

UNITED STATES
DEPARTMENT OF AGRICULTURE,
WEATHER BUREAU.

ANNUAL REPORT

OF THE

Iowa Weather and Crop Service

IN CO-OPERATION WITH THE

UNITED STATES WEATHER BUREAU,

FOR THE YEAR 1898.

JOHN R. SAGE,
Director.

GEO. M. CHAPPEL, M. D.,
*Local Forecast Official U. S. Weather Bureau,
Assistant Director*

PRINTED BY ORDER OF THE GENERAL ASSEMBLY.

DES MOINES:
F. R. CONAWAY, STATE PRINTER,
1899.

STATE OF IOWA,
OFFICE OF THE WEATHER AND CROP SERVICE, }
DES MOINES, February 1, 1899.

To His Excellency, Leslie M. Shaw, Governor of Iowa:

SIR—In accordance with the requirements of the law, we have the honor to submit herewith the ninth annual report of the Iowa Weather and Crop Service for the year 1898.

We are, sir, very respectfully your obedient servants,

JOHN R. SAGE,
Director.

GEO. M. CHAPPEL, M. D.,
*Local Forecast Official U. S. Weather Bureau,
Assistant Director.*

ANNUAL REPORT, 1898.

This report is a compilation of climate and crop data collected in accordance with the provisions of the law of the state, in coöperation with the Weather Bureau of the U. S. Department of Agriculture. The salient features of the climate, and the important statistics relating to the products of the soil during the year 1898, are herein presented in convenient form for reference and comparison in future years. There is an increasing public demand, both at home and abroad, for reliable statistical information in regard to the general climatic conditions and the products of the soil of this foremost agricultural state. The value of systematic and continuous records of atmospheric changes cannot be overestimated. They are of special interest to students of science, and of practical value to all classes of business men. And the statistics of farm products are highly valued and carefully studied by men engaged in commercial lines, transportation, and farming.

The U. S. Weather Bureau maintains five fully equipped meteorological stations within the territorial limits of this state; viz: at Des Moines, Davenport, Dubuque, Keokuk, and Sioux City. The records of the station at Omaha, Neb., are included in the meteorological records of this service. In addition to these regular stations the work of meteorological observation is now being carried on at 138 local stations, by competent voluntary observers, equipped with standard instruments for making records of daily temperature and precipitation. These public-spirited and faithful observers perform the exacting task of making systematic and continuous daily records of weather conditions without expense to the state, except the moderate amount required for the purchase of the necessary instruments. The results of the work for the year at all these weather bureau and other stations are presented in condensed form in the summaries and tables included in this report. There has been a net increase of nine stations since the close of the year 1897.

As an auxiliary to this able and efficient corps of meteorological observers, this service includes over 800 crop reporters, who report weekly or monthly the condition of the principal crops as affected by prevalent weather conditions during the crop-growing season. By this coöperation of the government

and the state, assisted by intelligent and public-spirited citizens, the most valuable results are secured at a minimum of cost for the service. These three contributing factors—the government, the State Weather and Crop Service, and the corps of generous citizens who report weather and crop conditions in their respective localities—are all essential to the production of the high measure of utility that has been attained.

The various publications of this service have been widely distributed, and there is a constantly increasing demand for the Monthly Review and weekly climate and crop bulletins issued from this office. The issues of the Review amounted to something over 2,500 copies per month, or an aggregate of over 30,000 copies during the year. The Bulletins issued during the crop season—April 1st to October 1st—amounted to about 38,000 copies. The summaries of the Bulletins were also distributed to the press of the state and by that means valuable information in relation to the growing crops was widely disseminated. Requests have been received from public libraries in various parts of the United States for full sets of the annual reports of this service, and it is a matter of regret that the issues for the years 1890 and 1894 are exhausted. It has also been found impossible to supply complete sets of the Monthly Review for all the years since the establishment of this service. During the past year the gratifying fact has been noted that teachers of science in the high schools and colleges are becoming much interested in the study of climatic data, as indicated by requests received from this class for copies of monthly and annual reports. The time is evidently near at hand when there will be a demand for text-books of meteorology to be used in the public schools.

At the close of the year daily weather forecasts were received by telegraph at 120 stations, and from these stations and the central office they were distributed by mail to 1,122 postoffices, arriving in due time to be serviceable to the general public. At the telegraph stations signal flags are displayed, and by these various means the forecasts are seen by a very large percentage of the people of this state. The time is not distant when most of the farms and country neighborhoods will be connected by telephone with the towns and postoffices, and the weather reports will be received daily by all farmers who desire to receive the benefits of the service.

METEOROLOGICAL STATIONS AND OBSERVERS.

STATIONS.	OBSERVERS.	STATIONS.	OBSERVERS.
Adair.....	F. L. Morrison.	LeClaire.....	River Observer.
Afton.....	Hon. N. W. Rowell.	Lansing.....	G. H. Markley.
Albia.....	R. Moore.	Larchwood.....	K. E. Walker.
Algona.....	C. D. Pettibone.	Larrabee.....	H. B. Strever.
Alta.....	D. E. Hadden.	Lenox.....	J. L. Hurley.
Alta (near).....	W. J. Minard.	Le Mars.....	Dr. T. E. Cole.
Amama.....	Conrad Schadt.	Linn Grove.....	Rev. J. W. Hubbard.
Ames.....	Exp. station.	Logan.....	Mrs. M. B. Stern.
Ames (6 miles e.).....	Isaac Young.	Malvern.....	R. F. Norton.
Atlantic.....	J. W. Love.	Maquoketa.....	Dr. A. B. Bowen.
Audubon.....	F. P. Hocker.	Mason City.....	B. F. Gibbs.
Bedford.....	Prof. E. H. Griffin.	Marshalltown.....	C. M. Cook.
Belknap.....	A. W. Rankin.	Millman.....	W. H. Shaul.
Belle Plaine.....	S. P. Vandike.	Monticello.....	C. E. Helsey.
Bonaparte.....	Hon. B. K. Vale.	Moora.....	F. G. Thomas.
Britt.....	G. P. Hardwick.	Mount Vernon.....	Prof. A. Collin.
Burlington.....	Prof. H. L. Atkinson.	Mt. Airy.....	A. E. Beard.
Carrroll.....	Moses Simon.	Mt. Pleasant.....	Dr. Frank T. Stevens.
Cedar Falls.....	Prof. A. O. Page.	Neola.....	J. H. Garland, Jr.
Cedar Rapids.....	Electric Lt. & Power Co.	New Hampton.....	R. H. Gurley.
Centerville.....	J. W. Tanner.	Newton.....	A. Lufkin.
Chariton.....	Hon. S. H. Mallory.	Northwood.....	A. L. Thompson.
Charles City.....	Chas. O. Schmidt.	Odebolt.....	E. Starner.
Cherokee.....	Hon. L. W. Beal.	Ogden.....	E. Sayre.
Clarinda.....	A. S. Van Sandt.	Olin.....	Hon. Nathan Potter.
Clear Lake.....	A. S. Hawley.	Omaha, Neb.....	L. A. Welsh.
Clinton.....	L. Roberts.	Osceola.....	C. W. Lewis.
College Springs.....	A. M. Finley.	Ovid.....	H. C. Miller.
Corning.....	John W. Bixby.	Osage.....	G. D. Patingill.
Council Bluffs.....	J. B. Rishel.	Oskaloosa.....	Jos. Boyd.
Cresco.....	Gregory Marshall.	Ottumwa.....	Dr. J. B. Herrick.
Davenport.....	J. M. Sherrier.	Parnell.....	H. D. Berryhill.
Delaware.....	Wm. Ball.	Pella.....	T. W. Cox.
Decorah.....	F. H. Baker.	Pioneer.....	A. W. Hawley.
Denison.....	James H. Holmes.	Plover.....	J. S. Smith.
Des Moines.....	*Geo. M. Chappel, M. D.	Portsmouth.....	J. W. Dahlheimer.
Dows.....	R. E. Fuller.	Primghar.....	P. K. Bailey.
Dubuque.....	*E. H. Bowle.	Red Oak.....	William Boll.
Eagle Grove.....	Smallpage Bros.	Reinbeck.....	Dr. L. B. Hathaway.
Eldon.....	T. Madden.	Ridgeway.....	Arthur Betts.
Elkader.....	Prof. O. F. Woodward.	Rock Rapids.....	W. C. Wyckoff.
Estherville.....	Chas. Reinecke.	Rockwell City.....	C. M. Randall.
Fairfield.....	M. L. Archer.	Ruthven.....	H. Cook.
Fayette.....	Charles J. Fulton.	Sac City.....	Dr. C. Brown.
Ft. Madison.....	R. Z. Latimer.	Sibley.....	H. G. Doolittle.
Fonda.....	Miss. S. A. McCready.	Sidney.....	Wm. A. Cook.
Forest City.....	Chas. F. Linnan.	Siourney.....	Mrs. R. F. Ashbaugh.
Fredericksburg.....	J. A. Peters.	Sioux City.....	+U. G. Pursell.
Galva.....	J. D. Herrick.	Spencer.....	S. Gillespie.
Garden Grove.....	J. M. Orowley.	Spirit Lake.....	W. O. Drummond.
Gladbrook.....	J. E. White.	Storm Lake.....	Prof. M. L. Fuller.
Glenwood.....	Geo. F. Parker.	Stuart.....	H. E. Boatright.
Grand Meadow.....	J. P. Jackson.	St. Charles.....	R. D. Minard.
Greene.....	F. L. Williams.	Tara.....	W. E. Humphrey.
Greenfield.....	J. L. Gray.	Thurman.....	O. R. Paul.
Grinnell.....	J. G. Culver.	Toledo.....	Chas. Mason.
Grundy Center.....	Prof. M. J. Buck.	Vinton.....	T. F. McCune.
Guthrie Center.....	Geo. F. Ellis.	Villisca.....	C. E. Matteson.
Hampton.....	Oscar Klingman.	Wapello.....	Geo. W. Schofield.
Hedrick.....	E. O. Greenlie.	Washington.....	Wm. A. Cook.
Hawkeye.....	J. T. Brooks.	Washta.....	H. L. Felter.
Hopeville.....	Beatrice Kirkendall.	Waterloo.....	M. L. Newton.
Humboldt.....	M. T. Ashley.	Waverly.....	H. S. Hoover.
Independence.....	H. S. Wells.	Waukegan.....	N. O. Wragg.
Indianola.....	E. P. Wulke.	Webster City.....	Louis Frank.
Iowa City.....	Prof. J. L. Tilton.	What Cheer.....	Hon. J. C. Beem.
Iowa Falls.....	Prof. A. A. Veblen.	Whitten.....	Dr. Frank P. Butler.
Keokuk.....	J. B. Parmelee.	Wilton Junction.....	J. M. Rider.
Kossauga.....	*Fred Z. Gosewisch.	Winterset.....	W. W. McKnight.
Knoxville.....	Prof. J. H. Landes.	West Bend.....	Phil. Dorweller.
Lamoni.....	Casey and Reaver.	West Union.....	J. M. Lisher.
	T. J. Fitzpatrick.	West Branch.....	A. A. Madson.

*Walsh P. O. +U. S. Weather Bureau. #Postville P. O. §Mt. Vernon P. O. †Des Moines P. O.

WEATHER-CROP OBSERVERS.

STATIONS.	OBSERVERS.	STATIONS.	OBSERVERS.
Agency.....	J. H. Van Zant.	Humeston.....	Hon. S. H. Moore.
Albia.....	Wm. Mercer.	Larrabee.....	H. H. Carnahan.
Allerton.....	James Piper.	Le Mars.....	Hon. Henry Schrooten.
Alta.....	Jonas Cushman.	Lockridge.....	John F. Farman.
Ames.....	S. B. Mills.	Marshalltown.....	Hon. S. B. Packard.
Attica.....	G. W. Mendenhall.	Mason City.....	Wm. Nettleton.
Battle Creek.....	A. Preston.	Mapleton.....	A. Lamb.
Blairstown.....	T. H. Well.	Mt. Pleasant.....	W. S. Wright.
Boone.....	L. C. Morris.	Milton.....	Hon. E. C. Holland.
Centerville.....	Henry Galley.	Mount Vernon.....	Robert Smith.
Charles City.....	W. B. Towner.	Nevada.....	Geo. C. White.
Charlton.....	C. C. Burr.	Osage.....	E. W. Stacy.
Clarksville.....	F. M. Russell.	Orange City.....	H. J. Vande Waa.
Correctionville.....	Hon. W. B. Chapman.	Paton.....	A. B. Condit.
Corning.....	Jerome Smith.	Pittsburg.....	G. C. Duffield.
Corwith.....	Wm. Oxley.	Rockford.....	Hon. J. W. Bird.
Clermont.....	Chas. Larrabee.	Rock Rapids.....	D. E. F. Merrill.
Council Bluffs.....	L. Prouty.	Rockwell City.....	J. G. Palmer.
Oreston.....	M. V. Ashby.	Rossville.....	T. B. Wiley.
Danville.....	Sherman Matthews.	Rowley.....	L. Maxson.
Emerson.....	D. B. Nims.	Sageville.....	Hon. F. N. Knoll.
Ely.....	Hon. A. J. Fuhrmeister.	Seymour.....	L. B. Sager.
Farlin.....	Jesse Johnson.	Shenandoah.....	Reuben Mullison.
Fulton.....	Carl S. Frank.	Spirit Lake.....	L. Stowe.
Fontanelle.....	Hon. L. M. Kilburn.	State Center.....	E. P. Thompson.
Ford.....	J. C. Richards.	Tama.....	W. G. Mallin.
Fort Dodge.....	R. W. Blaine.	Unity.....	Edward Hummer.
Geneva.....	Wm. H. Thompson.	Van Horne.....	Spencer Smith.
Grinnell.....	A. O. Price.	Winterset.....	H. A. Kinsman.
Guthrie Center.....	W. W. Bailey.	Wall Lake.....	T. E. Wilcox.
Gilman.....	James L. Wylie.	Wilton.....	Thos. Boot.
Hesper.....	G. E. Dillingham.	Wlota.....	I. S. Coomes.

METEOROLOGICAL SUMMARY FOR 1898.

The general climatic conditions for the state were about normal. The mean pressure of the atmosphere, as shown by barometric records, was 30.03 inches. The highest barometer reading was 31.07 inches, at Clarinda, on November 9th; lowest, 29.30 inches, at Davenport and Dubuque, on November 21st. The range for the state was 1.77 inches.

The mean temperature of the state for the year, as deduced from the complete records of ninety-one stations, was 47.6°, which is practically normal. Dividing the state into sections, or belts, three counties wide, on lines east and west, the averages are as follows: Northern section, 45.7°; central section, 47.6°; southern section, 49.7°. The highest temperature recorded was 103°, at Council Bluffs and Clarinda, on August 20th; lowest, 25° below zero, at Estherville, Mason City and Ruthven, on December 25th. The range of temperature was 128°.

The average precipitation (rain and melted snow) for the state was 31.69 inches, as shown by the complete records of ninety-one stations. By sections, the average was as follows: Northern section, 27.72 inches; central section, 31.04 inches; southern section, 36.34 inches. Included in these figures the northern section had 31.6 inches of snowfall; central section, 44 inches; southern section, 40.3 inches; the average snowfall for the state being 38.6 inches.

Among the high measurements of precipitation for the year are the following: Bonaparte, 55.47 inches; Keokuk, 52.48 inches; Moor, 48.93 inches; Ovid, 46.43 inches; Clinton, 46.15 inches; Thurman, 44.11 inches; Sidney,

43.42 inches; Belle Plaine, 42.25 inches. Larchwood reported the lowest amount, 19.51 inches. Estherville received only 20.89 inches.

The greatest amount of rainfall in twenty-four hours was 9.70 inches, on July 6th and 7th.

The prevailing wind direction was northwest; highest velocity registered, sixty-six miles per hour, at Sioux City, on June 24th. There were 160 clear days, 105 partly cloudy and 100 cloudy days during the year.

MONTHLY METEOROLOGICAL SUMMARIES.

JANUARY.

The mean barometric pressure for January was 30.09 inches; the highest pressure observed was 30.70 inches, at Sioux City and Clarinda, on the 1st; lowest, 29.34 inches, at Keokuk, on the 25th; range, 1.36 inches.

The month was warmer than usual, the mean temperature for the state, as shown by records of 106 stations, being 23.4°. The lowest temperature recorded was 11° below zero, at Cedar Rapids, on the 27th.

The average precipitation for the state was 1.60 inches, which is nearly the normal amount for January. It was an unusually mild January for this latitude, with less than the average number of severe storms.

OBSERVERS' NOTES.

Clinton—DR. LUKE ROBERTS. The meteorological conditions of January, 1898, were markedly different from its last nineteen predecessors. In temperature it was 3.8° above a normal mean. My maximum and minimum temperatures only go back seventeen years, and during that time the minimum temperature for January was below zero from 9° to 36° except in 1891, when it was zero, and in 1898, when it was 1° above. The normal minimum is 24.6° below zero, which makes the minimum for 1898, 24.6° above normal. The maximum temperature was 56°, or 3° below normal. The warmest day was the 11th, with a mean temperature of 36.7°. The coldest day was the 31st—mean temperature 10°. The normal temperature for the warmest and coldest January days, is 37.8° for the former, and 4.4° below zero for the latter. The coldest January day for the last twenty years was the 5th, in 1884, the mean temperature being 30.5° below zero. The warmest day for the same time was the 1st, 1897, the mean being 54°; 21 inches of snow fell during the month. Total precipitation, rain and snow, netted 3.60 inches. This was in excess of January means by 1.6 inches. There were six stormy days, being two less than normal. The movement of the wind was decidedly sluggish, except on two days, the average for the month being only four miles per day. The total movement being only 2,960 miles, while a January normal is 5,070 miles.

Belknap—A. W. RANKIN. January, 1898, goes out with fully two feet of snow on the level and five to seven feet in places. Very near all of the precipitation of January (five inches) lies on the surface in the shape of snow and ice.

Bonaparte—HON. B. R. VALE. A pleasant month for feeding and for work. Fully eighteen inches of snow in sight at close. Only two notable storms, viz., 22d and 25th.

Forest City—J. A. PETERS. Only three days of zero weather. Good sleighing all the month.

Grand Meadow—F. L. WILLIAMS. The month was unusually pleasant; only once did the mercury reach zero; neither was it warm enough to have any mud. Fine sleighing all of the time and no drifts.

Lamoni—T. J. FITZPATRICK. Thunder and lightning on the 11th was rather pronounced and remarkable for the season. A heavy snowstorm raged all day the 25th. Trains blockaded until the next day. The worst storm in many years.

Larrabee—H. B. STREVER. Such a January has been seldom seen; so mild and free from storms and wind; so enjoyable throughout.

Logan—MRS. M. B. STERN. We have had no bad storms, but considerable cloudy weather. Very little wind. Altogether a rather mild winter.

Ovid—H. C. MILLER. A remarkable warm month. Thawed twenty-three days of the thirty-one. No frost in the ground except in the bare spots.

Sidney—G. V. SWEARINGEN. On the 22d a high wind came with the snow, which fell to the depth of 5.2 inches. Sledding has been from good to fair since December 4, 1897.

FEBRUARY.

The mean pressure for the month was 30.13 inches. At Clarinda on the 2d the highest reading was recorded, 30.86 inches; lowest, 29.58, at Clarinda, on the 16th; range for the state, 1.28 inches.

The month was warmer and drier than usual. The monthly mean temperature, as shown by reports from 104 stations, was 24° 2', which is slightly above the normal. Keosauqua reported the highest temperature, 62°, on the 8th. The lowest temperature reported was 18° below, on the 1st, at Iowa Falls.

The average precipitation for the state, according to reports from 106 stations, was 1.20 inches, a little below the normal for February. Cedar Rapids reported the greatest amount, 3.65 inches; and the least amount was .1 of an inch at Denison. There were no severe storms of wide extent; number of clear days, 10; cloudy, 9; partly cloudy, 9.

OBSERVERS' NOTES.

Bonaparte—HON. B. R. VALE. A very even-toned month. Fair roads; kind on stock; good for feeding, and all in all, a very profitable month.

Clarinda—H. S. VAN SANDT. High wind and fine snow night of 1st and 2d (40 miles); a genuine blizzard. Much damage to trees from heavy sleet of 9th and 10th. Telegraph and telephone lines and poles broken, and service badly demoralized.

Cresco—GREGORY MARSHALL. February 2d, blizzard from northwest early A. M.; snow of last month all drifted into heaps; travel impeded.

Dows—R. E. FULLER. February 20th, snow drifted all day; the air was thick with it to a height of 30 feet.

Fayette—R. Z. LATIMER. High wind on the 1st and 2d, also on the evening of the 5th. The worst storm of the month was on the 18th, 19th and 20th. Trains were delayed several hours.

Forest City—J. A. PETERS. Robins were singing on the 8th, and again on the 27th.

Grand Meadow—F. L. WILLIAMS. Except for the first three days the month was warm. Sleighing good most of the time. Snow drifted very little.

Greenfield—J. G. CULVER. Night of 9th-10th one of the heaviest sleet storms for many years. Sleet one inch thick by many measurements. Fruit and shade trees badly broken. Telephone, telegraph and electric light wires down. This will probably be known as the "great sleet." First visit of the robins 26th.

Humboldt—HENRY S. WELLS. There has been good sleighing all the month. The winter has been uniform. Stock has done well.

Lamoni—T. J. FITZPATRICK. During the night of the 1st and all day of the 2d, a stiff northwest wind prevailed, causing heavy drifts of snow, which blockaded the trains for hours. Thunder and lightning, unusual for the time of year, occurred on the 9th.

MARCH.

The mean pressure of the atmosphere was 30.08 inches; the highest observed being 30.58 inches; lowest, 29.43.

The month was warmer than usual, the mean temperature for the state, as deduced from 107 station records, being 37.5°. Fort Madison reported the highest mean, 44.6°, and Osage the lowest, 32.4°. The maximum temperature registered was 72°, at College Springs, on the 26th, and the minimum was 2°, at Eldora, Neola and Rock Rapids, on the 1st, 22d and 23d. There was an average monthly range of 54°.

The average precipitation was 1.94 inches, which is slightly above the March average for the state. The eastern counties received much the heavier rainfall. Fort Madison reported 6.21 inches, and Marshalltown only .33 of an inch. The highest wind velocity was sixty miles an hour, at Sioux City, on the 14th. There were 12 clear days, 9 partly cloudy and 10 cloudy.

OBSERVERS' NOTES.

Amana—C. SCHADT. The snow which commenced to fall in the beginning of December, before the ground was frozen to any considerable depth, afforded ample protection to fall wheat, rye and other plants and shrubs during the whole winter. At the close of February and beginning of March it melted away without causing much flow of water and percolated, apparently, nearly all into the ground, which was a great boon to farming. March was unusually mild and warm, so that sowing and planting (onions) began early. Toward the close of the month, however, cold weather set in and caused some damage, the extent of which cannot be estimated.

Bonaparte—HON. B. R. VALE. The 10th and 27th, inclusive, gave 5.08 inches rain—an unprecedented rainfall for March. Mercury dropped to 17° on the 23d, and to 22° on the 28th and 29th. No farm or field work done yet.

Clinton—DR. LUKE ROBERTS. March, 1898, took a departure from normal on all points. Its maximum temperature, minimum temperature, mean temperature of the warmest day, mean temperature of the coldest day were each above the normal. The rainfall, range of temperature, number of storm days, number of cloudy, number of clear days and the per cent of cloudiness were each in excess of normal. The movement of the wind was much below normal.

The rain (4.73) was in excess of any corresponding month during the last twenty years. The nearest approach to it was in 1886, when the March precipitation was 4.44 inches. The least precipitation for March, during my record, was .19 of an inch, occurring in 1885. While there was much rain there were no damaging storms and the earth absorbed a large share of it, supplying a needed want.

The first storm of the month was snow, which was deposited on the 1st, between 6 A. M and 5 P. M., the depth being five inches. Four more inches of snow fell on the 12th, from 3:30 P. M. to well into the night, loading trees, telegraph wires, etc., so that the landscape on the morning of the 13th was a beauty to behold.

Elkader—CHARLES REINECKE. Ice in the Turkey broke up and went out at Elkader on March 7th, at 4 P. M. The channel was thawed out before. For the first time since September the precipitation exceeded the average.

Forest City—J. A. PETERS. Severest snowstorm of the season on the 27th. Spring work commenced about the 15th, but was delayed on account of the storm of the 27th.

Galva—JAY M. CROWLEY. The storm on the 27th left from four to five inches of snow on the level.

Grand Meadow—F. L. WILLIAMS. A wonderfully fine display of auro-ras on the 14th and 15th. On the 15th work in the fields began. The month has been marked by extremes of temperature. The early part of the month was warm and pleasant, followed by every kind of weather, delaying farm work. Wheat all sown during the month; more sown than for years.

Humboldt—HENRY S. WELLS. High wind on the 14th. March came in like a lamb and went out like a lion. Wheat nearly all sown, and thought to be in good condition. Clover sod being plowed for corn.

APRIL.

The mean atmospheric pressure for the month was 30.08 inches. Highest observed, 30.54 on the 6th at Sioux City; lowest, 29.51 at Davenport and Keokuk on the 13th.

The average weather conditions for the month were about normal for April, as shown by the records of Iowa stations. The mean daily temperature, as deduced from the reports of 114 stations, was 48.1°. The highest mean, 53.2°, was reported from Fort Madison; the lowest, 43.8°, at Osage. The extremes of temperature were as follows: Highest, 91° on the 16th at Carroll, Logan, Glenwood, Portsmouth and Ogden; lowest, 14° on the 5th at Rock Rapids.

The average precipitation, as shown by reports from 114 stations, was 2.56 inches, which is about the normal for April in this state. The largest amount was recorded at Moorar, viz., 4.82 inches. Larchwood reported the least amount, being only .27 of an inch. There were 13 clear days, 8 cloudy, and 9 partly cloudy.

OBSERVERS' NOTES.

Amana—CONRAD SCHADT. The weather, although very cool, was favorable for farming, with moisture enough for good prospects.

Belknap—A. W. RANKIN. A cold, wet and backward month. Grass short at close of month, and fruit not in full bloom.

Bonaparte—HON. B. R. VALE. The frequency of rains, amounting to 3.71 inches, falling at ten different times, almost precluded seeding and farm work; grass doing well; fall grain backward, but improving.

Centerville—GEO. GOODLANDER. Season has been quite favorable for putting in crops. A severe wind on 13th damaged fences and small out-houses.

Garden Grove—HON. M. WEMPLE. A good month for all kinds of farm work. Grass backward on account of cold and dry weather. All orchards burdened with bloom, giving fair prospect for fruit.

Greenfield—J. G. CULVER. On April 30th plums, peaches and cherries were beginning to bloom; no damage by frost.

Logan—MRS. M. B. STERN. Quite a thunderstorm on 30th west of us, with considerable hail.

Plover—J. S. SMITH. On the 30th, a tornado passed seven miles west of this station, in a northeasterly direction. A number of buildings were destroyed, and a man and his eight-year-old son were killed. The storm passed about 7 P. M.

Pringhar—LEWIS CLARKE. On the 30th, a small "cyclone" passed through the west part of O'Brien county, damaging property to some extent.

Ridgeway—ARTHUR BETTS. At close of the month grass is green; wheat is up; willows and lilacs are leaved out; early garden vegetables are coming up.

Sioux City—U. G. PURSSELL. The mean temperature for April during the nine years that observations have been taken here is 51°, but last month it reached only 50°. The highest was on the 16th, when the mercury got up to 88°, and the lowest was on the 5th and 6th, when it went down to 19°. On the 15th there was a spread of 37° between the highest and the lowest, and on the 12th there was a variation of only 7° throughout the twenty-four hours. Notwithstanding the month was below the average in temperature, there is a large excess since New Years, the accumulation being 483°, or an average daily surplus of 4° since the beginning of the year. But most of this was piled up in January and February and early in March, when it couldn't do much good so far as crop-growing is concerned.

The total precipitation during April was only 1.37 inches, whereas the average for the month during the past nine years is 3.26 inches, so it will be seen we have had only about 52 per cent of what we had a right to expect. There has been only one year since the station was established here that there has been less precipitation in April, and that was 1890, when it reached but 1.32 inches. In 1896, it reached 6.16 inches, and last year it was 4.03 inches, both being much above the average. The total deficiency for the first third of the year is 2.94 inches. During the month there were 12 clear days, 8 partly cloudy days and 10 cloudy days. There were 7 days on which the precipitation was more than .01 of an inch.

DESTRUCTIVE STORMS, APRIL 30TH.

On the afternoon of April 30th a number of localities in the northwest district were swept by severe windstorms, that displayed some of the characteristics of tornadoes at various points in their pathway. The reports

indicate that the effects of tornadic action were visible, and funnel-shaped clouds were described by numerous observers.

The principal storm originated in northeastern Nebraska and moved in a northeast direction, passing through the southeast corner of South Dakota, causing some damage and loss of life in the latter state. A report from Newcastle, Neb., states that two tornadoes were observed near that place about 4 P. M., creating much havoc to property in that section. Passing thence near Elk Point, S. D., the storm entered Iowa near Chatsworth, in Plymouth county, and moved apparently up Indian creek. The town of Maurice, in Sioux county, at the crossing of the Sioux City & Northern and Chicago & North-Western railways, was directly in the pathway of this branch of the storm, and the place suffered severely, though, happily, no lives were lost. A special from that place to the *Sioux City Journal* says:

This town was visited by a destructive tornado at 4:45 last evening, but no fatalities resulted. The funnel-shaped cloud approached from the southwest. Its fearful roaring gave the citizens ample warning, and most of them had sought refuge in storm caves or cellars when the storm broke in its fury. In the northwestern part of town the most important structures leveled to the ground and totally destroyed are the following: Sioux City & Northern depot; St. Paul & Kansas City Grain Co.'s elevators, valued at about \$2,000, insured. The elevators contained about 1,500 bushels of wheat and the same amount of corn and oats, which will be saved with but little loss. Three cars containing nearly 2,000 bushels of wheat had been loaded and were billed for shipment. These cars were overturned, but the wheat will all be saved, with probably the loss of 100 bushels. The elevator is owned by the Sioux City & Northern railroad and leased by A. D. Thompson & Co. The building is ruined. The dwelling house of J. Nicolay was destroyed with its contents. The residence of C. Van Gorkam, with contents, is a total loss.

The storm moved in a northeasterly course, passing through the southern portion of Sioux and diagonally through O'Brien county, expending its force at Hartley and vicinity. In O'Brien county, a few miles south of Sheldon, two children were killed, and numerous homes were wrecked. Heavy damage to buildings resulted in Hartley. The central line of this storm covered a distance of over eighty miles.

There were evidently a small group of tornadoes, moving on parallel lines, some distance apart, within the belt of disturbance. The little town of Carnes was struck about 4:50 P. M., and badly shattered buildings mark the path of the destroyer.

While the storm above described was sweeping through the counties of Plymouth, Sioux and O'Brien, a similar disturbance passed on a parallel line, southwest to northeast, through the northern part of Monona (near Whiting), the southeastern part of Woodbury, across a corner of Ida and through a portion of Buena Vista county. Much damage was wrought by this branch of the same general storm. A special from Oto to the *Sioux City Journal* said:

The storm commenced about 4:45 P. M., with a terrific rain and hail, and at 5:15 the dreaded funnel cloud was seen to be forming about a mile southeast of here, causing much alarm, carrying away small houses and overthrowing those somewhat larger, and moving even the largest buildings in its path.

The following description of the storm in Buena Vista county is furnished by David E. Hadden, voluntary observer at Alta. Mr. Hadden writes:

A severe windstorm, which assumed some of the characteristics of a tornado, passed through a portion of Maple Valley and Nokomis townships, Buena Vista county, in the late afternoon of April 30th, which resulted in considerable damage to barns, sheds and other farm buildings. The sky was nearly overcast all forenoon, and partly cloudy in the afternoon of the 30th, with a brisk south to southwest wind. About 4:30 P. M. heavy clouds were observed in the southwest, with occasional murmurings of thunder. About 5 P. M. rain began, with some hail. This continued until 5:40 P. M., when rain and wind momentarily ceased, and heavy hail from one-half to two inches in diameter began falling, lasting about five or six minutes. Just at this moment I observed the clouds, which were rather low, about two miles south of town, revolving quite rapidly (horizontally), and at intervals the suggestion of a funnel cloud would form about half way from the cloud to the ground, then quickly disperse, and again form and disperse. This was repeated several times, but at no time could the cloud be seen to reach to the ground. I remarked to neighbors at the time that in all probability a tornado had just passed south of us. At 5:45 P. M. the wind suddenly ceased, but in a few minutes changed to the northeast, then north and brisk northwest, accompanied by a very heavy rain, which continued until about 6:30 P. M.

No lives were lost or persons injured. But little electric disturbance was noted. About three-fourths of the hailstones were of the size of large marbles, and the rest were one to two inches in diameter. The location of debris at each farm proves that the storm was of the tornado type.

It seems providential that so few casualties resulted from the numerous tornadic storms that swept across our state on that closing afternoon in April.

MAY.

The mean pressure for May was 29.92 inches. The highest observed was 30.30 inches at Cresco on the 4th; lowest, 29.49 inches at Davenport and Dubuque on the 27th.

The mean temperature for the month of May, as deduced from the records at 114 stations, was 59.6°, which is about the normal for the state. Keokuk reports the highest monthly mean, 64°; and Rock Rapids the lowest, 55°. The highest temperature reported was 92° at Odebolt and College Springs, on the 24th and 25th; the lowest was 26° at Rock Rapids, on the 6th.

The average rainfall for the state, as deduced from records of 114 stations, was 4.67 inches, which is a little above the state normal for May. Fort Madison reported the heaviest measurement for the month, 7.82 inches. The least amount was 2.22 inches, at Estherville. Clear Lake reported a fall of 3.73 inches on the 21st. For the state there were 9 clear days, 12 cloudy, and 10 partly cloudy.

OBSERVERS' NOTES.

Amana—CONRAD SCHADT. The weather during the month was very favorable for all crops and for farming generally. There is as fine a prospect as there ever was.

Belknap—A. W. RANKIN. An unusual amount of hail, thunder and lightning has characterized the month of May.

Bonaparte—B. R. VALE. Sixteen rainy days, giving 6.11 inches. Not to exceed a week's work in fields during month; 14.80 inches rain since March 1st; exceeds any year since 1892, which gave 15.90 in same time.

Carroll—MOSES SIMON. A fine month; no frosts; plenty of moisture and very favorable for outdoor work and the growing crops. Small fruit will be plenty.

Centerville—GEORGE GOODLANDER. Crops doing well. All kinds of fruit coming nicely.

Clinton—LUKE ROBERTS. No damage from frost. No damage from storms, except the destructive tornado on the 18th, which passed through a portion of the north part of the county, that was very destructive. On the whole, May was a very fine month.

Grand Meadow—F. L. WILLIAMS. May 7th, corn planting begun. Plums and apples in bloom, 10th to 13th.

Humboldt—H. S. WELLS. Wheat and small grain good; very little replanting corn; grass unusually good; fruit prospects never better.

Iowa City—MRS. C. M. HOBBY. Heavy rain and hailstorm on 19th. Cat birds and golden robies announced their presence May 1st.

Lamoni—T. J. FITZPATRICK. On evening of the 18th hail fell in quantity, many stones measuring over half an inch.

Larchwood—F. W. STOKES. First thunderstorm of the season on the 17th; a severe windstorm passed just east of town at 4 P. M. of that day, doing some damage to small buildings.

Logan—MRS M. B. STERN. Had three thunderstorms during month, one on 19th quite severe; one woman in Logan badly shocked but has recovered; weather cloudy and damp; not much damage from heavy rains.

Maquoketa—Dr. A. B. BOWEN. On afternoon of the 18th a tornado passed about five miles south of this city, causing much destruction to life and property.

Marshalltown—C. M. COOK. Hail fell from 1:15 to 1:20 P. M. on the 18th; largest stones 1 inch, and average size half inch in diameter.

Mason City—B. F. GIBBS. In half a century of farm life have never seen crops look better than at the close of May.

Mt. Ayr—A. F. BEARD. Hail on 18th broke quite a number of window glass in town; a windstorm struck the fair grounds on the 20th, wrecking some of the buildings there.

Olin—HON. NATHAN POTTER. On the 18th, at 3 P. M., hailstones fell 9 inches in circumference, the largest weighing 4 ounces; no wind accompanying the storm.

Ridgeway—ARTHUR BETTS. A good month; vegetation wonderfully advanced; some pretty mirages on four dates, elevating distances and making queer deceptions; gale on 27th and a cloudburst two miles away, an awful downpour.

MAY'S DESTRUCTIVE STORMS.

Though the elements were generally propitious throughout the state, yet the month of May brought its full quota of destructive windstorms; but, happily, their desolating effects were limited to a narrow pathway through four or five counties. The most severe storms of the month occurred on the 17th and 18th.

A wind and hailstorm on the evening of the 17th swept through a portion of Ringgold county, and reports indicate that it assumed the form and force of a tornado in Clinton, Benton and Rice townships. The storm was undoubtedly a continuation of the tornadic disturbance that swept through the southeastern counties of Nebraska, earlier in the afternoon of the same day. It passed near Maloy, a station on the Chicago Great Western railway, but fortunately it was deflected before reaching that place, and no

lives were lost, though the destruction of farm property amounted to several thousand dollars. Three persons were injured, one of them quite seriously.

The Mt. Ayr News says it was a genuine tornado, its revolving motion being observed by large numbers of people.

It started in Missouri, about 5:30 P. M., at a point about four miles south of Blockton, moving thence northeast, in the direction of Maloy. The path of the tornado, according to the *Record*, was over ten miles long and 200 yards wide.

Though it did not strike Maloy, yet it passed sufficiently close to lift a portion of the roof of the railway depot and to move buildings from their foundations, turning them partly around. Farm residences, barns, sheds, outhouses and timber lots suffered considerably. Fortunately, a considerable portion of the loss of buildings will be covered by insurance. The storm may be classed among the minor disturbances. In Mt. Ayr there was a heavy shower accompanied by hail and a strong wind. On the same date there were heavy local showers in the south central counties.

TORNADO MAY 18TH.

On the evening of the 18th a tornado originated near Stanwood, between 3 and 4 o'clock P. M., and moved in a direction north of east, traversing the northern portion of Cedar county, the northwestern part of Clinton county and the southeastern part of Jackson county, crossing the Mississippi river near Sabula, and thence sweeping through a portion of Illinois, in which state there was heavy damage and some loss of life. It was altogether the worst storm of the kind that has visited Iowa since the Pomeroy tornado on July 6, 1893. Its entire course was through prosperous farming districts; but fortunately it missed the populous towns in that section, else the loss of life would have been fearfully large. The fatalities reported in this state were nineteen, and more than double that number were injured more or less severely. The loss of property was very heavy, being variously estimated at three to four hundred thousand dollars.

The day was warm and the weather conditions were threatening. A well-defined cyclone was passing through the upper Mississippi valley, the storm center being near St. Paul at 7 P. M. The morning forecast for Iowa gave warning of "showers and probably severe thunderstorms in the east portion in the afternoon or night." The day has been described by weather observers as "a regular tornado breeder."

The first appearance of the tornado was observed in the vicinity of Stanwood, and James G. McKerron of that place gives the following report. He says: "On the 18th the air seemed oppressive up to about 2 P. M., and then a heavy thunderstorm came from the southeast. About 3 o'clock it began to hail, the stones varying in size from size of hickory nuts to walnuts, and two miles north and west the hailstones were much larger. At 2:30 P. M., a heavy cloud was noticed coming from the southwest, the lower part of the mass appearing to be 200 to 300 feet above the earth. When it reached a point one mile south, it formed a funnel, and a part of the cloud shaped like an elephant's trunk darted downward, striking the buildings of James K. Davidson. The main cloud seemed to move in a northeasterly direction, but the part that struck the ground would swing round, making

a zigzag track. The funnel united with the thunderstorm when it was about two miles east of this place, becoming very black, and showing a rotary motion, the whirling being from right to left. It followed very closely the track of tornadoes reported to have passed through this section several years ago. There was no loss of life near this place, but several miles east a number of people were killed. Much damage was done to buildings and stock that happened to be in its path. The amount cannot now be estimated." Newspaper reports accord with Mr. McKerron's description of the storm as it appeared near Stanwood.

☐ The storm crossed the track of the Chicago & North-Western railway between Stanwood and Clarence, and swept through the townships of Dayton and Massilon in Cedar county. It missed the town of Clarence by about eighty rods. Crossing the Davenport branch of the Chicago, Milwaukee & St. Paul railway about half way between Massilon station and Oxford Junction, the storm swept eastward through the corners of Clinton and Jackson counties. In its course it closely brushed the towns of Lost Nation, Elwood, Delmar, Riggs, Brown, Preston, Miles and Sabula. It seems miraculous that it did not hit some of these places when passing so near to their outskirts.

Mr. J. E. Gilroy, of Lost Nation, describes the storm as it appeared in that vicinity: "The storm appeared at 3:40 P. M., and was small when first seen in the southwest. It was moving in a direct line toward this town, nearly due east. It destroyed the residence of F. P. Welch and a school-house sixty rods north of his place. The Welch family saved their lives by fleeing to the cellar, and other families near there were saved in the same way. In Sharon township it destroyed the homes and property of Peter McAndrews and Maurice Wolf. No lives were lost in this vicinity, but destruction of live stock was large. Further east the people suffered more, and many were killed. Many curious incidents could be related, such as picking chickens and wrapping barbed wire around stock. No rain came with the tornado, but a heavy shower fell about three hours later."

The storm reached the vicinity of Elwood, five miles east of Lost Nation, at about 4 P. M. S. H. Clark, postmaster of that place, sends a description, from which we make the following extracts: "A funnel-shaped cloud appeared in the southwest a few minutes before 4 o'clock, and passed Elwood at 4. It struck Brookfield township near the southwest corner, and moved east by north, crossing the east line near the center. For want of a name we call it a 'Kansas twister.' In its track there was not much left worth picking up. In this township there were three hundred head of cattle killed, also four to five hundred hogs, mostly pigs. William Ruggles was cleared of everything in the shape of buildings, and his loss is estimated at \$7,000. George Teskey's buildings, fences, and most of his stock were swept away. Among the heavy losers were C. C. Ruus, R. Claus, H. H. Hicks, John Severine, J. A. Hines, E. A. Coverdale, and William Cook. Every tree in the track of the storm appears to be twisted from the roots, the bark all gone. Lumber, buildings, and fences were broken into kindling wood."

George G. Holcomb, postmaster of Riggs, Waterford township, writes that the tornado reached that vicinity at 4:30 P. M., and destroyed everything in its pathway in the farming district, except the crops, which were slightly damaged. When the funnel appeared it seemed to draw every

cloud near by into the core of the storm. It appeared very black and clouds twisted in every direction. There was some hail about ten or fifteen minutes before it came, with but little rain.

The storm passed about a mile and a half south of Preston, Jackson county, sweeping eastward nearly on the Clinton county line. Postmaster J. W. Campbell, of that place, in his report kindly furnished this office, says the storm could be seen for more than an hour in the southwest before it reached the vicinity of Preston. Its general appearance was funnel-shaped, and from the cloud there was an appendage of a long point or tail, which was swaying with a whirling motion. Five lives were lost, Mr. and Mrs. Charles Flora and three children, comprising their whole family, at a place about two miles south of Preston. In the vicinity of Preston, within five miles each way, the property loss will amount to nearly, if not quite, \$50,000.

The *Preston Times* says the storm passed that place about 4:30 P. M. To this it adds:

The afternoon had been sultry and a storm was expected to result, but an idea of the devastating effects which followed was hardly thought of. When the darkening clouds first appeared many hurried to their homes expecting only a heavy rain, but the heavy black, whirling mass of cloud which appeared in the southwest, quickly warned the citizens what to expect, and the direction in which it was moving, when first seen, made many feel that Preston was to feel the devastating effects of a tornado. A short time previous to its approach a message from Lost Nation stated that a cyclone had passed over that place going eastward, and the time taken in traveling the distance between the two places was about an hour and twenty minutes. There was little or no rainfall within the scope of the cloud, but after the storm immense hailstones were picked up in Preston, some measuring twelve to fourteen inches in circumference.

Albert Durant, of Preston, sends the following report of the storm in that section:

The first appearance of the storm was a narrow strip of black cloud reaching from the clouds above to the horizon, slightly to the southwest; but it did not reach this vicinity for over an hour after. The distance near here that the destruction was complete is about seven miles; trees, buildings, fences and stock were entirely destroyed or killed in its track. Most of that distance is in Clinton county, just south of our county line, but came into Van Buren township for about one mile. It passed about one and one-half miles south of Preston. Fourteen farm places lay in its track. The damage is not less than \$50,000. It was the most severe storm that has ever passed through here. Considerable hail followed the tornado. The cloud as it approached was funnel-shaped, and had a whirling motion, and traveled in its course rather slowly. Very little rain fell with the storm. It struck the ground about five miles west of Preston and did not raise again until about two miles east.

The storm was observed at the city of Maquoketa, about six miles north of its track. The *Excelsior* of that place says:

This terrible instrument of destruction was seen by many in the south part of this city and is described as the usual funnel-shaped cloud, but not moving very fast. Its course was from west to east, and it apparently followed the line of the Chicago, Milwaukee & St. Paul railway, going along about a mile south of it. The power of this death-dealing twister was tremendous. Trees were uprooted, large groves of them were stripped down to nothing but their trunks; horses, cattle and hogs carried like straw for three-quarters of a mile or so much further that their owners cannot find them; houses, barns, outbuildings blown no one knows where; green

trees stripped of their foliage and even bark, fences gone, people killed or seriously injured, others with their faces driven full of dirt, tell partially of the immense amount of damage done in a strip about a quarter of a mile in width. One of the most remarkable features of the storm was the slowness with which it traveled. It was an hour and twenty minutes traveling from Lost Nation to Preston, a distance of about twenty-five or thirty miles. From Elwood to Delmar a freight train easily ran ahead of it.

Beyond Preston the pathway of the storm was not well defined, but it is known that it crossed the Mississippi river between Sabula and Elk Junction, and reports indicate considerable loss of life and destruction of property in Illinois. The distance traversed in Iowa was about fifty miles, but in that distance there were considerable intervals wherein the damage was relatively slight. It appears to have skipped and swayed from side to side, making a zigzag pathway, but its general course was about as direct as the flight of an arrow. The track varied in width from a hundred yards to about a quarter of a mile.

Though it revolved swiftly on its axis, its progressive movement to the eastward was remarkably slow. Warnings were sent on ahead from town to town near its track, furnishing a new basis for the theory that it is possible to establish a system of signals whereby the people may be warned of the approach of that class of destroyers.

The following list of names of persons killed by the storm is copied from a press special, and is probably correct:

Near Riggs' Junction: Michael Hines, Maggie Maloney, James Maloney, Rose Maloney, Mary Call.

Near Delmar: Oba Allison, Pat Hines, Sauren Clemensen, two children of Francis Allison, A. D. Hildebrand, William Grieme.

Near Preston: Charles Flora, Mrs. Charles Flora, three Flora children.

Near Quigley: William O'Meara, child of John Clark.

It is wholly impracticable to compile a list of the persons injured and the losses of property.

The following paragraph is clipped from the Clinton *Herald*:

The steamer Saturn, which was going down the river with a raft, had a very narrow escape. The storm struck her about two miles below Sabula. Capt. W. A. Krotka was seen by a *Herald* reporter this afternoon, and told the experience of the Saturn. He said the boat was anchored near Sabula when he saw the storm coming. He moved down the stream in order to keep from being blown into the bridge. He says he watched the clouds closely and saw one from the southeast approaching one from the northwest. They met just over the hill near Sabula and took an easterly direction. Captain Krotka said there was no whirling motion until the clouds came in contact. He saw the storm coming directly toward him, and thought the boat would surely be lost. When the cyclone was within a few rods of the Saturn, Mr. Krotka says a fierce wind from the south struck the approaching storm and turned its course enough so that the full force just missed the boat. However, it did not fully escape, and when struck by the wind turned nearly over. He says the engine-room had a foot of water in it when the boat righted itself. During this time Captain Krotka was struck on the head with a board from the pilot-house, and Mate Eugene Clark was injured by a line breaking.

While the storm was passing over, the crew say they saw some animal, either a cow or horse, in the cloud.

George Nevitt, who came down the river last evening on the steamer Cyclone with a raft, and was near Sabula when the storm passed, gave a vivid description of what he witnessed. He says that they were in the wake of the storm and had a fine view of it as it passed over the river. The

air was filled with timbers and trees. Large limbs would float through the air like parachutes and gradually settle to the ground. One board, ten feet long, fell upon the fore-castle of the boat and penetrated through the floor. Hail fell in great quantities, chunks being found as large as a man's fist. The barrels on deck were filled with the ice.

Mr. Nevitt says that an island opposite what is known as Dark Schute was completely stripped of its growth of timber. On the banks of the river, where the storm crossed, the timber was torn down to a width of at least 700 feet.

A SMALL TORNADO MAY 31ST.

The Grinnell *Herald*, in its issue of June 2d, under the caption "Wild Wind," reported a small tornado dropping down in Washington and Grinnell townships, Poweshiek county, on the evening of May 31st. The *Herald* said:

"A number of people, about 6:30 Tuesday night, observed a funnel-shaped cloud plowing its way through the air in a northeasterly direction, southeast of town. The roaring was distinctly heard a distance of two miles, and a good many cool heads along the track of the storm took to cellars for safety. It seemed to be above the ground, and to most people who saw it, it meant nothing but an aerial tornado, ugly enough looking, but too high in the air to be dangerous. It was a more serious matter, however, to two families along its track, where it settled to the ground and performed the usual pranks attributed to such storms, destroying everything in its path, uprooting trees, and crushing in its mighty force large buildings to the ground.

"The unfortunate homes in the path of the storm were L. P. Spooner's and C. A. Ratcliffe's, the one south and the other east of Maple Grove schoolhouse.

"Mr. Spooner had just risen from supper, and, chancing to step to the south door, he saw a funnel-shaped cloud in the air about a mile and a half to the southwest. He quickly closed the house, and with the other members of the family went to the cellar. The storm seemed to come slowly, striking first the north end of G. F. Hyde's grove, a few rods south of Mr. Spooner's residence. It then swept through Mr. Spooner's orchard, uprooting large trees, overturning his apiary, striking the house with such force as to unshingle a portion of it, knock out nearly all the windows, and fill it with dirt and water. The windmill was demolished, corncribs unroofed, whole sections being torn from the cribs, and the large barn and other buildings were crushed and scattered in piles on the ground.

"The center of the storm here seems to have been just east of the house, with the west swirl of the wind going southward. Seven horses were in the barn, and strange to say none were injured, although the timbers fell all around them and on them. Only three small pigs were killed for Mr. Spooner. Mr. Spooner at once came from the cellar and watched the storm swing northeasterly, but as it stopped in English bottom and seemed to be turning back, he wisely took to the cellar again.

"At C. A. Ratcliffe's, one-half mile north of Mr. Spooner's, Mr. Ratcliffe's attention was first called to the storm by the slamming of his barn door, where he was at work. He at once noted the cloud at Mr. Hyde's grove, and so smoky and fiery did it appear, that he thought Mr. Hyde's house was on fire. He started to give orders to go and help Mr. Hyde, but

the onward sweep of the storm and the flying of the timbers at Mr. Spooner's showed him a cyclone was coming, and with his family he went to the cellar. The center of the storm seemed east of the house, on the east uprooting trees at Mr. F. F. Lee's, a few rods from Mr. Ratcliffe's, and unroofing his corncrib. At Mr. Ratcliffe's his windmill, stables, large hay barn, 108x64 feet, went down—in fact everything but his house and one smaller building. Windows in the house were broken and the roof unshingled. Though there were eight horses in the stable and a dozen head of cattle close by, none were injured except one calf was killed. Here, too, the west side of the storm carried debris south, and ruins of the hay barn northeast of the house were left in the yard by the house. Mr. Ratcliffe came out of the cellar as soon as the storm had passed, but had the same experience as Mr. Spooner when he saw the cloud stop and appear about to take a backward swing.

