these producers in a variety of ways. The federal government provides loans to meat producers, conducts research, pays for meat inspections, purchases meat for the military and government programs, subsidizes meat exports, and provides forecasts and estimates of future and current production, prices, and inventories. Our bibliography at the end of this report identifies a number of publications that provide an overview of U.S. cattle, hog, and broiler production.

In a November 30, 1989, letter, and in subsequent discussions with his office, Senator J. Robert Kerrey asked us to determine the accuracy of USDA's short-term production and price forecasts for cattle, hogs, and broilers and USDA's estimates of current cattle and hog inventories and broiler production. He made his request because of concern about reports of inaccurate USDA forecasts and estimates.

In consultation with his office, we developed the following evaluation questions to address Senator Kerrey's concerns.

1. Who uses USDA forecasts and estimates? (See appendix III.)

2. How can the accuracy of forecasts and estimates be measured? (See appendix IV.)

3. How accurate are USDA's short-term production and price forecasts for cattle, hogs, and broilers? (See appendix V.)

[1]The 9 percent includes production, food processing, transportation, and out-of-home preparation. The overall estimates are discussed in Measuring the Size of the U.S. Food and Fiber System, authored by Chinkook Lee et al., Economic Research Service Agricultural Economic Report Number 566 (Washington, D.C.: USDA, March 1987). This study estimated that, as of 1985, the food and fiber system accounted for 17.5 percent of GNP. An Economic Research Service (ERS) analyst provided us with the estimate that meat represents as much as 9 percent of GNP.

[2]A broiler is a young chicken, usually 5 to 8 weeks old and weighing 4 to 6 pounds, raised primarily for its meat. Other meat production includes lamb, veal, fish, turkey, and other chicken. See Richard J. Crom's Economics of the U.S. Meat Industry, Economic Research Service, Agriculture Information Bulletin Number 545 (Washington, D.C.: USDA, November 1988), p. iv.

4. How accurate are NASS's cattle-on-feed and hogs inventory and broiler production estimates? (See appendix VI.)

5. What other forecasts and estimates are available for use as benchmarks against which to evaluate the board forecasts and NASS estimates? (See appendix VII.)

6. What are the implications of forecast, estimate, and bias error on U.S. government policy, program, and budget decisions? (See appendix VIII.)

7. How can USDA improve its forecasts and estimates? (See appendix IX.)

Who Uses USDA Forecasts and Estimates

To understand the importance and usefulness of USDA forecasts and estimates, we reviewed existing literature and interviewed individuals who prepare and use them. We limited our review to the literature published primarily 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 use of forecasts and estimates. In addition to talking to USDA officials who prepare forecasts and estimates, we discussed their importance with officials from

- federal agencies, such as the Council of Economic Advisors, Office of Management and Budget, State Department, U.S. International Trade Commission, Office of U.S. Trade Representative, Bureau of Labor Statistics, and Commodities Futures Trading Commission;
- industry associations such as the American Meat Institute, National Cattlemen's Association, National Pork Producers Council, and National Broiler Council;
- universities and consulting firms with expertise in forecasting, as well as our own consultants.

We also looked at publications of interest to the meat industry such as Knight-Ridder Financial News Service and the Broiler Industry magazine.

Forecast and Estimate Accuracy Measurement

To determine how forecast and estimate accuracy should be measured, we updated the extensive literature review completed previously for our report entitled USDA's Commodity Program: The Accuracy of Budget Forecasts.[3] We measured accuracy by comparing forecasts and estimates with actual data.

We selected summary error measures that would allow us to determine the extent of total error and any bias error that results from consistent over- or underestimation in forecasts and estimates. The error in a single forecast has two components: random (unsystematic) error and bias (systematic) error. We describe and explain these measures in appendix IV.

Given the uncertainties involved in predicting the future, it is to be expected that some amount of error will occur in making forecasts. Total and bias error measures alone do not provide a basis for evaluating whether forecasts and estimates are reasonable. Comparisons with other forecasts and estimates (that is, benchmarks) that are available can also provide another means to assess accuracy. Such comparisons can show where differences exist and whether improvements are needed. We identified benchmarks for use in making comparisons based on our review of the literature and discussions with forecast experts.

USDA Short-Term Production and Price Forecast Accuracy

To determine the accuracy of USDA's short-term production and price forecasts for cattle, hogs, and broilers, we compared the 1983-89 forecasts with actual production and price figures using our summary error measures described in appendix IV. We limited our analyses to this time period because earlier forecasts were not available. For actual production and price, we used the final estimate made in March after the forecast year.

For production, we used USDA's forecast of commercial production, which includes all production except a small amount identified for farm use. Prior to 1985, the board published two forecasts for some months. We used the first production forecast published each month during this period.

For price, we used the only annual price forecasts USDA makes for cattle, hogs, and broilers. These are "Choice Steers, Omaha, 1000-1100 Pound Class," "Barrows and Gilts, 7 Markets," and "Broilers Wholesale, 12

[3]U.S. General Accounting Office, GAO/PEMD-88-8 (Washington, D.C.: April 1988).

City Average." Price forecasts are expressed as a range. For analysis, we used the mean of each forecast range.[4]

NASS Inventory and Production Estimate Accuracy

To determine the accuracy of NASS's cattle and hog inventory and broiler production estimates, we compared NASS's estimates for 1980-89 with the actual numbers reported in the Census of Agriculture. We conducted our analysis for 1980 to 1989.

For cattle numbers, we had a choice of two NASS estimates—those reported in the monthly Cattle-on-Feed—7 States report or the quarterly Cattle-on-Feed—13 States report. Both report NASS estimates of cattle and calves being fattened on grain or other concentrates for the slaughter market that are expected to produce a grade of select or better. We used the monthly report because these estimates were of greater interest to Senator Kerrey's office. The 7-state report includes about 70 percent of the estimated cattle-on-feed in the United States.

For hog inventory and broiler production, we used the only estimates NASS makes. The hog inventory consists of hogs and pigs, separated into those intended for market and those for breeding. NASS reports its estimates of hog inventories quarterly in the Hogs and Pigs report.

Broiler production information comes primarily from data on broilers slaughtered under federal inspection. NASS reports its estimates in its monthly Poultry Slaughter report.

Available Benchmark Forecasts and Estimates

To determine if there were other forecasts and estimates that could be used as benchmarks against which to compare USDA forecasts and NASS estimates, we reviewed those made by other government agencies and private sector organizations. We identified them through our literature review and discussions with USDA officials and other experts. We then compared them with those produced by the board and NASS.

[4]USDA analysts first make point estimates and then apply a range to account for anticipated variability. These ranges vary from a maximum of $3.00 per hundred pounds for the early forecasts to $1.00 per hundred pounds for the latter forecasts. The ranges are the same for all three meats. The board's meat analyst stated that the mean is traditionally used for analysis.

Implications of Forecast and Estimate Errors

To assess the implications of forecast and estimate errors on U.S. government policy and budget decisions, we reviewed existing literature and included this topic in our interviews with government and private sector officials. In addition, where we found significant total error or bias error, we searched for direct links between these errors and relevant policy, program, and budget decisions.

Improving USDA's Forecast Management Process

To identify how USDA's forecasting and estimating process could be improved, we reviewed past GAO reports of relevance to USDA, conducted a literature search, solicited comments regarding potential improvements from forecast developers and users, and conducted an analysis of our own.

We conducted our review in accordance with generally accepted government auditing standards during the period November 1989 through August 1990. The written comments that USDA provided on a draft of this report are presented in appendix XI.

USDA's Meat Forecasts and Estimates

USDA prepares and publishes forecasts of production and prices for the next year (that is, short term) and up to 10 years in the future (that is, long term). USDA also prepares estimates of production, prices, and inventories for the most recent month or quarter. Several USDA agencies are involved. The World Agricultural Outlook Board chairs interagency committees that make the USDA forecasts, and the National Agricultural Statistics Service makes the USDA estimates. Representatives from the Economic Research Service (ERS), Foreign Agricultural Service (FAS), and Agricultural Marketing Service (AMS) serve on the interagency committees. Each year, USDA devotes about 1,100 staff years to making forecasts and estimates, including 130 staff years for the meat forecasts and estimates. Approximately 1,000 of these people work in NASS and are responsible for preparing the estimates of current or past conditions.[1]

USDA Forecasts

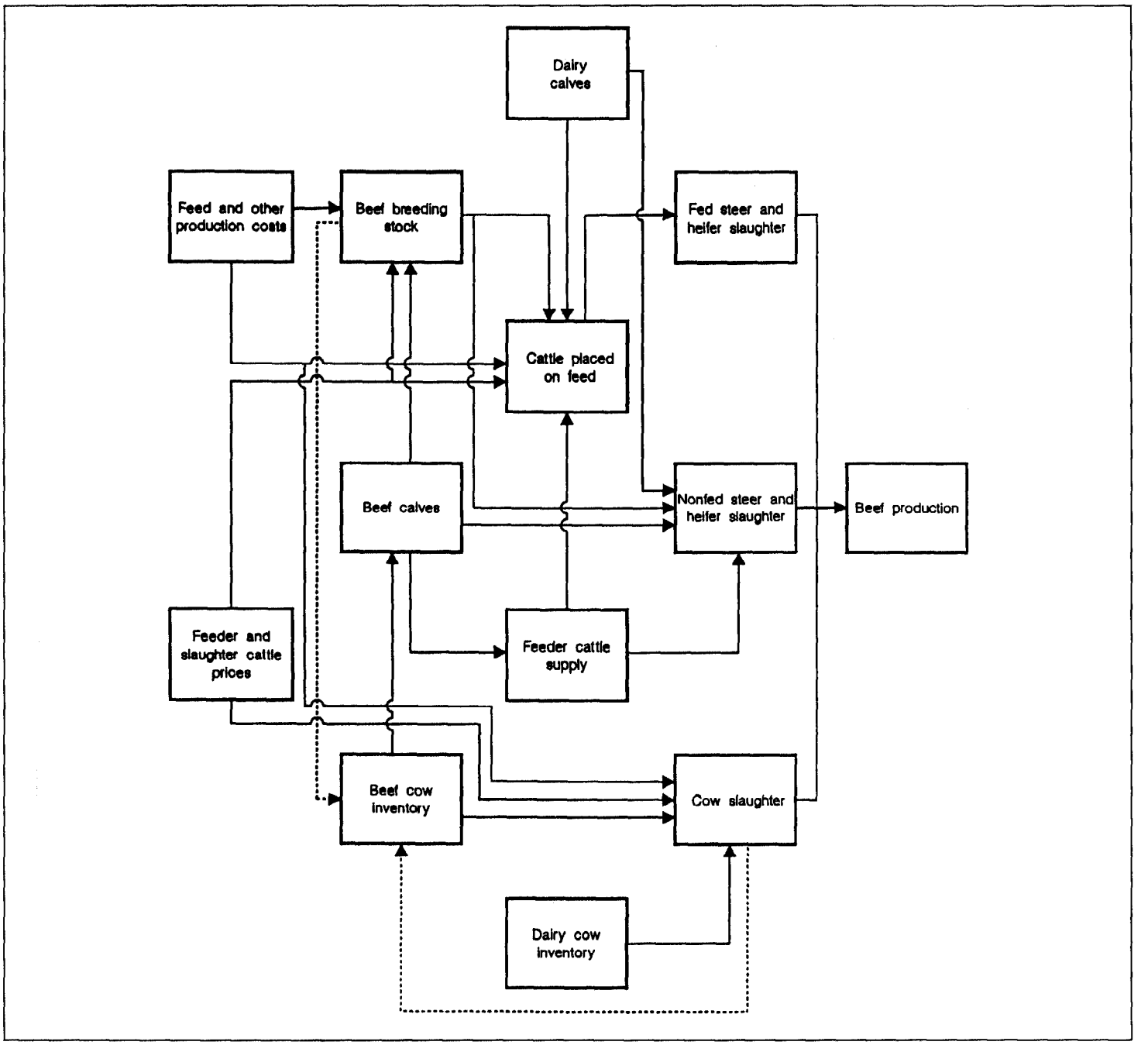
USDA's forecasts are the result of a committee process involving representatives of the board, ERS, FAS, and AMS. Each representative contributes the expertise and knowledge of his or her respective agency to the committee deliberations. The individual analysts use models and other analytical techniques to derive their own forecasts. The resulting forecasts represent their consensus about future production and prices. 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 to develop, administer, and evaluate agricultural and rural policies and programs. FAS promotes U.S. exports and gathers information about foreign agriculture through a network of about 100 U.S. professional agriculturalists at 60 American embassies and consulates around the world. AMS collects and publishes daily information about market prices for grain and meat.

The committee representatives consider many variables when developing annual forecasts of production and prices. For example, when forecasting annual cattle production, they consider feed and other production costs, feeder and slaughter cattle prices, beef calf inventory, beef cow inventory, dairy cow inventory, cattle placed on feed, feeder cattle supply, fed steer and heifer slaughter, nonfed steer and heifer slaughter, and cow slaughter. Figure II.1 shows this complex process and the information needed in forecasting beef production. In addition to the information displayed in the figure, analysts must be aware of

[1]The NASS staff years also include research and reimbursable survey work.

