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Soybean Objective Yield Research: Assessment of the Revised Forecast Procedure

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ABSTRACT

This study examines the operational practicality of removing three independent variables and one plant maturity category from the Soybean Objective Yield program. Comparisons of reduced and full variable forecast models were made using mean square errors. The dependent variable was number of pods with beans per plant. The analysis showed that forecast precision was maintained when models were constructed using the reduced set of variables and revised maturity categories. By removing variables, data collection is simplified and the potential for plant handling damage is reduced.

KEY WORDS: Soybean Objective Yield, variable reduction, forecast models, relative efficiency

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CONTENTS

	PAGE
SUMMARY	iii
INTRODUCTION	1
CURRENT PROGRAM	2
Field Procedures	2
Modeling Procedures	3
ANALYSIS	3
MATURITY CLASSIFICATION	4
Model Performance	4
Forecasting Performance	5
CONCLUSIONS AND RECOMMENDATIONS	7
REFERENCES	8
APPENDIX 1 - Description of Maturity Categories and Maturity Stages	9
APPENDIX 2 - List of Independent Variables	13
APPENDIX 3 - Cross Tabulations of Current and Revised Maturity Categories	15
APPENDIX 4 - Data Source Preparation and Problems	34
APPENDIX 5 - Model Statistics	36

SUMMARY

The precision of the models for forecasting pods with beans per plant was maintained when three independent variables, lateral branch nodes with fruit, main stem nodes with fruit, and nodes with fruit buds only -- were deleted from the forecast models. The reduction in the number of variables necessitated a revision in the criteria needed to determine plant maturity categories. The number of maturity categories in the revised system was reduced from twelve to eleven.

Full and reduced models were constructed from three sets of data: years 1977-1979, years 1978-1980, and years 1979-1981. Forecast of pods with beans per plant were made for years 1977, 1978, 1980, and 1981 with model comparisons based on mean square errors.

The performance of the reduced models indicated that four plant counts could be eliminated from the Soybean Objective Yield Survey forms B-1 and B-2 and two counts could be deleted from all succeeding month B forms. By simplifying the data collection process, the enumerator workload is reduced along with the potential for nonsampling error and plant handling damage.

SOYBEAN OBJECTIVE YIELD RESEARCH: ASSESSMENT OF THE REVISED FORECAST PROCEDURE

By Robert J. Battaglia and Gary N. Bovard

INTRODUCTION

At the time the Soybean Objective Yield Survey became operational (in 1968), the survey procedures included observations on a number of plant characteristics which seemed to have potential for placing boundaries on the maturity categories. This paper presents the first research conducted to investigate the usefulness of the many counts and measurements made during the survey. Other research projects have evaluated new procedures (1,2)[1/], yet the numerous variables which were part of the original survey remain. The purpose of this paper is to document the research which has led to the revised soybean yield estimating program.

Enumerators have indicated that there were no major definitional problems with the individual counts. However, determining total nodes on the main stem when a growing tip was present and properly identifying lateral branches in varieties having fruiting stalks can sometimes be a problem. The largest problem was identifying the least important item, nodes with fruit buds only. Problems in the survey were not related to the individual counts, but to the multitude of counts. Heavy vegetation combined on occasion with unfavorable weather conditions makes the soybean survey one of the most difficult of the objective yield surveys for enumerators. A reduction in counts would not eliminate these conditions, but would reduce the effect of these stresses on the enumerators.

Greater concern rests with possible handling damage. The soybean plant and its surrounding environment were very vulnerable to handling damage. The recent reports (1,2) found evidence of handling damage. Although the results were inconsistent, a significant indication of as much as a 12 percent reduction in number of pods with beans per plant in Arkansas in 1979 is of major concern. If handling damage does exist, a reduction in number of counts should reduce the damage.

The major revision being suggested was the deletion of several monthly plant component counts. As many as nine components of each plant were counted (See Appendix 2, Figure 2-1). These counts were used in constructing multiple regression models for forecasting number of pods with beans at maturity. The models were created using a stepwise regression procedure for each maturity category in each state. Seldom did an individual model utilize all the variables, but none of the variables were excluded across all states and maturity categories.

1/ Numbers in parenthesis refer to literature cited in the references.

Therefore, none of the variables could be deemed extraneous. The first objective of this research was to find the variables which could be deleted without a great loss in forecasting ability. This was done by examining frequencies of variables in the final stepwise equations and the values of regression coefficients and standard errors. The variables considered for elimination were:

#16 Number of nodes with blooms, dried flowers, or pods on lateral branches;

#13 Number of nodes with blooms, dried flowers, or pods on main stems; and

#4 Number of nodes with fruit buds only.

These changes all resulted in reductions in enumerator workload, plant handling, potential plant damage, and survey costs. The number of per plant component counts was reduced from 9 to 5 in August and September and 6 to 4 in the remaining months.

The second objective was to revise the maturity classification system. The current system is based on enumerator determined maturity stages and complex relationships between individual plant components. The revised system was designed due to the elimination of the three variables listed above. Description of maturity categories for each system are presented in Appendix 1. The revised system was patterned after the current system. The number of categories was reduced from 12 to 11. In the revised system, categories 1 through 3 were prior to bean development in the pods. The breakdown among the three categories is based on the ratio of total fruit to main stem nodes. Categories 4 through 8 were based on the ratio of pods with beans to total fruit. Category 9 is reached only when the enumerator codes the units as maturity stage 4.

The analysis showed that forecast precision was maintained when forecast models for pods with beans were constructed using the reduced number of variables and revised maturity categories.

CURRENT PROGRAM

Field Procedures

The objective yield forecast of gross yield per acre is determined by multiplying three values -- forecasted number of plants, forecasted number of pods per plant, and a historic average weight of bean per pod. Plant numbers are forecast by either a curvilinear or linear regression, using the plant count obtained in the 3 foot by 2 row plot as the independent variable (4). The weight per pod is a 5 year historic average based on the weight of pods at maturity in the three foot by one row area. The number of pods per plant is forecast by a multiple regression equation which uses detailed plant component counts (see Appendix 2) obtained from a six-inch by two row plot as the independent variables.

Beginning with the August 1 survey period and continuing monthly until maturity, enumerators complete B forms which include the plant

component counts. The Form B-1 is used in August, B-2 in September and Forms B-3, B-4 and B-5 in later months (3). In August and September, beginning with question 7, a total of nine counts are obtained from the plants in the 6-inch section. In most instances this requires handling the plants eight times in order to obtain the counts. In later months six counts are made.

Modeling Procedures

The regression models used to forecast number of pods with beans per plant are created monthly by maturity category for each state. Stratification into maturity categories is based on an enumerator determined stage of maturity and the relationships between the various plant components. Appendix 1 contains brief descriptions of the maturity stages and maturity categories. The procedures for determining maturity categories are rather complicated and utilize virtually all of the plant component variables. The proposed elimination of certain counts would require a revised procedure for determining maturity categories.

The soybean models have traditionally been created using three years of historic data. Stepwise regression procedures are used to identify significant independent variables. The variables available to the models are listed in Appendix 2. Normally only a subset of the eligible variables will enter into a model. These models then use current year data to produce the pod indication by unit.

ANALYSIS

The elimination of plant counts will affect the forecast models. Before any independent variables are eliminated it must be shown that an acceptable level of model precision and forecasting accuracy is maintained. Model precision refers to the amount of variability in the dependent variable, final pods with beans per plant, that was explained by the model. Since fewer independent variables are available, and no new variables were added, improvements in R^2 values are not expected. What kind of drop in model efficiency that is acceptable is a rather subjective measurement. However, it is a moot question if forecasting accuracy deteriorates greatly. It was shown that the precision of the forecasts is maintained.

Models were created from three sets of data -- years 1977-1979, years 1978-1980, and years 1979-1981. The development of the maturity classification system and the original supportive analysis were based upon the 1977-1979 data. Data from 1980 were used to test the forecasting accuracy. A review of the results of this analysis proved encouraging. A major concern in model evaluation was that the maturity classification system will perform well on a data set other than the one from which it was derived. This led to creating the models for the other two sets of data. Forecasts were made for the years 1977, 1978, 1980, and 1981 (see Appendix 5 Tables 10-13).

The analysis is presented for all states in the soybean program. This includes six states in August and fifteen states in September and October, except for 1981. During 1981, data were not collected in the nine southern states until October. Any analysis utilizing the 1981 data

includes only the six northern states. Model outliers were not removed from the data. An outlier in the full model, using all variables, might not be an outlier in the reduced model. Due to the desire to compare the two sets of models using the same data sets, it was decided to retain outliers. Some minor data problems were encountered during analysis. Refer to Appendix 4 for a description of these problems, data sources, and analysis procedures.