"It is hardly necessary to describe to Grinnell people the fury and destruction of such a storm. Everything in its path was crushed, and the debris was scattered in all conceivable directions.

JUNE.

The mean pressure was 29.93 inches; highest observed, 30.28 inches, at Dubuque and Cresco, on the 15th; lowest, 29.47 inches, at the same places, on 24th and 25th.

The month of June was slightly warmer than usual, with an excess of moisture. The mean temperature for the state was 71.4°, which is about 1° above the normal. The average of the north section (a belt three counties in width across the state east and west), was 69.7°; central section, 71.3°; southern section, 72.9°. Fort Madison recorded the highest mean, 76.1°, and the lowest, 67.6°, was recorded at Cresco and Grand Meadow. The maximum reported was 99°, at Belle Plaine, on the 30th.

The average rainfall for the state was 4.72 inches, which is slightly above the normal for June. The averages by sections were as follows: Northern section, 4.36 inches; central section, 4.47 inches; southern section, 5.29 inches. The maximum amount recorded for the month was 12.48 inches, at Greenfield, Adair county; minimum amount, 1.80 inches, at Olin, Jones county. At Greenfield 7.21 inches fell on the 9th. The greater amount of the rainfall came in the first half of the month; the latter half being generally dry and favorable for farm work. There were 13 clear days, 10 partly cloudy and 7 cloudy.

OBSERVERS' NOTES.

Amara—CONRAD SCHADT. With the close of June we have just entered the harvest season of small grain. Rye is being cut and winter wheat is ripe for the reaper. Barley, spring wheat and oats will follow soon. It will be an extraordinary good crop, as was also hay. Corn and potatoes are in the best condition; in fact there hardly ever was a season when all crops together looked better than they do now.

Atlantic—HON. J. W. LOVE. Severe thunderstorm on the morning of the 22d; very hard rain with some hail; reported damage to crops considerable.

Bonaparte—HON. B. R. VALE. An unprecedented wet month; 9.01 inches of rainfall. This beats any one month since 1890, by 1.47 inches, and

it beats the year 1892 to date, by 3.17 inches. We have had 27.37 inches rainfall since January 1st, which is .40 more than all last year.

Charles City—IDA SCHOTT. June 25th cyclone-shaped clouds formed which gradually grew wider; wind blew very hard with heavy rain and sharp lightning.

Dows—R. E. FULLER. Small cyclone twenty miles northwest of here on the 18th, did considerable damage.

Forest City—J. A. PETERS. A windstorm on the morning of the 24th did considerable damage to trees and growing crops. It was a straight blow. Greatest precipitation of any one month since the establishment of this station, 1894.

Humboldt—HENRY S. WELLS. This month has been wonderful for growth of all crops. Corn is king. Haying is three weeks early.

Larrabee—H. B. STREVER. Windstorm on the 24th did slight damage to crops. June has been an ideal month for vegetation.

Primghar—P. R. BAILEY. Severe hailstorm on the morning of the 30th, destroying crops in central and south central part of county.

Thurman—C. R. PAUL. Heaviest electric and rainstorm ever experienced here, noon to 2:20 P. M., June 6th.

Clinton—DR. LUKE ROBERTS. June, 1898, was exceptionally fine in all respects. The fruitage of the soil seems never to have presented a more gratifying outlook for a generous ingathering than was apparent at the close of the month.

Temperature, sunshine and moisture were harmoniously blended—the winds were on good behavior, and the storms and atmospheric electricity were very moderate, except one extraordinary downpour on the 13th, which was entirely local, and covering not more than six or eight square miles. This storm precipitated 4.61 inches of water in three hours, and while the people were in bed and not aware of the flood formation going on around them until they opened the doors in the morning and found submerged gardens, floating sidewalks, and navigable streets and alleys.

This storm caused an increase in the monthly aggregate of precipitation above normal. The rainfall for the month was 8.02 inches, normal being 4.73 inches. Three Junes during the last twenty years have exceeded this; viz: 1881, 8.17 inches; 1882, 8.97 inches; 1892, 9.39 inches.

JULY.

The mean pressure of the atmosphere was 30 inches. The highest observed was 30.26 inches, at Cresco and Dubuque, on the 12th; lowest, 29.50 inches at Clarinda, on the 19th.

The month was seasonable in its average temperature. The average temperature of the northern section (three counties in width across the state) was 72.1°; central section, 73.6°; southern section, 74.6°; average for the state, 73.4°, or about the normal for July. The highest temperature reported was 102°, at Clarinda on the 19th and at Rock Rapids on the 24th. The average range of temperature for the month was 45.5°.

The average precipitation of the state was 2.98 inches, which is a little below the normal amount for July. The averages by sections were as follows: Northern section, 3.02 inches; central section, 2.10 inches; southern section, 3.83 inches. The central belt suffered most from the effects of

the drouth, which continued with slight abatement from the 8th to the 27th. A large share of the rainfall fell in the last four days of the month. The records show the heaviest rainfall for the month in the extreme southwest, in a portion of Fremont county. The station at Thurman recorded a total of 12.88 inches, of which amount 9.70 inches fell on the 6th and 7th. At Sidney the records show 9.90 inches for the month, the fall on the 6th being 6 inches.

Dubuque reported the highest velocity of wind, 56 miles per hour, on the 19th. There was an average of 19 clear days, 9 partly cloudy and 3 cloudy.

OBSERVERS' NOTES.

Britt—GEO. P. HARDWICK. High wind 1st and 17th. Hail north of station on 19th, doing some damage to grain.

Dows—R. E. FULLER. On the morning of the 19th hail as large as hens, eggs fell two and a half miles northwest of the station.

Forest City—J. A. PETERS. Wind on night of 26th lodged grain badly in places.

Humboldt—HENRY S. WELLS. Corn, potatoes and pastures have suffered from drouth. Hay and harvest have been gathered in the best of shape.

Amana—C. SCHADT. The severest storm for many years occurred on the evening of the 19th. Trees were broken and uprooted, windmills wrecked and all the shocks in the field blown down, and about half the apples torn from the trees.

Greenfield—J. G. CULVER. A severe storm of wind on the 19th. Many hay stacks blown over; oats and corn suffered considerable damage; trees broken and injured. In the neighborhood of Orient and Spaulding many cribs and light buildings were injured and some destroyed. The windmill owned by the Chicago, Burlington & Quincy, at Orient, was wrecked and the tower blown over.

Sigourney—MRS. R. F. ASHBAUGH. On the night of the 2d there was a bright rainbow in the north about 2 A. M. The moon was full and shining bright in the southern sky, while raining far north. Was witnessed by several reliable men.

Thurman—C. R. PAUL. A severe rainstorm, which assumed some of the characteristics of a waterspout, passed through this section on the night of the 6th and morning of the 7th, with 9.70 inches of rain.

Bonaparte—B. R. VALE. A cool but seasonable month. No severe storms or extremes in temperature. Rairs have been opportune, but not in excess of the need.

A SEVERE JULY WINDSTORM.

The month of July brought its full quota of severe windstorms, with some local manifestations of tornadic force. The most severe and destructive windstorms occurred on the 19th and 27th, detailed reports of which have been received in form of newspaper clippings and observers' notes.

On the afternoon and evening of the 19th, wind squalls of considerable severity swept across more than two-thirds of the state, the central line of greatest disturbance extending from the southwest through the central and across the northeast districts, and covering a very wide belt on both sides of the line. The maximum velocity of the wind at the Des Moines station

was forty-five miles per hour, but the reports of the damaging effects indicate that a higher velocity was reached at numerous other localities.

The duration was short, and the amount of rainfall was generally light. The storm was accompanied by sharp lightning, and in the northern part of the belt some hail fell in scattered localities. The storm was quite destructive to light buildings, windmills, shade and fruit trees, hay and grain stacks and grain in shocks; and probably the aggregate of damage would make quite an astonishing figure. The insurance companies that cover hazards of that character report numerous losses in all the sections visited by the storm. The character of the storm was that of the ordinary summer squall—a straight blow, with no evidence of tornadic action.

The severest storm of the month, though happily confined to a small area, occurred on the evening of the 27th, extending over portions of the southwest and south central districts. In the central part of the disturbance a small tornado developed and passed through a narrow strip in the eastern part of Mills county and the western part of Montgomery county. The following brief description is from Observer D. B. Nims, of Emerson, Mills county:

On the afternoon of July 27th a tornado formed about two miles northwest of Emerson and moved in a direction east by southeast. It passed about one mile north of Emerson, but its effect was felt strongly in the north portion of the town in the breaking down of shade trees and shattering various buildings. In the path of the storm all buildings were destroyed, orchards and shade trees were uprooted or twisted into splinters. Whole fields of small grain were blown away, and one group of stacks was blown entirely away, with not a straw remaining to show where it stood. Mrs. Thornton and her little child were involved in the destruction of their home and killed. Three other children were injured, one seriously. Several persons narrowly escaped death. Twenty head of fat steers, feeding in a pasture, were killed, some of them being lifted and blown from ten to forty rods. Crops in the path of the storm were entirely destroyed, and in adjacent fields stacks were blown into shapeless heaps. The storm traversed a distance of about five miles, and was from twenty to sixty rods in width. It increased in violence until it finally spent its force or was lifted into the air. All who took refuge in cellars or caves escaped injury.

The Emerson *Chronicle* gave some interesting details in relation to the storm. Its pathway was through the cemetery of the town, and about sixty monuments were blown down and many of them broken.

The Red Oak *Express* of July 29th published many items of interest in relation to the effects of the storm in Montgomery county. It says the tornado appears to have originated in the eastern part of Mills county. Its path was not over eighty rods wide, but the destruction in these limits was heartrending. Its course was directly towards Red Oak, but was lifted before reaching that place, which only felt the force of a heavy, straight blow. Twelve farm houses and barns were totally destroyed, and the total loss of property amounted to many thousands of dollars. The *Express* says: "All the vagaries of a tornado were present. Chickens had their feathers blown off and walked about in their nakedness." Outside of the direct path of the storm lightning was doing its work of destruction, and numerous reports of losses of buildings and stock are made in that section. About 2:30 in the afternoon of the 27th, William R. Penry, residing about eight miles northeast of Red Oak, was struck by lightning and instantly killed. A church near Wallin was struck and burned.

The *Glenwood Tribune* says the storm seems to have started in Indian Creek township, where it destroyed some buildings and took off the top of the Nishnabotna bridge near Hastings. It further says: "Like the majority of tornadoes, its actions and appearances were most peculiar. It went in streaks and by jumps, and did its deadly work in the main by means of twists, everything that came into the grasp of these singular vortices being wrenched into a shapeless mass, whether it be iron or flesh. The storm was accompanied by a dull, heavy roaring, which could be heard for twenty-five miles around, and struck terror to the hearts of all listening, whether they were in the track of the storm or not."

AUGUST.

The mean pressure for August was 29.94 inches; highest observed, 30.18 inches, at Cresco on the 9th; lowest, 29.63 inches, at Omaha on the 22d.

The first half of the month was cooler than usual, and during the most of the last half it was unseasonably warm, the mean temperature for the state being 71.2°, as shown by the records of 110 stations. The mean for the northern section was 67.8°; central section, 71.6°; southern section, 74.3°. The average was therefore about normal. The maximum temperature reported was 103°, at Clarinda and Council Bluffs on the 20th, and the lowest was 40°, at Britt on the 1st. There was an average monthly range of 47.4°.

The average precipitation for the state was 3.44 inches, as shown by the records of 118 stations. This amount is slightly above the average of recent years. The distribution was very unequal, the lowest amount reported being .58 of an inch, at Adair, and the largest total 10.56 inches, at Bonaparte. The averages by districts were as follows: Northern district, 3.43 inches; central, 3.71 inches; southern, 3.17 inches.

The average number of clear days was 17; partly cloudy, 9; cloudy 5.

OBSERVERS' NOTES.

Bonaparte—HON. B. R. VALE. Rainfall, 10.55 inches; for the year up to date, 41.14 inches, which exceeds any since this office kept a record. Very warm at close of month.

Britt—GEORGE P. HARDWICK. Electrical storm night of the 19th, with high winds blowing down corn and other crops. Some live stock killed by lightning.

Centerville—GEORGE GOODLANDER. No severe storms except heavy rain on the 7th. If weather continues warm corn will do well.

Clinton—LUKE ROBERTS. The heavy rain of the 15th and 16th was accompanied by terrific thunder and lightning, doing damage in many places. Rainfall was much above normal.

Cresco—GREGORY MARSHALL. The month ends very hot and dry; pastures are burned up, grass seeding is killed, and corn, which was quite promising, is reduced by 25 per cent. Rainfall has been below average for past four months.

Forest City—J. A. PETERS. Very wet month for August. Ground in splendid condition for plowing. Corn will be out of danger of frost by September 10th to 15th.

Humboldt—HENRY S. WELLS. A portion of the corn badly blown down. Hay and grain well secured. Corn has matured rapidly the past ten days.

Logan.—MRS. M. B. STERN. The month has been very dry and hot. Hot winds one day.

West Bend—PHIL. DORWEILER. A pleasant month. The first half rather cool. Small grain yielding above the average.

Clinton—DR. LUKE ROBERTS. August, 1898, an exceptionally enjoyable summer month, had, so to speak, a marked individualism as compared with the same month in any of the last twenty years, where the normal precipitation was 2.84 inches, while in August, 1898, it was 7.87 inches, being 5.03 inches in excess of normal, and greater than any August except that of 1885, when the precipitation was 10.02 inches, or 2.15 inches more than that of 1898.

There were nine days on which rain fell. In the storm which commenced on the 15th, .45 of an inch of water fell in the morning before 6 o'clock; then at 6:40 P. M. a severe storm set in, lasting until 4:45 A. M. the 16th, and precipitated 3.01 inches of water, making 3.46 inches in about twenty-four hours. This downpour was accompanied by a frightful and terrorizing electric storm, the lightning doing damage in many places.

A storm similar, but of somewhat less severity, occurred on the evening of the 23d, between 5:50 and 8 o'clock, leaving two inches of water.

AUGUST STORMS.

Though August is usually the mildest period of the year in this region, the month of August, 1898, brought severe wind and hailstorms, with violent electric disturbance, extending over considerable areas of the state.

On the evening of the 16th a windstorm of much force passed through the country east of Fairbank, near the line of Buchanan and Fayette counties. The *Waterloo Reporter* describes the storm as a "cyclone" (tornado) though the reports do not show the usual effects of a genuine funnel-shaped storm. The destruction of buildings and crops was quite heavy within the limited area over which it passed. Six or seven houses and other farm buildings were razed or badly damaged within a short distance of the place where the storm began. No human lives were lost, but several horses and other stock were killed.

The most widely extended and destructive windstorm of the month occurred on the evening of the 19th. The disturbance was widespread, showing its destructive force at numerous points in the northwestern part of the state, and extending as far south as the main line of the North-Western railway. Within this wide belt there were many local wind-squalls of much severity, and considerable destruction by hail and lightning. The greatest destruction by hail occurred within an area of 10 miles wide and 15 to 20 miles long, covering most of the distance between Spencer and Emmetsburg. The corn crop in that area was almost totally ruined, and other crops suffered great damage.

At Spirit Lake and vicinity the windstorm is described as the worst that ever visited that region, with a total rainfall of 3.50 inches. The local papers contained reports of losses and damage to prominent buildings; showing a very heavy aggregate of loss resulting from the storm at that point. Windows were broken by hail, houses and other buildings were unroofed by wind, telegraph and telephone poles were prostrated, summer cottages about the lakes were wrecked and trees were broken or uprooted.

At Milford, Arnold's Park, Monument Park, Superior, West Bend, Estherville, and other localities in that section the storm caused a great amount of damage and aroused much terror among the people. The following extract from the Estherville *Republican* gives a vivid idea of the nature of the disturbance:

Friday was one of the most sultry days of this month and all day it seemed to indicate a storm, but not one of such severity as came. About 6 o'clock in the evening it began to sprinkle a little and the distant rumble of thunder could be heard in the northwest. No one expected anything more than a severe thunderstorm. At about 7:30, however, the wind suddenly turned to the northwest and north and blew a terrific gale for fully one hour, accompanied by some hail and the heaviest downpour of water that has visited this section for years. It was almost a waterspout. The strongest buildings creaked from the force of wind and several large windows about town were blown in and the apartments flooded. In the country great havoc was done generally to corn and flax fields and grain stacks, and hardly a windmill was left standing. In several places the roofs of barns were blown off. West of Estherville, and particularly at Spirit Lake, the storm was a great deal more destructive. Several cottages were wrecked, one residence was blown to pieces, the roof of the Crandall House was blown off, half of the sanitarium was smashed into kindling wood, the restaurant west of the Hotel Orleans was taken up bodily and carried across the railroad track and completely torn to pieces, the Moran boathouse was demolished, the railroad tank badly damaged and about half of the platform of the Burlington, Cedar Rapids & Northern, in front of the Hotel Orleans, was taken up and strewn over the grounds of the state fish hatchery; one chimney on the hotel was blown down and it crashed clear through the roof, but otherwise the hotel did not seem to be injured. Two freight cars in Spirit Lake were blown over and two at Montgomery, one of them being utilized for a temporary home by John Montgomery. He was in the car at the time and was badly shaken up, but luckily escaped without serious injury or broken bones.

The only fatalities heard of occurred near Petersburg, a few miles north of Superior. Mr. and Mrs. Eglenstein were living in a barn not far from the state line. The barn was blown to pieces and both occupants killed.

The wind and rain was followed by an electrical storm of great severity and also magnificence. In Estherville, Painter Greenfield was struck by lightning and his shoes completely torn off, and his stockings perforated with holes as if made with shot. He was badly shocked, but is recovering. Marcus Coon, who was near Mr. Greenfield at the time, was smoking a briar pipe that had a metal band about the stem. The lightning tore this off and pulled the bowl and stem of the pipe from the mouthpiece, leaving Mr. Coon with only the latter sticking from his mouth.

At the residence of F. C. Williams the electrical fluid cut up some queer antics. It seemed to come in under the door in a blaze and crackled in an alarming manner. Clarence Williams was severely shocked.

Newspaper clippings have been received showing that the storm of the evening of the 19th reached localities in Boone and Story counties, causing considerable damage and bringing a heavy fall of rain. Charles Bassett, a farmer residing near Boone, was killed by lightning, and the same bolt killed a valuable team belonging to Bassett. And northeast of Ames lightning destroyed a barn containing 150 tons of hay, belonging to Orrin Shaw. Near Reinbeck, Grundy county, a barn was burned by lightning, causing loss of hay and seventeen cows and calves. The details of losses would fill many columns.

The following interesting item is clipped from the Mt. Ayr News of August 26th: "The barn of James Moore, south of Kellerton, was struck by lightning Tuesday, August 23d. The electricity seemed to penetrate

every part of the building, which was immediately wrapped in flames. Nine men and eleven horses were in the barn, but all got out safely. Besides the barn, twenty tons of hay, 350 bushels of corn, and farm implements were destroyed."

THE AUGUST CLOUD-BURST IN DES MOINES COUNTY—BY MAURICE RICKER.*

It is my purpose to give merely a statement of facts concerning the storm which deluged Des Moines county the morning of August 16, 1898. I believe it was the heaviest rainfall ever noted in the United States for the period of its duration, and while the area covered was not large, it proved to be very destructive. No doubt there have been storms in which the precipitation was as heavy where no one saw fit to chronicle the event. Many great disasters, as the Johnstown flood, with a greater area and less precipitation, have become historic, because of loss of life.

My attention was called to the excessive rainfall that morning at daylight by the little swollen creek which divides South from West Hills in the city of Burlington. Yet this was in the very edge of the storm. The newspapers contained many sensational stories of narrow escape from loss of life, damage to county, city, railroad and farming interests. I read these with no special interest and dismissed their estimates of 16 to 20 inches of rain in Flint valley as exaggerations so commonly found in popular accounts of natural phenomena. As soon as the tracks were repaired I had occasion to make many trips by rail through the flooded district. The terrible strength of the water flow then became apparent and, noting the limited drainage area of Dry Branch in particular, I began to take more interest in the event, believing at this time that the real precipitation must be about five or six inches. I have since made a thorough canvass of the county and record for those interested in these phenomena only those things which are beyond dispute.

At 10 o'clock on Monday night, August 15th, it began to rain. The precipitation was not extraordinarily heavy, and, while it rained steadily, no one noticed that there was anything unusual about it. According to good authority the so-called cloud-burst began about 2 o'clock A. M. and ceased shortly after 4. It rained, more or less, for an hour later, however. A liberal estimate of time for the heavy rain is three hours. The precipitation outside of these hours, from all accounts, could hardly have been more than two inches.

The area of heavy rainfall can be approximately bounded on the south by the divide between Spring creek and Flint river. The former stream was not out of its banks. Keokuk reports a trace only. The county line forms a close boundary on the west, Yarmouth being in the edge of the heavy rain, but suffered only from lightning. Washington reports 1.72; Iowa City, .40. The north boundary of very heavy rain is not far above the county line, Wapello reporting 5.16. On the east, the river was the boundary for excessive rain, although the precipitation was heavy as far east as Biggsville, Ill. This maps out two-thirds of Des Moines county, or approximately 250 square miles. The Flint river and its tributaries drain one-half of this area. Dry Branch, Yellow Springs, Dolbee and Swank creeks

*Paper read before the Iowa Academy of Sciences, December 28, 1898.

drain the remainder, save a strip of three miles in width, which drains north into Louisa county. Dry Branch drains only about eleven square miles, yet its waters caused much damage. Yellow Springs creek drains a much larger area and carried perhaps more water proportionately to its bed than Dry Branch.

It is not easy to estimate the rainfall accurately. There was no rain gauge in the county at this time. I shall give some of the reports as I obtained them. Great care has been taken to get accurate and truthful accounts of this phase of the investigation.

Mr. J. W. Merrill, editor of the *Mediapolis New Era*, vouches for this story: A large circular windmill tank, with nearly straight sides, stood removed from buildings upon level ground. It had never been used as a tank and was dry Monday night. It had a semi-circular cover which was open, exposing one-half the tank to the rain. The water in the tank measured twelve inches in depth on Tuesday morning. We will grant that some of the water in the tank ran in from the half which was covered. Yet, had it all run in—and it could not—there would have been a rainfall of twelve inches. If the tank had been perfectly level would more than one-half the water which fell on the cover have entered the tank?

In Dry Branch valley below Latty, six miles south, lives a member of the county drainage board, a man whose judgment can be relied upon. He states that on Monday night an empty, straight-sided tin can, which was used for mixing spray fluids for fruit trees, was left in open ground. The can was about fifteen inches in diameter and sixteen inches high. At 5 o'clock the can was full and running over. North of West Burlington lives a truck gardener, who left standing in the garden several sprinkling pots, whose open tops are half covered with tin in the usual manner. These ought to have shed one-half the water, yet daylight found them all with eight or nine inches of rainwater in them.

Other less reliable cases have come to my notice, where the hole of a barrel becomes the outlet for overflow, etc. The instances given suffice to show the character of the information which leads me to firmly believe that over an area of fifty square miles at least sixteen inches of water fell in three hours.

The instances of incredibly rapid rise in streams, even when already in the flood plains, seem to corroborate the estimates given above, while the records at the Mississippi bridge at 6 P. M., August 16th, show a state of 4 feet 5 inches, a rise of 3 feet 2 inches. When we remember that local rain seldom affects the stage of water noticeably, and take into account the limited area of the storm, we must readily see that something extraordinary must have happened. The rain extended some distance up the river, it is true, Clinton reporting 3.01, Davenport 2.24.

The erosion was well in keeping with the figures given for rainfall. Little idea can be conveyed of the force of the water, which tore up trees twelve inches in diameter and floated rocks weighing hundreds of pounds many feet from their former location. Hay stacks were floated bodily against steel bridges, carrying them many hundred yards down stream. In the city of Burlington whole timber piles floated from the yards and blocked the entrance to the great sewer. Wagons and farm machinery of all kinds went down the Mississippi river, together with many dead animals. The oldest settler had never seen the water so high in these valleys.

Many houses, barns, sheds, etc., were flooded, and this in spite of the rapid fall of these streams, which here break through the escarpment to the Mississippi.

The upper valleys broaden out with many fertile plats, often planted in truck and garden produce. The lower stream has low banks through the flood plain of the Mississippi. The rush of water necessarily did very great damage to both crops and soil. In many cases acres of ground which had been fall plowed were denuded of soil and left covered with sand and pebbles.

Flint river, which formerly entered into O'Connell slough after paralleling its course for half a mile, cut a new channel directly through cornfields to the slough, tearing out acres of soil with crops and timber. A raft of logs belonging to the J. D. Harmer Manufacturing company went down before it like straws. O'Connell slough, which had been the storage place for logs in summer and steamboats in winter, was piled with the debris, which will cost \$15,000 to remove unless the ice and high water next spring can scour it out. Manufacturing establishments situated upon the slough will otherwise be cut off from navigation.

Hawkeye creek, a covered sewer through Burlington, became clogged with floating lumber and caused much damage to lumber yards, a foundry, the pickling works and the Murray Iron works. The stone apron at its mouth went out. The clearing of the sewer and the rebuilding of the apron will cause the city's heaviest bill for damage. The county lost twenty-three bridges, some of which have been replaced at an immediate outlay of \$16,000. The Burlington, Cedar Rapids & Northern railway lost nearly two miles of track and five bridges. The bridges which replaced the lost ones are fine steel spans, much better than the old ones, costing \$30,000. The loss to land owners is hard to estimate, but must have been very heavy in crops and damage to soil. The loss of live stock drowned would probably have been almost as heavy had it occurred in daylight, owing to the very rapid rise of the streams. The estimate of \$100,000 total loss is not far from correct.

There are many other interesting features which should be written up. The weather conditions can be obtained from the Weather Bureau. The map for the date shows a low reaching into Iowa, but would not warrant a forecast of general rain. The energy liberated by so heavy a fall of rain would form an interesting study. I have collected some data concerning similar storms in previous years. The heaviest fall that has come to my notice was fifteen inches, at Wilmington, Del., on the 29th of July, 1839.

SEPTEMBER.

The mean barometric pressure for the month was 29.98 inches. The highest observed was 30.60 inches, at Cresco, on the 10th; lowest, 29.62 inches, at Des Moines, on the 4th and 29th.

The mean temperature of September for the state at large was 65.3°, which is slightly above the normal for the month. The mean of the northern section was 63.4; central section, 65°; southern section, 67.6°. Clarinda reported the highest monthly mean, 72.6. The highest temperature reported was 99°, at Galva, on the 1st, and the lowest was 29°, at Britt, Estherville, Sibley and Spencer, on the 30th.

The average precipitation for the state was 2.69 inches, slightly below the September normal. By sections the averages were as follows: Northern section, 1.38 inches; central section, 2.67 inches; southern section, 4.02 inches. The maximum amount reported was 8.45 inches, at Fort Madison; least amount, .41 of an inch, at Estherville.

There were 16 clear days, 5 cloudy and 9 partly cloudy.

OBSERVERS' NOTES.

Atlantic—J. W. LOVE. Thin ice formed on the morning of the 30th.

Alta—DAVID E. HADDEN. On the 2d a low, flat, but bright aurora was observed. A very dry month.

Bonaparte—HON. B. R. VALE. Another wet month; 7.30 inches rainfall following August with 10.55, and 35.12 the last five months, and 48.24 since January 1st, is evidence sufficient that the soil is full of water. Fall seeding not nearly done.

Centerville—GEORGE GOODLANDER. Very warm and dry during the entire month.

Clinton—LUKE ROBERTS. A fine month for the maturing of crops. Latter part of the month warm.

Estherville—M. L. ARCHER. Killing frost on the 30th; thin ice formed on standing water.

Forest City—J. A. PETERS. Corn all out of the way of frost. A splendid fall for all kinds of work. Pastures afford plenty of feed for cattle. Great deal of fall plowing done. Hog cholera quite bad.

Grand Meadow—F. L. WILLIAMS. Ice formed on low ground on morning of 12th; no damage on high ground. Extremely warm and dry.

Larrabee—H. B. STREVER. Another warm September. Vegetation on low ground killed by frost on 30th. Corn ripe.

Oskaloosa—JOSEPH BOYD. The month of September was noted for high and low temperature, which was favorable for maturing the corn.

Ovid—H. C. MILLER. The most tender vegetation is green yet. The corn crop in this county is the largest ever known.

Sidney—G. V. SWEARINGEN. A severe thunder and hailstorm the 5th, which damaged all kinds of fruit; stripped apple trees and grapevines of about all their fruit. A strip from four to six miles wide crosses the county from west to east. Hail as large as hens' eggs and smooth.

OCTOBER.

The mean pressure for the month was 30.2 inches. The highest observed was 30.55 at Clarinda, on the 30th; lowest, 29.39 at Davenport and Des Moines on the 17th.

The month of October was cooler than usual, with more than the normal amount of precipitation. The first half of the month was generally fair and seasonable, and the last half wet and cold, with storms of unusual severity.

The average temperature for the state was 47.5°, which is about 3° below the October normal. The average for the northern section was 45.8°; central section, 47.2°; southern section, 9.5°. The highest temperature reported was 90° at Maquoketa on the 3d; lowest temperature, 17° at Estherville on the 31st.

The average precipitation for the state was 3.56 inches, which is about 1.33 inches above the October average. By sections the averages were as

FINAL CROP REPORT, 1898—AVERAGE PER ACRE AND TOTAL YIELD BY COUNTIES.

COUNTIES.	WINTER WHEAT.		SPRING WHEAT.		CORN.		OATS.		RYE.		BARLEY.		FLAX.		POTATOES.		CULTIVATED HAY.		WILD HAY.	
	per	ushels	per	ushels	per	ushels	per	ushels	per	ushels	per	ushels	per	ushels	per	ushels	per	ushels	per	ushels
Pocahontas	20	16,120	16	219,856	35	2,612,640	37	1,940,891	17	16,150	31	165,291	11	80,762	32	89,492	17	9,775	14	60,170
Polk	16	20,144	15	115,008	34	3,843,646	30	1,040,020	17	24,327	24	70,272	10	217,862	47	217,862	18	40,230	15	16,385
Pottawattamie	19	11,617	16	16,448	34	6,796,053	32	1,543,748	15	34,190	24	27,702	10	284,320	68	284,320	2.0	23,029	1.0	21,900
Poweshiek	20	47,080	12	2,220	31	2,911,551	25	671,200	19	23,165	20	5,910	10	133,870	118	133,870	2.0	77,069	1.5	2,550
Ringgold	15	195,720	13	277,300	38	4,398,790	40	2,294,680	16	23,895	30	210,510	10	37,410	38	45,110	1.8	70,182	1.0	1,850
Sac	19	7,050	13	56,297	30	1,782,150	26	706,250	16	23,523	21	481,608	10	137,070	90	137,070	1.6	31,185	1.0	21,220
Scott	15	2,928	13	549,888	35	3,877,160	37	2,176,672	12	18,700	25	277,925	11	17,710	75	181,425	2.0	41,580	1.0	9,490
Shelby	24	9,842	17	86,670	36	4,004,668	34	1,981,145	19	46,759	27	20,150	10	3,500	87	143,115	1.8	4,901	1.0	34,140
Story	21	144,123	15	10,335	30	3,425,450	28	2,011,912	18	10,800	25	569,724	10	17,710	95	165,110	1.9	61,294	1.0	26,250
Taylor	19	96,120	12	8,291	28	2,011,912	28	637,930	15	41,325	27	569,724	10	3,500	40	133,880	1.0	72,940	1.0	11,290
Van Buren	17	15,538	13	1,740	30	1,247,250	33	1,112,714	12	9,384	22	6,006	10	3,500	52	51,948	1.7	45,849	1.0	2,189
Wapello	30	148,269	14	1,330	30	2,577,570	30	830,460	17	11,736	22	6,006	10	3,500	64	27,520	2.0	32,900	1.0	1,018
Warren	17	50,269	14	1,330	30	2,577,570	30	830,460	17	11,736	22	6,006	10	3,500	70	90,300	2.0	32,900	1.0	1,018
Washington	17	50,269	14	1,330	30	2,577,570	30	830,460	17	11,736	22	6,006	10	3,500	62	131,812	1.7	51,527	1.0	2,105
Wayne	12	15,458	14	1,330	30	2,577,570	30	830,460	17	11,736	22	6,006	10	3,500	74	59,644	1.7	69,938	1.0	680
Webster	16	376,028	16	110,789	35	3,921,406	24	512,064	20	24,800	30	96,300	10	32,250	78	134,160	2.0	16,542	1.0	48,420
Winnebago	19	9,063	16	376,028	37	3,401,812	35	1,132,255	16	1,856	40	294,500	13	132,275	43	74,390	1.8	6,165	1.0	38,610
Winneshiek	18	2,700	17	108,000	36	2,620,656	33	2,380,660	18	32,076	28	400,568	12	175,948	75	99,525	1.6	53,548	1.0	9,330
Woodbury	18	2,700	17	901,408	37	5,973,953	31	1,128,144	20	44,720	28	102,102	18	11,250	52	121,576	1.6	14,228	1.0	30,130
Worth	18	101,880	16	130,806	36	1,385,352	36	2,128,085	16	12,128	28	303,460	10	102,960	63	86,726	1.8	18,968	1.0	21,115
Wright	18	130,806	16	130,806	36	2,000,555	36	2,128,085	16	6,042	31	129,052	9	71,460	109	66,340	1.8	23,060	1.0	35,501
Total yield	18.6	3,165,916	14.8	19,152,352	31.5	289,214,850	32.5	136,915,340	16	3,370,550	27.5	14,138,011	10.5	2,370,601	76	12,538,411	1.7	3,852,561	1.2	1,645,419
Average per acre	18.6	171.3	14.8	1,358.2	31.5	15,612.1	32.5	8,328.2	16	209.4	27.5	836.2	10.5	134.2	76	784.1	1.7	213.5	1.2	94.1

The s
the Sept
ern secti
inches.
least am
There

Atlan
Alta—
observed
Bona;
fall follo
since Jan
seeding i
Cente
entire m
Clinto
Latter pr
Esthe
on standl
Fores
did fall f
Great de
Grand
ing of 12
Larra
low grou
Oskak
high and
Ovid—
corn crop
Sidney
which da
about all
county fr

The m
was 30.55
Moines or
The m
amount o
seasonabl
The av
the Octob
section, 4
was 90° at
the 31st.
The av
1.33 inche

follows: Northern section, 3.11 inches; central section, 3.76 inches; southern section, 3.42 inches. The maximum amount for the month was 5.75 inches at Ridgeway; least amount reported, 1.27 inches at Larchwood. The greatest daily precipitation was 3.42 inches at Hawkeye on the 21st. Snow fell at various localities on the 17th, 18th and 25th. There were 7 clear days, 9 partly cloudy, and 15 cloudy. The average percentage of sunshine was unusually low.

OBSERVERS' NOTES.

Afton—HON. N. W. ROWELL. First frost on the 6th; second frost on 14th and froze ice. On 26th ice formed half an inch thick.

Amana—CONRAD SCHADT. First killing frost on the 14th, but many tender plants escaped total destruction. The snowstorm on the 25th was quite unusual for this month. It was like a regular blizzard, only not so cold. When it ceased the snow measured 4 inches, and traces of the snow were still visible on the 30th.

Atlantic—J. W. LOVE. Severe snowstorm on the 17th, melting in large part as it fell.

Alta—DAVID E. HADDEN. First snow of the season fell on the 17th—an old-fashioned blizzard, with high northwest wind, continuing until early morning of the 18th. About six inches of heavy snow remained on the ground after the storm, and it would have made fully nine inches in all if it had been colder. It was the severest storm at this time of year for eighteen years.

Bonaparte—HON. B. R. VALE. A cold, wet month, not favorable for fall grain or the maturing of corn; soil full of water.

Bedford—PROF. E. H. GRIFFIN. Snow fell from before daylight till night on the 17th, the greatest depth observed being 4 inches. There had been no killing frost and vegetation was nearly as green as in midsummer. Rain and snow on the 25th; first freeze on 26th. Petunias and many other flowers were not frozen until the 26th.

Cresco—GREGORY MARSHALL. The first real killing frost was on the 22d, and up to that date tomato plants were growing green in the yards.

Clinton—DR. LUKE ROBERTS. The storm of the 25th was rain, snow and wind; the snow clinging tenaciously to trees and shrubs. Most of the trees had parted with few of their leaves and consequently held more snow than the limbs had strength to support, and great damage resulted. Corn was also damaged badly.

Dows—R. E. FULLER. First frost of the fall occurred on the 6th; and on the 14th there was a killing frost, exceeding severe.

Denison—JAMES H. HOLMES. First killing frost on the 6th; snowed all day on the 17th.

Eldon—T. MADDEN. On the 14th the first killing frost was noted; on the 25th, rain, snow and sleet.

Forest City—J. A. PETERS. October has been a very wet month, pastures are good, and conditions were favorable for farm work, except threshing.

Fort Madison—MISS L. A. MCCREADY. The storm of the 25th—rain, snow and wind—caused considerable damage to trees.

Greenfield—J. G. CULVER. On the 7th tree toads were heard; first snow fell on the 17th, with heavy north wind; on the 20th first ice observed.

Grundy Center—GEORGE F. ELLIS. October 18th the first snow of the season began falling at 5 A. M., and changed to rain; many potatoes still unharvested.

Grand Meadow (Clayton Co.)—F. L. WILLIAMS. On the 17th and 18th, 2.60 inches of rain fell, and mostly went into the soil. On the 25th a heavy, wet snow fell nearly all day; surface of ground is very wet.

Humboldt—H. S. WELLS. Snow on the 17th; probably about 4 inches. The month has been good for pastures and for seed to germinate; corn is being cribbed in good condition.

Iowa Falls—J. B. PARMELEE. A continuous rain fell from early morning on the 16th to 3 P. M. on the 17th; on 18th, rain and snow flurry.

Kcosauqua—JOHN H. LANDES. Snow fell nearly all day on the 25th, but most of it melted as it came and only 2 inches remained when the storm ceased.

Logan—MRS. M. B. STERN. The 17th brought an unusual snowstorm for the season; the next morning I found 10 inches of wet snow on the ground, and 1.63 inches of water in the gauge.

Monticello—C. E. HEISEY. A heavy snowstorm visited these parts on 25th, falling from 9 P. M. on the 24th till 6 P. M. on the 25th, making .90 of an inch when melted; said to be the hardest storm on record for October.

Marshalltown—C. M. COOK. Light frost on the 6th; heavy frosts on 14th, 23d and 31st.

Newton—A. LUFKIN. Last half of the month was very unfavorable for farming operations.

Ovid—H. C. MILLER. Snow fell on the 18th, but melted as it came. Snow on the 25th was very damp, leaving 6 inches on the ground at close of storm. It was the worst storm in October for 35 years.

Olin—REV. NATHAN POTTER. A remarkable snowstorm occurred on the 25th, melting about half as fast as it came, leaving 6 inches at its ending. Leaves were green, and it was a remarkable sight for this latitude.

Pella—T. W. COX. First heavy frost on 14th, killing all vegetables. On the 18th light snow, melting as it fell. On the 25th, snow fell from 6 A. M. till 12 M., and melted rapidly.

St. Charles—R. D. MINARD. Tender plants killed; petunias, chrysanthemums, pinks, verbenas, pansies and other hardy plants were still growing at close of the month.

Sidney—G. V. SWEARINGEN. On the 17th a very wet snow fell, making 2.75 inches of water when melted, the heaviest that has fallen here in the forty-one years I have lived in this place. On the 25th 1 inch of snow fell.

Tara—W. E. HUMPHREY. Heavy white frost on the 14th. On the 17th 1 inch of snow fell, with cold northwest wind.

Villisca—C. E. MATESON. Storm of 16th and 17th was severe on stock, because unseasonable. Light snow flurries on the 25th. From the 16th to 21st the sun was visible only 15 minutes.

Wapello—G. W. SCHOFIELD. An unprecedented snowstorm, almost a blizzard, occurred on the 25th; 3 inches of snow was on the ground when it ceased. Bad weather for drying corn.

Whitten—FRANK P. BUTLER. First snow on 18th; cold, wet month. Corn husking about two weeks behind usual time; yield of corn good.

West Branch—A. A. MADSON. Light snow with rain on 18th; snowed from 5 A. M. till 5 P. M. on the 25th, with strong northwest wind.

NOVEMBER.

The mean pressure for November was 30.06 inches; the range for the state was 1.23 inches.

The first and second decades of the month were generally mild, but the last decade brought severe storms of rain, snow and sleet, and weather of the wintry type. The advent of winter was nearly a week earlier than usual in this section.

The mean temperature for the state was 32.2°, as shown by records at 112 stations. By sections the averages were as follows: Northern section, 29.8°; central section, 32.2°; southern section, 34.5°. The state average, 32.2°, is slightly below the normal for November.

The precipitation by sections was as follows: Northern section, 1.56 inches; central section, 1.40 inches; southern section, 1.41 inches; average for the state, 1.50 inches. The precipitation was largely in the form of snow and sleet, and was fairly well distributed. The "norther" on the 21st and 22d was unusually severe for the month of November. At Sioux City on the 22d the wind attained the extreme velocity of 60 miles per hour.

OBSERVERS' NOTES.

Alta—DAVID E. HADDEN. A "norther" raged all day of 21st, the high northwest gales continuing until evening of the 22d. Snow drifted greatly and in places was five or six feet deep. It was one of the severest blizzards in this section for many years. A cold wave followed which continued nearly all week.

Bonaparte—B. R. VALE. A variable month. Many snows of small importance. A poor month for gathering corn.

Denison—J. H. HOLMES. Very severe storm all day of 21st. Snowed and blowed until all business and work was stopped.

Grundy Center—GEORGE F. ELLIS. Only half of the corn crop has been gathered.

Humboldt—H. S. WELLS. The snow caught the farmers with much corn in the field. Where it stands up it is being gathered. Ground was not frozen when snow came.

Iowa Falls—J. B. PARMELEE. A cold rain, freezing as it fell, began at 5 A. M. of the 21st, and continued to about 10 A. M., when it gradually changed to sleet and snow, wind changing to northwest. By night a genuine blizzard was in progress, continuing all night and till noon of the 22d.

Larrabee—H. B. STREVER. A blizzard raged on the 21st, from early morn till late at night. Stock suffered generally.

Linn Grove—J. W. HUBBARD. Sun dogs on the 22d and 23d.

Monticello—C. E. HEISEY. This has been a severe month for the farmers. The different snowstorms of November 20th, 27th and 28th have caught a great many of our farmer friends with all the way from ten to fifty acres of corn to pick.

Sidney—G. V. SWEARINGEN. Severe blizzard the 21st. Drop in temperature of 64° in twenty-eight hours; 14 2 inches of very light snow fell.

Toledo—CHARLES MASON. The fore part of the month was rather mild and favorable for corn husking. The latter part was stormy with considerable snow and good sleighing.

Thurman—C. R. PAUL. One of the worst blizzards that ever visited this section of the country at this time of the year was on the 21st. Four inches of snow and a very strong wind that drifted snow badly.

Washta—H. L. FELTER. Big blizzard on the 21st. Coldest weather 13° below zero on the 25th.

Whitten—F. P. BUTLER. Rain, sleet and snow on the 21st; temperature fell 59° in thirty-six hours.

Wapello—G. W. SCHOFIELD. Thunder on the 21st; it has been a very disagreeable month for farmers in keeping them out of the cornfields.

Ridgeway—ARTHUR BETTS. A good month, though the last nine days were decidedly wintry. A good month for fall work. Ground froze up on the 22d. The night of the 4th was phenomenally warm, mercury not going lower than 50°. We had several hazy days which farmers call Indian summer. There was constant lightning in the east on the 4th in the evening, after the warm night and two warm days.

DECEMBER.

The mean pressure for the month was 30.18 inches. Clarinda reported the highest, 31.07 inches on the 9th; lowest, 29.43 inches, at Dubuque, on the 29th.

The month was colder than usual in all parts of the state. The monthly mean as deduced from reports of 111 stations was 18.1°. The highest monthly mean was 27.1° at Ft. Madison, and the lowest, 9.7° at Estherville. The mean temperature by sections was as follows: Northern section, 15.1°; central section, 18.3°; southern section, 20.8°. The highest temperature reported was 60° at Wapello on the 29th; lowest, 25° below zero at Estherville, Mason City and Ruthven, on the 31st. There were several cold waves during the month; the most severe cold waves occurred on the 13th and 30th.

The precipitation was generally very light, the average for the state being .48 of an inch. The average for the northern section was .28 of an inch; central section, .42; southern section, .73. The range was a trace at Mason City, and 1.70 inches at Eldora. There were 15 clear days, 8 partly cloudy and 8 cloudy. The highest wind velocity was 44 miles an hour at Sioux City, on the 24th.

OBSERVERS' NOTES.

Alta—DAVID E. HADDEN. Norther in afternoon of 29th, followed by severe cold wave on 30th. Temperature fell 44° in eighteen hours.

Amana—C. SCHADT. A large part of the corn crop was in the field yet at the beginning of the month, on account of the unseasonable weather in the fall. This month, however, although generally cold, was most favorable for gathering the crop in.

Bonaparte—B. R. VALE. A pleasant winter month, good for all kinds of winter work and stock feeding. No snow in this locality.

Clinton—DR. LUKE ROBERTS. December, 1898, was cold, quite clear and nearly stormless, with less than normal force of wind. Mean temperature, 21.1°; normal being 24.9°. Maximum temperature, 53°; normal, 53.6°. Minimum temperature, 8° below zero; normal, 9.4° below zero. Mean temperature of the warmest day, which was the 29th, was 35.3°; normal being 44.1°, or 8.8° warmer than the warmest December day for 1898. The coldest

day, the 31st, gave a mean temperature of 1° below zero, while a December normal for the coldest day is 9.9° below zero. The movement of the wind was 3,780 miles, or 660 miles below normal. The maximum was 23 miles an hour, occurring on the 6th. The prevailing direction was from the west. There were five days with storm, the total precipitation amounting to only .45 of an inch of water. The total snowfall did not reach 2 inches.

Grand Meadow—F. L. WILLIAMS. The month was cold, culminating in a fall of 46° in sixteen hours on the afternoon of the 29th; mercury rose 1.15 inches in the same time. Good sleighing most of the month. Cholera still killing hogs in some localities; other stock doing well.

Ovid—H. C. MILLER. At noon on the 29th thermometer stood at 49°; the next morning, at 7 o'clock, it was zero.

Villisca—C. E. MATTESON. Total eclipse of moon on 26th; total from 6:15 to 7 P. M.

WEATHER AT CLINTON, 1898.

ANNUAL REVIEW BY DR. LUKE ROBERTS.

The year 1898 was an off year, meteorologically as well as politically. None of the conditions were normal, yet plentiful harvests and general prosperity prevailed. Few alarmists of any grade or color were to be seen or heard.

It is interesting to note many of the meteorological peculiarities of the year. The number of storm days was 116, and, during the last twenty years, was exceeded only in 1884, which furnished 125 stormy days. The number of cloudy days was 129 and the number of clear days 141. The former, during the last 20 years, was exceeded only in 1884, by five days, and the latter in 1897 by two days, in 1896 by one day, in 1895 by six days.

The rainfall exceeded any former year's precipitation during the last twenty years by 3.44 inches; exceeding normal by 11.35 inches. The fall of snow exceeded normal by 7.35 inches.

The movement of the wind was less than normal by 9,850 miles. The first six months furnished an excess of precipitation. So, also, did October. From the fact that the last five previous years were deficient in rainfall, the excess referred to proved a great blessing to farming interests as well as replenishing springs and streams which had for a long time been low.

Notwithstanding June precipitation was great, the condition of the soil was excellent, and the outlook was promising for a generous harvest.

January and February furnished about thirty days of very good sleighing. On the 11th of January the first thunder and lightning occurred, which, coming unannounced and terrific, frightened many people by being suddenly awakened from a sound sleep, and thinking the whole city was on fire from the intensity of light.

Nearly every month furnished an electrical storm of more or less intensity. Especially severe and damaging was the one occurring on the 16th of August.

A very destructive tornado passed over the northern portion of Clinton county on the afternoon of May 18th, in which several lives were lost, and many thousands of dollars' worth of property destroyed.

Notwithstanding the large per cent of cloudiness, the temperature and moisture combined to bring growing crops to a normal condition by the last of May. The drouth of July following the excessive rains rendered the quality and flavor of fruits and vegetables inferior.

The hay crop, however, was large, of good quality and saved in good condition. During July and August farmers felt some uneasiness as to the outcome of corn, much of it being late planted and but little of the land could be properly worked at a seasonable time on account of being too wet, so that the weeds got some advantage.

And by the time the fields were in good condition for the cultivator much of the corn had got so large that the stalks were easily broken by cultivating. Besides these reasons the season was so far advanced as to leave a too short time for corn to mature before frost might be expected. The season, however, proved long enough, as the first frost to injure vegetation came later than was ever known, to the delight of everybody.

The first freezing temperature occurred on the 12th of October—an exceptionally disagreeable month, with only four clear days. The foliage remained green and beautiful until after the heavy snow and windstorm of the 25th, which made havoc among trees and shrubbery, breaking and splitting large numbers. About a week elapsed ere all the snow had disappeared, and with it the foliage. It was a sudden transformation of a bright summer into a barren winter, although pastures and lawns remained green until November.

Corn, which had been badly bent in all directions by the heavy rains and winds previously, was rendered difficult to harvest, but yet was in good condition for cribbing.

The weight of snow pressed it closer to the ground, and not only increased the difficulty of gathering, but did much damage to the crop. However, the weather was favorable to the germination of wheat and rye, an increased acreage of which had been sown.

The eleventh month was 1.5 degrees colder than a November normal—there having been but two colder in two decades. December was cold, clear and almost stormless, which furnished the best of conditions for the formation of ice. The ice harvesters were pleased, and lost no time in filling their immense ice houses with a superior quality of ice, besides doing a large shipping business.

CONSPECTUS.

Highest temperature, 99°, July 19th.
 Lowest temperature, 8° below zero, February 3d and December 31st.
 Extreme range of temperature, 35°.
 Mean daily temperature, 48.5°, or 1.5° above normal.
 Mean daily range of temperature, 21°.
 Greatest mean monthly range of temperature, 27°, occurring in July.
 Least mean monthly range of temperature, 16.3°, occurring in October.
 Greatest daily range of temperature, 39°, occurring on the 3d day of June; maximum being 91°; minimum 52°.
 Least daily range of temperature, 3°, occurring on the 21st of December.
 Warmest month, July, mean temperature, 71.8°.
 Coldest month, December, mean temperature 21.1°.
 Warmest day, June 24th, mean temperature, 84°.

Coldest day, February 2d, mean temperature, 2.5° below zero.

Total number of days with maximum temperature, 80° or above, 28; 6 in June, 14 in July, 5 in August, 3 in September.

Total number of days with the maximum temperature at 32° or below, 39; 8 in January, 10 in February, 1 in March, 6 in November, 14 in December.

Total number of days with the minimum temperature at or below 32°, 148; 30 in January, 25 in February, 22 in March, 8 in April, 8 in October, 24 in November, 31 in December.

Mean daily cloudiness, 48 per cent of the surface of the sky.

Month with the greatest per cent of cloudiness, October, 67 per cent.

Month with the least per cent of cloudiness, July, 24 per cent.

Total number of clear days, 141.