Figure II.1: Beef Production



Source: Richard J. Crom, Economics of the U.S. Meat Industry, Economic Research Service, Agriculture Information Bulletin Number 545 (Washington, D.C.: USDA, November 1988), p. 50.

such factors as pasture and range conditions, government policy decisions, and general economic conditions.

The initial annual forecasts are made in August preceding the forecast year and are revised monthly through March following the forecast year. For example, USDA's initial forecast of 1989 beef production was made in August 1988 and updated monthly through March 1990, for a 20-month cycle. The revised March forecast is considered the actual production, although it may be revised later. The USDA forecasts and revisions are published monthly in a report entitled World Agricultural Supply and Demand Estimates (WASDE). Other USDA publications, such as the ERS and FAS Situation and Outlook series, provide more detail.

NASS Estimates

NASS estimates current production, prices, and inventories using several surveys. For example, NASS conducts a nonprobability panel survey of cattle feeders to estimate its cattle-on-feed for slaughter inventories and a probability survey of over 75,000 agricultural producers to estimate quarterly hog and pig inventories.[2] It uses USDA Food Safety and Inspection Service reports of processing activity at food processing plants to estimate broiler production.

NASS estimates of production, prices, or inventory are made for the previous month or quarter in the case of hogs and then revisions of them may occur in the next month or quarter and again between January and May of the following year. For example, NASS estimated the July 1989 cattle-on-feed inventory in mid-July 1989 and then revised this estimate in mid-August 1989 and again in January 1990. Revisions made in the following year are considered the actual inventory, price, or production—subject to further revision as a result of comparisons made with the Census of Agriculture, which is published every 5 years. NASS publishes its estimates in individual publications devoted to a particular commodity or product. For example, NASS publishes its monthly estimate of the number of cattle-on-feed in its monthly Cattle-on-Feed—7 States report.

[2]Cattle-on-feed surveys involve collecting information on a random sample of the smaller feed lot operators as well as all the larger operators. They are called nonprobability surveys since confidence intervals cannot be calculated. Panel surveys address only specific cattle issues, while other NASS surveys request information on several commodities.

Importance of and Uses for USDA Forecasts and Estimates

In this appendix, we answer evaluation question 1, "Who uses USDA forecasts and estimates?" USDA forecasts and estimates are important because of their use by decisionmakers. Farmers and agriculture-related businesses use them in deciding when to expand or reduce production and market their products. Policymakers use them to evaluate policy options and to make policy decisions. Federal executive agencies use them to administer their programs. In addition, private sector analysts use them as an aid in making their own forecasts and estimates, which are then used both by federal decisionmakers and by the analysts themselves. To the extent that errors occur in either USDA's forecasts or its estimates, users' resource-allocation decisions may be affected. Since these users consider other factors in the decisionmaking, the effect of forecast and estimate errors is not clear.

Production and Marketing Decisions

USDA forecasts and estimates are widely distributed to the public through periodicals, newspapers, and other news reports. Agricultural specialists rely on this information for providing technical assistance and advice to farmers and others.[1] Farmers and personnel from agriculture-related industries also use this information in their meat production and marketing decisions. Farmers and feed lot operators, for example, need to know anticipated prices when determining how much to produce and when to market their products. Their inability to make informed decisions, based on timely and accurate forecast information, can lead to financial losses.

Producers need these forecasts in making decisions for the coming year. Forecasts may, or may not, influence their production and marketing decisions. Other factors, such as an animal's reproductive cycle or a farmer's ability to change production practices, are also likely to be considered by producers. To the extent forecasts are used, errors can lead farmers to misinterpret market signals and overcapitalize their operations or prematurely change inventories when prices move in a direction different from what is projected.

Policy Analysis and Decisionmaking

Decisionmakers' use of USDA forecasts and estimates in policy analysis and decisionmaking is reflected in legislation, decisions by the secretary of USDA, and international trade policies.

[1] U.S. General Accounting Office, What the Department of Agriculture Has Done and Needs to Do to Improve Agricultural Commodity Forecasting and Reports, GAO/RED-76-6 (Washington, D.C.: August 27, 1975), p. 1.

Legislation

Legislators use forecasts to monitor meat producers' financial conditions and limit meat imports into the United States. Concern over the effect of imported beef on domestic prices, for example, resulted in the enactment of the Meat Import Act of 1979, which revised existing legislation limiting imports. The law requires that the secretary of USDA fot anticipated production and imports and then establish import quotas based on this information. (See appendix X for a detailed explanation of these provisions.)

Decisions by the Secretary

The secretary of USDA uses production and price forecasts to assess the probable effect USDA programs will have on farmers, as well as on the economy, in the exercise of discretionary authority to administer agriculture programs. For example, forecasts of future market conditions are used in the secretary's decisions about how much meat to purchase for the school lunch program and in other programs such as evaluating the indirect effects the 1986 dairy termination program would have on meat prices.[2] Further, the board chairperson stated that meat production forecasts are used as an input into forecasting domestic feed grain consumption. A recent USDA study indicates there is a clear relationship between the meat industry and the feed grains.[3]

Trade Negotiations

Three different agencies use forecasts and estimates when they negotiate or evaluate international agricultural trade. The Office of the U.S. Trade Representative is responsible for overall trade policy negotiations. The U.S. International Trade Commission furnishes studies, reports, and recommendations involving international trade and tariffs to the president, the Congress, and other government agencies. The Department of State advises the president in formulating and executing foreign policy, including resource and food policy. These agencies rely on the USDA projections to understand U.S. and world agricultural conditions, which is essential for them to carry out their responsibilities. To the extent that USDA forecasts underestimate or overestimate future meat imports, trade negotiators may fail to properly assess the future effects of import policy changes.

[2]USDA, Agricultural Stabilization and Conservation Service, Final Regulatory Impact Analysis: Price Support Program for Milk, 1985-86 and 1986-87 Marketing Years (Washington, D.C.: February 7, 1986), pp. 14-16.

[3]Clark Edwards, Crops, Livestock, and Farm Programs: Overlooked Interactions, Economic Research Service, Agricultural Economic Report Number 638 (Washington, D.C.: USDA, September 1990), p. 5.

Program Administration

Federal agencies use forecasts and estimates in administering programs related to such diverse activities as regulating commodity futures markets, providing credit, forecasting general economic conditions, and limiting beef imports.

Regulating Commodity Markets

The Commodity Futures Trading Commission is responsible for monitoring and regulating futures markets to ensure fairness. The commission uses the USDA forecasts and estimates to derive an expectation of future market behavior. It then compares actual behavior to this expected behavior as part of efforts to identify possible irregularities, such as abnormal price swings or trading volume increases, that may require regulatory action.

We evaluated whether the cattle futures markets' reaction to USDA's 1986 announcement of the dairy termination program was accurately based on supply-and-demand conditions.[4] We recommended that to help mitigate price volatility encountered at the time of the program's announcement, the secretary of USDA direct USDA futures-traded commodity program officials to discuss and coordinate their plans with appropriate commission officials.

Providing Credit

The federal government offers a substantial amount of credit to the farm sector, including meat producers. The Farm Credit Administration considers USDA forecasts and estimates when assessing future agricultural conditions. The Farmers Home Administration uses the USDA forecasts in calculating cash flow estimates used in making decisions affecting new loans, as well as extending credit for existing loans. Should Farmers Home Administration use USDA forecasts that overestimate future meat prices, future cash flow forecasts may be overstated, and more money may be loaned than the borrower can repay.

Forecasting General Economic Conditions

Forecasts of general economic conditions include agricultural and food components. Meat prices affect both. The Federal Reserve System uses USDA forecasts in assessing future agricultural conditions. An economist from the Council of Economic Advisors said he considered USDA's forecasts when projecting the Consumer Price Index (CPI). CPI forecasts are

[4]U.S. General Accounting Office, Commodity Futures Trading: Purpose, Use, Impact, and Regulation of Cattle Futures Markets, GAO/RCED-88-30 (Washington, D.C.: November 10, 1987), pp. 43-55 and 74.

used in developing some federal agency budgets, as well as by private analysts who use the forecasts for decisionmaking.

Limiting Beef Imports

The Meat Import Act of 1979 requires USDA to calculate a quota for imports. The law requires the president to restrict imports to the quota level if imports are expected to equal or exceed the trigger level, which is 110 percent of the quota. In administering the act, USDA uses forecasts to set the trigger and quota levels and determine if imports are expected to trigger the limit on imports.

Private Sector Analyses

Private sector analysts who evaluate various aspects of the agricultural economy, including the meat industry, rely on the USDA forecasts and estimates. They use them in analyzing current and future agricultural conditions and in making their own forecasts. Private sector analysts use this information when (1) providing consultative services to meat producers, meat production-related businesses, and the public; (2) planning future meat purchases; (3) participating in the commodity futures markets; and (4) offering input into public policy deliberations as lobbyists or advisers to lobby groups.

Board and NASS officials stated that errors in forecasts and estimates can affect commodity futures markets. They stated that forecast or estimate changes have in the past affected commodities markets. This stimulates investor and producer concern, since market changes can cause them to immediately make or lose money.

Measuring Forecast and Estimate Accuracy

In this appendix, we address evaluation question 2, "How can the accuracy of forecasts and estimates be measured?" As discussed below, we use (1) a series of summary error measures to indicate the magnitude of total error and identify bias error and (2) alternative or benchmark forecasts and estimates as a means of comparison to determine whether accuracy can be improved. The concepts and formulas are drawn from available literature on forecast evaluation.[1] Our discussion of forecast error in this appendix applies equally well to estimate 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 error may be positive or negative. It does not have much value for gauging the quality of a forecasting model or procedure, but multiple forecasts over time can be used to show how accurately a forecasting procedure is working.

A single forecast error can be separated into two parts: "random error," which varies unsystematically from one forecast to the next, and "bias error," which remains constant for a particular forecasting procedure. Table IV.1 illustrates these concepts for a hypothetical series of 10 forecasts.

Table IV.1: Hypothetical Data Demonstrating Forecast Error

			Error		
	Actual	Forecast	Single	Random	Bias
	27	20	7	4	3
	16	18	−2	−5	3
	32	29	3	0	3
	25	26	−1	−4	3
	21	21	0	−3	3
	19	15	4	1	3
	27	22	5	2	3
	29	23	6	3	3
	17	15	2	−1	3
	34	28	6	3	3
Mean	24.7	21.7	3	0	3

[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.

As shown in the table, the mean error over the time series is 3 while the random error, which fluctuates, has a mean of 0. Over many forecasts, the mean of the random error should equal 0 because it is defined as unsystematic error and these errors tend to offset one another. The bias error in this hypothetical example is 3 in every forecast. Measured by the mean error measure, this bias error indicates that every forecast is too low by 3 points.

Actual forecasting procedures are rarely so consistent. If the forecasting procedure is changed, no bias error will be consistent from period to period, particularly when the forecast has several input variables or is made up of several component forecasts.

USDA expressed concern in its comments about the statistical measures we used. It acknowledged, however, that because of the limited amount of forecasts available, more sophisticated measures could not be used. Further, our analysis, using more complex measures, identified the same high-error forecasts.

The length of the time series or number of data points affects the statistical validity of the measurements. A USDA official stated a minimum time needed for evaluating the accuracy of annual forecasts may very well be 20 years.[2] Nonetheless, we were asked to evaluate existing forecasts while recognizing there was not a sufficient number of forecasts available to make statistically accurate measurements. However, managers and forecasters both need timely evaluations of forecasts to improve their quality and credibility and to ensure that decisionmakers are getting the information they need. The results of our analysis should therefore not be considered definitive concerning the accuracy of USDA forecasts and estimates.

Measures of Single Forecast Error

The basic error measurements are for a single forecast. These measurements stress identifying the deviation between actual data and the forecast. In all cases, the actual serves as the base, with the forecast being deducted. As we stated above, error (E) is defined as $E = A - F$, or the difference between A and F.

[2]See U.S. General Accounting Office, USDA's Commodity Program: The Accuracy of Budget Forecasts, PEMD-88-8 (Washington, D.C.: April 21, 1988), p. 34.

Absolute error (AE) is defined as AE = |E| and is a measure of error without regard to whether the forecast is overestimated or underestimated.

Individual percentage error (IPE) is defined as IPE = (E/A) x 100. That is, IPE is the error divided by the actual, multiplied by 100. The measure shows whether the error is negative or positive. The individual percentage error measurement favors forecasts that are less than the actual, or underestimates. If the forecast is less, the error cannot exceed 100 percent, but there is no limit to the percentage error for overestimates.[3] Negative percentage errors indicate the forecast was overestimated.

Absolute percentage error (APE) is defined as APE = |E|/A x 100. It is absolute error divided by the actual multiplied by 100. The absolute percentage error measurement also favors forecasts that are less than the actual, or underestimates. If a forecast is less, the error cannot exceed 100 percent, but there is no limit to the percentage error for overestimates.

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 conscious or unconscious subjectivity 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 or estimate 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.

[3]The potential built-in bias in the IPE and APE measures is negligible until errors exceed 20 percent. Since meat forecast errors are small, this potential measure bias is not an issue.

