Early Season USDA Projections of Sugar Production

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Abstract: This article examines methods used in the early projection period (May-January) by the Interagency Commodity Estimates Committee (ICEC) of the U.S. Department of Agriculture (USDA) for forecasting sugar production. This early period is important because it includes the time when the sugar tariff-rate quota is established and when the first tranche is either allocated or canceled. The quantitatively-based techniques that the Economic Research Service provides as input to the ICEC process are discussed. The article describes estimation techniques for forecasting sugar yield per acre. It also describes the influence of technological improvements on increasing sugar yields and the influence of weather. USDA within-season estimates of sugarcane and sugarbeet yields are analyzed.

Keywords: beet sugar, cane sugar, forecasts, projections, sugar production, sugarcane, sugarbeets.

Early-Season USDA Projections Of Sugar Production

Each month, the U.S. Department of Agriculture (USDA) publishes its projections of sugar supply and utilization for the preceding, current, and upcoming (May to September) fiscal years in the World Agricultural Supply and Demand Estimates (WASDE) report. Personnel from several USDA agencies, who constitute the Sugar Interagency Commodity Estimates Committee (ICEC), have the responsibility of making projections. These agencies include the World Agricultural Outlook Board (WAOB), the Foreign Agricultural Service (FAS), the Farm Service Agency (FSA), and the Economic Research Service (ERS). The representative from the WAOB chairs the committee. The projections are closely followed by industry participants (producers and consumers) and by policymakers. The projections are instrumental in determining the volume of tariff-rate quota (TRQ) imports, including the tranches scheduled for January, March, and May.

The first fiscal year (October/September) sugar production, consumption, non-TRQ import, and export forecasts are made 5 months before the start of the fiscal year (FY) in the May WASDE. A complete projection of U.S. sugar supply, utilization, and ending stock levels is made in October after the volume of TRQ imports is established subsequent to the September WASDE. The ICEC meets monthly and updates the projections as new information becomes available.

The periods during which projections are made and revised can be divided into early and later stages. These stages are distinguished by the type of data and analysis available on which to make the projections. Prior to the February ICEC meeting, there is not enough Sweetener Market Data (SMD) from FSA to provide an accurate gauge of the current WASDE projections. Up to then, information from a variety of sources, including USDA's National Agricultural Statistics Service (NASS), is carefully analyzed, using statistical techniques and econometric forecasting methodologies in establishing and updating projections. The February SMD report information through December, the end of the fiscal year's first quarter. By then, cane sugar production from Louisiana is largely complete, and enough beet sugar production has taken place to allow for a comparison with what is projected. After February, actual production, consumption, and trade data from SMD play an increasingly important and larger role in revising projections.

The purpose of this article is to examine more closely the methods used in the early projection period, especially August through January, for forecasting sugar production. August is a good starting point for analysis because it is the first month that NASS makes yield and production forecasts for sugarbeets and sugarcane.[2] The August-to-January period is important because it includes the time when the TRQ is established (i.e., immediately after the September WASDE) and when the first tranche is either allocated or canceled. Both have direct implications for the quantity of raw sugar imports available to U.S. refiners. The emphasis is centered on the quantitatively-based techniques that ERS uses as input into the ICEC process. Although actual projec-

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[2] As explained below, projections of sugar yield per acre rely on yield forecasts from NASS. Although sugar projections are made starting in May, it is not until August that actual effects of weather are quantified through yield forecasts in a useful way for making sugar projections.

tions made each month are not necessarily the same as those suggested by the techniques examined herein, the ERS projections focus discussion in the ICEC meeting and help the committee to arrive at a consensus.

Projections for Sugar Production In FY 1999

The ICEC relies heavily on NASS reporting and forecasting during the early part of the sugar production projection cycle. Although NASS does not forecast sugar production, it reports on the production of the primary sugarbeet and sugarcane crops from which the sugar is extracted. The ICEC must join together NASS-generated forecasts of beet and cane production with information about extraction rates. NASS does not report on sucrose content of the primary crops, and is silent on other factors that may influence the sugar extraction rate.