Total number of cloudy days, 129

Month with the greatest number of clear days, July, 21.

Month with the least number of clear days, October, 4.

Month with the greatest number of cloudy days, October, 19.

Month with the least number of cloudy days, July, 3.

PRECIPITATION.

Total depth of snowfall, 54 inches.

Greatest fall of snow at any one storm, 13 inches, February 20th.

Total precipitation rain (and snow melted), 46.48 inches.

Greatest rainfall in 24 hours, 4.61 inches, June 13th. August 16th furnished next, 3.01 inches.

Month with the greatest precipitation, June, 8.02 inches.

Month with the least precipitation, December, .42 inches.

Month with the greatest number of storm days, October, 15.

Month with the least number of storm days, December, 5.

Total number of storm days, 116.

THE WIND

Total movement of wind, 32,776 miles.

Maximum velocity per hour, 27 miles, occurring in October and November.

Greatest monthly movement, 3,896 miles, in February; least monthly movement, 1,280 miles, occurring in August.

Prevailing direction of the wind was from the observations taken at 7 A. M., 2 P. M., and 9 P. M., show the movement of the wind to have been from the north 87 times, from the northeast 131 times, from the east 98 times, from the southeast 80 times, from the south 172 times, from the southwest 155 times, from the west 193 times, from the northwest 169 times.

Maximum velocity of the wind for January 28 miles an hour, for February 21 miles, for March 23 miles, for April 22 miles, for May 20 miles, for June 13 miles, for July 18 miles, for August 24 miles, for September 23 miles, for October 27 miles, for November 27 miles, for December 23 miles.

SNOW AND FROST.

The last spring snow fell on the 22d day of March.

The first snow to cover the ground made its appearance on the 25th day of October.

Last frost in spring severe enough to injure vegetation, April 21st.
Last light frost May 12th.

First hoar frost in autumn, October 12th.

First killing frost in autumn, October 14th.

Number of consecutive days without frost, 152.

The temperature of the air was at freezing point or below for the last time in the spring, on the 21st day of April.

The first in autumn, October 14th.

The last day in the spring when the mean temperature was below 32°, April 5th.

The first in autumn, October 25th.

ELECTRO METEORS.

Number of auroras observed, 1, March 15th.

Number of days with thunder and lightning, 29; 1 in January, 6 in March, 1 in April, 2 in May, 7 in June, 4 in July, 2 in August, 4 in September, 1 in October, 1 in November.

OPTICAL METEORS.

Number of solar haloes observed, 6.

Number of lunar haloes observed, 15.

Meteor, very fine, November 15th and April 20th. A fine rainbow on June 6th at 5:30 P. M.

The following interesting facts are gleaned:

The extreme range of the yearly mean temperature of the 20 years was 6°, the highest being 49.8° in 1894, and the least 43.8° in 1885. The normal yearly temperature for the 20 years is 47°.

The total rainfall for the same time was 702.75 inches, or 58.56 feet, averaging 35.14 inches per year, or a little over .09 of an inch per day. Total movement of wind during the last 7 years was 847,355 miles, a distance equal to 34 times the circumference of the earth.

WEATHER AT DES MOINES, 1898.

COMPARISON WITH PRECEDING YEAR.

The mean temperature in 1898 was 49.5°, which is .5° above the normal of the station for twenty-one years, against 49.6° in 1897, when it was .6° above the normal. The highest temperature was 99°, on August 30th, against 98° on September 1, 1897. The lowest temperature was 10° below zero, on December 31st, against 17° below zero on January 25, 1897. The mean relative humidity was 72 per cent, against 69 per cent during the preceding year.

The total precipitation in inches during 1898 was 28.33, which is 4.20 inches below the normal of the station for twenty-one years. The greatest precipitation in any twenty-four hours was 2.19 inches, against 2.95 inches in 1897. The total depth of snowfall was 37 inches, against 49 inches in 1897.

The percentage of sunshine was 60, against 59 in 1897. The average hourly wind velocity was 7.6 miles per hour, against 8.1 of 1897. The prevailing wind direction in 1898 was north, and of the preceding year southwest. The highest velocity was 40 miles an hour from the west, against 50 miles an hour from the northwest in 1897. There were 182 clear days, 95 partly cloudy and 88 cloudy days during the year, against 183 clear days, 82 partly cloudy and 100 cloudy days in 1897.

There were 38 days on which thunder was heard, against 42 in 1897. There were no auroras during the year, against 1 in 1897.

ERRATA FOR THE 1897 ANNUAL.

	INCHES.
Denison annual precipitation should be	25.50
Hampton precipitation for April should be	4.96
Hampton annual precipitation should be	27.40
Centerville precipitation for August should be	1.62
Larrabee annual precipitation should be	27.38
Maquoketa annual precipitation should be	20.81
Mt. Ayr annual precipitation should be	32.68
Mt. Ayr precipitation for November should be .....	.92
Rockwell City precipitation for December should be	2.20
Sac City annual precipitation should be	22.67
Spirit Lake precipitation for November should be .....	.20
Spirit Lake annual precipitation should be	20.39
Toledo annual precipitation should be	22.02
Toledo precipitation for June should be	3.11
Wilton Junction precipitation for February should be	1.45
Wilton Junction annual precipitation should be	30.78
Winterset precipitation for March should be	1.89
Winterset annual precipitation should be	36.16

IOWA'S SOIL PRODUCTS.

GENERAL REVIEW OF THE CROP SEASON, 1898.

The winter months were warmer than usual, with generally light precipitation, and the advent of spring was relatively early. March was warm and favorable for early farm operations, except in the southeastern counties where the soil was saturated by excessive rains. More than the usual amount of spring grain was sown in March, and there was a marked increase in the acreage of spring wheat compared with recent years.

April was nearly normal in all weather conditions, and generally favorable for preparation of soil and seeding. The bulk of small grain was sown before the middle of the month, except in the extreme north and in some of

the southeastern counties where work was retarded by excessive moisture.

The first half of May was cooler than usual, retarding the germination of seed and the growth of corn; but the last half was sufficiently warm to bring the temperature of the month up to normal. The spring months were especially favorable for the growth of grass and small grain. The pastures afforded ample feed for stock, and the meadows gave promise of a large crop of hay. On the first of June, wheat, rye, oats and barley had made phenomenal advancement, and the chief drawback was the danger of injury resulting from an excessive growth of straw. The bulk of the corn area was planted between the 10th and 25th of May, and the soil was in excellent tilth. The seed was unusually sound, and the germination was almost perfect, resulting in an exceptionally good stand. And on the 1st of June the condition of corn was above the average for that date in recent years.

June was warmer than usual, with excessive moisture in a large part of the state, and all the conditions were favorable for a rank growth of vegetation, especially of the grasses, cereals and weeds. In portions of the southern districts, and notably the southeastern counties, the heavy rains caused considerable damage and greatly retarded field work. At the close of the month, however, the weather conditions were about normal, and corn was rated above the average, with small grain crops exceptionally good and promising.

With considerable variability in the daily temperatures, the average for July was about normal. The month was generally dry, though scattered localities received excessive amounts of rainfall. Drouthy conditions prevailed generally from the 3d to the 27th, mitigated in a few sections by showers the 6th and 19th. For a period of about twenty-four days the larger part of the state received very little moisture, and the greater portion of the precipitation of the month fell in the last four days. And the drouth was intensified by some high temperatures, ranging from 90° to 100°, with brisk to high winds during a part of the dry period.

Though the dry weather was somewhat unfavorable for corn, late potatoes and pastures, yet there were compensating advantages resulting from the almost ideal conditions for maturing and harvesting the unusually large crops of hay, wheat, oats, rye, and barley. In the larger part of the state the bulk of the hay was secured in perfect condition; and, for the most part, the weather was all that could be desired for cutting, shocking, and stacking the heavy grain crops, which, because of the great bulk of straw, needed continued dry weather to secure it in good order.

The condition of corn was unusually good the first week in July, giving promise of more than an average yield. The dry weather and occasional periods of high temperature that prevailed from the 8th to the 27th, during the critical stage in the development of the corn plant, unquestionably caused material injury in fields most exposed to the effects of the heat and arid conditions. The average temperature of August was very close to the normal, the first half being cooler than usual and the last half unseasonably warm. The rainfall was very unequally distributed, ranging from less than an inch to more than ten inches, the heavier amounts being reported from stations in the southeast district. The larger part of the state received considerably less than the normal rainfall for August. The first two weeks

brought some measure of relief from the drouthy conditions that prevailed through the larger part of July. Though the nights were too cool for the rapid development of corn, yet the reports showed fairly good progress of that crop, and at the middle of the month the general conditions gave promise that it would reach maturity in advance of the usual period of killing frosts. During the last half of the month the prevalent high temperatures and dry weather hastened the ripening process of the belated portion of the corn crop and brought the larger part to a sufficient degree of maturity to be cut and shocked. In some sections the extreme heat caused some damage to late corn, but generally the crop was benefited by the conditions which carried so much of it beyond the danger line. The potato crop suffered some damage by the dry and hot weather in the latter part of August.

In considerable portions of the state there was sufficient moisture in the soil to facilitate plowing, and more than the usual area had been plowed at the close of the month, and a good beginning had been made in sowing winter wheat and rye. On the whole, August was a favorable month for farm operations and for the ripening of crops.

September brought almost ideal weather for ripening the late-growing crops, for threshing and garnering the small grains, and for fall plowing and sowing fall wheat and rye. The mean temperature was slightly above the normal for the month, and there was abundant sunshine to afford normal ripening conditions. The rainfall was generally ample for current needs to facilitate plowing and to maintain growth in the pastures, though in a portion of the state the supply of moisture was somewhat deficient. The larger part of the rainfall came during the first half of the month, and at the time when it was most needed; and the bright, clear weather of the last fifteen days brought the belated fields of corn and other crops to full maturity without a touch of frost. At the close of the month more than the usual amount of fall plowing and seeding had been accomplished.

The first half of October was favorable for outstanding crops and corn was fully ripened and nearly dry enough to crib before killing frost. But the last half of the month was cold and wet, with severe storms of rain, wind and snow flurries, causing material injury to the unharvested corn that was more or less flattened by wind and snow. The conditions were generally favorable for early sown fall wheat and rye, which have made a good stand, with an increased acreage. On the whole the crop season of 1898 has been propitious, and this state has seldom harvested more abundant yields of the staple products of the soil.

JUNE CROP REPORT.

ACREAGE AND CONDITION OF CROPS JUNE 1, 1898.

From reports of correspondents of this service, June 1, 1898, the following summary is made, relative to the acreage and condition of the staple crops for the current season. The acreage is obtained from careful estimates of increase or decrease, compared with the number of acres harvested

in 1897. The condition is estimated in form of percentage, compared with the average or normal of the several crops.

Wheat.—Of winter wheat the number of acres planted last fall and not abandoned appears to be 191,451, a decrease of 3,015 acres compared with last year.

Of spring wheat the acreage is 1,293,231, an increase of 216,394 acres compared with 1897. The total acreage of winter and spring wheat for this harvest is 1,484,682 acres, as against 1,271,303 acres last year. The condition, June 1st, of winter wheat was fully 101 per cent, and of spring wheat 104 per cent. Last year on the corresponding date winter wheat was 67 per cent and spring wheat was rated 91 per cent.

Corn.—The acreage of corn planted this year is reported to be 8,396,286 acres—a decrease of 213,859 acres compared with 1897, or an average decrease of a little less than 2½ per cent. The condition of the crop June 1st was rated at 101 per cent; last year at the corresponding date it was 79 per cent.

Oats.—the total acreage of oats for the state is 4,299,243 acres, and the condition June 1st was 105 per cent. Last year the area sown was 4,405,782 acres, and the condition June 1st, 83 per cent. This shows a net decrease of 106,539 acres.

Rye.—Total area sown, 210,309 acres; condition June 1st, 100 per cent. Last year the acreage was 226,198, and the condition was 90 per cent.

Barley.—Area seeded, 509,589; condition June 1st, 102 per cent. Last year the area was 551,867 acres; condition 86 per cent.

Flax.—Area seeded, 22,014 acres; condition, 100 per cent; area in 1897, 249,882 acres; condition, 89 per cent.

Cultivated Hay.—Total number of acres, 2,230,455. Last year the area was 2,159,334 acres; an increase for this season of 71,121 acres. The condition of new seeding of timothy is 105 per cent, and of clover, 107; millet is rated at 98 per cent. This has been a very favorable season for the grasses.

Potatoes.—The condition of common potatoes is 101 per cent. The area planted is 164,456 acres. Last year the area was 163,248 acres; condition June 1st, 92 per cent.

Condition of other crops are as follows: Broom corn, 91; sweet potatoes, 98; sorghum, 96; apples, 98; pears, 91; plums, 80; peaches, 96; grapes, 99; blackberries, 95; raspberries, 94; strawberries, 100; currants, 97; cherries, 97 per cent.

Live Stock.—Condition, cattle, 104; sheep, 101; hogs, 98; spring pig crop, 76; horses, 99; foals, 91 per cent.

Meadows are rated 105, and pastures 106 per cent.

IOWA CROPS, 1898—NUMBER OF ACRES BY COUNTIES.

COUNTIES,	Winter wheat— acres.	Spring wheat— acres.	Corn— acres.	Oats— acres.	Rye— acres.	Barley— acres.	Tame hay— acres.	Flax— acres.	Irish potatoes— acres.
Adair.....	589	11,079	106,226	52,320	693	480	23,900	.....	2,078
Adams.....	1,980	6,933	74,310	21,823	212	214	22,070	.....	680
Allamakee.....	2,295	2,100	39,974	43,690	7,635	3,591	33,150	351	1,613
Appanoose.....	3,332	69	46,351	10,258	1,185	.....	43,650	90	517
Audubon.....	62	25,582	76,913	42,296	523	2,043	13,210	.....	1,346
Benton.....	392	728	103,610	72,365	2,695	10,035	34,350	85	2,050
Black Hawk.....	299	90	97,520	66,623	5,177	3,010	33,570	130	1,864
Boone.....	53	3,224	97,705	47,039	1,462	480	12,250	177	1,150
Bremer.....	98	181	56,794	51,707	2,221	1,597	18,210	1,887	1,345
Buchanan.....	.....	70	84,167	59,020	3,384	1,798	32,790	351	1,278
Buena Vista.....	.....	18,652	104,978	61,050	951	5,993	9,210	3,197	2,279
Butler.....	50	1,661	103,207	77,175	4,737	2,881	15,270	1,678	1,382
Calhoun.....	33	8,044	101,557	54,876	1,104	3,095	9,330	4,297	1,450
Carrroll.....	46	17,910	116,772	61,934	1,804	7,282	12,470	1,184	2,228
Cass.....	3,099	18,906	112,110	50,341	937	1,117	15,240	.....	5,063
Cedar.....	2,751	383	103,537	42,781	1,288	4,324	47,020	.....	1,465
Cerro Gordo.....	36	2,173	77,167	68,859	2,931	6,485	5,170	6,695	1,408
Cherokee.....	.....	40,164	108,425	37,118	614	9,421	15,730	1,509	1,620
Chickasaw.....	43	994	61,246	63,028	1,594	4,059	18,310	8,010	1,438
Clarke.....	1,185	246	59,970	19,564	2,198	90	26,550	30	1,039
Clay.....	.....	25,475	82,359	56,609	3,327	21,367	11,260	8,083	1,361
Clayton.....	6,691	2,202	74,706	65,791	9,534	4,266	32,330	167	2,463
Clinton.....	1,944	531	117,192	61,550	7,319	915	50,290	22	1,953
Crawford.....	57	50,775	143,833	57,390	2,651	8,478	20,310	150	2,015
Dallas.....	3,361	4,970	104,460	43,115	1,482	270	21,650	.....	1,175
Davis.....	4,697	99	64,669	22,167	1,701	.....	34,590	.....	540
Decatur.....	6,741	150	77,560	18,603	1,265	70	34,890	.....	1,239
Delaware.....	164	424	92,195	46,077	5,845	2,523	39,650	47	1,484
Des Moines.....	6,246	138	54,048	35,716	1,420	.....	18,130	.....	1,456
Dickinson.....	.....	19,834	27,898	23,113	814	10,336	1,650	6,065	670
Dubuque.....	567	523	70,775	61,767	4,684	1,015	40,250	.....	2,497
Emmet.....	33	34,111	37,418	25,526	1,075	10,554	1,710	7,300	621
Fayette.....	692	1,558	81,828	73,795	4,600	5,000	44,870	3,187	1,938
Floyd.....	125	2,637	72,440	62,896	2,199	3,692	20,820	4,128	2,906
Franklin.....	37	4,496	101,618	86,422	1,070	3,200	16,300	7,590	1,482
Fremont.....	4,348	6,710	96,840	11,430	740	120	11,080	.....	760
Greene.....	25	3,225	104,295	60,270	1,370	1,440	14,250	1,510	1,150
Grundy.....	40	4,912	90,686	58,620	1,190	8,050	17,580	1,090	1,940
Guthrie.....	1,090	11,760	98,260	55,600	1,605	790	21,250	260	1,310
Hamilton.....	.....	3,090	94,430	47,140	465	1,130	15,470	3,320	1,015
Hancock.....	.....	14,275	66,870	60,820	790	12,464	8,650	15,500	960
Hardin.....	.....	5,825	96,510	62,710	710	2,110	8,240	2,140	1,485
Harrison.....	280	39,064	92,490	23,900	2,660	710	8,603	.....	1,256
Henry.....	4,765	220	73,518	37,410	1,330	.....	21,190	.....	1,040
Howard.....	90	3,584	45,190	55,570	490	9,010	15,540	11,410	1,160
Humboldt.....	.....	21,390	60,402	35,330	510	2,029	16,050	2,940	1,203
Ida.....	.....	3,387	92,710	36,813	920	5,407	13,980	126	1,265
Iowa.....	828	670	977,720	50,520	5,390	1,880	37,690	.....	1,525
Jackson.....	1,880	937	77,185	43,520	10,150	693	35,190	.....	1,060
Jasper.....	1,270	9,190	120,183	43,850	1,980	678	29,730	.....	8,673
Jefferson.....	4,303	152	59,340	24,610	2,310	.....	24,104	.....	547
Johnson.....	3,280	725	92,665	42,318	4,450	890	31,020	.....	1,630
Jones.....	102	181	82,719	31,644	4,238	1,338	35,490	.....	1,009
Keokuk.....	4,035	336	49,144	46,348	3,349	286	36,118	.....	1,156
Kossuth.....	33	58,327	105,370	80,085	508	14,240	10,785	25,176	1,550
Lee.....	18,465	45	46,002	18,269	2,015	.....	31,220	.....	1,463
Linn.....	266	325	108,841	45,667	5,192	790	46,780	170	2,300
Louis.....	3,626	205	66,293	23,871	1,512	.....	15,450	.....	604
Lucas.....	4,183	45	65,812	18,541	2,002	225	21,430	.....	528

COUNTIES.	Winter wheat— acres.	Spring wheat— acres.	Corn— acres.	Oats— acres.	Rye— acres.	Barley— acres.	Tame hay— acres.	Flax— acres.	Irish potatoes— acres.
Lyon	4,994	97,843	55,034	38,013	594	51,057	4,250	2,730	1,359
Madison	5,292	8,893	92,454	28,259	1,683	256	27,830	...	853
Mahaska	5,270	1,028	87,338	28,825	2,872	506	30,760	...	1,843
Marion	221	3,386	96,164	30,269	3,328	399	23,820	...	2,205
Marshall	1,569	8,018	71,447	42,204	1,448	1,570	25,560	147	1,347
Mills	87	18,395	76,061	17,929	447	220	14,480	...	2,058
Mitchell	67	5,894	49,166	52,531	2,466	19,366	22,150	14,314	1,335
Monona	3,675	17,089	115,168	25,944	1,703	2,898	31,130	620	1,231
Monroe	4,294	75	47,263	12,118	2,703	...	30,350	...	500
Montgomery	5,638	17,643	101,154	21,315	795	...	13,360	...	1,302
Muscatine	142	1,159	67,184	24,562	3,015	4,170	28,220	...	1,676
O'Brien	...	41,338	73,740	50,665	820	40,018	10,380	5,168	1,396
Osceola	11,342	59,612	36,230	33,256	430	28,673	4,450	5,346	1,140
Page	15	8,052	129,694	21,513	723	198	28,380	...	1,832
Palo Alto	77	11,537	64,686	58,710	703	5,114	6,460	7,947	1,186
Plymouth	806	101,860	124,614	62,703	1,303	10,397	10,570	2,090	2,907
Pocahontas	1,259	13,741	74,644	52,443	950	5,332	5,750	7,342	1,721
Poik	613	7,188	98,344	36,334	1,431	90	22,350	...	4,636
Pottawattamie	2,354	57,853	205,941	48,239	1,942	2,928	25,029	280	4,240
Poweshiek	...	1,028	94,222	48,469	2,511	1,026	38,540	...	1,217
Ringgold	...	185	93,921	26,848	1,535	297	38,990	...	795
Sac	13,048	17,325	114,705	57,492	1,593	7,018	19,490	3,741	1,523
Scott	350	3,559	59,405	30,625	2,271	20,087	27,430	...	6,344
Shelby	122	34,378	110,776	35,071	1,560	9,117	20,790	...	2,119
Sloux	518	150,581	114,369	64,896	600	32,745	3,280	1,610	1,645
Story	6,863	3,920	110,963	58,269	2,461	806	19,580	350	1,171
Tama	548	5,978	97,870	60,658	2,755	22,212	32,260	...	1,738
Taylor	8,010	6,863	95,630	24,957	494	273	36,420	...	3,347
Union	7,442	377	71,874	22,785	782	...	26,970	...	999
Van Buren	914	8,010	41,575	14,352	1,304	...	18,110	...	430
Wapello	2,957	70	61,570	15,570	2,239	...	31,450	...	1,290
Warren	1,124	5,551	85,929	27,682	2,872	...	30,310	...	2,126
Washington	...	95	90,360	35,894	2,664	...	41,140	...	806
Wayne	...	...	73,736	21,336	1,834	...	47,420	48	1,720
Webster	...	6,517	112,040	59,723	1,241	...	9,190	2,225	1,730
Winnebago	...	23,558	36,239	32,353	116	5,614	4,110	10,175	628
Winneshiek	477	6,000	68,972	64,276	1,783	14,306	33,480	11,254	1,327
Woodbury	151	53,024	161,459	36,424	2,236	3,927	9,300	1,410	2,338
Worth	7	6,792	38,482	51,650	758	10,838	11,110	10,258	842
Wright	...	7,267	82,873	60,831	318	4,192	12,870	7,940	960
Totals..	191,451	1,293,231	8,396,286	4,299,243	210,309	509,589	2,230,455	225,014	104,456

JULY CROP REPORT.

The reports of county and township correspondents of the Iowa Weather and Crop Service made a flattering showing of the condition of the crops on July 1, 1898, as will be seen by the following summary of averages for the state: Winter wheat, 97 per cent; spring wheat, 99; corn, 102; oats, 98; rye, 97; barley, 100; millet, 98; flax, 98; broom corn, 93; potatoes, 102; sweet potatoes, 97; sorghum, 99; meadows, 103; pastures, 105; apples, 79; pears, 71; plums, 70; peaches, 88; grapes, 99.

On the 1st of July, 1897, the same correspondents reported the average condition of the staple crops at much lower figures, as follows: Winter wheat, 61 per cent; spring wheat, 88; corn, 76; oats, 83; barley, 93; rye, 87; flax, 88; millet, 100; broom corn, 82; potatoes, 92; sweet potatoes, 92; sorghum, 85; apples, 84; plums, 72; grapes, 80; timothy and clover, 89.

A COMPARATIVE EXHIBIT.

AVERAGE CONDITION OF IOWA CROPS ON JULY 1ST FOR FOUR SEASONS.

CROPS.	1898.	1897.	1896.	1895.
Winter wheat	97	61	91	83
Spring wheat	99	88	87	96
Corn	102	76	92	101
Oats	98	83	91	102
Rye	97	87	93	82
Barley	100	93	97	96
Millet	98	100	95	93
Flax	98	88	94	96
Broom corn	93	82	91	96
Potatoes	102	92	100	103
Sweet potatoes	97	92	95	93
Sorghum	99	85	92	96
Apples	79	84	83	62
Grapes	99	80	92	42

AUGUST 1ST CROP REPORT.

Reports received from the county and township correspondents of the Iowa Weather and Crop Service, on or before August 1st, have been tabulated, and the estimates as to the condition of the unharvested crops show the following averages:

Corn, 94 per cent; millet, 90; flax, 95; broom corn, 90; potatoes, 78; apples, 63; grapes, 95; pastures, 86.

The fact should be noted that since the dates on which most of these reports were written the copious rains have broken the drouth and greatly improved the condition of the crops that were most injuriously affected by heat and aridity. It remains to be seen whether or not the corn crop has been so materially injured as to reduce the final output below the average.

CROP REPORT SEPTEMBER 1ST.

The regular crop report, September 1st, made by the county and township correspondents of the Iowa Weather and Crop Service, has been tabulated and the results are given below. The report gives estimates of the condition of the unharvested crops, and the yield per acre of the cereal crops so far as may be ascertained from threshers' returns and other sources of information.

Corn.—The condition of this important crop is shown to be unusually variable, or "spotted," as some reporters describe it, as a natural result of the unequal distribution of rainfall in the critical stage of its growth. The estimates of condition show a very wide range in different counties and districts, the figures ranging from 60 to 120 per cent. The average of all the estimates of condition is 86 per cent for the state at large. This is a reduction of 8 per cent as compared with the August report.

The crop reporters were asked to make a careful estimate of the probable yield of corn in their respective localities, and the result accords with

their estimate of condition. The average of the estimates by counties indicates an average yield of 34 bushels per acre for the state at large, or 5 bushels per acre above the average output in 1897. If their estimates are sustained by the final returns of the harvest, the corn crop of Iowa for 1898 will be slightly above the average of the past 15 years, which is about 33 bushels per acre. This report, however, is only a preliminary estimate by the crop reporters, nearly all of whom are practical farmers, and it may be materially reduced by husking returns.

It is interesting, however, as showing that the standard of estimate is high; and the average crop reporter understands 100 per cent to signify a crop of 40 bushels of sound corn per acre.

As showing the variable condition of corn, the fact may be noted that the reports from 17 counties indicate a yield of 25 to 30 bushels per acre; 66 counties give promise of 30 to 40 bushels; and 16 counties make a showing of 40 to 45 bushels per acre.

If the estimates of our reporters are sustained by the husking returns, the corn crop of Iowa this year will be about 280,000,000 bushels, or 40,000,000 bushels in excess of the total in 1897.

Wheat.—Threshing returns from the counties that produce winter wheat show an average yield of 18 bushels per acre; and the reports indicate an average of 16 bushels per acre of spring wheat. These figures, if borne out by the later returns, will give the state a total wheat harvest of 24,137,814 bushels. This amount is 9,524,760 bushels in excess of the wheat output of last year.

Oats.—The yield of oats appears to be 33 bushels per acre, as the state average. This indicates a total yield of 141,875,000 bushels, or 9,304,000 bushels more than in 1897.

Barley.—Average yield per acre, 28 bushels; total yield, 14,268,492 bushels

Rye.—Average yield per acre, 17 bushels; total yield, 3,575,253 bushels.

Timothy seed averages 4.2 bushels per acre. Tame hay yields 1.8 tons per acre, which will give a total of 4,014,819 tons, which amount is 652,532 tons in excess of the output last year.

Wild hay will average 1.4 tons per acre, making a total of over 2,000,000 tons.

The condition of the minor crops is rated as follows: Millet, 91 per cent; buckwheat, 86; potatoes, 75; apples, 58; pastures, 84.

FINAL CROP REPORT, 1898.

AVERAGE YIELD PER ACRE, TOTALS FOR THE STATE, AND FARM PRICES DECEMBER 1ST.

Final reports for the season have been received from the county and township correspondents of the Iowa Weather and Crop Service, giving the average yield of the staple soil products, and the average home prices obtainable therefor on or about December 1st. The reports have been tabulated by counties, and the following summary is made for the state.

Wheat—Winter wheat made a large yield considering the reported condition of the crop at the close of winter. The average yield as reported is 16.5 bushels per acre, and the total output for the state is 3,168,916 bushels. The average home price is 55 cents per bushel. Spring wheat brought a total product of 19,152,352 bushels, an average of 14.8 bushels per acre. The home price is 52 cents per bushel. The aggregate amount of both winter and spring wheat is 22,321,268 bushels, valued at \$11,702,126.

Corn.—There has been an unusually variable output of this great staple, the county averages as reported ranging from 25 to 42 bushels per acre. The stand was perfect everywhere, and in many counties the yield was far above all previous estimates. Fifteen counties report 25 to 30 bushels, fourteen counties 40 to 42, and seventy counties range from 31 to 39 bushels per acre. The aggregate for the state, figured from the several county totals, is shown to be 289,214,850 bushels, produced from an area of 8,396,286 acres. The average for the state is, therefore, 34.5 bushels per acre. The average home price on December 1st, was 23 cents per bushel, and the present value of the crop is, therefore, \$66,519,405. The greater part of the crop, however, is not sold on the market, but is used as raw material in the manufacture of animal and dairy products, at an average increment of 40 to 50 per cent above the current prices paid for corn.

It should be stated in this connection that a considerable percentage of the corn crop in this state, probably 20 per cent, was still unharvested on December 1st, the work having been seriously retarded by the early advent of winter. A portion of the unharvested corn will likely be materially damaged, and it may be estimated that fully 10 per cent of the crop of the state will be unmerchantable, though it may possess some feeding value. The general condition of the cribbed corn is good.

Oats.—The total yield of oats is 139,915,346 bushels; an average of 32.5 bushels per acre; the average home price is 21 cents per bushel, making the present market value of the crop \$29,383,222.

Rye.—Total product, 3,370,550 bushels; average per acre, 16 bushels; home price, 33 cents per bushel; present value, \$1,280,809.

Barley.—Total product, 14,138,011 bushels; on an acreage of 509,589 acres; average yield, 27.5 bushels per acre; home value, average 30 cents per bushel; value of crop, \$4,209,741.

Flax.—Total product, 2,376,604 bushels; average per acre, 10.5 bushels; average home price 80 cents per bushel; total home value, \$1,901,283.

Potatoes.—Total bushels harvested, 12,538,411; average per acre, 76 bushels; home value, 31 cents per bushel; value of crop, \$3,886,907.

Cultivated Hay.—Total number of tons harvested, 3,852,561; average per acre, 1.7 tons; value, \$1.30 per ton; total value, \$16,566,012.

Prairie Hay.—Product, 1,645,419 tons; value, \$5,758,966.

Buckwheat.—The average yield is 13.8 bushels per acre; total product, 169,740 bushels, worth \$34,870.

Timothy Seed—Average yield, 3.9 bushels per acre; yield (estimated), 725,000 bushels; valued at \$768,500.

Clover Seed.—Yield per acre, 1.7 bushels; total product (estimated), 87,550 bushels; value, \$288,915.

Millet Seed.—Product, 19 bushels per acre; total yield, 161,500 bushels; worth \$61,370.

Sweet Potatoes.—Product (estimated), 245,000 bushels; value at home, \$218,250.

Sorghum.—Yield per acre, 94 gallons; estimated value, \$350,000.

Broom Corn.—Estimated value, \$25,000.

Corn Fodder.—In shock and field, worth \$8,250,000.

Pasturage.—Estimated worth, \$30,000,000.

Fruits and Vegetables.—Estimated value, \$6,200,000.

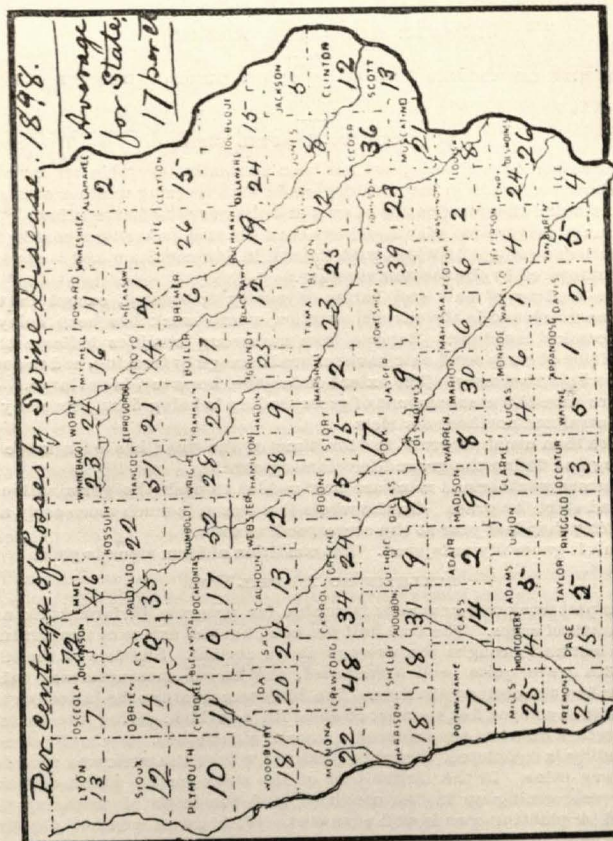
The reports show the average farm price of horses to be \$50 per head; milch cows, \$35; average price of wool, 16 cents per pound. Amount of fall plowing is estimated at 88 per cent.

The reporters were asked to estimate the percentage of loss of hogs, by cholera or other disease, for the year ending December 1st. The reports show an average loss of 17 per cent for the state at large. The county estimates indicate a wide range in the ravages of the disease, from 1 per cent in several counties to 72 per cent in the county reporting the greatest loss.

GENERAL CROP STATEMENT, 1898.

CROPS.	YIELD PER ACRE.	AGGREGATE YIELD.	HOME VALUES DEC. 1ST.
Winter wheat.....	10 5	3,168,916 bus.	\$ 1,742,908
Spring wheat.....	14 8	19,152,362 bus.	9,459,223
Corn.....	34 5	239,214,850 bus.	66,519,405
Oats.....	32 5	139,915,346 bus.	26,383,222
Barley.....	27 5	14,138,011 bus.	4,209,741
Rye.....	16 0	3,370,560 bus.	1,280,869
Potatoes.....	78 0	12,538,411 bus.	3,888,907
Cultivated hay.....	1 7	3,852,761 tons.	16,566,012
Prairie hay.....	1 2	1,645,419 tons.	5,758,966
Buckwheat.....	13 8	168,740 bus.	84,870
Flax.....	10 5	2,376,694 bus.	1,901,283
Timothy seed.....	3 9	725,000 bus.	768,500
Clover seed.....	1 7	87,550 bus.	288,915
Millet seed.....	19 0	161,500 bus.	61,370
Sweet potatoes.....		245,000 bus.	218,250
Sorghum.....	94 gals.	Estimated.	350,000
Broom corn.....		Estimated.	25,000
Corn fodder.....		Estimated.	8,250,000
Pasturage.....		Estimated.	30,000,000
Fruits and vegetables.....		Estimated.	6,200,000
Total.....			\$187,455,376

To the above figures should be added the increment in value gained by consumption of crops in the production of beef, pork, mutton, wool, dairy products, poultry and eggs, horses, etc. The aggregate value of the soil products of Iowa for the year 1898 is not less than \$225,000,000.



CLIMATE AND CROP BULLETINS.

SUMMARIES OF WEEKLY BULLETINS ISSUED DURING THE CROP SEASON,
1898.

BULLETIN NO. 1, APRIL 12TH.

The season opened early, and has been unusually favorable for farming operations and seeding; but cool, dry winds, with freezing weather at night, have retarded the germination of seed and the growth of vegetation.

A much larger area than usual has been planted in spring wheat in the northern and central districts, with the soil in fine condition, and it appears to be uninjured by the low temperature.

The seeding of oats and barley is nearly completed, except in the extreme north and in the eastern counties, where work has been delayed by excessive moisture. Reports from numerous localities indicate that some fields of early sown oats have suffered damage by freezing, and re-seeding has been necessary. The extent of damage, however, is not large.

More than the usual amount of grass seeding is being done, especially in the central and northern districts.

More than usual progress for the time of the year has been made in plowing and fitting the ground for planting corn.

Warmer weather and rains are now needed to push the germination of seed and start the grass. On the whole the season is much more early and promising than last year at the corresponding date.

Fruit is generally uninjured. The condition of farm stock is good.

BULLETIN NO. 2, APRIL 19TH.

The past week was generally favorable for progress in farm work, and for growth of crops. The first half was cool, but the excess of temperature of the last half brought the average above normal. Showers on the 12th and 13th were quite well distributed, the larger measurements being reported in the eastern districts. The high temperature the latter part of the week developed fine showers on the 16th and 17th, giving the central and western districts a considerable amount of moisture.

Seeding is completed, except in localities where the work was retarded by heavy rains. In the larger part of the state spring wheat, oats and barley are coming up in fine condition, and the work of preparing the ground for planting corn is well advanced. With warm weather planting will be commenced before the close of April.

Grass is making a fine start, and reports indicate that pastures will afford support for stock earlier than usual. The general outlook for winter wheat is much better than early reports indicated. The season is early and prospects are flattering.

BULLETIN NO. 3, APRIL 26TH.

The past week has been cool, with general deficiency of sunshine; but no damage resulted from the frost or low temperature. The rainfall was well distributed, and sufficient for the present needs of all crops. In portions of the southeast district farm work has been seriously retarded by excessive moisture. In the larger part of the state the rainfall was much needed, and it came in a form to afford the largest measure of benefit to grass and grain crops. The soil is generally in the best possible condition for the germination of seed and for planting.

Good progress has been made in plowing, and with the early advent of warm weather corn planters will begin operations. On the whole the agricultural outlook was never better in Iowa in the closing week of April.

BULLETIN NO. 4, MAY 3D.

The average temperature of the past week was slightly below the normal. Light frosts were noted in many localities, but no damage has been reported. The amount of sunshine was somewhat less than normal.

The rainfall came in the form of light showers, quite well distributed, and generally ample for the present needs of crops. In the southeast district, where the soil has been too wet in the early spring, the conditions are somewhat improved, and plowing for corn is in progress. In more than four-fifths of the state there has been no excess of moisture, and the soil is in excellent condition for farming operations. Reports indicate that a large area is now in readiness for planting corn, and farmers are only awaiting warmer weather to start their planters. In numerous localities in the southern and central districts planting has been commenced, and even in the northern districts a few have ventured to begin that work.

Grass and grain crops are generally reported in good condition, showing an excellent stand. Pasturage is coming on finely, and in many sections it is ample to support stock. Fruit blossoms are somewhat belated by cool weather, but the prospects are flattering.

The storm on Saturday evening developed severe local squalls, with hail and some indications of tornadoes in the northwestern section of the state, resulting in considerable damage to buildings, and possibly some injury to persons.

BULLETIN NO. 5, MAY 10TH.

The week has been unseasonably cool, with a large excess of cloudiness. Numerous light showers with cold winds checked growth of vegetation and retarded field work during the larger part of the week. Conditions were generally more favorable on Friday and Saturday, and some progress was made in farming operations.

All reports indicate that wheat, oats, barley and rye are in fairly good condition, giving promise of average yields. Grass is generally doing well, though not making rapid growth. The season has been quite favorable for germination of clover, timothy and blue grass seed.

A good beginning has been made in planting corn in all districts, and with favorable weather that work will be pushed rapidly during the coming week. It is probable that some replanting will be necessary in fields that were planted before May 1st.

Fruit trees are rapidly coming into full bloom in the northern districts, and there are no reports of damage from the effects of light frosts on the mornings of the 6th and 7th.

The season of germination and blooming is later than the average, but farm work is well advanced except in the southeast district.

BULLETIN NO. 6, MAY 17TH.

Unseasonably cool weather prevailed during the past week in the larger part of the state, with considerable cloudiness. Light frosts are reported, but no damage resulted to vegetation, except checking its growth.

The rainfall was ample in all parts of the state, with some excess in the southeast district, where dry weather is greatly needed.

In the larger part of the state, however, the weather conditions were favorable for field work, and for the growth of wheat, oats, barley and grass. Except in the extreme southeastern counties corn planting has been vigorously pushed, and in portions of the central and northern districts it is nearing completion. The soil is generally in first class condition for reception of the seed, and the well-distributed rainfall of the 14th was timely and beneficial. The coming week will probably bring this work to a practical completion.

BULLETIN NO. 7, MAY 24TH.

The past week was warmer than usual, with a large excess of rainfall and general deficiency of sunshine.

All sections were abundantly watered, while in portions of the southern, southeastern and eastern districts the amount of rainfall was very heavy and detrimental to farming interests. The southeast district appears to have suffered most in this respect, the soil being saturated throughout the season. The station at Keokuk reports an excess of nine inches of precipitation since January 1st. Under such conditions field work has been greatly retarded in that section.

But probably three-fourths of the state has not as yet received an excess of moisture. In many localities some detriment resulted from heavy showers, which washed the soil considerably in fields recently planted.

In all sections corn planting was somewhat retarded by the frequent showers, but in the northern and central districts the work is nearly completed. Reports indicate that the seed is good and germination is quite satisfactory. In early planted fields the stand is promising, and cultivation is in progress.

The wet weather has been generally favorable for grass, wheat, oats, rye and barley.

BULLETIN NO. 8, MAY 31ST.

This has been a fine growing week—the best of the season—with almost ideal weather conditions in the larger part of the state. The average temperature was above normal, with abundant sunshine and ample rainfall in all districts. The showers were generally light, and in four-fifths of the state there is no complaint of excessive moisture.

Corn planting is practically completed, except in the southern and southeastern counties, wherein work was retarded by heavy rainfall. In those counties the soil conditions are much improved and farm work is

being pushed as rapidly as possible. In more than three-fourths of the state the condition of the corn crop is fairly good and much more promising than at the corresponding date in 1897. Generally a good stand has been secured, and less than the usual amount of replanting has been found necessary. The work of cultivation is in progress in all districts.

Grass is unusually heavy in meadows and pastures. Spring wheat is doing notably well. Oats and barley are making heavy growth, and the chief drawback is liability to damage by excessive growth.

An abundant hay crop is practically assured.

BULLETIN NO. 9, JUNE 7TH.

The daily mean temperature of the past week was from 3° to 5° above the normal in all districts. The heaviest rainfall of the week came on Saturday and Sunday, the 4th and 5th, and there were from four to five fair days for field work.

The conditions were favorable for the rapid growth of vegetation, and the weeds as well as crops responded to the quickening impulse. Fair progress has been made in the cultivation of corn, and in some favored localities the second plowing is in progress. Where the rainfall has been excessive, and in undrained fields, the crop is weedy. But in the larger part of the state corn has made a good stand, and its condition is fairly satisfactory. In the southeastern counties, where planting had been retarded by continued saturation of the soil, the work of planting was pushed vigorously during the week; but the acreage of corn will be materially decreased in that section.

Reports from all districts indicate that on rich lands oats may suffer material damage from excessive growth. In many localities the crop is already badly flattened. Wheat and barley are liable to suffer considerable injury from the same cause. Drier weather is needed for the normal development of all grain crops.

Conditions have been unusually favorable for pastures, meadows, new seeding of timothy and clover, flax, the potato crop, and small fruits. On the whole the crop situation is quite promising.

BULLETIN NO. 10, JUNE 14TH.

The past week was warm and excessively wet, with a very small percentage of sunshine.

All sections report copious showers, and in numerous localities there were phenomenal downpours that caused considerable damage by washing the slopes and flooding the bottoms. The heaviest amounts reported fell in Adair county, 8.58 inches in Fontanelle, and 10.57 in Greenfield from the 4th to 10th inclusive. Following are some heavy measurements reported at other localities: Clinton, 6.56 (for week ending Sunday); Marshalltown, 3.99; Parkersburg, 5.50; Fairfield, 3.39; Albia, 4.26; Des Moines, 3.46; Newton, 3.35; Waverly, 5.52; Toledo, 3.15; Boone, 3.10; Ames, 2.91; Mapleton, 3.75; Sioux City, 3.05; Thurman, 5.50; Lamoni, 3.58; Mt. Ayr, 3.09; Ft. Dodge, 3.33; Grundy Center, 4.17; Humboldt, 3.85; Allerton, 3.16 inches.

The effects on crops have been more or less damaging in all districts. In the larger part of the state the soil has been too wet for field work, and where the cultivation of the corn crop has been suspended, weeds and grass have made rapid advancement. Probably the acreage of this crop has

been slightly reduced by washing out and flooding. But with dry weather and normal conditions in the future, corn will make a rapid recovery and produce a good yield.

Spring wheat, oats and barley are very rank, and these crops are in imminent danger of heavy damage by lodging and rust. They are going down in all sections, and nothing but a radical change in weather conditions can save them from almost total failure.

Grass and potatoes are doing well. The wet weather has caused some timothy and clover to lodge; but the hay crop will be very heavy.

The burden of vegetation of all kinds is probably the heaviest that was ever seen in Iowa in the middle of June. The output of vegetable life, in all its varied forms, has certainly never been exceeded in this state, so early in the season, and in this enormous bulk is the chief danger to the yield of the harvest.

BULLETIN NO. 11, JUNE 21ST.

The past week averaged slightly cooler than usual, and there was less than the normal amount of sunshine. The rainfall was light in the larger part of the state, only a few localities reporting an excess.

The weather conditions were generally favorable for field work, and fairly good progress has been made in cleaning out the weedy corn fields. On all naturally well drained or tiled lands the condition of the corn crop is quite satisfactory,—better in fact than an average. On low, moist ground a small percentage has been ruined, and the extent of the loss in acreage will depend upon the weather in the near future. With the return of normal conditions, the corn fields may be speedily cleaned out, and the outlook for that crop will be very promising.

Spring wheat, oats and barley, are heading out. In all districts reports show that the growth is rank and the grain considerably lodged. The extent of damage from this cause cannot as yet be determined, but evidently it will be materially reduce the condition of these crops below the estimates made June 1st.

Cutting clover is in progress in many places, and timothy is nearly ready for the harvest. The flax crop is quite promising. Potatoes have made unusual advancement. Pasturage is extra fine.

BULLETIN NO. 12, JUNE 28TH.

The temperature of the week was high, with an abundance of sunshine. The rainfall was seasonable in amount, except within a limited area in the southwestern district, where considerable damage was caused by a heavy shower on the night of the 21st. Severe wind squalls swept over the central belt on the night of the 24th, causing additional injury to wheat and oats in fields where the growth is rank.

Generally, however, the weather conditions were highly favorable for farming operations and the advancement of all crops. The corn fields show satisfactory progress in cultivation, and the bulk of the crop is well cleaned and in a promising condition. At the close of another favorable week the work of cultivation will be practically completed, except in some of the southern counties where the work was delayed by excessive rains.

Winter wheat and rye are about ready for the reaper, with good prospects. Spring wheat, oats and barley are heading; and the outlook for these crops is made uncertain by their heavy growth and tendency to lodge.

The hay harvest is in progress, with very heavy yields reported in all sections. Potatoes, garden truck and small fruits are doing notably well.

BULLETIN NO. 13, JULY 5TH.

Seasonable weather conditions prevailed generally during the past week and good progress has been made in farm operations and in the growth of crops. The cultivation of corn has been pushed to a practical completion in nearly all sections of the state, and this crop is being laid by in a remarkably promising condition in respect to size, color, stand and freedom from weeds.

The hay harvest has progressed fairly well, except in some localities in the northern districts where the crop was injured by showers. Spring wheat, oats and barley are making good progress toward maturity, and have not lodged to the extent that was anticipated.

The harvest of winter wheat and rye is in progress, and some fields of barley are about ready to be cut. There are some reports of damage to winter wheat by rust and insects.

BULLETIN NO. 14, JULY 12TH.

The past week averaged slightly cooler than usual. The rainfall was variable and generally light; but in a few localities heavy showers occurred. At Thurman, Fremont county, the rainfall on the 6th and 7th amounted to 9.70 inches, causing heavy damage on the bottom lands.

The cooler weather was favorable for small grain crops, checking the tendency to rust, and the conditions were generally favorable for work in the harvest fields. Haying is well advanced in all districts, with heavy yield, generally secured in good condition. Winter wheat and rye are mostly in shock, and threshing operations are about to begin. Spring wheat and oats are filling well, and early sown fields are nearly ready for the harvest. Allowing for all damage by lodging and rust, these crops are likely to bring about an average yield.

BULLETIN NO. 15, JULY 19TH.

Bright, warm days, cool nights and no rainfall except light showers in a few localities in the western districts were the special features of the past week. It was a full week of ideal harvest weather, which has been well improved in securing the matured crops in fine condition.

The harvest of fall wheat and rye is practically completed and threshing is in operation. Barley is mostly in shock. In the southern section the bulk of the oats crop has been cut, and the harvest of early sown fields in the central and northern sections is in progress. The ripening of oats has been hastened by dry weather and rust on the blades, which will tend to lighten the yield to some extent. The ripening of spring wheat has also been hastened by the same cause, and the harvest of that crop is begun in various localities.

Rain is needed in all sections for pastures, potatoes, garden truck and corn, though the latter crop is not generally suffering from lack of moisture. Flax is an excellent crop. A very large amount of good hay has been secured in fine condition.

BULLETIN NO. 16, JULY 26TH.

Dry and hot weather prevailed generally during the past week. The midsummer drouth is still unbroken, though its severity has been somewhat mitigated by local showers and high winds on the nights of the 19th and 24th. In the larger part of the state, however, there is urgent need of copious rains for the relief of corn, potatoes and pastures. The severe and widely extended wind squalls on the 19th inst. caused quite serious damage to small grain in shock and stack; and corn was also injured to some extent.

Corn is doing as well as could be expected, but the crop is at a critical stage, and there is danger of serious injury unless relief is afforded within a few days. The extent of damage already suffered can not as yet be estimated.

In the southern and central sections small grain has been generally put in shock, and the work of stacking and threshing is in progress. In the northern section the cutting of spring wheat and oats is nearing completion, and early-sown flax is being harvested. The reports indicate variable returns from threshing but the average will be above the output of recent years.

Late potatoes are suffering material injury by the drouth.

BULLETIN NO. 17, AUGUST 2D.

During the past week substantial relief has been afforded to the crops that were beginning to suffer from the effects of extreme heat and drouth. Fairly well distributed showers and cooler weather, with copious dews, have been very beneficial to corn, potatoes, grass and vegetables. The damage caused by high winds in various localities has been immeasurably overbalanced by the good effects of the refreshing showers and cooler temperature.

The corn crop has received the largest share of benefit, and, making due allowance for all injury by hot winds and severe squalls, the present general condition of the crop gives promise of a full normal yield, if seasonable weather prevails the balance of the season.

The potato crop has been materially shortened, and needs more rain in the near future to prevent further damage.

In the grain fields stacking and threshing are in progress. Reports of yield give promise of more than an average output of wheat, rye and barley, and the oats crop is better than early reports indicated.

The crop of apples and plums will be very light. Grapes, watermelons and tomatoes promise an abundant yield.

BULLETIN NO. 18, AUGUST 9TH.

The past week was cooler than usual, and generally showery. The average temperature ranged from 3° to 5° below the normal. The showers extended to all parts of the state, but the amount of rainfall was widely variable, ranging from less than an inch to above five inches. Phenomenally heavy measurements are reported from the west central, northwest and north central districts.

The drouth is broken, with great benefit to corn, late potatoes, pastures, and other late maturing crops. Threshing and stacking operations were delayed, and grain in shock has been in danger of damage by wet weather.

The reports generally have a more cheerful tone in relation to the corn crop, which with favorable conditions in the future now gives promise of a full average output for the state at large. Threshing returns, so far as received, indicate above an average yield of wheat, rye and barley. Oats variable, but likely to make an average.

BULLETIN NO. 19, AUGUST 16TH.

