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Evaluation of Monthly Corn Yield Indications and Forecasts

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ABSTRACT

This report examines the estimated accuracy of several monthly corn yield survey indications and composite forecasts for the 10 corn Objective Yield States from 1977 to 1986. Indications adjusted for an estimated bias produced more accurate forecasts than unadjusted indications about 85 percent of the time.

Composite forecasts performed as well or better than the Agricultural Statistics Board (ASB) forecasts in August, September, and October. No one composite, however, consistently outperformed the ASB forecasts. The ASB forecast outperformed all other forecasts in November. The nonprobability based Acreage and Production yield indication approximates the final ASB yield estimate the best in five States, while the November ASB forecast is best in four States.

Recommendations are: The composite consisting of the bias adjusted Farmer Reported Yield and Daily Weather Model Yield indication should be available for ASB August 1 forecast review; The composite consisting of the bias adjusted Farmer Reported Yield and Objective Yield indications should be available for all ASB forecast reviews, and; This type of analysis should be extended to other crops.

Key words; bias, composite forecast, indication, objective yield, root mean square error, mean absolute percent error.

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SUMMARY

This report explores the estimated accuracy of several monthly corn yield survey indications and composite forecasts for the 10 Objective Yield States from 1977 to 1986. Indications adjusted for an estimated bias produced more accurate forecasts about 85 percent of the time. Composite forecasts using bias adjusted indications were only slightly more accurate than composites using unadjusted indications.

A trend indication, alone or in composites with other August 1 bias adjusted indications, seldom produced forecasts more accurate than the Agricultural Statistics Board (ASB) or any bias adjusted August 1 indication. The trend indication performed as well as the unadjusted Objective Yield (OY) indication.

In August, the composite forecast using the Farmer Reported Yield (FRY) and the Daily Weather Model Yield (DWMY) indications outperformed the ASB forecast in six States.

In September and October, the inverse mean square error composite forecast using bias adjusted OY and FRY indications performed as well or better than the ASB forecasts in five and seven States, respectively.

In November, the ASB produced the most accurate forecasts in seven States and tied in another.

The DWMY indication provided better information than the OY indication in August. In October and November, the ASB composite forecast outperformed the inverse mean square error composite forecast of bias adjusted OY and FRY indications.

The unadjusted Acreage and Production Survey indication outperformed several indications and composite forecasts in 5 out-of-10 States. This is somewhat disconcerting that a nonprobability based survey still seemingly has more influence than the final OY survey estimate on the ASB official estimate. The November ASB forecast was closer in four States.

All the analyses assume the final ASB yield estimate is the best approximation of true yield. Thus, any nonstatistical influences, such as expert judgment, on the ASB forecasts and final estimates cannot be detected with this type of analysis. Using the above stated assumption, the basic conclusion of this analysis is none of the new monthly yield composites

consistently outperformed current procedures. However, two composite forecasts performed favorably and it is recommended that:

1. The composite forecast consisting of the bias adjusted FRY and DWMY indications should be available for ASB August 1 review, and

2. The inverse root mean square error weighted composite of the bias adjusted OY and FRY indications should be available for all monthly ASB forecast reviews.

It is also recommended that this type of analysis should be extended to other crops.

EVALUATION OF CORN YIELD INDICATIONS AND FORECASTS

Gary Keough

INTRODUCTION

The National Agricultural Statistics Service (NASS) conducts surveys to forecast and estimate crop yields and production. The State Statistical Office (SSO) collects, edits, and summarizes the data in each State. The Agricultural Statistics Board (ASB) incorporates each State's summarized data to prepare regional and national forecasts and estimates. The ASB is an "expert panel" made up of seven permanent members and several statisticians selected mostly from SSO staffs in key producing States.

Bigsby[1] evaluated composite yield forecasts and the Feyerherm winter wheat model for eight States and proposed the use of composite yield forecasts for other crops.

This report evaluates the forecasting and estimating performance of current NASS corn yield indications and corn yield indications developed from trend, original indications, bias adjusted indications, and composite indications.

This report also introduces several standard evaluation techniques that can be applied to better understand forecasting performance of current yield indications for any crop. Yield indications and forecasts for the 10 corn Objective Yield States from 1977 through 1986 are evaluated. Accuracy was measured by root mean square error (RMSE) and mean absolute percent error (MAPE) for each indication and composite forecast. The ASB final yield estimate is considered the best approximation to the true yield. The sign test[3] is used to determine if adjusting indications and composites for an estimated bias increases accuracy.

Monthly indications examined are the Objective Yield (OY) and the nonprobability based Farmer Reported Yield (FRY). August 1 indications include a Trend (TY) indication and the Daily Weather Model Yield (DWMY) indication of Warren and Cook[8]. End-of-year indications are the final OY and the nonprobability based Acreage and Production Yield.