MATURITY CLASSIFICATION

Cross tabulations of current to revised maturity categories are presented in Appendix 3 for the 1977-1979 and 1979-1981 data sets. The two systems are very similar for the two lowest and two highest maturity categories. Disagreement is frequent in the middle categories during the months August and September. Most differences are probably due to the fact that the revised system uses a reduced amount of data to determine maturity category. The maturity descriptions in both systems were developed subjectively so it is difficult to say that one is more efficient than the other.

Model Performance

From each of the three data sets, two groups of models were created for each forecast year. One group of models was created under the current procedures with all independent variables available for selection by stepwise regression. These models are referred to as the full models. A second group of models, called the reduced models, was constructed excluding three variables (x4, x13, x16; see Appendix 2, figure 2-1) from the stepwise procedure. Consequently, the reduced models used the revised maturity categories, as explained above.

It was not possible to compare the two sets of models based upon the R^2 values due to differing distributions of observations. Model performance could be compared using Mean Square Errors (MSE) which indicated the amount of variation in the data not explained by the model. The model with the lowest MSE explained the most variation in the dependent variable. A ratio of the MSE's, Relative Efficiency (RE), can be used to compare the performance of the full and reduced models. The RE is a measure of the comparative ability to explain the variability in the dependent variable.

$$RE = \frac{\text{mean square error for reduced model}}{\text{mean square error for full model}}$$

A relative efficiency of more than 1.00 would mean that the full model explains more of the variability in the dependent variable than the reduced model. The full model should be expected to perform at least as well as the reduced model since no new variables are added to the reduced model. Only an improvement in the stratification system could result in a RE of less than 1.00. Determining a level of RE which is too large to be acceptable is rather subjective. Relative efficiencies at the state level can be expected to vary greatly and should not be a determining factor. The RE of all states within a month is a more suitable figure since the RE for an individual state can be largely influenced by one observation.

Model statistics are presented in Tables 5-1 through 5-9 in Appendix 5 for the three sets of data. Relative efficiencies aggregated across states are presented in Table 1. The relative efficiencies across states are quite stable within month across the three sets of data. The largest loss in efficiency occurs in August ranging from 6 to 12 percent at the six state level. This should be expected since the items being deleted pertain most closely to the early maturity categories. The September loss in efficiency is not considered serious and is much better than was expected. The loss in efficiency ranged from 4 to 9 percent. In October the loss ranges from 1 to 6 percent and in the six northern States ranges 5 to 6 percent.

Much of the reasoning for completing analysis through 1981 was to assure that the revised maturity system would perform properly on a new data set. The results clearly show that the loss in efficiency in the 1979-1981 data was as small as the 1977-1979 loss in efficiency.

Table 1 -- Relative Efficiencies by Month, State Group, and Year

Month	State Group 1/	Relative Efficiency 2/		
		1977-79	1978-80	1979-81
August	6-state	1.12	1.11	1.06
September	6-state	1.07	1.04	1.09
	15-state	1.06	1.04	
October	6-state	1.05	1.05	1.06
	15-state	1.02	1.01	

1/ 6-state group includes Illinois, Indiana, Iowa, Minnesota, Missouri and Ohio.

2/ The relative efficiency is for the reduced model with the full model as the base.

Forecasting Performance

A review of model performance is a necessary part of the analysis. However, actual forecasting performance must be the major factor when determining the acceptability of the revisions. Forecasting performance is evaluated on both the lack of bias (accuracy) and the precision of the forecasts. Bias is the mean difference between the expected value of the forecasted values and the actual values of pods with beans per plant. Forecasting consistency is evaluated with the root mean square error (RMSE). The RMSE is a measure of the variance of the differences and also the bias. RMSE is of the form:

$$RMSE = \left(\sum_{i=1}^{n} (\hat{Y}_i - Y_i)^2/n\right)^{1/2}$$

where

$\hat{Y}_i$ = forecasted number of pods per plant at unit level,
Y_i = actual number of pods per plant at unit level, and
n = number of units.

The state level forecast errors and RMSE values for 4 years -- 1977, 1978, 1980 and 1981 -- are presented in Tables 5-10 through 5-13 of Appendix 5. No forecasts were made for 1979 since three consecutive years were not available for developing the models. Forecast errors and RMSE values have been weighted to state groupings using harvested acres as the weights. Statistics for the groups are presented in Table 2.

Table 2 -- Pods per Plant Forecast Errors and RMSE Values for Full and Reduced Models by Month, State Group and Year

Month	State Group[1]	Year	Full Model		Reduced Model	
			Forecast Error[2]	RMSE[3]	Forecast Error[2]	RMSE[3]
August	6-state	1977	1.96	14.4	1.76	13.3
		1978	.04	14.6	.15	14.9
		1980	.35	13.3	.27	14.2
		1981	-1.00	13.0	.17	13.2
September	6-state	1977	-1.09	8.9	-1.08	8.4
		1978	-.27	8.2	.25	8.0
		1980	-.43	7.8	-.18	7.8
		1981	-.46	9.4	-.55	8.1
	9-state	1977	.76	12.2	.25	14.9
		1980	3.13	15.5	1.33	14.7
	15-state	1977	-.37	11.3	-.56	11.0
		1980	.99	10.9	.42	10.5
October	6-state	1977	-.13	4.7	-.56	4.7
		1978	-.06	6.0	.24	5.4
		1980	-.61	4.8	-.41	4.8
		1981	.68	7.2	.73	7.2
	9-state	1977	.33	7.3	.10	7.3
		1980	.32	9.0	.64	9.0
	15-state	1977	.06	5.7	-.30	5.7
		1980	-.24	6.5	.01	6.4

1/ 6-state group is same as for Table 1.
2/ Forecast error = forecast value-actual value.
3/ RMSE = mean square error, a measure of variance and bias.

Because the lower maturity categories are of greatest concern, the August data was considered first. The results in Table 2 indicate that the reduced models performed very well. The reduced model weighted forecast errors were smaller in 3 of the 4 years. Weighted RMSE values tended to be somewhat larger for the reduced models. In September and October the reduced model forecast errors were generally as good or better than those of the full model. Weighted RMSE values for the reduced models were consistently lower for the reduced models in September and October.

CONCLUSIONS AND RECOMMENDATIONS

The analysis has shown that the precision of the models for forecasting pods with beans was maintained when the three independent variables -- lateral branch nodes with fruit, main stem nodes with fruit and nodes with fruit buds only -- were deleted from the forecast models. This also required a revision of the maturity category definitions.

Based upon the performance of the reduced models, the following counts should be deleted from the Soybean Objective Yield Survey B-1 and B-2 forms:

Number of nodes with blooms, dried flowers or pods on lateral branches;

Number of nodes with blooms, dried flowers or pods on main stem;

Number of blooms on plants; and

Number of nodes with fruit buds only.

From the B-3, B-4 and B-5 forms the following counts should be deleted:

Number of nodes with pods on lateral branches;

Number of nodes with pods on main stem.

The elimination of these counts may reduce enumerator workload, reduce plant handling damage and improve data accuracy. These proposed gains have not been proven in any data collection effort. However, the average time for completing B Forms decreased from 85.3 minutes in 1981 to 78.2 minutes in 1982.

The elimination of the four plant component counts for the 1982 Survey required that the pods with beans models be developed without the three independent variables listed above and with the revised maturity categories defined in this paper.

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APPENDIX 1
Description of Maturity Categories and Maturity Stages

Maturity categories are calculated by unit. The purpose of the categories is to group units by maturity with the intention of improving the forecasting models. Calculation of the maturity categories is based on an enumerator observed maturity stage and per plant counts. Maturity stage is observed in the three-foot section. Listed below are the maturtiy stage and maturity category descriptions. Additional information can be found in the Objective Yield Survey Enumerators Manual and the Objective Yield Supervising and Editing Manual.

Table 1-1: Soybean Objective Yield Maturity Stages Determined by Enumerators

Maturity Stage	Description
1	Plants still in bloom stage. Any pods found are still green with little or no seed development.
2	Very few blooms. Most pods still filling and leaves are still green.
3	Leaves turning yellow. Almost all pods filled and some ripening.
4	All leaves have turned yellow and some have fallen. Pods full sized and changing from green to brown color. Beans not yet firm.
5	Pods brown and easily opened. Beans brown and have shrunken. Most leaves have been shed.
6	Pods brown and ready to combine. Beans very hard.

