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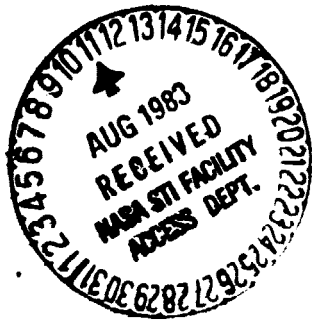
A Joint Program for Agriculture and Resources Inventory Surveys Through Aerospace Remote Sensing

MAY 1983

# Yield Model Development

## COMPARISON OF CRD, APU, AND STATE MODELS FOR IOWA CORN AND SOYBEANS AND NORTH DAKOTA BARLEY AND SPRING WHEAT

VIKKI FRENCH

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ABSTRACT

A comparison was made among the CEAS crop reporting district (CRD), agrophysical unit (APU), and state level yield models for corn and soybeans in Iowa and barley and spring wheat in North Dakota. The best predictions were made by the state model for North Dakota spring wheat, by the APU models for North Dakota barley, by the CRD models for Iowa soybeans, and by APU covariance models for Iowa corn. Because of this lack of consistency of model performance, CRD models would be recommended due to the availability of the data.

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# Comparison of CRD, APU, and State Yield Models for Corn and Soybeans in Iowa and Barley and Spring Wheat in North Dakota

by

Vikki French

This research was conducted as part of the AgRISTARS Yield Model Development Project. It is part of Task 4 (subtask 2) in major project element 1, as identified in the 1982 Yield Model Development Implementation Plan. As an internal project document, this report is identified as shown below:

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# Comparison of CRD, APU, and State Yield Models for Corn and Soybeans in Iowa and Barley and Spring Wheat in North Dakota

by Vikki French

## REVIEW OF MODELS

The CEAS models are multiple regression models which predict crop yields using meteorological variables based on monthly mean temperature and monthly total precipitation. Trend terms are simulated by piecewise linear and quadratic functions of year. Models for North Dakota spring wheat and barley and Iowa corn and soybeans have been developed. Some models were developed for crop reporting districts (CRDs). Others were developed for agrophysical units (APUs), and still others were developed for the entire state. It is the intent of this study to compare CRD, APU, and state models to determine which models lead to the most accurate prediction of crop yields.

Barley models for North Dakota CRDs and for the state were developed by Raymond Motha (1980a). Spring wheat CRD and state models were developed by Sharon LeDuc (1981), as were the barley and spring wheat APU models (LeDuc 1982a). Raymond Motha (1980b) developed the soybean models for Iowa CRDs and state and Sharon LeDuc (1980) the corn CRD and state models for Iowa. The APU corn and soybean models for Iowa were developed by Sharon LeDuc (1982b).

## EVALUATION METHODOLOGY

County level meteorological data were averaged to produce both CRD and APU level data. County level production and harvested area data were summed to the CRD and APU level and the yield calculated. Meteorological data were weighted by harvested area and aggregated to the state level for the state model. Bootstrap tests were for the years 1970 to 1979 for barley, spring wheat, and soybeans, and 1971 to 1980 for corn. CRD and state models for each crop used the variables which had been previously determined. A separate APU

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model for each APU was used (APU1). A second APU model used a covariance methodology which required all coefficients to remain the same across the state so that only the intercepts could vary between APUs (APU2). This second methodology was documented for the APU corn and soybeans but not for barley or spring wheat. These latter models were developed specifically for this comparison by the model developer (Sharon LeDuc).

## COMPARISON METHODOLOGY

Comparison was made on the basis of the difference between observed yields and the various model predictions for the ten bootstrap test years. The same base period was used for all models in computing model-related values for a particular year.

Separate yield predictions were made for each CRD and APU (using the APU1 and APU2 models). A weighted average of the CRD, APU1 or APU2 predictions was used to produce state level predictions. The weighting factor used was harvested hectares. These aggregated predictions (CRD, APU1, and APU2) could be compared to the state model prediction (State).

The models were compared on the basis of each of the following indicators of yield reliability (Wilson et al., 1980). Order does not imply relative importance.

(1) the bias,

(2) the root mean square error (RMSE),

(3) the standard deviation (SD),

(4) the percent of years the absolute value of the relative difference exceeds ten percent (% RD),

(5) the largest absolute value of the relative difference (|RD|)(direction is indicated),

(6) the next largest absolute value of the relative difference (|RD|2) (direction

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is indicated),

(7) the percent of years in which the direction of change from the previous year in the Y's (estimated yields) agrees with the Y's (observed yields) (DC),

(8) the percent of years in which the direction of change from the average of the previous three years in the Y's agrees with the Y's (DC3), and

(9) the Pearson correlation coefficient between the actual and predicted yields during the independent test years (Corr).