Two composite methods are examined. The first method is currently used by the ASB. A bias is calculated for each indication from the previous 10 years of data. The calculated

bias is then subtracted from the current value of the indication. A simple average of bias adjusted indications produces a composite forecast.

A second composite method suggested here weights indications by the ratio of an indication's inverse mean square error to the sum of all the indications' inverse mean square errors. Adjusting for bias in this composite is optional.

The following sections describe the indications, the bias adjustment procedure, composite forecast methods, the comparison methods, results of comparisons, and conclusions.

INDICATIONS

Objective Yield (OY), Farmer Reported Yield (FRY), and Acreage and Production Yield (A&PY) indications are obtained from operational surveys conducted by NASS[7].

Monthly and final OY indications are derived from actual field measurements. Measurements are obtained from randomly located plots in randomly selected corn fields from the June Agricultural Survey, Area Portion. This was previously called the June Enumerative Survey.

The monthly FRY indication is a weighted average of yields reported by a panel of farm operators from a nonprobability survey. Agricultural Statistics District average yields are weighted by the proportion of harvested corn acres from the previous year and summed to the State total. In Illinois, a rotating panel of farm operators replaced this indication in 1986.

The A&PY indication is derived from a nonprobability end-of-season survey of farm operators. Yield is derived by dividing total reported production by total reported harvested acres. A probability indication from the December Quarterly Agriculture Survey replaced this indication in 1986.

The Trend indication, TY, is a regression prediction of the final ASB yield (ASBY) using a trend variable, t, where t indexes the forecast years from 1966 through 1986, numbered 1 through 21. TY_t is calculated as

$$TY_t = a + (b \cdot t),$$

Parameters a and b are least squares estimates of regression coefficients[6]. Two methods were needed in order to estimate coefficients for all years. For 1977 through 1986, coefficients are estimated only from historic data. For example, coefficients used to calculate the TY for 1977 are estimated from data for 1966 through 1976. This method could be used operationally by the ASB.

Using the first method however, no TY's for 1966 and 1967 are possible because at least two data points are needed to estimate regression coefficients. Also, the TY's for some earlier years would of been made based on very little historic data. Therefore a second method was used to estimate coefficients for years 1966 through 1976. This method estimates coefficients using historic

and future values of t and ASBY. It excludes data for the year to be predicted. For example, coefficients used to calculate the TY for 1966 are estimated from data for 1967 through 1987. The coefficients used to calculate TY for 1967 are estimated from data for 1966, 1968,..., 1986 data. This second method allows TY's for 1966 and 1967 to be calculated and uses more years of data to calculate TY's for earlier years. However this method is not operationally possible because future data are never known. Therefore TY values from this second method are only used to generate composite weights.

The Daily Weather Model Yield (DWMY) indication uses a predicted ear weight derived from daily weather data and median silking dates. The predicted ear weight is applied to the estimated number of corn ears per acre from the OY survey. The DWMY indication is computed only as an August 1 forecast.

The ASB monthly forecast is a consensus forecast of its members. ASB members review the current month's indications recorded on time-series charts, consider SSO commodity statistician recommendations, and evaluate written comments about crop condition and development.

Similarly, the ASBY is a consensus estimate. This estimate is initially published the January after harvest. The ASB may revise the estimate the next year and after the next Census of Agriculture. The ASBY's used in this analysis are those as of December 1987. The revised 1986 ASBY's were not available for this analysis.

One indication not considered in this analysis is the August 1 Farmer Reported Crop Condition which is to be discontinued. Other indications not examined are the adjusted OY indication and the corn production forecasting model developed by Birkett[2]. The adjusted OY indication uses the Farmer Reported Crop Condition. The corn production forecasting model primarily forecasts a regional yield and forecasts State yields secondarily.

METHODS

This section describes the methods used to adjust for bias, obtain composite forecasts, and analyze indications and forecasts.

ADJUSTING INDICATIONS FOR BIAS

Assumptions used to adjust indications for bias were:

1) the bias is constant over time,
2) the deviation of the indication from ASBY equals bias plus an error component, and
3) the expected value of the error component is zero.

Bias for the ith indication in the jth month for year t is defined as

$$Bias_{ijt} = (1/t-1)\sum_{k=1}^{t-1}(ASBY_k - X_{ijk}),$$

where

X_{ijk}=the historic value of the ith indication for the jth month in year k, k=1,2,...,t-1.

