TABLE 2

	West	Northwest	North	Northeast	East
Number of observations	8	16	33	21	21
V_{no} (modified Beaufort)	2.1	4.4	4.3	2.9	2.8
V_m (modified Beaufort)	2.2	2.4	2.1	1.9	2.1
$\frac{V_{no}}{V_m}$	.94	1.80	2.08	1.53	1.29

V_{no}=Anemometer velocity at New Orleans airport (66.1 feet above surface).
V_m=Anemometer velocity averaged for three surrounding stations. (Mobile, Tyler, Lake Charles).

The data in table 2 are taken from winter synoptic charts without regard to time but when no fronts were within a hundred miles. Diurnal effects should be practically eliminated between day and night readings. It must be remembered that the normal value for the ratio, V_{no}/V_m should be approximately 1.4 for wind directions between WNW. and E., through N., since the lower frictional drag of the water surface at New Orleans would increase the surface wind about this much above the land exposures of the surrounding stations. The west winds which are not affected by the lake, show nearly the expected value of 1.0. The NW. and N. winds, as expected, show values much greater than normal, while the NE. and E. winds show marked decreases to near or below normal. East winds should show a marked deficiency in this value, and that they do not, is attributed to the fairly uniform, low value of surface friction to the east of the airport composed of low grass marshes and water surfaces. The average wind at New Orleans from N. and NW. is found to be 4.4 modified Beaufort, or approximately 18 m. p. h. while these same directions give averages in the surrounding stations of 2.2 or about 8 m. p. h.

Table 3 is offered to show that air drainage, while perhaps a definite factor, is not the controlling force. Three New Orleans balloon runs are given for 1,100, 1,700, and 2,300, seventy-fifth meridian time April 7, 1939. They are typical of such balloon runs from north through northwest. In two of them, the ratio of V_a/V_1 is above 1.0, which is a very unusual occurrence, yet one that is probable according to figure 2. At no time does this value drop to a normal figure. The lowest ratio of 0.92 occurs at 1,100, but the wind direction of 10° to 20° which is slightly unfavorable for this effect, probably accounts for even this low a value.

TABLE 3

Altitude	1,100 ES	1,700 ES	2,300 ES	Estimated normal over sea surface for adiabatic lapse rates
Surface	360-22	360-20	350-19	
1,000	10-24	340-17	340-10	
2,000	10-20	360-16	340-10	
3,000	20-19	10-17	350-11	
V_a/V_1	0.92	1.2	1.9	0.8

V_a=anemometer wind. V_1=wind at 1,000 feet.

Some attention should be paid to the conditions of formation of the pseudo fronts mentioned before. Figure 4 shows the directions of wind which permit the formation of these fronts for each of the Great Lakes. The insert at the upper right shows how these directions were obtained. Since the lakes are not squares, it is necessary to choose the directions in such a manner that the wind blows along the edge and not across the corner of lakes. For instance, if the direction were taken as along the dotted lines marked "A" in the insert, air progressively crosses more water toward the center and a gradual zone of transition is produced instead of a discontinuity.

SUMMARY

(1) It is found that there is definite increase in surface wind velocities on the right portion of the lee shore of lakes (looking down-wind).

(2) It is probable that a marked increase in velocity at the top of the convective layer is found to the left of large warm lakes, and a decrease to the right.

(3) That the effects in (1) and (2) above vary from the formation of pure thermal cyclones, for wind velocities approaching zero, to merely a steepening of lapse rates for very high wind velocities, and a smaller lake traverse.

(4) That stationary, pseudo fronts will be formed only under certain local conditions.

THE RELATION OF WEATHER FACTORS TO WHEAT YIELDS ON LEVAN RIDGE, UTAH [1]

By NORAH E. ZINK

[Geographer, State Teachers College, Indiana, Pa., February 1940]

Much interest exists in the relation of weather to crop yields. Some of this interest is occasioned by the desire to forecast yields and thus to predict, at least in part, economic conditions at the time of harvest, or to change farm practices in order to avert loss. Some of the interest is manifested because of the desire to determine the suitability of a region to a specific method of development; the geographer uses the correlation of weather data and crop yields as a means of delimiting regions or interpreting man's activities in relation to his natural environment.

WEATHER FACTOR IMPORTANT TO WHEAT GROWTH AND YIELDS

Opinions of students of the relation of yields to weather data suggest that a large number of factors are important over wide areas. Some of these factors are the amount, distribution, reliability and effectiveness of rainfall; evaporation; maximum, minimum, and average temperatures; length of drought periods; length of growing season; and amount of sunlight and soil moisture.