To measure total and bias error, we used percentage error measures that express the error (actual minus the forecast or estimate) as a percentage of actual. Percentage error measures allow comparisons between forecasts or estimates of different quantities such as production and price, as well as comparisons of forecasts or estimates of price over time. Analysis using percentage error allows us to give each observation an equal weight. This is important, since USDA analysts tend to use the same forecasting methodology each year. Averages calculated using other units, such as dollars or bushels, give greater weight to years in which the units are larger.[4]

Measures of Total Error

Absolute measures over multiple forecasts show total error. Total, or absolute, error measures over a time series of forecasts ($F_1, F_2, \ldots, F_n$) and actual observations ($A_1, A_2, \ldots, A_n$) can be expressed as total absolute error (TAE), mean absolute error (MAE), and mean absolute percentage error (MAPE).

Total absolute error (TAE) is the sum of the single forecast absolute errors, or

$$TAE = \sum_{i=1}^{n} |E_i|$$

Mean absolute error (MAE) is defined as MAE = TAE/n. It is the sum of absolute errors over multiple forecasts divided by number of forecasts. MAE shows the average or typical error but does not distinguish between random error and bias error. This is also called the mean absolute deviation (MAD).

Mean absolute percentage error (MAPE) is defined as

[4]Other approaches can be used to measure forecast errors such as those employing a mean or weighted mean. In our analysis, we did compare error rates for selected variables using such other measures and found similar results.

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

or the sum of the absolute percentage error (absolute error for each forecast divided by actual observations) divided by the number of forecasts. MAPE is dimensionless and useful for comparing forecasts from different series. 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, but the percentage error on the high side has no limit.

Measures of Bias Error

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

Net error (NE) is defined as

$$\text{NE} = \sum_{i=1}^{n} E_i$$

or the sum of the errors for each period with regard to whether the forecast was underestimated or overestimated. It is a measure of bias error over multiple forecasts, because the net error would be 0 if the single forecast errors were random.

Mean error (ME) is the average of the errors with regard to underestimates and overestimates; that is, ME = NE/n. The mean error would be 0 if the single forecast errors were random. Mean error gives a measure of the bias error of individual forecasts in a time series.

Mean percentage error is defined as

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

For our analysis, we measured bias error as the sum of the percentage errors, whether underestimates or overestimates, divided by the number of forecasts and multiplied by 100. The mean percentage error 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), but the percentage error on the high side has no limit.

Trimmed mean percentage error (TMPE) is defined as

$$TMPE = \left(\frac{\sum \frac{E_i}{A_i}}{n-2} \right) \times 100$$

where the largest and smallest errors are dropped. The 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

$$WMPE = \left(\frac{\sum E_i}{\sum A_i} \right) \times 100$$

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

Benchmarking

Producing error-free forecasts is not possible, given that most forecasts are based on uncertain knowledge about the future. However, total and bias errors alone are not enough to determine the reasonableness of forecast accuracy. What is missing is a basis for comparison. One way to evaluate the reasonableness of a forecast's accuracy is by comparing it with other forecasts (that is, "benchmarks") to determine whether

lower errors can be produced. For example, a forecast with an error of 40 percent may not be unreasonable if the next best forecast has an error of 50 percent. Benchmarks should start with simple, low-cost naive models.

We use two types of benchmarks: competitive and naive. Competitive forecasts are simply other forecasts used for comparison purposes. Individual forecasts can be used for this purpose or can be combined into a consensus forecast. Consensus forecasts can be combined as means, trimmed means, or weighted means.

Naive forecasts are derived from historical information. They involve little or no judgment and generally assume the future will closely resemble the past. The simplest naive models use the latest actual value as the forecast. Another form of naive forecast would be to draw a straight line through points representing historical production and forecast future production by extending the line to a future point.

Benchmark forecasts made with naive models or consensus methods can provide two types of checks. First, they help establish acceptable error and bias error rates for a specific type of forecast. For example, one agriculture forecaster considers error rates greater than those of a naive model to be unacceptable, believing that a reasonable goal for errors may be three fourths or less of the number generated by a naive model.[5] Second, benchmarks provide a means of questioning the methodology being used to generate forecasts. If postanalysis shows that comparison forecasts are more accurate over time, then the methodology being used should be reexamined carefully.

[5]John Ferris, "Evaluation of Forecasts from the Annual AAEA Outlook Survey," presented at the annual meeting of the American Agricultural Economics Association, Reno, Nevada, July 1986.

Accuracy of USDA Price and Production Forecasts

In this appendix, we respond to evaluation question 3, "How accurate are USDA's short-term production and price forecasts for cattle, hogs, and broilers?" Table V.1 summarizes the bias and total error rates for the USDA 1983-89 short-term production and price forecasts for cattle, hogs, and broilers. All forecasts for this 7-year period are included.[1] The mean percentage errors, which measure bias error, were less than 3 percent for these forecasts. The mean absolute percentage errors, which measure total error, were less than 6 percent for these forecasts.[2] These overall measures showed underestimated actual production. Broiler price forecasts also showed underestimated prices, while cattle and hog price forecasts showed overestimated prices.

Table V.1: 1983-89 Meat Production and Price Percentage Errors[a]

	Bias error	Total error	Average quantities and annual prices[b]
Production			
Cattle	2.64%	2.66%	23.436
Hogs	1.14	1.83	14.894
Broilers	0.64	0.97	14.598
Prices			
Cattle	−2.17	3.40	$64.46
Hogs	−2.09	5.34	47.38
Broilers[c]	2.64	5.76	54.46

[a]Positive percentages for bias error reflect underestimates—that is, the actual value exceeds the forecast. Negative bias error measures reflect overestimates.

[b]Production is in billions of pounds; prices are dollars per 100 pounds.

[c]Broiler price error rates are for 1984 through 1989. USDA discontinued its 9-city average and began using a 12-city average in the second quarter of 1983.

Bias error and total forecast error measures for cattle production were approximately equal, indicating the forecast errors resulted from bias error. In contrast, the total errors exceeded the bias error for hog and

[1]The calculation of these error rates is based on all USDA's 140 forecasts made for each commodity variable during 1983-89. Among the 20 forecasts per year for each product or price, there likely is autocorrelation among the forecast errors. This means that the principal cause of error in the 20-month forecast, perhaps an unanticipated drought, will also be the principal cause of the 19-month forecast error, and so on. The more severe the autocorrelation, then the more proper it would be to consider the 20 forecasts per year for each product or price as just one forecast per year. Nonetheless, neither the degree of autocorrelation nor the decision to consider annual forecasts as 20 different forecasts or just 1 forecast would appreciably affect the detection of bias among forecast errors.

[2]We use one bias error measure, MPE, and one total error measure, MAPE. We also used the adjusted mean absolute percentage error (AMAPE) and root mean square percentage error (RMSPE) total error measures. We found that the different total error measures all identified the same years as having the most significant errors. As expected, the use of the RMSPE tended to result in the highest values. We did not include those measures in this report.

broiler production forecasts and all price forecasts, indicating these forecast errors included both bias error and random error. The largest production forecast bias error and total error results were for cattle, followed by hogs and then broilers. The largest price forecast bias error and total error results were for broilers.

Mean Percentage Errors by Month 1983-89

Figures V.1 and V.2 show the production and price bias error by month for 1983-89. Each monthly data point represents seven forecasts for each month for 1983-89. USDA publishes its first forecasts in August preceding the start of the calendar year. The final forecasts are released in March following the year's end. Forecast bias error is initially above 5 percent for production and 6 percent for prices but declines to about 1 or 2 percent by July. USDA analysts underestimated production and broiler prices but overestimated cattle and hog prices. These 1983-89 average monthly forecast errors mask considerable individual monthly data variability. In some years, individual monthly forecast errors were several times as large as the seven averaged monthly forecast errors.

Figure V.1: Production Mean Percentage Error 1983-89

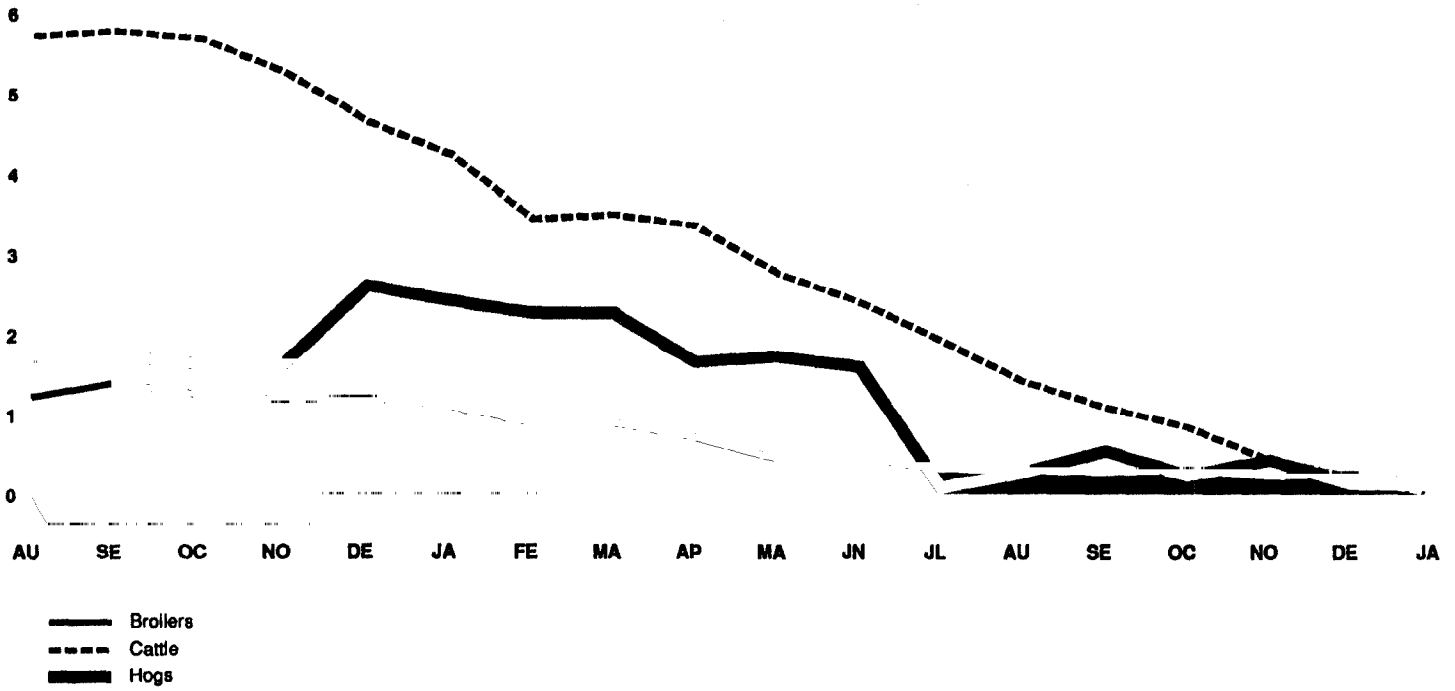
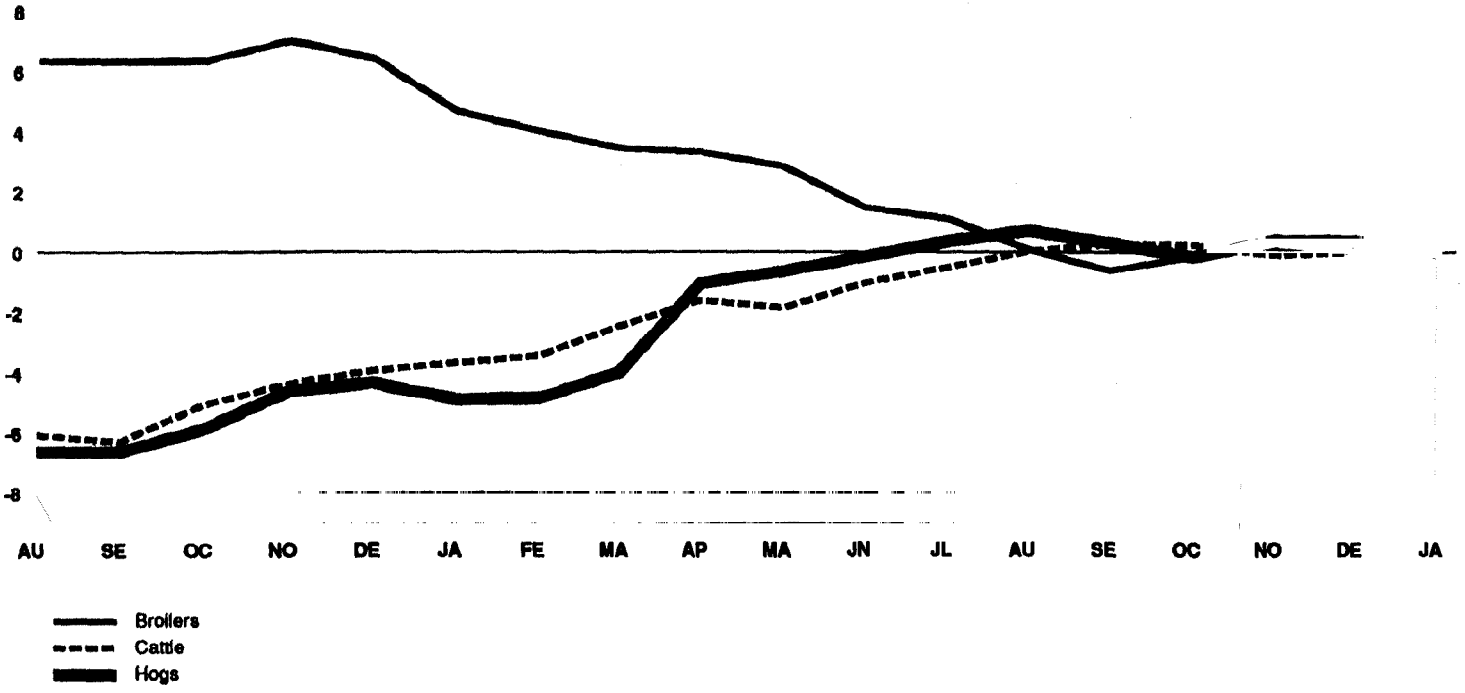


Figure V.2: Price Mean Percentage Error 1983-89



Although not shown in the figures, the relationship of bias error and total error for the monthly forecast in many cases closely approximated the relationship of these overall measures for 1983-89. For example, monthly cattle production forecast total error and bias error were both 5.7 percent in August prior to the forecast year and declined to 1.9 percent in July of the forecast year. Further, monthly broiler price forecast total error and bias error were 12.4 and 6.3 percent, respectively, in August and declined to 2.9 and 1.1 percent in July.