When $Bias_{ijt}$ is added to the current year indication, a bias adjusted forecast, X^*_{ijt}, results:

$$X^*_{ijt} = X_{ijt} + Bias_{ijt}.$$

COMPOSITE FORECASTS

Composite forecasts are weighted averages of indications. By using different weighting techniques, a best available composite forecast will outperform or equal the best individual forecast, it cannot do worse[4].

The inverse mean square error composite method weights the indications unequally by the ratio of the indication's inverse mean square error and the sum of inverse mean square errors of all indications in the composite. Therefore, the sum of weights equals one. This technique gives more weight to indications which perform better over time. This algorithm treats all years equally. To obtain composite forecast, C_{jt}, in the jth month in year t, let

X_{ijk} = the historic value of the ith indication for the jth month in year k, k=1,2,...,t-1;

M_{ijt} = the mean square error of the ith indication for the jth month for the period of available years preceding the forecast year t,

$$= (1/t-1)\sum_{k=1}^{t-1}(X_{ijk} - ASBY_k)^2;$$

and

$$W_{ijt} = 1/M_{ijt}$$

is the inverse mean square error of the ith indication for the jth month of forecast year t. Therefore, the composite forecast of r indications for jth month in forecast year t is:

$$C_{jt} = \sum_{i=1}^{r}(X_{ijt} \cdot W_{ijt}) \; / \sum_{i=1}^{r}(W_{ijt}),$$

where X_{ijt} is the value of the ith indication in the jth month for forecast year t.

The DWMY indication is available from 1972 to present for most States. The DWMY forecast is not available for Minnesota in 1973 and Missouri in 1978. Therefore, in these States, weights used in the composite forecasts of the DWMY and FRY indications were calculated using years where both indications were available. Also, since the DWMY is an August 1 indication, the value of the DWMY indication is constant for all months in the same year. The OY and FRY indications are available for all States in all years from 1967 to 1986.

The ASB composite method:

1) uses only the previous 10 years of data to generate bias adjusted indications,
2) uses equal weights for all indications to derive the composite forecast.

This forecast has been used by the ASB since 1983[5]. To obtain the ASB composite, C^*_{jt}, with r indications for the jth month year t let

$$D_{ij} = (1/10) \sum_{k=t-11}^{t-1} (X_{ijk} - ASBY_k)$$

then,

$$C^*_{jt} = (1/r) \sum_{i=1}^{r} (X_{ijt} - D_{ij}).$$

All indications available are used in this composite. Therefore, if the August Farmer Reported Crop Condition yield indication is available it is used in the composite. This report examines composite forecasts using only the OY and FRY indications. Therefore the August forecasts generated by this method do not necessarily equal those generated previously for ASB use.

ANALYSIS OF FORECASTS

Forecast accuracy was measured using root mean square error (RMSE) and mean absolute percent error (MAPE).

A RMSE is the square root of the average of squared deviations of a forecast from truth. The ASBY is considered truth for computing RMSE's. No one knows the actual true value. This measure of performance is not a pure measure of root mean square error but is one method of approximation. True statistical estimates of the relative sampling error (which take into account the covariance structure of the data) were not calculated for any of the composites.

The RMSE for the ith forecast in the jth month is defined as:

$$RMSE_{ij} = [(1/t) \sum_{k=1}^{t} (f_{ijk} - ASBY_k)^2]^{1/2}.$$

Here f_{ijk} is the ith forecast, either indication or composite, for the jth month in year k. RMSE's were computed using forecasts from years 1977 through 1986.

MAPE is a relative measure of accuracy. Forecast errors are transformed to percents of the ASBY. The absolute value of these percents is averaged over years. MAPE does not penalize large deviations as severely as the RMSE when the ASBY is also large.

The MAPE for the ith forecast in the jth month is defined as:

$$MAPE_{ij} = (1/10) \sum_{k=t-10}^{t} | (f_{ijk} - ASBY_k) / ASBY_k | \cdot 100.$$

The nonparametric sign test was used to test if bias adjusting lowered RMSE's or MAPE's significantly. Bias adjusted indications or composite forecasts were tested against unadjusted indications or composite forecasts for each accuracy measure. The test assumes:

1) the pairs of observations are independent, and
2) the difference between a pair is not zero.

The RMSE's and MAPE's of bias adjusted forecasts were subtracted from the RMSE's and MAPE's of their unadjusted forecasts, for each month across States. The only information utilized is the sign of the difference. If the difference is negative the unadjusted forecast RMSE or MAPE is smaller, if the difference is positive the bias adjusted forecast RMSE or MAPE is smaller, and if the RMSE's or MAPE's are equal the pair is omitted from the test.