NASS publishes prospective plantings of sugarbeets at the end of March, or about 6 months before the start of the upcoming FY. This and other information, plus an analysis of production trends, are major inputs into the initial sugar production projection made in the May WASDE. In June, NASS makes its first acreage harvested forecast for sugarbeets and sugarcane and revises its acreage planted forecast for sugarbeets. It is not until August that NASS makes yield and production forecasts. NASS continues updating and publishing its forecasts of acreage harvested, yield, and production through January for sugarbeets (although there is no report for December) and through March for sugarcane. Revisions are published in June.

Figure A-1 shows WASDE beet sugar production projections for August 1998 through February 1999. Beet sugar was projected at slightly under 4.38 million short tons, raw value (STRV), in August. As NASS' forecasts of the size of the beet crop increased, the beet sugar projection was raised, first to 4.42 million STRV in September and then 4.5 million STRV in November. However, by February, beet sugar production through December from SMD were much lower than anticipated and inconsistent with the 4.5-million STRV projection from January. The projection, therefore, was lowered to 4.4 million STRV. At this point, projecting beet sugar production left the early stage when another set of information (i.e., SMD) became useful.

Figure A-2 shows changes in beet sugar projections and in NASS' forecasts of acreage harvested and yield from August through January. The variables each month are shown as proportions of the corresponding January amount, so all variables converge at the value of 1.0 in January. NASS' forecasts of acreage harvested do not change much—less than 1 percent downward over the period. The yield forecast shows greater variation and upward movement, 5 percent from August to January. The beet sugar projection also shows variation and upward movement, but less than the yield. Also, the sugar projection is imperfectly correlated with the yield. The strongest correlated period between sugar production and yield appears between October and November.

Figure A-3 shows WASDE cane sugar production projections through March for each of the cane producing regions, except Puerto Rico, which is not covered by NASS. Hawaiian production is spread out through most of the year. The harvests in Florida and Texas begin later in the fall and can extend into March and beyond. The harvest in Louisiana usually starts in late September/early October and is typically over by the end of December. Developments late in the season influence NASS forecasts, and thus are not reflected in sugar production projections until later. Also, NASS does

Figure A-1
WASDE Beet Sugar Projections, FY 1999

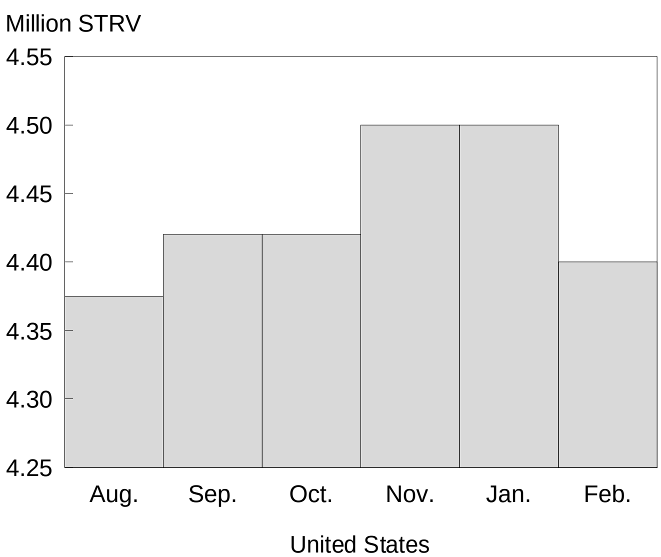


Figure A-2
Sugarbeet Acreage Harvested, Yield, and Beet Sugar Production: Changes in USDA Forecast and Projections, FY 1999

