1962-63 Research Projects

Objective Winter Wheat Yield Surveys - 1962 and 1963 Crops

7.1 Sample Design and Procedures

A. Purpose and History of Survey:

The objective yield surveys for wheat provide quantitative information which can be used to predict or measure wheat yield and production. The surveys have been conducted to obtain forecasts for yield and production on May 1, June 1, and July 1, and estimates of yield and harvesting loss on August 1. The sample data utilized in estimating production are gross yield, harvesting loss, and acres remaining for harvest.

A sample of 1,400 fields in nine States (Illinois, Indiana, Kansas, Michigan, Missouri, Nebraska, Ohio, Oklahoma, and Texas) was drawn, of which about 1,100 were sampled for the 1963 crop year. This 9-State area was fully operational for winter wheat on the July 1, final pre-harvest, and post-harvest surveys. (See Table 101.) The 1963 program also included about 275 pre-harvest field counts in a pilot survey conducted in six additional winter wheat States (South Dakota, Montana, Idaho, Colorado, Washington, and Oregon). In addition to the 275 sample fields, weekly counts and observations were made in 60 winter wheat fields for the new States during the entire growing season to obtain information for developing forecasting models for use in future years.

Objective yield counts and measurements were also started in six spring wheat States (North Dakota, South Dakota, Montana, Idaho, Washington, and Minnesota) for the first time during 1963. A single pre-harvest visit and a post-harvest visit were made to about 400 fields in these States for making an estimate of yield at harvest time. Weekly counts and observations were made in about 65 spring wheat fields throughout the growing season.

B. Sampling Techniques

The sample fields in which observations and counts were made were selected by a random process with probabilities proportional to size of field. These selections were made from farms reporting winter wheat seeded in the previous December Enumerative Survey. Approximately 1,400 sample fields were allocated to the 9-States in 1963 compared to 965 sample fields for the same States in 1962 (see Table 102). The samples were allocated to each individual State roughly in proportion to the expanded seeded acreage from the December Enumerative Survey, but also considered were differences in observed variances between States.

Sample fields were subsampled by selecting two plots within the field using a random process plot consisting of three rows, each about 26 inches long. In case wheat rows can not be distinguished due to reseeding or turn rows, the total area covered by the frame is used as the plot. In the latter case the unit is about 4.356 square feet (.0001 of an arce).

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Table 101: Winter Wheat: Number of Sample Fields

By States, 1962

State	May 1	June 1	July 1	Pre-Harvest	Post-Harvest
Illinois	33	33	100	100	100
Indiana	33	33	100	100	100
Kansas	100	100	300	300	300
Michigan	15	15	15	15	15
Missouri	20	20	20	20	20
Nebraska	30	30	30	30	30
Ohio	33	33	100	100	100
Oklahoma	50	150	150	150	150
Texas	50	150	150	150	150
Total	364	564	965	965	965

Table 102: Winter Wheat: Number of Sample Fields 1/

By States, 1963

State	May 1	June 1	July 1	Pre-Harvest	Post-Harvest
Illinois	33	33	100	100	100
Indiana	33	33	100	100	100
Kansas	100	100	300	300	300
Michigan	15	15	100	100	100
Missouri	20	20	20	100	100
Nebraska	30	30	30	150	150
Ohio	33	33	100	100	100
Oklahoma	50	150	150	200	200
Texas	50	150	150	250	250
Total	364	564	1,400	1,400	1,400

1/ Generally exceeded the number tabulated due to sample loss from such causes as plow-up, refusals, etc.

Table 103: Winter Wheat: Number of Weekly Samples 1/

By States, 1963

State	Weekly in May	Weekly in June	Weekly in July	Pre-Harvest 2/	Post-Harvest
S. Dakota	10	10	10	40	40
Colorado	10	10	10	60	60
Idaho	10	10	10	40	40
Montana	10	10	10	50	50
Oregon	10	10	10	40	40
Washington	10	10	10	50	50
Total	60	60	60	280	280

Table 104: Spring Wheat: Number of Weekly Samples 1/

By States, 1963

State	Weekly in May	Weekly in June	Weekly in July	Pre-Harvest	Post-Harvest
N. Dakota 2/	15	15	15	150	150
S. Dakota	10	10	10	75	75
Montana	10	10	10	75	75
Idaho	10	10	10	30	30
Washington	10	10	10	30	30
Minnesota	10	10	10	60	60
Total	65	65	65	420	420

1/ Generally exceeds the number tabulated due to sample loss from such causes as plow-up, refusals, etc.

2/ North Dakota weekly samples included 10 other spring samples and 5 durum samples.

In the States added to the program in 1963, the sampling rate was much lower since no forecasting was to be done. The objective was to obtain data for determining sample size and forecasting parameters and for making pre-harvest estimate for this group of States. Selection of plots within sample fields was done in the same way as for the other States.

The weekly observation fields in the new States were sampled selectively from two major producing areas of differing growing conditions within each State. Three sample units were randomly selected from each sample field. These units consisted of six rows, each about 26 inches long. The actual size of unit observed was four rows since the center two of the six rows were not used for counts or measurements. See Tables 103 and 104 for the sizes of the samples in the new States.

C. Collecting the Data

In the 9 winter wheat States which were in 1962 program (Ohio, Indiana, Illinois, Michigan, Missouri, Nebraska, Kansas, Oklahoma, and Texas), the sample fields were visited about May 1 and the farm operators were interviewed to determine acres of wheat planted, date of planting, and variety of wheat planted. Estimates were also obtained from the operators for the expected date of harvest and the probable yield. For summarization of the interview data collected see Table 105.

Table 105: Winter Wheat: May 1, 1962 and 1963 Estimates of Acreage and Yield From Operator Interviews

State	Fields		Ratio of May 1 acres standing to December intentions		Ratio of May 1 acres for grain to May 1 standing		Growers forecast of yeild per acre harvested	
	(Number)		(Percent)		(Percent)		(Bushels)	
	1962	1963	1962	1963	1962	1963	1962	1963
Illinois	31	32	95.5	98.0	100.0	100.0	32.5	34.5
Indiana	26	56	89.4	97.5	98.0	99.2	30.0	37.6
Kansas	155	165	95.6	86.9	99.6	92.8	27.0	21.3
Michigan	15	15	101.1	98.9	97.9	99.2	--	30.5
Missouri	19	62	92.7	94.2	100.0	99.8	29.7	28.8
Nebraska	30	113	115.2	95.6	100.0	99.2	29.5	28.3
Ohio	30	58	87.9	99.9	96.1	99.7	30.0	32.5
Oklahoma	43	132	78.9	86.4	96.7	88.6	19.6	19.0
Texas	45	204	78.5	79.2	92.8	97.0	22.6	17.3

Following the interview with the operator, counts and measurements were taken in the sample units. The average row space was recorded to be used in computing the expansion factor for each sample. The grain was classified according to stage of maturity and counts were made on number of stalks, number of stalks taller than ten inches, number of heads in boot, number of heads emerged, and number of stalks damaged or infested. The accuracy of the forecasting model hinges to a large extent on proper classification of data as to maturity eategory, so that clear, unambiguous definitions of maturity stages are mandatory as in strict adherence to these definitions by the samplers.

Just outside the unit, sample heads were cut for making spikelet counts and obtaining grain weights. For subsequent monthly visits to the same sample plots, similar counts and measurements were obtained until the wheat was mature. When the grain was classified as being in the hard dough or ripe stage of maturity heads were counted and sample plots harvested to obtain grain weights and moisture content.

As soon as possible after the field had been harvested, the operator was interviewed to obtain information on acres harvested for grain and grain yields. A final visit was then made to the sample fields where new plots were selected in the same manner as the original sample units. These new plots were gleaned to obtain the number of heads and kernels left after harvest to provide an estimate of harvesting loss. The field counts and interview data are summarized in Tables 106 through 114.

Table 106: Winter Wheat: Averages from Field Counts - May 1, 1962 and 1963, by States

State	Fields		Distance across 10 row spaces		Stalks 1/		Stalks 10 inches tall 1/		Heads 1/		Damaged stalks 1/		Average Height of stalk 1/	
	(number)		(Feet)		(Number)		(Number)		(Number)		(Number)		(Inches)	
	1962	1963	1962	1963	1962	1963	1962	1963	1962	1963	1962	1963	1962	1963
Illinois	31	34	6.15	6.19	1,079	922	-	52	0	29	-	16	-	5.0
Indiana	32	33	6.04	5.75	770	877	-	0	0	0	-	0	-	4.6
Kansas	91	86	7.69	7.72	847	499	-	76	19	67	-	9	-	6.9
Michigan	-	15	-	5.83	-	694	-	0	-	0	-	0	-	1.5
Missouri	20	34	6.06	6.09	672	748	-	128	0	78	-	0	-	7.8
Nebraska	28	45	7.13	6.76	763	744	-	0	0	0	-	0	-	3.4
Ohio	29	31	5.97	5.95	852	827	-	0	0	0	-	12	-	1.9
Oklahoma	43	51	7.29	7.33	409	410	-	210	94	227	-	2	-	12.7
Texas	41	62	7.70	7.99	558	275	-	88	64	92	-	10	-	10.6

1/ Per 13.1 feet of row with .6 foot of row space (2 sample units)

Table 107: Winter Wheat: Averages from Field Counts, June 1, 1962 and 1963, by States

State	Fields		Stalks 1/		Stalks 10 inches tall 1/		HEADS 1/ Emerged		HEADS 1/ In boot		Stalks 1/ damaged		Height of stalks 1/	
	(Number)		(Number)		(Number)		(Number)		(Number)		(Number)		(Inches)	
	1962	1963	1962	1963	1962	1963	1962	1963	1962	1963	1962	1963	1962	1963
Illinois	31	33	461	518	-	402	389	400	15	9	2.4	7.4	27.9	31.8
Indiana	32	32	358	476	-	402	318	245	25	88	4.9	8.4	31.8	25.7
Kansas	95	85	505	339	-	232	371	295	10	9	5.3	7.5	22.1	20.3
Michigan	15	15	403	572	-	133	91	0	44	0	5.8	.4	20.4	8.8
Missouri	20	33	299	463	-	356	278	352	9	8	1.6	15.2	24.5	28.1
Nebraska	27	45	418	470	-	353	181	315	162	36	7.0	4.1	22.5	22.6
Ohio	29	31	430	559	-	282	176	69	80	74	27.0	17.4	22.0	15.3
Oklahoma	122	159	281	303	-	218	225	225	1	0	7.3	1.4	22.6	20.9
Texas	112	175	391	230	-	173	298	242	2	3	7.0	7.5	23.0	16.7

1/ Per 13.1 feet of row with .6 foot of row space (2 sample units).

Table 108: Winter Wheat: Averages from field counts, July 1, 1962 and 1963, by State

State	Fields		Stalks 1/		Stalks 10 inches tall 1/		HEADS 1/ Emerged		HEADS 1/ In boot		Stalks 1/ damaged		Height of Stalk 1/	
	(number)		(number)		(number)		(number)		(number)		(number)		(inches)	
	1962	1963	1962	1963	1962	1963	1962	1963	1962	1963	1962	1963	1962	1963
Illinois	94	95	411	-	--	-	400	298	0	0	4.7	7.9	29.2	33.7
Indiana	89	90	325	-	-	-	320	328	0	0	6	18.8	32.8	36.0
Kansas	255	250	447	-	-	-	376	318	3	1	17.3	7.8	23.7	22.2
Michigan	15	97	533	-	-	-	235	256	0	2	4.6	4.9	33.6	35.1
Missouri	20	85	282	-	-	-	274	355	0	0	3.2	13.4	25.1	29.1
Nebraska	27	128	438	-	-	-	372	346	7	1	11.7	17.3	28.0	25.5
Ohio	88	88	333	-	-	-	271	274	1	3	22.6	4.2	30.5	37.9
Oklahoma	116	76	264	-	-	-	220	218	0	2	9.3	4.8	22.3	21.1
Texas	109	162	382	-	-	-	300	252	1	0	10.0	5.4	23.3	18.1

1/ Per 13.1 feet of row with .6 foot of row space (2 sample units).