The past week was somewhat cooler than usual, the daily mean temperature being from 2° to 4° below the normal. It was generally dry the larger part of the week, and favorable for threshing and stacking, and good progress has been made in securing the grain crops.

Corn has made fair progress, though the nights have been too cool for its rapid growth. Generally, the crop is more advanced than at the corresponding date last year; but it is in all stages of growth, from the silk to roasting ears. In many early planted fields there differences are noted in the development of the ears, resulting from the reviving influence of the rains following the drouth.

In response to inquiries as to the date when the corn crop will be safe from damage by frost, quite variable opinions are given by crop reporters. The condition of the crop is variable, resulting from local differences as to time of planting and the weather conditions during the period of cultivation and growth. The average opinion seems to indicate that the more advanced corn will be fairly well matured by September 10th, the larger part of the crop will be practically safe by September 25th, and the belated portion will require all of September without killing frost to reach full maturity. In this state the average date of first killing frost is later than the first of October. So, with normal weather conditions, the corn crop is well assured, and for the state the total output will be very close to the average of recent years, and possibly above.

BULLETIN NO. 20, AUGUST 23D.

The average temperature of the past week was a little above the normal. The rainfall was quite unequally distributed, being generally very light in the western districts, and phenomenally heavy in considerable portions of the eastern and central districts, the larger measurements reported ranging from 2 to 4 inches. Several local wind and thunderstorms caused some injury to crops, but on the whole the showers were timely and beneficial. The heaviest damage was suffered by grain in shocks and in poorly constructed stacks.

The corn crop has made good progress, and, except within a limited area there is ample moisture to bring it to an early maturity. The larger number of reports as to the condition of corn are quite favorable, though in some sections the crop is reported to be somewhat below an average.

The rains have greatly improved pastures, and the soil is in good condition for fall plowing, which is in progress. Late potatoes are also receiving a measure of benefit.

Threshing small grain is progressing, with numerous favorable reports as to yield and quality of grain.

BULLETIN NO. 21, AUGUST 30TH.

The week was warmer than usual, with very light rainfall except in scattered localities.

The conditions were favorable for farm work, and good progress has been made in threshing small grain and grass seed. Considerable progress has been made in fall plowing, except in sections where the soil is too dry, and in some localities a beginning has been made in sowing fall wheat and rye, with prospects of an increase in the acreage of these crops.

Corn has made unusual advancement in the last half of August, and there has been a corresponding shortening of the time required to place it beyond danger from frost. In some localities the early planted fields are being cut, and a considerable portion of the crop will be practically safe by the 15th of September. With normal weather conditions throughout the coming month the late planted portion will reach full maturity.

Very conflicting reports are received as to the condition of corn, the estimates depending upon the point of view of the crop reporters. It is certain that the midsummer drouth materially cut down the total yield of what at one time promised to be the largest crop ever grown in this state. But allowing for this reduction of prospective yield, the fields to-day carry a heavier average burden of corn than was in sight at the corresponding date last year.

BULLETIN NO. 22, SEPTEMBER 6TH.

The past week was the warmest of the season, the daily mean temperature ranging from 8° to 10° above the normal. The protracted heated term culminated in showers on the 3d and 4th, which were quite widely distributed, affording a large measure of relief to the people and the suffering vegetation.

Corn has been forced toward maturity somewhat too swiftly for the perfect development of the late-planted portion of the crop, and in some counties the hot, dry weather has unquestionably caused some damage. But on the whole, corn has done notably well, and a very large percentage is now fairly well matured and in condition to be cut up or to withstand a sharp frost. For all of the crop it would better to have seasonable weather, without frost, until the latter part of this month. Considerable progress has been made in cutting, especially in the dairy districts where the farmers fully appreciate the value of corn fodder.

More than the usual amount of plowing has been done, and seeding fall grain is in progress. The pastures need rain, and in some sections it is much needed to facilitate plowing.

BULLETIN NO. 23, SEPTEMBER 13TH.

The past week was unseasonably cool, with less than the usual amount of sunshine. The daily average temperature was from 5° to 7° below the normal. Light frosts were observed in many localities, but no damage resulted. The amount of rainfall was generally ample for present needs, and in the larger part of the state the pastures have been improved and the soil is moist enough for fall plowing. Seeding of fall wheat and rye is in progress, with prospective increase in the acreage of wheat.

The greater part of the corn crop is now sufficiently mature to withstand frost, and a considerable portion is being cut and shocked. The ripening

of late corn has been retarded, but it is doing fairly well, and with normal weather in the near future it will soon be safe. Late potatoes need two or three weeks to ripen.

BULLETIN NO. 24, SEPTEMBER 20TH.

The first half of the week was cool and showery, and the last half warm and dry. The rainfall was generally sufficient for present needs in the greater part of the state, affording ample moisture to improve the pastures, replenish the streams, and to put the soil in good condition for plowing. The central and southern districts received the larger amounts of rain, and it was much needed in the southwestern counties.

Fall plowing is now well advanced in all sections, and much seeding of fall grain has been done under most favorable conditions.

The corn crop is now practically beyond danger of material injury by frost, though some of the late-planted fields will mature in better condition if normal weather prevails through the balance of the month. The crop is generally more fully matured in the northern half than in the southern half of the state, and with drying weather much of the crop will be in condition to crib early in October. A considerable area has been cut and shocked, especially in the eastern districts.

On the whole, this has been a season of bountiful production in this highly favored state.

LOSSES BY LIGHTNING.

[FROM SEPTEMBER MONTHLY REVIEW.]

Blanks for the collection of statistics of losses due to lightning were sent out last spring to agents and adjusters of insurance companies, and to others who were willing to aid in this undertaking. The inquiries cover a wide range, relating to the losses and the conditions under which they occurred. The responses have not been as general and comprehensive as we hoped to receive, but perhaps they were as numerous and specific as could be expected at the inception of this work.

Up to date, October 1st, we have received 186 reports, mainly from adjusters of losses of insurance companies doing business in this state.

These reports give details of the loss or damage by lightning of 37 buildings, and the killing of 266 head of live stock, including 37 horses and mules, 32 sheep, 40 hogs and 157 cattle.

The aggregate loss on buildings burned or damaged, with their contents, is \$17,336. Of the number of buildings struck, there were 28 barns and 9 houses. Of the dwelling houses only 2 were burned, causing a total loss of \$1,000; and 7 were struck and damaged to the amount of \$180. Barns suffered much more heavily than houses, 17 of the 28 being consumed with their contents, the loss amounting to \$16,156. Of all the buildings struck, 2 were reported to have been provided with lightning rods, and these were barns. The rods were of rough iron, but we have no information as to the manner of attachment, or the ground connection. One of the rod-damaged barns was only slightly injured, and the other was consumed.

The reports show that 14 barns were struck by lightning in the months of July and August, and of that number 11 were totally consumed; whereas, in May and June, 12 barns were struck and only 5 were burned. This affords evidence of the fact that barns suffer greater loss after the hay and grain harvest, when they are filled with the products that generate large quantities of vapor. Records show that of the number of barns struck before harvest only 41 per cent were consumed, while after harvest 78 per cent were burned by the fiery bolts. And yet there was greater electric energy displayed in the early, than in the latter, part of the season, as shown by the fact that the live stock killed in the months of May and June, were double the number reported in July and August.

These reports show the interesting fact that of the 266 head of live stock killed by lightning, 118 were found in close contact with wire fences; and also that these wire fences were not provided with ground wires. That is to say, over 44 per cent of the losses of live stock may have been caused by contact with wires charged with electric force.

Unquestionably, wire fences, as now constructed, serve as death traps to live stock, causing a vast amount of loss every year. And it is also quite evident that a considerable percentage of danger may be avoided by use of ground wires at frequent intervals, in the construction of wire fences. In some of the reports it was stated that there were evidences that the lightning struck the fence at a considerable distance from the point where the stock was killed.

As an illustration of this matter, Mr. J. R. Chandler, of Dexter, reported the loss of a flock of 32 sheep, on the premises of G. F. Lenocker, in Madison county, June 22d. They were found lying along the wire fence, against which they were driven by the storm, and it was observed that the lightning struck the fence 20 rods from the place where the sheep were killed. That deadly bolt might have been sent into the earth within a few feet of where it struck. This emphasizes the need of careful observation of all the conditions connected with losses of that kind, to discover the causes and possible means of prevention.

Of the 186 destructive strokes reported, we find that 55 occurred on low, moist ground, and in 41 cases near timber or trees. The others were on dry land, and in open fields.

It is hoped that during the next season we may awaken sufficient interest to bring out a largely increased number of reports. By the systematic collection and tabulation of the details, and a careful study of all the facts that may be gathered in this form, we may possibly gain some knowledge of practical utility as well as of scientific interest.

LOCAL CLIMATIC CHANGES.

[MONTHLY REVIEW U. S. WEATHER BUREAU.]

A correspondent in Northfield, Mass., desires our opinion on the question: "Were the winters of fifty years ago much colder, or were the snowfalls deeper than at present? The opinion is widely held that the winters were colder and the snowfalls deeper, but I can find nothing to warrant the belief

except that in the first part of the century a much larger percentage of the population lived in the hill towns or in the interior, which are both colder than the valley or the coast towns."

On the general question as to the appreciable changes in climate, the editor's opinion is that there has been no such change in any respect whatever so far as meteorology proper is concerned. If we divide our records of the weather recorded in North America since the days of Columbus into two periods, viz., before and after the year 1800, we shall find that every peculiarity, such as remarkable storms, winds, rains, floods, frosts, etc., recorded in the current century can be matched by a corresponding remarkable event before the year 1800. The popular impressions alluded to by our correspondent result almost entirely from the imperfections of our records, and especially of our memories. There is a large class of persons whose habits of thought are so crude that when they experience any very remarkable weather they jump to the conclusion that the climate has changed, forgetting that they themselves have had such a limited personal experience that they are not fair judges of the weather over the whole country or of the climate of a century.

Our correspondent seems to suggest that a certain change in the habits of the people, such as the removal from the interior to the coast, or from forests to prairies, or from country to city, or vice versa, will partly account for widespread errors in respect to climate. The suggestion is excellent, but the editor would be inclined to interpret the phenomenon somewhat differently. The general movement of the population in the past century has been from the Atlantic states westward, and from the country to the city, or quite opposite to the movement suggested by our correspondent. In fact, we find no real agreement in the so-called popular traditions with regard to the weather. We have met with quite as many persons who think the winters are more severe as with those who think the winters are less severe than formerly. Everything seems to depend upon how and where the "oldest inhabitant" lived when he was a boy as compared with his present condition. If he moved from a farm on a windy hilltop in the country down to a cosy house in the village, the climate seemed to him to have improved. If he moved from the milder climates on the coast in his youth to the severer climates in the interior, he was, as a boy, struck with the great change, and the impression still remains with him that those winters were severer than now. If he has lived continuously in a large city like New York, where the growth of tall houses, the increased smoke, and diminished sunshine, have completely changed the climate, and where these combined with the changes in the mode of living, especially the abolition of the open wood fire, have rendered the human system vastly more sensitive, he finds that the inequalities of climate are greater than formerly.

From a hygienic point of view "the climate" includes everything that affects the health and comfort of the body. The meteorological climate that agrees perfectly with one person may be entirely too severe for another. Our remembrance of our physical sensations is not a safe criterion when judging of climate. Our remembrance of an occasional storm or winter is not a safe guide in comparing the past with the present. Our records of deep snows are too fragmentary to give anything more than a general conviction that there has been no material change in the snowfall. Our

records of extreme low temperature are liable to be in error several degrees by the ancient use of very imperfect thermometers, and are almost certain to be exaggerated if the thermometers were placed in valleys or lowlands where cold air settles on still, clear nights, so that we must use great caution in interpreting these records; differences of 5° to 10° degrees, and even 20°, have occurred between the minimum temperatures recorded by weather bureaus and voluntary observers located within a few miles of each other, owing to the combination of these two sources of error.

Remarkable rains and snows are usually quite local phenomena; there have been several remarkable cases of this nature in certain portions of New England and the middle Atlantic states within the past ten years. Similar remarkable cases occurred in other portions of these states fifty years ago, and equally remarkable cases occurred in still other portions just before 1800. If there has been any change in the climate of Northfield, Mass., it is because it lay within some one of these regions of extraordinary rain or snow on one occasion and not on another. Such a change of climate at one spot is no criterion by which to judge of changes at other places 100 miles away. The average climate of New England, so far as the weather is concerned, has not appreciably changed since the days when her oldest forest trees were young saplings, and that carries us back nearly five hundred years.

CLIMATE AND SOIL FERTILITY.

HEAT AND ARIDITY AS IMPORTANT FACTORS IN THE PRODUCTION AND MAINTENANCE OF A FERTILE SOIL.

A recent bulletin issued by the experiment station at Brookings, South Dakota, presents some interesting facts and theories relative to the causes which have operated in the production of the wonderfully fertile soil of that portion of the great central basin. We copy the following extract of this valuable report, and append thereto brief comments:

All that portion of South Dakota lying east of the Missouri river is covered by what is known as drift or boulder clay, except a few small isolated areas. This formation varies in depth from a few feet to two or three hundred feet, and when the entire mass of the deposit is considered it is of a remarkably uniform character throughout the state. Its chief characteristic is a light yellow color, with numerous small, calcareous masses and more or less boulders, stones and pebbles in the subsoil, gradually merging into a dark brown or black loam on the surface. This dark color is due to the presence of decaying vegetable matter and the action of the elements.

Everywhere drift soils are recognized as containing practically in exhaustible quantities of the elements of fertility, but in most glacial areas the ice-sheet, in its movement from the north, encountered so many exposed ledges of rock that the material it deposited was composed largely of boulders that had not yet been reduced to soil; so that, while drift soils are universally recognized as fertile soils, they are usually so stony as to be difficult to till. Fortunately for this state, the character of the country to the north of us for hundreds of miles was such that little raw material in the form of rocks was added to the moving mass of ice and soil, but the materials which it did bring had been so thoroughly mixed up and ground down by the time it reached its present location that it is composed almost entirely of thoroughly disintegrated soil material. Thus we have all the

advantages of a drift formation, with far less stones than are usually found in drift or boulder clay.

In addition to the foregoing there have been other very potent factors in producing a soil of great uniformity and remarkable fertility throughout this region. Most important of these is the fact that this has been a region of light rainfall for a great length of time. We have become accustomed to associate the ideas of humidity and fertility, on account of the very luxuriant growth of vegetation which is found in those countries having a heavy annual rainfall. But the very same causes that produced the heavy growth of forest and underbrush will, as soon as that forest growth is removed, begin to carry away, not only those elements of stored up plant food in the soil, but in many instances the soil itself; so that in many of the humid districts the luxuriant forest areas of one generation become the washed and worthless hillsides of the next. No such wasting effects have been experienced upon our open prairies, although they have been unprotected by forest growths for ages; but, on the contrary, there has been a steady increase in the store of available plant food as a direct result of those chemical and physical changes which are constantly going on in the soil. Had this been a region of heavy rainfall, the salts which result from these changes would have been washed off or leached out as fast as formed, and no such store of available plant food would have been possible.

The influence of temperature in soil formation is also an important one. It has an effect upon both the chemical and physical changes which take place in the soil. Other conditions being equal, all chemical changes taking place in soil formation are accelerated by high and retarded by low soil temperatures. The very high soil temperatures which have been observed in this region during the summer and fall months have contributed in no small measure to the reduction of the soil to its present condition. The effect that temperature has upon the physical changes that take place in soil formation is largely due to expansion and contraction. There are but few regions that have experienced such frequent, sudden and violent changes as this. So it seems probable that the temperature conditions of this climate have had a beneficial effect upon the physical, as well as the chemical, changes which are necessary for the production of fertile soil.

The all important question to be considered is how to till the soil so as to place it in the best possible physical condition for plant growth. The object of all tillage is to secure the proper arrangement of the soil particles with relation to each other. It is true that tillage has a very beneficial effect in the destruction of weeds, but any system of tillage that will keep the soil in the best physical condition will also keep the weeds down, so that destruction of weeds does not need to be considered.

There is probably no locality where the question of tillage needs more careful study, nor where it promises greater rewards. We have everything that is needed for a rich, prosperous agricultural state; a soil of particularly inexhaustible fertility, easily and cheaply worked, favorable conditions of temperature and sunshine, and, if properly husbanded, sufficient rainfall. That there is frequently an insufficient supply of moisture to produce a full crop under the wasteful and oftentimes thoroughly shiftless system of farming which has been so extensively practiced in the past, admits no denial. That the normal precipitation is sufficient for the production of good crops under a proper system of tillage, we believe can be demonstrated. What the best system of tillage is, we are not yet prepared to say.

Much of the foregoing extract relating to the effects of geologic forces and climatic conditions is applicable to a large portion of the upper valley lying westward of the Mississippi river. In all this region the thoroughly disintegrated drift formation is capped by a deep layer of dark loam that is marvelously rich in all the elements of fertility. And unquestionably this wonderful surface deposit of available plant food is a direct product of the

climatic conditions that have prevailed in the vast period of time since the glacial epoch.

In our deep, rich soil we find irrefutable proof of the statement that both heat and aridity have been important factors in its production. The rainfall must have been relatively light for a very great length of time; and the ready inference is that there has been no essential change of general climatic conditions for many centuries. This tendency toward aridity for so large a portion of the year is a powerful conservator of the vast store of fertility that is the heritage of the people of this favored region. As a rule we have ample rainfall for the production of an abundance of the staple crops, and not so much as to wash off and leach out the salts and other essential elements of our fertile soil.

THE ALMANACS AND THE WEATHER BUREAU.

[MONTHLY WEATHER REVIEW, JANUARY, 1898.]

During the past few months the editor has noticed a number of newspaper paragraphs discussing the relative merits of the weather predictions published daily by the officials of the weather bureau for one or two days in advance, and those published by the numerous "farmers' almanacs" published several months, or even a year, in advance, and sold in large numbers throughout the country. The predictions of the weather, as made by the weather bureau, are based entirely upon the daily maps that show the actual condition of the atmosphere, as reported by reliable observers throughout the country. On the other hand, the predictions in the various almanacs are founded upon a variety of principles among which are the following:

First.—The most conservative and rational almanacs are those that compile from the records of many past years a table showing what sort of weather has prevailed most frequently on the respective days of the year.

Second.—The least rational almanacs are those that pretend that the weather is controlled by planetary combinations and stellar influences, therefore, such predictions are properly said to be based upon astrology.

Third.—An intermediate class publishes predictions based upon the probability of spots upon the sun, thereby assuming it to have been demonstrated that the solar spots control terrestrial weather.

Fourth.—The least scientific system of preparing the almanac predictions was explained to the editor many years ago by a gentleman whose almanac made the greatest pretensions to high scientific accuracy. This gentleman stated that on certain days he felt endowed with a certain ability or inspiration. These were his weather making days, on which he sat down, and with the most absolute confidence in the accuracy of his work, wrote up the weather for the coming year, continuing at the work for a considerable time until the inspiration seemed to leave him, whereupon he necessarily stopped and delayed resuming the work until again filled with the spirit of divination.

Doubtless some almanac makers adopt a combination of the four preceding methods, but, in general, these seem to be the principles most widely

recognized in the long-range predictions of the almanacs, except only in all cases the authors make free use of a system of general and rather indefinite terms that will apply just as well to a thunderstorm, a hurricane, or an earthquake. The warning "Look out for something very unusual about this time" is, of course, not a meteorological prediction, and not nearly as definite as the railroad signboard "Look out for the engine when the bell rings."

EVAPORATION FROM THE OCEAN.

[MAURY'S PHYSICAL GEOGRAPHY OF THE SEA.]

The mean annual fall of rain on the entire surface of the earth is estimated at about five feet. To evaporate water enough annually from the ocean to cover the earth, on the average, five feet deep with rain; to transport it from one zone to another, and to precipitate it in the right places, at suitable times and in the proportion due, is one of the offices of the grand atmospherical machine. The water is evaporated principally from the torrid zone. Supposing it is all to come thence, we shall have, encircling the earth, a belt of ocean 3,000 miles in breadth, from which this atmosphere evaporates a layer of water annually sixteen feet in depth. And to hoist up as high as the clouds and lower down again all the water in a lake sixteen feet deep, and 3,000 miles broad and 24,000 long, is the yearly business of this invisible machinery. What a powerful engine is the atmosphere! And how nicely adjusted must be all the cogs, and wheels, and springs, and compensations of this exquisite piece of machinery, that it never wears out, nor breaks down, nor fails to do its work at the right time and in the right way! The abstract logs at the observatory in Washington show that the water of the Indian ocean is warmer than that of any other sea; and therefore it may be inferred that the evaporation from it is also greater. The north Indian ocean contains 4,500,000 square miles, while its Asiatic watershed contains an area of 2,500,000. Supposing all the rivers of this watershed to discharge annually into the sea four times as much water as the Mississippi discharges into the gulf (107 cubic miles, or about one-sixth of all the rain that falls on its watershed), we shall have an average annual evaporation from the Indian ocean of 6 inches, or .0165 per day.

The rivers of India are fed by the monsoons, which have to do their work of distributing their moisture in about three months. Thus we obtain .065 inch as the average daily rate of effective evaporation from this ocean. If it were all drained down upon India, it would give a drainage which would require rivers having sixteen times the capacity of the Mississippi to discharge. Nevertheless, the evaporation from the north Indian ocean required for such a flood is only one-sixteenth of an inch daily throughout the year. I estimate the total amount of evaporation that annually takes place in the trade-wind region generally at sea as not exceeding four feet.

CLIMATE.

[DAVIS' ELEMENTARY METEOROLOGY.]

The average values of the atmospheric conditions of a region constitute its climate. The most important climatic elements are first, temperature; second, various forms of moisture, as vapor, cloudiness, and precipitation; third, wind, including storms. The pressure of the atmosphere is not a climatic element, and needs to be considered only in its association with the divisions of the wind system.

While annual averages were first considered in the definition of climate, more and more importance has come to be attached to the average of seasonal values, and to such special quantities as the average highest or lowest temperature or rainfall of a season or month. Even the extreme values are often included in climatic tables, in order to present as fully as possible the meteorological features of a district; but in so doing we approach the consideration of its weather. A full climatic account of a locality should include: for temperature—the monthly and annual means, the mean diurnal range for the several months, the mean and the absolute extremes for the year and months, the mean diurnal variability (the mean of the differences between the successive daily means), the average dates of the latest and earliest frost, the average number of days without frost; the average duration and value of cyclonic ranges of temperature in the several months; the mean intensity of sunshine in clear weather of the different months; the mean temperature of the soil at successive depths down to five or six feet: for moisture—the monthly mean absolute and relative humidity, the mean monthly evaporation from a water surface; the mean cloudiness and mean duration of sunshine in the several months; the mean monthly and annual rainfall, with additional data for melted snow in the winter months; the mean number of rainy and snowy days in every month, the mean frequency of rainfall in every month (number of rainy days divided by the total number of days), the average dates of latest and earliest snowfall, the average depth of snow on the ground at the end of every month; if possible, the proportion of rainfall received from general cyclonic storms and from local thunderstorms in the several months, and the mean diurnal variation of rainfall for the different months; the mean number of days with thunderstorms and with hail in the several months; for winds—the frequency of different directions for the several months, with the corresponding mean velocities, and indication of the frequency of calms and of exceptionally strong winds; the mean diurnal variation in direction and velocity for several months.

In regions like the eastern United States, the means of climatic elements in corresponding months of successive years vary so greatly that a considerable number of years is required to determine their true values. Hence the importance of maintaining weather records continuously under conditions as nearly constant as possible, in order to outlast the influence of dry or wet, warm or cold periods. It is hardly worth while to begin such records unless there is a fair probability of their continuance, and unless good instruments can be secured and properly exposed.

PRECIPITATION DATA—CONTINUED.

STATIONS.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.	No. years.	Record in-cluded be-tween dates be-low.
Nashua.....	1.54	2.23	2.76	2.07	4.19	5.35	6.68	3.87	5.81	3.45	2.34	3.94	44.33	11	1878-1888
Newton.....	.92	.97	1.35	3.50	4.50	4.03	3.19	3.55	3.30	2.56	1.87	1.27	31.04	12	1878-1898
Onawa.....	2.32	1.12	1.51	2.79	4.61	5.11	4.23	4.04	2.33	2.11	1.05	1.06	32.28	17	1879-1895
Osage.....	.92	1.17	1.45	2.90	4.69	4.22	3.40	2.74	3.38	2.57	1.48	1.31	29.63	8	1891-1898
Oskaloosa.....	2.96	1.07	1.98	2.74	3.71	4.00	3.72	2.73	2.91	2.28	1.66	1.15	28.91	22	1875-1893
Ottumwa.....	2.50	1.13	2.10	3.88	4.87	3.40	4.25	3.35	3.38	2.53	1.53	1.79	34.79	5	1894-1898
Ovid.....	2.01	1.35	2.19	3.64	3.42	3.83	3.53	3.86	3.74	2.34	1.36	1.58	32.85	6	1893-1898
Panama.....	.36	.55	1.29	4.08	4.09	3.83	4.56	4.13	2.77	2.34	1.08	1.16	30.24	6	1891-1896
Rock Rapids.....	.68	.14	1.59	3.75	3.39	3.74	2.52	1.76	2.30	1.75	.99	.61	23.17	6	1893-1898
Sac City.....	1.11	1.06	1.61	3.37	4.18	5.09	3.73	3.32	3.09	2.28	1.16	1.24	31.24	24	1870-1898
Seymour.....	1.45	1.66	1.21	3.95	3.11	4.40	3.46	4.49	4.07	1.61	1.81	1.99	33.21	5	1893-1897
Sioux City.....	.69	.56	1.22	3.26	3.65	3.75	3.16	2.80	1.48	1.63	.89	.88	23.97	10	1889-1898
Sibley.....	.80	.38	1.17	3.48	3.36	3.95	3.01	2.03	2.39	1.90	1.03	.70	24.20	6	1893-1898
Smithland.....	.54	.65	.66	2.09	3.50	4.32	2.96	2.77	2.84	1.76	1.71	.63	24.43	9	1879-1887
Spirit Lake.....	.57	.28	.83	3.29	2.62	3.02	2.37	2.65	2.14	2.18	1.09	.59	21.63	5	1894-1898
Storm Lake.....	.81	.68	1.37	2.49	3.47	4.52	3.79	2.66	2.68	1.45	.79	.92	25.61	10	1884-1893
Toledo.....	1.00	.62	1.33	3.42	3.14	2.48	3.08	2.56	3.11	2.04	1.30	1.18	25.26	5	1894-1898
Vinton.....	1.37	.96	1.69	3.15	3.72	3.54	2.59	2.21	2.72	2.49	1.19	1.23	26.86	9	1890-1898
Villisca.....	.72	.85	2.14	3.94	3.88	4.89	4.55	4.42	2.39	1.91	1.12	1.00	31.81	6	1893-1898
Washington.....	1.82	1.00	2.25	2.71	3.53	3.12	3.84	2.56	2.62	1.65	1.46	1.22	27.78	9	1890-1898
Waterloo.....	1.20	1.11	1.38	2.48	3.60	3.60	3.98	3.59	4.24	2.28	1.43	1.23	30.12	20	1864-1898
Webster City.....	1.13	1.05	2.13	3.33	3.36	3.63	3.46	2.60	1.70	2.40	1.20	1.31	27.35	6	1891-1898
Wesley.....	1.14	1.05	1.41	2.30	3.30	4.74	3.50	2.79	3.52	2.17	1.13	2.16	29.21	12	1879-1890
West Bend.....	.76	.92	1.70	3.42	2.81	3.86	2.96	2.59	2.16	1.38	1.56	.88	25.00	6	1893-1897
Winterset.....	1.11	.89	1.83	4.43	4.56	6.17	5.81	3.07	3.10	1.94	1.18	1.35	34.94	8	1891-1898
Means.....	1.22	1.06	1.75	3.20	3.97	4.28	3.68	3.07	2.99	2.28	1.42	1.38	30.30	—	—

ANNUAL REPORT OF THE

MEAN TEMPERATURE.

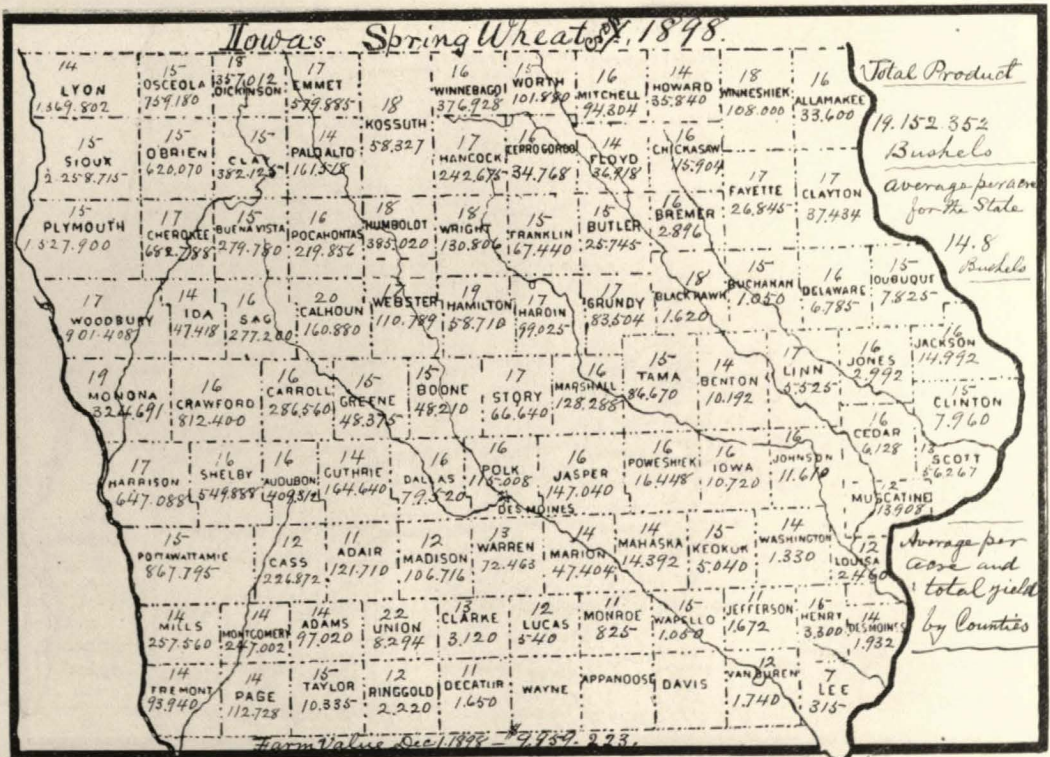
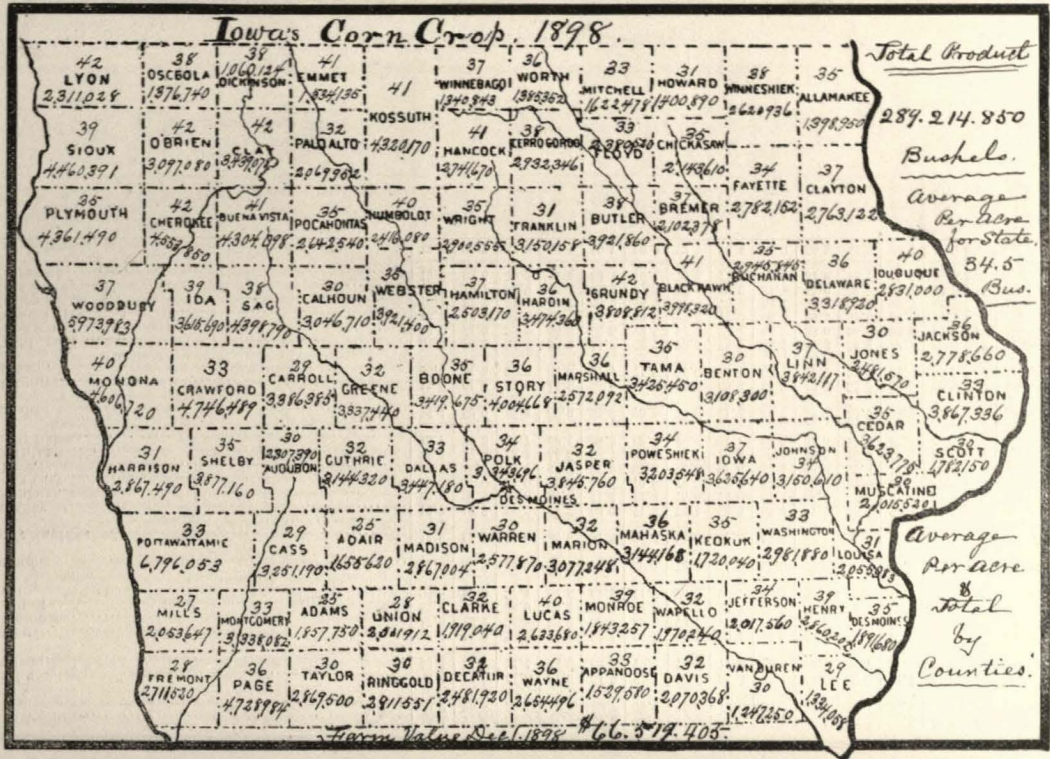
Average monthly and annual mean temperature at various Iowa stations for the period of years named.

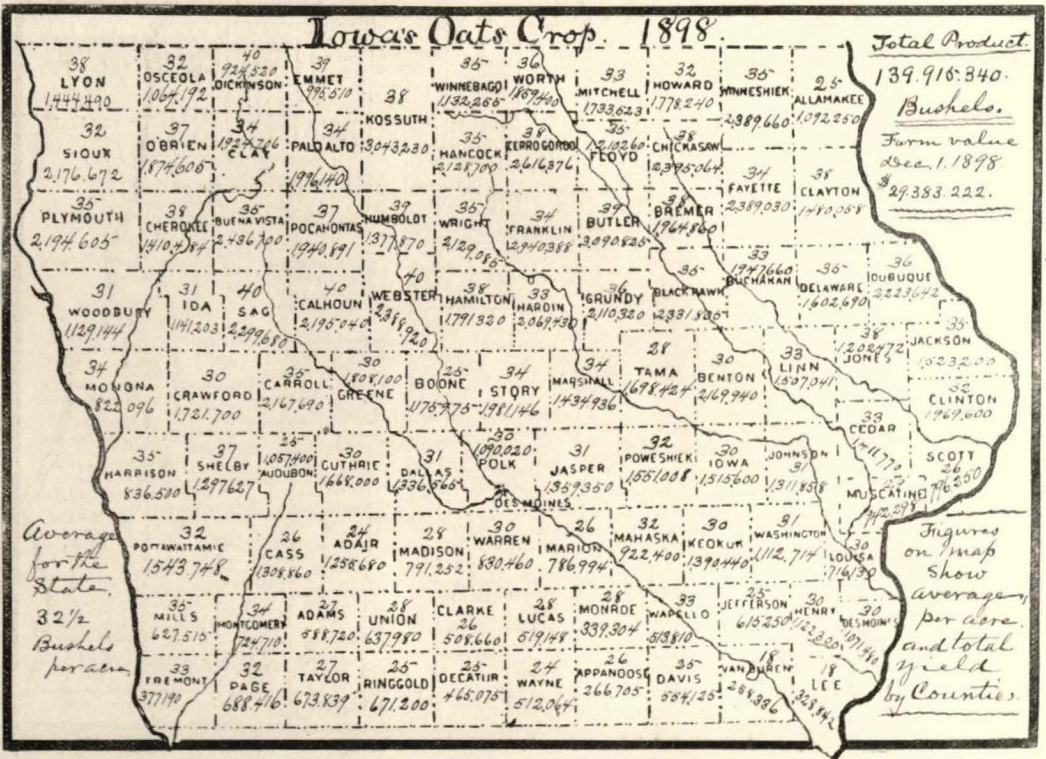
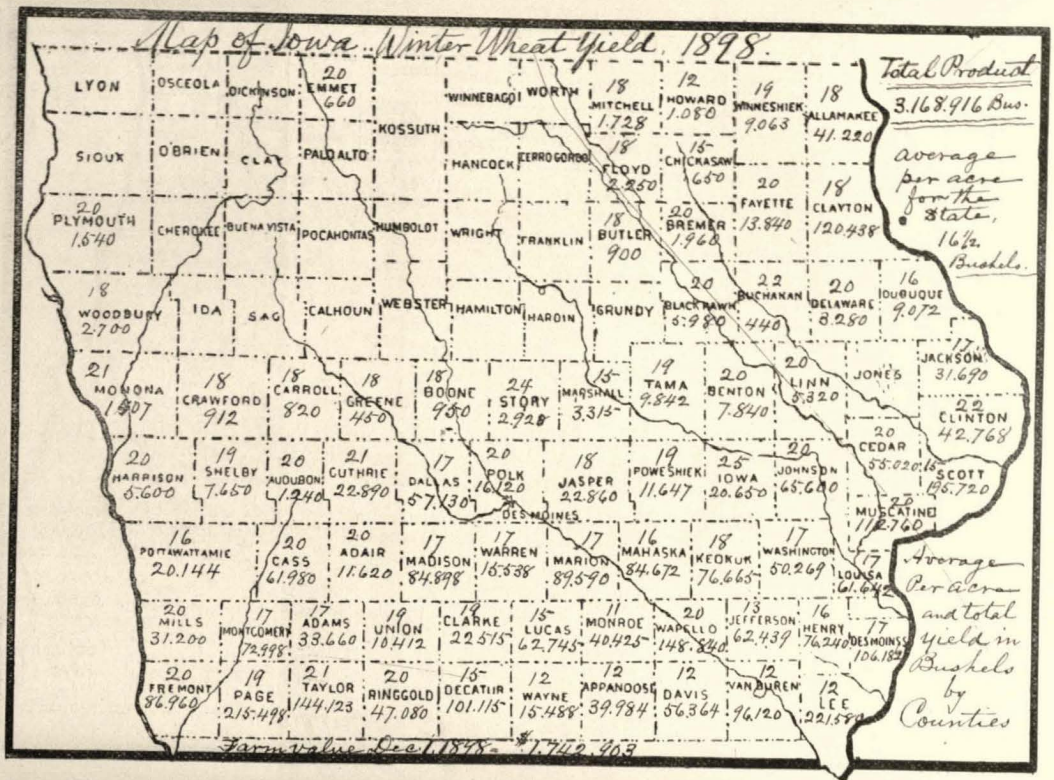
STATIONS.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Means.	No. years.	Record in-cluded be-tween dates be-low.
Albion.....	11.6	17.3	28.7	45.3	58.4	66.9	70.9	69.0	59.5	49.1	29.7	17.1	42.0	6	1879-1884
Algona.....	14.2	19.1	30.7	48.0	58.4	70.0	73.6	69.3	63.6	48.1	29.4	20.4	45.4	7	1891-1898
Amana.....	14.4	20.8	31.1	48.4	59.6	69.6	73.7	70.3	61.9	48.5	32.0	21.8	46.1	23	1876-1898
Ames.....	15.8	22.4	32.4	49.1	59.0	70.0	75.0	72.0	63.6	49.9	31.8	21.8	46.9	19	1876-1898
Alta.....	15.0	18.2	29.6	47.4	57.6	69.1	72.4	70.0	64.6	49.1	29.0	21.6	45.3	8	1891-1898
Atlantic.....	18.4	23.9	33.4	49.0	58.4	69.8	72.8	70.6	65.7	50.2	32.5	24.9	47.4	8	1891-1898
Audubon.....	18.2	21.0	34.0	49.8	59.5	69.5	73.2	71.7	64.2	48.8	32.1	24.0	47.2	6	1893-1898
Blakeville.....	13.7	23.0	30.0	47.5	55.8	71.2	74.5	71.5	66.3	52.3	34.3	24.5	47.0	4	1890-1893
Belle Plaine.....	18.0	22.5	32.4	49.6	58.2	69.9	72.8	69.9	64.1	49.1	32.3	23.9	46.9	9	1890-1898
Bonaparte.....	21.6	25.4	38.4	52.0	62.3	73.1	75.9	74.1	68.8	54.2	36.2	28.8	50.9	8	1891-1898
Brookside.....	12.7	19.9	29.1	45.1	59.0	68.6	73.4	69.9	61.0	46.6	31.4	17.5	44.5	17	1862-1876
Carroll.....	18.5	20.7	31.2	48.8	58.5	70.0	73.1	70.2	63.9	49.4	31.1	23.3	46.6	9	1890-1898
Oedar Falls.....	16.4	19.7	32.6	49.6	59.1	70.6	73.4	71.7	65.0	50.5	31.1	23.4	46.9	8	1891-1898
Oedar Rapids.....	16.7	21.7	32.8	43.8	59.0	70.6	74.6	71.5	63.4	50.0	34.6	24.7	47.0	17	1882-1898
Centerville.....	21.5	22.7	40.7	53.4	62.0	72.0	76.5	74.0	68.8	51.5	37.0	30.3	51.0	6	1892-1898
Charles City.....	13.9	17.6	30.5	46.9	57.3	68.6	73.4	70.2	63.6	49.1	29.3	20.6	45.1	8	1891-1898
Clarinda.....	21.2	24.9	34.9	52.0	60.8	71.9	75.8	73.8	67.6	53.0	35.8	27.2	49.9	9	1890-1898
Clinton.....	18.7	22.7	36.7	50.9	60.9	71.5	74.1	72.1	65.4	51.2	33.6	26.3	48.7	8	1891-1898
College Springs.....	22.5	26.4	37.3	50.7	60.6	70.8	74.4	73.5	68.8	55.8	37.1	28.0	50.5	8	1892-1898
Corning.....	20.6	25.2	36.7	51.1	60.3	70.4	73.5	72.0	66.4	52.7	35.8	26.6	49.3	7	1892-1898
Cresco.....	10.3	15.9	25.8	44.4	56.5	66.3	70.9	68.6	59.8	46.3	29.4	18.2	42.7	27	1872-1898
Davenport.....	20.0	25.0	35.0	50.0	61.0	71.0	75.0	73.0	65.0	52.0	37.0	28.0	49.3	27	1872-1898
Delaware.....	13.3	18.1	30.9	46.7	57.9	68.8	71.6	68.8	61.8	46.5	29.5	21.4	44.6	8	1891-1898
Decorah.....	12.5	17.5	32.0	49.2	59.8	68.4	70.3	61.5	63.2	48.5	30.3	21.0	45.2	6	1893-1898
Denison.....	20.0	22.5	32.1	49.3	60.0	68.7	72.8	70.7	65.3	48.4	31.7	22.3	47.0	6	1893-1898

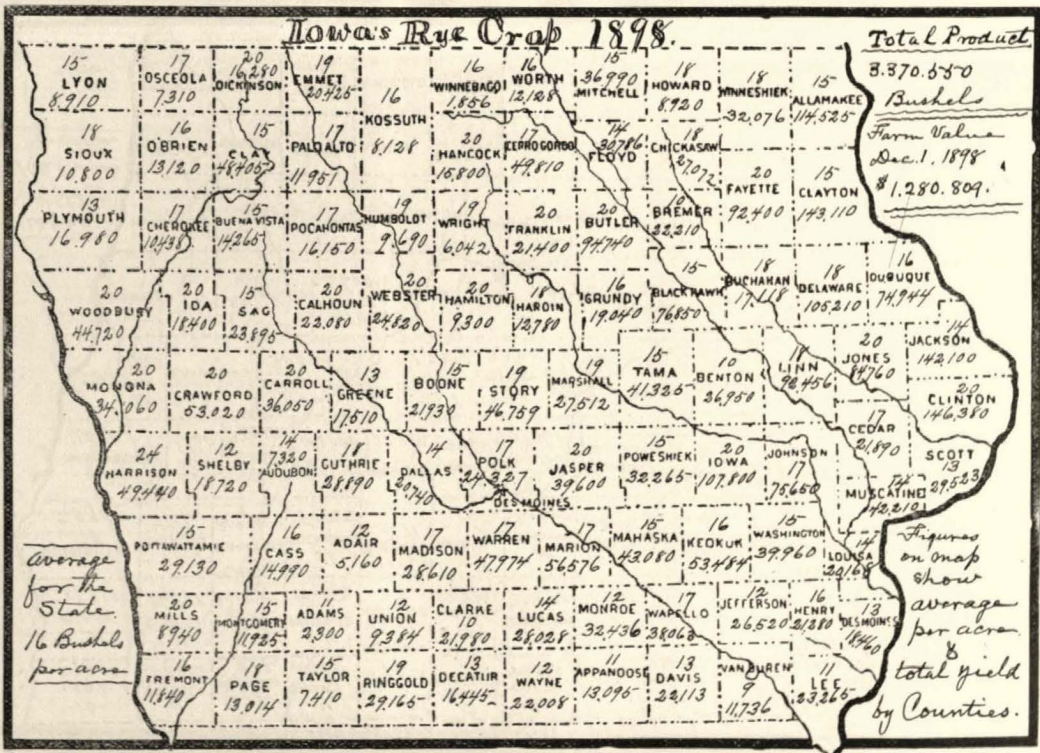
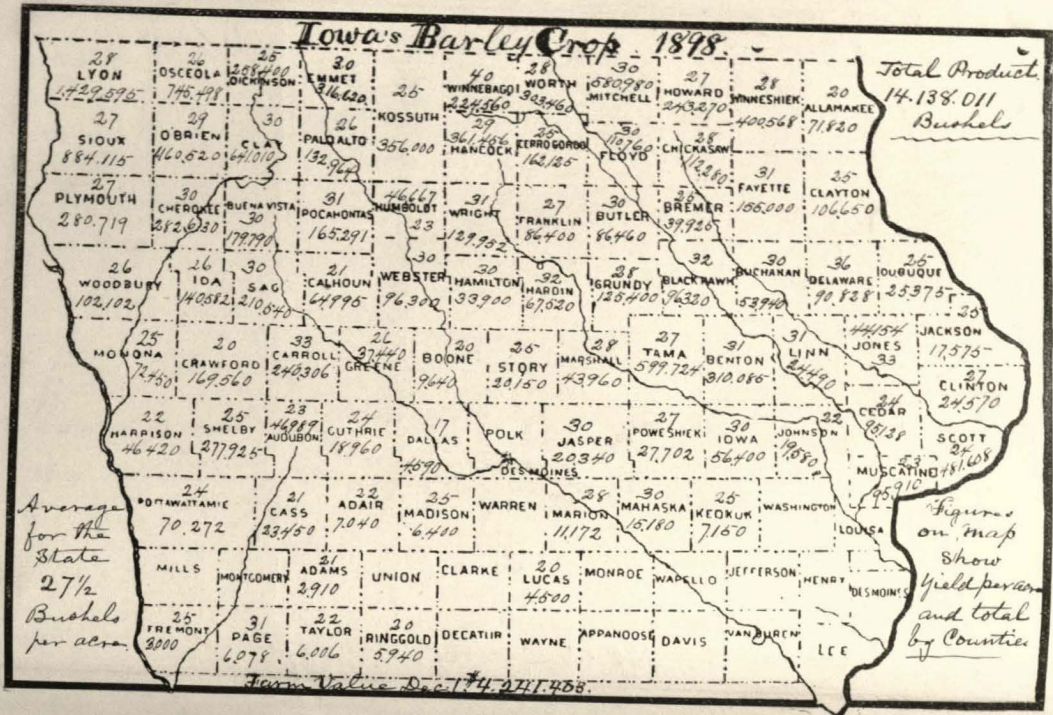
IOWA WEATHER AND CROP SERVICE.

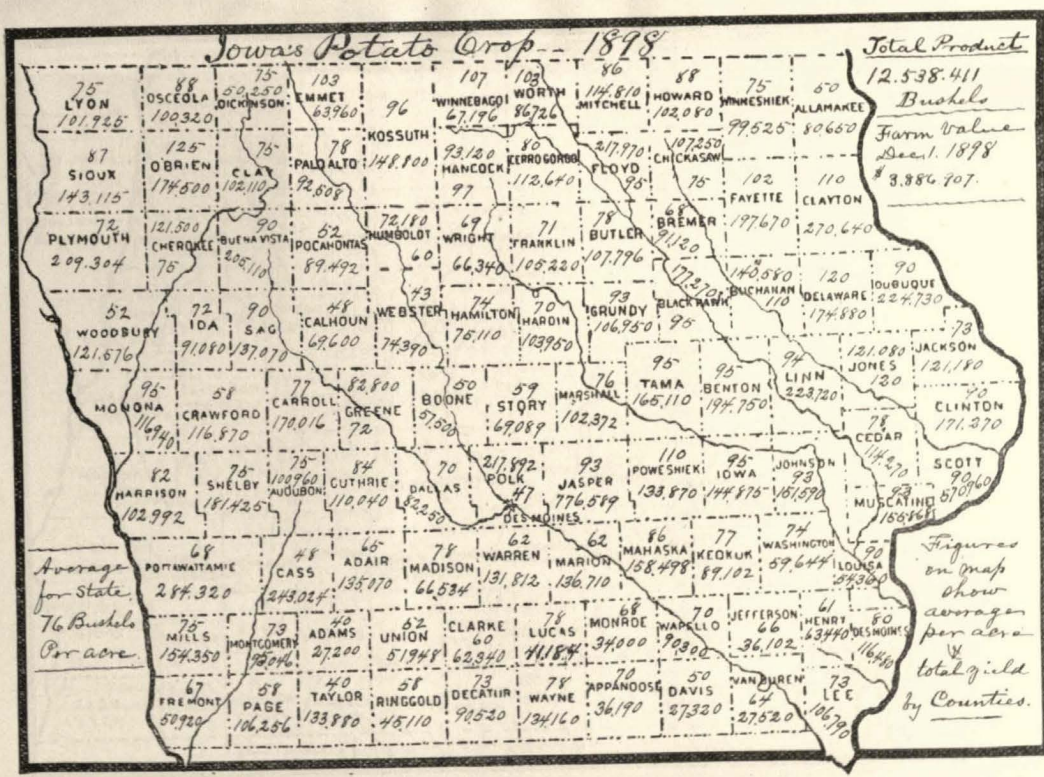
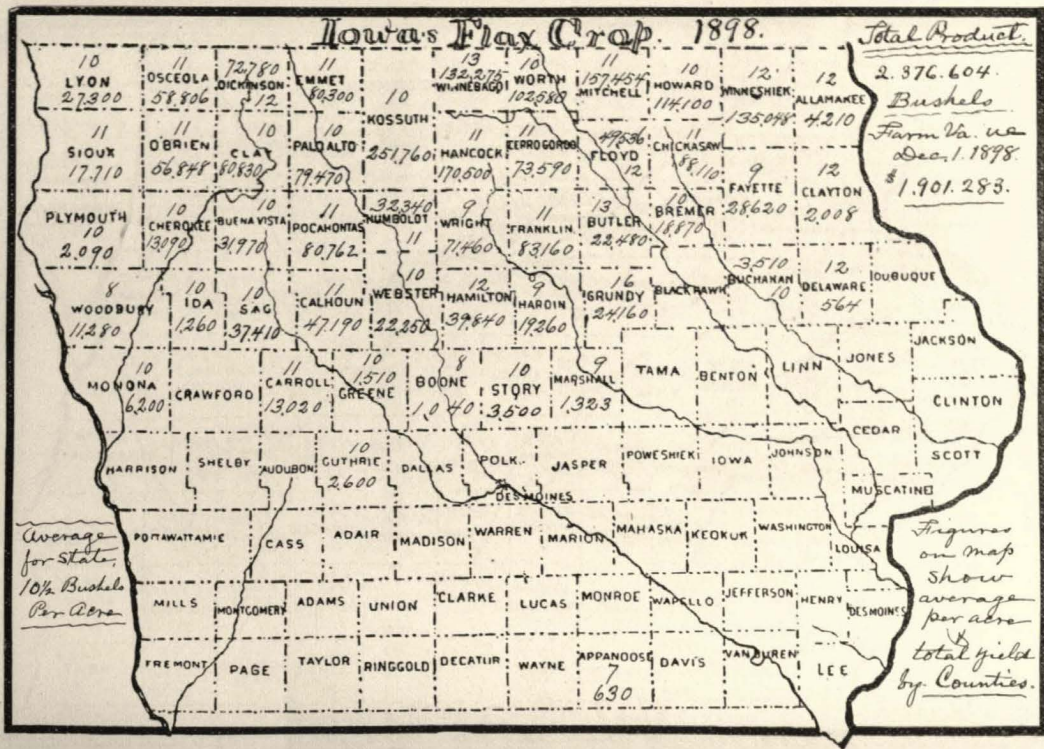
MEAN TEMPERATURE—CONTINUED.