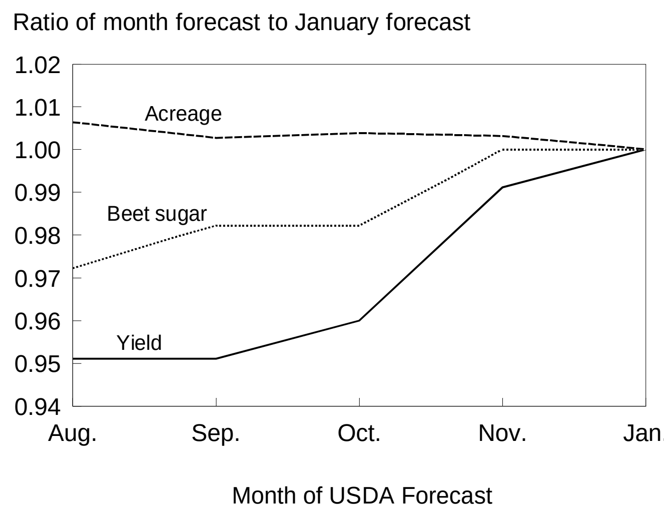


Figure A-3
WASDE Cane Sugar Projections, FY 1999

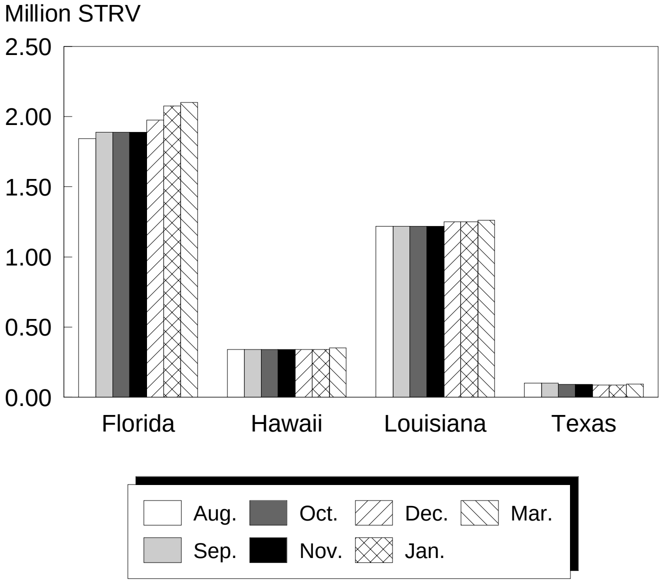
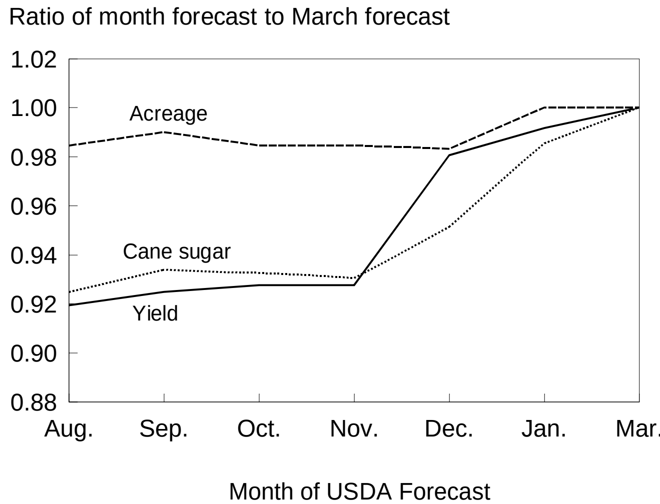


Figure A-4
Sugarcane Acreage Harvested, Yield, and Cane Sugar Production: Changes in USDA Forecast and Projections, FY 1999



not separate out cane for sugar from cane for seed until December. One way is to allocate cane use in the previous year's shares in computing cane for sugar.

Figure A-3 shows a rather flat profile, especially through November. The largest increases take place in Florida in December and January as the cane harvest gets in full swing. The Louisiana cane sugar projection was increased in December. Compared with Florida, a greater proportion of the Louisiana cane crop had been milled into raw sugar, and therefore, there is less uncertainty regarding the volume of total production.