Some investigators use the month or the year as a unit of time. Others are concerned with stages of plant growth; many plants have a particular period during their growth when certain weather factors or combinations of factors are thought or known to be necessary to produce large yields, and since the presence or absence of these factors at a so-called critical stage is perhaps more important than favorable weather conditions throughout the rest of the plant's life, the use of plant-growth stages as time-factors is superior to monthly or yearly divisions. There are, however, two difficulties in the use of plant-growth stages. In the first place, there are almost no records giving dates for these stages. Secondly, the dates differ from year to year, and from one place to another. Among those advocating the use of plant-growth stages in making correlations between yields and weather factors are J. Warren Smith in this country, and Girolamo Azzi in Italy.[2]

[1] The advice and assistance of Dr. John Kerr Rose in the preparation of portions of this study is gratefully acknowledged.

[2] Azzi, Girolamo, "Problems of Agricultural Ecology." MONTHLY WEATHER REVIEW, April 1922, 50: 193.

Stages in the growth of wheat which are well recognized are germination, tillering, jointing, heading, blossoming, and ripening. Two of these stages have been regarded as critical in the growth of wheat, the period of germination and formation of the first leaf, and the period of flowering.[3] The flowering period is very short and there has been some question as to whether the critical time is before, during or after flowering.[4]

Perhaps the most critical stage consists of the 3 or 4 weeks before the plant heads.[5] The date of heading is very important and is more reliable than the date of ripening.[6] From the heading date, the most critical period in the growth of the wheat, which seems to occur shortly before heading, is established. In a study of the critical periods of winter-wheat growth in Italy, Azzi found that the 20-day period just preceding heading was very important in the region studied. He said that the soil had to be kept moist at that time or the crop would be reduced.

Another supposedly critical period occurs at the time of planting when both temperature and moisture requirements are exacting.[7]

It has also been said that the yield of winter wheat will be greatly affected by the temperature of a single month or of a season.[8] In Utah the April temperature,[9] and the precipitation falling during the fallow year and in April, May and June [10] are thought to have a direct influence on yield.

PROBLEM AND PROCEDURE

The general problem was to determine which, if any, of the weather factors represented by the records were, in terms of probability, significant to the resulting yield and to what degree. The results would, of course, be strictly applicable only to the area studied but presumably of considerable validity over much wider areas of dry-farming lands in the drier part of the United States.

Levan Ridge is a dry-farming region located almost in the center of Utah near the town of Nephi. It is a small area comprising only 24 square miles, forming a rectangle in shape, 6 miles long and 4 miles wide, with nearly 15,000 acres in wheat. It is the best known dry-farm region of the State and the only area in the State which has accumulated data which might be studied in this manner.

It was possible to secure from the experiment station on Levan Ridge yields and dates covering a 25-year (1908–33) for the planting, emergence, heading and ripening of the wheat at the station. These are the average dates for 15 to 20 plots.[11] Because the averages represent a fairly large number of plots and because crop practices on the Levan Ridge follow closely those of the experiment station, these dates and yields parallel quite closely the averages for the entire area. Humidity figures were secured from the Smithsonian Institution. Other weather records were obtained from the United States Weather Bureau, Salt Lake City, Utah. Rainfall varies greatly within short distances in Utah, so it is essential that weather data should be recorded within the area furnishing the data on crop yields.

The opinions given above concerning the relation of yields and weather factors, as well as other theories, directed the choice of the climatic factors used in this investigation. In all, 120 different combinations of weather factors were studied for the 25 years for which data were available. The information concerning these factors was computed partly by calendar months and years, and partly by plant-growth stages.

In connection with planting, temperature and moisture conditions immediately preceding or following the planting date, and the period from the date of planting until the temperature dropped below 42° F. were used.[12] Much attention was given to the heading date. Data concerning rainfall, temperature, humidity, and evaporation for ten 5-day periods preceding heading were computed. These same factors were computed by 5-day intervals from heading to ripening and for the entire period from April 1 to heading. In addition to these, other factors were arranged, such as the number of days receiving 0.10 of an inch of rain; the longest rainless period; the severity of drought; maximum, minimum, and average temperatures for April; rainfall for April, May, and June; rainfall for September and October; rainfall for the year in which harvest occurred; for the actual time the wheat was in the ground; for the fallow year; and for 40 percent of the fallow year plus the rainfall of the time the plant was growing.[13]

On the Levan Ridge the date of planting at the experiment station ranged from September 15 to October 30, a range of 46 days; the date of heading ranged from June 4 to June 30, and that of ripening, from July 8 to July 29. The wheat emerged before snowfall in only 12 of the 25 years; and the period between planting and emergence covered from 9 to 43 days, requiring 17 days half of the time.[14]

Scatter diagrams showing the relation between yields and a particular weather factor were made for each of the 120 combinations in order to see if the correlations were linear. Those factors were discarded for which no correlation was discovered. About 40 diagrams indicated a fair amount of correlation between yields and the weather factor plotted; therefore simple Pearsonian coefficients of correlation were computed for them. The 15 highest of these were placed in four logical groups, and partial and multiple correlations were made for them.