For the indicators (1) - (6), the model with the smallest numeric value is the best in terms of yield reliability. For the remaining quantities, the model with the largest value is best.

It should be remembered that the models were compared only in relation to one another and not to an absolute standard. Therefore, saying that a particular model was best does not necessarily imply that the model would be the best of all possible models. It would be the best only of those with which it was compared.

Because the models were developed by different people, differences between the models would not necessarily be due to differences in the stratification. Any comparison between models would also be a comparison of model development techniques. It would be difficult to separate which part of the difference was due to stratification and which to modelers. For the purposes of this paper, it was assumed that any differences detected would be due to stratification only.

## MODEL COMPARISON

The indicators of yield reliability based on the difference between observed yields and predicted yields are shown in Tables 1, 2, 3 and 4. The observed yields, predicted yields, and differences are in the Appendix. No

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model is clearly better than the others in all cases.

The state model is clearly preferable for spring wheat in North Dakota. It is the best model for spring wheat according to all of the indicators except for the two direction of change indicators, DC and DC3. For these two indicators, the APU covariance models, APU2, would be preferred.

For barley, no model is obviously preferable. The state model would be preferred using the indicators standard deviation (SD), correlation (Corr), and $|RD|$. The CRD models would be preferred using the indicators bias, %RD, and DC3. The APU1 models would be preferable for the indicators root mean square error (RMSE), %RD, and $|RD|2$. The state model would be the least preferable in terms of bias, RMSE, and %RD, the CRD models in terms of DC3, and the APU2 models in terms of $|RD|2$. The APU1 models would probably be the best taking all of these into consideration.

The CRD models are generally better for Iowa soybeans as indicated by all but two of the indicators, bias and $|RD|2$. The state model fares poorly, the worst on all indicators except bias, SD, and $|RD|$.

For Iowa corn, the APU covariance models, APU2, would be recommended on the basis of RMSE, SD, $|RD|$, $|RD|2$, DC3, and Corr. Again, the state model is poor, having the worst indicators on all except bias.

## RECOMMENDATIONS

In summary, the state models would be better for North Dakota spring wheat and the APU1 models for North Dakota barley. The CRD models would be preferred for Iowa soybeans and the APU2 models for Iowa corn. This remarkable impartiality is not very encouraging for researchers who would like to be able to recommend one methodology which would be consistently better. CRD and state data are more readily available than APU data. Because of this, with no

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evidence that APU models are consistently better, CRD or state models would be recommended. The state model, however, was not satisfactory for Iowa corn, indicating that the CRD models should be the first choice.

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Table 1

Indicators of Yield Reliability for Model Comparison-North Dakota Spring Wheat

| | State | CRD | APU1 | APU2 |
|---|---|---|---|---|
| Bias | -0.15 | 0.58 | 0.86 | 0.52 |
| RMSE | 1.46 | 1.64 | 2.62 | 1.84 |
| SD | 1.46 | 1.53 | 2.47 | 1.77 |
| %RD | 20 | 30 | 70 | 30 |
| \|RD\| | 19.0 | 25.3 | 27.2 | 29.7 |
| \|RD\|2 | 13.1 | 16.1 | 25.8 | -13.5 |
| DC | 78 | 78 | 67 | 89 |
| DC3 | 57 | 57 | 57 | 86 |
| Corr | 0.73 | 0.72 | 0.63 | 0.66 |

Table 2

Indicators of Yield Reliability for Model Comparison-North Dakota Barley

| | State | CRD | APU1 | APU2 |
|---|---|---|---|---|
| Bias | -1.90 | 0.14 | 0.36 | -0.23 |
| RMSE | 2.29 | 2.18 | 1.44 | 1.57 |
| SD | 1.27 | 2.18 | 1.40 | 1.55 |
| %RD | 60 | 20 | 20 | 30 |
| \|RD\| | -13.2 | 34.4 | 19.2 | 15.9 |
| \|RD\|2 | -12.7 | 11.5 | 10.4 | 13.1 |
| DC | 67 | 67 | 67 | 67 |
| DC3 | 86 | 71 | 86 | 86 |
| Corr | 0.94 | 0.68 | 0.89 | 0.84 |