It is assumed no difference in the accuracy of bias adjusted and unadjusted forecasts. Therefore, the chances of getting a (+) sign, p(+), is the same as getting a (-) sign, p(-):

$$p(+) = p(-) = 1/2.$$

A test of hypothesis is conducted using tables of the binomial distribution where n equals the number of pairs (10 unless there were ties), p=1/2, and k equals the number of (+) signs. When testing across States, a k=0,1,2,8,9,or 10 is significant at the 0.1 level. The null hypothesis is

$$H_o: \quad 3 \leq k \leq 7, \text{ for } k = 0,1,2,\ldots,10.$$

The alternative hypothesis:

$$H_a: \quad k < 3 \text{ or } k > 7, \text{ for } k = 0,1,2,\ldots,10.$$

Also, k=0, 1, or 2 implies the bias adjusted forecasts are significantly inferior. Likewise, k=8, 9, or 10 implies bias adjusted forecasts are significantly superior.

RESULTS

This section presents results of several comparisons:

a) bias adjusted versus unadjusted indications;
b) TY indication versus August 1 indications;
c) monthly indications and composites; and,
d) end-of-year indications and composites.

ADJUSTING FOR BIAS

Table 1 summarizes the results of the sign test. Composite 1 is an inverse mean square error composite of the DWMY and the FRY indications. Composite 2 is an inverse mean square error composite of the OY and FRY indications.

Results using RMSE's and MAPE's are similar for individual indications but inconsistent for composites. Adjusted monthly OY and FRY indications were significantly more accurate for most months. The bias adjusted DWMY indication showed little improvement. Composite forecasts using bias adjusted indications showed marginal improvement or were inconsistent. Adjusted monthly individual indications produce lower RMSE'S about 85 percent of the time, however, totals were not tested for significance since State affects could exist.

Table 1. Sign test results of bias adjusted versus unadjusted 10-State corn indications, 1977-86.

	Composite forecasts		Individual indications		
Month	Composite 1	Composite 2	DWMY	OY	FRY
	number of years bias adjusted less than unadjusted				
RMSE's					
Aug.	4	3	6	7	9*
Sept.	6	9*[1]	--	9*	10*
Oct.	7	8*	--	9*	9*
Nov.	5	5[1]	--	10*	8*
Totals	22	25	6	35	36
MAPE's					
Aug.	0*	5[1]	6	7	10*
Sept.	9*[1]	5	--	10*	10*
Oct.	10*	7	--	8*	9*
Nov.	8*	6	--	8*	8*
Totals	27	23	6	33	37

[1] = 1 pair with difference of zero is omitted.
* = Significant at 0.1 level.

TREND YIELD INDICATION

The RMSE's for TY and associated composites are in Table 2. Forecasts from a TY indication were not more accurate than the ASB or any bias adjusted indication in August. The TY indication's accuracy is similar to the unadjusted August 1 OY indication. Composite forecasts with TY and unadjusted indications failed to outperform composites without the TY indication or the ASB. Three composite forecasts using TY were also created. Composite 3 consisted of TY and OY indications. Composite 4 used TY and FRY indication. Composite 5 used TY, OY, and FRY indications. Composites 3 and 4 failed to outperform the comparable bias corrected indication. Composite 6 failed to perform as well as a similar composite 2 (See Appendix table A1). This analysis suggests current NASS surveys provide some information about the current yield by August 1. Analysis using MAPE's were similar.

Table 2. Root mean square errors for the 10 speculative corn States. Yield indications adjusted for bias, 1977-86.

State	Month	ASB	TY	Composite 3	Composite 4	Composite 5
				bushels per acre		
IOWA	Aug.	10.8	18.0	16.5	12.5	12.8
ILL		10.7	19.7	18.6	13.2	14.3
IND		8.2	16.6	15.5	10.6	10.8
MICH		6.9	10.5	7.6	8.4	7.1
MINN		11.3	16.9	15.6	14.7	14.1
MO		10.9	25.2	23.3	13.1	13.9
NEBR		8.2	14.0	13.3	9.9	10.1
OHIO		12.3	15.3	12.9	12.9	*11.8
S.DAK		8.4	19.1	15.5	10.7	11.9
WIS		5.4	13.4	9.9	8.3	7.5

* = RMSE less than ASB forecast.

MONTHLY FORECASTS

Unadjusted indications seldom produced the lowest RMSE or MAPE for a State in any month. Therefore, only monthly results using bias adjusted indications and their composites are examined to answer these questions:

(a) In how many States did a forecast produce a RMSE or MAPE lower than the ASB forecast?

(b) Which forecasts produce the minimum RMSE or MAPE for the most States in each month? This was done including and excluding the ASB forecast.

(c) What is the average percent change of the ASB forecast's RMSE and MAPE?