Most of the simple correlations given in figure 1 are statistically significant. The higher multiple coefficients of correlation would indicate good probabilities that the weather factors represented had a rather close correlation with yield on Levan Ridge. Of the partial coefficients rainfall was most consistently significant; but over a long period of time it, too, was less significant. As with the simple coefficients, the highest coefficients obtained were for evaporation. Several of the partial coefficients are insignificant, indicating that they showed up as significant in the first order coefficients only because these were correlated with other weather factors.

Graphs, which plotted yields in a descending series, and some attendant weather factor, were made (1) in order to show the closer relationship which is disclosed when plant growth stages are employed, and (2) to show some characteristics of the weather on Levan Ridge, itself (figs. 2–9).

[3] Alsberg, Carl L., and Griffing, E. P., Forecasting Wheat Yields from the Weather: Elements of an Unsolved Problem, Wheat Studies, vol. V, No. 1, Leland Stanford University, Junior. Palo Alto, California, November 1928, p. 19.
[4] Alsberg, Carl L., and Griffing, E. P., *op. cit.*, p. 17.
[5] Alsberg, Carl L., and Griffing, E. P., *op. cit.*, p. 16.
[6] "We find that the date of heading is a much more reliable and useful factor than the data of ripening." (Dr. John H. Parker, Professor of Crop Improvement, Kansas State College, Manhattan, Kans.—Letter, August 25, 1935).
[7] J. Warren Smith, Agricultural Meteorology (New York: Macmillan Co., 1920, p. 191.
[8] Smith, *op. cit.*, p. 199.
[9] Bracken and Stewart, A Quarter Century of Dry-Farm Experiments, Utah Agricultural College Experiment Station, Bulletin No. 222 (Logan, Utah, 1916), p. 7.
[10] Harris, Bracken, and Jensen, Sixteen Years of Dry-Farm Experiments, Utah Agricultural College Experiment Station, Bulletin No. 175 (Logan, Utah, 1916), pp. 6 and 8.
[11] Unpublished data, Utah Experiment Station, Nephi, Utah. August 1933.
[12] Alsberg, Carl L. and Griffing, E. P., *op. cit.*, p. 7. "It (the wheat plant) must cease to grow when the temperature drops to a certain point. This point varies for different kinds of plants, but for most garden crops it is close to 6° C. (42.8° F.) The British Meteorological Office adopted 42° F. as the critical point."
[13] Merrill, Lewis A. Seven Years Investigations of Dry-Farming Methods, Utah Agricultural College Experiment Station, Bulletin 112 (Logan, Utah, 1916), p. 160.
[14] Data from weather reports on file in the U. S. Weather Bureau office, Salt Lake City, Utah.