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Table 3

Indicators of Yield Reliability for Model Comparison-Iowa Soybeans

| | State | CRD | APU1 | APU2 |
|---|---|---|---|---|
| Bias | 0.13 | 0.49 | 0.37 | 0.40 |
| RMSE | 1.78 | 1.09 | 1.26 | 1.18 |
| SD | 1.75 | 0.98 | 1.20 | 1.11 |
| %RD | 20 | 10 | 10 | 10 |
| \|RD\| | -17.2 | 16.0 | 20.2 | 15.4 |
| \|RD\|2 | 10.0 | 4.1 | -3.7 | 6.3 |
| DC | 56 | 78 | 67 | 78 |
| DC3 | 71 | 100 | 86 | 86 |
| Corr | 0.71 | 0.86 | 0.78 | 0.81 |

Table 4

Indicators of Yield Reliablity for Model Comparison-Iowa Corn

| | State | CRD | APU1 | APU2 |
|---|---|---|---|---|
| Bias | 0.64 | 0.77 | 2.64 | 1.99 |
| RMSE | 8.35 | 7.39 | 6.52 | 6.47 |
| SD | 8.33 | 7.35 | 5.97 | 6.16 |
| %RD | 12.8 | 11.3 | 8.9 | 9.3 |
| \|RD\| | 40 | 40 | 40 | 30 |
| \|RD\|2 | -22.0 | 14.9 | 12.2 | -11.0 |
| DC | 50 | 50 | 40 | 40 |
| DC3 | 75 | 75 | 88 | 88 |
| Corr | 0.56 | 0.61 | 0.75 | 0.75 |

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Appendix

Observed and Predicted Yields
for Bootstrap Test Years

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OBSERVED AND PREDICTED YIELDS

NORTH DAKOTA SPRING WHEAT - CRD

| YEAR | OBSERVED YIELD | PREDICTED YIELD | D | RD |
|---|---|---|---|---|
| 1970 | 15.8 | 19.8 | 4.0 | 25.3 |
| 1971 | 21.4 | 21.5 | 0.1 | 0.5 |
| 1972 | 19.4 | 21.5 | 2.1 | 10.8 |
| 1973 | 18.5 | 18.1 | -0.4 | -2.2 |
| 1974 | 13.7 | 15.9 | 2.2 | 16.1 |
| 1975 | 17.4 | 17.1 | -0.3 | -1.7 |
| 1976 | 16.6 | 16.7 | 0.1 | 0.6 |
| 1977 | 16.7 | 16.2 | -0.5 | -3.0 |
| 1978 | 20.1 | 19.4 | -0.7 | -3.5 |
| 1979 | 17.7 | 16.9 | -0.8 | -4.5 |

OBSERVED AND PREDICTED YIELDS

NORTH DAKOTA SPRING WHEAT - APU

| YEAR | OBSERVED YIELD | PREDICTED YIELD | D | RD |
|---|---|---|---|---|
| 1970 | 15.8 | 20.1 | 4.3 | 27.2 |
| 1971 | 21.4 | 24.1 | 2.7 | 12.6 |
| 1972 | 19.4 | 24.4 | 5.0 | 25.8 |
| 1973 | 18.5 | 16.4 | -2.1 | -11.4 |
| 1974 | 13.7 | 15.3 | 1.6 | 11.7 |
| 1975 | 17.4 | 18.7 | 1.3 | 7.5 |
| 1976 | 16.6 | 16.7 | 0.1 | 0.6 |
| 1977 | 16.7 | 15.0 | -1.7 | -10.2 |
| 1978 | 20.1 | 17.6 | -2.5 | -12.4 |
| 1979 | 17.7 | 17.6 | -0.1 | -0.6 |

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OBSERVED AND PREDICTED YIELDS
NORTH DAKOTA SPRING WHEAT - STATE

| YEAR | OBSERVED YIELD | PREDICTED YIELD | D | RD |
|---|---|---|---|---|
| 1970 | 15.8 | 18.8 | 3.0 | 19.0 |
| 1971 | 21.4 | 21.5 | 0.1 | 0.5 |
| 1972 | 19.4 | 19.1 | -0.3 | -1.5 |
| 1973 | 18.5 | 17.0 | -1.5 | -8.1 |
| 1974 | 13.7 | 15.5 | 1.8 | 13.1 |
| 1975 | 17.4 | 16.7 | -0.7 | -4.0 |
| 1976 | 16.6 | 16.7 | 0.1 | 0.6 |
| 1977 | 16.7 | 15.3 | -1.4 | -8.4 |
| 1978 | 20.1 | 18.1 | -2.0 | -10.0 |
| 1979 | 17.7 | 17.1 | -0.6 | -3.4 |