Annual Percentage Error Rates for 1983-89

Although overall error rates by year appeared low, some error rates for individual years exceed those averages by three or more times. USDA officials cited a number of factors that affected their ability to forecast accurately from year to year during 1983-89. These include two major droughts, increased consumer demand for broilers, and payment-in-

kind, milk diversion, and dairy termination programs.[3] Under the payment-in-kind program, the government paid farmers with excess government-owned grain not to produce grain. This decreased the amount of surplus grain and contributed to increased grain prices paid by meat producers, which in turn reduced production.[4] Under the dairy termination program, the government contracted to pay some farmers to stop producing milk for 5 years. For farmers who entered into such contracts, their dairy cows and replacement heifers had to be sold for either slaughter or export. Since the majority of the purchased cattle were slaughtered, there was an increase in the supply of meat.[5]

The annual percentage error rates for cattle, hog, and broiler production and prices are discussed separately below, along with USDA officials' explanations of the larger errors.

Cattle Production Percentage Error Rates

Table V.2 summarizes the cattle production mean percentage error rates by year for 1983-89.[6] These error rates show consistent underestimation bias error. The highest error rates occurred in 1986.

Table V.2: 1983-89 Cattle Production Percentage Error Rates

Year	Bias error	Total error	Actual annual production[a]
1983	1.89%	1.89%	23.060
1984	2.54	2.59	23.418
1985	2.46	2.46	23.557
1986	4.63	4.63	24.213
1987	2.18	2.20	23.405
1988	2.76	2.76	23.424
1989	2.03	2.10	22.973
1983-89[b]	2.64	2.66	23.436

[a]Billion pounds.

[b]Average for 1983-89.

[3]The milk diversion program was authorized under the Dairy and Tobacco Adjustment Act of 1983. The dairy termination program, authorized in the 1985 Food Security Act, is the one we concentrate on in this report.

[4]U.S. General Accounting Office, 1983 Payment-in-Kind Program Overview: Its Design, Impact, and Cost, GAO/RCED-85-89 (Washington, D.C.: September 25, 1985).

[5]U.S. General Accounting Office, Dairy Termination Program: An Estimate of Its Impact and Cost Effectiveness, GAO/RCED-89-96 (Washington, D.C.: July 6, 1989).

[6]USDA makes about 20 annual forecasts over the full cycle for each commodity variable.

USDA analysts said cattle production increased more than anticipated from 1983 through 1989 because (1) slaughter weights increased substantially during this period, (2) the proportion of cattle herd slaughtered increased from the dairy termination program, drought, and financial stress, (3) the period analyzed incorporated only a part of the 10-to-14-year cattle cycle, and (4) the NASS cattle-on-feed estimates systematically underestimated cattle being prepared for market.[7]

USDA analysts stated that the basic reason for the high 1986 cattle production error rate was the dairy termination program. They said there was more liquidation than anticipated from the dairy buy-out program throughout the year, as the program was extended several times. As a result, forecasts were corrected throughout the year to account for continued selling under the program. The dairy termination program covered most of 1986 and 1987.[8] By 1987, the effect of the program was larger and error rates declined.

Hog Production Percentage Error Rates

Table V.3 summarizes the hog production mean percentage error rates by year for 1983-89. Small but consistent underestimation bias errors are evident during the period, except for 1983, when considerably higher errors occurred, and for 1986, when an overestimate occurred.

[7]The average dressed weights of commercial, federally inspected cattle rose from 636 pounds in 1983 to an estimated 676 pounds in 1989. Two major droughts in 1983 and 1988 resulted in grazing problems and increased grain prices. With higher grain prices, cattle producers reduced their inventories. The NASS January Inventory of Cattle and Calves steadily declined from 1982 through 1989. Financial crises also played a role. One estimate indicates that as many as 100,000 cattle producers left the industry during the 1980's. A detailed discussion of NASS's cattle-on-feed estimates, specifically the unusual 1986-89 estimate errors, is in appendix VI.

[8]See Dairy Termination Program for a discussion of the program.

Table V.3: 1983-89 Hog Production Percentage Error Rates

Year	Bias error	Total error	Actual annual production[a]
1983	5.08%	5.08%	15.117
1984	0.92	0.97	14.720
1985	1.73	1.73	14.728
1986	−1.90	2.01	13.998
1987	0.99	1.24	14.312
1988	0.77	0.89	15.623
1989	0.39	0.86	15.759
1983-89[b]	1.14	1.83	14.894

[a]Billion pounds.

[b]Average for 1983-89.

USDA analysts said the 1983 drought and payment-in-kind program had a major cumulative effect. Hog production is corn-oriented. Thus, their view is that the decline in corn production, which fell by 41.9 percent as a result of the drought and payment-in-kind program, caused feed prices to increase and hog production to decline.

Broiler Production Percentage Error Rates

Table V.4 summarizes the broiler production mean percentage error rates by year for 1983-89. Overall broiler production mean error rates by year show underestimation bias error. The highest error rates occurred in 1989.

Table V.4: 1983-89 Broiler Production Percentage Error Rates

Year	Bias error	Total error	Actual annual production[a]
1983	0.20%	0.21%	12.389
1984	1.67	1.67	12.999
1985	−0.40	0.82	13.569
1986	0.24	0.35	14.266
1987	1.33	1.33	15.502
1988	−0.37	0.57	16.124
1989	1.82	1.82	17.334
1983-89[b]	0.64	0.97	14.598

[a]Billion pounds.

[b]Average for 1983-89.

USDA analysts said the USDA broiler production error rates are about as low as possible, but they are unsure why. They stated that broiler production was easier to forecast than other meats because of the relatively constant production increase during the last few years.

The board's meat analyst noted that in 1989 the production error rates went up because of the 1988 upward price rises. The analyst's opinion is that producers increased production in response to these price increases, thus producing more than USDA anticipated.

Cattle Price Percentage Error Rates

Table V.5 summarizes the cattle price mean percentage error rates by year for 1983-89. Overall, cattle price mean error rates show overestimation bias error. The highest errors occurred in 1985 and 1986.

Table V.5: 1983-89 Cattle Price Percentage Error Rates

Year	Bias error	Total error	Average annual price[a]
1983	−3.85%	4.11%	$62.52
1984	−0.51	1.17	65.84
1985	−8.37	8.43	58.37
1986	−5.32	5.32	57.74
1987	0.64	0.89	64.68
1988	3.03	3.03	69.54
1989	−0.84	0.86	72.52
1983-89[b]	−2.17	3.40	64.46

[a]Per hundred pounds.

[b]Average for 1983-89.

USDA analysts said production bias error was a major reason for the price bias error. Reasons for production errors were discussed previously. The analysts said they have discussed the cattle production (and hence price) bias error many times, but they have not arrived at a consensus on what to do about it.

The board meat analyst said that large errors occurred in 1985 because the high 1984 prices did not continue into 1985, as had been anticipated. Instead, in 1985 prices weakened as producers began rebuilding their inventory following the 1983-84 drought. Weights were higher when producers began selling more cattle in 1985. Lower-quality higher-weight cattle resulted in declining prices.

USDA analysts said the large 1986 errors resulted from the dairy termination program, which had an unexpected effect on price and production estimates.

Hog Price Percentage Error Rates

Table V.6 summarizes the hog price mean percentage error rates by year for 1983-89. Overall, hog price forecasts show some overestimation bias error, especially in 1983-85, when the largest errors occurred.

Table V.6: 1983-89 Hog Price Percentage Error Rates

Year	Bias error	Total error	Average annual price[a]
1983	−9.64%	10.43%	$47.71
1984	−2.70	3.37	48.86
1985	−8.25	8.89	44.77
1986	4.47	4.90	51.19
1987	0.22	3.60	51.69
1988	0.99	3.00	43.39
1989	0.29	3.18	44.03
1983-89[b]	−2.09	5.34	47.38

[a]Per hundred pounds.

[b]Average for 1983-89.

A board analyst said a major drought as well as the payment-in-kind program reduced grain supplies and increased feed costs during 1983-85. The higher prices for grain forced producers to scale back their hog production plans and reduce their herds. The analyst believes that this led to lower prices than anticipated. In addition, unexpected decreases in 1985 cattle prices contributed to the unanticipated decline in hog prices.

Broiler Price Percentage Error Rates

Table V.7 summarizes the broiler price mean error rates by year for 1984-89. Broiler price mean error rates generally show underestimation bias error. The largest errors occurred in 1986-88.

Table V.7: 1984-89 Broiler Price Percentage Error Rates

Year	Bias error	Total error	Average annual price[a]
1984	1.28%	3.99%	$55.60
1985	−0.94	1.53	50.80
1986	6.70	7.04	56.90
1987	−5.24	5.41	47.40
1988	12.44	12.44	56.30
1989	1.61	4.15	59.00
1984-89[b]	2.64	5.76	54.33

[a]Per hundred pounds.

[b]Average for 1984-89. Broiler price rates are for 1984 through 1989 because USDA discontinued its 9-city average and began using a 12-city average in the second quarter of 1983.

USDA analysts attributed the large errors in 1986-88 to increased demand for broilers by the hotel, restaurant, and institution (HRI) trade, hot weather, and a salmonella scare that encouraged speculative buying. The board analyst said that in 1986 the broiler industry experienced a significant increase in demand by the HRI trade, as major fast food chains introduced chicken sandwiches and built up their stocks of broiler meat for their new products. Further, he noted that during the summer of 1986, extreme temperatures in the broiler growing areas caused speculation that supply would decline, increasing prices more than anticipated. There was a speculative overreaction, he believes, and as a result, prices fell more in 1987 than anticipated. In 1988, there was a repeat HRI demand increase and hot weather once again caused prices to exceed USDA estimates. According to the analyst, by the summer of 1988, prices adjusted to the new conditions and stabilized, allowing USDA to more accurately forecast prices for 1989.

Quarterly and Individual Monthly Error Rates

Single or multiyear forecast error averages provide comparisons between large numbers of individual commodities or variables. But such averages mask the dramatically higher errors exhibited during the earlier months in which USDA makes its forecasts. Table V.8 shows two measures demonstrating higher rates, individual monthly forecast errors and decision quarter forecast errors.[9]

[9]We selected a period early in USDA's forecasting process. We chose the 3-month period October to December for three reasons. First, USDA's outlook conference occurs during the quarter. The outlook conference represents a major publicity effort at releasing forecasts for the coming year. Second, grain consumption needed for the meat production forecasts is used as input into the president's budget-related commodity forecasts. These forecasts are made in November or December. Third, cow-calf and hog producers make decisions in the spring or fall about whether to sell off cows and sows or try to raise offspring. Thus, fall forecasts for the coming year can be important.

As shown in table V.8, the range of maximum under- and overestimates is rather large. The individual monthly forecast maximum underestimate, for example, was almost 24 percent for broiler prices, while the maximum overestimate was almost 30 percent for hog prices.

Table V.8: 1983-89 Commodity and Variable Forecast Error Rates

	Cattle		Hogs		Broilers	
Commodity variable	**Production**	**Price**	**Production**	**Price**	**Production**	**Price**
Bias error forecast						
Decision quarter average						
Average	5.19%	−4.46%	1.62%	−4.95%	1.21%	6.60%
Standard deviation	1.59	6.86	4.27	10.59	1.30	11.08
Maximum underestimate	8.93	6.53	10.53	7.81	2.92	23.62
Maximum overestimate	[a]	−15.36	−4.30	−23.66	−0.63	−11.81
Minimum error	3.98	−0.49	0.14	0.40	0.32	−1.71
Individual monthly forecast						
Maximum underestimate	10.38	7.97	11.36	15.02	3.38	23.62
Maximum overestimate	−0.57	−19.92	−4.30	−29.55	−2.07	−11.81
Minimum error	0	0	0	0	0	0
Total error forecast						
Decision quarter average						
Average	5.19	6.32	2.90	9.07	1.39	11.10
Standard deviation	1.59	5.20	3.53	7.36	1.10	6.56
Maximum error	8.93	15.36	10.53	23.66	2.92	23.62
Minimum error	3.98	0.49	0.14	0.40	0.32	1.71
Individual monthly forecasts						
Maximum error	10.38	19.92	11.36	29.55	3.38	23.62
Minimum error	0	0	0	0	0	0

[a]Not applicable since no overestimates occurred during the decision quarter.