(d) Is composite 2 more accurate than the ASB composite?

(e) Are the DWMY indication and its composites more accurate than the OY indication and its composites?

In table 3, composites 1 and 2 are the same as in table 1. The ASB composite is the composite used by the ASB in which indications are adjusted for bias then averaged. Table 3 shows the number of States in which a forecast's RMSE or MAPE was: lower or equal the ASB forecast; the minimum; and minimum excluding the ASB forecast. Appendix tables A1 and A2, contain the RMSE's and the MAPE's, respectively.

Table 3. Forecast performance summary. Number of States where forecast RMSE|MAPE is: lower or equal ASB; minimum overall; and minimum excluding the ASB forecast.

Month	ASB Forecast	Composite forecasts 1	Composite forecasts 2	Composite forecasts ASB	Individual indications DWMY	Individual indications OY	Individual indications FRY
		Number of States					
August							
lower or equal ASB	---	6|2	2|2	2|2	5|2	1|2	0|0
minimum overall	3|7	3|1	0|0	1|2	3|0	0|0	0|0
minimum excluding ASB	---	4|5	0|0	2|3	3|2	0|0	1|0
September							
lower or equal ASB	---	4|2	5|5	2|2		0|0	3|2
minimum overall	3|5	2|1	2|3	1|1		0|0	3|2
minimum excluding ASB	---	3|3	3|5	1|1		0|0	5|5
October							
lower or equal ASB	---	3|4	7|5	6|6		2|2	2|3
minimum overall	3|4	0|1	3|2	4|3		2|1	0|0
minimum excluding ASB	---	0|1	4|4	4|5		2|2	1|0
November							
lower or equal ASB	---	2|2	2|3	3|4		1|1	2|2
minimum overall	8|6	1|0	0|0	2|4		0|0	0|0
minimum excluding ASB	---	1|1	2|2	6|7		0|0	2|0

Table 3 shows that comparisons using RMSE's and MAPE's are similar except in a few cases. A higher MAPE count indicates one or more forecasts where the RMSE procedure penalizes the deviation more than the MAPE procedure. Therefore, RMSE is more likely to penalize a procedure that misses in an unusual year but does a very good job the rest of the time.

AUGUST

Composite 1 outperformed the ASB forecast in 6 of 10 States. The ASB forecast, composite 1, and the DWMY indication each produced the minimum RMSE's in three States. Excluding the ASB forecasts, composite 1 produced the minimum RMSE in four States.

Table A1 shows the DWMY indication, by itself or in composite 1, nearly always outperformed the OY indication, the ASB composite, and composite 2. Composite 2 and the ASB composite performed about the same.

SEPTEMBER

Composite 2 produced lower RMSE's than the ASB forecast in five States. The ASB forecast and the FRY indication each produced the minimum RMSE in three States. Of the ASB's three States, only Missouri repeats from August. Excluding the ASB forecasts, the FRY produced the minimum in five States. Tables A1 and A2 show that composite 2 produced RMSE's and MAPE's lower or equal to the ASB composite in all States.

OCTOBER

Composite 2 outperformed the ASB forecast in seven States while the ASB composite outperformed the ASB forecast in six States. The ASB composite produced the minimum RMSE in four States, including or excluding the ASB forecasts. Table A1 shows that composite 2 and the ASB composite combined have RMSE's lower than the ASB forecast in eight States. The RMSE's for composite 2 and the ASB composite are very close. They differ by more than 0.4 of a bushel in only three States. The most they differ is 0.9 of a bushel.

NOVEMBER

The ASB forecasts outperformed composite forecasts and individual indications in most States. The ASB forecast

produced the minimum RMSE in eight States. Excluding the ASB forecasts, the ASB composite produced the minimum RMSE's in six States.

Table 4 shows the percent reductions from the previous month's RMSE and MAPE for ASB forecasts. The percent reductions across States from month to month for both statistics are similar. Also, the percent reduction can vary greatly across States and from month to month. The most interesting result is the ASB forecast's low average percent reduction in RMSE's from September to October. In 7 of the 10 States, the October-November percent reduction is greater than in September-October. This may indicate a reluctance of the ASB to make changes in October. It should be noted the October ASB forecasts performed the worst when compared with the composite forecasts (table 3).

Some State characteristics should also be noted. Missouri and South Dakota change the least from October to November but their RMSE's are the highest for any State in November.

Table 4. Percent reduction from previous month of accuracy measures (RMSE MAPE), ASB corn yield forecasts, 1977-86.