Table 109: Winter Wheat: Laboratory Analysis of Head Samples, June 1, 1962

By States

State	Maturity category	Number Samples	ALL HEADS: Head clipped per sample	ALL HEADS: Weight per head	SUBSAMPLE OF 5 HEADS: Average head weight	SUBSAMPLE OF 5 HEADS: Spikelets per head	SUBSAMPLE OF 5 HEADS: Grains per head	FORECAST WEIGHT: Method 1	FORECAST WEIGHT: Method 2
	(Code)	(Number)	(Number)	(Grams)	(Grams)	(Number)	(Number)	(Grams)	(Grams)
Illinois	3	10	64	.369	.444	13.6	-	.392	.834
	4	15	58	.494	.577	14.1	-	.399	.469
	5	6	86	.707	.527	14.2	-	.403	.504
Indiana	3	18	60	.407	.520	14.3	-	.422	1.023
	4	13	64	.911	1.040	17.3	-	.646	.668
	5	0							
Kansas	3	9	55	.538	.533	15.0	-	.476	.601
	4	38	69	.587	.607	15.2	-	.478	.392
	5	27	64	.746	.696	15.0	-	.466	.390
Michigan	3	0							
	4	0							
	5	0							
Missouri	3	6	44	.365	.327	12.3	-	.291	.754
	4	9	50	.656	.587	13.2	-	.354	.553
	5	5	48	1.060	.880	16.2	-	.568	.751
Nebraska	3	3	38	.556	.273	12.9	-	.316	1.174
	4	13	41	.430	.280	12.9	-	.325	.356
	5	0							
Ohio	3	26	47	.513	.560	15.2	-	.480	1.322
	4	1	57	.847	.980	17.8	-	.700	.596
	5	0							
Oklahoma	3	1	99	.875	.940	17.4	-	.846	.846
	4	16	32	.648	.696	13.5	-	.393	.393
	5	56	42	.888	.918	14.2	-	.431	.431
Texas	3	1	7	.071	.060	5.6	-	.200	.084
	4	4	44	.443	.390	13.2	-	.367	.234
	5	61	62	.880	.844	15.4	-	.512	.444

Table 110: Winter Wheat: Laboratory Analysis of Head Samples - June 1, 1963, by States

State	Maturity category	Number Samples	ALL HEADS: Heads clipped per sample	ALL HEADS: Weight per head	SUBSAMPLE OF 10 HEADS: Average head weight	SUBSAMPLE OF 10 HEADS: Spikelets per head	SUBSAMPLE OF 10 HEADS: Grains per head	FORECAST WEIGHT: Method 1	FORECAST WEIGHT: Method 2
	(Code)	(Number)	(Number)	(Grams)	(Grams)	(Number)	(Number)	(Grams)	(Grams)
Illinois	3	27	74	.435	.417	14.8	-	.514	.856
	4&5	6	38	.871	.890	15.6	22.2	.557	.649
Indiana	3	24	56	.419	.438	16.4	-	.568	.821
	4&5	1	60	.932	1.010	16.6	26.3	.884	.576
Kansas	3	17	55	.435	.435	15.0	-	.604	.583
	4&5	64	53	.720	.702	14.6	15.5	.514	.437
Michigan	3	0	-	-	-	-	-	-	-
	4&5	0	-	-	-	-	-	-	-
Missouri	3	3	64	.319	.300	12.9	-	.621	.629
	4&5	30	59	.640	.651	14.3	15.5	.399	.452
Nebraska	3	30	73	.378	.333	14.7	-	.585	.746
	4&5	12	53	.466	.424	14.0	13.8	.371	.363
Ohio	3	10	47	.460	.464	17.2	-	.876	.903
	4&5	0	-	-	-	-	-	-	-
Oklahoma	3	0	-	-	-	-	-	-	-
	4&5	100	44	.837	.865	14.5	17.1	.558	.452
Texas	3	9	33	.399	.363	15.9	-	.551	.534
	4&5	109	42	.586	.624	13.7	15.7	.515	.320

Table 111: Winter Wheat: Laboratory Analysis of Head Samples, July 1, 1963, by States

State	Maturity category	Number samples	ALL HEADS: Heads clipped per sample	ALL HEADS: Weight per head	SUBSAMPLE OF 10 HEADS: Average head weight	SUBSAMPLE OF 10 HEADS: Spikelets per head	SUBSAMPLE OF 10 HEADS: Grains per head	FORECAST WEIGHT: Method 1	FORECAST WEIGHT: Method 2
	(Code)	(Number)	(Number)	(Grams)	(Grams)	(Number)	(Number)	(Grams)	(Grams)
Illinois	3	0	-	-	-	-	-	-	-
	4&5	11	66	1.140	1.143	15.7	20.2	.510	.753
Indiana	3	0	-	-	-	-	-	-	-
	4&5	32	50	1.266	1.223	16.7	23.4	.773	.709
Kansas	3	0	-	-	-	-	-	-	-
	4&5	0	-	-	-	-	-	-	-
Michigan	3	1	32	.709	.730	17.1	-	-	1.391
	4&5	96	45	1.138	1.093	16.8	21.9	.857	.668
Missouri	3	0	-	-	-	-	-	-	-
	4&5	0	-	-	-	-	-	-	-
Nebraska	3	0	-	-	-	-	-	-	-
	4&5	22	57	.615	.627	13.8	13.0	.344	.395
Ohio	3	2	42	1.270	1.495	15.6	-	.790	2.490
	4&5	80	48	1.227	1.234	17.0	21.7	.855	.718
Oklahoma	3	0	-	-	-	-	-	-	-
	4&5	0	-	-	-	-	-	-	-
Texas	3	0	-	-	-	-	-	-	-
	4&5	3	34	.691	.407	12.3	17.7	.583	.367

Table 112: Winter Wheat: Laboratory Analysis of Head Samples, Hard Dough and Ripe Stage, 1963, by States

State	Sample size	ALL HEADS: Heads clipped per sample	Weight per head	Threshed weight per head	Moisture content	Weight adjusted to 14.5% moisture	SUBSAMPLE OF 10 HEADS: Average weight per head	Spike-lets per head	Grains per head	Average wt. of grain per head
	(Number)	(Number)	(Grams)	(Grams)	(Pct.)	(Grams)	(Grams)	(Number)	(Number)	(Grams)
Illinois	88	402	.821	.583	15.9	.585	.819	15	18	.606
Indiana	88	329	1.020	.705	17.5	.691	1.819	16	22	.800
Kansas	250	317	.734	.484	15.1	.476	.740	15	15	.512
Michigan	95	248	1.109	.837	17.6	.766	1.210	17	23	.840
Missouri	85	359	.711	.492	15.5	.498	.731	14	16	.528
Nebraska	125	350	.633	.417	14.5	.412	.659	14	14	.449
Ohio	83	294	1.192	.797	17.4	.766	1.187	17	21	.889
Oklahoma	135	275	.728	.507	15.0	.483	.412	14	16	.507
Texas	137	239	.716	.318	16.7	.432	6.891	14	15	.463

Table 112: Winter Wheat: Laboratory Analysis of Head Samples, Hard Dough and Ripe Stage, 1962, by States

State	Sample number	ALL HEADS: Heads clipped per sample	Weight per head	Threshed weight per head	Moisture content	Weight adjusted to 14.5% moisture	SUBSAMPLE OF 10 HEADS: Average weight per head	Spike-lets per head	Grains per head	Average wt. of grain per head
	(Number)	(Number)	(Grams)	(Grams)	(Pct.)	(Grams)	(Grams)	(Number)	(Number)	(Grams)
Illinois	93	412	.625	.455	13.2	.470	.609	14	16	.454
Indiana	88	312	.921	.681	16.8	.649	.837	16	19	.646
Kansas	263	376	.674	.464	15.1	.459	.683	16	15	.473
Michigan	15	226	1.088	.842	14.1	.863	1.052	17	23	.864
Missouri	20	279	.651	.450	13.8	.457	.635	15	16	.461
Nebraska	27	395	.537	.308	13.0	.320	.530	15	13	.296
Ohio	87	271	.963	.425	16.3	.692	.898	15	19	.677
Oklahoma	110	218	.687	.422	15.5	.397	.672	14	16	.479
Texas	49	223	.620	-	15.2	.389	.543	12	13	.380

Table 113: Winter Wheat: Averages from Post-Harvest Interveiws, 1963, by States

State	Farms	Ratio of acres harv. to acres for grain May 1	Net yield per harvested acre	METHODS OF DETERMINED PRODUCTION					Estimated harvesting loss per acre
				Capacity of combine bins	Truck loads	Weighed at elevator	Capacity of storage bins	Other	
	(Number)	(Percent)	(Bushels)	(Farms)	(Farms)	(Farms)	(Farms)	(Farms)	(Bushels)
Ill.	95	99	41.4	6	2	83	4	0	0.9
Ind.	92	99	44.5	10	5	64	4	9	1.1
Kan.	263	96	21.1	34	48	162	15	9	1.4
Mich.	95	93	39.9	32	6	42	8	7	1.2
Mo.	100	93	30.7	9	2	72	0	11	0.9
Nebr.	135	95	24.5	8	17	77	25	1	2.9
Ohio	87	95	41.2	8	2	27	3	11	1.1
Okla.	160	93	21.6	9	7	132	1	11	0.6
Tex.	198	92	16.1	6	12	152	0	6	2.2

Table 114: Winter Wheat: Averages from Post-Harvest Gleaning of Fields, 1962 and 1963, by States

State	Fields		Whole heads		Loose kernels		Total wt. of heads and kernels		Threshed wt. of heads and kernels		Moisture content of grain	
	(Number)		(Number) 1/		(Number) 1/		(Grams) 1/		(Grams) 1/		(Percent)	
	1962	1963	1962	1963	1962	1963	1962	1963	1962	1963	1962	1963
Illinois	96	92	14.5	7.0	102.9	95	9.1	6.7	6.4	5.3	12.3	10.8
Indiana	91	92	11.4	6.2	11.2	83	11.0	7.5	9.0	6.0	14.0	11.4
Kansas	271	236	14.9	11.0	170.8	115	12.2	8.2	9.0	6.2	13.9	10.9
Michigan	-	90	-	7.5	-	171	-	11.8	-	9.6	-	15.3
Missouri	20	100	12.3	6.6	109.6	75	8.7	5.4	6.8	4.1	11.8	10.3
Nebraska	-	128	-	12.3	-	115	-	8.7	-	6.6	-	11.2
Ohio	87	76	16.1	7.2	109.1	134	12.4	10.4	9.7	8.8	13.6	15.6
Oklahoma	106	142	14.0	3.9	44.9	39	8.9	3.3	5.2	2.5	12.1	12.0
Texas	60	157	12.8	10.3	43.5	54	7.8	7.6	4.5	4.9	9.9	10.0

1/ Per 13.1 ft. of row adjusted to .6 foot of row space (2 sample units).

The number of sample fields for each State remaining after disaster, abandonment, change in intentions, refusals, and other losses is shown in Table 115.

Table 115: Winter Wheat: Number of Sample Fields, by States Monthly 1963, Annually 1962

State or Region	May 1 1963	June 1 1963	July 1 1963	August 1	
				1962	1963
Ohio	31	31	88	88	85
Indiana	33	15	90	90	91
Illinois	34	32	95	94	89
Michigan	15	33	94	15	95
Missouri	34	33	86	20	86
Nebraska	45	37	128	27	125
Kansas	86	84	239	264	248
Oklahoma	52	160	135	111	135
Texas	62	175	164	101	164
Region	392	600	1,119	810	1,118

The general program used in the eight new States is a pilot study and applies only to 1963. Essentially the same pre-harvest counts and measurements were made but only on the pre-harvest survey conducted just prior to havest time. The post-harvest survey was the same as for the nine States. The sample units which were drawn for weekly visits in the new States were observed each week for the same counts and measurements obtained in the other sample units. The objective of the weekly measurements was to get a complete record of growth and development of the plants for use in developing effective forecasting models.

7.2 Forecasting Models

To predict yield per acre for winter wheat by State, separate forecasting models were used for the two components of yield, weight of grain per head and number of heads. These models were combined to give a yield forecast in bushels per acre for each sample and the average of these self-weighing sample yields gave the forecast of yield per acre for the State. The forecast of yield was combined with acres of wheat for harvest to give the production forecast for the State. Since the models differ from survey to survey, they will be described separately for each survey.