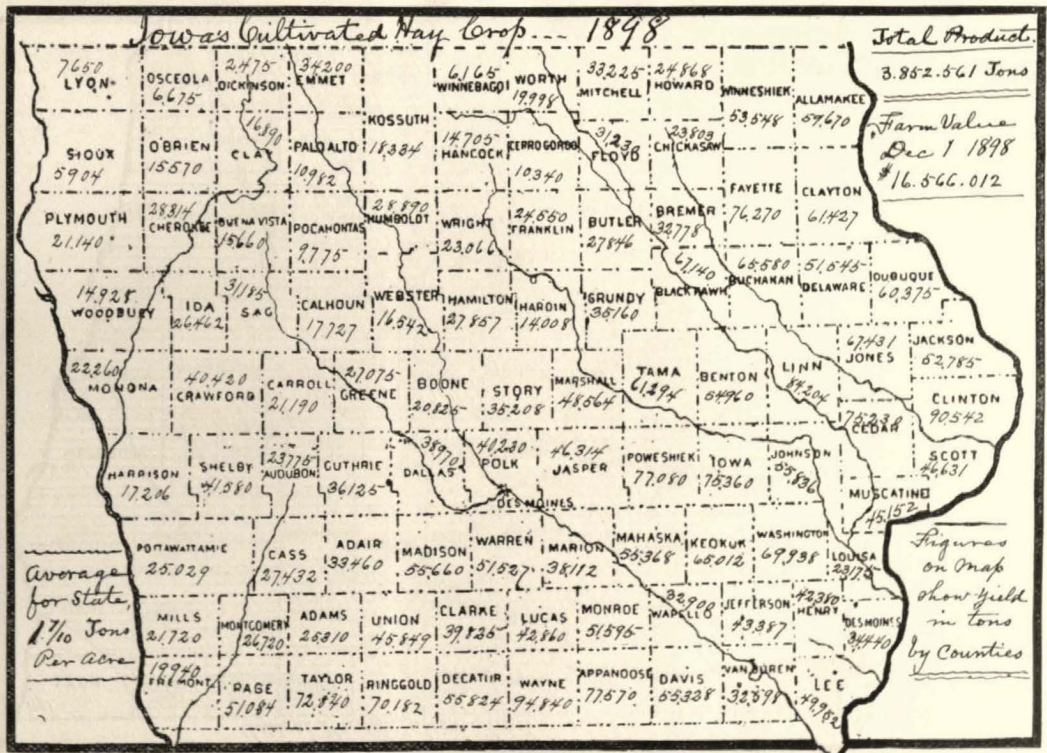
STATIONS.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Means.	No. years.	Record in-cluded be-tween dates be-low.
Des Moines.....	18.0	23.0	35.0	52.0	61.0	71.0	75.0	72.0	65.0	53.0	37.0	26.0	49.0	21	1878-1898
Dubuque.....	17.0	23.0	33.0	49.0	60.0	70.0	74.0	72.0	64.0	51.0	34.0	26.0	47.8	26	1873-1898
Dysart.....	16.4	23.2	34.5	53.3	66.6	76.2	80.7	77.9	69.9	57.1	37.6	23.9	51.4	10	1879-1882
Elkader.....	13.0	19.1	30.9	48.0	60.6	69.5	73.7	70.2	62.2	48.2	31.3	21.5	45.7	18	1879-1898
Fairfield.....	15.4	22.7	33.6	49.1	59.1	70.1	74.8	70.4	64.1	51.4	35.3	25.0	47.6	13	1879-1898
Fayette.....	15.7	20.1	30.9	47.2	56.8	68.4	71.7	68.7	63.6	48.3	31.0	22.9	45.4	9	1890-1898
Ft. Madison.....	22.8	27.8	37.7	51.7	63.2	73.4	77.7	74.5	66.3	53.1	38.4	27.4	51.2	51	1848-1898
Garnaville.....	9.0	15.3	26.4	43.4	56.8	65.4	69.1	66.6	58.2	46.1	29.9	16.6	41.8	7	1880-1886
Galva.....	15.4	20.0	33.8	49.3	60.2	69.2	73.5	70.0	65.5	48.8	30.5	22.4	46.6	6	1893-1898
Glenwood.....	17.7	23.7	33.3	48.8	59.9	70.5	74.1	72.1	62.4	49.0	33.9	24.9	47.5	29	1867-1898
Grand Meadow.....	14.9	19.7	31.1	47.2	57.5	66.9	70.1	67.9	63.0	48.2	30.5	22.5	45.0	8	1891-1898
Greenfield.....	20.1	23.0	34.0	50.8	59.6	70.8	74.0	72.2	66.1	51.8	33.8	22.6	48.2	8	1891-1898
Grinnell.....	18.3	23.2	33.1	50.7	59.4	70.2	72.7	70.0	63.4	47.2	34.5	24.8	47.3	9	1890-1898
Grundy Center.....	14.9	20.0	32.1	48.8	58.1	69.8	71.8	69.8	63.8	49.8	30.6	23.0	46.0	8	1891-1898
Guttenberg.....	14.0	20.0	28.7	44.5	57.8	66.7	70.6	67.9	59.5	47.1	31.9	19.3	44.0	22	1864-1885
Hampton.....	13.9	18.0	29.0	46.8	57.0	67.9	71.7	68.7	62.4	48.1	29.7	21.0	44.5	9	1890-1898
Hopeville.....	20.4	23.8	35.1	51.6	60.0	70.2	73.5	72.1	67.1	53.1	34.3	25.9	48.9	8	1891-1898
Independence.....	14.8	20.3	30.4	47.2	59.4	67.0	71.2	68.1	60.0	47.1	32.0	21.1	44.9	37	1861-1898
Indianola.....	19.3	25.0	36.6	52.1	60.4	70.8	74.2	72.8	67.0	54.6	36.0	25.7	49.5	7	1892-1898
Iowa City.....	21.0	24.9	35.2	50.8	59.6	71.2	73.9	70.7	65.2	50.6	35.8	27.0	48.8	9	1890-1898
Iowa Falls.....	12.2	17.2	31.7	47.0	59.0	68.7	72.3	69.0	62.5	48.0	29.7	21.0	44.9	6	1893-1898
Keokuk.....	23.0	29.0	38.0	52.0	63.0	72.0	77.0	75.0	67.0	55.0	39.0	30.0	51.7	28	1871-1898
Keosauqua.....	22.4	28.6	39.0	53.0	62.1	73.3	76.4	74.1	68.0	54.6	37.1	27.2	51.2	7	1892-1898
Knoxville.....	23.4	24.2	37.0	52.8	62.8	72.0	75.5	73.0	67.2	51.8	36.2	25.5	50.1	6	1893-1898
Larrabee.....	16.5	20.5	30.6	48.5	57.6	69.6	72.2	70.2	64.5	49.2	30.0	22.6	46.0	8	1891-1898
Logan.....	20.3	24.1	34.0	51.9	60.8	71.7	74.8	72.1	66.8	52.3	34.9	26.8	49.2	34	1890-1898
Marshalltown.....	18.0	21.7	31.9	49.1	58.6	69.1	72.4	70.6	64.9	50.7	32.6	23.6	46.9	7	1891-1898
Mason City.....	14.7	16.7	31.0	50.2	58.2	68.1	71.7	68.5	63.3	47.2	28.2	19.9	44.8	5	1894-1897
Maxon.....	17.0	23.2	35.4	53.4	62.0	72.7	75.8	73.5	66.7	51.6	33.8	26.4	49.8	6	1891-1896
Maquoketa.....	17.8	25.3	35.7	48.3	60.7	71.1	75.7	71.6	64.7	53.2	35.8	25.3	48.8	6	1881-1898
Mechanicsville.....	15.2	20.2	34.8	49.2	59.0	69.6	73.0	71.2	63.6	49.4	32.2	25.2	46.8	5	1892-1896
Monticello.....	15.4	21.4	31.9	48.2	59.2	68.8	72.9	70.0	61.7	48.5	33.2	22.1	46.1	45	1854-1898
Mt. Ayr.....	22.2	26.5	36.4	52.2	62.2	71.0	75.2	73.0	68.2	53.0	35.4	25.5	50.1	6	1892-1898
Nashua.....	15.4	26.0	41.8	54.9	54.9	64.7	70.6	66.3	57.1	48.2	30.6	18.1	41.8	9	1879-1887
Newton.....	16.3	21.7	34.4	48.6	60.5	70.6	74.8	71.8	62.9	50.2	32.7	21.9	47.2	12	1878-1898
Osage.....	12.4	16.0	28.5	44.8	56.1	66.5	69.9	66.1	59.3	43.7	26.4	19.1	42.4	8	1891-1898
Oskaloosa.....	17.6	22.4	34.3	50.2	59.9	69.9	74.7	71.1	64.5	50.6	35.7	26.2	48.1	16	1883-1898
Ottumwa.....	22.6	25.2	38.9	53.5	63.0	72.9	75.6	73.8	67.9	53.0	36.4	27.7	50.9	5	1894-1898
Ovid.....	22.6	24.8	37.4	52.6	61.2	71.3	75.3	73.7	67.8	52.7	35.7	26.5	50.1	6	1893-1898
Panama.....	18.5	21.2	33.0	50.7	59.2	69.3	72.3	71.0	65.0	49.5	31.8	25.2	47.2	6	1891-1896
Rock Rapids.....	14.8	17.0	29.8	48.6	57.2	68.4	72.8	69.8	63.0	47.5	28.0	19.7	44.7	6	1893-1898
Sac City.....	18.9	19.7	31.2	49.7	59.0	71.7	76.1	72.5	63.9	51.2	33.1	23.4	47.1	20	1870-1898
Seymour.....	23.2	26.5	38.8	53.4	61.8	71.8	75.6	74.0	68.2	54.2	36.8	31.0	51.3	5	1893-1897
Sioux City.....	18.0	21.0	31.0	51.0	59.0	70.0	74.0	71.0	65.0	50.0	32.0	26.0	47.3	10	1880-1898
Sibley.....	12.7	18.0	30.4	48.2	57.8	67.3	70.3	67.6	62.2	48.2	27.8	19.4	44.2	6	1893-1898
Smithland.....	14.4	17.0	28.5	44.5	63.1	67.9	70.7	70.9	56.8	49.5	26.9	16.4	43.9	4	1879-1882
Spirit Lake.....	13.7	19.3	31.7	49.1	59.3	68.9	74.1	71.7	65.3	47.5	27.4	21.1	45.7	5	1894-1898
Toledo.....	18.4	22.0	35.0	50.9	61.6	70.5	73.8	71.4	64.6	49.1	33.0	23.3	47.8	5	1894-1898
Vinton.....	17.2	21.9	32.4	48.9	58.8	69.9	73.2	69.6	63.2	49.2	32.8	24.6	46.8	9	1890-1898
Villisca.....	20.8	24.5	36.2	52.0	61.4	71.0	74.0	71.0	65.2	50.7	34.2	24.0	48.8	6	1893-1898
Washington.....	21.5	25.4	35.2	52.3	61.0	73.7	75.6	73.1	66.7	52.3	35.6	26.3	49.9	8	1890-1898
Waterloo.....	16.7	21.9	32.9	50.3	63.5	72.8	77.8	74.4	66.0	52.0	36.6	23.3	49.0	20	1863-1898
Webster City.....	16.3	19.3	31.3	46.7	57.3	69.8	73.8	71.0	65.2	50.2	31.0	21.3	46.1	6	1891-1898
Wesley.....	15.1	22.2	34.4	54.7	60.3	74.7	77.6	75.7	66.4	54.2	35.8	22.8	49.5	13	1879-1891
West Bend.....	15.6	19.7	29.9	46.2	58.4	68.2	72.2	69.2	61.5	45.6	27.7	17.9	43.8	6	1893-1898
Winterset.....	19.8	23.6	34.2	51.4	60.4	70.4	73.4	71.4	65.9	51.6	33.7	25.6	48.4	8	1891-1898
Means.....	17.1	21.7	33.2	49.5	59.7	70.0	73.7	71.1	64.3	50.2	32.8	23.6	47.2	.....	.....











TEMPERATURE AND PRECIPITATION DATA FOR 1898.

NORTHERN SECTION.

Table with columns for months (January to December) and rows for stations (Algona, Albia, Brit, etc.). Columns include Mean, Maximum, Minimum, Total precipitation, and Snowfall.

CENTRAL SECTION.

Table with columns for months (January to December) and rows for stations (Amana, Ames, Audubon, etc.). Columns include Mean, Maximum, Minimum, Total precipitation, and Snowfall.

SOUTHERN SECTION.

Table with columns for months (January to December) and rows for stations (Adair, Albia, Atlantic, etc.). Columns include Mean, Maximum, Minimum, Total precipitation, and Snowfall.

* Maximum and minimum taken from eye readings. # Not included in annual means; December report received too late.

INDEX.

	PAGE.
A comparative exhibit.....	47
Annual precipitation chart, 1898.....	86
Annual report.....	5- 6
August 1st crop report.....	47
Climate.....	68
Climate and crop bulletins.....	52-61
Climate and soil fertility.....	64-66
Crop report, September 1st.....	47-48
Errata for the 1897 annual.....	41
Evaporation from the ocean.....	67
Final crop report, 1898.....	48-50
Iowa crops, 1898.....	45-46
Iowa's soil products.....	41-43
July crop report.....	46
June crop report.....	48-44
Local climatic changes.....	62-64
Losses by lightning.....	61-62
Map, percentage of losses by swine disease...	51
Maps, crop yields and stock by counties.....	76-85
Mean temperature, table.....	70-72
Meteorological stations and observers.....	7- 8
Meteorological summary for 1898.....	8- 9
Monthly meteorological summaries.....	9-37
Precipitation data, table.....	70-72
The almanacs and the Weather Bureau ...	66-67
Weather at Clinton, 1898.....	37-40
Weather at Des Moines, 1898.....	40-41

UNITED STATES
DEPARTMENT OF AGRICULTURE,
WEATHER BUREAU.

ANNUAL REPORT

OF THE

Iowa Weather and Crop Service

IN CO-OPERATION WITH THE
United States Weather Bureau,
FOR THE YEAR 1899.

JOHN R. SAGE,
Director.

GEO. M. CHAPPEL,
*Local Forecast Official U. S. Weather Bureau,
Assistant Director.*

PRINTED BY ORDER OF THE GENERAL ASSEMBLY.

DES MOINES:
F. R. CONAWAY, STATE PRINTER,
1900.

STATE OF IOWA.
OFFICE OF THE WEATHER AND CROP SERVICE. }
DES MOINES, April 14, 1900.

To His Excellency, Leslie M. Shaw, Governor of Iowa:

SIR—In accordance with the requirements of the law, we have the honor to submit herewith the tenth annual report of the Iowa Weather and Crop Service for the year 1899.

We are, sir, very respectfully,

Your obedient servants,

JOHN R. SAGE,
Director.

GEO. M. CHAPPEL,
*Local Forecast Official, U. S. Weather Bureau,
Assistant Director.*

ANNUAL REPORT, 1899.

The climatological data and statistics of the staple farm crops for the year are herein compiled in convenient form for reference and comparison. Through the co-operation of the United States Weather Bureau and the Iowa Weather and Crop Service the state has been well covered with meteorological stations, and a large number of well-trained and efficient meteorological observers and crop reporters have been enlisted to furnish the data and aid in this useful branch of the public service. In this joint service the national government has borne by far the heavier burden of expense and labor, and for a large share of the benefits received the people of Iowa are deeply indebted to the honored Secretary of Agriculture and the efficient Chief of the Weather Bureau.

The United States Weather Bureau maintains five fully equipped meteorological stations within the territorial limits of this state, viz: At Des Moines, Davenport, Dubuque, Keokuk and Sioux City. The records of the station at Omaha, Neb., are also included in the meteorological records of this service. In addition to these regular stations the work of meteorological observation is now being carried on at 156 local stations, by competent voluntary observers, equipped with standard instruments—a net increase of 18 stations during the year.

As an auxiliary to this efficient corps of meteorological observers, this service includes over 800 crop reporters, who report weekly or monthly the condition of the principal crops as affected by the prevalent weather conditions during the season.

There is a constantly increasing public demand for the monthly and weekly reports of this office. The issues of the Monthly Review amounted to something over 2,600 copies per month, or an aggregate of 31,000 copies during the year. The weekly crop bulletins issued during the season, April 1st to October 1st, amounted to over 40,000 copies. In addition thereto, summaries of the weekly reports were mailed in advance to newspapers, and through that channel the information was widely disseminated.

At the close of the year daily weather forecasts were received at 105 stations, and from these stations and the central office the forecasts were distributed by mail on cards to 1,172 postoffices, arriving each day in time to be of value to the general public. At the telegraphic stations signal flags are displayed. By-signals, cards and telephone messages the forecasts are very widely distributed among the people who are specially interested therein.

CLIMATOLOGY OF THE YEAR 1899.

Barometer.—The mean atmospheric pressure for the year was 30.04 inches. The highest observed was 31.08 inches on February 11th, at Sioux City; lowest, 29.19, on December 11th, at Davenport; range for the state, 1.89 inches.

Temperature.—The mean temperature, as deduced from the complete records for the year of 91 stations, was 47.6°, which is about .2 of a degree above the average for the past decade. The highest temperature reported was 104°, on September 6th at Eldon; lowest reported, 40° below zero, at Sibley, on February 11th. The range for the year was 144°.

Precipitation.—The average amount of rainfall and melted snow for the year was 29.10 inches, as shown by the complete records of 89 stations. This is about 1 inch below the average for the past decade. There was considerable inequality in its distribution, the southern section receiving the larger amount of moisture. The greatest amount reported for the year was 42.06 inches at Ft. Madison; least amount reported, 21.79 inches, at Plover, Pocahontas county. The greatest monthly rainfall was 12.24 inches, at Ft. Madison, in May. The least monthly precipitation was nothing, at Northwood and Primghar, in January. The greatest daily rainfall was 7.74 inches, at Sac City, on June 26th. The average number of days on which .01 of an inch or more fell was 77.

Wind and Weather.—The prevailing direction of the wind was south. The highest velocity reported was 50 miles per hour, at Sioux City, on April 28th; average daily wind movement, 211 miles. There were 160 clear days during the year, 89 cloudy days, and 116 partly cloudy days. On the whole, the general meteorological features of the year were about normal.

MONTHLY SUMMARIES.

JANUARY.

The month was warmer than usual, with much less than the normal amount of precipitation. The mean temperature for the state, as deduced from records of 118 stations, was 19.8°. The average of the northern section (a belt across the state east and west, three counties in width) was 15.9°; central section, 19.9°; southern section, 23.5°. The lowest temperature reported was 34° below zero at Mason city on the 31st. The highest

was 68° at Council Bluffs on the 21st. Estherville reported the lowest monthly average, 10.8°. Keokuk reported the highest monthly average, 27.8°. The average precipitation, as reported by 114 observers, was .28 of an inch, which is nearly an inch below the normal for January. By sections the averages were as follows: Northern section, .30 of an inch; central section, .29 of an inch; southern section, .24 of an inch. The largest amount reported was 1.15 inches at Eldora; several stations reported only a trace, and two stations no precipitation. There were 15 clear days, 6 cloudy, and 10 partly cloudy.

EXTRACTS FROM OBSERVERS' NOTES.

Clinton—DR. LUKE ROBERTS: January, 1899, was milder than usual, the mean temperature being 3.8° above normal. The month came in with the temperature 5° below zero, but it did not drop so low again until the 27th, and was repeated every day for the balance of the month; the last three days giving a daily mean below zero; on the 29th .5° below, 30th 9.2° below, and the 31st 1.5° below. The 5th, 6th, 7th, 8th and 26th gave a minimum but little above zero, leaving the balance of the month quite mild. During the last twenty-one years there were eight Januaries with a higher mean temperature than 1899, the highest of which was 35.8°, occurring in 1880. The lowest temperature reached during the time mentioned above was 36° below zero, occurring in 1884, and the 5th day of the month, the mean for the day being 30.5° below zero. The warmest day of the month was the 3d; mean temperature, 39.2°. The coldest day was the 30th; mean temperature, 9.2° below zero. The month was nearly stormless, notwithstanding the weather prophet, DeVoe, said, in his forecasts for January, 1899: "January will be one of the greatest storm months of this stormy year." There were only four storm days during the month, and a precipitation of .27 of an inch; the greatest amount of that which fell in any twenty-four hours was .19 of an inch. The precipitation was mostly in rain, there having been about one-half inch of snow all told. It is less than any former record. This was the lightest January rainfall on record. The number of clear days was 14; part cloudy days, 11; cloudy days, 6. Total movement of the wind was 3,720 miles, or 1,275 miles below normal, and the least on record, except one year ago; maximum velocity, 26 miles an hour, occurring on the 26th. Per cent of cloudiness, 49; this was 12 per cent below normal.

Alta—DAVID E. HADDEN: Cold wave with high northwest wind on 26th; very cold weather continued until close of month. Unusual fall in temperature after sunrise January 28th. At 8 A. M. temperature was 7° below zero; after this time it fell rapidly, and at 10 A. M. was 14.5° below; it then rose and at 11 A. M. registered 10° below zero, and remained steady nearly all the balance of the day. The sky was clear; wind northwest.

Amana—CONRAD SCHADT: The weather was generally fair and mild till the 26th, when a cold snap set in, which continued for several days and made the mercury go down to 17° below zero on the morning of the 30th. For farmers who still had some corn in the field, the weather and ground was better for corn harvesting than in the corn harvesting months. The cold snap may have seriously damaged winter wheat, as the ground was entirely bare.

Bonaparte—B. R. VALE: A remarkably fine month; good roads, no snow on the ground, no rain. Good month for feeding stock and for work of all kinds.

Forest City—J. A. PETERS: Wind on morning of 26th blew car from track; no damage to buildings.

Grand Meadow—F. L. WILLIAMS: On 26th wind blew a gale from the northwest; air filled with fine snow and dust; 29th, 30th and 31st were bitter days; morning of the 30th 22° below zero and blowing a gale.

Larrabee—H. B. STREVER: January has been remarkably mild. Sleight spoiled by the mild weather. The most of the corn snowed under last fall has been gathered.

Olin—NATHAN POTTER: Very fierce wind on the 26th from the northwest; air full of frost. Thermometer fell from 40° above in the afternoon of the 25th, to 6° below zero on the morning of 26th. Wagon roads almost perfect during the whole month; smooth as a floor and as hard as a rock.

FEBRUARY.

The month of February was notable for its extremes of high barometric pressure and low temperature. The mean pressure was 30.16 inches. The highest observed was 31.08 inches at Sioux City on the 11th. The monthly mean temperature of the state deduced from records of 119 stations, was 12.2°, which is about 9° less than the normal. The lowest temperature reported was 40° below zero at Sibley on the 11th. Estherville reported the lowest mean for the month, 2.6°. The mean temperature by stations was as follows: Northern section, 8.3°; central section, 12.8°; southern section, 15.6°. The average precipitation for the state was .89 of an inch, which is .17 of an inch below the February normal. By sections the averages were as follows: Northern section, 1.17 inches; central section, .73 of an inch; southern section, .78 of an inch. The largest amount reported was 4.32 inches at Ridgeway. There was an average of 11 clear days, 10 partly cloudy and 7 cloudy. The highest wind velocity was 48 miles an hour at Sioux City on the 23d.

EXTRACTS FROM OBSERVERS' NOTES.

Bonaparte—B. R. VALE: The first two weeks were very cold, but remainder of month remarkably pleasant. Roads dusty and feed lots as dry as in August. Some spring wheat sown on 20th.

Denison—J. H. HOLMES: The first twelve days of the month satisfied even the old settler for cold weather, beating his experience.

Elkader—CHARLES REINECKE: Ice went out of Turkey river below the dam on the 20th; above the dam it has not moved yet, although it is broken up.

Forest City—J. A. PETERS: A hard month on the coal bin, corn crib and hay stack.

Grinnell—A. O. PRICE: Frost in ground 4-2-3 feet. Fields bare of snow first of month, with extreme cold and then thawing, has damaged winter sown grain. Microscopic examination of plum and cherry buds at the college, reveals no damage by the extreme cold. Apples and other fruits are thought to be all right.

Sigourney—MRS. R. F. ASHBAUGH: On the 8th the thermometer registered 19° below zero at 7 A. M., at noon 12° below, and at 7 P. M. was down

to 24° below and had reached 27° below zero before morning of the 9th. The wind blew from the northwest with a vengeance, and the "oldest inhabitant" cannot remember such a "cold snap" since 1863.

Wapello—G. W. SCHOFIELD: Ground frozen about 4 feet; no precipitation during January and up to February 20th. Nearly all cellars have been subject to frost and one-half of the potatoes stored in the cellars are frozen.

Washita—H. L. FELTER: According to the memory of the oldest inhabitant, this has been the coldest February in this county.

West Bend—PHIL. DORWEILER: Coldest month on record; thermometer dropped below zero seventeen days, and nine days it staid below zero all day.

Lenox—J. L. HURLEY: During the recent cold weather I made a comparison of records for the local papers, showing the marked difference between the present and preceding winters. I append a copy, covering the years since this station was established, showing the maximum, minimum and mean, for the last five days in January and the first thirteen days in February, since 1883:

	LAST FIVE DAYS OF JANUARY.			FIRST THIRTEEN DAYS OF FEBRUARY.			Average for eighteen days.
	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	
1893	38	-5	11.6	58	-14	13.7	13.1
1894	40	0	19.3	58	4	28.3	24.3
1895	38	-10	11.0	39	-19	5.4	6.9
1896	47	13	34.0	44	-14	30.1	31.2
1896	47	13	34.0	44	-14	30.1	31.2
1897	34	-5	17.6	41	-11	20.8	25.3
1898	40	8	20.2	41	-3	26.4	24.5
1899	29	-18	2.3	14	-29	-3.3	-1.8

MARCH.

March was unusually cold for this region. The mean temperature for the state was 24.5°, which is about 8.7° below the normal. The mean for the northern section was 19.6°; central section, 25°; southern section, 28.9°. The maximum temperature reported was 75° at Mt. Pleasant, on the 10th and 11th; minimum temperature, 16° below zero at Charles City and Cresco, on the 7th. Average precipitation for the state, 1.62 inches, which is very nearly normal; average for the northern section, 1.92 inches; central section, 1.20 inches; southern section, 1.73 inches. There were 7 clear days; 12 partly cloudy, and 12 cloudy. The general weather conditions were wholly unfavorable for farming operations. At the central station it was the coldest March since the establishment of the service in Des Moines.

EXTRACTS FROM OBSERVERS' NOTES.

Amara—CONRAD SCHATZ: March was very cold. On two days only, 10th and 11th, did the temperature not fall below the freezing point, and on those two days it came very close to it. The ground was frozen as in midwinter and no farming whatever could be done. Winter wheat, which apparently suffered no damage during February, was injured by the cold weather which followed the mild days of 10th and 11th.

Bonaparte—B. R. VALE: A damp, cold and disagreeable month. Bad for feeding and for all stock not sheltered. Great fatality to young calves and pigs.

Grinnell—A. O. PRICE: Continued cold and cold winds mark March, '99, as backward. Plenty of frost in ground. Field work, none of importance. Fruit buds damaged badly and strawberries not covered, dead.

Ovid—A cold, disagreeable month, with mist, hail, snow and rain in succession and sometimes all together. A furious snow storm commenced about dark on the 29th, and continued until after 3 P. M. on the 30th, the strong northeast wind causing it to drift badly. Twelve years ago a similar storm commenced on the 29th that blockaded the railroads. More than three feet of frost in the ground at commencement of month and none thawed from the top at the close.

Waverly—H. S. HOOVER: March, 1899, was the coldest March in the twelve years of which I have preserved records. March, 1890, was nearly as cold as this month, being 1° warmer. It has been winter, not spring; freezing every day except the 10th and 11th. On the 7th it was 13° below zero, which is the lowest March reading I have.

Ogden—E. SAYRE: At close of March there were snowdrifts on north sides of fences and buildings; little ponds were frozen solid; the ground was frozen three or four feet; a great many potatoes have been frozen; some corn in fields not yet husked. The total snowfall from November 1st to April 1st has been 24.3 inches. Prices of grain at Ogden April 1st: Wheat, 52 cents; corn, 22 cents; oats, 22 cents.

Clinton—DR. LUKE ROBERTS: March, 1899, was the first I have to record with so limited phenomena. There was no fog, solar or lunar halos, thunder and lightning, hail or aurora. Some one or more of this stands to the credit of former March months. The minimum temperature was 3° below zero, occurring on the 6th, and the average minimum for the month was 20.9°. Normal March minimum is 5° above zero, therefore, March, 1899, gave a minimum of 3.5° below normal. The maximum temperature was 63°, occurring on the 10th and 11th. The mean temperature was 28.7°, or 4.1° below normal. But for March in 1888 and 1890, each of which gave a mean temperature of .1° lower, March, 1899, would have beaten the record. It was one of the coldest Marches. The warmest day was the 10th, which gave a mean of 51.5°, or .7° above normal. The coldest day was the 6th; mean, 1.7°, or 10.3° below normal. The number of storm days was 8, giving a precipitation of 1.90 inches. Total depth of snowfall, 7 inches. The greatest precipitation during any 24 consecutive hours was .90 of an inch of water, occurring on the 17th. Most of the storms were mixtures of rain and snow. The number of cloudy days was 20, being in excess of any previous March, and were above normal. Only 4 clear days, being 5 below normal. The per cent of cloudiness was 61, being 9 per cent above normal.

The steamboat Reindeer was the first boat to pass through the drawbridge for this season on its trip south at 6:30 A. M., on the 27th. The steamboat Artemus Gates, passed up at 8:45 the same morning. The packet Verne Swain came up from Davenport at 2 o'clock P. M., the 28th, as her initial trip for the season, but new formed ice prevented her from returning the next morning.

APRIL.

The first decade of April was wintry and much colder than usual; the second and third decades were warmer than usual, bringing the mean up to about the normal for April. The mean temperature for the state was 48.9°. The mean for the northern section was 47.2°; central section, 48.9°; southern section, 50°. The highest temperature reported was 89°, at Thurman on the 12th; lowest, 1°, at Bedford, on the 4th. The month was notable for its extremes, the average monthly maximum being 82.8°, and average monthly minimum, 11.9°. The average precipitation was 2.40 inches, which is about .60 of an inch below normal. The average for the northern section was 1.82 inches; central section, 2.65 inches; southern section, 2.73 inches. There were several days of very high winds during the closing week. The highest velocity reported was 60 miles an hour at Sioux City, on the 28th. There were 12 clear days, 11 partly cloudy, and 7 cloudy.

EXTRACTS FROM OBSERVERS' NOTES.

Bonaparte—B. R. VALE: The first two weeks were cold and severe on all young stock, causing great fatality. The last of month has been above normal and very growing weather, but such frequent rains and showers as to prevent the usual amount of seeding and other farm work. Farm work two to three weeks late.

Clinton—LUKE ROBERTS: Farm and garden work progressing nicely; vegetation making rapid strides. Some fruit trees in full bloom.

Coon Rapids—DOWNS & CO: Seeding all done; some small grain up. Farmers plowing for corn. No corn planted yet. The ground is in first-class condition to work; grass coming good, but nearly all clover winter killed.

Forest City—J. A. PETERS: Farmers commenced seeding about the 15th. Season about two weeks late. Small grain about all in at close of month and some plowing for corn.

Grand Meadow—F. L. WILLIAMS: First plowing, 12th; first seeding, 13th; farm work backward. Hardly grass enough for stock at end of month. Ground works fairly well.

Grinnell—A. O. PRICE: First seeding, 7th and until 27th; generally favorable for field work, with ground in fine condition. Hail on 29th at 3 P. M., size of buckshot to size of marbles. The storm of the 30th was a big downpour for an hour, washing out culverts and doing other damage; some stock killed by lightning.

Logan—M. B. STERN: The month has been remarkable for cold and cloudiness, but vegetation is progressing slowly; fruit trees are coming into bloom, but many things have suffered from our long cold winter.

Storm Lake—M. L. FULLER: Sleighting continued up to the 4th, but spring came quickly after it started. Sunday, the 2d, was more like New Year's day than like Easter. Light snow fell most of the day; overcoats and sleigh-bells had not been laid aside. Four weeks later the leaves had begun to unfold on the trees, and grass was large enough for pasturage in many fields.

Tara—W. E. HUMPHREY: Season about two weeks late; small grain nearly all in; trees are leafing out; pastures look green.

SEVERE APRIL STORMS.

Very high winds prevailed during the closing week in April, causing dust storms in some localities, and developing tornado activity within a limited area.

On the night of the 26th a small but violent tornado swept through a portion of the Soldier river valley, in Monona county, causing some loss of life and destruction of property. The storm originated early in the evening, in Boone county, Neb., and entered the Soldier valley about 10 P. M. According to newspaper reports, and letters from postmasters and others, the tornado cloud first made its appearance at the farm of George Swenson, about three miles northeast of Moorhead. On that farm the dwelling was spared, but the barn and outbuildings were demolished. There were eight horses in the barn, of which five were crippled and three only slightly injured. The next building demolished was the home of Rev. H. J. Hjorlholm. Mr. Hjorlholm and family had taken refuge in the storm cave when they heard the roaring of the wind, and so escaped death. Not a stick of the house was left standing and the outbuildings were wrenched and smashed. The High Hill schoolhouse, a mile and a half south of Soldier postoffice, was torn from its foundation and turned half way round.

The tornado next visited the farm of Anton Hanson, sweeping away his residence and fatally injuring his father-in-law, Peter Peterson. The home of Arnt Amundson was also wrecked and Mr. Amundson was seriously injured and died from the effects.

The house of George Furne, about three miles southeast of Ute, was destroyed, and one son, aged about 11 years, was instantly killed. Mrs. Furne was very badly injured.

A number of other farms were in the track of the storm, and more or less damage was done to buildings, trees and fences. Newspaper reports state that some fall plowed fields were swept bare of loose soil down to hard pan. The track of the storm was twelve to fifteen miles long, but the tornado cloud did not touch the earth all that distance. Four persons lost their lives as the result of the storm and one or two others may not survive their injuries.

On the 30th, about 3:30 P. M., a severe wind and rainstorm developed near Macedonia, Pottawattamie county, and wrought considerable damage in a narrow pathway, passing near the towns of Oakland, Hancock and Avoca. It was a straight blow or heavy squall, with some of the characteristics of a tornado at various points along its track. No residences were destroyed and no persons were injured, but several barns were demolished and other buildings were unroofed. Along the railway track telegraph poles were blown down and many trees were uprooted or twisted off. The same general disturbance developed a severe hailstorm at various points in the western and northern districts, the most destructive effects being felt at Bode, in Humboldt county, and heavy winds were experienced in all parts of the state.

MAY.

May was seasonably warm and unusually wet and cloudy, causing considerable delay in planting and cultivating. The mean temperature was 60.2°, which is slightly above the normal. The mean of the northern section was 58.3°; central section, 60.4°; southern section, 62°. The highest

temperature reported was 90° at De Soto on the 26th; lowest, 27° at Larrabee and Spencer on the 13th, which was the date of the latest frost reported during the spring. The average rainfall for the state was 6.23 inches, which is 2.26 inches in excess of the normal. The average for the northern section was 5.31 inches; central section, 6.83 inches; southern section, 6.55 inches. The greatest amount reported for the month was 11.47 inches, at Keokuk; least amount, 3.09 inches, at Ridgeway. Measureable amounts of rain fell at one or more stations every day during the month. The percentage of sunshine was unusually low. There were an average of 9 clear days, 12 partly cloudy, and 10 cloudy. It was a phenomenally stormy month, with an excessive amount of wind movement and electrical energy. The maximum velocity of wind was 47 miles per hour at Sioux City, on the 28th.

EXTRACTS FROM OBSERVERS' NOTES.

Amana—CONRAD SCHATZ: A tornado, happily of small dimensions, passed through that part of South Amana which forms the station of the Chicago, Milwaukee & St. Paul railway, at 12:30 A. M., May 31st. After having wrecked corn cribs, it tore off one side of the four-sided roof of the station, the roof of the elevator and engine buildings. The roof the hotel was lifted and let down again in its original place, a barn was badly wrecked, trees were broken off, and a long timber 8x8 inches square was driven into the ground several feet. The tin roof of the engine house was carried a mile away. It made its way in a northeasterly direction, striking Mr. Rummer's farm and taking off the upper half story of his brick building, leaving the lower intact; overturned the frame addition in which his father slept, but luckily he was thrown through the window and escaped with some bruises. At Price creek the storm struck a small timber, through which it cut a path 200 feet wide. The general agreement is that it lasted from one-half to a full minute in passing a house. It is learned that it demolished a barn and corn crib at Mr. Jacob's place, over a mile southeast of Amana.

Belknap—A. W. RANKIN: A very cold, backward month; very little corn planted yet and soon will be too late; too wet, even, for grass.

Bonaparte—B. R. VALE: Absolutely no farm work done since the 13th; it will take a week of dry weather to get to work; but little plowing done for corn, and still less planted.

Clinton—DR. LUKE ROBERTS: May, 1899, exceeded normal in temperature by 1.5°, and 3.77 inches in precipitation. The total precipitation was 8.38 inches and was exceeded but once during the last twenty-one Mays. In 1892 the May rainfall was 8.41 inches. That month, however, furnished two more rain days and one more cloudy day, and 15 per cent more cloudiness, besides a deficiency of 6° daily in temperature.

Except for the inconvenience to farmers in getting seed in the ground at a reasonable date, the excess of rainfall for May, 1899, was of inestimable value in replenishing the earth with needed moisture. It is several years since the earth has been normally moist, as evidenced by the fact that old wells have been dug deeper and deeper from year to year in order to obtain a needed supply of water for stock and other purposes.

The maximum temperature was 85°, occurring on the 17th, and 26th, and 2.3° below normal, while the minimum temperature was 41°, or 7.3°

above normal, occurring on the 13th and 21st, thus giving a more uniform temperature at a higher degree than was experienced in May, 1892.

The warmest day was the 16th—mean temperature 74.2°, or one-half a degree above normal. The coldest day was the 14th, mean temperature 47.8° or 2.8° above normal.

The movement of the wind was light, being only 2,700 miles, while normal is 4,173 miles. The prevailing direction was south and the maximum velocity was twenty-seven miles per hour, occurring on the 27th.

Electrical storms occurred on nine different days, and were notably severe on the 27th and 28th, with hail accompaniment.

On the morning of the 27th a small tornado passed over the southern portion of the county, going somewhat southeasterly, doing some damage in its course. About one mile south of Low Moor it demolished a barn and sheds and fencing for Thomas Tate. The tornado was only about two rods wide, and no dwellings in its path. Some damage was done by lightning—buildings burned, trees broken and a few people stunned.

On Saturday night, the 27th, the downpour of rain, was very great, inundating the western portion of the city, not only to the discomfort of the dwellers of the flooded district, but much damage to gardens and other property resulted. The total precipitation on that night and Sunday morning was 3.06 inches. Add to this what fell on the morning of the 27th and evening of the 28th, we have a total of 3.46 inches, an amount unusual in this locality to be precipitated in so few hours.

Forest City—J. A. PETERS: Water froze on morning of the 13th, but no damage to vegetation; corn about ten days to two weeks late; the season thus far has been very favorable for farm work.

Grinnell—A. O. PRICE: May records severe storms, washing out bridges and hillsides, and damage by lightning. Barn with six horses and six cows burned on 15th; three fat steers in feed yard and thirteen yearlings in field, all near barbed wire fence, killed. Some stock killed by hail, storm of 28th, hail size of duck eggs, destroying fruit.

Humboldt—H. S. WELLS: Moisture has been too great the last week of the month; corn is in better condition than was reported; fruit scarce; some damage by lightning, wind and hail. Grass is growing rapidly.

Lamoni—T. J. FITZPATRICK: The frequent rains delayed farm work three weeks; high winds and local storms did considerable damage to orchards and buildings.

Larrabee—H. B. STREVER: Fruit blossoms damaged by frost on 13th; cold wet weather during the second decade of month retarded germination of corn; about one-third of corn replanted in consequence.

Sioux Center—J. DE RUYTER: Corn planting commenced May 5th; frost of 13th nipped barley; heavy hail of 15th damaged grain to some extent; small grain is doing well; corn nearly half replanted.

West Bend—PHIL DORWEILER: Month cool and wet; much corn had to be replanted; small grain and pastures look well; roads are bad.

SEVERE STORMS IN MAY.

The latter half of the month brought more than the usual number of destructive windstorms, though happily they traversed short distances and did not strike towns or densely populated districts.

The most notable storm of the month occurred on the evening of the 16th, in the northeastern part of Delaware county, traversing a track about thirty rods wide and ten miles in length. Reports from observers and local papers indicate that it was a tornado of sufficient force to destroy nearly all forms of movable property in its pathway. Mr. William Ball, of Delaware, writes that the day had been sultry and oppressive, the wind blowing from the southwest. About 4 P. M., heavy thunder clouds appeared in the northwest, and from that time to 10 P. M., there was the appearance of a thunderstorm a few miles north and northwest of the station at Delaware, with a light sprinkle at that place about 8:15, and very little wind.

The *Delaware County News*, of May 18th, contained a well written story of the storm, giving interesting details of its inception, appearance and destructive effects. Concerning the atmospheric conditions preceding the development of the tornado, the *News* said:

The oppressive condition of the atmosphere during Tuesday afternoon presaged a severe storm and timid hearts trembled under the premonitory influences which depressed them, and hoped the unseen danger which they were impotent to avert might be passed around them. The conditions were ripe for a tornado. The air was both cool and sweltering; it was extremely oppressive. Those who were in the vicinity of the starting point of the tornado watched the gathering clouds with extreme apprehension. There was a foreboding appearance to the sky that sent fear into every breast. Suddenly the great masses of vapor converged together in an inky blackness that is indescribable, the whirling mass dropped its funnel to the earth and went bounding on its mission of ruin. It spared nothing that happened to be in its deadly path.

According to the *News* report the whirlwind formed and began its effective work at about 8:30 P. M., on the farm of A. L. Schneider, three miles northwest of Greeley, Delaware county. From this place the tornado moved on a nearly direct line north of east, passing within a mile of the little town of Colesburg. As the storm increased in force its track was narrowed to about fifteen rods in width, and for the distance of two or three miles it swept everything in its pathway. Its force diminished after passing a short distance into Clayton county. The *News* states that four persons were killed, named as follows: J. B. Jacobs, George Lang, Walter Sheppard and Charles Sheppard. Eight persons were injured, more or less severely. The damage to property has not been carefully estimated, but it evidently amounted to many thousand dollars on the score of farms swept by the tornado. The *News* report contains the following tragic incident:

C. Miersen, J. B. Jacobs and George Lang were returning to Colesburg from Elkport, where the two former had been to transact business. They were caught directly in the path of the storm. Jacobs and Lang jumped from the wagon and endeavored to save themselves by seeking shelter by the roadside, but without avail. The wind caught them up into the air and dropped their mangled bodies to the ground with life extinct, and bruised almost beyond recognition. When the body of Jacobs was found the only clothing left upon him was one boot and a part of one pants leg. Instead of jumping from the wagon as did the other two men, Mr. Miersen whipped the team to a run and forced them to the outer edge of the storm, when they became unmanageable and he jumped to the ground, escaping with slight injuries. The frightened horses wheeled about and entered the storm once more and both were found dead.

The freaks of the storm are set forth in the following:

At the Sheppard farm a rail was driven into a large basswood tree, piercing it clear through like a needle, and leaving both points exposed. When Mr. Sheppard was picked up the barrel of a shotgun, with the stock missing, was found driven through one of his pants legs without injury to the flesh.

At one place a lath torn from a wrecked house was found sticking through the sides of an iron kettle.

Chickens with the feathers stripped from their bodies were running about. At one place the featherless mother hen was found brooding her flock, which had escaped without a scratch; and in another, a hen was found calmly sitting upon her nest of eggs, which had been safely carried several rods from its former resting place.

At the Sheppard farm a watch was found several rods from the house, the works intact in one place and the open case in another.

In the Klaus cemetery but one tombstone is left erect. Parts of the monuments were found scattered over the ground for a distance of two miles.

A DISTINCTIVE STORM PERIOD.

The last five days of May—27th to 31st inclusive—formed a notable storm period in respect to the number of local disturbances of a minor character that traversed portions of this state. A low pressure area that hovered almost continuously over the Missouri valley to the westward and northwestward of Iowa, hatched a brood of squalls, hailstorms and windstorms of limited extent that displayed some of the characteristics of tornadoes.

On the evening of Saturday, the 27th, severe hail and windstorms swept across the state from Buena Vista to Butler county, causing considerable damage in numerous localities along the line of disturbance. Prof. David E. Hadden, voluntary observer at Alta, wrote a detailed report of the storm at that place, from which we glean the following items: The day was warm and very humid; storm clouds were first observed in southwest and west about 2:30 P. M.; rain began falling gently at 4:10 P. M.; hail began at 4:20 and fell one and one-half hours, the stones ranging from the size of peas to one and one-half inches in diameter; rain continued to 6:30 P. M., and the total amount of rain and melted hail was 4.85 inches, of which amount 3.85 inches fell in one hour and fifty minutes. Much damage was done to fruit and shade trees, gardens and field crops; storm was more severe in Maple Valley township, south of Alta, where hailstones measured 8 to 9 inches in circumference. Every bridge and culvert in that township was washed out. It was the hardest rainstorm since the Cherokee flood of June, 1891. There was much electric disturbance.

This storm was extremely severe at Fonda, in which place and vicinity the hail caused great damage.

At Dows, Wright county, the storm developed severe electrical and wind disturbances and but little hail. Observer R. E. Fuller writes that the path of the storm was fifteen miles wide. He says: "In Vernon and Blaine townships twenty-one large barns were wrecked, fifty-four windmills blown down, and two dwellings destroyed. Three persons were injured; two probably fatally. The lowest estimate I would place on the damage to property would be \$30,000." The storm caused considerable damage in Clarion, Wright county, at New Hartford, Butler county, and other intermediate points.

Sunday, the 28th, was partly cloudy, and conditions of pressure, humidity, and temperature favored the development of local storms. During the afternoon two minor tornadoes were observed moving in the same general direction though over fifty miles apart, and their characteristic effects were wrought within the short distances of their contact with the earth. One of the storms made its appearance in Adams township, Keokuk county, passing within a half mile of the village of Keswick, and moving in a northeasterly direction. It reached the western part of Johnson county before its force was exhausted, but it was not in close contact with the surface throughout the entire distance covered by the funnel cloud.

The *Keokuk County News*, June 1st, gave a detailed account of its appearance and effects in that county. The property loss was considerable, but happily no persons were seriously hurt, though some remarkable narrow escapes were made. Numerous characteristic freaks of the storm were noted.

Another tornado originated somewhere in the vicinity of Bondurant, Polk county, Sunday afternoon, and traveled northeasterly, passing near the little town of Mingo, Jasper county. The small cloud, in an almost clear sky, with its pendent "twister" reaching the earth, was plainly seen by people in Altoona, Newton and other points. The *Newton Journal* describes it as a small "cloud-with-a-tail-to-it." It says: "The cloud from which the tail protruded was a common, ordinary, dark summer cloud, with nothing startling or alarming about it, but the long, far reaching, ever destructive tail was so plain that all who saw it realized that the powers of the air were being turned loose on the earth. As it touched the ground a great dust and smoke arose, resembling the burning of a large straw stack." Ample warning was given to the people in the track of the storm, and no one was hurt, though several looked out from their caves or other places of retreat and saw their movable effects whirled to destruction. The roar of the storm was heard eighteen miles distant. It was short-lived, but very vigorous while at work. In its wake a severe hailstorm passed into the edge of Marshall county."

Numerous local windstorms occurred on the afternoon and night of May 30th, and reports indicate that in two localities the storms were probably tornadic in character. A newspaper special states that a tornado in the northwestern part of Mills county, on the night of the 30th, destroyed the house and farm buildings of John Rohrburg, killed his 11-year-old daughter, injured the other members of the family and did considerable damage elsewhere.

This same storm, at a later hour, after passing over Montgomery county and the southeastern part of Cass county, again developed the tornado funnel and wrought heavy damage in Eureka and Prussia townships, Adair county. Observer J. G. Culver, of Greenfield, visited the locality over which the storm passed, and sent a detailed report from the columns of the *Adair County Democrat* of June 1st. Six people were injured in those townships, and two brothers, John and Philip Herr, were probably fatally injured. The storm reached that locality after 10 P. M. The tornado was from twenty to forty rods in width. No rain accompanied it or followed in its wake. A brisk shower had fallen a short time previous, and there was a strong wind from the south. Then came a calm, and those who were

awake heard the roar of the coming tornado. The loss of property was quite heavy.

Another tornado was reported to have passed about three miles west of Kingsley, Plymouth county, on the same night, but happily no loss of life resulted. In numerous localities high winds caused more or less damage to buildings, trees and crops, and hail fell at many places. Thus closed the stormiest May that has been known in Iowa within the past twenty years.

JUNE.

The temperature was seasonable, the mean being 70.7°, or about .7° above normal. The mean of the northern section was 68.9°; central section, 70.9°; southern section, 72.4°. Highest temperature reported, 100° at Clarinda and Stuart, on the 18th; lowest, 42°, at Decorah, Maquoketa, West Branch and Ruthven, on the 12th, 15th, 16th and 17th. The average rainfall was 5.04 inches, which is about .78 of an inch above the normal. The average for the northern section was 6.70 inches; central section, 5.10 inches; southern section, 3.33 inches. The greatest amount for the month was 11.99 inches, at Logan. The greatest daily rainfall was 7.74 inches at Sac City, on the 26th. The least amount for the month was 1.10 inches, at Lockridge. There were 12 clear days, 13 partly cloudy, and 5 cloudy. The highest wind velocity reported was 57 miles per hour, at Sioux City, on the 3d. The state was visited by one tornado at Salix and vicinity, on the 11th, and severe storms in numerous localities.

EXTRACTS FROM OBSERVERS' NOTES.

Alta—DAVID E. HADDEN: Thunderstorms occurred at this station on the 2d, 3d, 6th, 11th, 12th, 13th, 16th, 18th, 20th, 22d, 25th, and 26th. The total rainfall at station was 8.66 inches. The amount of electric force for the month was greater than usual.

Larrabee—H. B. STREEVER: Abundant rainfall and otherwise seasonable weather have given vegetation a remarkable growth during the month; corn has made up largely for retarded growth in May, while small grain has nearly reached the danger line of excessive growth.

Logan—MRS. M. B. STERN: The month has been remarkable for some heavy rains, doing much damage by high water washing away bridges and drowning stock; cornfields and meadows on low ground are all covered with mud, doing much damage.

Ridgeway—ARTHUR BETTS. Quite a rainy month; vegetation growing fine, though corn is a little backward.

Sioux Center—J. DE RUYTER: Small grain doing well; corn cultivated for the second time and much behind in growth with other years.

Toledo—CHARLES MASON: The heavy rains of May and June have saturated the low lands to such a degree that much rich land will not produce any crops this year; hail has damaged and destroyed crops and fruit in many localities; otherwise crops look promising.