OBSERVED AND PREDICTED YIELDS
NORTH DAKOTA SPRING WHEAT - APU COV

| YEAR | OBSERVED YIELD | PREDICTED YIELD | D | RD |
|---|---|---|---|---|
| 1970 | 15.8 | 20.5 | 4.7 | 29.7 |
| 1971 | 21.4 | 21.2 | -0.2 | -0.9 |
| 1972 | 19.4 | 21.1 | 1.7 | 8.8 |
| 1973 | 18.5 | 16.0 | -2.5 | -13.5 |
| 1974 | 13.7 | 15.1 | 1.4 | 10.2 |
| 1975 | 17.4 | 17.7 | 0.3 | 1.7 |
| 1976 | 16.6 | 17.2 | 0.6 | 3.6 |
| 1977 | 16.7 | 16.2 | -0.5 | -3.0 |
| 1978 | 20.1 | 20.0 | -0.1 | -0.5 |
| 1979 | 17.7 | 17.5 | -0.2 | -1.1 |

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OBSERVED AND PREDICTED YIELDS
IOWA SOYBEANS - CRD

| YEAR | OBSERVED YIELD | PREDICTED YIELD | D | RD |
|---|---|---|---|---|
| 1970 | 21.9 | 21.9 | 0.0 | 0.0 |
| 1971 | 21.9 | 22.8 | 0.9 | 4.1 |
| 1972 | 24.2 | 23.6 | -0.6 | -2.5 |
| 1973 | 22.9 | 23.2 | 0.3 | 1.3 |
| 1974 | 18.8 | 21.8 | 3.0 | 16.0 |
| 1975 | 22.9 | 23.2 | 0.3 | 1.3 |
| 1976 | 20.8 | 21.2 | 0.4 | 1.9 |
| 1977 | 23.9 | 23.3 | -0.6 | -2.5 |
| 1978 | 25.2 | 26.2 | 1.0 | 4.0 |
| 1979 | 25.2 | 25.4 | 0.2 | 0.8 |

OBSERVED AND PREDICTED YIELDS
IOWA SOYBEANS - APU

| YEAR | OBSERVED YIELD | PREDICTED YIELD | D | RD |
|---|---|---|---|---|
| 1970 | 21.9 | 22.0 | 0.1 | 0.5 |
| 1971 | 21.9 | 21.7 | -0.2 | -0.9 |
| 1972 | 24.2 | 23.3 | -0.9 | -3.7 |
| 1973 | 22.9 | 23.4 | 0.5 | 2.2 |
| 1974 | 18.8 | 22.6 | 3.8 | 20.2 |
| 1975 | 22.9 | 23.0 | 0.1 | 0.4 |
| 1976 | 20.8 | 21.1 | 0.3 | 1.4 |
| 1977 | 23.9 | 23.8 | -0.1 | -0.4 |
| 1978 | 25.2 | 25.0 | -0.2 | -0.8 |
| 1979 | 25.2 | 25.5 | 0.3 | 1.2 |

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OBSERVED AND PREDICTED YIELDS
IOWA SOYBEANS - STATE

| YEAR | OBSERVED YIELD | PREDICTED YIELD | D | RD |
|---|---|---|---|---|
| 1970 | 21.9 | 21.2 | -0.7 | -3.2 |
| 1971 | 21.9 | 24.1 | 2.2 | 10.0 |
| 1972 | 24.2 | 24.5 | 0.3 | 1.2 |
| 1973 | 22.9 | 24.6 | 1.7 | 7.4 |
| 1974 | 18.8 | 19.9 | 1.1 | 5.9 |
| 1975 | 22.9 | 22.6 | -0.3 | -1.3 |
| 1976 | 20.8 | 19.8 | -1.0 | -4.8 |
| 1977 | 23.9 | 19.8 | -4.1 | -17.2 |
| 1978 | 25.2 | 27.0 | 1.8 | 7.1 |
| 1979 | 25.2 | 25.5 | 0.3 | 1.2 |