"Acres for harvest" was obtained by adjusting planted acres reported in the December Enumerative Survey to final acres for harvest based on ratios from the Objective Yield Surveys. For May 1 and June 1, the December Enumerative Survey "acres planted to winter wheat" (see Table 116) was adjusted to "acres for harvest: by ratios which were computed from data on the Objective Yield Form A-1. For the July 1 and August 1 Yield Surveys, the June Enumerative Survey supplied an estimate of acres for harvest which was adjusted for abandonment by ratios obtained from data on the Objective Yield Form A-2. See Table 117 for a summarization of the ratios and indicated acerages by State.

Table 116: Winter Wheat: Estimates of Planted Acres from December Survey, 1962 and 1963

State	1962		1963	
	Direct expansion	Ratio to June	Direct expansion	Ratio to June
	(000)	(000)	(000)	(000)
Ohio	1,167	1,259	1,283	1,288
Indiana	1,203	1,070	1,289	1,299
Illinois	1,237	1,419	1,272	1,628
Michigan	917	649	1,009	880
Missouri	1,459	1,260	1,636	1,305
Nebraska	1,795	2,281	3,061	3,030
Kansas	8,734	8,377	8,080	7,902
Oklahoma	4,538	3,972	4,034	3,881
Texas	3,125	2,913	3,019	3,122
TOTAL	24,175	23,200	24,683	24,335

Table 117: Winter Wheat: Acreage Adjustment Ratio by States, 1963

State	Dec. Enum. acres seeded	FORM A-1 LISTING				June Enum. acres for harvest	FORM A-2 LISTING		ESTIMATES ACRES FOR HARVEST- BY MONTHS			
		R-1 1/		R-3 2/			R-1 3/	R-3 4/				
		May	June	May	June				May 1	June 1	July 1	Aug. 1
Ohio	1,288	1.004	1.004	.992	.992	1,431	.976	.986	1,283	1,283	1,377	1,377
Indiana	1,299	.978	.997	.992	.993	1,421	.843	.998	1,260	1,286	1,196	1,196
Illinois	1,628	.981	.981	.999	.968	1,791	.936	.997	1,595	1,546	1,671	1,671
Michigan	880	.989	.989	.980	.980	1,129	.955	.993	853	853	1,070	1,070
Missouri	1,305	.943	.949	.995	.981	1,189	.919	1.000	1,225	1,214	1,093	1,093
Nebraska	3,030	1.020	1.020	.910	.914	2,654	.938	.993	2,813	2,825	2,472	2,472
Kansas	7,902	.993	.994	.813	.814	8,287	.908	.998	6,380	6,394	7,510	7,510
Oklahoma	3,881	.994	1.003	.746	.770	3,307	-	-	2,878	2,998	3,307	3,307
Texas	3,122	.970	.973	.739	.751	2,064	-	-	2,238	2,282	2,064	2,064
Region									20,525	20,681	21,760	21,760

1/ (Acres seeded as of May) ÷ (Acres seeded as of previous December)

2/ (Acres for grain harvest) ÷ (Acres seeded)

3/ (Acres seeded as of July) ÷ (Acres seeded as of May)

4/ (Net acres for grain harvest in field) ÷ (Acres for harvest in field)

The symbols in this table will be limited to the same meanings throughout the report, i.e. "a" is the y intercept of a regression line, "b" is the regression coefficient or slope of the line, "r^2" is the coefficient of determination, "$\bar{x}$" and "$\bar{y}$" are arithmetic means of the variables involved and "x" and "y" are independent and dependent variables. Stalk count has been the most satisfactory variable found for forecasting head counts at harvest from May 1 information and this relationship has produced fairly good results. The main difficulty appears to be inaccurate stalk counts because of the large number to be counted and, as the season progresses, because of the large number of dead stalks. In many cases it is difficult to get an accurate count of the live and dead stalks. In 1963 for the first time, the count of stalks taller than 10 inches was obtained. By substituting this count for that of total stalks, much greater accuracy and consistency was obtained. The bar charts shown in Figures 1 through 6 depict the effectiveness of the May 1 head count model considering the stage of maturity at this time.

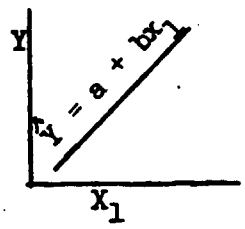
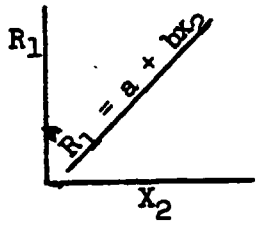
For the June 1 forecast of number of heads per sample at harvest, a regression of two ratios was tested. The ratio of number of heads on June 1 to number of heads at harvest was predicted by a regression on the ratio of June 1 heads to stalks. Most of the relationship proved to be spurious and this model was dropped in favor of a relationship similar to the one used May 1 but with June 1 parameters. The relationship of stalk counts to final head count was used to forecast heads at harvest if the maturity of the wheat in the sample unit was in categories 1 through 3 (preflogs, early boot, late boot or flowers). For categories 4 through 7 (milk, soft dough, hard dough, and ripe) the head count was adjusted to final heads per sample based on averages developed from observations made in past years.

The July 1 and August 1 forecast of final head count used the same models depending upon maturity category. The change in head count in July and August is small so the adjustment for converting current head count to final head count at this stage is neglegible.

Head weight on May 1 is difficult to predict from counts and measurement made since there are no plant characteristics to indicate what the final head weight will be. In some of the earlier States such as Oklahoma and Texas the May 1 counts do provide some indication of expected head weight. However, for the most part, the May 1 forecast of final head weight was made by using the average pre-harvest head weight observed over the past few years.

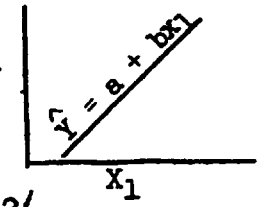
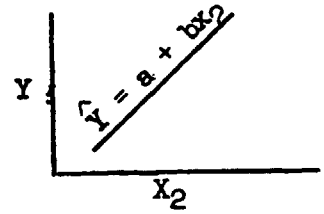
The June 1 and July 1 forecasts of head weight also uses stage of maturity to determine relationships and parameters to be used. For samples classified in maturity categories 1 or 2 (preflag or early boot) the average historical harvest weight was used as was done in the May 1 forecast. For sample fields in maturity category 3 (late boot or flowers) the relationship between spikelet count and final head weight was used in the form or a regression estimator. Two forecasts were obtained, one from State parameters and one from regional parameters as shown in Table 119.

Procedure Used in 1963 for Forecasting Final Heads Per Sample

Categories 1, 2, and 3 for $X_2 \leq .02$	Categories 1, 2, and 3 for $X_2 \geq .02$	Categories 4, 5, 6, and 7
		$\hat{Y}$ = (Current head count)(R_2)
$\hat{Y} = a + bx_1$	$\hat{Y}$ = (Current head count) $\div R_1$	

Where $\hat{Y}$ = Estimate of final head count
x_1 = Current stalk count
x_1 = (Current head count) $\div$ (Current stalk count)
R_1 = (Current head count) $\div$ (Final head count)
R_2 = Past years average of $\left[\text{(Final head count)} \div \text{(Current head count)}\right]$

Forecasting Final Weight per Head

Categories 1 and 2	Category 3 1/	Categories 4, 5, 6, & 7 1/
$\hat{Y}$ = Average head wt. from past years		

Categories 3, 4, 5, 6 & 7 2/

$\hat{Y}$ = Current head weight adjusted to harvest weight

Where $\hat{Y}$ = Forecast head weight
x_1 = Current spikelet count
x_2 = Current grain count

1/ Method 1

2/ Method 2 uses adjustment based on average of past years.