SEVERE STORMS IN JUNE.

The month of June in this section usually brings the maximum of rainfall and storm energy, but this year May scored a higher record. The

amount of rainfall and meteorological disturbance, however, was somewhat in excess of the June average.

On the evening of Sunday, June 4th, wind and severe electric storms swept over a belt of the state extending from Ringgold county on a diagonal line to Winneshiek, and reaching from that line eastward to the Mississippi river. It was a straight blow, though at numerous points the velocity of the wind attained nearly the force of a hurricane, being sufficient to uproot trees, break telegraph wires, unroof buildings, and demolish numerous windmills. Happily no lives were lost, but the aggregate damage to property was quite heavy.

TORNADO AT SALIX, JUNE 11.

The most notable storm of the month was the tornado that passed near the town of Salix on Sunday, June 11th, at about 5:30 P. M. Though the track was narrow and short in extent, yet in that small area five people were killed, and five residences were destroyed, with their surrounding outbuildings.

U. G. Pursell, official in charge of the Sioux City Weather Bureau office, writes that the tornado started west of Homer, Neb., crossing the Missouri river and bottoms southwest of Salix, and expanding its force before reaching the town of Luton, about three miles northeast of Salix. The storm moved forward slowly across the bottoms about as fast as a man can run, and was seen by the Salix people a long time before it struck the houses south of town, so that most of the people had time to reach their cellars. All of the occupants of the demolished houses escaped injury, except five members of the family of John Malloy. The members of this unfortunate family went into their cellar when warned of the approaching storm cloud; but after remaining there several minutes, came up, thinking the storm had passed in some other direction, when they were caught in the destruction of their fine, new residence. Five of the family were instantly killed, or fatally injured, viz: John Malloy, Kate Malloy (his wife), and three of their children, named Bessie, Harry and Thomas.

The storm, as described by several observers, was a true tornado in form and general characteristics, being funnel-shaped and rotating swiftly from right to left. The width of the track, according to Mr. Pursell, was about forty rods. There was a considerable fall of rain and hail before the tornado appeared and some rain after it passed.

A number of other storms of considerable severity occurred during the month.

A newspaper special from Swea City, Kossuth county, gave some details of a severe storm that passed over that township on the 13th, and the report of damage indicates that it was a squall, or straight blow, of sufficient force to destroy buildings and uproot trees in its pathway. One school-house, a dwelling house and numerous barns and windmills were demolished or badly wrecked, but fortunately no person was injured.

On the evening of Saturday, June 17th, wind-squalls and hailstorms of much severity swept over the eastern part of Calhoun county and through Webster, inflicting great damage in localities from the effects of hail and wind. Near Manson, Calhoun county, the force of the wind was great enough to demolish four or five residences and a half dozen barns. Hail

was the principal agent of destruction to crops, and the damage was heavy over a wide belt of country. The city of Fort Dodge suffered severely.

JULY.

The month was about normal in temperature, the average for the state being 73.1°, with a range of about 6° from the lowest to the highest mean. The average of the northern section was 71.8°; central section, 73.4°; southern section, 74°. The extremes for the month were recorded as follows: 101° at De Soto on the 23d, and 38° at Mason City on the 30th. The hottest weather of the month was from the 23d to the 26th, inclusive. The average rainfall for the month was 3.07 inches, which is about half an inch below the July normal for the state. The extremes were 8.66 inches at Lenox, and .42 of an inch at Whitten. By sections the averages were as follows: Northern section, 2.53 inches; central section, 2.30; southern section, 4.37 inches. There were 16 clear days, 5 cloudy, and 10 partly cloudy.

EXTRACTS FROM OBSERVERS' NOTES.

Bonaparte—B. R. VALE: A royal month for corn culture, hay making and grain harvest generally; June and July corn late, but in good tilth.

Coon Rapids—DOWNS & CO.: Harvesting of all small grains well under way, and had most favorable weather for haying and harvesting; corn has gained, and is as far advanced as usual for this time of year.

Greenfield—J. G. CULVER: There has been very little wind during the month; oats and corn mostly stand well.

Grinnell—A. O. PRICE: Seldom better harvest weather, and seldom grain standing better to harvest.

West Bend—PHIL. DORWEILER: A fine month and harvesting pretty well along, promising a fair yield.

AUGUST.

The month was warmer than usual. The average temperature for the state was 74.4°, which is about 3.3° above the normal, 1.3° above the average for the preceding month. The averages by sections were as follows: Northern section, 73.1°; central section, 74.4°; southern section, 75.6°. The highest average in the state was 77.2°, recorded at Glenwood; lowest, 71° at Eagle Grove and Cresco. The maximum temperature recorded was 100°, at Wapello on the 3d, at Bedford on the 9th, and at Hampton and Clarinda on the 23d. The average rainfall for the state was 3.68 inches, which is about .61 of an inch above the normal for August. The averages by sections were as follows: Northern section, 3.40 inches; central section, 3.38 inches; southern section, 4.25 inches. The greatest amount reported for the month was 10.45 inches, at Thurman; least amount, 1.12 inches at Algona. There were 17 clear days, 10 partly cloudy, and 4 cloudy days. Sioux City reported wind velocity of 59 miles an hour from the northwest on the 2d.

EXTRACTS FROM OBSERVERS' NOTES.

Bonaparte—B. R. VALE: A profitable and seasonable month; temperature above normal at close; soil too dry for seeding at close of month.

Clinton—LUKE ROBERTS: The hailstorm of the 11th was an unusual one for this section; hailstones as large as walnuts fell and did considerable damage.

Grinnell—A. O. PRICE: For finishing harvest and rounding out the corn crop, an ideal month.

Humboldt—H. S. WELLS: Corn cutting begun; threshing is about done or is in stack; too dry and hard for plowing; most pastures are good; best yield of oats, 60 bushels; wheat, 20; flax is nice crop; the bulk of corn crop should be safe from frost now.

Lamoni—T. J. FITZPATRICK: The month closed very dry and hot; corn at end of the month safe from frost, but suffering some from the dry weather.

Ovid—H. C. MILLER: A very warm clear month, with no high winds.

Toledo—L. G. BOOKWALTER: The month of August has had hot days and cool nights; corn is making progress and that which was planted early is ready to be cut and shocked; the high temperature has dried the blades in some places; the apple crop is very thin; pastures are very good.

West Bend—PHIL. DORWEILER: Month was favorable for haying and threshing; corn planted in season will be all right in about a week.

SEPTEMBER.

The month was characterized by abnormal extremes of temperature, breaking all previous September records in Iowa for both hot and cold weather. At the central station the average temperature of the first seven days was 80.2°, and on the 5th and 6th the maximum was 99°. Several voluntary stations reported maximum temperatures exceeding 100°, the highest being 104°, at Eldon on the 6th. The mean for the state for the month was 62.5°, which is about 1.8° below the normal for September. By sections the averages were as follows: Northern section, 60.6°; central section, 62.8°; southern section, 64.1°. The coldest weather occurred during the last five days of the month, all portions of the state being visited by killing frost and freezing temperature. The lowest record was 15° at Sheldon and Sibley on the 29th, and at Mason City on the 30th. The month was unusually dry, the average rainfall for the state being .93 of an inch, which amount is 2.06 inches below the normal. The average of the northern section was 1.01 inches; central section, .72 of an inch; southern section, 1.06 inches. Lockton station reported only a trace, and at Fond du Lac no rainfall was recorded. There were 16 clear days, 9 partly cloudy, and 5 cloudy.

EXTRACTS FROM OBSERVERS' NOTES.

Bonaparte—B. R. VALE: Too dry for fall plowing or seeding to advantage.

Greenfield—J. G. CULVER: Corn generally well matured; pastures very short; very little fall plowing done.

Ovid—H. C. MILLER: All tender vegetation killed by frost on the 29th and 30th.

Sioux Center—Threshing about half done; corn is ready and husking will be commenced.

Toledo—L. G. BOOKWALTER: This has been a very dry and dusty month; the latter part of the month unusually cold, with frost and frozen water.

West Bend—PHILIP DORWEILER: A fine month but too dry; no killing frost till the 26th; very hard frost on the 29th and 30th; corn all right

and will be a good crop; oats yield well; wheat only fair, hardly an average.

OCTOBER.

The month was warmer than usual, with a very large percentage of clear and fair weather, and generally deficient rainfall. The monthly mean temperature of the state, as shown by 118 reports, was 56.7°, which is about 6.5° above the October average. The mean of the northern section was 54.2°; central section, 57°; southern section, 59°. The highest temperature reported was 95°, on the 13th, at Mooar, Lee county; lowest, 17°, at Hampton on the 29th. The average precipitation for the state was 1.73 inches, which is about .5 of an inch below the normal for October. The average for the northern section was 1.90 inches; central section, 1.44 inches; southern section, 1.73 inches. The largest amount reported was 4.64 inches at Thurman and the least amount .15 of an inch at Hamburg, both places being located in Fremont county. Of the total reported at Thurman, 3.72 inches fell in 24 hours, on the 24th and 25th. The prevailing wind direction for the month was south. The month was very favorable for farm operations, except plowing, for which work the soil was too dry and hard.

EXTRACTS FROM OBSERVERS' NOTES.

Algona—C. D. PETTIBONE: First snow of the season on the 19th.

Bonaparte—B. R. VALE: A splendid month for maturing corn and all kinds of work except plowing; fall grain very spotted. Corn husking in progress the last ten days.

Forest City—J. A. PETERS: Temperature about 8° above normal, and precipitation about 1 inch below. Many of the farmers have finished picking corn; ground very dry.

Grand Meadow—F. L. WILLIAMS: The month was extremely favorable for all farm work; corn husking well along and the crop is in good cribbing condition; pastures still fair.

Grinnell—A. O. PRICE: Too dry for plowing, but a pleasant month for farm work otherwise. Less than an inch of rain during the past two months.

Lamoni—T. J. FITZPATRICK: The first killing frost occurred on the 17th.

Ridgeway—ARTHUR BETTS: A warm October; minimum temperature did not go as low as in September; much hazy weather; wild geese around since the 16th; no frost during the first 16 days. The 23d was a phenomenal day with the temperature ranging from 64° to 88° and averaging 76°, with a gale from the south.

West Bend—PHIL. DORWEILER: Month favorable for farm work and corn husking well along, with pretty good yield.

NOVEMBER.

The month was much warmer than usual in all parts of the state, breaking all previous records for the state. The mean temperature was 43.9°, which is about 11° above the normal. The mean by sections was as follows: Northern section, 41.9°; central section, 43.8°; southern section, 46°. Burlington reported a maximum of 86° on the 17th. The lowest temperature reported was 8° at Primghar on the 2d. The average precipitation for the state was 1.20 inches, which is about .22 of an inch below the

normal. The average for the northern section was 1.16 inches; central section, 1.41 inches; southern section, 1.03 inches. Belle Plaine reported the largest amount for the month, 2.97 inches; Estherville the lowest, .13 of an inch. There were 12 clear days, 8 partly cloudy, and 10 cloudy days. The month was favorable for cribbing corn, and securing in prime condition all late-maturing crops.

EXTRACTS FROM OBSERVERS' NOTES.

Alta—DAVID E. HADDEN: First snowfall of the season on the 30th. November, 1899, was a warm and very pleasant month; lawns were green during the entire month.

Bonaparte—HON. B. R. VALE: An ideal month for all kinds of work. Since the rain on the 14th a large acreage has been plowed.

Carroll—MOSES SIMON: A very fine month. Farmers plowing up to the 30th.

Clinton—DR. LUKE ROBERTS: Lightest November rainfall in 21 years, except in 1885 and 1889. The warmest November in 21 years.

Corning—JEROME SMITH: Dandelions in blossom in the fields on the 30th. First snow of the season on the 30th.

Cresco—GREGORY MARSHALL: The mean temperature, 39.6°, is the highest ever known here.

Fonda—N. C. BARRON: Corn husking is nearly all done and more than the average amount of fall plowing done.

Forest City—J. A. PETERS: Farmers are plowing at the close of the month. Corn is all gathered. Temperature over 15° above normal.

Fort Madison—MISS L. A. MCCREADY: A very pleasant, but dry month. Thanksgiving was more like a spring day.

Grinnell—A. O. PRICE: Perfect weather for husking corn and preparing for winter. Roads like a pavement.

Guthrie Center—RALPH H. JONES: The month has been mostly clear.

Fort Dodge—R. W. BLAIN: November was fine for fall work. Corn all gathered in good condition; too dry to plow; first snow on the morning of the 30th; there were 11 clear, 11 partly cloudy, and 11 cloudy days.

Humboldt—HENRY S. WELLS: Corn all harvested; plowing all done; much attention is paid to purchasing sheep.

Lamoni—T. J. FITZPATRICK: The month was remarkable for dry, warm weather; excellent for the corn harvest.

Larrabee—H. B. STREVER: The month has been very warm; corn husking completed near the close and considerable plowing done late in the month. First snow on the 30th.

Logan—MRS. M. B. STERN: The fall has been dry, but remarkable for clear, warm sunshine. The morning of the 30th was ushered in with a thunderstorm with bright, vivid lightning, followed by our first snow, which melted as it fell.

Mount Vernon—REV. JOS. W. HUBBARD: A wonderful November; nothing to compare with it in fourteen years.

Ovid—H. C. MILLER: A very warm and pleasant month; grass as green as in the spring, and lots of dandelions in bloom.

Ridgeway—ARTHUR BETTS: This November has been a phenomenon; it is a winter shortener; children were gathering wild flowers on December 1st; the dandelions and white mallows are quite abundant; no frost from

14th to 24th. October, 1898, was only 3° warmer than this November; wild geese going south 22d.

DECEMBER.

The general character of the month was very pleasant and favorable. The mean temperature was 22.6°, which is about 1° below the normal for December for the state. By sections the means were as follows: Northern section, 20.2°; central section, 22.7°; southern section, 25°. The maximum temperature reported for the state was 75° at Belknap on the 22d; minimum temperature, 19° at Ruthven on the 31st.

The average precipitation for the state was 1.61 inches, which is about .23 of an inch above normal. By sections the averages were as follows: Northern section, 1.34 inches; central section, 1.80 inches; southern section, 1.69 inches. The largest amount was reported at Monticello, amounting to 4.28 inches for the month; least amount, .10 of an inch at Clear Lake. There were 12 clear days, 10 cloudy, and 9 partly cloudy days.

EXTRACTS FROM OBSERVERS' NOTES.

Albia—R. MOORE: Winter has been quite mild so far; very little snow and rain during the month.

Bancroft—E. G. BAILEY: December closes with clear skies and no snow; but little wind during the month.

Bonaparte—B. R. VALE: A very pleasant month; favorable for stock and farm work.

Clinton—DR. LUKE ROBERTS: Maximum temperature, 2.9° below normal; minimum temperature, 4.8° below normal. From 1882 to 1887, inclusive, the mean minimum for December was -20.3°. The mean temperature for December, 1899, was 5° below normal. Rainfall, .24 of an inch below December normal.

Decorah—F. H. BAKER: Amount of precipitation for 1899 at this station, 27.52 inches; number of days below zero in the year, 42; highest temperature, 93°, July 22d.

Elkader—CHARLES REINECKE: Mean temperature for 1899 was 46.9°; total precipitation, 29.50 inches; snowfall, 25.16 inches; highest temperature, 100°, September 5th; lowest, -28°, February 9th and 10th.

Fayette—R. Z. LATIMER: Ground and streams froze up December 3d, and thawed out 11th; streams froze again on 14th, with sleighing from 13th to 19th; light snow and ice at end of month.

Grinnell—A. O. PRICE: No snow of importance; month generally pleasant; only one severe storm.

Harlan—C. A. REYNOLDS: On the whole, a fine month; neither too cold nor too warm for winter weather.

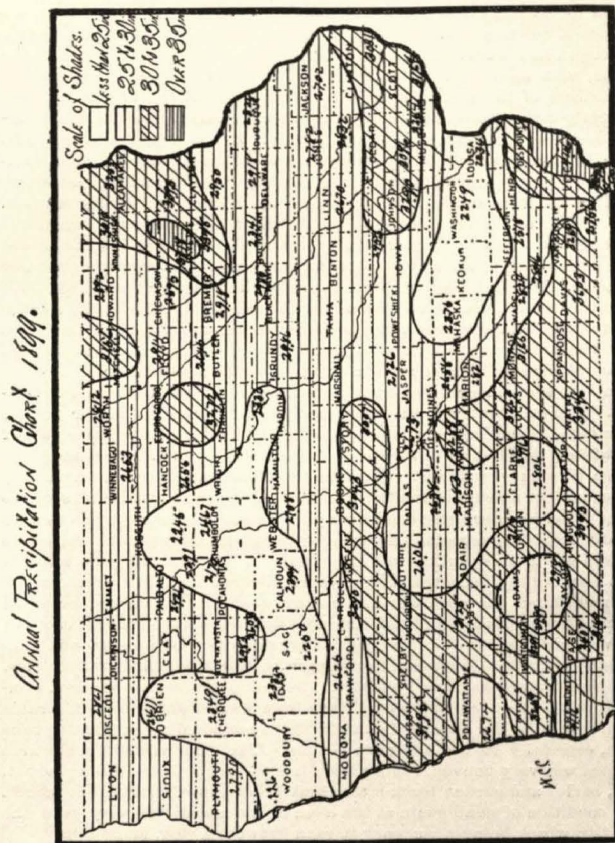
Larrabee—H. B. STREVER: Unusually warm until Christmas, when winter was ushered in with a cold wave.

Logan—MRS. M. B. STERN: A fine winter month; no severe storms nor extremely cold weather.

Newton—A. LUFKIN: Total rainfall, including melted snow, for the year, 27.26 inches.

Ovid—H. C. MILLER: Winter commenced without the usual fall rains; ground dry and water scarce.

Ridgeway—ARTHUR BETTS: The warmest of three Decembers; big snow on 11th, came to stay. Last week was coldest; plowing was done until the 11th.



CLIMATE AND CROP REVIEW—SEASON 1899.

The unusually severe winter of 1898-9, which began about ten days earlier than the average, was protracted fully two weeks beyond the usual period for the advent of spring. The extremely low temperature that prevailed in February and March froze the soil to an unusual depth, and the season for farming operations opened two to three weeks later than the average of recent years. Seeding of spring wheat and other small grain was begun in the northern and central districts about April 10th, and continued, with more or less interruptions, to about the 25th of the month. In portions of the southern section seeding operations and field work generally were greatly delayed by excessive moisture, resulting in a material decrease of the acreage of small grain. It was early discovered that more than 80 per cent of the winter wheat in the southern section and a very large percentage of the clover in all parts of the state, had been killed by alternate freezing and thawing during the winter and spring months. The acreage of winter wheat sown in the fall of 1898 was very small, and the aggregate loss by winter-killing was relatively light; but the almost total destruction of the clover plant was seriously felt in nearly all parts of the state. The last half of April was somewhat warmer than usual, with plentiful rainfall, giving a vigorous start to vegetation, and by the close of the month farm work was fairly well advanced, and the fields showed a good stand of spring wheat, oats and barley. Grass was about as well advanced as usual in meadows and pastures by the close of April.

In May the temperature of the air was about normal, though quite variable. The soil, however, was unseasonably cold during the larger part of the month, in consequence of the deep freezing during the latter part of the winter, the lateness of the spring, the excessive precipitation, and prevalence of cloudy weather. The number of stormy days was unusually large, and the amount of rainfall was much above the normal in all sections of the state. Under these conditions plowing and planting operations were greatly retarded, especially in the southern and central sections, where the soil was almost continuously saturated. A fair beginning was made in corn planting in the central and northern districts during the first half of the month, but the cool, wet and cloudy weather that followed rendered germination unusually difficult, and more than the usual amount of replanting was made necessary. The heavy showers caused much damage in corn-fields by washing of slopes and flooding the undrained low lands and bottoms. All these drawbacks caused a material lessening of the corn acreage, compared with the area that would have been planted under more favorable conditions. At the close of the month there remained much planting to be done, especially in the southern section. The stand secured in the area planted was very uneven, ranging from fair to poor. Grass, spring wheat, oats, barley and garden truck made remarkable growth during the month. The condition of small grain at the close of the month was very good, the chief drawback being a tendency to rank growth on rich, moist soils.

June, as a whole, was seasonably warm, and the average amount of rainfall was slightly above the normal, though quite unequally distributed. The average of the northern section was 6.70 inches, the central section, 5.10 inches, and the southern section only 3.33 inches. The greater number of showers occurred in the first half of the month, with much humidity and

warmth, causing a rapid growth of all kinds of vegetation. The last half of the month was generally dry and more favorable for cultivation of corn, especially in the southern section, where dry weather was greatly needed. At the close of the month corn was in all stages of growth, ranging from an inch to two feet in height; and fair progress had been made in its cultivation, though under great disadvantages in many localities. Small grain was mostly headed out, with rank growth and a marked tendency to lodge, and numerous indications of damage by rust.

July was normal in temperature and the weather conditions were generally favorable for the rapid advancement of crops, and also for the comfort of those who were engaged in farming operations. The rainfall was less than normal, the southern section receiving the larger amount; but there was sufficient moisture in the larger part of the state. From the 3d to the 15th the weather was murky, cloudy and showery, causing much delay in haying and cultivating late corn. But the moisture was beneficial to corn, potatoes, pastures and garden truck. The last half of the month was dry and warm, affording ideal weather conditions for harvesting hay and grain. The month, as a whole, was favorable for the rapid advancement of corn, which had made a late start and needed forcing weather to bring it to maturity in advance of frost. And all growing crops were well advanced during July.

August was warmer than usual, the daily average for the state being 1.3° above the mean for July. And the average rainfall in all sections was slightly above the normal for August. During the first week there was an excess of rain in the central and southern districts, with local windstorms of considerable severity, causing some damage to corn and grain in shocks; but the benefits resulting from the timely and liberal supply of moisture greatly exceeded the incidental damage and delay in harvest operations. The month closed with a protracted period of warm and dry weather, which was favorable for maturing early planted corn and for threshing and closing up work in the harvest fields. And at the end of the month the larger part of early planted corn was sufficiently advanced to be cut and shocked. The soil was generally too dry for plowing, and pastures were short.

September was notable for extremes of hot and cold weather, exceeding all previous records for that month in all the years since observations have been recorded in the state. Hot winds prevailed during the larger part of the first week, and on the 5th and 6th the maximum temperatures at numerous stations registered from 96° to 104°. This period of extreme heat terminated on the night of the 7th, with light and fairly well distributed showers, followed by much cooler and generally very dry weather during the remainder of the month. The effects of the hot and dry winds were very marked in the cornfields, but the crop as a whole was much benefited by being swiftly hastened to maturity, placing it beyond danger of harm by the killing frosts that reached all parts of the state during the last five days of the month. Frosts were noted at various places as early as the 14th, and thereafter on various dates with increasing severity, until freezing temperatures were recorded at all stations from the 26th to the 30th. The month was generally favorable for bringing the late growing crops to maturity; but unquestionably corn and potatoes would have been better in quality and total yield if the temperature had been equable and the killing

frosts had been deferred till the normal period. The total output of soil products in the state, however, is fairly satisfactory and remunerative. The drouthy conditions in the latter part of the season materially retarded fall plowing and lessened the acreage of fall wheat and rye compared with former years.

CLIMATE AND CROP BULLETINS.

SUMMARIES OF WEEKLY BULLETINS ISSUED DURING THE CROP SEASON, 1899.

BULLETIN NO. 1, WEEK ENDING APRIL 10TH.

Compared with last year the season for beginning seeding and other farm operations is about three weeks late; and it is fully two weeks later than the average of the past ten years. Winter conditions prevailed through the month of March, and until about the close of the first week of April. At the central station the daily mean temperature of the past week was about 9° below normal, and at Keokuk the average daily deficiency was 16° for the week ending the 8th inst. Under these conditions the frost in the soil is receding very slowly, and the surface has been generally too wet for field work. In some of the counties in the central section a beginning has been made in seeding on dry ridges and well drained fields. With favorable conditions a fair start in that line will be made the coming week. The fields of winter wheat have not as yet shown signs of life, and it is believed that late sown wheat is about all killed. The early sown fields have also suffered material damage. Last year's seeding of clover has been badly injured in all sections. Less hardy varieties of fruit have been considerably injured. The consumption of grain and forage during the past winter has been much greater than usual.

BULLETIN NO. 2, APRIL 17TH.

The past week brought a decided improvement in weather conditions. The temperature of the first half of the week was much above the normal; lower temperature prevailed during the last half, but the average for the week was warmer than usual for the second week in April. There was more than the normal amount of sunshine, with a prevalence of drying winds, causing a rapid improvement in the condition of the soil. There were a few light showers, but the amount of rainfall was not sufficient to retard field work. In the northern and central districts much progress has been made in seeding wheat and oats; and the bulk of small grain will be planted within the coming week, with generally fair conditions of the soil. In portions of the southern districts the work of seeding has been retarded by excessive moisture in the soil. The acreage of spring wheat seeding in the northern and central districts will not be materially less than last year, and about the usual area of other small grain will probably be sown. The extensive killing of clover will probably necessitate plowing and planting more than the usual amount of meadow and pasture land. Reports as to condition of winter wheat are generally unfavorable.

BULLETIN NO. 3, APRIL 24TH.

The average temperature for the past week was about normal, and weather conditions were generally favorable for rapid progress in farming operations. Scattered showers in the central and southern districts gave an ample supply of moisture for present needs; but in portions of the northern and western districts the soil is becoming quite dry and rain is needed to start vegetation. Spring wheat seeding is practically completed, and the acreage is probably a little less than last year. In the northern and central sections seeding oats and barley is nearing completion, the acreage of these crops being nearly an average. In the southern section oats seeding has been considerably delayed by the wet condition of the soil and recent copious showers. On the whole the outlook for spring grain crops is fairly satisfactory, though somewhat below the normal condition. Winter wheat is practically a failure in the larger part of the limited area seeded to that crop. Clover has been badly winter-killed in all parts of the state. A good beginning has been made in plowing and preparing ground for corn. Grass is making a late start, and stock will require feeding much later than usual.

BULLETIN NO. 4, MAY 1ST.

The past week was warmer than usual, the daily excess of temperature ranging from 6° to 12°. Nearly all parts of the state received copious showers, giving an abundance of needed moisture. All conditions have been very favorable for the growth of vegetation; and rapid progress was made in farm operations except in portions of the southern districts where work was retarded by excessive rains. Grass has started nicely, and in many sections pasturage is sufficient for the support of stock. Spring wheat, oats and barley germinated quickly, and generally show a good stand. In some of the northwestern counties very high winds caused dust storms on the 28th, and some injury resulted to recently sown fields of small grain. Active preparations are in progress in all sections for planting corn, and with favorable weather a good beginning will be made during the first week in May. Reports indicate a probable increase in the acreage of corn compared with last year, in consequence of winter-killing of wheat and clover and the unfavorable conditions for early seeding of small grain. The spring pig crop is likely to be much lighter than usual.

BULLETIN NO. 5, MAY 8TH.

The mean temperature of the past week was above normal, the average daily excess ranging from 2° to 9°. On the morning of the 4th frost was observed at many stations, but no damage resulted. The rainfall was ample in all districts and somewhat excessive in portions of the southern and central sections. Weather conditions have been favorable for the growth of grass and all small grain crops, which are reported to be in very fine condition. Pasturage sufficiently advanced for the full support of stock. A large area has been prepared for corn and planting will be in full progress as soon as the conditions of soil will permit. In numerous localities a fair beginning has been made in planting. Apple, plum and cherry trees are generally in bloom. In respect to leafage, bloom and general growth of vegetation the season is about as well advanced as the average of recent years.

BULLETIN NO. 6, MAY 15TH.

There was more than the usual amount of cool and cloudy weather during the past week, and the week closed with a heavy storm which brought excessive moisture in portions of the central and southern sections. Iowa City reported 4.35 inches for the seven days ending Monday A. M., and Cedar Rapids 2.01 inches, which will cause some delay in field work. Conditions were generally favorable, however, during most of the week, and the time has been well improved in plowing and planting operations. In all districts considerable progress has been made in planting corn, with the soil in good tilth. This work is probably more advanced in the northern and central districts than in the southeastern part of the state, where there has been an excess of moisture. Spring wheat, oats and barley have made fine advancement, and the week has been very favorable for grass. But little damage resulted from frost on the 13th. Fruit trees, vines and berries that escaped destruction during the winter give promise of good crops.

BULLETIN NO. 7, MAY 22D.

The past week was unseasonably cold and wet, with an excessive amount of cloudiness. The daily mean temperature ranged from 3° to 5° below normal. The amount of rainfall was above normal in all districts and was very heavy in the southern half of the state, where the soil was already saturated by the heavy showers of the preceding week. Under these conditions but little progress has been made in planting corn, except in some favored localities and on the naturally dry or tile-drained lands. In the northern districts planting is more advanced than in the central and southern sections. In large portions of the central and southern districts plowing and planting operations will not be completed until after June 1st, even under the most favorable weather conditions in the future. Numerous reports show failure of germination of early planted corn, and it is probable that more than the usual amount of replanting will be necessitated. The conditions have been very favorable for grass in pastures and meadows, new seeding of timothy and clover and all spring grain crops.

BULLETIN NO. 8, MAY 29TH.

The first three days of the week were slightly cooler than usual, and generally fair. The last three days brought much higher temperature and showery conditions, which developed severe storms of rain, hail and wind in numerous localities on the 27th and 28th. Considerable local damage resulted from effects of hail and floods. The corn and wheat district reports received by wire show the following excessive amounts of rainfall at the stations named: Cedar Rapids, 4.87 inches; Clinton, 4.35; Hampton, 3.92; Ogden, 3.93; Waterloo, 3.79; Marshalltown, 4.31; Forest City, 1.86; Iowa City, 2.55. The heaviest storms of the week swept through the central and northern sections of the state. Some progress has been made in planting corn in districts where the soil was sufficiently dry. In considerable portions of the northern section the work is practically completed, though some will need replanting. For the state at large it is estimated that about three-fourths of the corn area has been planted, but the condition of the stand secured in the early planted fields will necessitate more than the usual amount of replanting. Under existing conditions it is prob-

able that planting operations will not be completed in all districts before June 10th. Experience in past years proves that with the soil in good tilth, and with thorough cultivation, a fair output of corn may be secured from good seed planted at that date.

BULLETIN NO. 9, JUNE 5TH.

The past week was warmer than usual, the average daily temperature ranging from 4° to 8° above the normal. The humidity of the air was excessive and frequent showers added to the large surplus of rainfall of the preceding two weeks. The northern section received some of the heaviest showers, which flooded the low lands and damaged cornfields on the slopes in numerous localities. In all parts of the state the amount of moisture is excessive. These conditions have not been favorable for small grain crops, which are likely to become too rank on all rich and moist lands. Some progress has been made in planting corn in the southern section, where the work has been previously delayed; but there is a considerable area yet to be planted if weather conditions in the near future are more favorable. The acreage in that section is likely to be materially reduced. Much replanting has been done in all sections, and a fair start has been made in cultivation wherever the soil was dry enough. The weather has been favorable for new seeding of timothy and clover, and for potatoes and garden truck generally.

BULLETIN NO. 10, JUNE 12TH.

The average temperature of the past week was slightly above normal, with about the usual amount of sunshine. The first half of the week was showery and latter part generally fair. Except in portions of the northeast and southeast districts conditions were favorable for drying up surplus moisture, and placing the soil in condition for cultivation, and completing the work of planting where it had been retarded by excessive rains. It has been the best week of the season and the crop situation is considerably improved. Fair progress has been made in cultivating corn, the fields present a cleaner appearance, and the plants a better color. In portions of the southeast district planting operations will be continued throughout the coming week, if weather is favorable; and at best, some of the land intended for corn will be sown to forage crops or abandoned. Conditions during the week were somewhat improved for spring wheat, oats and barley; but many reports indicate that small grain is becoming too rank for best results. Grass in meadows and pastures is doing well, but the stand was greatly impaired by the severe winter, and the hay crop will not be as heavy as usual. The shortage will be made good by millet and other forage crops.

BULLETIN NO. 11, JUNE 19TH.

The average temperature of the past week was about normal. Very heavy showers on the 12th and 13th brought a great excess of rainfall on the western slope and over the greater portion of the northern half of the state. Following are some of the heavier amounts reported: Harrison county, 6.55 inches; Carroll, 4.26; Crawford, 3.73; Adair, 3.40; Mills, 2.74; Monona, 2.63; Palo Alto, 2.88; Buena Vista, 2.65; Webster, 2.56; Black Hawk, 4.48; Bremer, 4.13; Wright, 4.50; Humboldt, 4.04; Franklin, 3.66; Winne-

bago, 3.10; Floyd, 2.64; Howard, 2.26; Winneshiek, 2.29. Considerable damage by floods and soil erosion resulted from these showers, and the needed work of cleaning the corn fields was delayed. On the 17th considerable damage was caused by local hail and windstorms in some of the counties in the central and northern districts. Despite these drawbacks fair progress has been made in cultivating the cornfields, and in finishing planting in the southern section. The condition of corn is very uneven, and the output uncertain; but with favorable conditions in the future it is possible to bring the crop up to an average in the larger part of the state. Reports from nearly all sections confirm previous advices as to the rank growth of spring wheat, oats and barley, and the danger of loss by lodging. Grass, potatoes, gardens and small fruit have been favored by the abundant moisture.

BULLETIN NO. 12, JUNE 26TH.

The past week was slightly warmer than usual, and the percentage of sunshine was about normal. The rainfall was phenomenally heavy in a small portion of the central district. Ames reported 4.61 inches, accompanied by damaging hail and wind; Ogden, 3.81, and Marshalltown, 2.04 inches. In the larger part of the state, however, the amount of rainfall was light, and conditions were favorable for drying the soil and for general farm work. On the whole the weather conditions were about all that could be desired, and fair progress has been made in cleaning out the weedy cornfields. In portions of the southeast district planting operations have been continued on lands that were previously too wet; and the cultivation of corn on drier lands is in progress with improved prospects. All small grain crops are yet standing up fairly well, though unusually heavy on rich moist lands. Haying is commenced in many localities, with generally less than the average yield. The potato crop is very promising in all sections. Pastures are notably good. Conditions have been very favorable for berries and garden vegetables.

BULLETIN NO. 13, JULY 3D.

The past week was slightly warmer than usual, the average being reduced by cool nights; but there were four to five bright, clear days, affording excellent conditions for work in the fields and the advancement of all crops. Sac county reported phenomenally heavy rainfall on the 26th, and some other northwestern counties received more than the normal amount; but in the bulk of the state there was scarcely any hindrance of work on account of wet weather. In the southern section the soil was becoming too dry, and the showers on the 2d and 3d were timely and beneficial. The week was especially favorable for oats, which had made rank growth and is in danger of lodging. There are some reports of damage by falling and rust, but in the main this crop is standing fairly well. Spring wheat and barley are doing well. Excellent progress has been made in cultivating corn, and reports as to this crop are generally more cheerful in tone. A considerable portion of the early planted corn will be laid by during the first week in July. The cornfields show all stages of growth, from early germination to waist high and first appearance of tassels. On the whole the crop outlook is somewhat improved.

BULLETIN NO. 14, JULY 10TH.

The average temperature of the past week was reduced somewhat below normal by cool nights and showery weather. In the larger part of the state the amount of rainfall was seasonable and beneficial to crops; but there was some local excess in portions of the central and southern sections. Windstorms with heavy rains on the night of the 5th and 6th caused some damage to corn and rank fields of oats and other small grain in the central and northern sections. On the whole crops are doing fairly well. A large portion of the early planted corn has been laid by, and good progress has been made in cultivating late planted cornfields. Barley is ripening and much of it ready for harvest. Oats considerably lodged, but generally filling well and promising a fair yield. Spring wheat is doing well, with no signs of material damage by rust or lodging. Rye is mostly in shock. Haying is in progress with less than normal yield. Reports from county and township correspondents for July have been summarized, and show following averages of conditions for the state: Wheat, 93 per cent; corn, 83; oats, 96; rye, 80; barley, 97; flax, 94; millet, 97; sorghum, 87; hay crop, 82; potatoes, 100; sweet potatoes, 96; apples, 60; plums, 66; grapes, 43.

BULLETIN NO. 15, JULY 17TH.

The week was warm, with more than the usual amount of humidity and cloudiness. The weather was unsettled and threatening, with tendency to frequent showers, which brought excessive moisture in portions of the east central, northeast, north central and south central districts. In the balance of the state, however, the amount of rainfall was not in excess of the requirements for crop growth. In about one-third to one-half of the state work in the hayfields was retarded, and a good deal of hay has been injured by frequent rains and lack of sunshine. In the drier districts fair progress has been made in haying and harvesting rye, early sown oats and barley. With favorable conditions harvesting spring grain crops will be general in the larger part of state within the coming ten days. Corn has made very good progress in all sections, and the bulk of the crop has been laid by in fair condition; but work of cultivation is in progress in late planted fields and bottom lands. Prospects for the crop as a whole are steadily improving. Oats and other small grain crops are standing up fairly well, under somewhat adverse conditions, and with a favorable harvest season the output will be good. Potatoes, pastures and garden truck are doing notably well.

BULLETIN NO. 16, JULY 24TH.

The past week was warmer than usual, the maximum temperatures ranging above 90° the last two days. The rainfall was light and confined to a very small area, the bulk of the state being dry, with a large percentage of sunshine. There were six days of ideal weather for finishing haying, and harvesting early grain crops. The oats harvest is well advanced in nearly all sections, and a good beginning has been made in cutting spring wheat. Barley and rye are mostly in shock and threshing is begun, the returns showing good average yields. Corn has made very good progress, and the more advanced fields are in full tassel and earing in good condition. The reports generally show that rain will be needed in the near future, though

no damage has thus far resulted from dry weather. Pasturage, late potatoes and garden truck need rain.

BULLETIN NO. 17, JULY 31ST.

The temperature during the past week was variable, ranging from 5° to 10° below the normal; but being generally dry the weather conditions were about all that could be desired for rapid progress in haying and harvest operations. In the southern section the bulk of small grain is in shock or stack, and threshing is in progress. In the northern and central sections the work of cutting grain is well advanced, and in extensive districts it is nearly completed. A few more days of good weather will be sufficient to secure the late sown fields of spring wheat and oats in fine condition. Early reports of threshers show variable results, but the yield of oats is generally fair to good. The rainfall of the week was very light except in a few scattered localities, and many reports indicate that corn, potatoes and pastures are in need of more moisture; but no material injury has been done, and the condition of corn has steadily improved throughout the month of July. With a moderate supply of moisture and reasonable temperature in the coming month the output of the corn crop is likely to be fairly satisfactory. It is a week to ten days late compared with last year, but with reasonable temperature in September there will be ample time to mature the crop.

BULLETIN NO. 18, AUGUST 7TH.

The past week was seasonably warm, with a considerable excess of rainfall, and more than the normal amount of cloudiness and humidity. The heaviest rainfall was in the central and southern districts, but all sections of the state received an ample supply of moisture for present needs. Some damage to corn and grain was caused by severe storms of wind with heavy downpours of rain in numerous localities; but the benefits resulting from the timely and liberal supply of moisture will very greatly exceed the local and incidental damage, and the inconvenience of delaying harvest operations. In the larger part of the state early corn is earing finely, and the condition of the entire crop is generally promising. Potatoes, pastures and garden vegetables have been greatly improved by the recent rains.

BULLETIN NO. 19, AUGUST 14TH.

The highest temperature of the season was recorded during the past week, and this, with excessive humidity, made the weather conditions oppressive on the 9th, 10th and 11th. The average for the week was but little above normal. The rainfall was unequally distributed, the larger amounts being recorded in the southern and central districts; but it was generally ample for the needs of all growing crops. In considerable portions of the state the wet weather was not favorable for stacking or threshing, and oats in the shock received additional injury from continued dampness. In the northern and portions of the central sections conditions were more favorable for securing oats, wheat and barley, and fair progress was made. The corn crop is making rapid advancement toward maturity. It is reported in all stages of growth, ranging from first appearance of silk and tassels to well filled and hardening roasting ears. The early planted and well cultivated fields will be safe from harm by frost about the 15th of September. Probably 60 per cent of the whole crop in the state will be

entirely safe, with reasonable weather, on or before September 15th. With warm and dry weather the bulk of late planted corn may be well matured by September 30th. But it will require unusually favorable weather conditions to make sound merchantable corn of all the late planted portions of the crop. The rank growth of stalks will necessitate a protracted period of dry, warm weather, to bring the grain to full maturity.

BULLETIN NO. 20, AUGUST 21ST.

Typical August weather prevailed during the past week, with conditions favorable for completing harvest work, and for the rapid advancement of the corn crop. The hot and dry weather was followed at the close of the week by a cool wave, that brought refreshing showers in numerous localities, the northern and central districts receiving the larger amounts of rainfall. The conditions were especially favorable for maturing early planted corn, that has made a rank growth and needs no more moisture than is contained in the soil and stalks. The late planted corn, however, would be benefited by more copious rainfall and may suffer material damage by continued drouth and hot winds. Excellent progress has been made in threshing and securing wheat and oats; but there is a considerable amount of grain still in the shock, awaiting the threshers. Pasturage is being shortened in many localities from effects of dry weather, but it is better than usual for the month of August.

BULLETIN NO. 21, AUGUST 28TH.

The past week was warmer than usual, the excess of temperature at the central station averaging 4° daily. The rainfall was variable, but sufficient in the larger part of the state for the needs of the unripened crops, and to facilitate fall plowing. The conditions were very favorable for closing up work in the harvest fields and threshing from the shocks. Reports of yield of wheat, oats and barley are variable, but with the exception of wheat the returns indicate quite satisfactory results. In numerous localities the yield of oats is unusually heavy. Corn is making notable progress towards maturity and a considerable portion of early planted corn is sufficiently ripened to be cut and shocked. Late corn is doing remarkably well, except in sections where the rainfall has been insufficient. The high temperature has "fired" the blades to some extent in dry and sandy lands. On the whole corn bids fair to make a full average crop. Pastures are very good for August. The apple crop will be much below the average. Reports from special observers to the State Horticultural society indicate but little more than half a crop of this staple fruit.

BULLETIN NO. 22, SEPTEMBER 4TH.

The past week was the hottest of the season, with the greatest amount of sunshine and the lowest percentage of humidity. At the central station the mean temperature was 78°, and the average daily excess was over 10°. Showers were reported in the north central and northeast districts, but no rain fell in the larger part of the state. The weather conditions were favorable for forcing the maturity of early planted corn, and more than one-half the crop is now in fit condition to be cut and shocked. Late corn needs more rain for its normal development, and reports indicate that in many localities it has been "fired" by excessive heat. Rain is also needed

to facilitate fall plowing, and for pasturage and late vegetables. Winter apples have suffered to some extent from effects of excessive heat and dry weather. Good progress has been made in threshing wheat and oats.

BULLETIN NO. 23, SEPTEMBER 11TH.

The week ending 8 A. M., September 11th, was notable for extremely high temperature, exceeding all previous records for September at any Iowa station. At the central station on the 5th and 6th the maximum was 99°, and at several voluntary stations standard instruments registered 100° and upwards. Brisk to high winds prevailed during the heated period, which terminated with light and well distributed showers on the night of the 7th. At the close of the week the temperature was much lower, the minimum at several stations registering dangerously near the frost line. The heat and high winds do not appear to have been as damaging to corn as some alarming reports indicated. Fully two-thirds of the crop was fairly well matured and able to withstand drouth or moderate frost. The late planted corn will be much better in quality if the life of the plant is terminated by hot and dry weather than by the opposite extreme. So, on the whole, the benefits resulting from this swiftly ripening period may measurably offset the injury to the straggling and belated portion of the crop. The weather was favorable for harvesting millet, flax and late hay. Late potatoes will be cut short to some extent, but the crop as a whole will be above the average. Winter apples are reported to be falling off badly in some sections, and the marketable apple crop will be very light.

BULLETIN NO. 24, SEPTEMBER 18TH.

The average temperature of the past week was about normal. Light frosts were observed in numerous exposed localities on two or three mornings, but no damage to crops has been reported. The amount of rainfall was light and unequally distributed. The weather conditions have been favorable for cutting corn, and more than the usual amount of fodder has been saved by that method in sections where the hay crop was light. The corn crop is now practically assured in all parts of the state, though in some sections a portion of the late planting would be materially helped by a week or two of good ripening weather. As a whole the crop is satisfactory, and more likely to exceed than to fall short of a normal yield. The dry weather that has hurried the corn crop beyond danger has been severe upon pasturage, necessitating feeding stock in some sections, and lessening the supply of milk. It has also hindered fall plowing and seeding. Farmers are generally well advanced with their work except plowing, and for that general and copious rains are needed.

CROP REPORT JUNE 1ST.

Summary of reports by crop correspondents on the acreage and condition of state crops June 1st:

WINTER WHEAT.—The average condition of winter wheat, as shown by reports of correspondents in the counties where it has been planted in recent years, is only 28 per cent. This estimate expresses the judgment of correspondents as to the possible output of the crop compared with 1898. An effort will be made next month to obtain some reliable figures as to the

number of acres that were left for the harvest, after deducting loss of acreage by winter-killing and abandonment.

SPRING WHEAT.—The acreage shows an average decrease of 4 per cent for the state. The average condition June 1st was 96 per cent.

CORN.—The lateness of the season and the fact that a considerable area of ground prepared for corn had not been planted when these reports were mailed, will render it necessary to defer until July a final estimate of the number of acres of this crop. The reports received indicate an increase of about 4 per cent in acreage compared with 1898. The average condition of the crop is rated at 76 per cent.

OATS.—Acreage decreased 1 per cent; average condition June 1st, 99 per cent.

RYE.—Acreage decreased 11 per cent; average condition, 79 per cent.

BARLEY.—Acreage seeded compared with last year decreased 2 per cent; average condition, 98 per cent.

TIMOTHY.—New seeding, 1 per cent increase; condition, 99 per cent.

CLOVER.—New seeding of clover, 2 per cent decrease; condition, 96 per cent.

MILLET.—Increase of acreage, 11 per cent; condition, 97 per cent.

FLAX.—Decrease in acreage, 12 per cent; condition, 96 per cent.

BROOM CORN.—Decreased acreage, 9 per cent; condition, 88 per cent.

POTATOES.—Decrease in acreage, 2 per cent; condition, 95 per cent.

SWEET POTATOES.—Decrease, 6 per cent; condition, 95 per cent.

SORGHUM.—Decrease, 6 per cent; condition, 88 per cent.

MEADOWS.—Condition, 87 per cent.

PASTURES.—Condition, 96 per cent.

CONDITION OF FRUIT.—Apples, 74 per cent; pears, 55; peaches, 10; blackberries, 40; grapes, 46; raspberries, 62; strawberries, 88; currants, 88; cherries, 76.

LIVE STOCK.—Condition, cattle, 98 per cent; horses, 97; sheep, 96; hogs, 96; spring pig crop, 73 per cent; foals, 95 per cent.

Correspondents were asked to give a careful estimate of the percentage of last year's corn crop held in farmers' hands June 1st. The reports show an average of 21 per cent, or about one-fifth of the product of 1898. This would indicate that farmers' present holdings amount to about 53,000,000 bushels.

JULY CROP REPORT.

Following is a summary of the regular July 1st report of the county and and township correspondents on the condition of the staple crops:

Corn is unusually variable in condition in all districts, in respect to stand, height of plants, and the amount of cultivation received. It is reported to have been on July 1st in varying stages, from an inch above ground to vigorous plants nearly waist high. The average for the state appears to be 83 per cent. Condition of spring wheat is estimated at 93 per cent, and other crops as follows: Oats, 96 per cent; rye, 80; barley, 97; flax, 94; hay crop, 82; pastures, 98; millet, 97; potatoes, 100; sweet potatoes, 96; broom corn, 85; sorghum, 87; apples, 60; plums, 65; grapes, 43.

AUGUST CROP REPORT—CONDITION AUGUST 1ST, AND NUMBER OF ACRES IN STAPLE CROPS.

Following is a summary of the reports of county and township correspondents showing the average condition of unripened crops August 1st:

Corn has made marked advancement, and the average condition of the crop is rated at 90 per cent, as against 83 per cent on July 1st. The condition of other crops is estimated as follows:

Millet, 94 per cent; flax, 95; buckwheat, 90; broom corn, 88; sorghum, 91; apples, 59; grapes, 48; potatoes, 100; pastures, 94.

ACREAGE IN CROPS.

We present herewith a carefully prepared table showing the acreage of crops by counties for the current season. It is based on the census of crop acreage for the preceding season, made by the township assessors under the direction of the secretary of state, as provided by the statute. The acreage for this season is figured from the reports of county and township correspondents estimating the increase or decrease as compared with the year 1898. The figures are believed to be approximately correct. The following summary of the figures for the whole state will be of general interest:

CORN.—The total number of acres planted of this leading crop appears to be 8,460,521. Last year, according to assessors' returns, the total was 8,374,530 acres, showing an increased planting this year of 85,991 acres. There was a considerable increase noted in many counties, but this was in part offset by a decrease in others, so that the net gain in acreage was small.

WINTER WHEAT.—The area of winter wheat sown in the fall of 1898, as returned by the assessors, amounted to 154,177 acres. The larger part of the crop was lost by winter-killing, and according to careful estimates of crop correspondents the total number of acres left for the harvest was only 27,427 acres, or about 18 per cent of the area planted. It is quite probable the destruction was more nearly complete than those figures indicate.

SPRING WHEAT.—Acreage sown this year, 1,539,391 acres, a decrease of 87,735 acres, compared with last year.

OATS.—Number of acres sown this year, 4,069,557. Last year's acreage, 4,076,669; decrease, 7,112 acres.

BARLEY.—Number of acres harvested this season, 557,598. Last year, 575,815 acres; decrease, 18,217 acres.

RYE.—Acreage this year, 126,236 acres.

FLAX.—Area sown this year, 142,175 acres. Area last year, according to assessors, 189,882 acres, showing a decrease of 47,707 acres.

POTATOES.—Area planted, 154,243 acres. Area planted in 1898, 155,131 acres.

TIME HAY.—Present acreage of timothy and clover meadows, 2,544,343 acres. Last year the aggregate was 235,286 greater.

PRAIRIE HAY.—Acreage of wild hay reported by assessors last year was 1,198,332 acres.

PASTURAGE.—Acreage reported by assessors, 7,460,922 acres.

IOWA CROPS, 1899—NUMBER OF ACRES BY COUNTIES.

Table with columns for County, Winter Wheat, Spring Wheat, Barley, Oats, Flax, Potatoes, Hay, and Total. Rows list counties from Palo Alto to Wright and a final 'Totals for state' row.

DECEMBER

city and giving prices have been assessors with are have most are ies, and

the fall rience returns about 11 spring al yield ge farm bushel.

average 25 to 45 25 to 29 cents, hals, an was 34.5

placed at at date, thin the ef, pork, at least

tal yield per acre. king the

IOWA CROPS, 1899—NUMBER OF ACRES BY COUNTIES.