Figure A-4 shows changes in monthly forecasts of sugarcane acreage harvested, yield, and cane sugar, all relative to the March level (similar to Figure A-2). The profiles are fairly flat through November. Both yield and cane sugar increase from November to December, and all three increase from December to January. (NASS increased its forecast of Louisiana acreage harvested from 385,000 to 400,000 acres.)

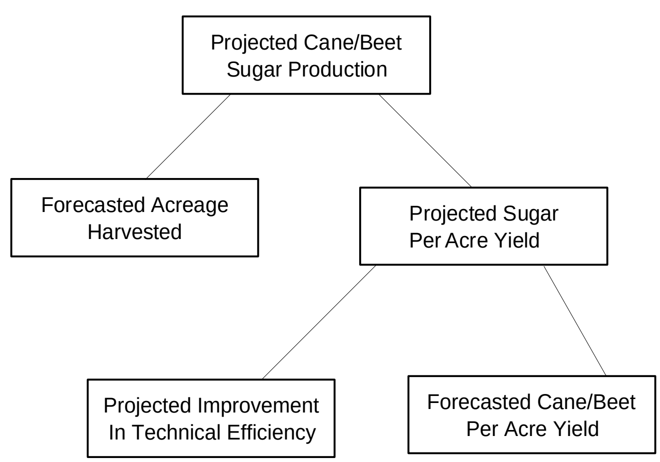
ERS Early-Season Projections Of Sugar Production

Figure A-5 illustrates the primary method ERS uses to project sugar production during the early season. The method derives from the separation of production into two multiplicative components: acreage harvested and sugar yield per acre. As explained, acreage harvested forecasts are made by NASS and typically do not vary that much during the forecast season.

Sugar yield has several features that can be projected based on available data. The first feature is technical change. Over time, improvements in several areas have been made that consistently and predictably increase the degree of recovered sugar per acre. These areas include milling technology improvements, new mill capacity expansions, harvesting improvements in the field, better disease control, improvements in controlling pests and weeds, etc. Also, for beets, there is the additional recovery of sugar from the desugaring of molasses.

Besides technical changes, sugar per acre is influenced by weather-related events. One way to analyze weather-related effects on sugar yield is to first consider the effect of weather events on primary product yields (cane and beet yields). The effect of weather is typically strong on primary product yields, and the relationship of primary product

Figure A-5
Projecting Sugar Production Prior to Cane/Beet Harvest



yields to technical improvements is less certain than it is for sugar yield. Technically, this means that there is low correlation between technical improvements influencing sugar yields and primary product yields. This low correlation permits interpretation of changes in primary product yields as chiefly related to random weather events that change year-to-year.[3]

The explicit model representation for sugar yield is:

*SugarYield = A + B*Time + C*Beet/Cane Yield*

This equation can be estimated with times-series data to show how sugar yield has been increasing due to technical improvements (coefficient B) and how yearly variations in beet or cane yields have influenced sugar yield (coefficient C). [4] With estimates for A, B, and C, and with NASS forecasts of beet and cane yields, a projection of sugar yield can be made. This number can in turn be multiplied by the NASS acreage harvested forecast to provide a projection for sugar production.

Lack of available data restrict the level of disaggregation in the analysis. There is only a national beet sugar equation because beet sugar production is reported only on a national level (although NASS forecasts sugarbeet production on a State level). The beet sugar equation can be estimated net of the effect of desugared molasses to isolate on the effect that the other technological factors have on improving beet sugar yield. This estimation can be done because USDA has estimates of the sugar produced from the desugaring of beet molasses. Regional cane sugar equations can be estimated because cane sugar production is reported regionally.