Summary

When viewed over the 1983-89 period, USDA's total and bias errors were less than 6 percent and 3 percent, respectively. Error rates, however, were sometimes considerably larger when the forecasts were assessed on a yearly, quarterly, or monthly basis. The errors were particularly large during the early months of the forecast cycle, when less reliable information is available to the forecasters. Cattle production forecasts also had a consistently large bias error component, as indicated by the mean percentage bias error rates approximating the mean absolute percentage total error rates.

Accuracy of NASS Cattle and Hog Inventory and Broiler Production Estimates

In this appendix, we provide information in response to evaluation question 4, "How accurate are NASS's cattle and hog inventory and broiler production estimates?"[1] Bias error and total errors were less than 2 percent for the NASS estimates of cattle and hog inventories and broiler production over the period 1980-89. Error rates did not vary by more than 1 to 2 percent in any given year. However, while these errors were relatively small, the fact that inventories or production were generally underestimated supports bias error.

Percentage Error Rates

Table VI.1 summarizes overall annual percentage error rates for NASS's estimates of cattle and hog inventories and broiler production. Cattle inventory estimate errors, generally 1 percent or less through 1985 and 3 to 4 percent after 1985, were largest. Broiler production estimate errors, generally from 1 to 2 percent, were next. Hog inventory estimate errors, generally 1 percent or less, were smallest. Cattle-on-feed and broiler production bias error and total error measures were quite similar. This indicates that all the revisions were in a similar direction, increasing inventory and production levels.

Table VI.1: Mean Percentage Error Rates for NASS's Estimates for Cattle-on-Feed, Hogs, and Broiler Production

	Cattle-on-feed		Hogs and pigs		Broilers	
Year	Bias error	Total error	Bias error	Total error	Bias error	Total error
1980	0%	0%	−0.32%	0.40%	1.40%	1.40%
1981	−0.03	0.15	0	0	0.97	0.97
1982	0	0	0.75	0.75	0.79	0.79
1983	0.01	0.04	1.07	1.07	1.12	1.12
1984	0.25	0.25	0.91	0.91	1.52	1.52
1985	0.89	0.89	0.21	0.21	1.77	1.95
1986	3.50	3.50	−0.14	0.31	2.07	2.07
1987	4.14	4.21	−0.12	0.96	1.10	1.10
1988	4.07	4.07	0.68	0.76	2.09	2.09
1989	3.13	3.13	0.10	0.76	0.76	0.76
1980-89	1.59	1.61	0.31	0.61	1.36	1.38

Table VI.2 summarizes the maximum and minimum individual monthly (cattle and broiler) or quarterly (hogs) estimate errors. As shown in the table, the errors ranged from a maximum underestimate of 7.5 percent to a maximum overestimate of 1.9 percent.

[1]The NASS estimates we reviewed are for recently completed periods, whereas the USDA forecasts are for future periods.

Table VI.2: 1980-89 Maximum Monthly Percentage NASS Estimate Error Rates for Cattle-on-Feed, Hogs, and Broiler Production[a]

Error type	Cattle-on-feed	Hogs and pigs	Broilers
Maximum underestimate	7.2%	2.4%	7.5%
Maximum overestimate	−0.9	−1.9	−1.1
Minimum estimate	0	0	0

[a]Total errors are the same as the bias error measures.

Concerns About Cattle-on-Feed Estimate Errors

Users expressed concern about the cattle-on-feed estimate errors, which averaged 3 to 4 percent after 1985. These errors became apparent when the 1987 Census of Agriculture was released in 1990. The census data showed that over 90 percent of the bias and total error occurred as a result of NASS's estimates for Iowa.

The error occurred because NASS failed to maintain the universe of Iowa cattle feeders from which NASS sampled in making its estimates. In a February 1990 memorandum to the secretary of USDA, the NASS administrator explained that the Iowa revisions occurred in part since 16,000 small feeders market two thirds of the fed cattle. Keeping the list of Iowa farm feeders up to date was very expensive, and in the "era of declining budget resources for this work the list was not maintained at an appropriate level."

NASS updated its list of Iowa farm feeders, and a new sample, drawn from the corrected universe, confirmed the census data. NASS corrected its estimates for 1986 through 1989 on the basis of the census data and sample. NASS officials plan to keep the corrected universe of smaller feeders current and anticipate that cattle-on-feed estimate error will return to its historic level of 1 percent or less.

Concerns About Broiler Production Estimate Errors

Although 1988 NASS broiler production estimate errors averaged only 2.09 percent, the National Broiler Council expressed concern about these errors. The council believed that some individual monthly errors were too high and were caused by coordination problems between NASS and the Food Safety and Inspection Service (FSIS). NASS uses the service's data to compile and publish the number and pounds slaughtered under federal inspection. The council's analysis indicated that for 1988, the smallest error was in April at 0.02 percent and the largest was in September 1988 at 7.3 percent. A council staff member deemed this 7-percent revision unacceptable and unnecessary. In a memo to his board of directors, he provided the following analysis.

"At fault are not the people involved, but rather the system. FSIS is responsible for providing the individual slaughter plant data to NASS. However, if an inspector fails to submit plant data, or if NASS suspects the data is wrong, the NASS poultry statisticians are not permitted to directly contact the inspector of the plant. NASS must go through FSIS bureaucracy and have the designated FSIS official contact the inspector. More often than not, the reply from FSIS is not received in time for the first publication of the monthly data. Further, NASS is also prohibited from estimating their own number for missing or incorrect plant data. Thus, known, wrong poultry data is essentially published each month."

We discussed the National Broiler Council staff member's concerns with a NASS official, who acknowledged that the council's assessment of the problem and its cause was correct. A NASS analyst said, however, that NASS could substitute its estimate for missing or incorrect plant data provided it disclosed that this was done. As of October 1990, NASS is developing computer programs to identify missing or questionable FSIS plant information and substitute its estimates for this information in its published reports.

Opportunities for Improvement

Overall, the NASS estimates for 1980-89 were quite accurate; they have shown very small errors. Except for cattle-on-feed, the NASS revisions showed no increasing estimate error trend. In spite of the overall small total annual errors, bias errors for particular months were somewhat larger. The 7-percent maximum estimate errors for cattle-on-feed and broiler production were large. These errors have resulted in concerns from estimate users.

While the higher errors are of some concern, NASS is to be commended for revising estimates when it sees the need. NASS can do more, however, to inform data users what the effect of the revisions may be. While NASS does include confidence interval information for probability samples such as the hogs and pigs report, no accuracy measures are included for the nonprobability samples such as cattle-on-feed and broiler production. NASS can include in its publications information on average error rates for cattle-on-feed and broiler slaughter. Further, NASS can expedite the computer programming necessary to identify the missing FSIS broiler slaughter data and substitute historic information for the missing plant reports. This should improve estimate accuracy for broiler slaughter estimates.

In a letter to GAO, the NASS administrator stated that during the 1980's he believed both the quantity and quality of agricultural statistics have been negatively affected by budget cuts. With regard to meat statistics,

the administrator expressed concern about the cattle-on-feed and the hogs and pigs reports. He stated that the limited resources forced NASS to completely eliminate one of its two area frame benchmark surveys, which has undoubtedly affected the quality of the December 1 hog and pig estimates. He stated that the recent large revisions in Iowa cattle-on-feed estimates are partially attributable to reductions in resources available for keeping the Iowa list of feeders up to date.

Benchmarks for USDA Forecasts and Estimates

This appendix responds to evaluation question 5, "What other forecasts and estimates are available for use as benchmarks against which to evaluate the USDA forecasts and NASS estimates?" We did not find other forecasts or estimates that could be used as benchmarks for comparison and analysis without some reconstruction.[1] For the most part, this was because historical information for other forecasts and estimates was not easily accessible. However, we were able to reconstruct the annual American Agricultural Economics Association forecasts of production and prices as well as the Knight-Ridder Financial News Service predictions of NASS estimates of cattle-on-feed and hogs inventories for this purpose.

Additional benchmark forecasts could be used for comparison with the forecasts and estimates. These include consensus forecasts, naive models, and futures market prices.

AAEA Consensus Forecasts

In July, AAEA member economists submit forecasts for selected commodities and variables and these are assembled into a consensus forecast. As many as 100 economists participate but not for all commodities or variables. Two annual forecasts are made for each variable, one for the next year and one for the current year. AAEA combines the individual forecasts into consensus forecasts, which are published in late July or early August at the AAEA national convention.

We obtained the AAEA 1984-89 consensus forecasts for cattle, hog, and broiler production and prices and computed the mean percentage errors for these forecasts. We then compared the mean percentage errors for the USDA forecasts with those for the AAEA forecasts.

As shown in table VII.1, the differences between USDA and AAEA errors are quite small. AAEA price and cattle production forecasts for the next year are, on the average, slightly more accurate than the USDA forecasts. Conversely, the USDA forecasts for the current year tend to be a little more accurate than AAEA's. However, the AAEA current year forecasts for cattle production and broiler prices are slightly more accurate. We did not calculate whether these differences are statistically significant.

[1]For example, the forecasts were seldom prepared on the same date and for the same time periods. Thus, we had to combine different forecasts to get an average for a comparable USDA forecast.

Table VII.1: 1984-89 Comparison of USDA and AAEA Bias Errors[a]

	Future year		Current year	
	USDA	AAEA	USDA	AAEA
Production				
Cattle	6.20%	4.04%	1.94%	1.56%
Hogs	0.84	0.92	0.44	0.75
Broilers	1.20	2.87	0.40	0.82
Price				
Cattle	−5.76	−4.03	−0.82	−0.97
Hogs	−5.74	−2.12	0.16	−0.89
Broilers	7.68	5.15	1.99	1.58

[a]Future year bias error measures are for 1985-89; current year measures are for 1984-89.

Total error measures exhibit similar results but higher error rates. For cattle production, bias error and total error measures were identical, meaning that all the individual errors are in the same direction.

Knight-Ridder Consensus Estimates

The Knight-Ridder Financial News Service publishes private analysts' predictions of the number of cattle-on-feed by month and hogs and pigs by quarter. Knight-Ridder publishes this information several days before NASS releases its estimates.

A NASS analyst compared the Knight-Ridder consensus estimates and the NASS quarterly 10-state hogs and pigs estimates during 1985-88. His analysis indicated that when compared to the year-end actuals, the Knight-Ridder consensus estimate was more accurate than the NASS estimates in only 1 of the 16 quarters during this period.

We found that NASS's estimates were about equal. We obtained Knight-Ridder's 1989 cattle-on-feed and hogs and pigs estimates and computed the mean percentage error of these estimates for 1989. In table VII.2, we compare the mean percentage error for the NASS and Knight-Ridder consensus estimates.

Table VII.2: 1989 NASS and Knight-Ridder Cattle-on-Feed and Hogs and Pigs Estimate Error Rates

	Bias error	
Estimation	Cattle-on-feed	Hogs and pigs
NASS	3.12%	0.38%
All Knight-Ridder consensus estimates	3.18	−0.71

Other Available Benchmarks

A number of additional benchmarks could be used for comparison to USDA's forecasts. These include other consensus forecasts, naive models, and futures markets.[2] USDA could use these other benchmarks.

Other published forecasts and estimates—such as those published by the WEFA Group, Food and Agricultural Policy Research Institute, Sparks Commodities, Connell Commodities, and Cattle-Fax—could be used for this purpose if historical information had been maintained in an easily accessible format or the forecasters had been willing to provide the historical information.

A board analyst has conducted some research using commodity futures markets for selected crops. He concluded that the futures markets were much more responsive to short-term changes but that for forecasts approaching 1 year, USDA forecasts were quite competitive. Other existing research indicates that meat commodity futures prices can be used as benchmarks but are not necessarily superior to forecasts.[3]

USDA, as well as published research, indicates that naive models may or may not demonstrate superior forecast accuracy, compared to USDA forecasts. Board analysts are now conducting additional research into the use of naive models as benchmarks for their forecasts.

Summary

In this report, we focused on bias error and benchmarks to examine the accuracy of USDA forecasts and estimates. Our benchmarks indicate the potential to improve some of the USDA forecasts. We found that the 1-year AAEA forecasts, for example, were more accurate than USDA's forecasts for cattle production and all meat prices but less accurate than USDA's forecasts for broiler production. The Knight-Ridder estimates were about the same as the NASS estimates.

[2]For part of our analysis, we did compute naive model forecasts for selected variables, which resulted in error rates similar to those of the AAEA and Knight-Ridder benchmark comparisons.