Figure 1 -- Winter Wheat: Objective Yield Forecasts for Indiana, 1963

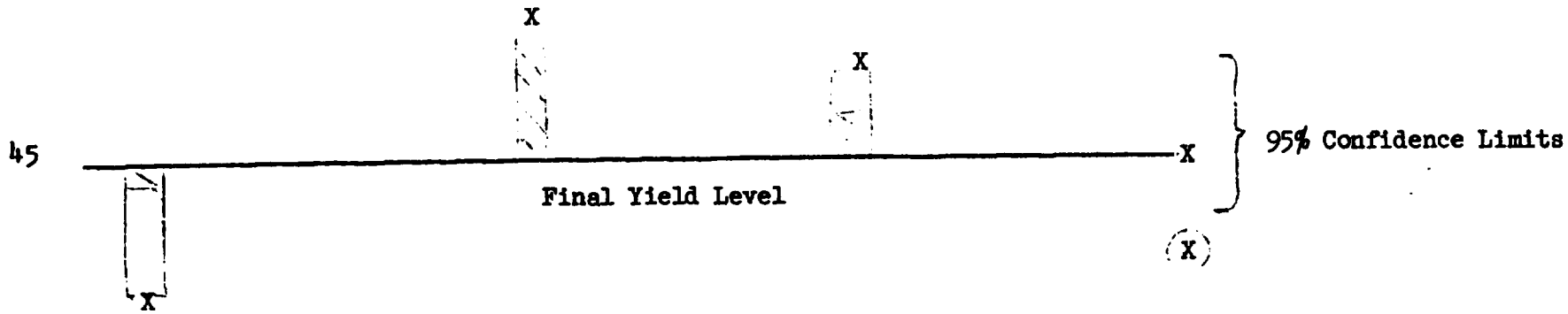


Figure 2 -- Winter Wheat: Objective Yield Forecasts for Illinois, 1963

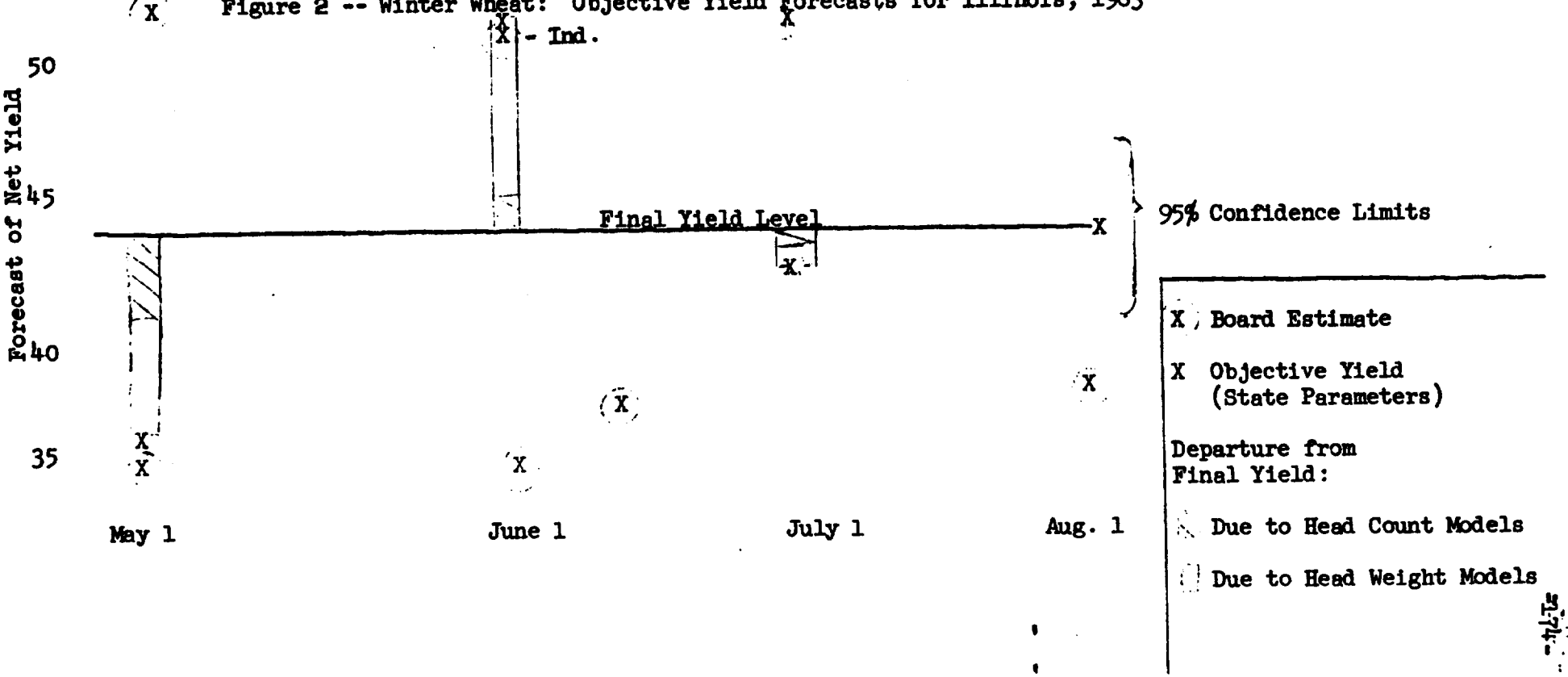


Figure 3 -- Winter Wheat: Objective Yield Forecasts for Michigan, 1963

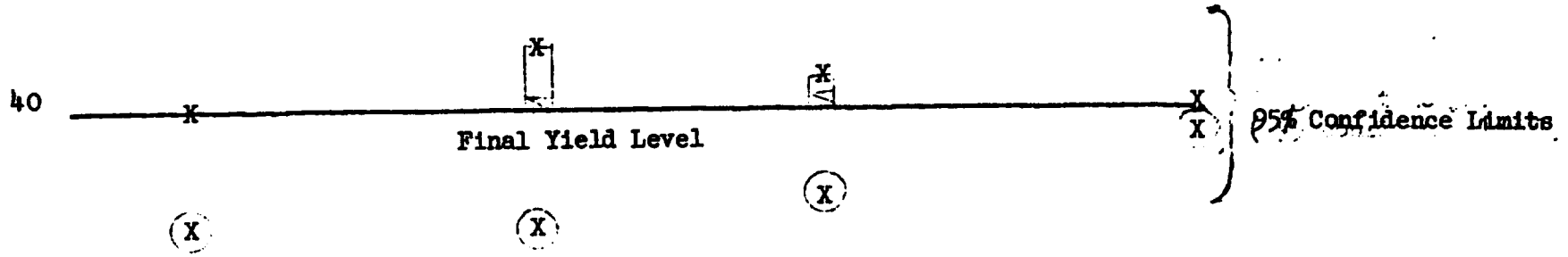


Figure 4 -- Forecasts of Winter Wheat for Ohio (Region I)

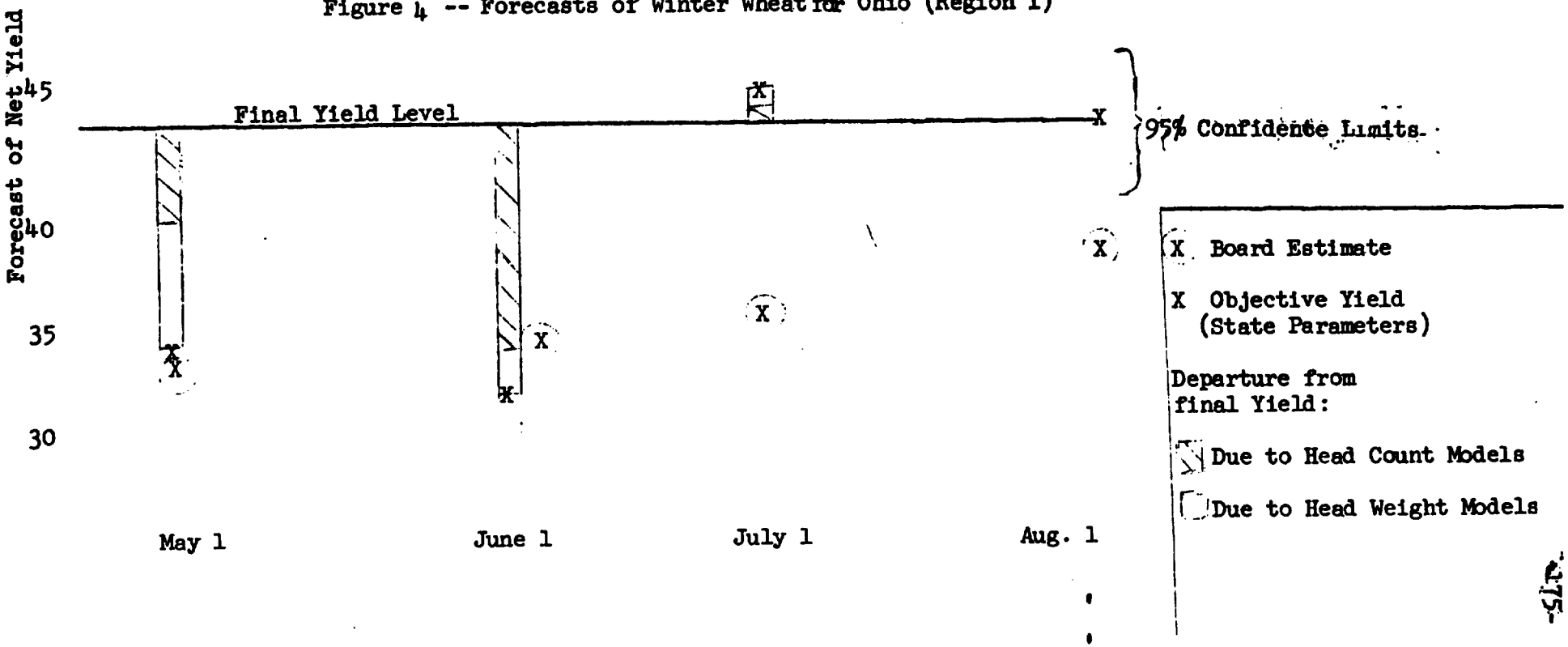


Figure 5 -- Winter Wheat: Objective Yield Forecasts for Kansas, 1963

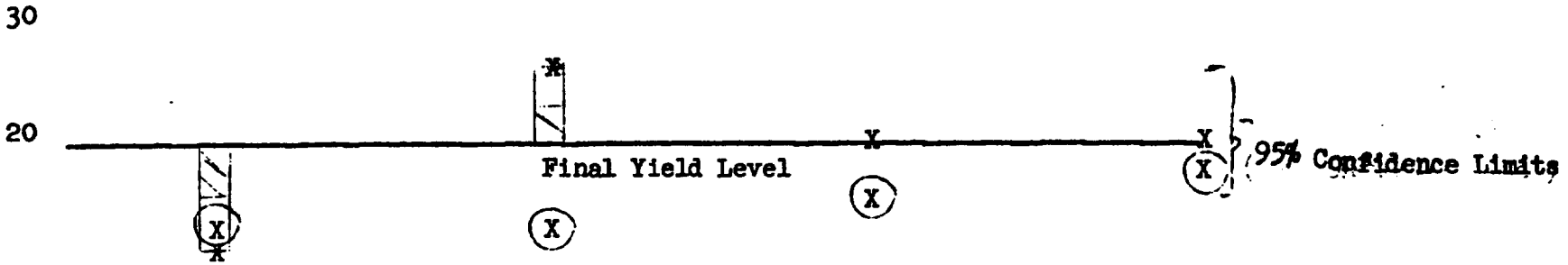


Figure 6 -- Forecasts of Winter Wheat for Missouri (Region II)