State	August-September		September-October		October-November	
	percent					
IOWA	58	61	27	26	46	30
ILL	51	52	27	28	34	36
IND	55	58	38	36	17	13
MICH	33	34	0	0	41	42
MINN	38	38	44	43	46	50
MO	57	55	9	5	9	10
NEBR	43	40	9	14	38	31
OHIO	46	43	44	50	46	29
S.DAK	15	16	20	23	0	0
WI	22	23	7	18	51	48
Avg.	42	42	22	24	33	29

END OF YEAR INDICATIONS

Table 5 shows that the unadjusted A&PY indication (A&P) produced as good or better estimates of the ASBY in five States based on the minimum RMSE criteria. Table 6 shows that very similar results using the minimum MAPE criteria. This should be considered surprising and somewhat disconcerting considering that the Acreage and Production Survey is a nonprobability survey.

The bias adjusted A&PY indication has the minimum RMSE in three States. Composite 2 has the minimum RMSE in two States when using either bias adjusted or unadjusted indications. It also outperformed the ASB composite in all States. Michigan is the only State in which the A&P indication's RMSE is over four bushels. Composite 2 produced the minimum RMSE in Michigan. Table A1 also shows the November ASB forecast outperformed the A&PY indication in Indiana, Michigan, Ohio, and Wisconsin.

Table 5. End-of-year RMSE'S for corn yield indications and composite estimates, unadjusted and bias adjusted, 1977-86.

	Unadjusted indications			Adjusted indications			
State	A&P	OY	Composite 2	A&P	OY	Composite 2	ASB
			bushels per acre				
IOWA	£0.5	9.5	0.9	1.5	4.0	2.0	2.3
ILL	£1.2	12.0	£1.2	1.9	3.7	1.3	1.5
IND	2.1	12.5	5.7	£1.7	6.3	3.2	3.9
MICH	4.3	4.9	4.2	1.7	4.2	£1.6	2.2
MINN	1.1	6.6	£1.0	1.1	3.7	1.2	1.7
MO	1.5	13.0	1.8	£1.2	6.8	2.1	3.6
NEBR	£0.6	9.4	0.7	0.8	3.2	1.2	1.8
OHIO	£2.2	11.3	4.4	3.2	5.8	£2.2	2.7
S.DAK	£0.7	12.2	0.9	£0.7	5.2	0.8	2.5
WIS	2.7	4.3	2.7	2.6	3.8	£2.1	2.4

£ = minimum RMSE for the State.

Table 6. End-of-year MAPE'S for corn yield indiations and composite estimates, unadjusted and bias adjusted, 1977-86.

	Unadjusted indications			Adjusted indications			
State	A&P	OY	Composite 2	A&P	OY	Composite 2	ASB
			percents				
IOWA	£0.4	7.7	0.6	1.3	2.6	1.7	1.7
ILL	£0.8	10.4	0.9	1.4	2.4	1.2	0.9
IND	1.5	11.4	5.1	£1.3	5.2	3.5	3.1
MICH	4.3	3.8	4.0	1.6	3.6	£1.1	1.9
MINN	0.8	5.4	£0.7	1.0	3.2	1.1	1.4
MO	1.5	13.5	1.7	1.2	4.2	£0.9	2.2
NEBR	0.5	7.9	£0.4	0.6	2.1	0.7	1.1
OHIO	1.8	9.9	3.6	2.4	3.9	£1.3	2.1
S.DAK	£0.8	18.1	0.9	0.9	7.4	0.9	3.4
WIS	£1.9	3.1	2.0	2.2	3.3	2.1	£1.9

£ = minimum RMSE for the State.

CONCLUSIONS AND OBSERVATIONS

A comparative analysis was performed for the 10 corn OY States from 1977 through 1986. In the analysis, the final ASB estimate was considered the closest approximation to the true yield.

A TY indication, either alone or in a composite with the OY indication, the FRY indication, or both, did not produce more accurate forecasts than the ASB forecast or any bias adjusted August 1 yield indication.

Bias adjusted OY and FRY indications consistently outperformed the unadjusted indications in most States. The bias adjusted DWMY indication showed little increase in accuracy. Results using bias adjusted indications in composites where inconsistent.

Composites generally outperformed individual indications. The September FRY indication, however, did produce lower RMSE's and MAPE's in more States than any composites considered. This result suggests the September OY indication is not being used since it is not providing much information for some States.

The DWMY indication provided better information in August than the OY indication. The OY indication provided better information later in the season.

An inverse mean square error composite of bias adjusted OY and FRY indications slightly outperformed the ASB composite. The two composites performed nearly equal in August. The inverse mean square error composite thoroughly outperformed the ASB composite in September. The ASB composite did slightly better in October and November. However, the most their October and November RMSE's differed by is 0.9 of a bushel, and they differed by 0.5 bushels or less 15 of 20 times.