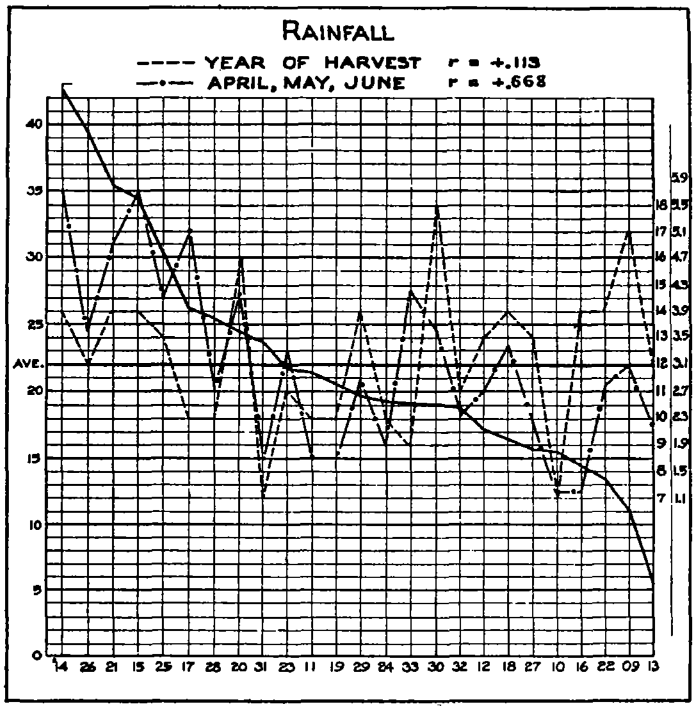

FIGURE 1

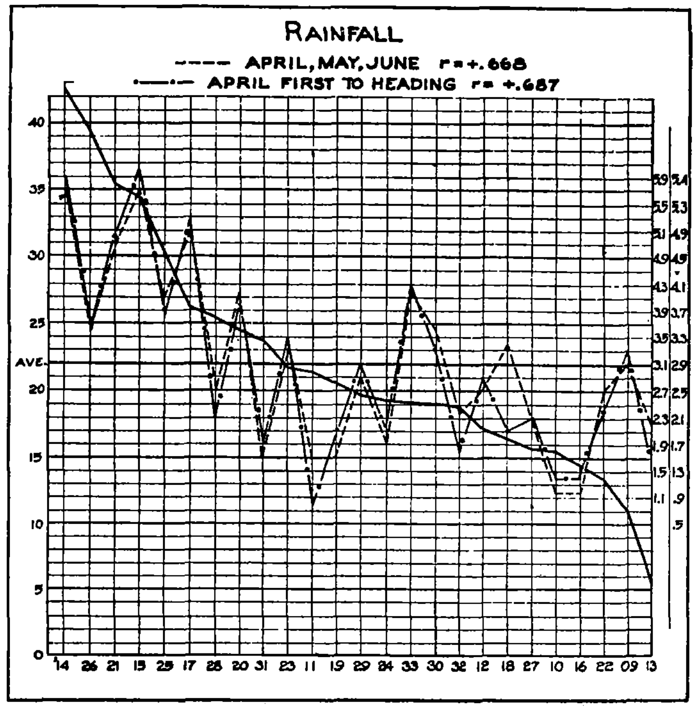

FIGURE 2

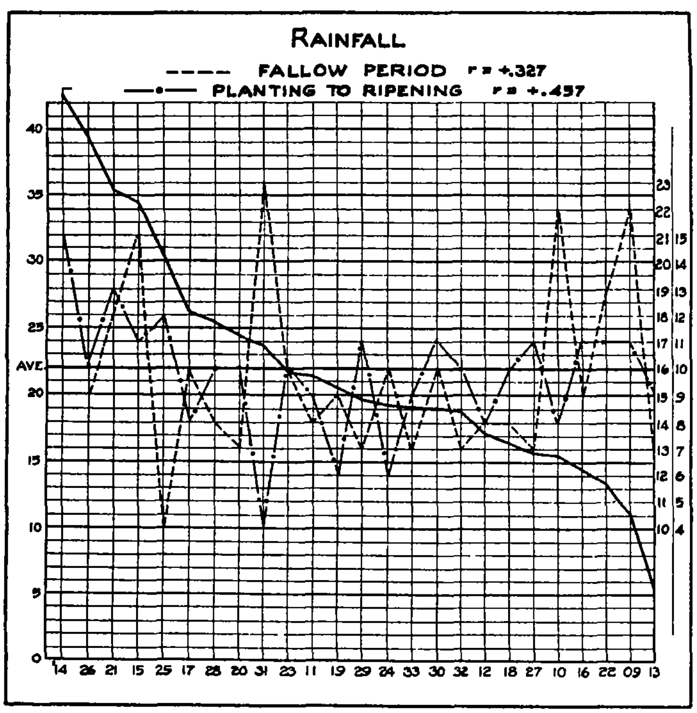

FIGURE 3

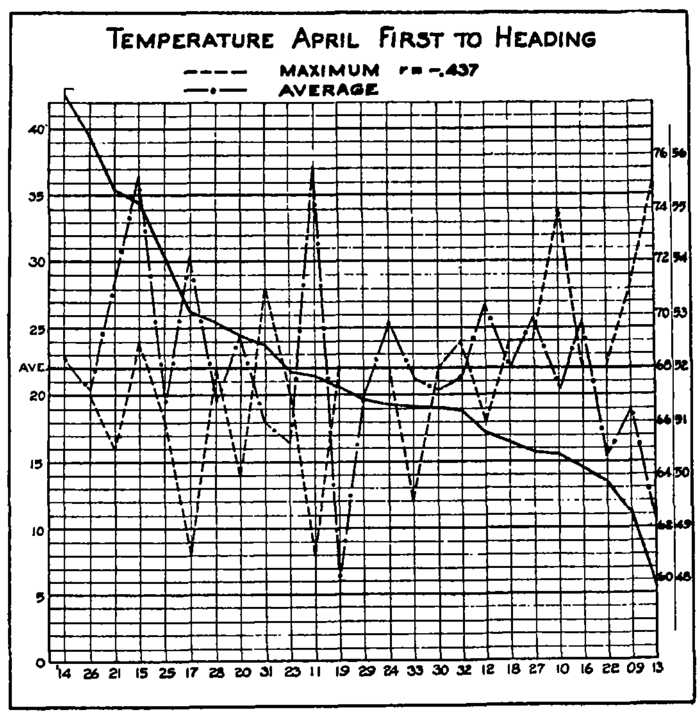

FIGURE 4

The heavy line represents crop yields in a descending series, figures for which are shown at the left. The years are given below the chart, and other data, such as rainfall, etc., are shown at the right side of the chart; figures for the factor mentioned first occurring next to the chart. The *average* line represents averages for all three factors shown.