Table 1-2: Soybean Objective Yield Assigned Maturity Categories

Maturity Category	Description[1/]
0	No plants were present in either row of the two 6-inch row section per unit.
1	No pods are present and less than 60% of the plants in the 6-inch row sections have blooms.
2	At least 60% of the plants in the 6-inch row sections have some blooms but no pods were counted. Also, the ratio of blooms to nodes is not greater than one.
3	a) If pods were counted, the number of pods was not larger than the number of blooms. b) If no pods were counted, the ratio of blooms to nodes is larger than one.
4	The ratio of pods to total fruit (blooms plus pods) is between .50 and .75, and the ratio of pods with bean (if any) to fruit is less than or equal to .01.
5	The ratio of pods to total fruit is larger than .75, or the ratio of pods with means to total fruit is between .01 and .10.
6	The ratio of pods with beans to total fruit is between .10 and .30.
7	The ratio of pods with beans to total fruit is between .30 and .50.
8	The ratio of pods with beans to total fruit is larger than .50 and the leaves have not yet started to turn yellow.
9	Leaves have started to turn yellow but no leaves have been shed (Maturity stage 3).
10	Leaves have all turned yellow and are starting to fall from the plants (Maturity stage 4).
11	At least half of the leaves have been shed by the plants. (Maturity Stages 5 and 6).

1/ Brief approximation of each category determination.

Table 1-3: Revised Maturity Categories

Maturity Category	Description
0	No plants were present in either row of the two 6-inch row sections per unit.
1	No pods with beans are present and the ratio of total fruit to mainstem nodes is less than 0.2.
2	No pods with beans are present and 0.2 total fruit/mainstem nodes $\leq$ 1.75.
3	No pods with beans are present and total fruit/mainstem nodes $<$ 1.75.
4	Pods with beans 0 and pods with beans/total fruit $\leq$ 0.05.
5	0.05 $\leq$ pods with beans/total fruit $<$ 0.20.
6	0.20 $\leq$ pods with beans/total fruit $<$ 0.65.
7	0.65 $\leq$ pods with beans/total fruit $\leq$ 0.85.
8	Maturity stage = 3 or 0.85 pods with beans/total fruit.
9	Maturity stage = 4.
10	Maturity stages 5 and 6.

APPENDIX 2
List of Independent Variables

Figure 2-1: Description of independent variables used in current forecasting models

Variables	Maturity Categories	Description
X15	1-10	Number of plants in both 3 foot and 6 inch sections adjusted to 18 square feet.
X8	1-10	$(X15)^2$.
X12	1-10	Current pods with beans per plant.
X9	1-3 4-10	Total mainstem nodes per plant $(X12)^2$.
X4*	1-3 4-10	Nodes with fruit buds only per plant. All pods and dried flowers per plant.
X10	1-10	Blooms, pods, and dried flowers per plant.
X13*	1-10	Mainstem nodes with blooms, dried flowers, or pods, per plant.
X14	1-10	Lateral branches per plant.
X16*	1-10	Lateral branch nodes with blooms, dried flowers, or pods per plant..

* In reduced models, these variables are not used.

APPENDIX 3
Cross Tabulations of Current and Revised Maturity Categories

The following tables show frequencies of observation by the current and revised maturity category systems. Tables are ordered by state within the month.

Table 3-1a: Cross tabulation of current and revised maturity categories for August, 1977 - 1979 data

Current Maturity Categories

Illinois

Revised Maturity Categories	1	2	3	4	5	6	7	8	9	10	Total
1	48										48
2	2	61	13								76
3		1	49	33	11						94
4		2	13	43	25						83
5			10	38	22	10	5				85
6						21	37	3			61
7								2			2
8											0
9											0
Total	50	64	85	114	58	31	42	5	0	0	449

Indiana

	1	2	3	4	5	6	7	8	9	10	Total
1	28										28
2	3	58	6								67
3		5	34	19	6						64
4		1	10	14	10						35
5		2	8	23	23	7	1				64
6		1				14	21				36
7											0
8											0
9											0
Total	31	67	58	56	39	21	22	0	0	0	294

Iowa

	1	2	3	4	5	6	7	8	9	10	Total
1	36										36
2		37	8								45
3		2	49	33	17						101
4		2	6	32	18						58
5		1	15	32	19	15	4				86
6		2	1			38	46	8			95
7								3			3
8											0
9											0
Total	36	44	79	97	54	53	50	11	0	0	424

Table 3-1b: Cross tabulation of current and revised maturity categories for August, 1977 - 1979 data

Current Maturity Categories

Minnesota

Revised Maturity Categories	1	2	3	4	5	6	7	8	9	10	Total
1	11										11
2		38	6	1							45
3		2	30	14	4						50
4		1	1	5	3						10
5	1		1	8	4	1	7				22
6						5	18	6			29
7								3			3
8											0
9											0
Total	12	41	38	28	11	6	25	9	0	0	170

Missouri

	1	2	3	4	5	6	7	8	9	10	Total
1	61										61
2	5	18	8	2							33
3		2	17	24	30						73
4			3	7	17						27
5			3	5	6	6	2				22
6			1			4	2				7
7							1				1
8								1			1
9											0
Total	66	20	32	38	53	10	5	1	0	0	225

Ohio

	1	2	3	4	5	6	7	8	9	10	Total
1	47										47
2	2	36	17	3							58
3		2	43	41	18						104
4		1	3	22	7						33
5				8	16	3					27
6						3	2				5
7											0
8											0
9											0
Total	49	39	63	74	41	6	2	0	0	0	274

Table 3-2a: Cross tabulation of current and revised maturity categories for September, 1977 - 1979 data

Current Maturity Categories

Alabama

Revised Maturity Categories	1	2	3	4	5	6	7	8	9	10	Total
1	6										6
2	5	8		3							16
3		4	5	11	30						50
4	1			9	9		1				20
5				2	21	23	8				54
6						27	84	12			123
7							7	34	5		46
8			1				7	11	27		46
9											
Total	12	12	6	25	60	50	107	57	32		361

Arkansas

	1	2	3	4	5	6	7	8	9	10	Total
1	7										7
2	11	11	3	2							27
3		5	35	39	65						144
4			1	10	64		7				82
5			1	7	80	26	48				162
6				1		30	173	27			231
7							5	28	3		36
8							2	3	25		30
9											
Total	18	16	40	59	209	56	235	58	28		719

Georgia

	1	2	3	4	5	6	7	8	9	10	Total
1	5										5
2	7	4	7	6							24
3		1	5	26	42						74
4			1	19	26						46
5		1	1	14	17	13	10				56
6						25	46	3			74
7							3	5	1		9
8								5	11		16
9											
Total	12	6	14	65	85	38	59	13	12		304

Table 3-2b: Cross tabulation of current and revised maturity categories for September, 1977 - 1979 data

Current Maturity Categories

Illinois

Revised Maturity Categories	1	2	3	4	5	6	7	8	9	10	Total
1	1										1
2		2									2
3			1	2							3
4			3	1	1						5
5			2	3	3	1	2				11
6				1		11	101	163			276
7								279	82		361
8							3	28	215		246
9										6	6
Total	1	2	6	7	4	12	106	470	297	6	911

Indiana

	1	2	3	4	5	6	7	8	9	10	Total
1											0
2											0
3											0
4											0
5			3	1							4
6			2			8	61	82			153
7							3	221	46		270
8							1	18	144		163
9										2	2
Total	0	0	5	1	0	8	65	321	190	2	592

Iowa

	1	2	3	4	5	6	7	8	9	10	Total
1											0
2											0
3				2	6						8
4			2								2
5		1	1		3	6	3				14
6				1		8	56	121			186
7							2	238	38		278
8							8	25	276		309
9										30	30
Total	0	1	3	3	9	14	69	384	314	30	827

Table 3-2c: Cross tabulation of current and revised maturity categories for September, 1977 - 1979 data

Current Maturity Categories

Louisiana

Revised Maturity Categories	1	2	3	4	5	6	7	8	9	10	Total
1	1										1
2		3		3							6
3		4	5	10	43						62
4		1		3	9		2				15
5		1	1	1	10	7	14				34
6		1	1	1		15	70	21			109
7							2	33	18		53
8							4	18	134		156
9										4	4
Total	1	10	7	18	62	22	92	72	152	4	440

Minnesota

	1	2	3	4	5	6	7	8	9	10	Total
1											0
2		1									1
3					1						1
4							1				1
5			1				6				7
6							39	64			103
7								78	17		95
8								5	102		107
9										16	16
Total	0	1	1	0	1	0	46	147	119	16	331