OBSERVED AND PREDICTED YIELDS
IOWA SOYBEANS - APU COV

| YEAR | OBSERVED YIELD | PREDICTED YIELD | D | RD |
|---|---|---|---|---|
| 1970 | 21.9 | 22.0 | 0.1 | 0.5 |
| 1971 | 21.9 | 22.6 | 0.7 | 3.2 |
| 1972 | 24.2 | 23.5 | -0.7 | -2.9 |
| 1973 | 22.9 | 22.5 | -0.4 | -1.7 |
| 1974 | 18.8 | 21.7 | 2.9 | 15.4 |
| 1975 | 22.9 | 23.0 | 0.1 | 0.4 |
| 1976 | 20.8 | 21.3 | 0.5 | 2.4 |
| 1977 | 23.9 | 22.7 | -1.2 | -5.0 |
| 1978 | 25.2 | 26.8 | 1.6 | 6.3 |
| 1979 | 25.2 | 25.6 | 0.4 | 1.6 |

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OBSERVED AND PREDICTED YIELDS
IOWA CORN - CRD

| YEAR | OBSERVED YIELD | PREDICTED YIELD | D | RD |
|---|---|---|---|---|
| 1971 | 64.0 | 64.3 | 0.3 | 0.5 |
| 1972 | 72.8 | 66.3 | -6.5 | -8.9 |
| 1973 | 67.2 | 68.1 | 0.9 | 1.3 |
| 1974 | 50.2 | 66.3 | 16.1 | 32.1 |
| 1975 | 56.5 | 64.9 | 8.4 | 14.9 |
| 1976 | 57.1 | 63.9 | 6.8 | 11.9 |
| 1977 | 54.0 | 46.2 | -7.8 | -14.4 |
| 1978 | 72.2 | 72.6 | 0.4 | 0.6 |
| 1979 | 79.7 | 72.4 | -7.3 | -9.2 |
| 1980 | 69.0 | 65.4 | -3.6 | -5.2 |

OBSERVED AND PREDICTED YIELDS
IOWA CORN - APU

| YEAR | OBSERVED YIELD | PREDICTED YIELD | D | RD |
|---|---|---|---|---|
| 1971 | 64.0 | 65.3 | 1.3 | 2.0 |
| 1972 | 72.8 | 65.9 | -6.9 | -9.5 |
| 1973 | 67.2 | 68.2 | 1.0 | 1.5 |
| 1974 | 50.2 | 64.0 | 13.8 | 27.5 |
| 1975 | 56.5 | 63.4 | 6.9 | 12.2 |
| 1976 | 57.1 | 63.0 | 5.9 | 10.3 |
| 1977 | 54.0 | 54.4 | 0.4 | 0.7 |
| 1978 | 72.2 | 75.5 | 3.3 | 4.6 |
| 1979 | 79.7 | 73.3 | -6.4 | -8.0 |
| 1980 | 69.0 | 76.1 | 7.1 | 10.3 |

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OBSERVED AND PREDICTED YIELDS

IOWA CORN - STATE

| YEAR | OBSERVED YIELD | PREDICTED YIELD | D | RD |
|---|---|---|---|---|
| 1971 | 64.0 | 66.3 | 2.3 | 3.6 |
| 1972 | 72.8 | 65.2 | -7.6 | -10.4 |
| 1973 | 67.2 | 69.6 | 2.4 | 3.6 |
| 1974 | 50.2 | 68.8 | 18.6 | 37.1 |
| 1975 | 56.5 | 59.3 | 2.8 | 5.0 |
| 1976 | 57.1 | 64.4 | 7.3 | 12.8 |
| 1977 | 54.0 | 42.1 | -11.9 | -22.0 |
| 1978 | 72.2 | 75.5 | 3.3 | 4.6 |
| 1979 | 79.7 | 72.0 | -7.7 | -9.7 |
| 1980 | 69.0 | 65.9 | -3.1 | -4.5 |

OBSERVED AND PREDICTED YIELDS

IOWA CORN - APU COV

| YEAR | OBSERVED YIELD | PREDICTED YIELD | D | RD |
|---|---|---|---|---|
| 1971 | 64.0 | 65.1 | 1.1 | 1.7 |
| 1972 | 72.8 | 64.8 | -8.0 | -11.0 |
| 1973 | 67.2 | 68.0 | 0.8 | 1.2 |
| 1974 | 50.2 | 64.1 | 13.9 | 27.7 |
| 1975 | 56.5 | 62.1 | 5.6 | 9.9 |
| 1976 | 57.1 | 62.4 | 5.3 | 9.3 |
| 1977 | 54.0 | 56.7 | 2.7 | 5.0 |
| 1978 | 72.2 | 73.5 | 1.3 | 1.8 |
| 1979 | 79.7 | 71.7 | -8.0 | -10.0 |
| 1980 | 69.0 | 74.2 | 5.2 | 7.5 |