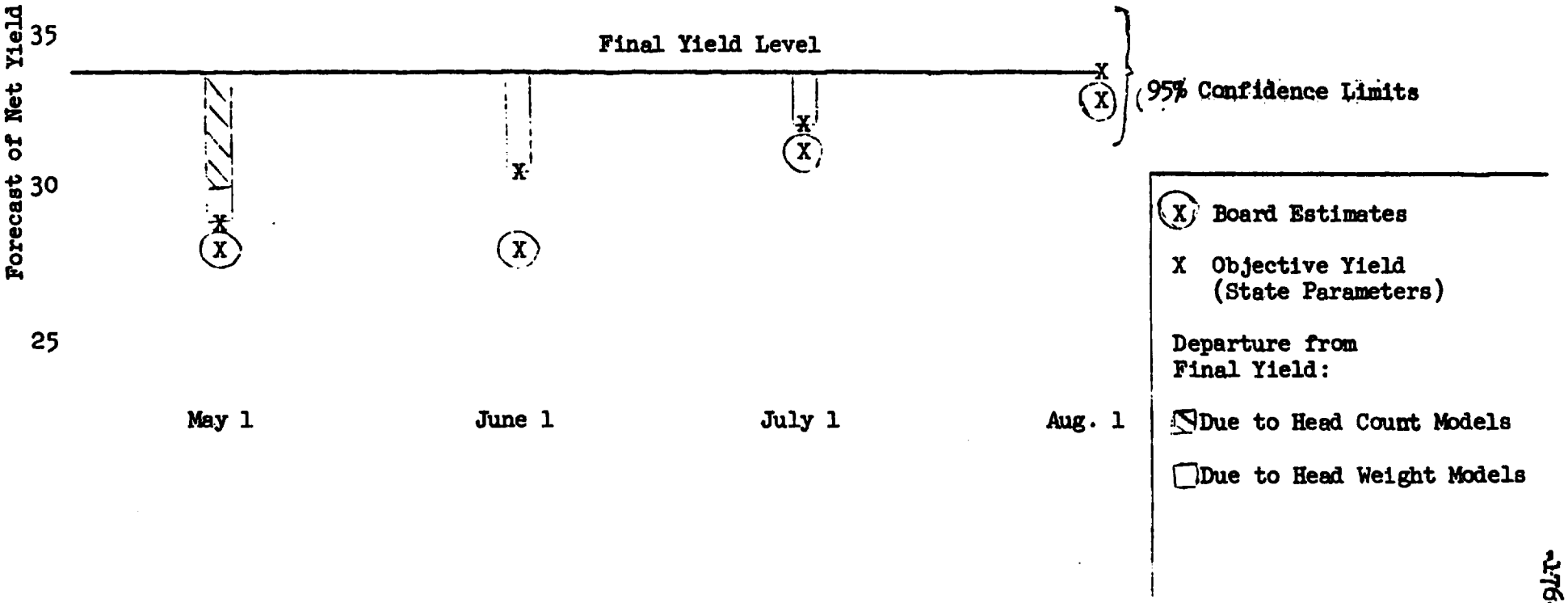


Figure 7 -- Winter Wheat: Objective Yield Forecasts for Nebraska, 1963

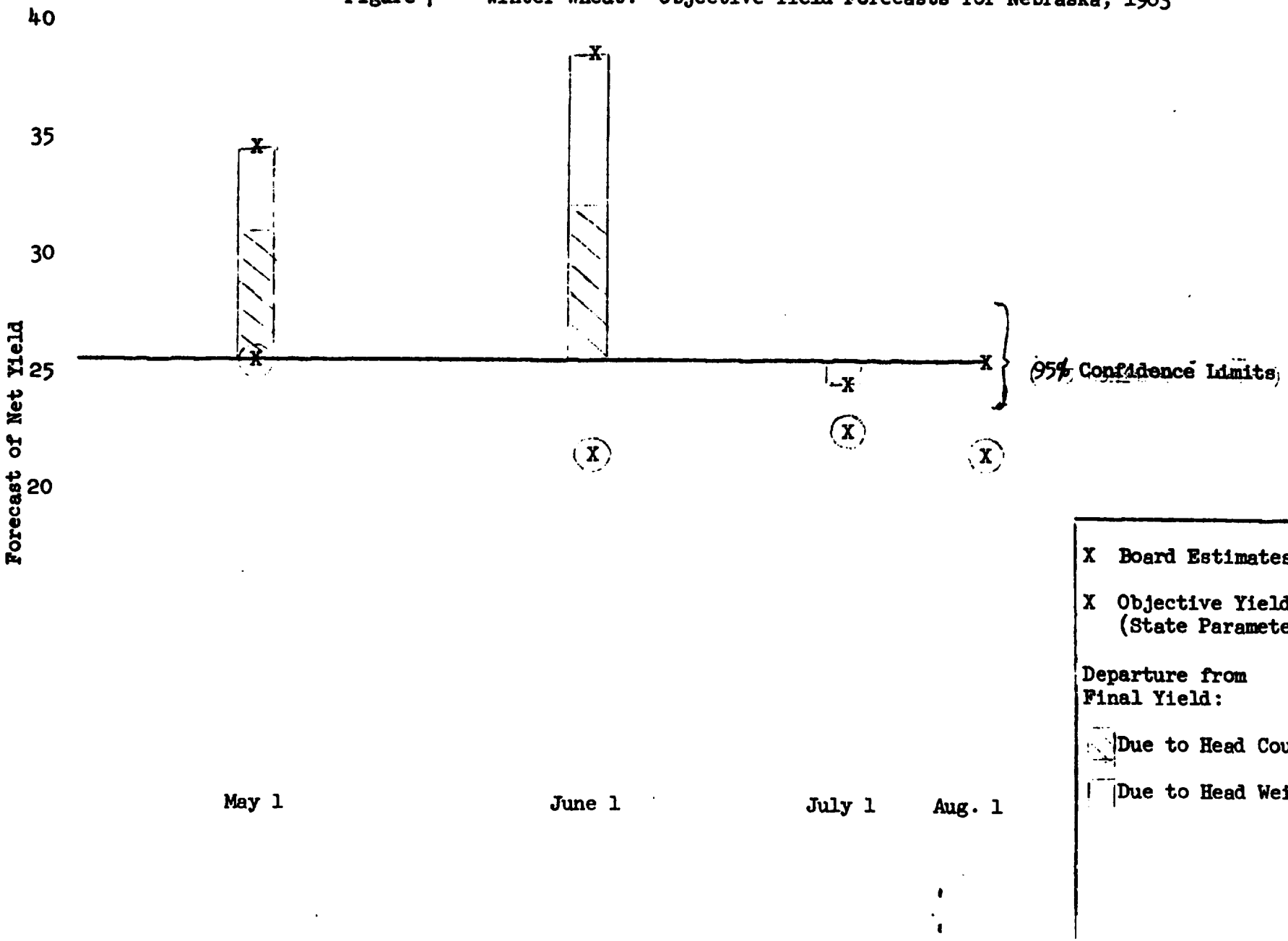


Figure : -- Winter Wheat: Objective Yield Forecasts for Oklahoma, 1963

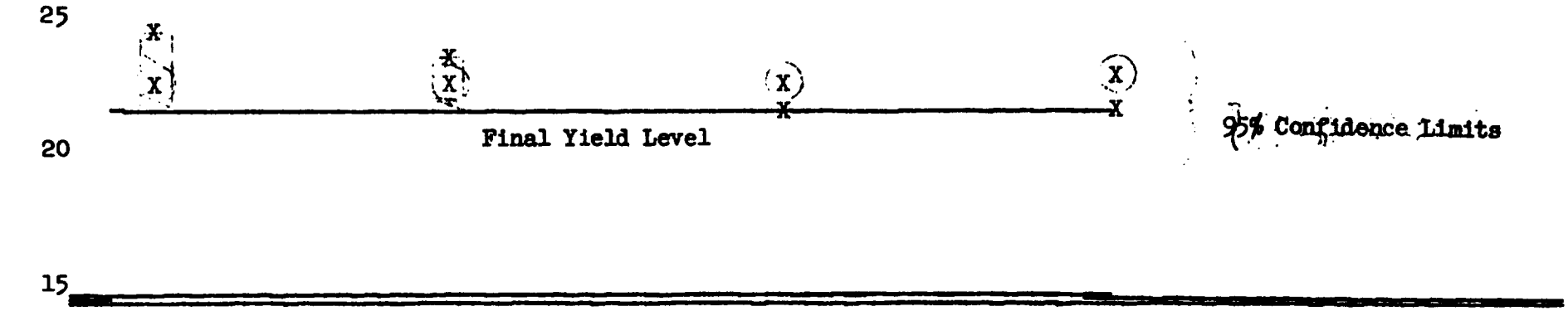


Figure 9 -- Winter Wheat: Objective Yield Forecast for Texas (Region III)

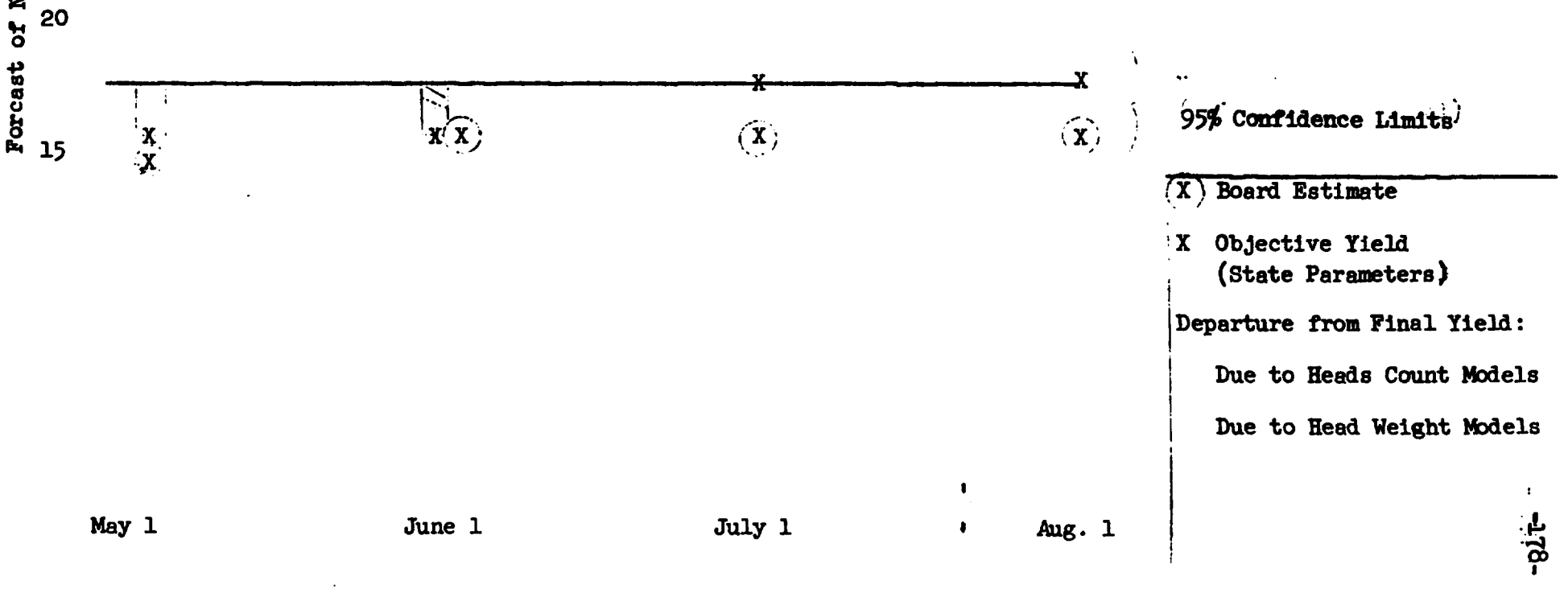
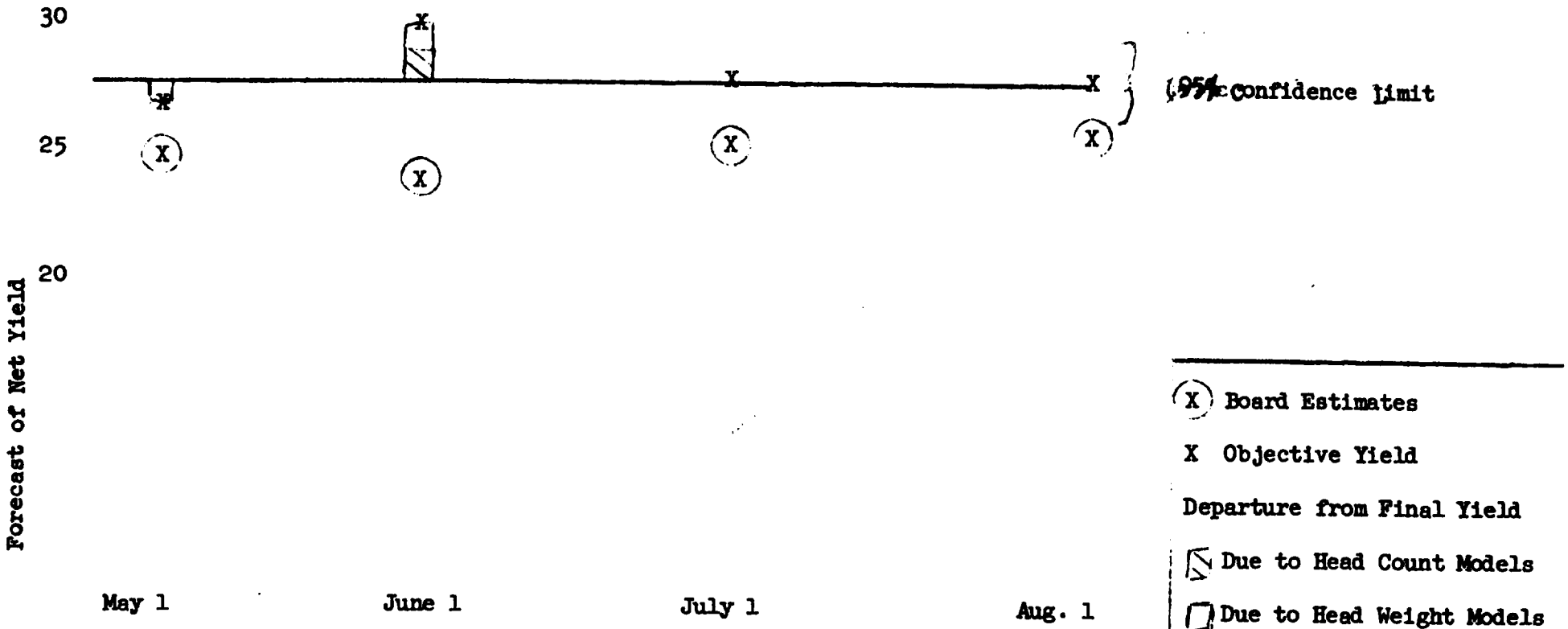


Figure -- Winter Wheat: Objective Yield Forecasts for Nine-State Region, 1963



Forecasts of the components of yield for the two models mentioned above are based on regional parameters and State parameters. The components for each of these models are combined to give two forecasts of gross yield in grams per sample for each field. This yield in grams per sample is converted to gross bushels per acre. The forecast gross yields for the two models are weighed together inversely proportional to the forecast error for each model to obtain one combined forecast of gross yield. Average post-harvest gleanings from previous years was used as a measure of the harvesting loss and was subtracted from the combined forecast gross yield to arrive at a forecast of net yield.

The May 1 model for forecasting number of heads in the sample at harvest time uses a linear regression between "talk count" and "heads at harvest". The coefficient of determination (r^2) for this relationship (1961 and 1962 combined for the 9-State Region) is .624. These regressions ($y_c = a + bx$) are shown by States in Table 118.