COUNTIES.	Winter wheat, acres.	Spring wheat, acres.	Corn, acres.	Oats, acres.	Barley, acres.	Rye, acres.	Flax, acres.	Potatoes, acres.	Tame hay, acres.	Wild hay, acres.	Pasture, acres.
Adair.....	107	11,770	99,557	46,254	550	4 0		1,861	27,120	6,569	72,915
Adams.....	107	7,840	71,608	23,480	170	150		880	23,105	2,270	58,254
Allamakee.....	3,108	4,870	52,406	43,188	5,775	490	7,388	2,253	34,880	1,740	78,017
Appanoose.....	380	160	42,760	8,725		340		488	44,161	1,174	88,223
Audubon.....		19,920	90,540	37,380	3,816	515		1,182	14,350	6,890	55,735
Benton.....		3,570	120,740	74,510	15,770	1,380		2,053	35,650	12,340	99,803
Black Hawk.....		708	92,150	57,302	6,751	3,261		1,670	34,045	12,880	80,418
Boone.....		8,264	105,490	50,650	896	1,220	160	1,895	15,720	23,840	69,606
Bremer.....		614	85,510	52,645	2,760	880	2,07	1,608	21,130	22,451	69,354
Buchanan.....		18,230	109,972	58,516	7,630	635	1,490	1,512	38,160	17,422	91,199
Buena Vista.....		5,160	98,170	70,995	4,790	835	1,490	2,051	14,810	27,104	62,087
Butler.....		16,130	102,550	51,738	3,920	1,265	1,198	1,456	19,350	15,558	78,206
Calhoun.....		28,357	120,960	54,750	4,415	970	290	2,303	11,135	25,318	53,510
Carroll.....		26,520	114,515	39,804	827	260		3,657	15,910	21,775	67,000
Cass.....	180	1,425	99,658	43,212	6,459	1,240		1,264	46,128	1,070	85,182
Cedar.....		6,583	87,350	73,887	8,270	1,767	5,682	1,650	26,410	15,865	79,559
Cerro Gordo.....		39,370	107,017	50,460	9,860	240	445	1,608	16,3 0	16,821	63,745
Cherokee.....		2,445	56,620	61,428	5,140	682	6,880	1,602	29,780	15,663	75,847
Chickasaw.....		185	76	55,568	19,890	1,030		883	36,550	763	73,238
Clarke.....		16,490	76,617	43,630	19,194	1,615	2,580	1,243	13,970	21,853	49,040
Clay.....	2,160	5,860	74,570	59,590	5,403	4,58 0	110	2,140	88,120	457	114,939
Clayton.....	550	1,805	117,207	56,330	2,015	3,440		1,517	47,614	4,577	103,020
Clinton.....		55,147	123,761	43,414	5,309	612	150	2,113	23,140	24,808	85,389
Crawford.....		280	6,847	90,238	32,285	705		1,091	20,107	10,798	67,900
Dallas.....	624	168	56,375	16,120		755		478	45,950	104	112,491
Davis.....	9 0	240	63,130	16,625	70	610		753	40,670	1,180	114,568
Decatur.....		922	88,513	47,465	5,370	1,407		1,400	40,915	11,091	106,534
Delaware.....		280	62,143	31,357		980		887	19,890	598	51,108
Des Moines.....		22,102	27,536	23,660	16,817	1,454	7,450	601	5,965	22,117	28,209
Dickinson.....		194	63,197	64,054	1,780	4,040		2,358	39,262	3,710	111,858
Dubuque.....	95	30,332	87,820	23,650	10,850	540	6,028	430	6,560	20,122	27,301
Emmet.....		3,043	89,220	63,633	7,123	2,103		1,920	52,535	15,691	105,001
Fayette.....	150	3,960	79,840	68,740	5,312	1,980	4,3 5	3,142	22,740	9,243	58,049
Floyd.....		9,270	99,242	76,610	8,080	1,330	3,390	1,320	19,114	16,602	65,274
Franklin.....		10,690	108,250	11,824	720	270		680	11,640	4,568	46,682
Fremont.....	3,508	6,760	103,455	54,030	2,860	6 5		1,906	15,071	26,328	67,242
Greene.....		10,389	96,370	70,690	13,730	960	402	2,148	22,590	16,987	66,144
Grundy.....		13,660	95,520	46,612	1,560	750		1,510	25,680	9,696	75,245
Guthrie.....		9,440	102,083	58,970	1,809	280	774	1,280	18,182	87,247	74,102
Hancock.....		20,078	71,730	63,960	9,836	1,780	8,594	1,120	15,300	31,764	44,952
Hardin.....		11,560	94,036	58,662	2,991	480	651	1,290	20,790	18,762	72,255
Harrison.....		41,330	102,650	15,802	860	1,025		1,502	8,630	17,086	78,274
Henry.....	420	163	67,730	27,850		990		712	29,804	24	87,000
Howard.....		3,394	50,490	52,362	6,742	250	6,285	1,099	3 521	14,260	53,075
Humboldt.....		24,504	61,283	33,746	2,658	247	2,068	872	11,965	23,055	42,821
Ia.....		25,356	98,014	39,890	4,393	190		1,188	18,026	5,182	48,691
Iowa.....	414	1,760	88,352	40,714	3,270	2,410		1,270	37,750	4,057	87,905
Jackson.....	156	1,267	76,863	41,570	1,613	7,018		1,645	39,810	1,938	127,801
Jasper.....	1,420	15,610	116,535	46,920	1,352	740		6,760	35,910	3,048	108,961
Jefferson.....	109	220	54,907	21,167		1,537		510	35,210	43	92,071
Johnson.....		1,617	98,560	48,780	1,770	3,820		1,635	43,082	2,332	106,933
Jones.....		796	80,970	31,390	1,378	2,610		1,070	42,031	1,566	110,869
Keokuk.....		940	95,450	42,216	820	1,780		1,415	41,880	663	91,559
Kossuth.....		50,810	114,560	78,407	15,620	530	9,886	2,930	15,260	68,467	75,302
Lee.....	587	1 0	46,187	13,590		1,245		1,170	34,890	288	73,684
Linn.....	79	1,390	104,970	50,435	1,900	3,375		2,310	47,310	7,532	111,994
Louisia.....	316	655	56,290	25,171		1,530		560	18,895	1,333	56 8 5
Lucas.....	503	290	47,083	17,580	5	1,120		460	40,808	415	72,243
Lyon.....		95,287	55,540	35,630	53,230	610	919	1,569	3,617	15,547	32,638
Madison.....	314	8,049	82,980	26,450	846	1,230		1,235	35,470	3,424	99,118
Mahaska.....	299	2,780	85,610	33,714	1,146	1,126		1,778	29,432	1,228	93,787
Marion.....	48	8,352	89,572	31,213	798	1,627		1,476	24,190	2,131	74,718
Marshall.....		17,734	96,950	48,320	1,9 0	437		1,838	30,430	3,102	71,677
Mills.....	315	19,304	96,318	14,518	3 0	294		1,096	15,450	6,633	62,743
Mitchell.....		5,839	53,837	51,310	15,290	1,014	12,020	2,027	33,810	4,328	44,654
Monona.....	48	32,943	119,320	14,780	4,580	980		1,130	7,5 0	29,760	74,718
Monroe.....	240	138	42,410	10,763		772		470	30,918	465	97,771
Montgomery.....	293	188	95,870	16,880		278		1,0 4	16. 60	2,374	62,896
Muscatine.....	840	2,160	64,508	23,380	3,835	2,270		1,865	23,409	4,280	65,973
O'Brien.....		42,1 9	91,101	45,343	36,395	290	1,956	1,350	12,340	15,743	51,116
Osceola.....		41,746	39,740	28,120	27,690	353	4,324	894	7,931	11,619	18,902
Page.....	2,680	13,370	123,558	22,511	741	905		1,320	28,207	4,243	83,872
Paio Alto.....		13,842	68,507	47,690	7,074	898	5,316	960	6,259	39,2 3	49,399
Plymouth.....		113,580	130,131	45,840	9,219	540		2,222	10,156	81,466	68,462
Pocahontas.....		17,065	90,173	53,270	7,220	910	5,210	2,446	8,940	41,696	61,723
Polk.....	112	14,949	99,872	34,260	210	640		3,836	21,357	14,574	67,231
Pottawattamie.....		63,058	213,178	35, 65	490	935		410	27,090	19,433	121,370
Poweshiek.....	185	3,390	85,198	48,920	3,490	73 9		1,380	39,880	2,085	104,793
Ringgold.....	318	270	87,016	25,578	210	590		9 0	40,620	1,517	105,147
Sac.....		18,875	79,905	50,152	6,802	739		1,270	20,170	19,344	66,378
Scott.....	3,048	7,540	119,550	25,450	24,476	2,020		5,402	25,627	6,512	90,173
Shelby.....		46,540	125,230	34,828	5,690	513		2,083	23,652	9,868	66,377
Sloux.....		119,573	107,020	58,480	27,524	517	495	1,504	6,127	24,162	48,025
Story.....		6,148	102,693	50,270	962	1,140		1,152	21,643	19,542	64,892
Tama.....	133	13,150	114,240	63,073	27,488	809		1,690	32,114	7,098	102,759
Taylor.....	1,194	597	86,340	23,707	506	719		2,146	36,481	1,862	86,178
Union.....	189	576	60,714	26,037	250	610		1,132	34,810	1,132	74,212
Van Buren.....		540	3,952	15,388		1,065		387	41,240	118	103,532
Wapello.....		7,929	63,273	19,843		1,008		901	33,290	2 4	80,606
Warren.....	201	84,395	29,610	260	1,146			1,890	34,070	2,329	96,280
Washington.....	249	397	85,742	40,988	460	2,113		946	40,360	253	84,094
Wayne.....	134	2,173	41,260	13,510		380		857	49,903	306	67,315
Webster.....		14,438	114,918	70,958	4,920	1,350	1,870	1,353	12,239	42,294	85,860
Winnebago.....		28,320	40,058	37,5 0	3,957	180	4,190	958	9,858	24,282	31,649
Winneshek.....	240	10,550	72,430	65,310	10,711	10,178		1,445	42,170	8,184	61,509
Woodbury.....		82,193	144,565	28,280	5,165	728		1,890	8,052	22,434	75,243
Worth.....		7,750	50,520	7,150	7,150	270		9,620	16,560	15,556	41,574
Wright.....		16,890	87,609	61,132	5,100	480		1,220	13,750	29,623	55,479
Totals for state.....	27,427	1,539,391	8,460,521	4,069,557	557,598	126,236	142,175	154,243	2,544,343	1,193,312	7,460,922

AUGUST CROP R

Following is
spondents showi

Corn has mac
crop is rated at
tion of other cro

Millet, 94 pe
91; apples, 59; g

We present
crops by countie
acreage for the
the direction c
acreage for this
correspondents
year 1898. The
lowing summar
interest:

CORN.—The
to be 8,460,521.
8,374,530 acres
There was a co
part offset by a

WINTER W
returned by th
the crop was
crop correspon
27,427 acres, o
the destruction

SPRING Wi
87,735 acres, o

OATS.—Nu
4,076,669; decr

BARLEY.—
575,815 acres;

RYE.—Acr

FLAX.—Ar
to assessors, 1

POTATOES
acres.

TAME HAY
acres. Last y

PRAIRIE H
1,198,332 acres

PASTURAC

FINAL CROP REPORT, 1899.

AVERAGE PER ACRE, TOTAL YIELD, AND AVERAGE FARM PRICES, DECEMBER 1, 1899.

Final reports for the season have been received from the county and township correspondents of the Iowa Weather and Crop Service, giving the average yield of the staple soil products, and the average home prices obtainable therefor on or about December 1st. Special pains have been taken to secure reliable statistics of the acreage of the staple farm crops harvested this year, and by using the official returns of township assessors as the basis of estimates it is believed that the figures given herewith are approximately correct. The reports as to the average yield per acre have been made by a large corps of able and experienced crop reporters, most of whom are practical farmers, and their conservative estimates are accepted as reliable. These reports have been tabulated by counties, and the following summary is made for the state:

Wheat.—The greater part of the winter wheat acreage sown in the fall of 1898, was lost by winter-killing, and much difficulty has been experienced in securing data as to the area saved and actually harvested. The returns indicate a total yield of only 226,640 bushels, with an average of about 11 bushels per acre. In 1898 the total was 3,168,000 bushels. The spring wheat acreage harvested this year was 1,539,391 acres, and the total yield was 19,574,792 bushels. Average per acre, 12.7 bushels. The average farm price of winter wheat is 58 cents, and spring wheat 54 cents per bushel. Total value of wheat crop December 1st, \$10,701,490.

Corn.—The area of corn harvested was 8,460,521 acres. The average yield in the respective counties was quite variable, ranging from 25 to 45 bushels per acre. Five counties reported averages per acre of 25 to 29 bushels; seventy-three counties, 30 to 39 bushels; and twenty-one counties, 40 to 45 bushels. The aggregate for the state was 306,852,714 bushels, an average of 36.3 bushels per acre. In 1898 the state average was 34.5 bushels, and the total, 289,214,850 bushels.

The average farm value of corn in the state December 1st is placed at 23 cents per bushel, showing the market value of the crop on that date, \$70,429,415. As fully 80 per cent of the crop will be consumed within the state, the increment gained by marketing it in the form of beef, pork, mutton, dairy goods, etc., will make the total value of the crop at least \$105,000,000.

Oats.—The acreage of oats harvested was 4,069,557 acres, and total yield is reported to be 140,647,309 bushels—an average of 34.5 bushels per acre. The average farm price December 1st was 19 cents per bushel, making the total value of the crop, \$26,722,988.

Barley.—Area of barley harvested, 557,598 acres; average per acre, 25.6 bushels; total yield, 14,719,311 bushels. Farm price, 30 cents per bushel. Value of crop December 1st, \$4,415,579.

Rye.—Area harvested, 126,236 acres; total yield, 2,061,169 bushels; average per acre, 16.3 bushels. Farm price December 1st, 40 cents per bushel; total value of crop, \$824,467.

Flax.—Number of acres harvested, 142,175; average per acre, 11.2 bushels; total yield, 1,597,979 bushels. Farm value, \$1.04 per bushel. Value of crop, \$1,661,898.

Potatoes.—Area harvested, 154,243 acres; average yield per acre, 98.8 bushels; total product, 15,252,934 bushels. Farm value, 24 cents per bushel; value of crop, \$3,660,714.

Sweet Potatoes.—Average yield per acre, 87 bushels. Estimated product, 305,300 bushels. Value, \$253,390.

Hay (cultivated).—Area, 2,544,343 acres; average yield per acre, 1.5 tons; total yield, 3,852,941 tons. Value of crop, 85.75 per ton; total value, \$22,154,410.

Hay (wild).—Area cut, 1,198,312 acres; total yield, 1,458,195 tons. Farm value, \$4.90 per ton; total value of product, \$7,145,155.

Buckwheat.—Average yield per acre, 15 bushels; total yield, 172,500 bushels; value \$96,600.

Timothy Seed.—Average yield, 4.3 bushels per acre. Estimated product, 780,000 bushels. Value, \$834,600.

Clover Seed.—Value (estimated), \$250,000. Average yield per acre, 1.7 bushels.

Millet Seed.—Yield, 20 bushels per acre. Value of product, \$75,000.

Sorghum.—Average 85 gallons per acre. Estimated value of product, \$375,000.

Broom Corn.—Estimated value of crop, \$45,000.

Corn Fodder.—In shock and fields, worth \$8,460,000.

Pasturage.—Estimated value, \$30,000,000.

Fruits and Vegetables.—Estimated value, \$6,500,000.

The average farm price of horses is shown to be \$61; milch cows, \$35; wool per pound, 17 cents. The amount of fall plowing, compared with the average of former years, appears to be about 64 per cent. By sections the average is: Northern section, 88; central section, 57; southern section, 49 per cent.

The crop reporters made estimates of the percentage of loss of hogs by cholera or other diseases in their respective counties, and their reports show an average loss of about 11 per cent for the state. The averages by counties range from less than 1 to 35 per cent. The reports show a steady decrease in virulence of the disease compared with its ravages in recent years.

FINAL CROP REPORT, 1899—AVERAGE PER ACRE AND TOTAL YIELD BY COUNTIES.

COUNTIES.	WINTER WHEAT.		SPRING WHEAT.		CORN.		OATS.		RYE.		BARLEY.		FLAX.		POTATOES.		CULTIVATED HAY.		WILD HAY.	
	Acres	Yield	Acres	Yield	Acres	Yield	Acres	Yield	Acres	Yield	Acres	Yield	Acres	Yield	Acres	Yield	Acres	Yield	Acres	Yield
O'Brien.....
Osceola.....
Page.....
Palo Alto.....
Plymouth.....
Pocahontas.....
Polk.....
Pottawattamie.....
Poweshiek.....
Ringgold.....
Sac.....
Shelby.....
Sioux.....
Story.....
Tama.....
Taylor.....
Union.....
Van Buren.....
Wapello.....
Warren.....
Washington.....
Wayne.....
Webster.....
Winnebago.....
Winneshiek.....
Woodbury.....
Worth.....
Wright.....
Total yield.....
Average per acre.....

1st.
11.103
0.387
9.415
2,938
5,579
4,467
1,898
0.714
4,410
5,155
6,600
3,390
4,600
0.000
5,000
5,000
0.000
0.000
0.000
5,708
non-
and
the
ant

FINAL CROP REPORT, 1899—AVERAGE PER ACRE AND TOTAL YIELD BY COUNTIES.

COUNTIES.	WINTER WHEAT.		SPRING WHEAT.		CORN.		OATS.		RYE.		BARLEY.		FLAX.		POTATOES.		CULTIVATED HAY.		WILD HAY.	
	Bushels per acre.	Total bushels	Bushels per acre.	Total bushels	Bushels per acre.	Total bushels	Bushels per acre.	Total bushels	Bushels per acre.	Total bushels	Bushels per acre.	Total bushels	Bushels per acre.	Total bushels	Bushels per acre.	Total bushels	Tons per acre.	Total tons.	Tons per acre.	Total tons.
Adair.....	15	176,550	45	4,480,065	35	1,618,890	18	7,380	29	11,000	130	242,190	1.6	43,390	1.0	6,560				
Adams.....	13	1,284	10	78,400	41	2,635,920	25	287,000	12	5,880	90	79,200	1.3	30,036	1.0	2,270				
Allamakee.....	10	31,080	9	43,830	35	1,834,210	30	1,325,640	12	5,880	28	46,200	15	110,490	100	225,300	1.2	41,850	1.0	1,740
Appanoose.....	12	2,160	27	1,154,520	27	218,125	25	218,125	14	4,760	84	40,992	1.5	66,240	1.0	1,174				
Audubon.....	14	278,880	35	3,168,900	27	1,008,720	11	5,665	26	99,216	125	64,375	1.4	20,090	1.2	8,268				
Benton.....	15	53,250	39	4,708,860	40	2,980,400	15	20,400	31	488,570	140	2,47,420	1.5	53,475	1.2	11,560				
Black Hawk.....	18	12,744	41	3,778,150	43	2,463,988	13	42,293	33	222,783	112	187,040	1.7	57,876	1.5	19,320				
Boone.....	17	140,488	40	4,209,600	41	2,076,450	13	15,860	28	25,088	8	1,280	105	146,475	1.5	23,580	1.0	23,340		
Bremer.....	20	9,960	35	2,105,250	35	1,842,575	14	12,320	30	82,500	15	30,405	80	128,640	1.2	25,350	1.2	26,841		
Buchanan.....	12	12,280	39	3,334,890	40	2,096,400	15	15,600	30	92,160	12	1,896	110	166,320	1.5	57,240	1.2	18,906		
Buena Vista.....	13	236,990	33	3,629,076	28	1,638,440	15	9,525	22	167,860	10	14,900	85	174,335	1.6	23,695	1.2	32,524		
Butler.....	16	82,560	34	3,337,710	38	2,697,810	15	53,295	31	148,490	12	11,352	130	189,280	1.4	27,090	1.2	18,549		
Calhoun.....	14	225,820	33	3,384,150	35	1,810,830	16	20,240	34	133,280	10	11,980	120	154,800	1.5	16,650	1.3	32,918		
Carroll.....	16	453,712	38	4,596,480	41	2,244,750	20	19,400	30	142,450	10	2,600	100	230,300	1.5	23,860	1.2	26,130		
Cass.....	12	2,190	34	3,447,600	38	4,351,570	28	1,114,512	15	3,900	25	20,670	105	388,980	1.6	35,320	1.5	8,184		
Cedar.....	11	15,675	44	4,384,950	35	1,512,420	15	18,600	28	180,600	85	107,440	1.7	78,417	1.0	1,070				
Cerro Gordo.....	12	78,996	37	3,231,950	33	2,437,271	11	19,437	22	181,940	10	56,600	109	179,850	1.7	44,890	1.4	22,210		
Cherokee.....	13	511,810	36	3,852,612	31	1,564,260	12	2,880	34	335,240	15	6,675	80	128,640	1.5	24,525	1.4	23,540		
Chickasaw.....	14	34,330	35	1,989,700	33	2,027,124	16	10,912	30	154,200	12	82,320	100	160,200	1.4	41,690	1.0	15,660		
Clarke.....	12	2,160	11	830	35	1,944,890	32	536,480	15	15,450	80	70,640	1.4	51,170	1.0	760				
Clay.....	11	181,390	36	2,758,210	33	1,439,790	10	16,150	34	652,590	11	27,380	100	124,300	1.5	20,950	1.2	26,220		
Clayton.....	11	22,760	14	82,040	40	2,982,800	41	2,443,190	12	54,960	32	172,890	12	1,320	105	224,700	1.8	68,010	1.0	450
Clinton.....	15	27,075	37	4,336,650	30	1,689,900	14	48,160	25	50,375	120	182,080	1.8	85,705	1.0	4,570				
Crawford.....	14	772,058	33	4,084,090	32	1,389,210	20	10,240	30	159,270	110	232,430	1.8	41,652	1.2	29,760				
Dallas.....	9	2,520	13	89,010	42	3,780,980	35	1,029,275	15	9,750	30	21,150	110	120,010	1.5	30,160	1.3	14,030		
Davis.....	5	2,050	29	1,624,875	25	403,000	8	6,040	15	14,700	95	84,265	1.2	23,870	1.5	890				
Decatur.....	9	5,130	10	2,400	31	1,956,720	32	532,000	11	6,710	73	54,969	1.4	56,938	1.0	1,180				
Delaware.....	13	11,986	35	3,097,955	37	1,756,205	12	16,884	33	177,210	130	189,800	1.2	49,097	1.0	11,090				
Des Moines.....	12	3,360	30	1,564,290	25	783,925	15	14,700	32	538,140	11	81,950	95	84,265	1.2	23,870	1.5	890		
Dickinson.....	10	221,020	34	936,224	27	638,820	32	1,389,210	20	10,240	30	159,270	110	232,430	1.8	41,652	1.2	29,760		
Dubuque.....	10	950	15	2,910	34	2,148,698	35	2,891,790	18	72,720	28	49,640	94	231,650	1.0	39,262	1.0	8,710		
Emmet.....	13	394,316	30	1,134,630	31	1,733,150	15	8,100	30	325,500	10	60,280	115	49,450	2.0	13,120	1.5	30,183		
Fayette.....	15	2,250	18	54,750	35	3,121,700	36	2,290,680	20	42,060	25	178,075	10	22,400	105	201,600	1.8	91,563	1.0	15,650
Floyd.....	15	59,400	40	3,193,600	38	2,612,200	18	35,640	33	175,295	14	60,270	120	377,040	1.4	31,835	1.0	9,240		
Franklin.....	15	139,050	36	3,572,710	38	2,911,180	15	19,950	32	117,760	14	47,460	110	145,200	1.3	24,840	1.2	19,220		
Frederick.....	11	27,588	13	138,870	28	3,031,000	28	331,072	18	4,860	22	15,840	120	79,600	1.5	16,460	1.2	5,480		
Greene.....	14	94,640	32	3,610,560	33	1,782,930	18	15,750	32	91,520	10	5,300	130	169,780	1.3	19,590	1.2	81,590		
Grundy.....	18	187,002	40	3,854,800	35	2,474,150	15	14,400	33	453,090	10	4,020	140	300,720	1.5	83,750	1.2	20,384		
Guthrie.....	12	163,929	39	3,724,280	31	1,444,970	14	10,500	25	39,000	95	143,450	1.5	38,520	1.0	9,690				
Hamilton.....	18	178,920	41	4,226,403	45	2,653,650	20	5,600	33	59,697	12	9,288	130	156,400	1.7	30,909	1.5	55,870		
Hancock.....	13	261,014	35	2,510,550	36	2,302,560	18	32,040	30	295,080	10	85,940	95	106,400	1.3	20,105	1.2	38,110		
Hardin.....	17	196,520	38	3,573,368	40	2,246,480	18	8,640	33	98,703	10	6,510	98	126,420	1.5	31,185	1.3	24,300		
Harrison.....	14	578,620	32	3,284,800	30	474,060	15	15,375	26	21,250	130	195,260	1.5	12,945	1.5	25,620				
Henry.....	7	2,940	13	2,119	35	2,370,550	33	919,050	15	14,850	80	56,960	2.0	59,605	
Howard.....	15	50,910	37	1,868,130	35	1,732,530	18	4,500	30	202,260	13	82,745	110	120,890	1.5	53,280	1.3	18,533		
Humboldt.....	14	343,056	38	2,328,754	40	1,394,840	20	4,940	27	71,760	10	20,680	120	102,640	1.5	17,495	1.0	23,055		
Ida.....	12	304,270	32	3,136,448	35	1,396,150	15	2,850	25	109,820	90	106,920	1.5	27,039	1.0	5,182				
Iowa.....	16	27,680	33	2,915,616	35	1,424,990	20	28,200	25	81,750	75	94,365	1.5	56,625	1.0	4,060				
Jackson.....	20	8,250	15	19,450	41	3,151,383	30	1,247,000	20	140,360	22	35,485	102	166,790	1.5	59,715	1.0	1,930		
Jasper.....	16	249,760	45	5,244,075	42	1,769,640	20	14,800	30	40,560	93	627,750	1.2	43,092	1.3	3,900				
Jefferson.....	10	4,200	33	1,811,930	32	677,340	16	24,590	18	64,940	32	56,640	120	196,200	1.5	64,630	1.3	3,031		
Johnson.....	15	1,630	14	22,670	42	4,139,520	38	1,853,640	17	64,940	32	56,640	120	196,200	1.5	64,630	1.3	3,031		
Jones.....	20	15,920	45	3,643,650	36	1,130,040	16	41,760	32	44,096	120	128,400	1.5	60,046	1.2	1,879				
Keokuk.....	12	11,780	38	3,627,100	35	1,477,560	20	35,600	25	20,500	85	120,275	1.4	58,632	
Kossuth.....	15	762,600	33	3,780,480	35	2,744,245	23	437,360	9	88,920	70	205,100	1.5	22,890	1.0	68,480				
Lee.....	6	2,880	25	1,154,650	24	336,160	11	13,695	11	13,695	63	73,710	1.4	48,846	1.0	280				
Linn.....	15	20,850	34	3,563,980	40	2,017,400	18	60,750	32	60,800	120	277,200	1.5	70,965	1.2	9,038				
Louisia.....	11	2,310	13	8,515	34	1,912,840	30	755,130	14	211,820	97	53,350	1.4	26,453	1.3	1,590				
Lucas.....	11	3,190	26	1,223,630	30	527,400	14	15,680	25	1,400	62	28,520	1.8	72,420	1.2	610				
Lyon.....	11	1,048,157	36	1,999,450	30	1,068,900	12	7,320	25	1,330,750	11	10,109	100	156,900	1.5	5,570	1.3	30,198		
Madison.....	13	2,730	13	104,520	41	3,402,180	35	925,750	16	19,680	27	22,840	110	135,550	1.3	46,110	1.2	4,108		
Mahaska.....	15	2,850	15	41,700	37	3,169,570	40	1,348,560	20	22,520	20	22,920	75	133,350	1.5	44,148	1.0	1,228		
Marion.....	12	576	12	10,220	33	2,955,875	30	936,390	14	22,680	25	19,975	85	125,460	1.4	33,860	1.2	2,750		
Marshall.....	18	319,176	38	3,784,100	42	2,029,440	16	6,992	31	61,380	95	174,610	1.3	39,560	1.2	3,720				
Mills.....	8	2,520	12	231,648	38	3,660,084	32	464,576	16	4,704	20	6,800	130	142,480	1.8	27,810	1.5	9,940		
Mitchell.....	15	87,585	35	1,884,295	35	1,795,850	12	12,168	24	366,240	13	156,250	110	222,970	1.5	50,760	1.0	4,320		
Monona.....	18	860	13	428,298	30	3,579,600	35	517,300	20	18,200	28	127,240	115	129,950	1.8	13,608	1.5	44,640		
Monroe.....	5	1,200	26	1,102,690	25	254,075	10	7,720	.....	.....	60							

Ba
 bushel
 Value
 Ry
 averag
 bushel
 Fla
 bushel
 Value
 Pot
 bushel
 value
 Sw
 produc
 Ha
 total
 \$22,154
 Ha
 value,
 Buc
 bushel
 Tin
 780,000
 Clo
 bushel
 Mill
 Sor
 \$375,00
 Bro
 Cor
 Pas
 Fru
 The
 wool pe
 averag
 averag
 per cen
 The
 cholera
 show a
 countie
 decreas
 years.

GENERAL CROP STATEMENT.

CROPS.	Yield per acre.	TOTAL PRODUCT.	Farm values December 1st.
Winter wheat.....	11.3 bus.	226,040 bus.	\$ 131,103
Spring wheat.....	12.7 bus.	19,574,792 bus.	10,870,887
Corn.....	36.3 bus.	306,852,714 bus.	70,429,415
Oats.....	34.5 bus.	140,647,309 bus.	26,722,988
Barley.....	23.6 bus.	14,719,311 bus.	4,415,579
Rye.....	16.3 bus.	3,061,169 bus.	824,467
Flax.....	11.2 bus.	1,197,979 bus.	1,861,898
Potatoes.....	98.8 bus.	15,252,394 bus.	3,060,714
Hay (cultivated).....	1.5 tons	3,852,941 tons	22,154,410
Hay (wild).....	1.3 tons	1,458,195 tons	7,145,155
Buckwheat.....	15 bus.	172,500 bus.	98,000
Sweet potatoes.....	87 bus.	305,300 bus.	253,390
Timothy seed.....	4.3 bus.	780,000 bus.	834,600
Clover seed.....	1.7 bus.	.....	290,000
Millet seed.....	20 bus.	.....	75,000
Sorghum.....	85 gals.	.....	375,000
Broom corn.....	.....	.....	45,000
Corn fodder.....	.....	.....	8,460,000
Pasturage.....	.....	.....	80,000,000
Fruits and vegetables.....	.....	.....	6,500,000
Total.....	.....	.....	\$ 194,605,706

To the above total there should be added the increment gained by consumption of crops in the production of beef, pork, mutton, wool, dairy and poultry products, horses, etc. This would make the aggregate value of all soil products for the year not less than \$230,000,000. On the whole the season has been fairly productive, and the people of Iowa have abundant cause for devout thankfulness.

STORY OF A DECADE.

IOWA'S CLIMATIC RECORDS AND FARM PRODUCTS FOR 10 YEARS—JANUARY 1, 1890, TO JANUARY 1, 1900.

The climate and crop table published herewith, which has been compiled from records of the Iowa Weather and Crop Service since the date of its establishment in 1890, presents a striking exhibit of the important climatic features and vast resources of soil of this leading agricultural state. We will briefly note some of the salient features of this tabulated exhibit.

The average annual temperature of the decade was 47.4°, which is practically the average of all past years of record for the state at large. The warmest year was 1894, with a mean of 49.7°, and the year following (1895) was the coldest, with a mean of 45.5°. The average temperature of the six crop months—April 1st to October 1st—was 67°, and of the three summer months, 71.7°. The coldest crop season was in 1891, with an average of 63.8° for the six crop months, and 68.9° for the summer months. The warmest crop season was in 1894, when the average of the six months was 67°, and of the summer months, 74.7°.

The average annual precipitation for the decade was 30.11 inches, which is substantially the average of all the years of general record for the state. The yearly average of the last five years was .52 of an inch greater than the average of the first five years of the decade. So it appears that the records do not disclose any facts to sustain the theory that this region is gradually drying up, or undergoing any climatic change.

The most notable feature of these weather records is the fact that more than two-thirds of the yearly precipitation has fallen in the six crop months—April 1st to October 1st. The average rainfall of the crop season has been 21.36 inches, which is 70.9 per cent of the annual precipitation. And the average of the three summer months has been 11.16 inches, or 37 per cent of the yearly average. So it appears that the copious rainfall and almost tropical heat of the crop growing months have been the prime factors in the production of the enormous crops that place Iowa in the first rank among the agricultural states of the Union.

During the decade there has been considerable variableness in the yearly output of the soil, but the total products of even the poorest crop seasons have brought ample rewards to the industrious toilers of the state. The leanest season would be regarded as fatness in many other sections of the country.

A study of the climatic records of the crop months will indicate some of the conditions that have caused variableness of production. In 1890 the average yield of corn and other cereals was light, compared with the average of the decade. The rainfall in June was 7.76 inches—over 3 inches above the state normal—which retarded the work of cultivation. This was

followed by a severe drought with hot winds, which condition was not relieved before the close of the season. The rainfall in July was only 1.98 inches for the state, with a mean temperature of 75.6°. Under these adverse conditions the average yield of corn was 28 bushels per acre, and of oats 29 bushels; and the total cereals were 343,000,000 bushels; which was remarkably large under the circumstances.

The year 1891 gave us one of the best all-around crop seasons of the decade, the corn crop yielding an average of 38 bushels per acre, and oats 40 bushels, with total cereal crops exceeding 485,000,000 bushels. Though the mean temperature for that season was below normal, yet there was ample heat to perfect the crops, and the rainfall was timely and well distributed. The months of April and May were warm and dry, though with sufficient moisture to insure germination and growth; June brought an average of 5.39 inches, with about normal temperature; and July added 4.22 inches to the summer's quota of moisture. That distribution of rainfall through the midsummer period proved to be just right for the development of a "bumper" corn crop. The season of 1892 was quite unfavorable, with a total of nearly 23 inches of rain in the crop months. There were heavy floods in April and May and considerable excess of moisture through most of the season of planting and cultivation. The corn yield was 29 bushels, and oats 25 bushels per acre.

The season of 1893 was fairly good as to conditions and results; though the latter part was dry, being the beginning of the droughty period that continued through the larger part of 1894. This great drought, which culminated in the summer of 1894, served as the supreme test of the productive capabilities of Iowa soil. The total precipitation for the year was only 21.95 inches, and the total for the summer was 4.88 inches. The month of July was almost entirely rainless, and destitute of dewfall, in the larger part of the state; and the average temperature was 76.4°, with the maximum ranging from 95° to 104°, intensified by high winds and a minimum of humidity. With all these adverse conditions it seems marvelous that the state harvested 256,000,000 bushels of corn and other cereals, and had an abundance of food for man and beast, though much less than the usual amount for export.

The ideal season of the decade was in 1895, with a corn crop of 38 bushels per acre, oats 48 bushels, and aggregate cereal products 521,638,000 bushels. The soil and subsoil were thoroughly dried out during the drought of the preceding year, and the surface was in perfect condition to absorb and retain the spring and summer rains, which came in sufficient amount and at the right time to start the crops early and carry them forward to perfection. The early spring was dry and warm, the rainfall of April being only 2.62 inches, and May 3.19 inches; but the summer months brought 12.15 inches of rainfall, with seasonable temperature. It was a year of great productiveness, as the crop records show. But in that period of general business depression the December 1st farm prices were too low to make a satisfactory exhibit of the value of the year's products. At the farm prices current at this time the cereal output in 1895 would have been doubled in value.

The greatest annual and seasonal precipitation in the decade fell in 1896, the annual being 37.45 inches, and the amount in the crop season 29.33

inches. It was altogether too much of a good thing, as will be seen by noting the marked shortage in the small grain crops of the season. It was excessively wet in April and May, and also in July, causing a muddy seed time and a "catchy" harvest. There was an enormous growth of straw on rich lands, but about half the crop was destroyed in the fields, and never reached the granaries. June was drier than the other months, and that gave time to dry off the cornfields and get the crop planted and laid by before the midsummer downpours came to ruin the grain in shock and stack. There was more than an average yield of corn in bulk, but the last of August and the first half of September were too wet and cold to bring the crop to perfect maturity, and a very large per cent was soft and in poor condition to crib. At the low price prevailing that year the aggregate value of the crops was below any year in the decade.

The crop season in 1897 was drier than usual, except the month of April, which received an excessive amount of rainfall, causing much delay in seeding and plowing. The dry summer checked the development of corn at the critical stage, and the average yield per acre was 29 bushels, with a total 239,452,150 bushels.

Very nearly normal conditions as to temperature and rainfall prevailed in the crop seasons of 1898 and 1899, and the results are shown in the very satisfactory output of the harvests. The enhanced farm prices give a brighter color to the financial exhibit for these latter years of the decade.

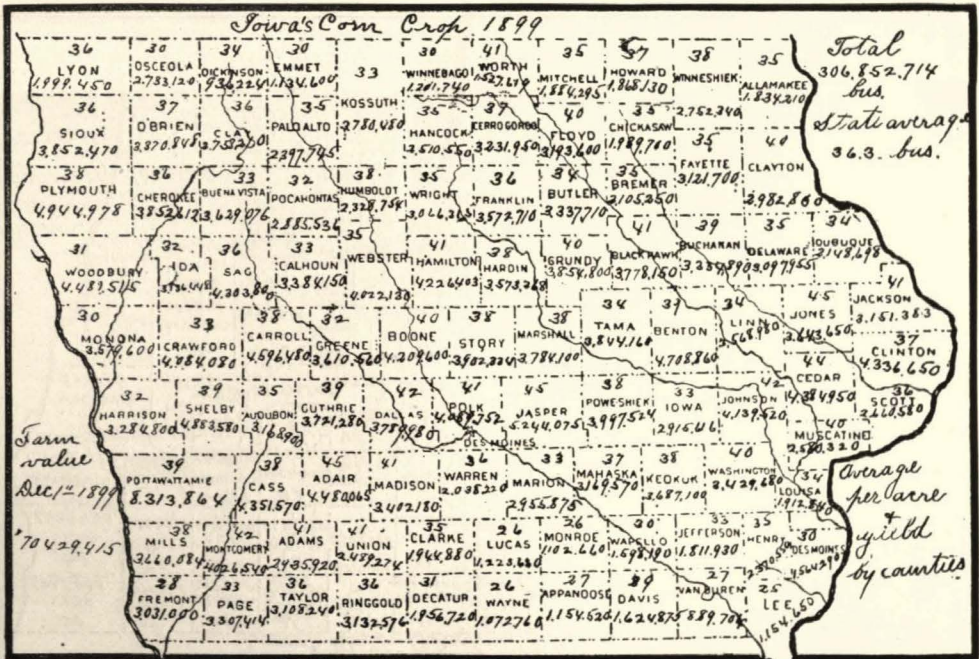
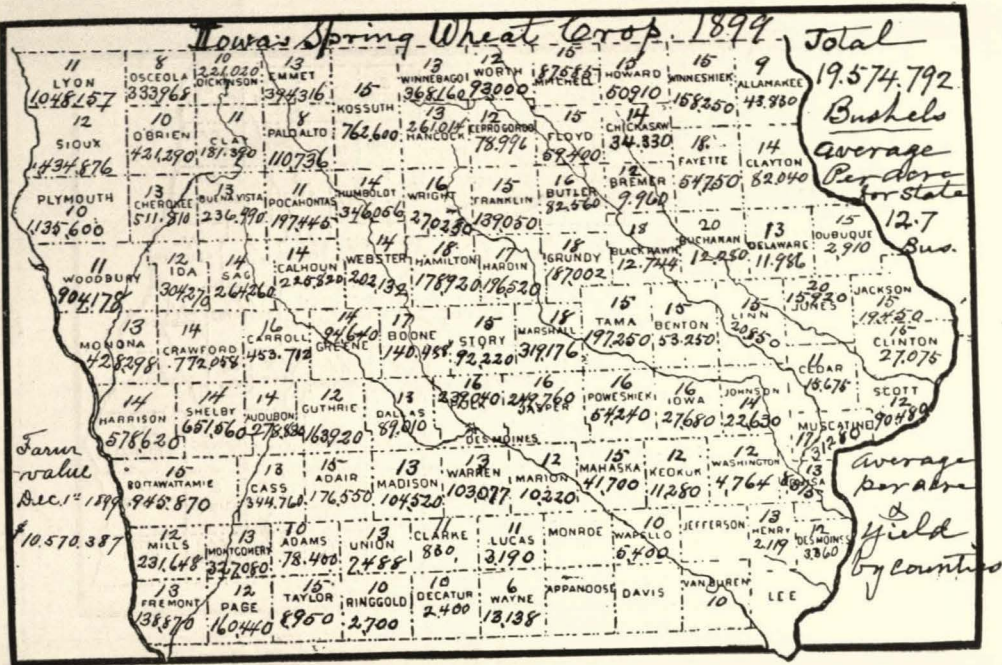
The figures in this table furnish ample material for study and comparison. They utterly disprove the pessimistic theory that the state is being desiccated, and that there is a continual decline in its productiveness. The cereal products of the last five years of the decade were 587,000,000 bushels greater than for the first five years, or an average increase of 117,000,000 bushels per year. In all lines of production we note the results of improved methods of culture. Drainage and cultivation have improved the condition of the soil, so that fair returns are secured in extremes of wet or dry seasons.

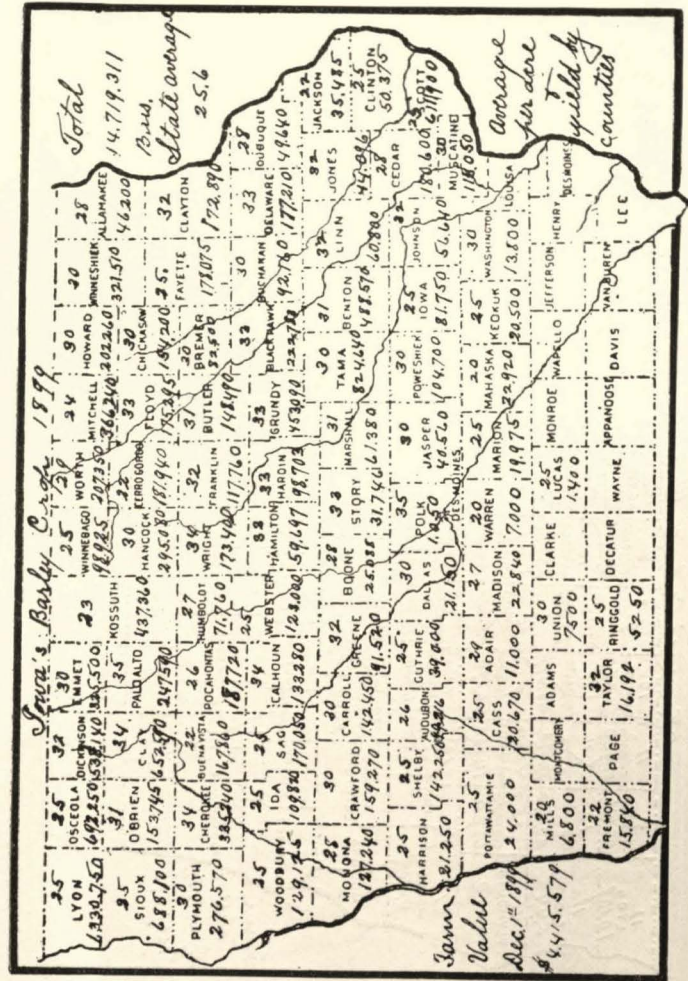
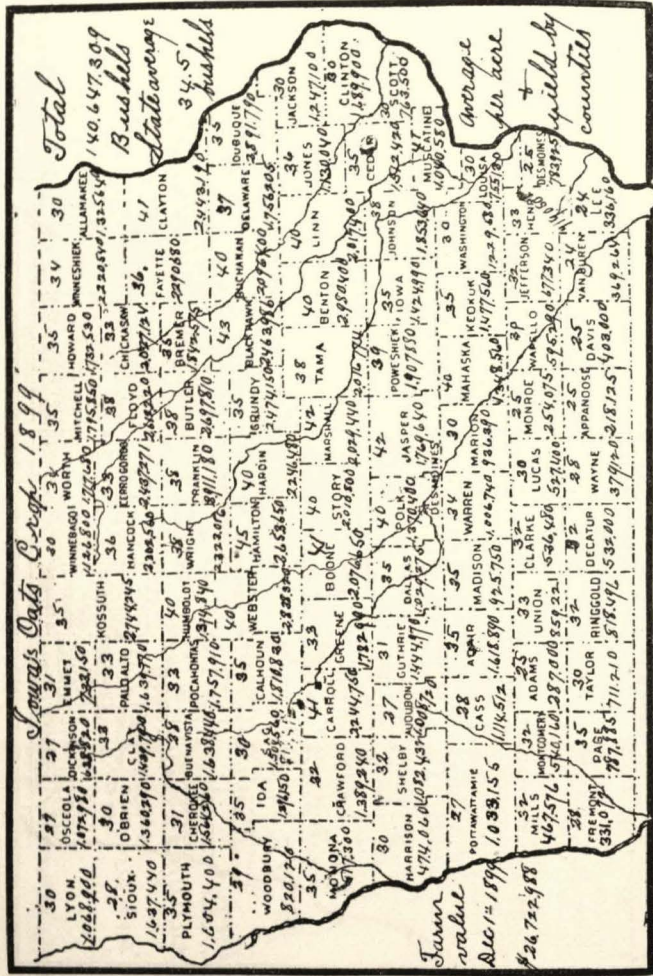
The figures as to the total value of farm products are based upon the prices current at the farms on the first of December in each year, and do not include the increment of value resulting from feeding stock and converting corn, grain, and forage into beef, pork, horses, dairy products, etc. Making due allowance for this increase year by year, the total value of Iowa's soil products for the decade exceeds \$2,000,000,000, or an average of more than \$200,000,000 per year. In view of these facts and figures it is easy to understand why there has been a steady advance in the selling prices of Iowa farms. Iowa climate and soil afford a safe basis for the investment of capital.

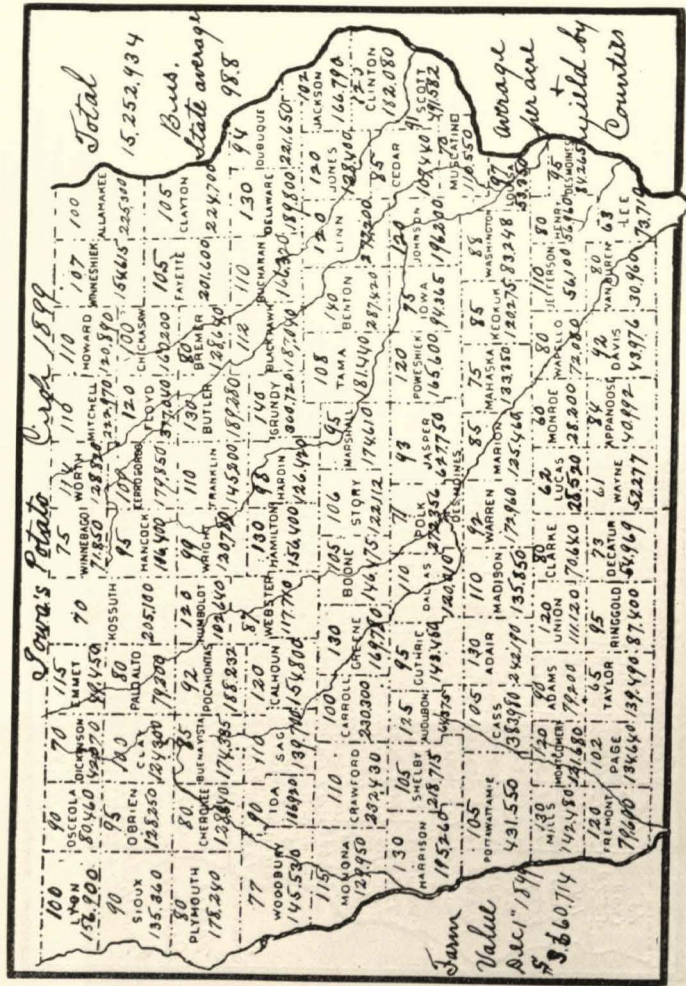
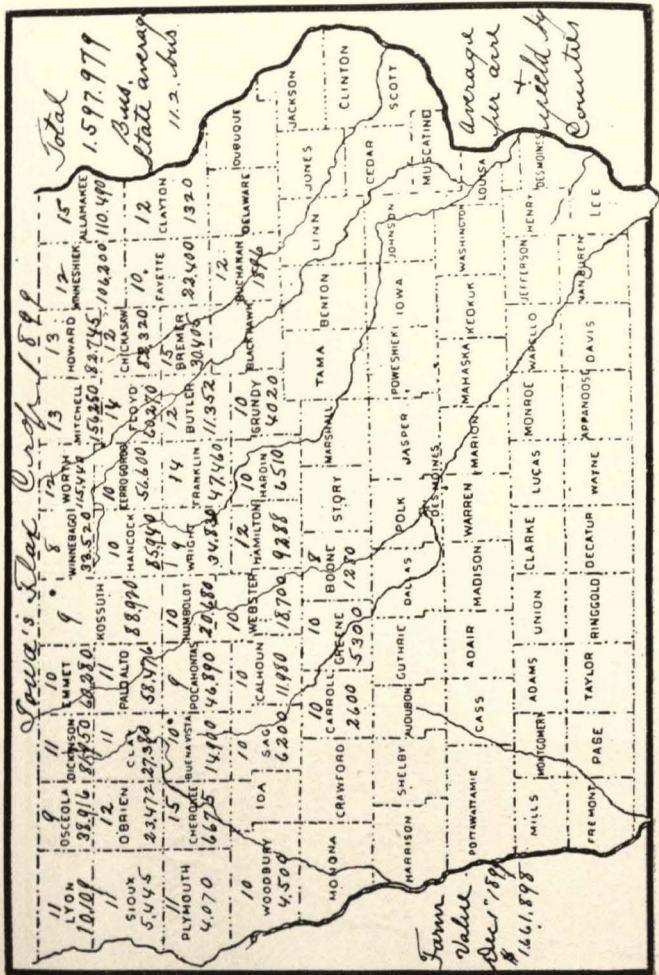
IOWA'S CLIMATE AND CROPS FOR THE DECADE—1890-1900.