The ASB forecasts consistently produced the most overall minimum RMSE's and MAPE's across months. However, in all months except November, a composite forecast produced lower RMSE's or MAPE's than the ASB forecast in five or more States. Yet, no one composite consistently outperformed the ASB forecast across months.

Possible explanations for the accuracy of the ASB forecasts are:

1. Weights used in composite forecasts or the bias adjustment procedure do not duplicate the expert judgment process used by the ASB. Also, if the true weights were known, one composite forecast would be the most accurate forecast.

2. The ASB used information that is not part of this analysis such as SSO Statistician comments on crop conditions, etc.

3. The ASB establishes all forecasts and the final yield judgementally. Therefore, the ASB may be opposed to making slight changes supported by survey indications at the end of the growing season.

The unadjusted A&PY indication is the most accurate of seven indications of the ASBY in five States. This is surprising and disconcerting considering the A&PY comes from a nonprobability survey.

RECOMMENDATIONS

Although none of the new monthly yield composites consistently outperformed current procedures, two composite forecasts are recommended for use by the ASB.

1. The inverse root mean square error composites using bias adjusted DWMY and FRY indications should be available for August 1 ASB review. In August this composite outperformed the ASB in six States and produced the best forecasts in three States.

2. The inverse root mean square error composite using bias adjusted OY and FRY indications should be available for all monthly forecast reviews after August. This forecast outperformed the ASB forecast in September and performed almost as well in October and November.

3. This type of analysis should be extended to other crop yield indications.

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APPENDIX

Table A1. RMSE'S for bias adjusted corn yield indications 1977-86.

Month	State	ASB Forecast	Composite forecasts			Individual indications		
			DWMY & FRY	OY & FRY	ASB	DWMY	OY	FRY
			bushels per acre					
Aug.	IOWA	10.8	£* 9.1	11.9	12.7	* 9.6	15.5	11.3
	ILL	10.7	* 9.3	12.8	14.1	£* 8.8	18.3	10.9
	IND	8.2	£* 7.4	9.5	10.6	* 7.8	15.1	9.3
	MICH	6.9	7.2	* 6.8	£* 6.2	7.3	7.3	8.3
	MINN	11.3	*10.7	13.5	12.9	£*10.6	15.6	14.6
	MO	£10.9	12.3	12.4	15.5	15.7	22.9	11.6
	NEBR	8.2	£* 7.4	9.0	9.0	9.9	12.9	9.0
	OHIO	12.3	*10.7	*10.8	*10.1	£*10.0	*11.5	12.7
	S.DAK	£ 8.4	9.7	11.6	11.3	11.9	16.7	11.7
	WIS	£ 5.4	7.1	7.0	6.6	7.7	8.4	7.8
Sept.	IOWA	£ 4.5	6.6	5.9	6.7		10.4	5.4
	ILL	5.2	* 5.1	* 5.1	5.8		10.9	£* 5.0
	IND	3.7	£* 3.3	4.4	5.7		9.9	4.5
	MICH	4.6	6.8	£* 3.8	£* 3.8		5.2	6.4
	MINN	7.0	9.4	7.4	7.6		9.7	£* 6.9
	MO	£ 4.7	4.8	5.0	5.8		12.3	6.4
	NEBR	£ 4.6	5.6	5.3	7.0		9.6	5.3
	OHIO	6.6	£* 4.9	* 6.2	7.0		12.5	7.3
	S.DAK	7.1	* 5.9	* 5.9	7.8		12.7	£* 5.7
	WIS	4.2	6.7	£* 4.0	* 4.1		5.1	5.0
Oct.	IOWA	£ 3.3	5.9	4.6	4.8		6.2	4.6
	ILL	3.8	5.1	£* 3.7	* 3.8		4.7	4.5
	IND	2.3	* 2.3	£* 2.1	3.0		5.6	2.9
	MICH	4.6	6.5	* 4.4	£* 3.6		4.9	6.9
	MINN	£ 3.9	8.0	4.9	4.9		£* 3.9	7.3
	MO	4.3	* 3.2	* 3.5	£* 3.1		5.6	4.5
	NEBR	4.2	4.7	* 4.0	* 3.7		£* 3.3	* 4.1
	OHIO	3.7	4.8	3.8	£* 3.2		6.0	6.7
	S.DAK	5.7	* 4.7	* 4.2	£* 4.1		7.2	* 4.9
	WIS	£ 3.9	6.1	£* 3.9	4.0		4.8	4.7
Nov.	IOWA	£ 1.8	4.2	2.3	2.6		3.4	2.3
	ILL	£ 2.5	4.1	2.9	2.6		4.1	3.9
	IND	£ 1.9	2.2	3.0	3.4		6.3	2.0
	MICH	£ 2.7	5.1	3.8	2.9		4.4	5.1
	MINN	£ 2.1	4.3	3.5	3.4		3.8	4.2
	MO	3.9	£* 3.1	* 3.4	* 3.8		6.2	* 3.8
	NEBR	£ 2.6	3.8	2.9	£* 2.6		3.6	3.5
	OHIO	£ 2.0	3.3	3.1	2.3		5.7	4.7
	S.DAK	5.7	* 4.5	* 3.7	£* 3.5		* 5.3	* 4.8
	WIS	£ 1.9	4.6	3.1	3.5		3.4	3.9