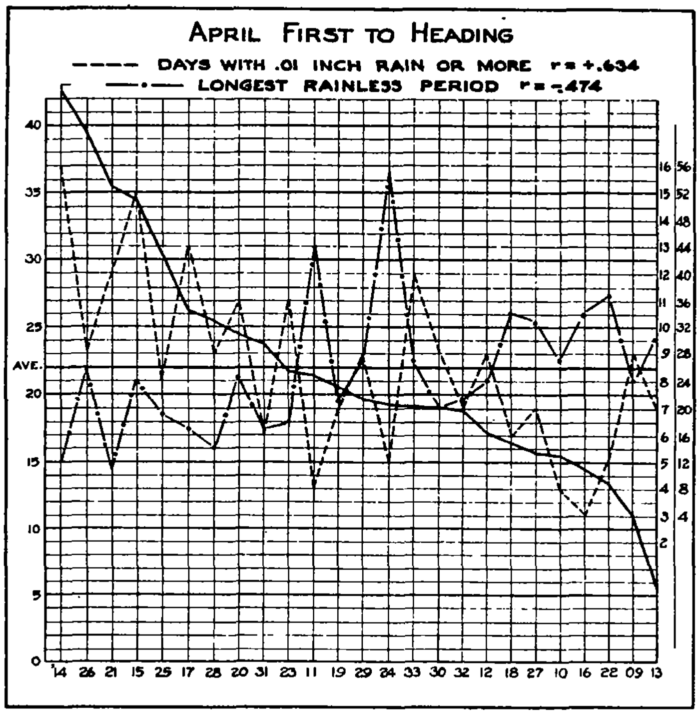

FIGURE 5

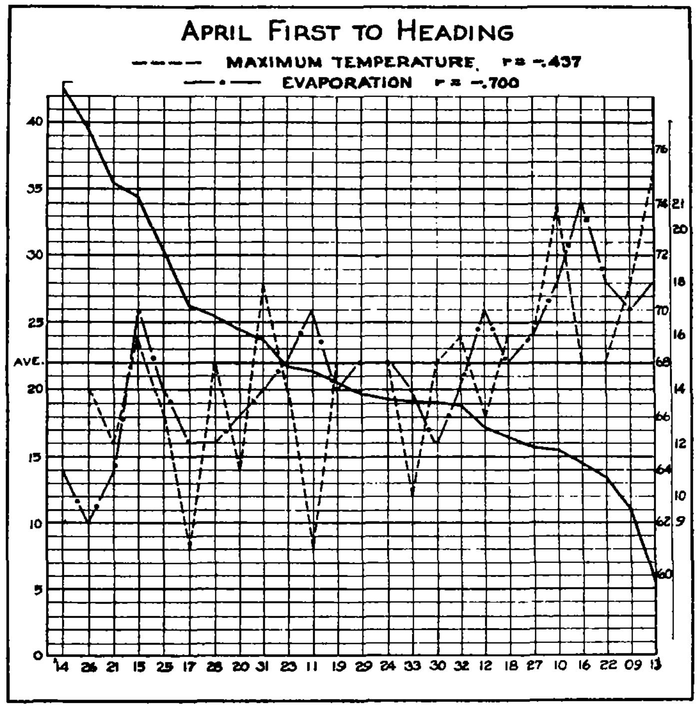

FIGURE 6

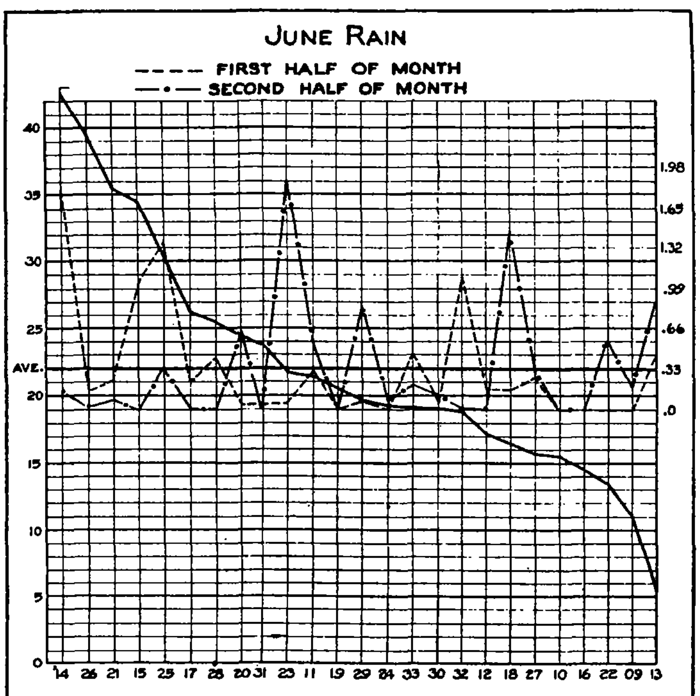

FIGURE 7

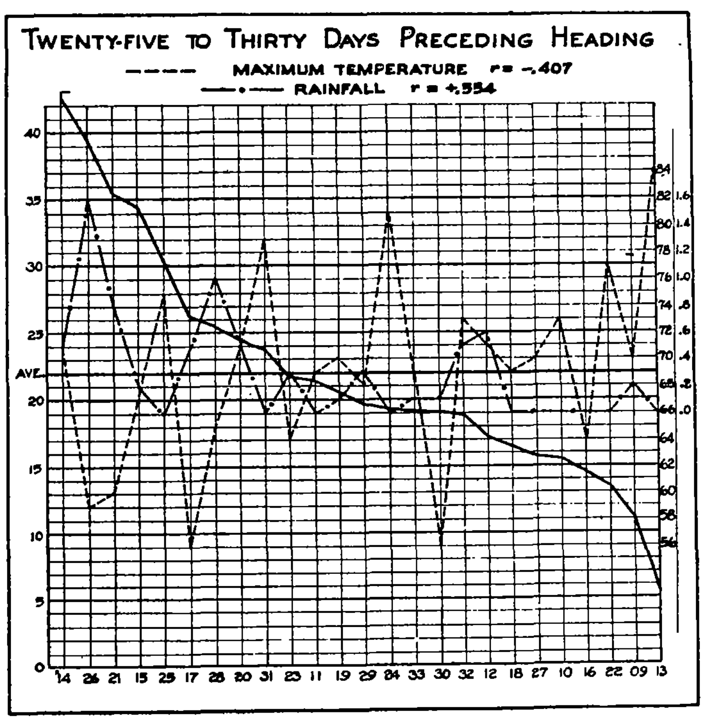

FIGURE 8

The heavy line represents crop yields in a descending series, figures for which are shown at the left. The years are given below the chart, and other data, such as rainfall, etc., are shown at the right side of the chart; figures for the factor mentioned first occurring next to the chart. The *average* line represents averages for all three factors shown.

TABLE 1.—*Correlations*

Factor	Correlation coefficient [1]		
	Simple	Partial	Multiple
I. Apr. 1 to heading:			
(1) Number days 0.10 inch rain	+0.634	−0.214	
(2) Severity of drought	−.474	−.102	
(3) Evaporation	−.700	−.511	[2] 0.811
(4) Maximum temperature	−.437	−.109	
(5) Rain	+.687	+.402	
II. 25 to 35 days before heading:			
(6) Evaporation	−.623	−.529	
(7) Rain	+.554	+.404	.721
(8) Maximum temperature	−.407	+.318	
III. 5 to 25 days before heading:			
(9) Rain	+.684	+.536	
(10) Maximum temperature	−.540	−.218	.708
(11) Evaporation	−.444	+.015	
IV. General factors:			
(12) Rain planting to heading	+.456	+.238	
(13) 40 percent of rain of the fallow year, plus rainfall planting to ripening	+.338	−.023	.531
(14) Average minimum temperatures for April	+.325	+.193	
(15) Rainfall for April, May, June	+.668	+.245	

[1] Smith (op. cit., p. 29) said that, for a series as short as 20 years to be significant, the coefficient of correlation should be above ±.40. Because of the unreliability of the measures for standard errors in considering so few cases, Fisher's Tables [R. A. Fisher, Statistical Methods for Research Workers (London: Oliver and Boyd, 1930)] were used. The probable error then is as follows: If the coefficient is as high as ±.34 there is not more than 1 chance in 10 it is accidental; coefficient ±.40, 1 in 20; coefficient ±.465, 1 in 50; coefficient ±.51, 1 in 100.