Table A-1 shows regression equation estimation results. The “B” and “C” coefficients are shown, along with standard errors, and computed t-statistics. T-statistic values above 1.96 generally mean that one can reject the hypothesis that the corresponding coefficient is insignificantly different from zero. Also shown is the adjusted r-squared (R2), an indicator of how much of the variation in sugar yield is accounted for by variations in the explanatory trend variable (i.e., technical change) and by beet or cane yields (weather). The closer to 1.0 the R2 is, the better.

[3] Times-series analysis reveals that Florida cane yields have been increasing about 0.22 ton a year since 1980 but that only 32 percent of yearly yield variation can be explained by the upward, technically-induced time trend. Louisiana cane yields show no consistent trend from 1980 to 1997, although yields since the mid-1990s have been growing due to the adaption of new enhanced cane varieties. Texas yields show no trend, and Hawaiian yields have been declining, probably due to the retirement of large amounts of productive land from sugar production. Almost all State beet yields show no trend, and there is no trend discernable in aggregate U.S. beet yields.

[4] Low correlation between primary product yields and time facilitates the interpretation of coefficients “B” and “C”. Otherwise, statistical correlation (called multicollinearity) would lessen the reliability of the statistical measures used to measure the significance of the hypothesized relationships embedded in the coefficient values.

Estimation results are generally good. The adjusted R2s are high, especially for the cane equations. The beet sugar adjusted R2s are not quite as high (0.55 to 0.61), partly influenced by aggregation over a wide set of differing producing-area conditions. The “B” coefficients are significantly greater than zero for all equations except Texas and Hawaii. All “C” coefficients are significantly positive, as hypothesized.

The coefficient for beet sugar, net of desugared molasses, is less than half the value of the corresponding coefficient in the beet sugar equation. This would seem to indicate that, on average, beet molasses desugaring has accounted for about half of trend growth in beet sugar yield.

The sugar yield equations are used to project sugar per acre. The projection is multiplied by NASS forecasts of acreage harvested to project sugar production for the cane regions and for U.S. beet sugar. The statistical properties of the equations can be used to provide confidence intervals (i.e., upper and lower bounds) for the projections.

A qualification to the approach involves the accuracy of within-season yields relative to the final estimates. The final yield estimates are those used in the sugar yield equations, but the within-season forecasts of final yields are used for within-season projections of the sugar yield. First-yield forecasts are made in August, 2 to 4 months prior to the harvest. Each month closer to the harvest provides additional information for making the forecasts more accurate. Given times-series data on forecasted yields and final estimates, it is possible to indirectly quantify how much is learned with the passage of time to the harvest season.

Within-Season USDA Yield Forecasts

The model used to measure pre-harvest yield forecast accuracy is:

*Yield (Final Estimate) = A + B*Yield (Month of Forecast)*

Desirable estimation results would be that coefficient “A” is equal to zero, that coefficient “B” is equal to one, and that a very high degree of the variance in the final yield is explained by the estimated equation. Table A-2 shows results for U.S. beet yields, and table A-3 shows results for regional U.S. cane yields. The tables show estimates for coefficients “A” and “B”, along with their standard errors and two sets of t-statistics. The first set relates to the hypothesis that “B” is significantly different from zero. A value of 1.96 or above is sufficient to conclude that the hypothesis is correct. The second t-statistic relates to the hypothesis that “B” is significantly different from one. A t-statistic less than 1.96 would indicate that this hypothesis cannot be rejected.

The tables also show the adjusted R2 (explained above) and the Schwarz Information Criterion (SIC). The SIC is an estimate of the 1-step ahead out-of-sample prediction error vari-

Table A-1--Regression results: Sugar yield per acre, 1980-97 1/

Sugar type/ Region	Coefficient on time trend - B	Coefficient standard error	T-Statistic for B=0 2/	Coefficient on cane/ beet yield	Coefficient standard error	T-Statistic for C=0 3/	Adjusted R2	Average sugar yield per acre
Beet sugar								
United States	0.021	0.005	4.182	0.082	0.025	3.316	0.614	2.851
Beet sugar, net of desugared molasses								
United States 4/	0.010	0.004	2.186	0.082	0.024	3.433	0.555	2.758
Cane sugar								
Florida	0.029	0.007	4.339	0.138	0.018	7.622	0.914	3.869
Louisiana	0.025	0.007	3.545	0.118	0.016	7.233	0.804	2.664
Texas 5/	0.008	0.008	0.909	0.155	0.019	7.930	0.849	2.868
Hawaii 6/	-0.018	0.045	0.390	0.079	0.027	2.945	0.749	11.146