Mississippi

	1	2	3	4	5	6	7	8	9	10	Total
1	4										4
2	3		1	9							13
3		3	5	28	105						141
4				4	45		2				51
5	1			12	28	29	24				94
6						50	92	19			161
7							1	29	10		40
8					2		2	3	62		69
9										10	10
Total	8	3	6	53	180	79	121	51	72	10	583

Table 3-2d: Cross tabulation of current and revised maturity categories for September, 1977 - 1979 data

Current Maturity Categories

Missouri

Revised Maturity Categories	1	2	3	4	5	6	7	8	9	10	Total
1	7										7
2	4	6	4	1							15
3		2	18	24	51						95
4				4	12						16
5		1	1	4	10	10	12				38
6						24	165	121			310
7							3	110	25		138
8								8	60		68
9											0
Total	11	9	23	33	73	34	180	239	85	0	687

Nebraska

	1	2	3	4	5	6	7	8	9	10	Total
1											0
2											0
3					1						1
4											0
5				1		1	2				4
6						2	88	114			204
7							4	84	11		99
8								10	21		31
9											0
Total	0	0	0	1	1	3	94	208	32	0	339

North Carolina

	1	2	3	4	5	6	7	8	9	10	Total
1	13										13
2	13	23	6	23							65
3		3	16	36	91						146
4		1	1	8	20		5				35
5		2		8	14	7	17				48
6				1	1	20	29	8			59
7								8	1		9
8								1	1		2
9											0
Total	26	29	23	76	126	27	51	17	2	0	377

Table 3-2e: Cross tabulation of current and revised maturity categories for September, 1977 - 1979 data

Current Maturity Categories

Ohio

Revised Maturity Categories	1	2	3	4	5	6	7	8	9	10	Total
1											0
2		4	2	1							7
3				1							1
4							1				1
5				1	1	1	6				9
6						10	139	136			285
7							1	140	29		170
8								3	81		84
9										2	2
Total	0	4	2	3	1	11	147	279	110	2	559

South Carolina

	1	2	3	4	5	6	7	8	9	10	Total
1	3										3
2	1	4	8	17							30
3		1	6	53	69						129
4			1	14	46		1				62
5				17	20	26	8				71
6			1	1		28	46	3			79
7								7			7
8											0
9											0
Total	4	5	16	102	135	54	55	10	0	0	381

Tennessee

	1	2	3	4	5	6	7	8	9	10	Total
1	5										5
2	7	3	1								11
3		4	13	6	27						50
4			1	2	15		1				19
5				2	22	5	23				52
6					4	22	138	35			199
7							3	38	8		49
8							2	1	20		23
9											0
Total	12	7	15	10	68	27	167	74	28	0	408

Table 3-3a: Cross tabulation of current and revised maturity categories for October, 1977 - 1979 data

Current Maturity Categories

Alabama

Revised Maturity Categories	1	2	3	4	5	6	7	8	9	10	Total
1											0
2											0
3											0
4											0
5							1				1
6								3			3
7								6	7		13
8									240		240
9										55	55
Total	0	0	0	0	0	0	1	9	247	55	312

Arkansas

	1	2	3	4	5	6	7	8	9	10	Total
1											0
2											0
3											0
4											0
5							3				3
6							18	35			53
7								56	33		89
8									455		455
9										85	85
Total	0	0	0	0	0	0	21	91	488	85	685

Georgia

	1	2	3	4	5	6	7	8	9	10	Total
1											0
2											0
3											0
4											0
5											0
6							1	8			9
7								14	9		23
8									251		251
9										22	22
Total	0	0	0	0	0	0	1	22	260	22	305

Table 3-3b: Cross tabulation of current and revised maturity categories for October, 1977 - 1979 data

Current Maturity Categories

Illinois

Revised Maturity Categories	1	2	3	4	5	6	7	8	9	10	Total
1											0
2											0
3											0
4											0
5											0
6								1			1
7								1	2		3
8									89		89
9										144	144
Total	0	0	0	0	0	0	0	2	91	144	237

Indiana

	1	2	3	4	5	6	7	8	9	10	Total
1											0
2											0
3											0
4											0
5											0
6											
7								1			1
8									94		94
9										213	213
Total	0	0	0	0	0	0	0	1	94	213	308

Iowa

	1	2	3	4	5	6	7	8	9	10	Total
1											0
2											0
3											0
4											0
5											0
6											0
7									1		1
8									73		73
9										248	248
Total	0	0	0	0	0	0	0	0	74	248	322

Table 3-3c: Cross tabulation of current and revised maturity categories for October, 1977 - 1979 data

Current Maturity Categories

Louisiana

Revised Maturity Categories	1	2	3	4	5	6	7	8	9	10	Total
1											0
2											0
3											0
4											0
5											0
6							2	3			5
7								7	11		8
8									217		217
9										98	98
Total	0	0	0	0	0	0	2	10	218	98	328

Minnesota

	1	2	3	4	5	6	7	8	9	10	Total
1											0
2											0
3											0
4											0
5											0
6											0
7								1			1
8									24		24
9										115	115
Total	0	0	0	0	0	0	0	1	24	115	140

Mississippi

	1	2	3	4	5	6	7	8	9	10	Total
1											0
2											0
3											0
4											0
5							1				1
6							5	15			20
7								29	17		46
8									355		355
9										72	72
Total	0	0	0	0	0	0	6	44	372	72	494

Table 3-3d: Cross tabulation of current and revised maturity categories for October, 1977 - 1979 data

Current Maturity Categories

Missouri

Revised Maturity Categories	1	2	3	4	5	6	7	8	9	10	Total
1											0
2											0
3											0
4											0
5											0
6							2	11			13
7								27	15		42
8									236		236
9										191	191
Total	0	0	0	0	0	0	2	38	251	191	482

Nebraska

	1	2	3	4	5	6	7	8	9	10	Total
1											0
2											0
3											0
4											0
5											0
6											0
7								3			3
8									45		45
9										130	130
Total	0	0	0	0	0	0	0	3	45	130	178

North Carolina

	1	2	3	4	5	6	7	8	9	10	Total
1											0
2											0
3											0
4											0
5						2	1				3
6						1	24	20			45
7								40	13		53
8									253		253
9										18	18
Total	0	0	0	0	0	3	25	60	266	18	372

Table 3.-3e: Cross tabulation of current and revised maturity categories for October, 1977 - 1979 data

Current Maturity Categories

Ohio

Revised Maturity Categories	1	2	3	4	5	6	7	8	9	10	Total
1											0
2											0
3											0
4											0
5											0
6								1			1
7								1	1		2
8									91		91
9										184	184
	0	0	0	0	0	0	0	2	92	184	278

South Carolina

	1	2	3	4	5	6	7	8	9	10	Total
1											0
2											0
3											0
4											0
5											0
6							20	16			36
7								35	21		56
8									280		280
9										9	9
Total	0	0	0	0	0	0	20	51	301	9	381

Tennessee

											Total
1											0
2											0
3											0
4											0
5											0
6							6	9			15
7								9	4		31
8									211		211
9										127	127
Total	0	0	0	0	0	0	6	18	215	127	366

Table 3-4a: Cross Tabulation of Current and Revised Maturity Categories For August 1979-1981 Data

Current Maturity Categories

Illinois

Revised Maturity Categories	1	2	3	4	5	6	7	8	9	10	Total
1	67										67
2	3	58	11								72
3		2	73	39	18						132
4		1	14	33	27						75
5			10	22	22	4	14				72
6						7	6				13
7											0
8											0
9											0
Total	70	61	108	94	67	11	20	0	0	0	431

Indiana

	1	2	3	4	5	6	7	8	9	10	Total
1	85										85
2	2	62	10								74
3		3	34	19	7						63
4		2	9	15	7						33
5			4	15	14	1					34
6		1		2		3	5				11
7											0
8											0
9											0
Total	87	68	57	51	28	4	5	0	0	0	300

Iowa

	1	2	3	4	5	6	7	8	9	10	Total
1	24										24
2	1	40	12	1							54
3			72	69	40						181
4		2	11	40	20						73
5			13	29	18	3					63
6			1			12	9				22
7											0
8											0
9											0
Total	25	42	109	139	78	15	9	0	0	0	417

Table 3-4b: Cross Tabulation of Current and Revised Maturity Categories for August 1978-1981 Data

Current Maturity Categories

Minnesota

Revised Maturity Categories	1	2	3	4	5	6	7	8	9	10	Total
1	40										40
2	1	62	11	2							76
3		2	48	27	10						87
4		2	8	14	1						25
5		1	8	18	5	6	2				40
6		1			1	2					4
7											0
8											0
9											0
Total	41	68	75	61	17	8	2	0	0	0	272