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OBSERVED AND PREDICTED YIELDS
NORTH DAKOTA BARLEY - CRD

| YEAR | OBSERVED YIELD | PREDICTED YIELD | D | RD |
|---|---|---|---|---|
| 1970 | 18.3 | 20.4 | 2.1 | 11.5 |
| 1971 | 24.2 | 23.4 | -0.8 | -3.3 |
| 1972 | 21.5 | 22.6 | 1.1 | 5.1 |
| 1973 | 19.9 | 20.8 | 0.9 | 4.5 |
| 1974 | 15.1 | 20.3 | 5.2 | 34.4 |
| 1975 | 20.4 | 19.1 | -1.3 | -6.4 |
| 1976 | 20.4 | 19.6 | -0.8 | -3.9 |
| 1977 | 21.0 | 20.7 | -0.3 | -1.4 |
| 1978 | 24.7 | 22.4 | -2.3 | -9.3 |
| 1979 | 24.7 | 22.3 | -2.4 | -9.7 |

OBSERVED AND PREDICTED YIELDS
NORTH DAKOTA BARLEY - APU

| YEAR | OBSERVED YIELD | PREDICTED YIELD | D | RD |
|---|---|---|---|---|
| 1970 | 18.3 | 20.2 | 1.9 | 10.4 |
| 1971 | 24.2 | 23.7 | -0.5 | -2.1 |
| 1972 | 21.5 | 21.8 | 0.3 | 1.4 |
| 1973 | 19.9 | 19.5 | -0.4 | -2.0 |
| 1974 | 15.1 | 18.0 | 2.9 | 19.2 |
| 1975 | 20.4 | 21.9 | 1.5 | 7.4 |
| 1976 | 20.4 | 21.5 | 1.1 | 5.4 |
| 1977 | 21.0 | 19.0 | -2.0 | -9.5 |
| 1978 | 24.7 | 23.9 | -0.8 | -3.2 |
| 1979 | 24.7 | 24.3 | -0.4 | -1.6 |

ORIGINAL PAGE IS
OF POOR QUALITY

OBSERVED AND PREDICTED YIELDS
NORTH DAKOTA BARLEY - STATE

| YEAR | OBSERVED YIELD | PREDICTED YIELD | D | RD |
|---|---|---|---|---|
| 1970 | 18.3 | 16.9 | -1.4 | -7.7 |
| 1971 | 24.2 | 21.0 | -3.2 | -13.2 |
| 1972 | 21.5 | 19.8 | -1.7 | -7.9 |
| 1973 | 19.9 | 17.9 | -2.0 | -10.1 |
| 1974 | 15.1 | 16.2 | 1.1 | 7.3 |
| 1975 | 20.4 | 17.8 | -2.6 | -12.7 |
| 1976 | 20.4 | 19.8 | -0.6 | -2.9 |
| 1977 | 21.0 | 18.5 | -2.5 | -11.9 |
| 1978 | 24.7 | 21.7 | -3.0 | -12.1 |
| 1979 | 24.7 | 21.6 | -3.1 | -12.6 |

OBSERVED AND PREDICTED YIELDS
NORTH DAKOTA BARLEY - APU COV

| YEAR | OBSERVED YIELD | PREDICTED YIELD | D | RD |
|---|---|---|---|---|
| 1970 | 18.3 | 20.7 | 2.4 | 13.1 |
| 1971 | 24.2 | 23.6 | -0.6 | -2.5 |
| 1972 | 21.5 | 20.4 | -1.1 | -5.1 |
| 1973 | 19.9 | 18.3 | -1.6 | -8.0 |
| 1974 | 15.1 | 17.5 | 2.4 | 15.9 |
| 1975 | 20.4 | 21.2 | 0.8 | 3.9 |
| 1976 | 20.4 | 19.7 | -0.7 | -3.4 |
| 1977 | 21.0 | 18.8 | -2.2 | -10.5 |
| 1978 | 24.7 | 23.0 | -1.7 | -6.9 |
| 1979 | 24.7 | 24.7 | 0.0 | 0.0 |