Table 118: Winter Wheat: Regression of Heads Produced to May 1 Stalk Count, 1961 and 1962 data pooled, by States

State	n	a	b	r^2	x 1/	y 2/
Ohio	43	172.3	.117	.323	782	264
Indiana	48	92.0	.270	.657	801	308
Illinois	45	62.2	.326	.702	1,008	391
Michigan	26	127.5	.163	.292	649	233
Missouri	33	115.8	.262	.417	700	299
Nebraska	62	2.3	.509	.719	788	399
Kansas	144	91.5	.337	.613	820	368
Oklahoma	100	6.6	.612	.821	422	265
Texas	73	47.1	.573	.834	522	346
Region	621	88.7	.351	.624	702	335

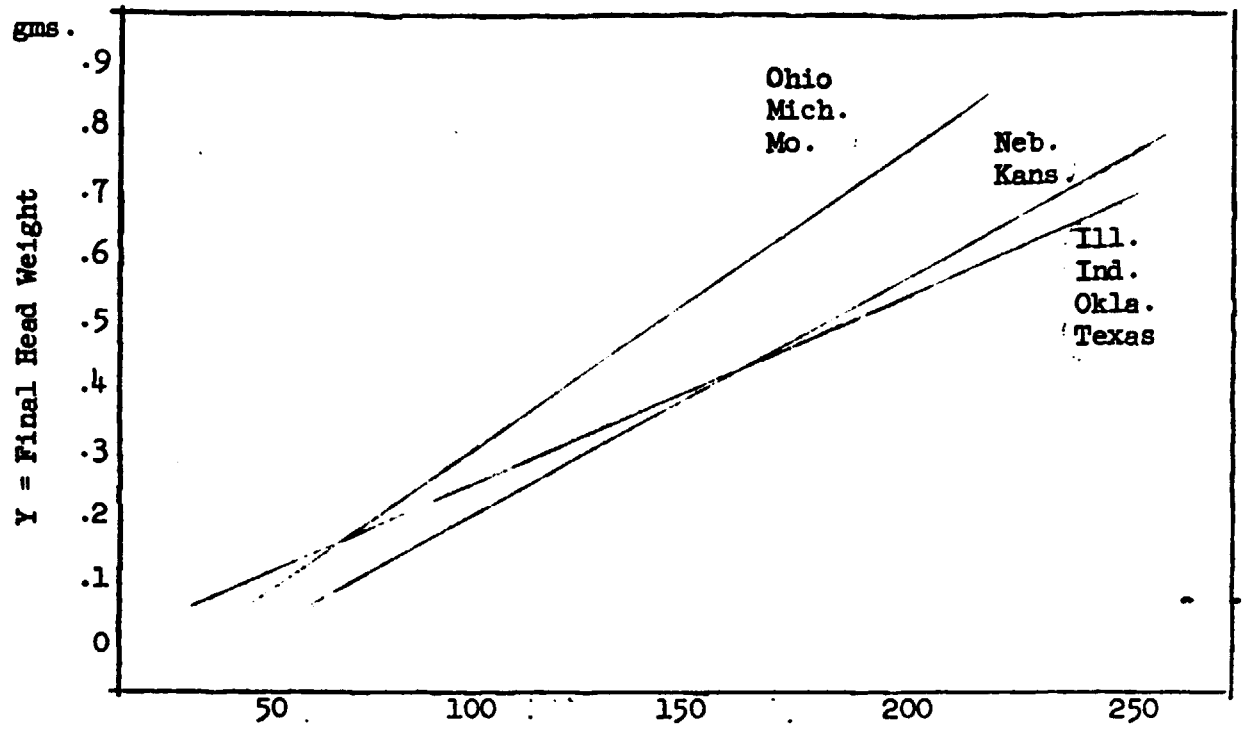
1/ x = stalk count in sample on May 1

2/ y = head count in sample at harvest

Table 119: Monthly Forecasts of Winter Wheat By States, 1963

State	MAY 1			JUNE 1			JULY 1		
	Forecast using State parameters	Forecast using Region parameters	August net yield	Forecast using State parameters	Forecast using Region parameters	August 1 net yield	Forecast using State parameters	August 1 net yield
Ohio	34.6	36.5	44.1	32.0	29.5	44.1	45.2	44.1
Indiana	40.8	38.7	44.6	48.1	35.4	44.6	46.6	44.6
Illinois	35.9	40.2	43.8	52.1	39.5	43.8	43.1	43.8
Michigan	39.0	32.5	39.0	41.6	43.1	39.0	40.6	39.0
Missouri	29.2	34.4	33.2	30.4	34.7	33.2	32.3	33.2
Nebraska	35.6	33.4	26.1	39.4	36.4	26.1	23.9	26.1
Kansas	19.9	23.3	22.8	24.0	23.2	22.8	22.3	22.8
Oklahoma	24.6	20.8	21.8	22.2	21.5	21.8	21.8	21.8
Texas	16.7	15.6	17.9	16.3	17.0	17.9	17.9	17.9
9-States	27.2	27.6	28.0	30.2	27.9	28.0	27.8	28.0

Figure 11-- Winter Wheat: Regional Regressions of Final Head Weight on Spiklet Count, 1962



In most states observations were made in only one-third of the sample fields for the May and June Surveys. This sample was not large enough to give stable forecasts by States of the weight per head so the States were grouped into Regions as shown in Figures 7 through 8 to utilize data from a larger number of observations. As shown by Tables 120 through 123, weighing the forecasts obtained from State parameters with those obtained from Regional parameters showed considerable improvement over using either set of parameters alone.

For sample fields in the maturity categories four through seven (milk, soft dough, hard dough, and ripe) the June 1 and July 1 forecasts for head weight were based upon the relationship between grain count and final head weight. As the coeffieients of determination shown in Tables 126 through 127 show the grain count had a much higher correlation with final head weight than did the spikelet count. Therefore, the grain count is used as soon as the head has developed sufficiently for accurate grain counts to be made. This model also used State and Regional parameters to give two forecasts. The regional regressions are shown in Figure 11 and a summary of the regression and correlation coefficients is shown by State and by Region in Table 127.

In addition to these regressions, factors have been developed for converting gross weight per head at the time of survey to mature net grain. These factors are the ratios of survey weight per head to final pre-harvest weight per head for each of maturity categories 3 through 7 (late boot, milk, soft dough, hard dough, and ripe.) The factors are shown in Table 128.

To compute a single forecast of head weight, the predictions resulting from this regression relationship and the ratio factors were weighed together.

The factor used for expanding the yield from grams per sample to bushels per acre is shown on the computation form as:

$$F = \frac{(43,560)(26.141)}{(453.59)(60)(13.1)(\text{Line 7})(\text{weighed average width wheat frame})}$$

Division by (453.59)(60) changes grams to pounds and pounds to bushels. Line 7 is the average row space so the (43,560) ÷ (13.1)(Line 7) is the expansion factor obtained by computing the reciprocal of the sampling fraction. The 13.1 represents six rows (number of rows in a sample) times the standard width of a wheat frame of 26.141 inches expressed in feet. The remaining factor of (26.141) ÷ (weighed average width wheat frame) adjusts for wheat frames used that were not of the specified width.

The harvesting loss is obtained for each State by years. The computation of harvesting loss is obtained by adjusting the gleaned weight of grain to 14.5 percent moisture content and expanding to bushels per acre. This is on the computation form as follows:

Harvest loss = (Line 11)(Summary F, Item 2) $\frac{1.0 - (\text{Summary F, Item 3})(.01)}{.855}$

where Line 11 = expansion factor
Summary F, Item 2 = weight of gleaning
Summary F, Item 3 = percent moisture content of gleanings

Figure 12 Winter Wheat: Regional Regression of Final Head Weight on Count, 1962

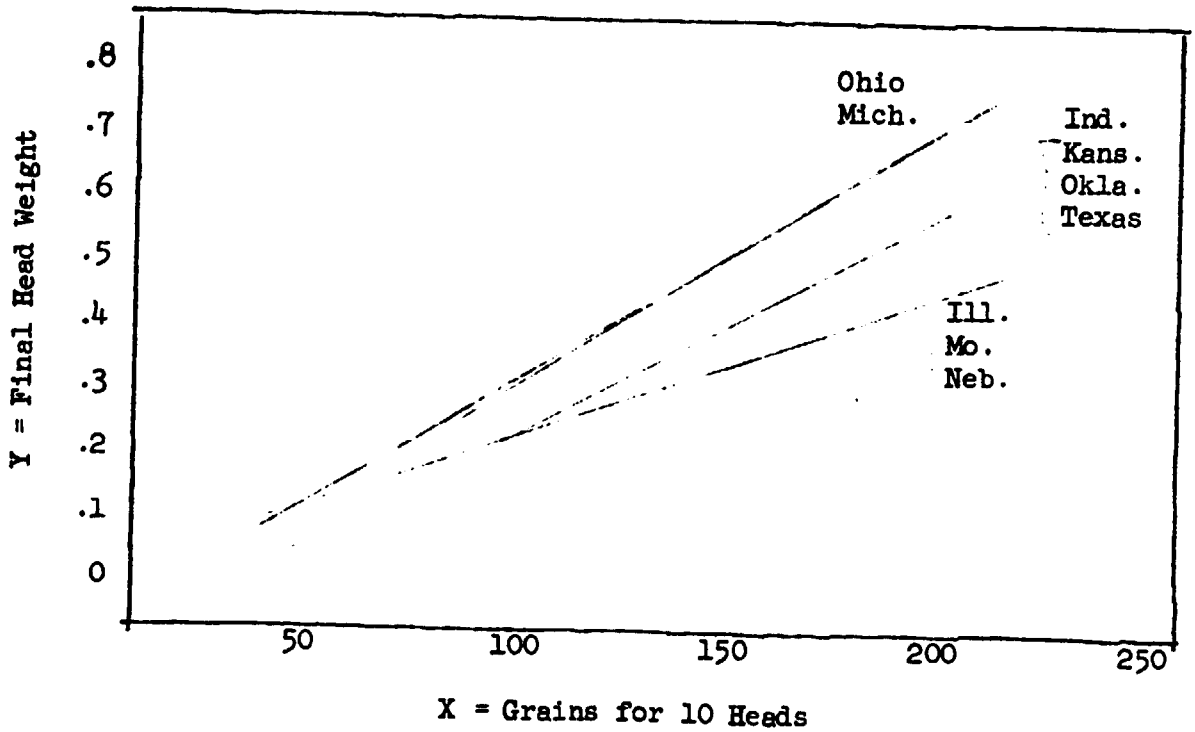


Table 120 -- Winter Wheat Objectivive Forecast May 1, 1963

State	Objective Yield Forecasts								Board Forecasts		
	Acres for harvest	Heads per plot	Average weight per head	NET YIELD PER ACRE: State Parameter	NET YIELD PER ACRE: Regional Parameter	FORECAST ERROR 1/ State Parameter	FORECAST ERROR 1/ Regional Parameter	Production	Acres for harvest	Yield per acre	Production
	(000)	(No.)	(Grams)	(Bu.)	(Bu.)	(Bu.)	(Bu.)	(000 Bu.)	(000)	(Bu.)	(000 Bu.)
Ohio	1,283	268	.669	34.6	36.5	2.7	3.0	45,675	1,366	34.0	46,444
Indiana	1,260	320	.635	40.8	38.7	2.5	2.6	50,148	1,304	37.0	48,248
Illinois	1,595	372	.511	35.9	40.2	2.4	2.4	60,610	1,735	35.0	60,725
Michigan	853	238	.819	39.0	32.5	4.3	3.7	30,537	1,060	35.0	37,100
Missouri	1,225	3.5	.485	29.2	34.3	2.4	2.5	38,955	1,191	28.0	33,348
Nebraska	2,813	427	.479	35.6	33.4	2.4	2.0	97,048	2,981	26.0	77,506
Kansas	6,380	308	.442	19.9	23.3	1.1	1.1	137,808	8,447	21.0	177,387
Oklahoma	2,878	3.5	.496	24.6	20.8	1.5	1.5	65,331	3,408	22.0	74,976
Texas	2,238	257	.456	16.7	15.6	1.3	1.0	36,256	2,540	16.0	40,640
Region	20,525	-	-	27.2	27.6	1.5	1.5	562,368	24,032	24.8	596,374

1/ Forecast Error = $S_x = \sqrt{\frac{\Sigma_i (\hat{\theta}_i - \theta_i)^2}{n}}$ where θ = yield

Table 121 -- Winter Wheat Objective Yield Forecast, June 1, 1963

State	Objective Yield Forecasts								Board Forecasts		
	Acres for harvest	Heads per plot	Average weight per head	NET YIELD PER ACRE: State Parameter	NET YIELD PER ACRE: Regional Parameter	FORECAST ERROR 1/: State Parameter	FORECAST ERROR 1/: Regional Parameter	Production	Acres for harvest	Yield per acre	Production
	(000)	(No.)	(Grams)	(Bu.)	(Bu.)	(Bu.)	(Bu.)	(000 Bu.)	(000)	(Bu.)	(000 Bu.)
Ohio	1,283	217	.737	32.0	29.5	4.1	4.6	39,516	1,366	34.0	46,444
Indiana	1,286	355	.683	48.1	35.4	2.6	2.9	53,755	1,304	36.0	46,944
Illinois	1,546	408	.670	52.1	39.5	3.6	2.2	70,807	1,735	35.0	60,725
Michigan	853	253	.819	41.6	43.1	-	-	36,167	1,060	35.0	37,100
Missouri	1,214	360	.443	30.4	34.7	1.9	2.3	39,576	1,191	28.0	33,348
Nebraska	2,825	403	.523	39.4	36.4	3.7	2.6	107,068	2,981	22.0	65,582
Kansas	6,394	307	.501	24.0	23.2	1.0	1.0	150,898	8,447	21.0	177,387
Oklahoma	2,998	277	.498	22.2	21.5	.4	.6	65,356	3,408	22.0	74,976
Texas	2,282	246	.442	16.3	17.0	.5	.5	37,881	2,540	16.0	40,640
Region	20,681	-	-	30.2	27.9	1.2	1.1	601,024	24,032	24.3	583,146