[2] For this, the highest of the multiple coefficients the following regression equation, all *n* variables in terms of standard measures (origin at means), has been computed: *Bij.* 12—*o*—*o*—*n* = +.40+.46+.084−.754+.077.

SUMMARY AND CONCLUSIONS

Many of the weather factors mentioned in the literature as influencing yield do not appear important on the Levan Ridge. Results were especially disappointing in regard to the planting period, which is commly thought to be one of the critical periods. However, the relation of the planting period to climatic factors in the fall seems to be obscured by two facts: First, that it is really soil moisture which is most important; and second, the data concerning the period after planting should be treated in two groups—one when the wheat emerges in the fall, and the other when it does not emerge before snowfall. In half of the years the wheat emerged in the fall, and in all but one of these years the yield was above average. Since the amount of rain in the months of September and October and October, during these years of emergence, varied from 0.47 inch to 3.86 inches, the relation is not linear, and it is evident that a large amount of rain does not increase the yield proportionately.

This study emphasizes the high importance of conditions in the spring period and especially in the period 2 or 3 weeks preceding heading, the date of which varies from June 4 to June 30, falling most frequently from the 10th to the 15th, and from the 20th to the 25th of June. Of the 8 years with low yields, the date of heading in 6 of them fell after June 15. The average rainfall for June at Nephi is only 0.58 inches. June rain, however, is unreliable during both halves of the month. In 6 of the 25 years, both periods received less than 0.24 inches, or half the normal. In 6 years there was no rain the first half of the month, and in 9 years there was none in the second half.