[3]Philip Garcia et al., "Pricing Efficiency in the Live Cattle Futures Market: Further Interpretation and Measurement," American Journal of Agricultural Economics, February 1988, pp. 162-69; Philip Garcia, Michael A. Hudson, and Mark L. Waller, "The Pricing Efficiency of Agricultural Futures Markets: An Analysis of Previous Research Results," Southern Journal of Agricultural Economics, 20:1 (July 1988), 119-30; Richard E. Just and Gordon C. Rausser, "Commodity Price Forecasting With Large-Scale Econometric Models and the Futures Market," American Journal of Agricultural Economics, May 1981, pp. 197-208; Emmett Elam and Bruce L. Dixon, "Examining the Validity of a Test of Futures Market Efficiency," The Journal of Futures Markets, 8:3 (1988), 365-72; David A. Bessler and Jon A. Brandt, "An Analysis of Forecasts of Livestock Prices," Texas Agricultural Experiment Station paper number 22437, May 1990.

Our assessment of bias error rates indicates that several forecasts and estimates such as those for hogs and broiler production are quite accurate. However, higher bias error rates for cattle production and prices again illustrates that modest improvements are needed.

Policy and Operational Implications

This appendix provides information that addresses evaluation question 6, "What are the implications of forecast and estimate error and bias error on U.S. government policy, program, and budget decisions?" We believe that forecast errors can have implications with respect to U.S. government policies, programs, and budget decisions. One example involves USDA's implementation of the Meat Import Act of 1979. USDA uses forecasts to establish the maximum imports allowed by the act and to limit imports to that maximum. We estimate that during 1983-89, excess meat imports totaled 135.6 million pounds, which is about 1.4 percent of total meat imports, in part because USDA used biased forecasts that underestimated actual production and imports. USDA commented that it was improbable that such a very small error rate could be significantly reduced in a cost-effective manner. (Other forecast use examples are discussed in appendix III.)

Excessive Imports Under the Meat Import Act of 1979

Public Law 88-482, as amended by the Meat Import Act of 1979 (Public Law 96-177), restricts imports of certain fresh, chilled, and frozen beef. The law requires that before January 1 of each year, USDA (1) establish the maximum imports allowed for the following year in accordance with a specified formula and (2) forecast anticipated imports for the following year. If forecasted imports equal or exceed 110 percent of the maximum allowed under the formula, and if no import limitation is already in place, the president is required to restrict imports to the maximum allowed under the formula.

Within USDA, ERS calculates the maximum beef imports allowed, using the USDA beef production and per capita cow-beef production forecasts, and FAS forecasts imports of feeder cattle.

We analyzed USDA's per capita cow-beef production forecasts and FAS's forecasts of anticipated feeder cattle imports to determine (1) if these estimates contain bias error and (2) what effect any bias error would have on USDA's implementation of the Meat Import Act of 1979.

Forecasts used in implementing the act did contain bias error, overestimating maximum allowed imports and underestimating actual imports. As a result, we estimate that during 1983-89, excess beef imports totaled 135.6 million pounds, which is about 1.44 percent of total beef imported during this period. As shown in table VIII.1, we estimate that 30.3 million of the 135.6 million pounds of excess beef imports resulted from bias error in USDA forecasts used by ERS and 105.3 million resulted from

biased FAS import forecasts and estimates. Virtually all the excess imports occurred in the 3 years 1983, 1987, and 1988.

Table VIII.1: 1983-89 Excess Beef Imports[a]

Year	Actual imports	Maximum imports		Excess imports from biased forecasts		
		GAO	ERS	USDA	FAS	Total
1983	1,249.1	1,222.8	1,231.0	8.2	18.1	**26.3**
1984	1,140.5	1,219.9	1,228.7	•	•	•
1985	1,314.1	1,312.6	1,319.0	1.5	•	**1.5**
1986	1,413.6	1,428.6	1,440.0	•	•	•
1987	1,488.9	1,431.3	1,440.0	8.7	48.9	**57.6**
1988	1,563.8	1,513.6	1,525.5	11.9	38.3	**50.2**
1989	1,234.3	1,357.7	1,369.8	•	•	•
Total, 1983-89	9,404.3			30.3	105.3	**135.6**
% of actual imports				0.32%	1.12%	**1.44%**

[a]Millions of pounds.

USDA forecasts of beef production and per capita cow-beef production used by ERS to establish the maximum imports allowed for 1983-89 contained bias error, underestimating beef production by 4 percent and per capita cow-beef production by 7 percent. After adjusting for this bias error, we estimate that the maximum imports allowed should have been 9,486.5 million pounds, or 67.5 million pounds less than the 9,554 million pounds computed by ERS.

However, we estimate that only 30.3 million pounds of excess beef were imported as a result of this bias error. This is because (1) actual imports did not exceed the maximum allowed in some years and (2) when imports did exceed the maximum allowed, we attributed only the portion of excess imports to this bias error that exceeded our recomputed maximum but not the maximum computed by ERS. As discussed below, we attributed imports in excess of the maximum computed by ERS to bias error in FAS forecasts and estimates.

FAS's forecasts during 1983-89 underestimated actual imports by 2.13 percent. These forecasts either (1) did not indicate that imports would exceed the maximum imports allowed, as computed by ERS, or (2) indicated that imports in excess of these maximums would be small (for example, 6.50 percent in 1983, 0.42 percent in 1987, and 0.03 percent in 1988). As a result, FAS officials did not initiate action during 1983-89 to have the president restrict imports to the maximum allowed. However,

they did initiate voluntary restraint agreements with importing countries to limit imports to the maximum allowed in 1983, 1987, and 1988—years they forecast imports in excess of these maximums.

Although FAS initiated voluntary restraint agreements in 1983, 1987, and 1988, these agreements were not effective in limiting imports to the maximum allowed. This was because FAS estimates of actual imports during 1983-89 understated anticipated imports by 2.24 percent. Actual imports exceeded the maximum allowed by 38.3 million pounds in 1988.

Agency Comments and Our Response

USDA agreed that voluntary restraint agreements were not totally effective in keeping meat imports below the maximum allowed. However, USDA's analysis indicates that forecasting errors were not the primary causal factor. USDA believes that the excess meat imports seem of limited practical importance. During the 7 years studied, excess imports of 1.4 percent translate into less than 0.1 pounds per capita annually. USDA believes it is improbable that this error rate could be significantly reduced in a cost-effective manner. In this regard, our suggestion that census data be used in preference to customs data lacks merit, given the longer lag time required to obtain census data.

FAS uses U.S. Customs Service monthly reports of imports for its estimates of actual imports, even though it knows these reports contain bias error that understates actual imports.[1] FAS officials believe that Executive Order 11539 mandates the use of the Customs Service reports for its decisionmaking purposes. However, we believe that Executive Order 11539 leaves to USDA discretion whether or not to use Customs Service data in implementation of the Meat Import Act of 1979. At a minimum, this order provides sufficient discretion that FAS could correct for bias errors in these data.

We believe our concerns about excess beef imports in this report are still valid. The error rates for the 4 of the 7 years in which imports approach the trigger are considerably higher than 1.4 percent. In years in which imports do not approach the trigger level, no issue exists. Further, it may be possible to cost-effectively construct forecasts that consider missing information. NASS is now constructing such forecasts for missing broiler slaughter statistics.

[1]Concern about the accuracy of import statistics is not new. See U.S. General Accounting Office, Federal Statistics, Merchandise Trade Statistics: Some Observations, GAO/OCE-89-1BR (Washington,D.C.: April 21, 1989), for a comprehensive analysis of data concerns.

Improving USDA's Forecast Management Process

This appendix provides information responding to evaluation question 7, "How can USDA improve its forecasts and estimates?" Our analysis of the forecast and estimate errors as well as of the benchmarks allows us to draw some conclusions about their reasonableness and accuracy. The benchmarks indicate that the 1-year meat prices as well as cattle production forecasts can be improved. Accuracy for the 1-year forecasts, such as those made during the early months of the forecast cycle, show the highest error rates. And although the NASS estimates appear reasonable from a benchmark standpoint, the cattle-on-feed and broiler production estimates do exhibit relatively high bias error rates. This again indicates the potential for improvement.

We believe that USDA can improve accuracy by improving its management of the forecasting process. In earlier reports on USDA's forecasting efforts, we identified the elements of a successful management program that, if properly implemented, should improve accuracy. These elements, which also pertain to USDA's forecasting and NASS's estimating of meat products, include

- measuring and reporting accuracy, including total and bias error, to determine how accurate they were;
- documenting, for subsequent analysis, the methodologies used, including all major assumptions and other information necessary to understand how they were made;
- assessing the reasonableness of USDA's accuracy by comparing to other benchmarks; and
- conducting an active evaluation effort to identify the need for, and then make, needed improvements.

Measuring and Reporting Accuracy

USDA can improve its accuracy measurement and reporting by first measuring the error for the forecasts and estimates addressed in this report and then reporting the results. We believe it is particularly important to report results if error rates are relatively high or bias error is clearly indicated. Forecast users should know how accurate the forecasts are in order to know what level of confidence to place in them.[1]

While USDA does have internal studies that evaluate meat forecast accuracy, no such information has been provided to WASDE users. WASDE does

[1]U.S. General Accounting Office, What the Department of Agriculture Has Done and Needs to Do to Improve Agricultural Commodity Forecasting and Reports, GAO/RED-76-6 (Washington, D.C.: August 27, 1975), p. ii.

provide information on forecast accuracy for crop forecasts. It is particularly important to inform users about forecasts that contain consistent bias error. An ERS analyst stated that a draft article addressing meat forecast accuracy is now awaiting publication.

NASS estimates can be more useful to users if historic revision rates that correspond to the accuracy measures discussed in this report are published with the estimates. At the time of our evaluation, NASS published accuracy measures for its hogs and pigs estimates. No accuracy measures, however, are reported for the cattle-on-feed or broiler production.

Documenting the Process

With regard to improving documentation, USDA could prepare a manual describing the forecast methodologies used along with all the major assumptions and other information necessary to understand how they were constructed.[2] It would also be useful if USDA constructed a data base of past forecasts.[3] Assumptions and reasons for errors can be included in an events register with the forecast data base.[4]

NASS has prepared a manual explaining its estimating procedures, but USDA has no comparable publication.[5] While USDA does list assumptions for its meat forecasts, the list is not published with the WASDE reports. NASS retains its past estimates and changes in a data base, which facilitates subsequent analysis. No USDA data base or events register currently exists for meat forecasts.

While USDA's meat forecast committees actively discuss why forecast errors occur, such information is not documented. The reasons for forecast error included in this report had to be reconstructed after extensive review of past forecast errors. (See appendix V.)

[2]U.S. General Accounting Office, What the Department of Agriculture Has Done, p. ii.

[3]U.S. General Accounting Office, USDA's Commodity Program: The Accuracy of Budget Forecasts, GAO/PEMD-88-8 (Washington, D.C.: April 1988), p. 76.

[4]W. L. Gorr, "Use of Special Event Data in Government Information Systems," Public Administration Review, 46 (November 1986), 532-39.

[5]USDA/Statistical Reporting Service, Scope and Methods of the Statistical Reporting Service, misc. publication number 1308 (Washington, D.C.: rev. September 1983).

Using Benchmarks to Assess Error Reasonableness

USDA can further assess the reasonableness of its forecasts and estimates by comparing them to other benchmarks. These benchmarks can be combined forecasts derived from other available forecasts or estimates, or they can be internally constructed using naive models of historic averages that compensate for historic error.[6]

USDA has not constructed any benchmark forecasts for comparison to its meat forecasts. While USDA informally compares its forecasts to other private sector forecasts, there is no effort to construct consensus forecasts and systematically compare forecast accuracy. Further, there is no effort to construct naive models or other benchmarks. NASS analysts, however, compared their estimates to the Knight-Ridder benchmarks and concluded that the benchmarks were not as accurate as the NASS reported estimates.

Evaluation Efforts to Identify Improvement Needs

Forecast organizations need an active evaluation effort to maintain the forecast data base and events register, identify why errors occur, improve the technical aspects of forecasting, develop benchmarks, and obtain user feedback on forecast utility.[7] Methods could be improved through periodic peer group reviews, as well as coordination with non-USDA experts. It is important to assess forecast and estimate user concerns. Reports should be as useful as possible to all potential users.[8]

For several years, USDA has proposed adding staff who will be responsible for evaluating its forecasting program. The additional appropriations request has not been approved. Individual analysts located in the board, ERS, NASS, the Agricultural Stabilization and Conservation Service, and the Economic Analysis Staff now do periodic evaluation in response to specific requests. Agencies that report to the assistant secretary for economics, which include the board and NASS, hold annual user feedback meetings. Every fourth year, these meetings include specific presentations focusing on livestock and meat forecast and estimate user concerns.[9] However, data users can comment on any topic each year.

[6]U.S. General Accounting Office, USDA's Commodity Program, p. 76.

[7]U.S. General Accounting Office, What the Department of Agriculture Has Done, p. ii.

[8]U.S. General Accounting Office, The Statistical Reporting Services' Crop Reports Could Be of More Use to Farmers, GAO/GGD-78-29 (Washington, D.C.: April 13, 1978), p. iii.

[9]USDA, Summary of 1988 Data Users Meetings (Washington, D.C.: Economic Research Service, 1988).