1/ Forecast error = $S_x = \sqrt{\frac{\Sigma_i (\theta_i - \theta_i)^2}{n}}$ where θ = yield

Table 122 -- Winter Wheat Objective Forecast, July 1, 1963

State	OBJECTIVE YIELD FORECASTS						BOARD FORECASTS		
	Acres for harvest	Heads per plot	Average weight per head	Net yield per acre	Forecast error 1/	Production	Acres for harvest	Yield per acre	Production
	(000)	(No.)	(Grams)	(Bu.)	(Bu.)	(000 Bu.)	(000)	(Bu.)	(000 Bu.)
Ohio	1,377	296	.786	45.6	1.3	62,791	1,366	36.0	49,187
Indiana	1,196	328	.700	46.6	1.4	55,734	1,282	38.0	48,716
Illinois	1,671	398	.574	43.1	.9	72,020	1,735	37.0	64,195
Michigan	1,070	255	.772	40.6	1.2	43,442	1,051	36.5	38,362
Missouri	1,093	357	.486	32.3	.5	35,304	1,191	31.5	37,516
Nebraska	2,472	348	.401	23.9	.9	59,081	2,815	22.5	63,338
Kansas	7,510	318	.467	22.3	.1	167,473	8,357	22.0	183,354
Oklahoma	3,307	279	.481	21.8	.0	72,093	3,408	21.5	73,272
Texas	2,064	250	.471	17.9	.0	36,946	2,267	16.0	36,272
Region	21,760	-	-	27.8	.4	604,884	23,472	25.3	594,701

1/ Forecast error = $S_{\bar{x}} = \sqrt{\frac{\Sigma_i (\theta_i - \theta_i)^2}{n}}$ where θ = yield

Table 123 -- Winter Wheat Objective Yield Estimates, August 1, 1963

State or Region	OBJECTIVE YIELD ESTIMATES						BOARD ESTIMATES		
	Acres for harvest	Heads per plot	Average weight per head	Net yield per acre	Standard error yield	Production	Acres for harvest	Yield per acre	Production
	(000)	(No.)	(Grams)	(Bu.)	(Bu.)	(000 Bu.)	(000)	(Bu.)	(000 Bu.)
Ohio	1,377	293	.778	44.1	1.4	60,726	1,366	39.0	53,274
Indiana	1,196	327	.684	44.6	1.3	53,342	1,282	41.0	52,562
Illinois	1,671	403	.582	43.8	1.4	73,190	1,735	39.0	67,665
Michigan	1,070	249	.762	39.0	1.8	41,730	1,051	38.0	39,938
Missouri	1,093	357	.499	33.2	1.3	36,288	1,191	33.0	39,303
Nebraska	2,472	353	.428	26.1	1.2	64,519	2,815	21.5	60,522
Kansas	7,510	320	.475	22.8	.7	171,228	8,357	22.0	183,854
Oklahoma	3,307	279	.481	21.8	1.1	72,093	3,408	22.0	74,976
Texas	2,064	250	.471	17.9	1.0	36,946	3,267	16.5	37,406
Region	21,760	313	.522	28.0	.3	610,062	23,472	26.0	609,500

$\frac{609,500}{21,760} = 28.0$

Table 124 - Winter Wheat Yield Indications - 1963

State	MAY FORECASTS					FINAL				
	Objective Yield		Regression	Late May (condition) General	May 1 Board	Other Indications			Objective	Board
	Farmer	Survey				Regression	A & P	General	Farmer	Count
	(Bushels)		(Bushels)	(Bushels)	(Bushels)	(Bushels)			(Bushels)	(Bushels)
Ohio	32.5	35.5	29.4	32.3	34.0	38.0	40.5	41.7	41.2	44.1	39.0
Indiana	37.6	39.8	30.7	34.9	37.0	40.1	43.5	32.9	44.5	44.6	41.0
Illinois	34.5	38.0	27.2	33.8	35.0	39.4	43.1	43.0	41.4	43.8	39.0
Michigan	30.5	35.8	31.9	37.0	35.0	37.4	40.7	41.1	39.9	39.0	38.0
Missouri	28.8	31.8	24.8	26.9	28.0	32.0	33.2	33.5	30.7	33.2	33.0
Nebraska	28.3	34.5	25.2	20.6	26.0	21.2	21.7	21.5	24.5	26.1	21.5
Kansas	21.3	21.6	17.2	18.4	21.0	19.5	21.6	21.2	21.1	22.8	22.1
Oklahoma	19.0	22.7	15.3	18.4	22.0	20.5	21.0	21.3	21.6	21.8	22.0
Texas	17.3	16.0	12.1	19.8	16.0	17.7	19.6	19.0	16.1	17.9	16.5

Table 125 -- Winter Wheat Yield Indications - 1962

State	MAY FORECASTS					FINAL					
	Objective Yield		Regression	Late May (condition) General	May 1 Board	Other Indications			Objective		Board
	Farmer	Survey				Regression	A & P	General	Farmer	Count	
	(Bushels)		(Bushels)	(Bushels)	(Bushels)	(Bushels)			(Bushels)		
Ohio	30.0	36.2	25.2	26.1	27.0	31.3	33.3	34.2	29.4	32.8	32.0
Indiana	30.0	33.2	26.7	31.0	30.0	34.6	37.3	37.6	32.5	39.3	35.5
Illinois	32.5	41.0	31.5	32.0	31.0	31.6	34.9	34.4	32.0	34.9	32.5
Michigan	----	35.3	28.2	32.6	31.0	30.0	35.2	33.2	----	36.9	32.5
Missouri	29.7	30.8	17.8	25.8	29.0	25.1	27.2	26.4	22.6	23.6	27.0
Nebraska	29.5	33.1	26.2	22.5	26.0	18.9	19.9	19.1	22.1	18.7	19.5
Kansas	27.0	27.8	19.1	19.3	25.0	21.3	23.6	23.1	25.3	25.9	23.5
Oklahoma	19.6	18.8	16.2	17.0	23.0	18.0	18.9	18.4	20.3	14.1	19.0
Texas	22.6	22.7	15.2	21.4	20.0	18.3	16.4	18.0	21.1	20.2	16.0

Table 126 -- Winter Wheat: Parameters for Final Weight Per Head vs. Spikelet Count, June and July Data

State	n	a	b	r^2	$\bar{x}$ 1/	$\bar{y}$ 2/
Ohio	87	-.0509	.0050	.185	155	.678
Michigan	15	-.7029	.0129	.405	174	.864
Missouri	20	-.0173	.0054	.741	148	.460
Region	122	-.1385	.0059	.258	159	.676
Nebraska	27	-.2598	.0066	.484	139	.406
Kansas	262	-.1269	.0051	.373	142	.480
Region	289	-.1926	.0053	.374	141	.462
Indiana	88	.0505	.0034	.159	156	.646
Illinois	93	.0307	.0027	.353	143	.454
Oklahoma	104	-.0545	.0044	.192	139	.502
Texas	75	-.0426	.0037	.244	126	.390
Region	360	-.--65	.0035	.211	138	.476

1/ X = Spikelet count per ten heads

2/ Y = Weight per head

Table 127 -- Winter Wheat: Parameters for Final Weight Per Head vs. Grain Count, June and July data

State	n	a	b	r^2	$\bar{x}$ 1/	$\bar{y}$ 2/
Ohio	87	-.0590	.0042	.683	186	.678
Michigan	15	-.0120	.0049	.982	227	.864
Region 1	102	-.0773	.0044	.784	205	.764
Illinois	93	.0106	.0027	.640	160	.454
Missouri	20	.0215	.0026	.807	160	.460
Nebraska	27	.0123	.0021	.739	129	.296
Region 2	140	.0084	.0025	.684	145	.376
Indiana	88	.0111	.0032	.487	195	.646
Kansas	262	-.0370	.0036	.589	152	.472
Oklahoma	104	-.0354	.0034	.648	169	.502
Texas	75	-.0330	.0033	.815	138	.390
Region 3	529	-.0353	.0035	.604	156	.476

1/ X = Grain count per ten heads

2/ Y = Weight per head

Table 128 -- Winter Wheat: Factors to Predict Final Head Weight from Weight of Immature Heads, by Region, 1963

Maturity Category	Code	Ohio Ind. Mich.	Ill. Mo. Nebr.	Kans. Okla. Texas
Late Boot	3	1.962	1.972	1.341
Milk	4	.618	.778	.679
Soft Dough	5	.558	.633	.532

Maturity Category	Code	Ohio Ill. Ind. Mich.	Mo. Nebr. Kans.	Okla. Texas
Hard Dough	6	.969	.986	.999
Ripe	7	.969	.986	.999

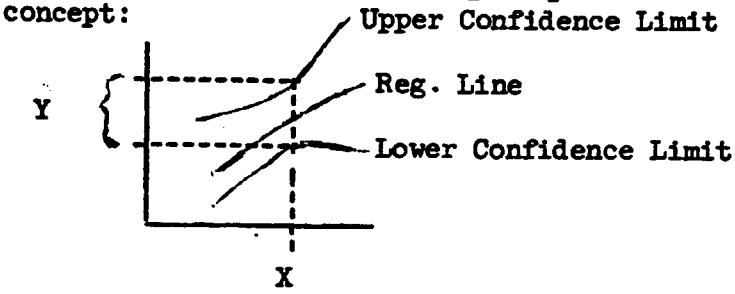
7.3 Evalvation of Yield Forecast

Comparisons of objective yield estimates and forecasts, and Board levels may be found in Tables 119 through 125 and Figures 1 through 10. Tables 129 through 131. show the forecasts that were made and give a measure of the forecast error as computed by the following formula:

$$S\bar{x} = \sqrt{\frac{\sum_j (\hat{\theta}_j - \theta_j)^2}{n}}$$

where $\hat{\theta}$ is yield forecast and θ is the final yield for each sample field

This error may be interpreted only very loosely in terms of confidence limits around May 1, June 1, and July 1 forecasts. The forecast models are based mostly on regression equations. In computing confidence limits around a regression line, the confidence range increases as the independent variable departs from the average of variables used to compute parameter estimates. Delineation of this concept:



The bracket indicates confidence limits around the dependent variable with a given independent variable X. The change in confidence range due to departure of a current mean ($\bar{x}$) and a long range mean ($\bar{X}$) is small enough to ignore as will be shown.