Missouri

	1	2	3	4	5	6	7	8	9	10	Total
1	128										128
2	1	27	8	1							37
3		2	28	60	48						138
4				6	7						13
5				1	2	3	2				8
6						1					1
7											0
8											0
9											0
Total	129	29	36	68	57	4	2	0	0	0	325

Ohio

	1	2	3	4	5	6	7	8	9	10	Total
1	111										111
2		51	17	1							69
3		2	46	31	11						90
4			1	11	3						15
5				8	5	1					14
6						1	2				3
7								1			1
8											0
9											0
Total	111	53	64	51	19	2	2	1	0	0	303

Table 3-5a: Cross Tabulation of Current and Revised Maturity Categories for September 1979-1981 Data

Current Maturity Categories

Illinois

Revised Maturity Categories	1	2	3	4	5	6	7	8	9	10	Total
1											0
2		1	3	1							5
3		1	2	1							4
4			3		1		1				5
5			4	4	2	1	1				12
6				1		18	115	154			288
7							2	214	48		264
8							1	17	148		166
9										2	2
Total	0	2	12	7	3	19	120	385	196	2	746

Indiana

	1	2	3	4	5	6	7	8	9	10	Total
1											0
2		3	1								4
3			2	3							5
4			1	3							4
5		1	9	5	3	1	1				20
6		1	2			6	87	92			188
7							1	137	19		157
8								16	111		127
9											0
Total	0	5	15	11	3	7	89	245	130	0	505

Iowa

	1	2	3	4	5	6	7	8	9	10	Total
1											0
2											0
3			2	1	1						4
4											0
5				1	1	2	4				8
6						8	66	105			179
7							2	239	59		300
8							3	20	162		185
9										4	4
Total	0	0	2	2	2	10	75	364	221	4	680

Table 3-5b: Cross Tabulations of Current and Revised Maturity Categories for August 1979-1981 Data

Current Maturity Categories

Minnesota

Revised Maturity Categories	1	2	3	4	5	6	7	8	9	10	Total
1											0
2		3									3
3		1			1						2
4							2				2
5						2	7				9
6						1	67	100			168
7							1	129	24		154
8								3	81		84
9										2	2
Total	0	4	0	0	1	3	77	232	105	2	424

Missouri

	1	2	3	4	5	6	7	8	9	10	Total
1	17										17
2	6	11	5	2							24
3		3	23	18	51						95
4				1	6						7
5		1		1	9	8	7				26
6						18	148	122			288
7							2	85	17		104
8							1	1	22		24
9											0
Total	23	15	28	22	66	26	158	208	39	0	585

Ohio

	1	2	3	4	5	6	7	8	9	10	Total
1	1										1
2		10	3								13
3			3	6	3						12
4				1	3		1				5
5		1		4	3	4	3				15
6						14	114	94			222
7							1	91	31		123
8								5	95		100
9											0
Total	1	11	6	11	9	18	119	190	126	0	490

Table 3-6a: Cross Tabulations of Current and Revised Maturity Categories for October 1979-1981 Data

Current Maturity Categories

Illinois

Revised Maturity Categories	1	2	3	4	5	6	7	8	9	10	Total
1											0
2											0
3											0
4											0
5											0
6											0
7								2	4		6
8									97		97
9										160	160
Total	0	0	0	0	0	0	0	2	101	160	263

Indiana

	1	2	3	4	5	6	7	8	9	10	Total
1											0
2											0
3											0
4											0
5											0
6											0
7								3			3
8									122		122
9										178	178
Total	0	0	0	0	0	0	0	3	122	178	303

Iowa

	1	2	3	4	5	6	7	8	9	10	Total
1											0
2											0
3											0
4											0
5											0
6											0
7											0
8									53		53
9										262	262
Total	0	0	0	0	0	0	0	0	53	262	315

Table 3-6b: Cross Tabulation of Current and Revised Maturity Categories for October 1979-1981 Data

Current Maturity Categories

Minnesota

Revised Maturity Categories	1	2	3	4	5	6	7	8	9	10	Total
1											0
2											0
3											0
4											0
5											0
6											0
7											0
8									31		31
9										232	232
Total	0	0	0	0	0	0	0	0	31	232	263

Missouri

	1	2	3	4	5	6	7	8	9	10	Total
1											0
2											0
3											0
4											0
5						1					1
6						1	6	11			18
7								23	17		40
8									184		184
9										176	176
Total	0	0	0	0	0	2	6	34	201	176	419

Ohio

	1	2	3	4	5	6	7	8	9	10	Total
1											0
2											0
3											0
4											0
5											0
6							1	1			2
7								4	5		9
8									134		134
9										137	137
Total	0	0	0	0	0	0	1	5	139	137	282

Data Source, Preparation, and Problems

Source: The data was obtained from the soybean longmaster file retained for Methods Staff's use in building models. This file contains monthly data for all months and forms. The data is at unit level. It also contains the maturity category which is calculated for each unit.

Preparation: SAS data sets were created prior to analysis. The data sets limited to units containing a positive number of plants in the 6-inch sections and a positive number of final pods. Analysis was done monthly for each state using SAS procedures. Distributions of maturity categories were created from all usable data. Models were created only for those categories which contained an adequate number of observations for proper analysis. No attempt was made to edit the data or to remove outliers from the models.

Revised maturity categories were created during the original analyses. Revised categories were patterned after the current definitions. Some minor adjustment in the revised definitions ware made during the early analysis.

Problems: Only one major problem was discovered in the data. No data were available for Minnesota and Missouri for August of 1977 and 1978. No data were available for September 1977 and 1978 for Minnesota. The major concern with this data problem is that the 1977-79 models for these cases contained only 1979 data.

Table 5-1: Statistics from August Models Using 1977-79 Data

State	FULL MODEL			REDUCED MODEL			Rel. Eff.
	Maturity Category	DF	R^2	Maturity Category	DF	R^2	
Illinois.....	1	47	.26	1	44	.30	
	2	59	.56	2	72	.35	
	3	82	.36	3	90	.41	
	4	110	.56	4	78	.62	
	5	52	.61	5	82	.47	
	6	26	.82	6	55	.66	
	7	37	.72				
	all						1.19
Indiana.....	1	27	.15	1	25	.16	
	2	63	.43	2	61	.44	
	3	53	.48	3	61	.35	
	4	52	.37	4	30	.44	
	5	35	.53	5	54	.33	
	all						1.09
Iowa.....	1	33	.30	1	34	.19	
	2	41	.24	2	42	.25	
	31	76	.35	3	96	.52	
	4	83	.64	4	54	.30	
	5	50	.42	5	82	.36	
	6	50	.78	6	84	.75	
	7	45	.81				
	all						1.04
Minnesota....	2	36	.54	2	43	.59	
	3	35	.46	3	33	.46	
	all						.95
Missouri.....	3	29	.35	2	8	.51	
	4	34	.53	3	68	.21	
	5	50	.51	4	24	.45	
				5	13	.71	
	all						1.11
Ohio.....	1	46	.36	1	44	.30	
	2	35	.56	2	54	.43	
	3	59	.61	3	102	.39	
	4	71	.31	4	30	.49	
	5	37	.68	5	22	.65	
	all						1.22
6 States	all						1.12

Table 5-2a: Statistics from September Models Using 1977-79 Data

State	FULL MODEL			REDUCED MODEL			Rel. Eff.
	Maturity Category	DF	R^2	Maturity Category	DF	R^2	
Alabama.....	5	57	.64	3	27	.65	
	6	47	.62	4	8	.46	
	7	103	.69	5	48	.65	
	8	54	.61	6	119	.60	
	9	30	.46	7	44	.54	
				8	41	.76	
	all						1.01
Arkansas.....	4	54	.59	3	101	.77	
	5	204	.69	4	77	.59	
	6	53	.78	5	158	.47	
	7	229	.74	6	227	.78	
	8	54	.77	7	33	.46	
	all						.98
Georgia.....	4	59	.61	2	4	.68	
	5	82	.65	3	65	.39	
	6	36	.60	4	42	.74	
	7	55	.73	5	49	.76	
				6	68	.57	
	all						1.17
Illinois.....	7	104	.79	6	261	.81	
	8	460	.87	7	357	.85	
	9	294	.84	8	244	.82	
	all						1.11
Indiana.....	7	62	.73	6	140	.32	
	8	317	.54	7	266	.83	
	9	187	.84	8	161	.84	
	all						1.00
Iowa.....	7	64	.90	6	174	.81	
	8	378	.76	7	275	.70	
	9	312	.77	8	306	.81	
	all						1.02
Louisiana....	7	89	.47	5	14	.73	
	8	69	.83	6	87	.71	
	9	147	.75	7	51	.80	
				8	153	.72	
	all						1.02