1/ Model: Sugar yield per acre = A + B*(time trend) + C*(cane/beet yield).
2/ Reject the hypothesis that B=0 at a 5% significance level if the T-statistic is above 1.96.
3/ Reject the hypothesis that C=0 at a 5% significance level if the T-statistic is above 1.96.
4/ Indicator variable for 1987 included in U.S. equation.
5/ Indicator variable for 1983 included in Texas equation.
6/ Hawaiian equation includes an autoregressive term, coefficient equal to .472, with standard error of 0.228.

ance. A smaller SIC relative to other SICs within a grouping indicates that the equation is a better predictor of the final yield estimate. It would be expected that the closer-to-harvest yield equation would explain more of the final yield variance (higher adjusted R2) and be a better predictor (lower SIC relative to earlier month yield forecasts). Month-to-month growth in adjusted R2 and the decline in SIC are rough indicators of how much information is learned between months in successfully forecasting the final yield.

Table A-2 shows results for U.S. beets, aggregated across States and also at individual State levels, from August through November. Aggregate U.S. results are the most useful because the beet sugar equation (table A-1) makes use of only the aggregate U.S. beet estimate. All "B" coefficients are significantly greater than zero, but rise to levels significantly above one. There is consistent growth in adjusted R2s, from 39 percent in August, to 63 percent (September), 71 percent (October), and 93 percent (November). The SICs fall each month closer to harvest. There is an especially large drop going from October to November, as much of the harvest winds down and information about it becomes known and incorporated into the forecast.

Table A-2 shows results for individual States. Results in six of the 10 States are very similar to the aggregate results. These States include Colorado, Michigan, Minnesota, Montana, Nebraska, and North Dakota. With each passing month the adjusted R2s increase consistently, and there is a relatively large drop in the SIC going from October to November. The "B" coefficients are all significantly greater than zero, and statistically very close to one (unlike the aggregate U.S. result). California results are close to fitting the pattern, but there is not much difference between October and November—practically the same values for adjusted R2s and for the SIC. Hard-to-forecast States include Idaho, Oregon, and Wyoming. Until November, all R2s are low and only rise between 45 to 60 percent by November.

Table A-3 shows results for the U.S. cane regions. Results for mainland producing areas of Florida, Louisiana, and Texas show a pattern of relatively low adjusted R2s until January. The largest decreases in respective SICs take place in January as well. These results indicate that hard-to-predict late-season developments are crucial to cane yield forecasting. Steadier Hawaiian results (i.e., more gradual changes in adjusted R2s and SICs) are reflective of the fact that production takes place throughout the year. Thus, late season developments matter less in yield forecasting. The "B" coefficients for Hawaii, Louisiana, and Texas (except August) are all significantly greater than zero. The "B" coefficients for Florida are only significantly greater than zero in September and January.

In conclusion, results indicate that more is known earlier in the season for sugarbeets than for sugarcane, even relative to the respective harvest periods for each. However, once beet or cane production is known with high certainty, implications for cane sugar production seem to be known with greater certainty than for beet sugar production: the test statistics for the cane equations in table A-1 are better than those for beets.[5]

An explanation is that cane is processed into raw sugar sooner after harvest than are the beets. Beets are stored in sheds and piles for a longer period during which sucrose deterioration can take place. This is especially true for the Red River producing area, where processing from crops harvested in October can continue on into May and June of the next calendar year.