Correlations between yields and factors of several other periods were significant. These periods were (1) April 1 to heading; (2) 5 to 25 days preceding heading; (3) a 5-day period just preceding the above period and (4) a group of general factors including rainfall from planting to heading, 40 percent of the fallow rain plus the rainfall from planting to ripening, lowest temperatures of April, and average temperature for April, May, and June.

The highest correlations were with evaporation, length of drought period, and rainfall. Correlations with average temperature were low, but were higher with maximum and minimum readings. "It is altogether unlikely that yields are directly proportional to increase in any single factor. The effect of each factor is modified by the rest." [15] It is because evaporation represents the integration of several other important factors, such as temperature, humidity, and wind velocity, that its coefficient of correlation is consistently so high. It is evident that one weather factor is highly correlated with others, that relations between weather factors and yields are not necessarily linear, and that there can be strict proportionality over only a very narrow range of variation. Yields above average or near the average seem to show this proportionality. Very low yields are frequently due to unmeasurable causes, or to a combination of causes. This is illustrated by the lowest yields recorded on the ridge. The average yield of 5 bushels in 1913 was largely the result of a loss of spring run-off due to the fact that the ground was frozen in the fall when the snow fell and remained frozen throughout the winter.

Correlations for plant-growth stages gave somewhat higher coefficients than those obtained by the use of seasonal or monthly data. This is shown in a comparison of the correlations for rainfall, (1) for the three months of April, May, and June, +.668 and (2) for the period from April 1 to heading, +.687; or (3) for a period of 5 to 30 days preceding heading, +.554. A comparison of the correlations for rainfall is also shown (1) for the calendar year in which the harvest occurs, +.114, and (2) from planting to ripening, +.456.

When the date of planting varies a month and a half and the heading date one month, and when the critical stage of plant growth covers a very short period, the importance of using plant-growth periods rather than calendar months is seen.

The graphs show (1) the advantages of using plant growth stages, (2) the lack of relation between rainfall of the harvest year and yield, (3) the closer relationship between extreme temperatures and yield than average temperatures and yield, (4) that early June rain is important, (5) that too heavy rainfall at planting time is not desirable and, (6) that late planting usually lowers yields.

SOME OTHER FACTORS INVESTIGATED

CONCERNING PLANTING

	r
Rainfall planting to emergence	+.346
Maximum temperature planting to emergence	+.171
Maximum temperature to end of period of 42° F	+.395
Maximum temperature to end of 22 days after planting	+.171

APRIL 1 TO HEADING

Number of rainless periods	+.487
Severity of drought	−.367

[15] Alsberg, Carl L. and Griffing E. P., *op. cit.*, p. 21.

PERIOD PRECEDING HEADING

Evaporation:	
45 to 50 days preceding heading	−.374
40 to 45 days preceding heading	−.449
35 to 45 days preceding heading	−.508
20 to 30 days preceding heading	−.446
Temperature:	
Average temperature 20 to 30 days preceding heading	−.316
Maximum temperature 15 to 25 days preceding heading	−.436
Humidity (for 10 years only):	
25 to 30 days preceding heading	+.368
5 to 25 days preceding heading	+.117

AFTER HEADING

Average temperature for 10 days after heading	−.250

GENERAL

Rainfall planting to ripening +40 percent of fallow year	+.247
Rainfall planting to heading +40 percent of fallow year	+.274
Rainfall fallow year	+.327
Rainfall of calendar year	+.113
Rainfall planting to ripening	+.457
Number of days from emergence to heading	−.133
September and October rain	−.317

TABLE 2.—*Crop yields and weather data* [1]

Date	Yield	1	2	3	4	5	6	7	8	9
1909	11.1	9	24	16.7	70.9	3.06	1.005	0.16	69.5	0.33
1910	15.8	4	27	17.9	74	1.21	1.286	T	73.4	.51
1911	21.4	4	44	17.0	61.1	.84	1.382	0	68.8	.17
1912	17.1	9	24	16.8	66	2.69	1.375	.55	70.8	.72
1913	5.4	7	30	18.3	74.65	1.63	1.503	.02	84.3	.46
1914	42.7	16	12	11.1	66.7	5.70	.679	.34	71	2.26
1915	34.2	15	24	17.2	68.77	5.75	.794	.18	66.8	1.04
1916	14.6	3	34	20.5	68.05	1.24	1.049	0	63.6	.00
1917	26.1	13	17	12.2	60.55	5.12	.467	.45	56	1.73
1918	16.4	6	34	15.1	69.05	1.91	1.226	0	68.8	.06
1919	20.6	7	21	13.8	68.05	1.70	.977	.14	70.4	.91
1920	24.4	11	25	12.7	64.09	3.81	.955	.53	70.6	.55
1921	35.4	12	11	10.8	64.7	4.80	.712	.84	60.2	1.72
1922	13.6	5	37	18.0	68.3	2.28	1.319	0	77	.00
1923	21.8	11	18	14.7	66.8	3.31	.701	.28	64	.94
1924	19.3	5	55	14.5	68.4	1.91	1.435	0	80.5	1.84
1925	30.3	8	19	14.1	65.92	3.60	1.174	0	74.6	1.39
1926	39.4	9	26	9.4	66.8	3.43	.535	1.58	59.4	1.65
1927	15.7	7	33	16.1	68.8	2.14	.977	.01	70.4	.26
1928	25.6	9	14	12.1	67.6	2.29	.732	1.03	65.2	1.52
1929	19.7	9	27	15.0	67.8	2.92	.941	.29	68.4	1.51
1930	19.0	9	20	11.7	68.2	3.23	.321	.11	56.2	.30
1931	23.7	6	17	13.8	70.9	1.70	1.232	0	79.2	.50
1932	18.9	7	21	14.2	68.78	1.61	1.194	.50	73	1.58
1933	19.2	12	27	13.5	62.50	3.98	1.279	.08	68.6	.11