Table 5-2b: Statistics from September Models Using 1977-79 Data

State	FULL MODEL: Maturity Category	DF	R^2	REDUCED MODEL: Maturity Category	DF	R^2	Rel. Eff.
Minnesota....	7	41	.65	6	104	.77	
	8	143	.87	7	92	.85	
	9	114	.89	8	102	.90	
	all						1.05
Mississippi..	4	51	.26	2	8	.54	
	5	173	.62	3	129	.51	
	6	74	.80	4	46	.72	
	7	115	.71	5	86	.76	
	8	49	.75	6	155	.67	
	9	70	.83	7	37	.70	
				8	67	.83	
	all						1.11
Missouri.....	5	68	.68	3	48	.50	
	6	29	.83	4	9	.82	
	7	173	.78	5	29	.55	
	8	223	.77	6	304	.77	
	9	79	.85	7	134	.74	
				8	66	.81	
	all						1.17
Nebraska.....	7	89	.89	6	200	.87	
	8	206	.92	7	86	.93	
				8	8	.98	
	all						1.01
N.Carolina...	4	72	.44	2	20	.36	
	5	121	.71	3	122	.60	
	6	25	.41	4	30	.71	
	7	45	.91	5	42	.61	
				6	46	.85	
	all						1.15
Ohio.....	7	140	.84	6	268	.84	
	8	273	.81	7	168	.79	
	9	107	.77	8	81	.72	
	all						1.00
S. Carolina..	4	99	.30	2	14	.47	
	5	130	.49	3	117	.44	
	6	51	.67	4	57	.54	
	7	52	.68	5	68	.58	
				6	71	.63	
	all						1.02
Tennessee....	5	64	.57	3	24	.78	
	6	23	.74	4	14	.42	
	7	161	.67	5	46	.61	
	8	70	.74	6	195	.65	
				7	42	.65	
	all						1.04
6 States							1.07
15 States	all						1.06

Table 5 -3a: Statistics from October Models Using 1977-79 Data

State	FULL MODEL			REDUCED MODEL			Rel. Eff.
	Maturity Category	DF	R^2	Maturity Category	DF	R^2	
Alabama.....	9	244	.80	7	5	.80	
				8	237	.81	
	all						1.00
Arkansas.....	8	87	.98	6	32	.70	
	9	484	.88	7	86	.97	
	10	83	.95	8	452	.88	
				9	83	.94	
	all						1.00
Georgia.....	9	255	.88	7	7	.95	
				8	249	.87	
	all						1.00
Illinois.....	9	87	.95				
	10	144	.92	8	88	.94	
				9	142	.91	
	all						1.06
Indiana.....	9	91	.96				
	10	210	.95	8	92	.94	
				9	210	.96	
	all						1.03
Iowa.....	9	71	.96				
	10	242	.94	8	70	.96	
				9	243	.94	
	all						1.02
Louisiana....	9	214	.94				
	10	94	.94				
				8	215	.94	
				9	96	.93	
	all						1.05
Minnesota....	10	112	.91	9	112	.91	
	all						1.00

Table 5-3b: Statistics from October Models Using 1977-79 Data

State	FULL MODEL			REDUCED MODEL			Bal. Eff.
	Maturity Category	DF	R^2	Maturity Category	DF	R^2	
Mississippi..	8	41	.89	6	13	.90	
	9	368	.84	7	43	.92	
	10	72	.85	8	351	.83	
				9	70	.84	
	all						1.01
Missouri.....	8	34	.89	6	9	.91	
	9	247	.90	7	38	.89	
	10	186	.97	8	234	.89	
				9	188	.96	
	all						1.07
Nebraska.....	9	42	.99				
	10	129	.96	8	42	.99	
				9	127	.96	
	all						1.03
N. Carolina..	8	58	.97	6	18	.98	
	9	262	.94	7	50	.96	
				8	249	.94	
	all						1.00
Ohio	9	88	.97				
	10	182	.96	8	89	.96	
				9	182	.96	
	all						1.02
S. Carolina..	8	48	.90	6	14	.76	
	9	298	.92	7	52	.95	
				8	277	.91	
	all						.99
Tennessee	9	211	.84				
	10	125	.95	8	207	.84	
				9	124	.95	
6 States	all						1.02
15 States	all						1.05 1.02

Table 5-4: Statistics from August Models Using 1978-1980 Data

State	FULL MODEL Maturity Category	DF	R^2	REDUCED MODEL Maturity Category	DF	R^2	Rel. Eff.
Illinois.....	1	53	.34	1	49	.29	
	2	72	.45	2	87	.32	
	3	101	.37	3	131	.36	
	4	103	.47	4	80	.44	
	5	76	.63	5	70	.62	
	6	9	.42	6	7	.97	
	7	6	.95				
	All						1.16
Indiana.....	1	42	.30	1	43	.30	
	2	73	.46	2	69	.45	
	3	58	.50	3	79	.30	
	4	62	.42	4	36	.50	
	5	30	.57	5	39	.44	
	All						1.12
Iowa.....	1	35	.21	1	34	.11	
	2	44	.24	2	49	.47	
	3	91	.36	3	143	.35	
	4	130	.52	4	77	.20	
	5	62	.42	5	70	.21	
	6	15	.80	6	19	.83	
	7	5	.68				
	All						1.08
Minnesota.....	2	44	.48	2	46	.41	
	3	37	.44	3	34	.61	
	All						.94
Missouri.....	3	27	.44	2	6	.87	
	4	47	.38	3	93	.42	
	5	37	.57	4	12	.43	
	All						1.13
Ohio.....	1	66	.35	1	65	.35	
	2	48	.43	2	66	.32	
	3	74	.37	3	98	.42	
	4	58	.49	4	21	.68	
	5	17	.39	5	11	.79	
	All						1.04
6 States	All						1.11

Table 5-5a: Statistics from September Models Using 1978-1980 Data

State	FULL MODEL			REDUCED MODEL			Rel. Eff.
	Maturity Category	DF	R^2	Maturity Category	DF	R^2	
Alabama.....	5	71	.95	3	41	.95	
	6	43	.58	4	21	.87	
	7	90	.66	5	52	.58	
	8	39	.56	6	104	.57	
	9	25	.44	7	32	.51	
				8	24	.59	
	All						1.13
Arkansas.....	4	60	.54	3	113	.78	
	5	202	.71	4	74	.54	
	6	45	.63	5	132	.55	
	7	175	.73	6	172	.75	
	8	22	.87	7	13	.91	
	All						.93
Georgia.....	4	38	.58	3	76	.36	
	5	102	.63	4	36	.73	
	6	32	.36	5	49	.60	
	7	59	.58	6	71	.34	
	All						1.20
Illinois.....	7	118	.86	6	290	.83	
	8	462	.83	7	353	.83	
	9	284	.83	8	226	.82	
	All						1.04
Indiana.....	7	76	.81	6	162	.65	
	8	314	.76	7	246	.82	
	9	185	.87	8	174	.86	
	All						1.08
Iowa.....	7	59	.75	6	169	.71	
	8	403	.76	7	319	.69	
	9	291	.69	8	261	.71	
	All						1.04
Louisiana....	7	92	.49	5	12	.44	
	8	59	.77	6	89	.51	
	9	96	.83	7	45	.80	
				8	100	.81	
	All						1.00

Table 5 -5b: Statistics from September Models Using 1978-1980 Data

State	FULL MODEL			REDUCED MODEL			Rel. Eff.
	Maturity Category	DF	R^2	Maturity Category	DF	R^2	
Minnesota....	7	63	.61	5	6	.66	
	8	165	.89	6	128	.81	
	9	84	.93	7	109	.94	
	All			8	66	.81	.95
Mississippi..	4	60	.54	2	10	.40	
	5	189	.57	3	162	.55	
	6	66	.79	4	37	.77	
	7	117	.69	5	89	.74	
	8	30	.94	6	133	.65	
	9	38	.87	7	26	.92	
				8	37	.87	
	All						1.05
Missouri.....	7	209	.80	5	12	.62	
	8	230	.82	6	322	.81	
	9	33	.86	7	116	.81	
				8	23	.82	
	All						1.05
Nebraska.....	7	89	.85	6	183	.88	
	8	207	.85	7	103	.82	
				8	8	.98	
	All						1.00
N. Carolina..	4	66	.75	2	20	.64	
	5	122	.72	3	119	.59	
	6	19	.90	4	30	.78	
	7	56	.89	5	46	.71	
				6	54	.85	
	All						1.34
Ohio.....	7	122	.81	6	246	.83	
	8	266	.87	7	175	.89	
	9	146	.84	8	115	.77	
	All						1.05
S. Carolina..	4	108	.40	2	15	.27	
	5	136	.45	3	111	.40	
	6	56	.60	4	64	.53	
	7	47	.58	5	89	.59	
				6	66	.59	
	All						.95
Tennessee....	5	85	.40	3	26	.79	
	6	49	.69	4	23	.25	
	7	143	.65	5	71	.48	
	8	51	.53	6	178	.61	
				7	28	.47	
	All						.94
6 States							1.04
15 States							1.04