NASS could improve its broiler production estimate accuracy when it completes a computer program that allows the use of historic broiler plant production information when the Food Safety and Inspection Service production reports for specific plants are missing. This program could serve as a naive model.

Recommendation

To improve meat production and price forecasts and estimates, we recommend that the secretary of USDA direct the board and NASS to develop a process to more clearly identify, report, and correct bias errors when they occur and to provide better documentation of their procedures and assumptions.

Legislation Suggesting USDA Secretary to Modify Forecasting Procedures

In response to one of our previous reports, the Food, Agriculture, Conservation and Trade Act of 1990 suggests the secretary of USDA implement new forecasting practices.[10] Specifically, the legislation states that

"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 demand forecasts;

(3) document its forecasting methods; and

(4) correct weaknesses in its various forecasting components."

The board chairperson stated that actions are either planned or under way to improve documentation, measurement and reporting, the use of benchmarks and naive models, and consultation with the user community.

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

Costs and Benefits of Implementing Our Recommendation

If our recommendation is implemented, its beneficial effect should be to increase forecast and estimate accuracy relative to what would have occurred without implementation. Since NASS's estimates program provides the primary publicly available data concerning meat production, and USDA's forecasts are widely used throughout the industry, accuracy improvements will directly benefit USDA information users, and ultimately our entire economy, through more efficient allocation of resources.

Costs will be incurred. Some additional staff resources will be required to conduct evaluations. The board chairperson estimates at least 1 staff year will be needed for establishing a routine evaluation program for all forecasts. Further, additional computer programming will be needed for NASS's monthly poultry slaughter report and setting up a board data base. We believe these costs, however, will be insignificant compared to the potential benefits that can be derived.

Background Information on the Meat Import Act of 1979

The Meat Import Act of 1979 (Public Law 96-177) provides for the imposition of import controls on certain fresh, chilled, and frozen beef.[1] Like its predecessor, Public Law 88-482, the 1979 act mandates quantitative import controls if imports are expected to equal or exceed 110 percent of the formula quantity. The most widely publicized feature of the 1979 act is its countercyclical approach to computing the allowable import level.[2] The 1989 free trade agreement with Canada exempted it from this law. A FAS representative said the adjusted basic import limits are lower since Canada's portion has been removed.

The secretary of USDA must publish an adjusted base quantity or "quota" for the coming year's imports before January 1 of each year. This quantity is computed on the basis of past U.S. production levels and projections for the coming year, and it is not revised as the year advances.

The secretary also publishes quarterly estimates of the quantity of meat products covered by the Meat Import Act that would enter the United States during the year without the imposition of limitations under the law. The first quarterly import estimate is published along with the year's adjusted base-quantity level before January 1, with subsequent estimates appearing before April 1, July 1, and October 1.

If USDA's estimate of imports in the absence of quotas equals or exceeds 110 percent of the adjusted base-quantity level determined at the beginning of the year, the president must proclaim that total imports for the calendar year will be limited to the adjusted base-quantity level (but not less than 1,250 million pounds). It is up to the secretary to allocate country shares within this global total, on the basis of the shares of the U.S. market that supplying countries had during a previous representative period. The president may, under certain circumstances, suspend the proclamation or increase the total quantity that may be imported.

Import limitations may be proclaimed at the beginning of any calendar quarter. They may also be removed at the beginning of a quarter on the basis of a change in the estimate for total calendar year imports, except that if limitations have been imposed for the third quarter, they may not

[1]Veal, mutton, and goat products are also covered by the Meat Import Act of 1979. They represent a minor part of the total import quota and therefore are not discussed in this appendix.

[2]Information included in this appendix is based on an FAS Circular, "Dairy, Livestock, and Poultry, Supplement 5-85, U.S. Meat Import Law," July 1985.

be removed on the basis of the fourth quarterly estimate without extraordinary action by the president.

Formula for the Adjusted Base Quantity

The Meat Import Act of 1979 provides for a basic import level of 1,204.6 million pounds (product weight) of meat products covered in the law. This base quantity, the average import level for 1968-77, is modified annually by two factors: a production adjustment factor and a countercyclical factor.

The production adjustment factor is a 3-year moving average of the domestic production of meats covered in the present law, divided by average U.S. production of those meats in 1968-77. Estimated production for the coming year is used for the third year of the 3-year moving average, which is the numerator of this factor. The law states that the carcass weight equivalent for all imported cattle other than dairy and breeding cattle must be deducted from the U.S. production total for each year involved in the computations.

In the long run, the production adjustment factor tends to increase the allowable import level in line with the long-run trend in the U.S. beef production. However, in the shorter term, the production adjustment factor would, according to some analysts, tend to allow imports to exaggerate the price effects of the domestic cattle cycle by increasing imports during the liquidation phase of the cycle when beef supplies are already plentiful.

To correct this perceived flaw in the formula, the 1979 act authorized the countercyclical factor, which is used to modify the base-quantity level. The countercyclical factor is a 5-year moving average of the U.S. per capita cow-beef supply, divided by a 2-year moving average of the per capita cow-beef supply. A current forecast of the coming year's per capita cow-beef supply is used for the fifth year of the moving average in the numerator and the second year of the moving average denominator of this factor.

When the U.S. cattle industry is in the liquidation phase of the cattle cycle and beef production is relatively high, the denominator of the countercyclical (2-year average) is larger than the numerator of the factor (5-year average). Therefore, the factor tends to reduce the allowable level of imports. When the cattle cycle turns to the rebuilding phase and production is low, the numerator is larger than the denominator, and the import level is increased. In 1980, a year of reduced domestic

beef production, the countercyclical factor increased the allowable import level by about 30 percent.

Once the adjusted base-quantity level for a particular year has been calculated, the key point of reference for import estimates is not the adjusted base quantity but, rather, the "trigger point" or "trigger level," which is 110 percent of the adjusted base quantity. It is only when imports are expected to equal or exceed the 110-percent figure that controls must be imposed.

Presidential Authority

The president has limited authority to suspend or increase quantitative limitations proclaimed under the Meat Import Act. The president may suspend or increase the limitations proclaimed under the Meat Import Act only if, after publication in the Federal Register of the intention to take such action, to allow public comment on it, the president determines and proclaims that such action is required by overriding economic or national security interests or that the supply of meat will be inadequate to meet domestic demand at reasonable prices. The president may also suspend or increase the limitations if trade agreements entered into after December 31, 1979, will ensure that the imports will not exceed the adjusted base-quantity level for the year. However, the president must publish a statement of intent to lift or increase the import limitation in the Federal Register and allow a 30-day comment period before the action.

When the countercyclical factor is below 1 (ample domestic cow-beef supplies), the president's authority to suspend or increase limitations is further restricted. Limitations must remain in place unless—during a declared national emergency—the president proclaims that the suspension is required by overriding national security interests of the United States or unless there is a shortage resulting from a national disaster, disease, or major market disruption. However, the law states that if actual data for the first two quarters indicate that the countercyclical factor for the year should be 1 or more, then these severe restrictions no longer apply.

Voluntary Restraint Agreements

In some past years in which it appeared likely that imports would exceed 110 percent of the adjusted base quantity under Public Law 88-482, the U.S. government has negotiated a program of voluntary restraint agreements and exchanged letters with supplying countries to ensure that total imports of meats covered by the law would not exceed

the trigger level. By this device, the U.S. government has, for the most part, avoided having to impose and administer formal import quotas, while supplying countries have been guaranteed equitable shares of the largest, practical total volume of imports under the law.

Import Monitoring and Control

The U.S. Customs Service monitors all meat imports subject to the Meat Import Act. When a voluntary restraint agreement program is in effect, the U.S. Customs Service, on direction from USDA, institutes special procedures to monitor imports from any country approaching its limit to help ensure that imports from that country do not exceed the negotiated level.

The Customs Service is responsible for ensuring that USDA regulations implemented to carry out the voluntary restraint agreements are enforced, and if formal quotas are in place under the Meat Import Act, that imports for each country are held to levels the secretary of USDA has determined. Countries may not export meats covered under the law to the United States as long as the import restrictions remain in effect.

USDA Agencies Responsible for Implementing the Act

Two USDA agencies are responsible for implementing the law. FAS makes the quota beef import forecasts. ERS calculates the adjusted base quantity and trigger levels.

FAS Quota Meat Forecasts

FAS staff forecast anticipated quota meat imports using information from agricultural attaches in the major quota meat importing countries, actual import information provided by the U.S. Customs Service, and their own analysis.[3] Since their objective is only to determine whether imports will exceed the adjusted base, the FAS analyst said their forecasts are of limited utility and less emphasis is placed on the forecasts when it is clear actual imports will not exceed the maximum allowed.

FAS has other implementation responsibilities. Should the forecasts exceed the adjusted base, it must initiate negotiations with the foreign governments to establish voluntary restraint agreements. Should these

[3]The three countries exporting the largest amount of beef to the United States are Australia, New Zealand, and Canada. Canada is no longer subject to the act, because of the 1989 bilateral trade agreement.

efforts not be successful, then it must initiate the import cutoff process, as established in the law.

ERS Calculations

ERS staff use historic USDA information and USDA forecasts of beef production, other meat production, per capita domestic cow-beef consumption, and average total carcass weight to calculate the adjusted base and trigger levels. The ERS administrator sends the adjusted base and trigger levels to the FAS administrator, who publishes it in the Federal Register by the first of the year.

Comments From USDA

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

January 22, 1991

SUBJECT: USDA Review of GAO Draft Report Entitled, "Short Term Forecasting: Accuracy of USDA's Forecasts and Estimates of Meat Production, Prices, and Inventories," dated December 3, 1990

TO: Eleanor Chelminsky
Assistant Comptroller General
Program Evaluation and Methodology Division
U.S. General Accounting Office

USDA is gratified with GAO's findings that the Department's meat sector forecasts are, for the most part, "reasonably accurate" and, in many instances, "extremely accurate." Despite USDA's excellent record in this area, the Department fully agrees with GAO's conclusion that there is room for improvement. To this end, GAO's draft report provides constructive criticism and is helpful in sharpening USDA's analytical focus.

In preparing this report, GAO made a strong effort to understand the complex forecasting procedures employed by USDA to arrive at the forecasts being scrutinized. The report freely acknowledges that unpredictable events may reduce forecast accuracy, i.e., government programs and severe weather anomalies can significantly change the agricultural outlook. Further, GAO recognizes that resource limitations may be a constraining factor. USDA appreciates GAO's constructive approach to this study.

It is in this spirit that USDA has reviewed GAO's draft report. A marked-up copy of the draft report which consolidates detailed comments by NASS, FAS, ERS and WAOB is being provided to GAO under separate cover. The observations which follow focus primarily on substantive issues. However, since reference is made to World Agricultural Outlook Board projections, forecasts, and estimates, the role of the Board should be clarified. Readers of the report should understand that the Board's role is to coordinate an interagency process aimed at reviewing methodologies and clearing analytical results for internal use and public release. Thus, the results of this process are properly attributable to USDA, rather than the Board.

USDA notes that GAO has chosen not to use statistical measures of forecast accuracy and comparability commonly used in agricultural supply, demand, and price forecasting. These measures include root mean square error, Theil's U1 and U2, and the coefficients of correlation and determination. It is recognized that GAO's choice of statistical measures was limited by the relatively short time period for which comparable data were available for examination. In this regard, USDA notes that it can be hypothesized that certain USDA forecasts may be biased, but in the absence of sufficient data, statistical measures of forecast bias are highly suspect.

USDA agrees with GAO's observation that Voluntary Restraint Agreements have not been totally effective in keeping meat imports below trigger levels. However, USDA's analysis indicates that forecasting errors have not been the primary causal factor. In any event, when put in perspective, GAO's comments with respect to excess meat imports seem of limited practical importance. During the 7 years studied, excess imports of 1.4 percent translate into less than 0.1 pounds per capita on an annual basis. It is improbable that this error rate could be significantly reduced in a cost-effective manner. In this regard, GAO's suggestion that Census data be used in preference to Customs data lacks merit given the longer lag time required to obtain Census data.

GAO observes that USDA can further assess the reasonableness of its forecasts by comparing them to benchmarks and naive forecasts. In practice, USDA analysts use benchmarks and naive forecasts but do so with caution. For example, analysts must guard against circular reasoning in using consensus forecasts. Many of the private sector forecasts reported by the wire services reflect little more than "educated guesses" based on pre-release qualitative assessments obtained from USDA analysts. Other private sector forecasts reflect even less analysis. Nevertheless, despite these concerns, USDA concurs that carefully selected benchmarks and naive forecasts are useful and should be systematically documented.

GAO recommends improved documentation, improved accuracy measurement and reporting, increased use of benchmarks and naive models, and greater consultation with the user community. USDA strongly supports all of these recommendations and is pleased to report that actions are either planned or underway which address each of them.

Using crop data as a prototype, WAOB has developed a comprehensive plan for monitoring and evaluating USDA commodity forecasts. The plan was submitted to and approved by the Assistant Secretary for Economics. In the context of GAO's recommendations, critical components of the plan call for construction of a forecast data bank; monthly monitoring and updating of the data banks; routine calculation of forecast reliability measures; consultations with industry analysts; and, development of recommendations to improve forecasts.