[1] Figures in column 1 show number of days with .10 inch of rainfall from April 1st to Heading, 2 Severity of drought (number of days in longest rainless period) etc. See arabic numbers in Figure 1, for other titles.

FLOODS IN THE SACRAMENTO VALLEY, FEBRUARY 27–MARCH 6, 1940

By E. H. FLETCHER

[Weather Bureau, Sacramento, Calif., May 1940]

The flood that occurred in the Sacramento Valley late in February may well be classified as one of first magnitude, exceeding that of December 1937, and in some respects surpassing any flood since systematic records have been kept by the Weather Bureau. From Kennett, Calif., to the mouth of the Feather River, new all-time high water marks were established generally.

The rainfall season of 1939–40 did not get under way until near the end of December. However, during January and most of February frequent rains over the Sacramento River system kept the streams and bypasses at high, but not flood levels.

Near the beginning of the year the California-Hawaiian high-pressure system had receded far southward of its normal winter position, and was replaced by storm areas of much greater intensity than ordinarily appear in that region. Consequently, a succession of slow-moving cyclonic disturbances, advanced northeastward off the Pacific coast, with intermittent warm-type occluded cyclonic systems moving inland over northern California, and causing precipitation in the form of rain at much higher elevations in the mountains than is usual during the midwinter months. This situation accounts for the marked deficiency in snowfall that prevailed until late in the season.

On February 24–25, the last one of this series of northeastward-moving storms apparently caused the importation of a large volume of semi-tropical air near the California coast, whence it was carried inland on February 27–28 by another and more intense storm of the Aleutian type with exceptional frontal activity, producing torrential rainfall in the Sacramento drainage area. On the morning of the 29th, a cold front had advanced inland over the Pacific northwest, bringing lower temperature and snow to the mountains, with clearing weather following. Thus ended a cycle of storms that was directly responsible for the disastrous flood of February.

The excessive rainfall was mostly confined to the 5-day period, February 25–29, with the most intensive fall occurring on the 27th–28th. However, the antecedent rainfall extending over a period of about 2 months, was a highly important contributing factor to the flood-producing run-off.

It was apparent as early as Monday morning, February 26, that a period of high water was inevitable, and the river bulletin that morning contained the following general forecast: "A general rise is developing in all streams, and with continued heavy rains in prospect, high stages will result in the Sacramento River and probably the lower San Joaquin, during the next 2 or 3 days."

During that day a close check was maintained on the situation by means of hourly weather reports that were received by teletype. At 5 p. m., when the river stage at Red Bluff (flood stage 23 feet) was only about 13 feet, flood warnings were issued for that vicinity and Tehama County.

The upper courses of all streams in the Sacramento drainage area began to rise rapidly during that night, and on the morning of the 27th, flood warnings were repeated, stressing that the serious conditions that were rapidly developing would be intensified during the next 24 hours by expected additional heavy rainfall, and that extremely critical flood conditions, equaling or exceeding those of December 1937, would prevail in the Sacramento Valley during the next 3 days.

Warnings were also issued to the effect that mild flood conditions would be experienced in the lower reaches of the eastern tributaries of the lower San Joaquin River, namely, the Consumnes, Mokelumne, Calaveras and Stanislaus Rivers.

From the influence of the American River, the Sacramento River at Sacramento rose steadily on the 27th, and at 10:30 p. m., when the stage was 28.5 feet, the 48 gates of the Sacramento Weir, 3 miles upstream from the City, were opened, permitting the excess water to escape westward into the wide expanse of the Yolo Bypass, which conducts the water southward to the vicinity of Rio Vista, where it reenters the broad river channel.

After the weir gates were opened the river at Sacramento fell during the next 5 hours to 26.5 feet and remained practically stationary for several days. The city of Sacramento was at no time endangered.