Table 5-6a: Statistics from October Models Using 1978-1980 Data

State	FULL MODEL			REDUCED MODEL			Rel. Eff.
	Maturity Category	DF	R^2	Maturity Category	DF	R^2	
Alabama	9	207	.94	8	206	.94	
	10	72	.89	9	74	.87	
	All						1.01
Arkansas	8	88	.98	6	31	.81	
	9	446	.85	7	81	.98	
	10	52	.98	8	425	.84	
				9	53	.98	
	All						1.02
Georgia	8	14	.88	7	17	.95	
	9	267	.87	8	257	.87	
	10	21	.90	9	22	.88	
	All						1.02
Illinois	9	76	.90	8	74	.89	
	10	138	.87	9	139	.86	
	All						1.08
Indiana	9	79	.96	8	80	.96	
	10	218	.97	9	219	.97	
	All						1.04
Iowa	9	72	.95	8	72	.95	
	10	258	.93	9	258	.93	
	All						1.01
Louisiana	9	226	.94	8	225	.94	
	10	86	.90	9	86	.90	
	All						1.00
Minnesota	9	20	.65	8	20	.65	
	10	178	.89	9	178	.89	
	All						1.00

Table 5-6b: Statistics from October Models Using 1978-1980 Data

State	FULL MODEL			REDUCED MODEL			Rel. Eff.
	Maturity Category	DF	R^2	Maturity Category	DF	R^2	
Mississippi..	8	44	.92	6	12	.98	
	9	333	.85	7	46	.94	
	10	51	.94	8	321	.84	
				9	52	.93	
	All						1.00
Missouri.....	8	36	.70	6	10	.73	
	9	220	.90	7	40	.84	
	10	169	.98	8	205	.89	
				9	169	.98	
	All						1.09
Nebraska.....	9	138	.99	8	138	.99	
	10	634	.99	9	634	.99	
	All						1.00
N. Carolina..	7	29	.42	6	48	.93	
	8	57	.97	7	47	.97	
	9	261	.94	8	251	.94	
	10	30	.99	9	30	.99	
	All						1.00
Ohio.....	9	84	.97	8	84	.97	
	10	179	.98	9	179	.98	
	All						1.00
S. Carolina..	7	32	.60	6	60	.66	
	8	65	.91	7	56	.93	
	9	270	.89	8	251	.89	
	All						1.01
Tenessee.....	9	223	.94	7	6	.93	
	10	117	.92	8	214	.94	
				9	117	.92	
6 States	All						1.01
15 States							1.05
							1.01

TABLE 5-7: Statistics from August Models Using 1979-1981 Data

State	Full Model: Maturity Category	Full Model: DF	Full Model: R^2	Reduced Model: Maturity Category	Reduced Model: DF	Reduced Model: R^2	Rel. Eff.
Illinois.....	1	65	.45	1	62	.44	
	2	57	.48	2	69	.39	
	3	102	.49	3	127	.53	
	4	88	.48	4	71	.55	
	5	62	.71	5	68	.42	
	6	8	.82	6	10	.88	
	7	17	.74				
	All						1.09
Indiana.....	1	84	.25	1	82	.27	
	2	64	.40	2	72	.22	
	3	54	.47	3	57	.50	
	4	46	.42	4	28	.68	
	5	26	.72	5	31	.47	
	All						1.10
Iowa.....	1	23	.31	1	24	.31	
	2	39	.40	2	52	.47	
	3	105	.30	3	177	.36	
	4	133	.46	4	70	.19	
	5	75	.34	5	59	.25	
	6	12	.80	6	17	.83	
	7	7	.73				
	All						1.06
Minnesota....	1	38	.58	1	36	.62	
	2	63	.48	2	72	.43	
	3	70	.50	3	85	.64	
	4	56	.58	4	20	.65	
	5	15	.80	5	30	.56	
	All						1.10
Missouri.....	1	126	.11	1	124	.13	
	2	24	.87	2	33	.76	
	3	34	.41	3	134	.49	
	4	64	.53	4	14	.43	
	5	54	.52				
	All						1.03
Ohio.....	1	106	.25	1	107	.21	
	2	49	.27	2	66	.24	
	3	62	.25	3	87	.50	
	4	47	.54	4	12	.79	
	5	16	.56	5	10	.69	
	All						1.00
6 States	All						1.06

TABLE 5-8: Statistics from September Models Using 1979-1981 Data

State	Full Model: Maturity Category	Full Model: DF	Full Model: R^2	Reduced Model: Maturity Category	Reduced Model: DF	Reduced Model: R^2	Rel. Eff.
Illinois.....	7	113	.86	6	265	.85	
	8	378	.83	7	260	.82	
	9	190	.87	8	162	.85	
	All						1.06
Indiana.....	7	86	.81	6	174	.72	
	8	239	.76	7	154	.76	
	9	128	.86	8	125	.87	
	All						1.08
Iowa.....	7	68	.80	6	167	.71	
	8	358	.71	7	296	.67	
	9	219	.68	8	182	.68	
	All						1.08
Minnesota....	7	75	.65	5	6	.91	
	8	229	.83	6	162	.80	
	9	103	.92	7	152	.90	
				8	80	.83	
	All						.91
Missouri.....	4	20	.45	3	68	.60	
	5	60	.76	4	3	.99	
	6	23	.88	5	22	.69	
	7	154	.79	6	284	.80	
	8	202	.90	7	99	.87	
	9	35	.89	8	22	.92	
	All						1.21
Ohio.....	7	113	.82	6	207	.81	
	8	185	.88	7	119	.87	
	9	123	.76	8	97	.74	
	All						1.10
6 States	All						1.09

TABLE 5-9: Statistics from October Models Using 1979-1981 Data

State	Full Model: Maturity Category	Full Model: DF	Full Model: R^2	Reduced Model: Maturity Category	Reduced Model: DF	Reduced Model: R^2	Rel. Eff.
Illinois	9	98	.94	8	98	.94	
	10	156	.89	9	157	.85	
	All						1.06
Indiana	9	118	.83	8	120	.80	
	10	174	.96	9	174	.96	
	All						1.10
Iowa	9	50	.93	8	50	.93	
	10	257	.91	9	258	.91	
	All						1.04
Minnesota	9	29	.69	8	29	.69	
	10	229	.90	9	229	.90	
	All						1.00
Missouri	9	199	.80	7	15	.91	
	10	173	.96	8	181	.77	
				9	172	.94	
	All						1.07
Ohio	9	137	.96	8	137	.96	
	10	135	.98	9	135	.98	
	All						1.00
6 States	All						1.06

Table 5-10: State Mean 1977 Pods with Beans per Plant with Forecast Differences Using 1978-1980 Models