[5] Another source of uncertainty for beet sugar production derives from the early-campaign harvesting of the beet crop. If beets are harvested in September and processed that same month, the production gets recorded in the previous year's totals. Crop and fiscal years are now the same and do not begin until October 1. A small amount of Louisiana cane sugar production is typically processed in September as well.

Table A-2--Regression results: USDA monthly forecasts of U.S. beet yields, 1980-98 1/

Month of yield forecast	Constant coefficient - A	Coefficient standard error	Coefficient on month yield forecast - B	Coefficient standard error	T-statistic for B=0 2/	T-statistic for B=1 3/	Adjusted R-squared	Schwarz Information Criterion 4/
U.S. Total								
August	-2.575	6.545	1.135	0.321	3.532	0.419	0.389	2.797
September	-10.256	5.462	1.508	0.267	5.638	1.899	0.631	2.293
October	-9.554	4.490	1.473	0.220	6.703	2.152	0.709	2.054
November	-3.144	1.533	1.152	0.074	15.462	2.035	0.930	0.635
California								
August	-0.188	5.930	1.012	0.224	4.518	0.052	0.519	3.781
September	-4.794	5.912	1.191	0.224	5.310	0.853	0.602	3.592
October	-2.884	4.102	1.111	0.155	7.190	0.718	0.738	3.173
November	-1.784	3.974	1.076	0.151	7.146	0.504	0.736	3.182
Colorado								
August	1.750	6.479	0.923	0.305	3.032	0.252	0.313	4.360
September	2.802	5.091	0.876	0.240	3.655	0.519	0.407	4.212
October	0.274	4.207	1.005	0.200	5.027	0.025	0.574	3.881
November	-0.837	1.458	1.050	0.069	15.292	0.730	0.928	2.100
Idaho								
August	13.328	7.368	0.474	0.301	1.573	1.745	0.076	3.801
September	7.104	8.067	0.727	0.329	2.208	0.828	0.177	3.684
October	7.069	7.451	0.729	0.305	2.396	0.888	0.208	3.645
November	1.853	5.015	0.932	0.203	4.601	0.337	0.528	3.127
Michigan								
August	2.823	4.276	0.827	0.229	3.605	0.755	0.400	3.879
September	-1.319	3.748	1.040	0.199	5.220	0.198	0.593	3.490
October	-0.975	3.174	1.037	0.171	6.057	0.217	0.665	3.297
November	-1.204	2.432	1.059	0.132	8.002	0.443	0.778	2.885
Minnesota								
August	-2.662	3.771	1.168	0.218	5.347	0.770	0.605	3.542
September	-4.538	2.671	1.277	0.155	8.254	1.790	0.789	2.917
October	-3.899	2.302	1.232	0.132	9.305	1.754	0.826	2.721
November	0.063	0.989	0.994	0.056	17.679	0.110	0.945	1.564
Montana								
August	2.284	4.721	0.903	0.224	4.023	0.434	0.458	3.506
September	0.692	4.230	0.971	0.199	4.868	0.145	0.558	3.302
October	0.784	4.290	0.969	0.203	4.778	0.155	0.548	3.324
November	-0.041	1.570	1.002	0.074	13.595	0.034	0.911	1.701
Nebraska								
August	3.277	5.858	0.846	0.296	2.860	0.519	0.285	4.267
September	-0.290	5.873	1.004	0.290	3.461	0.013	0.379	4.126
October	-2.531	4.950	1.116	0.245	4.561	0.474	0.524	3.860
November	-1.648	1.793	1.078	0.089	12.118	0.878	0.890	2.394
North Dakota								
August	0.057	4.248	1.027	0.248	4.144	0.111	0.473	3.923
September	-2.780	3.561	1.196	0.208	5.743	0.942	0.640	3.542
October	-5.665	2.550	1.354	0.148	9.154	2.399	0.821	2.841
November	-0.715	0.958	1.043	0.054	19.243	0.788	0.954	1.495
Oregon								
August	10.177	7.522	0.616	0.280	2.202	1.373	0.176	4.406
September	13.540	10.883	0.491	0.405	1.212	1.258	0.025	4.574
October	7.969	9.910	0.699	0.369	1.894	0.817	0.126	4.465
November	-0.749	6.756	1.014	0.249	4.071	0.058	0.464	3.976
Wyoming								
August	28.275	7.662	-0.384	0.373	1.027	3.706	0.003	3.585
September	23.627	7.442	-0.157	0.363	0.433	3.185	-0.047	3.634
October	10.743	10.058	0.479	0.498	0.962	1.045	-0.004	3.592
November	-0.687	3.984	1.042	0.197	5.302	0.213	0.601	2.669