* = Less than or equal ASB.
£ = Minimum for the State by month.

Table A2. MAPE'S for bias adjusted corn yield indications 1977-86.

Month	State	ASB Forecast	Composite forecasts			Individual indications		
			DWMY & FRY	OY & FRY	ASB	DWMY	OY	FRY
			percents					
Aug.	IOWA	£ 6.9	8.0	8.8	8.8	7.6	10.9	8.6
	ILL	8.2	£* 6.8	9.9	10.5	* 7.3	13.4	8.4
	IND	£ 6.0	6.1	7.8	8.1	6.8	10.1	7.2
	MICH	6.2	6.9	* 6.1	£* 5.4	6.8	* 5.6	7.4
	MINN	£ 7.9	10.1	11.8	10.6	8.5	11.3	13.7
	MO	£11.3	12.2	13.0	17.4	18.3	26.4	12.3
	NEBR	£ 6.2	6.4	7.7	7.5	6.9	9.9	7.0
	OHIO	8.4	* 7.7	* 8.3	£* 7.1	* 7.4	* 8.4	10.5
	S.DAK	£10.5	13.9	15.4	15.0	17.4	22.3	16.1
	WIS	£ 4.3	5.8	5.6	4.8	6.2	5.7	6.2
Sept.	IOWA	£ 2.7	5.4	3.7	4.4		7.2	3.5
	ILL	3.9	4.4	* 3.4	4.3		8.1	£* 3.2
	IND	£ 2.5	2.6	3.5	4.9		7.6	3.4
	MICH	4.1	5.8	£* 3.1	£* 3.1		5.3	5.9
	MINN	£ 4.9	7.2	6.5	6.5		7.5	6.2
	MO	£ 5.1	6.6	5.5	5.9		14.2	7.1
	NEBR	£ 3.7	4.0	4.0	5.1		7.7	4.0
	OHIO	4.8	£* 4.7	£* 4.7	5.3		10.5	6.1
	S.DAK	8.8	* 7.9	* 7.5	9.9		16.5	£* 7.2
	WIS	3.3	4.4	£* 2.9	* 3.3		4.2	3.4
Oct.	IOWA	£ 2.0	4.8	2.9	2.9		4.6	3.2
	ILL	2.8	4.3	£* 2.2	* 2.6		3.7	* 2.6
	IND	£ 1.6	£* 1.6	1.7	2.4		4.3	2.3
	MICH	4.1	6.4	* 3.8	£* 3.0		4.8	6.4
	MINN	£ 2.8	7.0	4.1	4.1		2.9	6.6
	MO	4.8	* 4.6	* 3.9	£* 3.0		* 4.5	4.9
	NEBR	3.2	* 3.1	* 3.0	£* 2.7		* 2.6	* 3.2
	OHIO	2.4	4.3	3.0	£* 2.3		4.8	5.5
	S.DAK	6.8	* 6.1	£* 4.8	* 5.3		9.1	* 5.9
	WIS	£ 2.7	4.1	2.9	2.9		4.0	3.5
Nov.	IOWA	£ 1.4	2.7	1.6	1.8		2.4	1.7
	ILL	1.8	2.0	* 1.7	£* 1.6		2.5	2.2
	IND	£ 1.4	1.5	2.3	2.6		5.2	1.6
	MICH	£ 2.4	4.8	3.7	2.5		3.9	5.1
	MINN	£ 1.4	3.7	2.8	2.7		3.2	3.0
	MO	4.3	* 4.1	* 3.9	£* 3.7		* 3.9	* 4.3
	NEBR	2.2	2.8	2.3	£* 2.1		2.4	3.0
	OHIO	£ 1.7	3.1	2.4	1.8		4.1	4.0
	S.DAK	6.8	* 5.9	* 4.4	£* 4.2		7.4	* 5.9
	WIS	£ 1.4	3.3	2.4	2.8		2.8	3.2

* = Less than or equal ASB.
£ = Minimum for the State by month.