Month/ State 1/	Obs.	Final Pods Per Plant	FULL MODEL Forecast Diff. 2/	FULL MODEL RMSE 3/	REDUCED MODEL Forecast Diff. 2/	REDUCED MODEL RMSE 3/
August						
Illinois	147	32.7	-3.26	16.3	- .33	16.4
Indiana	65	30.6	1.62	10.9	2.25	10.7
Iowa	140	30.5	8.59	18.8	2.92	13.4
Minnesota	13	19.3	2.15	6.1	- .05	8.2
Missouri	60	27.4	3.08	11.4	5.45	12.5
Ohio	86	30.9	- .04	18.1	.70	15.5
6 N. States			1.96	14.4	1.76	13.3
September						
Alabama	97	32.7	-3.32	13.6	-3.26	14.8
Arkansas	216	29.2	4.21	16.7	3.28	18.1
Georgia	69	27.8	-2.01	19.7	-5.22	18.1
Illinois	297	31.6	-5.26	12.3	-1.11	11.4
Indiana	126	29.2	1.37	7.1	1.81	6.8
Iowa	262	31.4	- .59	6.4	-3.59	10.0
Louisiana	123	40.7	-1.49	16.1	-1.65	16.7
Minnesota	161	28.1	-1.84	4.9	-2.27	5.0
Mississippi	200	31.8	1.94	15.6	3.13	15.0
Missouri	197	31.8	1.20	8.5	.82	8.1
Nebraska	97	27.9	1.81	5.0	1.71	5.2
N. Carolina	80	28.5	2.99	17.9	.26	13.9
Ohio	179	30.5	2.72	13.6	- .61	8.9
S. Carolina	97	31.1	- .97	15.2	-1.61	18.0
Tennessee	108	27.6	- .95	10.8	- .83	10.9
6 N. States			-1.09	8.9	-1.08	8.4
9 S. States			.76	12.2	.25	14.9
15 States			- .37	11.3	- .56	11.0
October						
Alabama	102	32.7	-1.20	6.7	-1.43	6.6
Arkansas	202	29.5	1.71	6.0	1.90	6.0
Georgia	89	25.8	-2.51	9.8	-2.79	9.4
Illinois	58	34.8	- .47	5.2	-1.62	5.8
Indiana	86	29.9	- .28	4.0	- .83	4.0
Iowa	59	35.3	.72	4.1	.02	3.5
Louisiana	105	40.3	.46	7.8	.43	7.8
Mississippi	160	29.4	.47	12.4	- .61	12.4
Minnesota	35	30.7	-1.26	4.2	- .06	3.6
Missouri	158	30.4	- .20	6.1	- .67	6.1
Nebraska	57	27.1	1.60	4.6	1.49	4.6
N. Carolina	113	25.0	1.18	4.8	1.33	4.8
Ohio	66	27.7	.51	4.2	.76	5.3
S. Carolina	118	30.0	- .05	6.1	.07	6.2
Tennessee	117	27.2	- .16	4.5	- .71	7.4
6 N. States			- .13	4.7	- .56	4.7
9 S. States			.33	7.3	.10	7.3
15 States			.06	5.7	- .30	5.7

See Footnotes on Table 13

Table 5-11: State Mean 1978 Pods with Beans per Plant with Forecast Differences Using 1979-1981 Models

Month/ State 1/	Obs.	Final Pods Per Plant	FULL MODEL Forecast Diff. 2/	FULL MODEL RMSE 3/	REDUCED MODEL Forecast Diff. 2/	REDUCED MODEL RMSE 3/
August						
Illinois	158	32.5	2.49	13.1	.94	13.3
Indiana	100	35.2	- .44	16.6	1.57	17.1
Iowa	133	33.0	1.50	13.3	- .26	13.1
Ohio	81	32.5	- .09	19.3	-2.88	20.4
4 States		33.1	.04	14.6	.15	14.9
September						
Illinois	304	31.6	.11	6.8	.57	6.8
Indiana	204	36.8	- .67	11.1	.26	11.0
Iowa	244	34.2	.02	6.9	.43	6.4
Missouri	186	32.2	-1.27	11.4	- .60	11.4
Ohio	177	31.1	.02	6.5	- .03	6.2
5 States		33.1	- .27	8.2	.25	8.0
October						
Illinois	104	29.0	1.46	6.8	1.61	7.2
Indiana	122	36.5	-1.39	8.6	- .11	4.0
Iowa	120	33.8	- .83	5.4	- .71	5.0
Missouri	139	29.7	- .37	5.3	- .12	5.7
Ohio	95	31.5	- .15	3.1	- .15	3.1
5 States		31.8	- .06	6.0	.24	5.4

See Footnotes on Table 13

Table 5-12: State Mean 1980 Pods with Beans per Plant with Forecast Differences Using 1977-1979 Models

Month/ State 1/	Obs.	Final Pods Per Plant	FULL MODEL Forecast Diff. 2/	FULL MODEL RMSE 3/	REDUCED MODEL Forecast Diff. 2/	REDUCED MODEL RMSE 3/
August						
Illinois	152	32.4	.67	16.2	1.05	17.6
Indiana	101	30.0	.70	12.8	1.93	14.6
Iowa	138	32.3	1.55	11.6	1.21	14.2
Minnesota	23	24.9	-1.21	11.2	-1.84	9.5
Missouri	72	28.5	1.28	12.6	- .78	12.3
Ohio	102	26.5	-2.85	13.9	-1.46	13.5
6 N. States		29.9	.35	13.3	.27	14.2
September						
Alabama	79	22.6	4.39	18.8	.34	12.6
Arkansas	142	21.3	.15	11.2	-1.02	11.9
Georgia	74	23.4	4.84	20.3	6.05	21.0
Illinois	305	31.8	.37	7.0	.28	7.5
Indiana	209	32.6	-2.19	8.8	-1.56	8.5
Iowa	262	33.1	- .93	10.4	- .72	9.7
Louisiana	65	42.0	-2.06	20.4	-2.69	20.0
Minnesota	168	24.6	.03	4.3	.17	4.1
Mississippi	144	29.6	4.99	15.9	4.47	15.7
Missouri	204	26.9	.17	7.1	.90	8.0
Nebraska	100	31.8	-3.58	9.6	-2.44	7.7
N. Carolina	89	26.3	2.49	13.7	1.63	13.0
Ohio	195	28.8	- .67	7.6	- .56	7.1
S. Carolina	111	22.4	11.62	17.9	8.41	17.6
Tennessee	78	25.7	4.29	14.2	.86	13.0
6 N. States		30.2	- .43	7.8	- .18	7.8
9 S. States		27.7	3.13	15.5	1.33	14.7
15 States		29.2	.99	10.9	.42	10.5
October						
Alabama	64	31.8	.26	7.6	.22	7.3
Arkansas	140	22.6	.49	9.6	.18	9.5
Georgia	86	24.8	2.35	8.7	2.48	8.6
Illinois	49	26.6	-1.57	5.2	-1.03	4.9
Indiana	87	31.1	- .29	3.2	- .26	3.2
Iowa	78	33.9	- .53	4.4	- .44	4.3
Louisiana	118	38.3	1.48	15.6	1.36	14.7
Minnesota	99	24.1	.20	4.7	.20	4.7
Mississippi	116	30.4	1.12	9.9	1.36	9.9
Missouri	113	23.8	- .96	6.3	- .92	7.0
Nebraska	12	33.4	- .05	6.5	- .05	6.5
N. Carolina	101	25.4	-1.20	5.0	-1.19	5.0
Ohio	65	29.4	- .50	3.1	- .54	3.1
S. Carolina	97	24.5	- .51	6.8	- .18	7.3
Tennessee	57	27.3	- .98	7.6	2.29	7.7
6 N. States		29.2	- .61	4.8	- .41	4.8
9 S. States		27.8	.32	9.0	.64	9.0
15 States		28.6	- .24	6.5	.01	6.4

See Footnotes on Table 13

Table 5-13: State Mean 1981 Pods with Beans per Plant with Forecast Differences Using 1978-1980 Models

Month/ State 1/	Obs.	Final Pods Per Plant	FULL MODEL Forecast Diff. 2/	FULL MODEL RMSE 3/	REDUCED MODEL Forecast Diff. 2/	REDUCED MODEL RMSE 3/
August						
Illinois	141	28.9	-2.45	12.3	- .12	13.4
Indiana	101	24.8	2.93	10.3	2.42	10.0
Iowa	141	32.5	2.02	13.7	1.58	13.7
Minnesota	41	24.7	-1.03	10.4	-1.85	10.0
Missouri	42	39.7	-6.40	14.7	-2.78	14.5
Ohio	99	22.9	-1.43	17.6	1.51	18.0
6 States		29.6	-1.00	13.0	.17	13.2
September						
Illinois	124	29.9	-5.72	11.9	- .15	6.7
Indiana	71	26.9	2.24	9.2	3.18	8.7
Iowa	137	32.6	1.67	7.8	-2.91	10.4
Minnesota	93	26.0	.67	6.5	.49	6.3
Missouri	60	36.7	-1.81	8.6	-1.92	8.4
Ohio	63	23.9	5.72	11.3	- .29	7.1
6 States		30.0	- .46	9.4	- .55	8.1
October						
Illinois	140	26.7	.97	7.7	.56	7.4
Indiana	117	25.3	.26	5.9	.26	5.8
Iowa	98	34.0	- .04	7.6	- .09	8.1
Minnesota	58	27.0	- .59	4.1	- .59	4.1
Missouri	132	32.5	3.26	12.2	3.21	11.2
Ohio	98	22.2	- .06	3.4	.28	3.4
6 States		28.6	.68	7.2	.73	7.2

1/ State statistics are weighted to monthly groups by harvested acres.

2/ Forecast difference = forecasted value - actual value.

3/ RMSE stands for root mean square error which is a measure of variance and bias.

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