WAOB has proposed to establish 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 Interagency Commodity Estimates Committee 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. An adjunct responsibility of the Coordinator will be to develop a manual, as envisioned by GAO, which will describe operating procedures, document USDA forecasting performance, discuss methodologies and outline major assumptions.

USDA agrees that it is important and useful to maintain a working knowledge of private sector forecasts. WAOB, for example, has constructed a data base of private sector forecasts which are published by a major news wire service immediately preceding USDA's scheduled reports. These data, which cover the period 1987 to date, are being compared with matching USDA forecasts. At the same time, both data sets are being matched with price movements to determine the relative impact, if any, each has on the market.

Though a high priority, quantification of USDA's forecast accuracy for many supply/demand parameters has been limited by resources and the relatively brief historical record available for examination. Beginning in 1986, WAOB introduced reliability tables to the World Agricultural Supply and Demand Estimates (WASDE) report. These tables show simple statistics which quantify the accuracy of monthly production, exports, domestic use, and ending stocks forecasts for grains, soybeans, soybean products and cotton. Separate calculations are shown for world, U.S., and foreign forecasts. Beginning in January 1991, WAOB will introduce a reliability table to the WASDE report which quantifies the accuracy of USDA domestic production forecasts for beef, pork, broilers, turkeys, milk, and eggs.

USDA is sensitive to the needs and concerns of its user community. Accordingly, each year USDA hosts several well-publicized forums specifically designed to promote the kinds of interaction suggested by GAO. As cited by GAO, NASS conducts data users meetings which have a rotating commodity theme. Depending on the commodity focus, appropriate meeting sites outside Washington are selected to promote user participation. Regardless of the conference theme, data users are invited to comment on any topic of interest. In addition, USDA sponsors a National Agricultural Outlook Conference which attracts approximately 1,000 data users. During the conference, participants are invited to comment both formally and informally on any agriculture/USDA-related topic. One full day of the conference is devoted to USDA commodity supply and demand forecasts. An industry critique of USDA forecasts and methodologies is formally incorporated into each session.

While USDA interaction with the user community is perhaps most visible in the forums described above, the daily interaction between USDA analysts and industry contacts should not be overlooked. While observing limitations with respect to data security, USDA analysts are encouraged to "reach out" to universities and the private sector for the purpose of promoting mutually beneficial information exchanges.

In summary, GAO's draft report is a constructive and useful document which USDA will use as a point of reference. USDA has already acted on or plans to act on all of GAO's recommended improvements. The Department looks forward to a productive relationship with GAO in the future.

James R. Donald

JAMES R. DONALD
Chairperson

Bruce L. Gardner
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1-10-91
Date

for Alan C. Raul
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1/16/91
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Bibliography

Armstrong, J. Scott. Long-Range Forecasting: From Crystal Ball to Computer, 2nd ed. New York: John Wiley and Sons, 1985.

Ascher, William. Forecasting: An Appraisal for Policymakers and Planners. Baltimore: Johns Hopkins University Press, 1978.

Barkema, Alan D., and Mark Drabenstatt. "A Crossroads for the Cattle Industry." Federal Reserve Bank of Kansas City Economic Review, November-December 1990, pp. 47-66.

Bessler, David A., and Jon A. Brandt. "An Analysis of Forecasts of Livestock Prices." Texas Agricultural Experiment Station paper number 22437, May 1990.

Bretschneider, Stuart. "Forecasting: Some New Realities." Metropolitan Studies Program, Syracuse University, Syracuse, New York, December 1985.

Bullock, J. Bruce. "Social Costs Caused by Errors in Agricultural Production Forecasts." American Journal of Agricultural Economics, February 1976, pp. 76-80.

Congressional Budget Office. The Outlook for Farm Commodity Program Spending Fiscal Years 1990-1995. Washington, D.C.: April 1990.

Crom, Richard J. Economics of the U.S. Meat Industry. Economic Research Service, Agriculture Information Bulletin Number 545. Washington, D.C.: USDA, 1988.

Edwards, Clark. Crops, Livestock, and Farm Programs: Overlooked Interactions. Economic Research Service, Agricultural Economic Report Number 638. Washington, D.C.: USDA, September 1990.

Elam, Emmett, and Bruce L. Dixon, "Examining the Validity of a Test of Futures Market Efficiency." The Journal of Futures Markets, 8:3 (1988), 365-72.

Ferris, John. "Evaluation of Forecasts from the Annual AAEA Outlook Survey." Presented at the annual meeting of the American Agricultural Economics Association, Reno, Nevada, July 1986.

Fox, Karl A. An Appraisal of Deficiencies in Food Price Forecasting for 1973, and Recommendations for Improvement. Washington, D.C.: n.p., November 29, 1973.

Garcia, Philip, et al. "Pricing Efficiency in the Live Cattle Futures Market: Further Interpretation and Measurement." American Journal of Agricultural Economics, February 1988, pp. 162-69.

Garcia, Philip, Michael A. Hudson, and Mark L. Waller. "The Pricing Efficiency of Agricultural Futures Markets: An Analysis of Previous Research Results." Southern Journal of Agricultural Economics, 20:1 (July 1988), 119-30.

Gorr, W. L. "Use of Special Event Data in Government Information Systems." Public Administration Review, 46 (November 1986), 532-39.

Gustafson, Ron. "Why the Cattle Cycle Went Awry." Farmline, May 1987, pp. 10-11.

Gunnelson, G., W. D. Dobson, and S. Pamperin. "Analysis of the Accuracy of USDA Crop Forecasts." American Journal of Agricultural Economics, November 1972, pp. 639-45.

Haidacher, Richard C., and Jim L. Matthews. Review of Forecasting in the Economic Research Service. Washington, D.C.: Economic Research Service, USDA, January 1977.

Just, Richard E. "The Impact of Less Data on the Agricultural Economy and Society." American Journal of Agricultural Economics, December 1983, pp. 872-81.

Just, Richard E., and Gordon C. Rausser. "Commodity Price Forecasting With Large-Scale Econometric Models and the Futures Market." American Journal of Agricultural Economics, May 1981, pp. 197-208.

Lasley, Jones, et al. The U.S. Broiler Industry, ERS Agricultural Economic Report Number 591. Washington D.C.: USDA, November 1988.

Lee, Chinkook, et al. Measuring the Size of the U.S. Food and Fiber System. Economic Research Service Agricultural Economic Report Number 566. Washington, D.C.: USDA, March 1987.

Matthews, Jim L. "Review and Appraisal of Forecasting Activities in the Economic Research Service." Initial report to the ERS Administrator, USDA, Washington, D.C., May 1974.

Makridakis, Spyros, et al. The Forecasting Accuracy of Major Time-Series Methods. New York: John Wiley and Sons, 1984.

Milonas, Nikolaos T. "The Effects of USDA Crop Announcements on Commodity Prices." Journal of Futures Markets, October 1987, pp. 571-89.

Park, Wayne I., Philip Garcia, and Raymond M. Leuthold. "Using a Decision Support Framework to Evaluate Forecasts." North Central Journal of Agricultural Economics, 11:2 (July 1989), 233-42.

Purcell, Wayne D. "The Case of Beef Demand: A Failure by the Discipline." Choices, second quarter 1989, pp. 16-19.

Sumner, Daniel A., and Rolf A. E. Mueller. "Are Harvest Forecasts News? USDA Announcements and Futures Market Reactions." American Journal of Agricultural Economics, February 1989, pp. 1-8.

U.S. Congress. Farm Commodity Market Performance and Economic Forecasts. Hearing Before the Joint Economic Committee. Washington, D.C.: January 23, 1984.

U.S. Congress. Review of the Activities of the U.S. Department of Agriculture's Crop Reporting Board. Hearing before the Subcommittee on Department Operations, Research, and Foreign Agriculture of the Committee on Agriculture, House of Representatives. Serial No. 98-61. Washington, D.C.: U.S. Government Printing Office, February 23, 1984.

USDA, Agricultural Stabilization and Conservation Service. Final Regulatory Impact Analysis: Price Support Program for Milk, 1985-86 and 1986-87 Marketing Years. Washington, D.C.: February 7, 1986.

USDA, Crop Reporting Board. Crop Reporting Board Standards. Report of the Crop Reporting Board Policy and Procedures Working Group, Washington, D.C.: July 1985.

USDA, Crop Reporting Board. Hog and Pig Reports: A Handbook on Surveying and Estimating Procedures. Economics, Statistics, and Cooperatives Service, ESCS-66. Washington, D.C.: August 1979.

USDA, Economic and Statistics Review Panel. Report to Secretary of Agriculture, John R. Block, June 28, 1985. Washington, D.C.: 1985.

USDA, Economic Research Service. Livestock and Meat Statistics, 1984-88. Statistical Bulletin Number 784. Washington, D.C.: September 1989.

USDA, Economic Research Service. Summary of 1988 Data Users Meetings. Washington, D.C.: 1988.

USDA, Statistical Reporting Service. Cattle Reports: A Handbook on Surveying and Estimating Procedures. Washington, D.C.: July 1981.

USDA, Statistical Reporting Service. Scope and Methods of the Statistical Reporting Service. Misc. Publication No. 1308. Washington, D.C.: September 1983.

USDA, World Agricultural Outlook Board. World Agricultural Supply and Demand Estimates. Washington, D.C.: 1983-90.

Weimar, Mark R., and Shauna Cromer. U.S. Egg and Poultry Statistical Series, 1960-87. ERS Statistical Bulletin Number 775. Washington, D.C.: USDA, April 1989.

Williams, Robert P., Janusz Kubica, and Constance F. Dixon. Leading Commodity Cash Receipts, 1960-87. Statistical Bulletin 777. Washington, D.C.: USDA, March 1989.

Winkler, Robert L., and Spyros Makridakis. "The Combination of Forecasts." Journal of the Royal Statistical Society, 146 (1983), 150-57.

Glossary

Accuracy	Measures the difference between an actual subsequent event and an initial estimate, or forecast.
Benchmark	An alternative forecast used to compare to the accuracy of the original forecast. Benchmark forecasts should be low-cost, simple alternatives.
Bias Error	Describes consistent under- or overestimation of the actual indicator.
Broiler	A young chicken, usually 5 to 8 weeks old and weighing 4 to 6 pounds, raised primarily for its meat.
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.
Countercyclical Factor	A 5-year moving average of the U.S. per capita cow-beef supply divided by the 2-year average of the U.S. per capita cow-beef supply. It is used in determining whether to restrict imports under the Meat Import Act of 1979.
Error	The estimate or forecast subtracted from the actual result.
Estimate	The preliminary calculation of the actual event. Estimates are normally made for short periods of time for future, current, or completed events. An estimate can be a numerical value assigned to a universe parameter on the basis of evidence from a sample.
Forecast	The prediction of what will happen in the future, given some continuation or modification of present trends.
Naive Forecast	A forecast based on historical information with little or no judgment that assumes the future will closely resemble the past.

Percentage Error	The result of the estimate or forecast subtracted from the actual result, which is then divided by actual result. The result is then multiplied by 100.
Production Adjustment Factor	A 3-year moving average of the domestic production of meats covered in the Meat Import Act of 1979 divided by the average U.S. production of those meats in 1968-77. The law states that the carcass weight equivalent for all imported cattle other than dairy and breeding cattle must be deducted from the U.S. production total for each year involved in the computations.
Random Error	The difference between total error and bias error. Random error is unavoidable and represents the minimum possible error.
Total Error	The sum of bias and random error.

Related GAO Products

Beef Industry: Packer Market Concentration and Cattle Prices (GAO/RCED-91-28, Dec. 6, 1990).

Dairy Termination Program: An Estimate of Its Impact and Cost Effectiveness (GAO/RCED-89-96, July 6, 1989).

Weather Satellites: Cost Growth and Development Delays Jeopardize U.S. Forecasting Ability (GAO/NSIAD-89-169, June 30, 1989).

Federal Statistics, Merchandise Trade Statistics: Some Observations (GAO/OCE-89-1BR, Apr. 21, 1989).

International Trade: Review of FAS Attache Service (GAO/NSIAD-89-73, Feb. 23, 1989).

USDA's Commodity Program: The Accuracy of Budget Forecasts (GAO/PEMD-88-8, Apr. 21, 1988).

Dairy Termination Program: A Perspective on Its Participants and Milk Production (GAO/RCED-88-157, May 31, 1988).

Commodity Futures Trading: Purpose, Use, Impact, and Regulation of Cattle Futures Markets (GAO/RCED-88-30, Nov. 10, 1987).

Imported Meat and Livestock, Chemical Residue Detection and the Issue of Labeling (GAO/RCED-87-142, Sept. 30, 1987).

1983 Payment-In-Kind Program Overview: Its Design, Impact, and Cost (GAO/RCED-85-89, Sept. 25, 1985).

Effects and Administration of the 1984 Milk Diversion Program (GAO/RCED-85-126, July 29, 1985).

Status of the Statistical Community After Sustaining Budget Reductions (GAO/IMTEC-84-17, July 18, 1984).

Agriculture Weather Information Is Not Effectively Communicated to Users (CED-79-110, Aug. 7, 1979).

Beef Marketing: Issues and Concerns (GAO/CED-78-153, Sept. 26, 1978).

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