1/ Model: Yield (final estimate) = A + B* yield (month of forecast).

2/ Reject the hypothesis that B=0 at a 5% significance level if the T-statistic is above 1.96.

3/ Do not reject the hypothesis that B=1 at a 5% significance level if the T-statistic is below 1.96.

4/ The Schwarz Information Criterion (SIC) is an estimate of the 1-step ahead out-of-sample prediction error variance. A smaller SIC relative to other SICs within a grouping indicates that the equation is a better predictor of the final yield estimate.

Table A-3--Regression results: USDA monthly forecasts of U.S. cane yields, 1980-97 1/

Month of yield forecast	Constant coefficient - A	Coefficient standard error	Coefficient on month yield forecast - B	Coefficient standard error	T-statistic for B=0 2/	T-statistic for B=1 3/	Adjusted R-Squared	Schwarz Information Criterion 4/
Florida								
August	18.364	12.024	0.452	0.368	1.228	1.489	0.029	4.374
September	8.379	11.618	0.753	0.353	2.131	0.700	0.172	4.214
October	5.639	17.402	0.823	0.521	1.580	0.341	0.081	4.319
November	12.785	18.913	0.605	0.562	1.075	0.703	0.009	4.394
January	0.716	12.663	0.968	0.378	2.560	0.086	0.246	4.120
Hawaii								
August	20.928	16.841	0.785	0.186	4.209	1.156	0.496	6.003
September	22.840	16.313	0.766	0.181	4.228	1.291	0.498	5.998
October	21.014	15.596	0.788	0.174	4.540	1.220	0.536	5.920
November	20.900	14.970	0.792	0.167	4.736	1.246	0.558	5.872
January	6.761	16.911	0.907	0.180	5.029	0.514	0.588	5.800
Louisiana								
August	11.853	4.537	0.515	0.182	2.832	2.669	0.292	4.332
September	12.839	4.072	0.491	0.165	2.974	3.474	0.303	4.442
October	14.710	4.129	0.405	0.167	2.421	3.552	0.222	4.426
November	9.458	3.667	0.623	0.150	4.162	2.517	0.490	4.004
January	1.544	1.909	0.937	0.077	12.148	0.819	0.896	2.414
Texas 5/								
August	21.905	5.846	0.296	0.193	1.532	3.639	0.369	4.446
September	20.170	5.355	0.357	0.178	1.998	3.605	0.424	4.355
October	16.346	5.937	0.483	0.197	2.446	2.623	0.478	4.255
November	17.093	5.458	0.459	0.182	2.525	2.973	0.488	4.237
January	11.233	3.409	0.644	0.112	5.769	3.184	0.773	3.422

1/ Model: Yield (final estimate) = A + B* yield (month of forecast).
2/ Reject the hypothesis that B=0 at a 5% significance level if the T-statistic is above 1.96.
3/ Do not reject the hypothesis that B=1 at a 5% significance level if the T-statistic is below 1.96.
4/ The Schwarz Information Criterion (SIC) is an estimate of the 1-step ahead out-of-sample prediction error variance. A smaller SIC relative to other SICs within a grouping indicates that the equation is a better predictor of the final yield estimate.
5/ Indicator variable for 1983 included in equation for Texas.