The regressons are based upon the assumption (which is valid in our case) that for each Y_i there is a corresponding known X_i. Estimates of regression parameters were computed from n observations and used to predict a $\bar{y}$ from a different set of n_1 observations of X_i. The mean $\bar{x}$ is from n_1 observations, $\bar{X}$ is the mean from the n observations used to estimate parameters, and

$$\sum_{i=1}^{n_1} x_i^2 = \sum_{i=1}^{n_1} (X_i - \bar{x})^2$$

The variance of a predicted mean $\bar{y}$ is:

$$V(y) = \sum_{1}^{n} \frac{(Y_i - \hat{Y}_i)}{n-2} \left(\frac{1}{n_1} + \frac{1}{n} + \frac{(\bar{X} - \bar{x})^2}{\sum_{i=1}^{n_1} x_i} \right) \quad 1/$$

taking expected value of last term we get

$$E \frac{(\bar{X} - \bar{x})^2}{\Sigma x_i^2} \doteq \frac{E (\bar{X} - \bar{x})^2}{E \Sigma x_i^2} = \frac{\sigma^2/n}{\sigma^2 (n_1 - 1)} \doteq \frac{1}{n^2}$$

$$S_p = \frac{\Sigma (\hat{Y}_i - \hat{Y}_i)^2}{n-2} \left(\frac{1}{n_1} + \frac{1}{n} \right)^{1/2} = 1.414 \, S_{\bar{x}}$$

as $S_{\bar{x}}$ is computed on the previous page from n observations where $n \doteq n_1$ and $n > 100$ so $1/n \doteq \frac{1}{n-2}$

$$P \left\{ \hat{\bar{y}} - t(\sigma, n-2) \, S_p \leq u \leq \hat{\bar{y}} + t(\sigma, n-2) \, S_p \right\} = 1 - \delta$$

1/ Principles and Procedures of Statistics, Steele and Torre McGraw-Hill, 1960

The bar portion of Figures 1 through 10 gives a distribution of the yield forecast error between the two components of the forecast, head weight and head count. The shaded bar represents that portion of the discrepancy of the yield forecast which is attributed to the forecast of weight per head while the unshaded bar represents that portion arising from the forecast of head count. The discrepancies charted are the differences between the forecast based upon State parameters alone and the final yield so in most cases, the actual forecasts obtained by weighing of the State and regional models were considerably smaller.

Table 123 summarizes the August 1 pre-harvest estimates. The standard deviation of the mean in this table contains no forecast error since the entire plots were harvested. These $S\bar{x}$ values may be used to make probability statements about the true yield. For example, the true yield will be within the range of the sample yield plus or minus (1.96) $S\bar{x}$ bushels, 95 times out of 100, so that the case of the 9-State total, the probability is .95 that the true yield is between 28.6 and 27.4 bushels per acre.

The $S\bar{x}$ is interpreted in terms of a confidence interval on Figure 1 through 10 area is represented by the brackets around the objective yield estimates. The "X" on the forecast bar charts represents objective yield forecasts on May 1, Junel, and July 1, and a yield estimate on August 1, all using State parameters. The "⊗" indicates the Board estimate. In most cases, the August Board estimate lies within the 95% confidence limits but for the 9-States is more than a bushel below the confidence range. Although it is difficult to mathematically justify any estimates outside this confidence range for the August 1 estimate, it should be noted in most cases that the objective yield and Board levels are not in serious disagreement. On a total production basis the August 1 objective yield is less than one-tenth of one percent away from the Board estimate for the 9-State total.

Table 124 shows the major survey and Board yield indications for 1963. In four of the States (Ohio, Indiana, Illinois, and Nebraksa) the objective Yield and Board level differ considerably. In Ohio, Indiana, and Illinois, the Board level is about three bushels per acre below the level substantiated by three of the more reliable indicators (general crop, farmer reported yield on the probability objective survey, and the field counts from the objective survey). In Nebraska both of the objective yield indications (farmer report and field counts) support a higher level than the Board has adopted. A similar situation is indicated in Table 125 for 1962. This would seem to indicate that a review of the Board level of yield for the East North Central States is warranted. The tables also show early season objective yield forecasts to be as good, or better than early Board forecasts in all cases except Nebraska. The 1963 yield forecasts by model, survey, and State, are shown in Table 119.

The individual early season forecasts of yield and acreages for harvest from the objective yield are not derived from the same bases as those used by the Board in estimating its harvested acres and yield per acre. The Objective Yield utilizes the acres intended for harvest at the time of the interview in its forecast. The poorer fields which may be abandoned later in the season are included in the forecast and give a higher acreage and a lower estimate of yield. The Board forecasts of final acres for harvest are generally based on an average acreage abondonment. While this is good for

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average years, it can give a very misleading forecast of acres for harvest and average yield for unusual years. An adjustment which could conceivably put early season objective forecasts of acres for harvest on the same basis as those of the Board would be a comparison of the June Enumerative Survey acres for harvest with the final acreage for harvest as derived from the Form D adjustment. This might adjust for some of the non-sampling bias which arises from the farmers' anticipation of acres reported for harvest in excess of those actually harvested.

It would appear then that the regional production figure whould be the indication utilized from the May and June Objective Yield. The Board regional production should not be more than two standard errors from the objective yield. The same would apply on a State level--the larger standard error gives just as good a measure of reliability as does a small standard error. The acres and yield for May and June should not necessarily be on the same level for objective yield and Board as covered above but by July and later these also should be measuring nearly the same thing.

No forecasts were made for the 8 States in the program. For the first time in 1963. Six of the States completed a winter wheat yield computation form and acreage record form at harvest time. The data on these forms were made available to the Crop Reporting Board on August 1 for all the new winter wheat States (Washington, Oregon, Montana, Idaho, Colorado, and South Dakota), and also on September 1 for winter wheat in Montana, Idaho, Washingotn, and Oregon. A summary of the data from these computation forms with comparison of Board estimates is shown in Table 129. The expansion factor used on the computation form is the same as for the 9 winter wheat States except that harvesting loss is taken out by the factor used for the new States.

The 6 spring wheat States (Washington, Montana, Idaho, North Dakota, South Dakota, and Minnesota) also completed the yield computation form and acreage record form and the data on these forms were made available to the Crop Reporting Board on September 1 and October 1. A summary of the data from these computation forms and with comparisons of the Board estimates is shown in Tables 130 and 131. In comparing the relative levels of Board and objective yields, it should be noted the objective yield program is not yet operational in these States.

Table 129 -- August 1 and September 1 Indications For Winter Wheat States New to Program in 1963

State	OBJECTIVE YIELD ESTIMATES						BOARD ESTIMATES		
	Sample Size	Acres for harvest (000)	Heads per plot (No.)	Average weight per head (Gms)	Net Yield (Bu.)	Production (000 Bu.)	Acres for harvest (000)	Yield per acre (Bu.)	Production (000 Bu.)
AUGUST 1									
S. Dakota	40	449	416	.381	17.6	7,902	515	19.5	10,042
Montana	40	2,043	457	.594	29.9	61,086	1,891	28.0	52,948
Idaho	12	691	499	.482	32.0	22,112	657	35.0	22,995
Colorado	52	1,620	377	.431	20.8	33,696	1,731	12.0	20,772
Washington	38	2,146	324	.917	39.6	84,982	1,783	40.0	71,320
Oregon	24	705	331	.897	42.0	29,610	734	38.5	28,259
SEPTEMBER 1									
Montana	44	2,042	462	.610	31.9	65,140	1,891	28.0	52,948
Idaho	39	685	470	.614	41.9	28,702	657	35.0	22,995
Washington	36	2,142	325	.924	43.1	92,320	1,783	40.0	71,320
Oregon	38	721	306	.999	47.5	34,248	734	39.0	28,626

Table 130 -- September 1 and October 1 Estimates for Durum Wheat States - 1963

State	OBJECTIVE YIELD ESTIMATES						BOARD ESTIMATES		
	Sample Size	Acres for harvest (000)	Heads per plot (No.)	Average weight per head (Gms.)	Net Yield (Bu.)	Production (000 Bu.)	Acres for harvest (000)	Yield per acre (Bu.)	Production (000 Bu.)
SEPTEMBER 1									
Minnesota	4	103	239	.670	32.5	3,348	51	29.0	1,479
N. Dakota	29	1,425	204	.747	30.7	43,748	1,653	26.0	42,978
Montana	2	123	222	.737	32.5	3,998	180	24.0	4,320
OCTOBER 1									
Minnesota	4	103	239	.670	32.5	3,348	51	30.0	1,530
N. Dakota	29	1,494	204	.747	30.9	46,165	1,653	26.0	42,978
Montana	2	123	222	.737	32.8	4,034	180	23.0	4,140

Table 131 -- September 1 and October 1 Estimates for "other Spring" Wheat States - 1963

State	OBJECTIVE YIELD ESTIMATES						BOARD ESTIMATES		
	Sample Size	Acres for harvest (000)	Heads per plot (No.)	Average weight per head (Gms.)	Net Yield (Bu.)	Production (000 Bu.)	Acres for harvest (000)	Yield per acre (Bu.)	Production (000 Bu.)
SEPTEMBER 1									
Minnesota	45	835	252	.491	27.3	22,796	791	25.0	19,775
N. Dakota	94	4,316	253	.486	24.5	105,742	4,029	21.0	84,609
S. Dakota	73	1,342	186	.408	12.3	16,507	1,389	13.0	18,057
Montana	61	2,003	270	.496	21.8	43,665	1,784	22.0	39,248
Idaho	25	294	317	.727	49.9	14,671	366	41.0	15,006
Washington	12	67	238	.783	32.4	2,171	135	30.0	4,050
OCTOBER 1									
Minnesota	45	832	252	.491	27.3	22,714	791	25.0	17,775
N. Dakota	94	4,205	255	.486	23.6	99,238	4,029	21.0	84,609
S. Dakota	73	1,310	186	.408	12.3	16,113	1,389	13.0	18,057
Montana	65	2,017	263	.506	21.8	43,971	1,784	21.5	38,356
Idaho	27	295	319	.732	50.0	14,750	366	41.0	15,006
Washington	14	67	232	.740	30.1	2,017	135	29.0	3,915

7.4 Summary of Research

The following is a brief summary of the research done during 1963 and will be used to supplement earlier research done for Winter Wheat in the 9 operating States.

Stalk count has proven to be a good indication of final head count. The main difficulty in its use is inaccuracy in counting due to the large number of stalks in a sample unit and because of inconsistancies in the counting of dead stalks. One of the principal difficulties is getting enumerators to count both live and dead stalks each month. Initial research has indicated that the count of stalks ten inches or higher obtained in the 1963 program will provide a more accurage indication of final head count.

To evaluate the effeciency of the head weight forecasting models, a comparison of forecast error was made between Model I and Model II by maturity categories. In forecasting head weight Model I uses the spikelet count and grain counts from heads clipped outside the unit and Model II is based on an adjustment of head weight from samples taken outside the sample unit during the growing season to find head weight at harvest time. A similar comparison was made to test the effectiveness of the grain count for Model I versus the spikelet count for Model I. For those States that have been compared to date, the grain count was the most effective forecasting variable for Model I in 1963. Hence, it should be used as soon in the season as accurate grain counts can be made. The comparison between Method I and Method II, showed Method II to be a precise indication for categories for through seven. The period of growth covered by category three (late boot stage) and the early portion of category four (milk stage) is a period of rapid change in head weight. The adjustment factors shown in Table 128 give some indication of this rapid change. The head weight forecasts made by using Method II were observed on an individual sample basis. This check showed the weight per head in the latter part of maturity category 3 was as much as three times as heavy as in the early part of that category. Checks were made on other observations to determine if the samples appeared to be miscategorized, but no evidence was found to substantiate this. It is suggested that Method II should not be used until the sample unit reaches the milk stage (maturity category 4).

The forecast error obtained in the present program (see Tables 120, 121,and 122) may be interpreted as a measure of accuracy involved in forecasting the final estimate of yield. This value computed from 1963 forecasting could be used as shown in section 7.3 to construct confidence limits around 1964 forecasts if we assume no change in the effectiveness of the forecast model from one year to the next.

We are interested in incorporating some method of putting accurage cofidence limits around our forecasts at the time they are made. One possibility for determining satisfactory confidence limits for the forecasts would be to use the $\Sigma \frac{(\theta - \hat{\theta})^2}{n - 2}$ values combined for several years. This should be acceptable after the program reaches a point of operational stability where the same forecasting models are used from one year to the next.

The weekly development data is being summarized to faciliate the study of plant growth and development during the growing season. Information expected to come from this time series study of plant growth should improve forecasting models by isolating the independent variables which have the most influences on final yield, and showing stages of maturity in which the particular models and variables are effective. For instance, initial research indicates that classification of the sample unit as to whether it is irrigated or dryland wheat and using a separate model for each of these groups may provide a more efficient forecast of yield. The time series study also points out stages of rapid transition which are not adapted to certain stypes of forecasting models. All reasonable relationships between early season counts and measurements versus final yields are being compared for effectiveness in forecasting final production. The use of curvilinear relationships will be considered.

The revisions in the present 9-state program and the models which emerge from studies now being made on the 8 new states are to be programmed for the 7074 computer and incorporated into the 1964 forecasts.