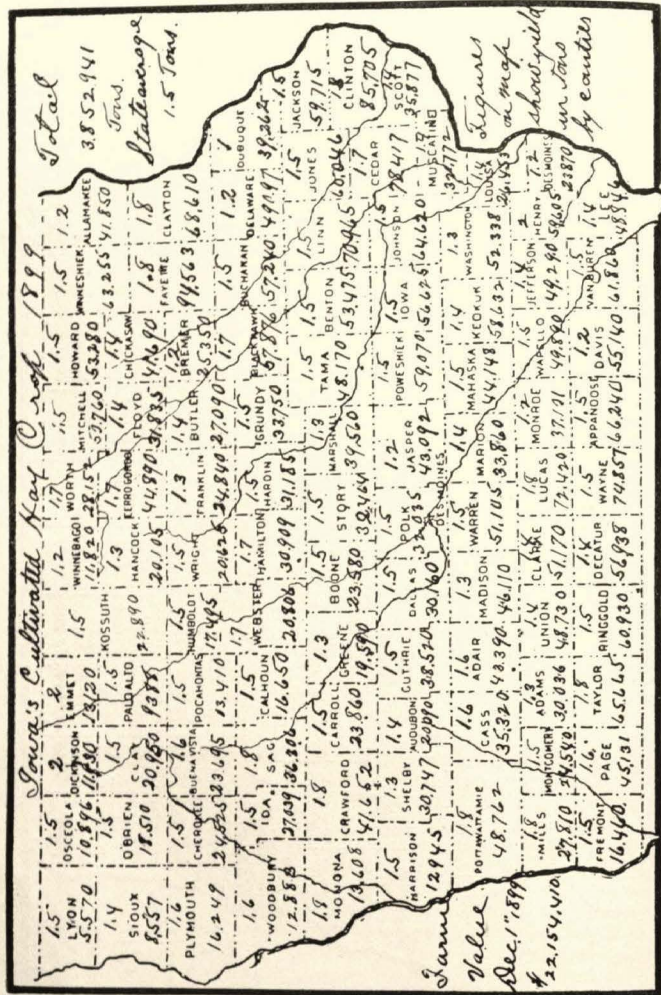
TEMPERATURE DATA.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	Averages for decade.
Annual mean temperature—degrees.....	47.7	47.4	47.5	45.7	49.7	45.5	48.5	46.7	47.6	47.6	47.4
Highest temperature and date—degrees.....	July 13:110	Aug. 7-9:106	July 11:104	July 13:104	July 26:109	July 16:104	July 8: 104	July 23:106	Aug. 20:103	Sept. 6:104	105.2
Lowest temperature and date—degrees.....	Jan. 27:-27	Feb. 4:-31	Jan. 19:-38	Feb. 4:-28	Jan. 25:-37	Feb. 1:-33	Jan. 4:-20	Jan. 25:-30	Dec. 25:-25	Feb. 4:-40	-30.9
Mean temperature—April—degrees.....	51.8	50.6	45.4	45.5	51.7	54.2	54.5	47.9	48.1	48.9	49.8
Mean temperature—May—degrees.....	57.7	58.3	54.0	56.6	61.1	61.7	65.5	59.6	59.6	60.2	59.4
Mean temperature—June—degrees.....	72.7	69.1	69.2	71.2	73.2	69.7	69.1	69.1	71.4	70.7	70.5
Mean temperature—July—degrees.....	75.6	68.6	73.0	75.0	76.4	72.1	73.6	75.6	73.4	73.1	73.6
Mean temperature—August—degrees.....	68.4	69.1	71.4	69.4	74.6	71.9	71.7	68.9	71.2	74.4	71.1
Mean temperature—September—degrees.....	69.3	67.3	64.7	64.7	65.1	66.8	58.5	70.9	65.3	62.5	64.5
Average temperature for six crop months—degrees.....	62.2	63.8	62.9	63.7	67.0	63.0	65.4	65.3	64.8	64.9	64.6
Av. temperature for three summer months—degrees.....	72.2	68.9	71.2	71.8	74.7	71.2	71.4	71.2	72.0	72.7	71.7
RAINFALL DATA.											
Average precipitation per year—Inches.....	31.12	33.13	35.74	27.31	21.95	26.63	37.45	28.99	31.69	29.10	30.11
Rainfall in April—Inches....	1.78	2.15	4.75	4.21	3.07	2.62	5.02	5.35	2.56	2.40	3.39
Rainfall in May—Inches....	3.56	3.18	8.77	3.45	1.87	3.19	6.69	1.92	4.87	6.23	4.35
Rainfall in June—Inches....	7.76	5.39	5.19	3.91	2.67	4.32	3.11	3.81	4.72	5.04	4.59
Rainfall in July—Inches....	1.98	4.22	5.29	3.33	0.63	3.40	6.90	3.26	2.98	3.07	3.50
Rainfall in August—Inches.....	3.41	4.24	2.24	2.32	1.58	4.43	3.52	1.86	3.44	3.68	3.07
Rainfall in September—Inches.....	2.97	1.33	1.53	2.34	3.57	3.03	4.09	2.04	2.69	0.93	2.45
Rainfall for six crop months—Inches.....	21.46	30.51	27.77	19.56	13.39	20.99	29.33	18.24	21.06	21.35	21.36
Rainfall for three summer months—Inches.....	13.15	13.85	12.72	9.56	4.88	12.15	13.53	8.93	11.14	11.79	11.16
STAPLE FARM CROPS FOR DECADE.											
Spring wheat yield per acre—bushels.....	12	16	14	12.4	12.8	19	13	13.4	14.8	12.7	14
Wheat, total yield—bushels.....	19,041,000	27,586,000	7,534,952	11,385,899	9,470,306	14,346,000	10,398,785	14,613,054	22,321,268	19,900,830	15,660,000
Corn, yield per acre—bushels.....	28	28	29	35.7	14.8	38	39	29	31.5	36.3	32.2
Corn, total product—bushels.....	239,675,156	335,631,508	173,867,351	214,804,758	129,104,930	285,000,000	313,692,210	239,452,150	289,214,860	306,852,710	252,661,170
Oats, yield per acre—bushels.....	29	40	25	28	24	48	25	30	32.5	34.5	31.7
Oats, total product—bushels.....	80,002,735	115,810,500	83,485,150	100,742,862	107,601,460	201,900,000	73,450,000	132,571,155	139,915,346	140,647,309	117,591,714
Barley, total product—bushels.....	3,664,368	4,528,039	14,049,072	11,437,666	8,635,001	18,673,000	15,881,618	14,076,850	14,138,346	14,719,311	11,781,880
Rye, total product—bushels.....	1,608,960	2,051,400	1,536,270	1,785,202	1,624,073	2,014,000	1,891,716	3,490,344	3,852,561	2,061,169	2,148,868
Flax, total product—bushels.....	2,979,081	3,151,016	5,188,104	2,263,861	1,371,165	2,310,000	1,946,720	2,498,600	2,376,604	1,597,797	2,563,112
Potatoes, total product—bushels.....	8,332,352	15,620,350	8,729,160	6,172,257	7,869,321	21,200,000	14,814,795	10,051,919	12,238,411	15,252,934	13,058,149
Hay (tame) total product—tons.....	4,901,335	5,582,880	6,288,200	4,569,341	1,901,038	2,610,000	3,376,440	3,362,287	3,852,560	3,852,944	4,038,033
Corn and small grain—bushels.....	343,992,190	483,008,467	280,412,798	240,412,798	256,526,378	521,638,000	415,314,231	404,203,563	469,172,371	483,717,957	400,051,870
Total value of farm products.....	\$204,375,000	\$207,841,000	\$175,727,940	\$161,507,464	\$137,804,000	\$168,235,420	\$133,664,628	\$151,084,069	\$187,455,376	\$194,605,706	\$172,350,260

- Below zero.









LOSSES BY LIGHTNING IN 1899*.

A notable feature of the crop season of 1899 was its unusual number of storms and excessive display of electric energy. This was an especial characteristic of the season from about the first of May to the middle of July, during which period more than three-fourths of the reported losses by lightning occurred. May was the stormiest month, the records showing that a measurable amount of rain fell at some station in the state during every day of the month. In June there was but one absolutely rainless day for the state at large. And nearly all the severe storms that occurred in these two months were accompanied by electric disturbances, resulting in more or less damage to farm property.

The United States Weather Bureau office in this city has received 395 reports of damage to farm property from the effects of lightning during the past season. Last year the number received was only 204, the increase indicating a more general interest in the collection of these statistics, and also the fact that the season of 1899 was more prolific in violent storms than the preceding year. Nearly all of these reports were contributed by the agents and other officials of insurance associations; and it is understood, of course, that they cover only a small percentage of the total losses that have occurred in the state during the season. The details are of interest whether viewed from a practical or scientific standpoint.

The aggregate loss of property covered by these 395 reports is \$52,524, of which sum \$35,194 was the total loss estimated on buildings, and \$17,330 on live stock.

The number of buildings struck was 86, including 29 houses and 57 barns and outbuildings. Of the 57 barns 22 were consumed with their valuable contents, involving a total loss of \$31,657. In 4 of the barns and stables 109 head of live stock were consumed, and are not included in the number of stock killed by lightning strokes. Only 3 of the 29 houses struck were consumed, and the total loss on that kind of property was \$2,696.

The reports show that two barns and one house of the number struck were provided with plain wire lightning rods, but there is no evidence to prove that they were properly constructed and attached to the buildings. The fact that over 96 per cent of the buildings were destitute of rods seems to carry some weight of evidence in favor of that form of protection.

These reports give details of the loss of 531 farm animals from the direct effect of lightning, and this number does not include the 109 that were cremated in buildings fired by electric bolts. Of the live stock nine were killed in barns that were struck and not fired; the others were in yards and fields.

*Report read before the annual meeting of the Iowa Mutual Insurance Association at Des Moines, November 15, 1899, by J. R. Sage.

And we are again confronted by the fact that wire fences are directly responsible for a very large percentage of the loss of live stock in the fields. The reports show that of the 581 farm animals killed by lightning 395, or 68 per cent of the whole number, were "electrocuted" while in close contact with wire fences. Tabulated by classes of live stock the figures are as follows:

KIND OF STOCK.	No. killed.		Per cent.
	No. killed.	No. against wires.	
Cattle.....	441	275	67
Horses.....	81	40	49
Hogs.....	23	19	86
Sheep.....	67	61	91
Totals.....	581	395	68

These are astounding figures, and vastly more effective and convincing than volumes of scientific theories relating to this matter. It appears that the stock growers of this state are paying a very heavy tax on their wire fences, in addition to the cost of construction. Or, possibly, these losses by lightning may not be considered a tax on that kind of fence, but rather a penalty for not constructing the fences properly, with necessary safeguards against such casualties. It is clear that some means should be devised to render wire fences less deadly, or, failing in that, they should be discarded altogether. It is believed that they may be rendered practically safe by the use of ground wires.

The fact may be noted that many of the storms of the past season have been accompanied by driving winds, with more or less hail, as well as an unusual amount of electric disturbance. During the prevalence of that class of storms farm animals in the fields seek closer companionship, and by the force of the storms are driven and crowded together in bunches or herds against the fences that obstruct their way. The reports show that many animals were killed in bunches by single strokes of lightning. A few of the details from the reports will be of interest. On April 30th three valuable steers were killed in Chester, Poweshiek county, by a stroke that splintered posts and fused the wires for some distance. May 15th thirteen young cattle were killed near Grinnell by a single shock that came over the wires. May 16th four head of cattle in Clinton county were killed by a single stroke that traveled a long distance. On May 22d thirteen head of Red Polled-Angus cows, valued at \$780, were killed in Jackson county. They were found huddled together against a wire fence. May 27th five young cattle were killed in Hamilton county, and three of their carcasses were found hanging over the wires. On June 11th, in Rock township, Sioux county, three head of cattle and thirty-eight sheep were killed by a single stroke. The animals were in the same pasture, and the bolt struck the wires half a mile distant from the spot where the cattle were killed. The sheep were crowded against the wires, many of them were found with their heads between the strands. June 12th, in Sac county, thirteen head of cattle and horses were killed by the same stroke, and the horses and cattle were twenty rods apart, on the same line of fence. August 23d twenty-

three sheep in Palo Alto county were "electrocuted" by the same strand of wire, and a single shock. These few instances serve to illustrate the manner of the taking off of many thousand farm animals in our country every year. There has been a notable increase in that class of fatalities since wire fences came into general use. The wires carry the electric force considerable distances. In one instance referred to in the reports of this season a single stroke of lightning destroyed a wire fence for a distance of forty rods. A half dozen ground-wires would have switched off that destructive current in short order.

The larger number of reports received this season give some details as to the localities where destructive strokes occurred, whether moist or dry, upland or lowland, near timber or in an open field. But from the mass of statements we are not yet able to make any special deduction of practical value or of scientific interest. Nearly 50 per cent of the reports show that the strokes occurred on high and dry lands, somewhat distant from timber; nearly 40 per cent on low moist grounds without timber, and 20 per cent in or near groves or timber lots. This may signify merely that more stock are pastured on high and dry than on low, moist or timbered lands; and also that buildings are generally erected on elevated and dry sites. It appears to be certain that isolated trees in pastures are sources of danger to stock or persons that seek shelter under their branches, and it is probably true that dense groves or heavy timber afford a measure of protection against electric force as well as the other elements of severe storms. The conclusion of the matter is that the safest retreat for man or beast, during a thunderstorm, is in a building protected by a well constructed rod or metallic roof.

It is gratifying that we have received so large a number of reports during the past season, and in my judgment it is worth while to continue our investigations along this line. I trust that a larger number of agents and officials will co-operate with the Weather Bureau in this work next year, and that the reports will be made to cover the more important details as to the losses that occur.

I am convinced that a very large percentage of losses by lightning may be prevented, and the special purpose of our investigations should be to discover the means of prevention. An ounce of prevention is better than a pound of indemnity.

TORNADO, HURRICANE AND CYCLONE.

SCIENTIFIC FACTS PRESENTED IN POPULAR STYLE.

[By Harvey M. Watts, Editor Philadelphia Press.]

Owing to the confusion attendant upon the popular use of the words cyclone, hurricane and tornado, as if they were interchangeable, it may be well, in these days of tornado and hurricane occurrence, to point out the radical differences between the three great classes of storm phenomena which are known to the United States. To begin with, the tornado is a purely local storm of great intensity and concentrated energy, whose main destructive effects are the result of the almost incredible velocity of its

rotary winds that blow spirally into and about its vortex. Though terribly destructive to life and property, it is at the same time the smallest of local weather disturbances, being limited in duration, in the width of its path, and extent of its track. In one case it may last but a few minutes along a track a few hundred feet wide and a mile or so in length; in another it may persist for hours, its path several hundred yards in width and extending from fifty to one hundred miles in length. Its forward motion on its track may vary from fifteen to thirty to sixty miles an hour, but this speed is insignificant, compared with the velocity of the rotary winds which may have any speed from one hundred to five hundred miles an hour and over.

The rotary motion of the winds about the central core is the axis of the tornado and is usually made visible by the twisting movement of the funnel-shaped cloud, which is one of the most marked features of the typical tornado, and the actual existence of the rotary winds is made clear by the character of the destruction and the lay of the debris after the tornado has passed by. The tornado is in type nothing more than the familiar dust whirlwind common to city streets on warm or windy days, differing from it only in intensity, not in kind. Though the tornado under given conditions, may form in any part of the United States east of the Rocky mountains, it is of most frequent occurrence in the plains and rolling country of the Mississippi valley, where topographical, as well as meteorological, conditions favor the formation and persistence of local whirlwinds of the tornadoic type.

Aside from the destructive effects due to the rotary winds, there are in every tornado ascending currents of terrific velocity which rush up the core of the vortex, as a draught of hot air up the center of a tall chimney. As the rotary motion causes a movement of the winds away from the center of the core, the air here is so exhausted that it almost reaches the condition of a vacuum. The result of this is that in addition to the destructive effects of its rotary and ascending currents the tornado causes serious damage by reason of explosive effects, for if the center with its partial vacuum passes over a house in which the air is at ordinary atmospheric pressure, this air blows outward as if gunpowder had exploded within it. In this way some houses are destroyed which escape damage from the whirling winds.

Though not as destructive as the tornado, and hence second to it in importance in this respect in the classification of local storm phenomena, the thunderstorm is a much more extensive weather disturbance. It is not a storm disturbance rotating about a vertical axis, but moves across the country with a comparatively straight front, often many miles in extent, out from under which rushes the wind squall. In depth from front to rear, the typical thunderstorm may reach from five to fifteen miles and more. The destructive effects of a thunderstorm are due to the lightning, hail, the heavy rainfall, which sometimes approaches the character of a so-called cloudburst, and the high winds that make up the familiar outrushing thundersquall, which may occur before or after rain has begun to fall. The squall winds may reach a velocity of sixty miles an hour or so in gusts, and hence may do a considerable damage, though the velocity is nothing compared with the rotary velocity of the tornadoic winds.

Covering a large area, under favorable conditions, the thunderstorm may endure for hours, and in its track may cover a region from one hundred to two hundred and fifty miles in linear extent. Itself the result of unstable conditions of the atmosphere, it may develop within its sphere of influence secondary disturbances of particularly violent type, and hence it is often the parent of tornadoes, which are small compared with the thunderstorms, while it itself is comparatively limited in comparison with greater weather disturbances that affect the circulation over extensive areas. The thunderstorm is the most extensive of local storms, and between it and the dry squalls of wind, local gusts and tornadoes, there are many variations, none of them, however, being anything but secondary disturbances, whirls and eddies in the general circulation.

The cyclone is differentiated from all local storms, whose operations are confined to a comparatively small region, since it is a weather disturbance, at its smallest on a large scale, and at times reaches a continental magnitude. The name is of technical, not popular, origin, and was first used by Piddington, an English meteorologist, to describe the tempests of the Bay of Bengal and other tropical waters. It is a descriptive epithet and refers to the almost circular movement of the winds about a common center, then supposed to be the unvarying characteristics of these great and destructive storms that are called typhoons in the eastern seas, and hurricanes in the Caribbean and West Indian waters. The word has been generalized in meteorology and is used to denote one of the two types of atmospheric eddies into which the circulation of the air in temperate zones is thrown. These are cyclonic and the anti-cyclonic.

The most destructive of all cyclones, and in fact the most destructive weather outbursts known, are the tropical cyclones, the so-called typhoons of the Philippines, China sea and Japanese waters, the hurricanes of the West Indies, and Atlantic and Gulf coasts of the United States. Though the largest tornado rarely has a diameter of a mile, the smallest tropical cyclone rarely falls below one hundred miles in diameter, and its sphere of destructive influence may range from one hundred to six hundred, even to one thousand miles. As the hurricane now ravaging the West Indies shows, the tropical cyclone may persist for days, traveling thousands of miles. The point of origin for the tempests that visit our coast is the eastern Atlantic in low latitudes. They cross over to the West Indies, recurve in the Gulf of Mexico, over or east of Florida, and then travel to the northeast, along the coast line of the United States, then out into the Atlantic over Newfoundland, sometimes reaching English waters. By that time they have taken on all the characteristics of a cyclone originating in the temperate zone. The destructive effects of the cyclone are the result of the winds that blow in spirally about its center, which in the front of the cyclone may reach any velocity from sixty to ninety miles an hour. The low pressure of the barometer in the center of the storm and the terrific winds lift up a tremendous sea that raises the tides above the normal, and hence through disastrous floods cause great loss to life and property along the low-lying coasts, as has been the fate of the bayou region of Louisiana and these islands of Georgia and North Carolina on numerous occasions. The rainfall is also often excessive and destructive.

Differing from the tropical cyclones merely in degree are the continental cyclones of the temperate zone. These are the largest weather disturbances known, but are not necessarily violent. On the contrary, they often represent a mild, vague, general circulation of the winds about a common center, within which area the rainfall may be light, heavy, nearly continuous, or broken up into separate areas. These cyclones—the real cyclones of the American continent—may have a diameter of from five hundred to fifteen hundred miles, and even larger, thus covering an area of over one million square miles. They persist for weeks, and, traveling from west to east may go two-thirds of the way around the globe. Save when their vortex is contracted to about the size of that met with in tropical cyclones, fifty to one hundred miles or so, the continental cyclones are beneficial rather than destructive factors in the general circulation.

When such contraction occurs in the fall, winter, or spring over the region of the Great Lakes, or over the Atlantic, the conditions repeat all the phenomena of a coast hurricane, and may cause loss of life and damage to property by reason of the hurricane velocity of the winds, the excessive rainfall, and the heavy weather on the lakes or at sea. From this it must be clear that the confusion of general cyclonic with local storm or tornado conditions, so common in the west is easily avoidable, as the contrasts are marked and the distinctions based on broad differences. The mere fact that a storm is local, of limited extent no matter how great its violence, is the first proof that it is not a cyclone, though the tendency in the west and south is to apply the technical term "cyclone" to all violent local outbursts, on the mistaken idea that the word "cyclone" means a tornado and a tornado only. Compared with the tremendous size and appalling character of the Porto Rico hurricane and other tropical cyclones of like destructive effects, such as that of St. Vincent and Barbadoes last year, the tornado at New Richmond, Wis., was of small account and thunderstorm casualties trivial.

HISTORIC COLD WINTERS.

In the year 401 the Black sea was frozen over for twenty days, and men crossed from Asia Minor to the Crimea.

In 764 the Black sea was frozen to a distance of fifty miles from shore. The Hellespont and Dardanelles were frozen and the Sea of Marmora was passable for cavalry.

In 1063 the River Thames was frozen over for thirteen weeks. All the rivers of the continent were frozen, and even south of the Alps the Po and many other streams were blocked with ice.

In 1294 the Cattagat was covered with ice seven feet thick. Batteries of artillery were moved to and fro on the strait.

In 1323 the Baltic sea was frozen over, and during three months travelers passed from the continent to Sweden on the ice. Heavy wagon trains were substituted for the traveling vessels.

In 1433 the Thames and all other rivers of England and Scotland froze over; the Seine, Rhine and Danube were closed to navigation early in December. The Dardanelles and Hellespont froze, as did many bays and

inlets of the Mediterranean. Ice formed in Algiers, and the Strait of Gibraltar was almost impassable from drift ice.

In 1460 the Baltic again froze over so as to permit travel on the ice. In Germany deer sought the towns for refuge from wolves. Packs of wolves came into the cities and attacked the people on the streets.

In 1544 the cold was so severe in Holland that wine was cut in blocks and sold by weight.

In 1594 the rivers of North Europe were frozen before Christmas. The Cattagat froze, together with a large part of the Baltic. The Sea of Venice froze so that during three weeks no boats could be used. The Tiber froze at Rome and men crossed it on the ice, a thing never known before or since.

In 1658 the bays and inlets of North Europe froze over early in December. Charles X of Sweden crossed the strait to Denmark with his whole army, including the artillery, baggage and provision trains.

In 1648 the Thames was covered with ice over a foot thick. Booths were erected for a fair, which was held on the river. Coaches plied to and fro on the ice as on dry land. All the French ports were closed for three or four weeks, the harbors being frozen over.

In 1691 the cold was so severe in eastern Europe that packs of starving wolves entered Vienna and attacked men and women in the streets. All the canals of Venice were frozen, and the principal mouth of the Nile was blocked with frozen ice for a week.

In 1740 the Thames was frozen for eleven weeks. Forest birds almost all perished, and trees were split by the frost. The harbor of Barcelona froze over, and navigation was suspended in the Greek Archipelago on account of the danger from floating ice.

The winter of 1812-13 was one of the hardest ever known in Europe. The Thames froze from the source to the sea; the Seine, the Rhine, the Danube, the Po and the Gaudalquiver were all covered with ice. The Baltic froze for many miles from land, and the Ikagerack and the Cattagat were both frozen over. The Adriatic at Venice was frozen, so was the Sea of Marmora, while the Hellespont and Dardanelles were blocked with ice and the archipelago was impassable. The Tiber was lightly coated, and the Straits of Massina were covered with ice. Snow fell all over North Africa and drift ice appeared in the Nile. This was the winter of Napoleon's retreat from Moscow, when 400,000 men perished, mostly of cold and hunger. The men froze to death in battalions, and no horses were left either for the artillery or cavalry. Quicksilver froze that winter.

In 1849 the cold in Sweden, Norway and Russia was so severe that great numbers of persons were frozen to death in all those countries.

In 1863-64 a severe cold wave swept over the whole of North America. The thermometer went to 60° below zero in the northwest. The Mississippi river was blocked with ice in a single night, and in twelve hours froze from St. Paul to Cairo.—*Ex.*

UNNECESSARY TORNADO ALARMS.

The following paragraphs are clipped from the June number of the *Monthly Weather Review*, edited by Prof. Cleveland Abbe:

It seems wise and necessary for the officials of the Weather Bureau to improve every occasion to allay the unnecessary alarm that pervades the community whenever one mentions the subject of tornadoes. Twenty years ago, when the Bureau began to collect and publish fairly correct statistics relative to these storms, the sum total of their number and the attendant destruction was so large as to be very impressive. The figures gathered by the meteorological reporters, purely for meteorological study with a view to the prediction of storms, were converted by sensational writers into a most alarming picture of the condition of the atmosphere in this country. Kansas, Iowa, and other portions of our fair land, became known as "tornado states." Many were frightened away from these states, and those who remained suffered unnecessary terror. Out of the natural desire to avoid a reputation for frequent tornadoes there grew a widespread determination to avoid the use of the word. Good citizens would allow that on very rare occasions they had an occasional "twister" or cyclone, a whirler or cloudburst, a hailstorm or hurricane, but *never a tornado*. Newspapers shunned the word and insisted on using evasive terms.

In 1884 the editor prepared for the proposed fourth edition of a little pamphlet entitled "Weather Maps, and How to Use Them," a table of relative frequency that clearly showed, not only the small chance of injury from tornadoes, but also that the chance was just as great in many small eastern states as in the large western states that had come especially under the ban of popular writers. One of the latter even went so far as to upbraid him for shirking his duty in that he did not join in the popular cry: "Beware of the western tornado."

There is really no more destruction done by tornadoes than by lightning, high winds, hailstorms, droughts and floods, or other meteoric visitations. Fear and dread are inspired by the general knowledge that harm may occur, but fright and panic do not seize one until the dreaded apparition is at hand and visible. Fright is largely a matter of the nerves and imagination; fear, of the intellect. Fright is not subject to reason, but fear may be so. By a careful, reasonable study of the maps of tornado tracks, our observers will always be able to calm the minds of the citizens. It is unnecessary to resort to the caves and cellars, or to stop our ordinary avocation for fear of a tornado, until we see the cloud in the distance, or are positively certain that one is about to pass near us.

DRY WEATHER HALF A CENTURY AGO.

The *Annals of Iowa*, Vol. IV, No. 3, contained the following notes on the weather, reprinted from the Bloomington (now Muscatine) *Herald*, dated February 26, 1847. It will be seen that there were some droughty periods in this section before the climate was "ruined" by drainage of shallow ponds and sloughs:

Since last July there has scarcely been enough rain to keep the vegetation from being parched up completely. Throughout the fall and winter thus far, it may be said that a drouth has rested upon the country. On the 1st day of January a little rain fell—sufficient to make it quite muddy, and on the 21 it changed to snow, which fell to the depth of six or eight inches in this place, but was much deeper north and west. At Iowa City the snow was nearly twice as deep as here—enough to make sleighing of the most superb quality. The sleighing lasted just one month. The climate of Iowa must ever be subject to less rain than almost any other portion of the west—lying, as it does, far from the influence of the Great Lakes, and having no range of mountains or highlands to operate as condensers to the rarefied and ascending vapors: the natural laws of evaporation will exhaust the moisture from her soil and bear it away to some cooler state of the atmosphere. It is only when a long continued heat shall operate to rarefy the air to an excess sufficient to produce a rapid circulation approaching to a storm, that we can reasonably expect rain. In this latter event the cooler vapors are forced into the vacuum, and if collected in sufficient quantities, fall of course to the earth.

WHAT GLACIERS HAVE DONE FOR IOWA.

BY PROF. SAMUEL CALVIN, STATE GEOLOGIST.

Everybody knows in a general way that Iowa was once the abode of glaciers and presented an aspect as dreary and uninviting as the central portions of northern Greenland or the ice-locked continent of the Antarctic. It may not, however, be so generally known that severe glacial conditions have recurred in Iowa more than once, and that in some cases at least, the interglacial intervals were characterized by a mild climate and, in point of duration, were more than equal to all postglacial time. A consideration of Greenland and Antarctica, in their present condition of frigid desolation, would scarcely suggest that the action of glaciers could be, in any way, beneficial; but it needs only a comparison of preglacial with postglacial Iowa to demonstrate the fact that glaciers and glacial action have contributed in a very large degree to the making of our magnificent state. What Iowa would have been, had it never suffered from the effects of the ponderous ice sheets that successively overflowed its surface, is illustrated, but not perfectly, in the driftless area. Here we have an area that was not invaded by glaciers. This area lies mostly in Wisconsin, but its edges overlap southeastern Minnesota, northeastern Iowa and northwestern Illinois. In our own state, Allamakee county and parts of Winneshiek, Fayette, Clayton, Dubuque and Jackson belong to the driftless area. Furthermore, the southern limits of glacial action are fairly well defined, coinciding in a general way with a line drawn from Jefferson City to St. Louis, and along the Ohio river from near its mouth to Pittsburg. East of Pittsburg the glacial boundary curves to the north and east, and at last conforms very nearly to the southern edge of Long Island. South of the line described there are further opportunities for comparing preglacial Iowa—or rather what Iowa would have been without the modifications wrought by glaciers—with the Iowa we know to-day. There is yet one other way of learning something about the surface of preglacial Iowa. During the last two decades numerous deep wells have been bored through the loose

surface deposits and down into the underlying indurated rocks. The records of these wells show that the rock surface is very uneven. Before the glacial drift, which now mantles nearly the whole of Iowa, was deposited, the surface had been carved into an intricate system of hills and valleys. There were narrow gorges hundreds of feet in depth, and there were rugged rocky cliffs and isolated buttes corresponding in height to the depth of the valleys.

If the eroded rock surface had not been covered up and protected by the mantle of glacial detritus, the angular, jagged topography indicated by well records as characterizing preglacial Iowa, would have been toned and softened, to some extent, by erosion and atmospheric waste. So far, therefore, as topography is concerned, the driftless area and other nonglaciated portions of the country give a more correct notion of what Iowa would have been if the great ice sheets had not worked their beneficent effects upon its surface.

The driftless area differs from the drift-covered portions of Iowa in a number of important particulars. For present purposes, however, these differences may conveniently be reduced to two classes: First, differences in topography, and, second, differences in the superficial materials or soils.

To a person passing from the drift-covered to the driftless part of the state, the topography presents a series of surprises. The gentle undulations of the drift give place to sharp contours and high reliefs. The topography is of the most pronounced erosional type. The principal drainage streams flow in valleys that, measured from the summits of the divides, are 600 feet or more in depth. The Oneota or Upper Iowa river, in Allamakee county, for example, flows between picturesque cliffs that rise almost vertically to a height of from 300 to 400 feet, while from the summit of the cliffs the land rises gradually to the crest of the divides, three, four, or five miles back from the stream. Tributary streams cut the lateral slopes and canyon walls at intervals. These again have tributaries of the second order. Each affluent indeed branches and re-branches until the whole surface of the drainage slopes is occupied by a palmate system of sharp erosion channels separated by rounded ridges. In such a region a quarter section of level land would be in the nature of a curiosity. The straight section-line roads that divide the drift-covered parts of the state into squares as regular as a checker board, are altogether unknown; for highways must, perforce, go where they can, and in the driftless area they wind along the summits of ridges or pursue an even more tortuous course along the stream valleys. In passing from valley to divide, the grades are steep and long; and always, no matter what the direction or purpose of the traveler, the way is sinuous, and the journey is much longer than would be necessary if it were possible to follow straight lines.

Railroad building in such a country is almost out of the question. At all events it is attended with difficulties that would scarcely be appreciated by the residents of drift-covered portions of the state. For example, the short piece of road between Waukon Junction and Waukon pursues a tortuous journey of thirty-three miles, and yet the two points, measured on an air line, are only about sixteen miles apart. In the thirty-three miles of distance the grade rises nearly 600 feet, while curves, numerous and sharp, offer further obstacles to successful operation. The road in question fol-

lows the valley of Paint creek, and trains winding back and forth on the sinuous track grind around the sharp curves with creakings and groanings unutterable. This is a fair example of railroading in the driftless area, a fair example of conditions that would have been met throughout the whole state of Iowa, had it not been for the leveling effects of glaciers. Compare this picture with that presented by railways in the counties west of Howard, Chickasaw, and Fayette, where the lines are laid out on straightaway courses, across valley and watershed, with scarce perceptible grade, for scores of miles at a stretch. For the matchless facilities with which the highways of transportation, between different portions of our state and neighboring states, are established and maintained, we are indebted, to an extent difficult to appreciate, to the beneficent action of glaciers.

In the matter of soils, our debt to glacial action is even greater than in the matter of topography. In a non-glaciated Iowa we might have moved from point to point, though as compared with present conditions it would about have involved great expense, great loss of time, and much inconvenience. But a non-glaciated Iowa could never have taken rank as a great agricultural state. In an area that has received no glacial tribute the soils are, in general, the result of decay of rocks in places. If, as in the case of Iowa, the area has recently been elevated from 300 to 600, or 800 feet above base level, the drainage streams flow in deep valleys. The sides of the valleys rise at a high angle. As fast as the soil is formed it is washed from the steep slopes. Over a large percentage of the surface the rocks are bare, while areas that are not completely denuded have soils too thin for purposes of successful agriculture. Furthermore, even where such residual soils as are possible to driftless regions accumulate to a moderate depth, they are found to vary with the nature of the underlying rocks from which they are derived; they are completely oxidized and thoroughly leached of all soluble constituents; they are difficult of cultivation, and crops can only be produced at the expense of much labor and by the liberal use of fertilizers. Exceptions to this general statement are found in narrow belts of rich alluvial soils along the stream valleys; but soils of uniform excellence, spreading between the two great rivers, and from northern to southern boundary, would have been impossible in a non-glacial Iowa.

The conversion of a deeply trenched and eroded surface into a gently undulating plain, upon which wagon roads and railways, facilitating social and commercial intercourse, may be constructed with a minimum of labor and expense, is a service of immeasurable value; and yet this is one of the least of the beneficent effects of glacial action in Iowa. The soils of Iowa have a value equal to all the gold and silver mines of the world combined. In fact it is difficult to find sources of wealth with which our soils may properly be compared. And for all this rich heritage of soils we are indebted to great rivers of ice that overflowed Iowa from the north and northwest. The glaciers in their long journey, ground up the rocks over which they moved and mingled the fresh rock flour, derived from granites and other crystalline rocks of British America and northern Minnesota with pulverized limestones and shales of more southern regions, and used these rich materials in covering up the bald rocks and leveling the irregular surface of preglacial Iowa. The materials are, in places, hundreds of feet in depth. They are not oxidized or leached, but retain the carbonates

and other soluble constituents that contribute so largely to the growth of plants. The physical condition of the materials is ideal, rendering the soil porous, facilitating the distribution of moisture, and offering unmatched opportunities for the employment of improved machinery in all the processes connected with cultivation. Even the driftless area received great benefit from the action of glaciers, for, although the area was not invaded by ice, it was yet to a large extent covered by a peculiar deposit called loess, which is genetically connected with one of the later sheets of drift. The loess is a porous clay rich in carbonate of lime. Throughout the driftless area it has covered up many spots that would otherwise have been bare rocks. It covered the stiff, intractable residual clays that would otherwise have been the only soils of the regions. In itself it constitutes a soil of great fertility. Every part of Iowa is debtor in some way or other to the great ice sheets of the glacial period.

SOME FACTS ABOUT WEATHER FORECASTING.*

BY WILLIS L. MOORE, CHIEF UNITED STATES WEATHER BUREAU.

To those who are familiar with the application of meteorological science to weather forecasting, and with the material benefits accruing to the commerce and industry of the United States from timely warnings of marine storms, frosts and cold waves, it will be interesting to note that, at the time of the founding of the first of the Thirteen Colonies, at Jamestown, Va., in 1607, practically nothing was known of the properties of the air or of methods for measuring its phenomena. To-day, at about two hundred stations in the United States, electrically-recording automatic meteorological instruments measure and transcribe for each moment of time the temperature, the air pressure, the velocity and direction of the wind, the beginning and ending of rainfall, the amount of precipitation, and the sunshine or cloud.

That we live in an age of great intellectual acumen, and that he is indeed a wise prophet who can outline, even dimly, the possibilities of the next century, is effectively shown by the development of meteorological science within the recollection of the present generation; although one must admit that in the making of weather forecasts—valuable as these in general are—we have not advanced much beyond the empirical stage. Nor have we any prospect that we shall ever attain the accuracy required by the astronomers in predicting the date of an eclipse or the occurrence of celestial events.

It was not until 1643, twenty-three years after the landing of the Pilgrims on Plymouth Rock, that Torricelli discovered the principle of the barometer, and rendered it possible to measure the weight of the superincumbent air at any spot where the wonderful, yet simple, little instrument might be placed. Torricelli's great teacher, Galileo, died without knowing why nature, under certain conditions, abhors a vacuum; but he had discovered the principle of the thermometer. All the data from the readings of these two instruments form the foundation of all meteorological science.

*Reprinted from The Forum, May, 1898, by permission.

The inventors as little appreciated the value of their discoveries as they dreamed of the great Western Empire which should first use their instruments to measure the inception and development of storms.

As early as 1738 Dr. John Lining, of Charleston, S. C., kept a record of the daily temperature in this country. The accurate thermometers of Fahrenheit had then been in use but a few years; and, compared with the fine instruments now used for measuring temperature, the error due to imperfect mechanical construction was probably considerable. About one hundred years after the invention of the barometer, viz., in 1747, Benjamin Franklin, patriot, statesman, diplomat and scientist, divined that certain storms had a rotary motion and that they progressed in a northeasterly direction. It was prophetic that these ideas should have come to him long before anyone had seen charts showing observations simultaneously taken at many stations. But, although his ideas in this respect were more important than his act of drawing the lightning from the clouds and identifying it with the electricity of the laboratory, yet his contemporaries thought little of his philosophy of storms, and it was soon forgotten. It will be interesting to learn how he reached his conclusion as to the cyclonic or eddy-like construction of storms.

Franklin had arranged with a co-worker at Boston to take observations of a lunar eclipse at the same time that he himself was taking readings of it at Philadelphia. Early on the evening of the eclipse an unusually severe northeast wind and rainstorm set in at Philadelphia, and Franklin was unable to secure any observations. He reasoned that, as the wind blew fiercely from the northeast, the storm was of course coming from that direction, and that Boston must have experienced its ravages before Philadelphia. Reports indicated that the storm was widespread. What was the surprise of Franklin when, after the slow passage of the mail by coach, he heard from his friend in Boston that the night of the eclipse had been clear and favorable for observations, but that a terrific northeast wind and rainstorm began early the following morning. He then sent out inquiries to the surrounding stage stations and found that at all places southwest of Philadelphia the storm had begun earlier, and that the greater the distance the earlier the beginning, as compared with its advent in Philadelphia. Northeast of Philadelphia the time of the beginning of the storm had been later than at that city, the storm not reaching Boston until twelve hours after its commencement at Philadelphia.

In considering these facts a line of inductive reasoning brought Franklin to the conclusion that the wind always blows toward the center of the storm; that the northeast hurricane which Boston and Philadelphia had experienced was caused by the suction exercised by an advancing storm-eddy from the southwest, which drew the air rapidly from Boston toward Philadelphia, while the source of the attraction—the center of the storm-eddy—was yet a thousand miles to the southwest of the latter place, that the velocity of the northeast wind increased as the center of the storm-eddy advanced nearer and nearer from the southwest, until the wind reached the conditions of a hurricane; that the wind between Boston and Philadelphia shifted, and came from the southwest after the center of the storm-eddy had passed over that region; and that the force of the wind gradually

decreased as the center of attraction passed farther and farther away to the northeast.

Another man whose name is dear to the heart of every patriotic American conducted in conjunction with his friend, James Madison (afterward bishop), a series of weather observations, which were begun in 1771 and continued during the stirring times of the Revolution. This was the sage of Monticello, Thomas Jefferson. Madison was near the sea, at the colonial capital, Williamsburg, Va.; Jefferson was at Monticello, 120 miles west. They took simultaneous observations for several years, until the British ransacked Madison's house and carried off his barometer.

Had the telegraph been in existence Jefferson and Madison would doubtless have conceived the idea of a national weather service, as they discovered by comparing observations that barometric and thermometric changes usually occurred at Monticello four or five hours before they did at Williamsburg.

Contrary to the statements which I believe have been made by some historians, the Fourth of July, 1776, was a cool day; for the great author of the Declaration of Independence did not fail to read his thermometer in Philadelphia on that day. An examination of his papers in the State Department, made by an official of the Weather Bureau, proved that he took several readings, viz: 6 A. M., 68°; 9 A. M., 72½°; 1 P. M., 76°; 9 P. M., 73½°. These early observers did not escape the one unfailling vagary that even at this late period haunts the mind by day and induces feverish dreams by night in nearly every person who has not made a study of meteorological data; for in 1781 Jefferson said:

A change in climate is taking place very sensibly. Both heats and colds are becoming much more moderate within the memory of even the middle-aged. Snows are less frequent and less deep. They do not often lie below the mountain more than one, two, or three days, and very rarely a week. The snows are remembered to have been formerly frequent, deep, and of long continuance. The elderly inform me that the earth used to be covered with snow about three months in every year.

But Jefferson and his neighbors were mistaken. Never during the period of authentic history has the snow covered the ground in Virginia for periods averaging three months per year for three years in succession. The old inhabitants of Jefferson's time were like those of to-day—they remembered only the abnormalities of the climate of twenty-five or fifty years before, and in comparing the unusual conditions of long ago with the average of the present they were deceived. I have known intelligent and truthful men publicly to declare that they *knew, from personal recollection*, that the climate of their particular places of residence had changed since they were boys—that they had reliable landmarks to show that the streams were drying up, that the precipitation was growing less, and that the winters were becoming milder—notwithstanding the fact that carefully taken observations of temperature and rainfall for each day for the previous hundred years showed no alteration of climate at such places. Of course, wide variations, sometimes extending over periods of several years, had occurred; but a deficit at one time was made up by an excess at another. To be sure, changes must have taken place during geologic periods; but these have been so slow that it is doubtful whether man in his civilized state has occupied the earth long enough to discover an appreciable quan-

tity. Quite accurate records of the opening of navigation in the rivers of Europe and of the time of vintages for five hundred years show no change in the average data of the first ten years as compared with the average of the last ten; and the date palm, the vine, and the fig tree flourish as luxuriantly to-day in Palestine as they did in the days of Moses. Dried plants have been taken from the mummy cases of the Pharaohs exactly similar to those now growing in the soil once trod by those ancient monarchs.

The matter of change of climate is very important to our subarid West, to the states whose normal rainfall is just enough to produce a profitable crop. Some years ago, when the tide of immigration was strong, there were several years of rather more than average rainfall in regions that theretofore had had little rainfall for profitable agriculture. These two conditions were accidentally coincident; but the fact probably gave rise to the theory that civilization brings an increase in precipitation. It was thought that the breaking of the virgin soil, making it more permeable, and thereby conserving the scant deposit of moisture; the planting of trees and the propagation of vegetation, by restricting the run off and by drawing up the moisture from below the surface of the ground through roots; the enormous quantities of aqueous vapor injected into the air by the combustion incident to a teeming population—had all combined to increase the rainfall and to render the subarid plains more responsive to the efforts of the husbandman. No one with even a spark of that fellow feeling which "makes us wondrous kind" can fail to regret that this theory is not founded upon fact. But a moment's thought will indicate to the physicist that the volume of superincumbent air is so great, and its capacity for moisture so enormous, that the additional vapor of water evaporated as above described, great though it be, is ineffectual to change appreciably the amount of rainfall which nature beforehand had ordained should be precipitated.

The size of continental areas, the topography of the land surface, the proximity of large bodies of water, and the direction of the prevailing winds, are all factors in determining the precipitation of a region; and it is probable that the feeble efforts of man will never be able materially to modify the result.

If the Rocky mountains were eroded down to the height of the Appalachian chain, the vapor-laden winds from the Pacific would blow inland, and probably cause copious rainfall as far east as Colorado, western Kansas, and western Nebraska. But these are changes which can be accomplished only in long geologic periods.

During the first half of the nineteenth century—nearly a hundred years after Franklin's northeast rainstorm—Redfield, Espy, Loomis, Henry, and other American scientists laboriously gathered by mail the data of storms after their passage, and demonstrated their principal motions to be much as Franklin had supposed. In 1855 Prof. Joseph Henry, secretary of the Smithsonian Institution, constructed a daily weather map from observations collected by telegraph and nearly simultaneous. He did not publish his forecasts, but used his large wall map for the purpose of demonstrating the feasibility of organizing a government weather service. If there were no other achievements to the credit of the grand institution founded in this country through the benevolence of the English philanthropist, James Smithson—who, by the way, never gazed upon our fair land—the work of

the Smithsonian Institution in connection with practical meteorology should always accord it a warm place in the hearts of those who believe that the crowning achievements of science consist in giving to the world knowledge which results in the saving of human life, the amelioration of the sufferings of humanity, and the acceleration of the wheels of commerce and industry.

Although American scientists were the pioneers in discovering the progressive character of storms, and in demonstrating the practicability of weather services, the United States was only the fourth country to give legal autonomy to a weather service. Holland established a weather service, with telegraph reports and forecasts, in 1860; England followed, with a smaller service, in 1861; and France, in 1863. But none of these countries has an area, from which observations can be collected, great enough to give such a synoptic picture of storms as is necessary in the making of useful forecasts. It would require an international service, embracing all the countries of Europe, to equal ours in extent of the area covered and in the accuracy of its forecasts.

The vast region now included in the scope of the Weather Bureau system of observations embraces Canada and the Gulf of Mexico; the whole having an area extending two thousand miles north and south, three thousand miles east and west, and so fortunately located in the interest of the meteorologist as to include an important arc on the circumpolar thoroughfare of storms of the Northern Hemisphere. Simultaneous observations, collected twice daily by telegraph from about two hundred stations, distributed throughout this great area, render it possible at several central offices, where all the reports are received, to present to the trained eye of the forecaster a wonderful panoramic picture of atmospheric conditions. Every twelve hours the kaleidoscope changes, and a new graphic picture of actual changes is shown. The movements of the storm centers and cold-wave areas are noted, and estimates made as to their probable course during the next twenty-four hours. Where else can the meteorologist find such an opportunity to study storms and atmospheric changes? The widely differing elevation, topography, temperature, humidity, and aridity of the broad region under observation offer unequalled conditions for the study of the mechanical phases of storm development and progression—so far as such can be profitably studied with observations taken only at the bottom of the ocean of air surrounding the earth. Our storms and cold waves can be studied during their inception at an average altitude of five thousand feet above sea level, under conditions of extreme aridity; they can be observed later, as they come down almost to sea level in the Mississippi valley and reach a more humid atmosphere one thousand miles from the place of their birth; and, finally, they can be seen as they reach the extremely humid air of the Atlantic ocean, fifteen hundred miles farther east.

The great winter storms which originate south of the Japanese Islands and cross the Pacific ocean come under our vision as they successively surmount the formidable Rocky mountains with but little diminution of energy, sweep across the continent with increasing force and heavy precipitation and within three days pass beyond our meteorological horizon at the Atlantic seaboard, to be heard from occasionally three days later as boreal ravagers of northern Europe.

The great anticyclones, or high-pressure areas, which constitute the American cold waves, drift into our territory from the Canadian northwest provinces and are studied under rapidly changing conditions during 3,000 miles of their course. The high-pressure eddy, with all the conventional principles of the cyclone reversed, may be said not to depend upon the land of its birth for the cold it brings; for a strong vortical and anticyclonic motion at the center is continually bringing down the cold air from above. In other words, our cold waves are not, as was once supposed, masses of heavy air chilled by flowing over the snow and ice fields of the Arctic ocean and transported to our central valleys with such rapidity of translation as to attain much of their original frigidify.

In 1870 and for some years thereafter our forecasts and storm warnings were looked upon by the press and the people more as experiments than as serious statements. The newspapers especially were prone to comment facetiously on the forecasts, and many were clamorous for the abolition of the service during the first years of its existence. There was some ground for the criticisms. We knew nearly as much about the mechanics of storms at that time as we do to-day; but we had not—by a daily watching of the inception, the development, and the progression of storms—trained a corps of expert forecasters such as now form a part of the staff of the chief of the Weather Bureau, and from which he himself was graduated. After a time mariners began to note that danger signals were, in the great majority of cases, followed by heavy winds, and they reasoned that it were better to take precaution against forecast storms that never came than to be unprepared for those which did come.

It is a fact that many times, by the operation of forces not indicated by the surface readings, the barometer at the center of a storm begins to rise and the velocity of the whirling mass to decrease. In such cases the storm signals placed in advance of the storm center would fail to give the proper information. Again, the storm center may suddenly acquire a force not anticipated, or it may pursue a track considerably divergent from the normal for the location and season. In this case, also, the forecasts may warn some cities that fail to receive the effects of the storm. The staff of the Weather Bureau, which includes many meteorologists, has not failed to make a study of the peculiarities of the several types of storms occurring in different localities during the various seasons of the year, their line of travel, and the force that they may be expected to attain. The comparative merits of those who by natural ability were best fitted correctly and quickly to correlate in their minds the conditions shown on the meteorological chart and to make accurate deductions therefrom as to the development, movement and force of storms have been tested by competitive examinations. This line of study and competition has resulted in improved forecasts, so that mariners now universally heed the storm warnings, horticulturists and truck gardeners make ample provision against frost, and shippers of perishable produce give full credence to the cold-wave predictions. Of the West Indian hurricanes which have swept our Atlantic seaboard from Florida to Maine during recent years not one reached a single seaport without danger warnings having been sent well in advance of the storm, and no unnecessary warning has been issued. The result is that no disaster of consequence has occurred. Large owners

of marine property estimate that one of these severe storms traversing our Atlantic coast in the absence of danger signals would leave not less than \$3,000,000 worth of wreckage. On two occasions a census was taken immediately after the passage of severe hurricanes to determine the value of property held in port by the danger warnings sent out in advance of the storms. In one case the figure was placed at \$34,000,000; in the other, at \$38,000,000. Of course this does not represent the value of property saved. It simply shows the value of property placed in positions of safety as a result of danger signals and warning messages sent to masters. On January 1, 1898, an extensive cold wave swept from the Rocky mountains eastward to the seaboard. Estimates secured from shippers in 100 principal cities indicated that property valued at \$3,400,000 was saved as a direct result of the predictions sent out.

There is hardly a daily paper that does not publish weather forecasts in a prominent place, and there is scarcely a reader who fails to note the predictions. The utility of these forecasts to the agriculture, the commerce, and the industry of the country is so great that it may be interesting to note more in detail the methods by which observations are collected, forecasts made, and meteorologic information disseminated.

Our Weather Bureau maintains about two hundred regular meteorological stations, each in charge of a trained observer, advantageously located geographically for the taking of observations. The transmission of reports is accomplished with remarkable rapidity by means of an effective arrangement of telegraphic circuits. Observations from all parts of the United States and Canada, from the Atlantic to the Pacific, are collected at Washington within thirty minutes after the observers have read the station instruments and filed their observations. Synoptic charts are prepared in the central offices at Washington and Toronto, and at many of the large stations at which reports are received; and by 9 o'clock (seventy-fifth meridian time) the charts are complete. The chart of greatest value to the forecaster contains for each station the temperature, barometric pressure, wind direction and velocity, weather conditions—whether raining, snowing, cloudy, partly cloudy, or clear—and the amount of precipitation, if any. Lines, called "isobars," are drawn for each one-tenth of an inch of barometric pressure, bounding the areas over which the air is respectively lightest and heaviest. These areas are called "highs" and "lows;" but they are only relative terms, as on one map the highest pressure may be over two inches in excess of the lowest, while on the map of another day the difference may be less than one inch.

Several other charts are prepared in the forecast room of the central office at Washington, as follows: Temperature-change map, showing the maximum and minimum temperature at each station, with changes from the day before and changes from the normal; barometer-change map, showing twelve and twenty-four hour changes and changes from the normal; cloud map, indicating the character, nomenclature, quantity, and movement of clouds; and a map showing wet-bulb and dry-bulb temperatures, with differences between the two.

If the student of the weather maps will pay close attention to them each day, he will find that the highs and lows move across the country in almost regular succession. If the high be a decided one, it will cover a territory

one or two thousand miles in width, the weather within its influence will be cold and clear, and the winds will have a general tendency spirally outward from the center in a direction corresponding to the movement of the hands a watch. The low is the opposite of the high in almost all its characteristics. It is usually attended by clouds, rain or snow, and high winds. The winds within the influence of the low blow spirally inward in a direction contrary to those under the influence of the high. The lower the barometer and the steeper the gradient, the more rapid is the whirl. These are some of the characteristics of lows. Those of like class take nearly the same course, and produce about the same results; but they do not always move with the same rapidity. No exact rule in regard to them can be laid down. Empirical reasoning, and intimate association with the charts, day after day and year after year, in the main equip the successful forecaster for his important functions.

Just as the eddies in a river go whirling down stream, so are cold-wave eddies (highs) and rainstorm eddies (lows) carried eastward by the general movement of the upper atmosphere in the latitudes of the United States. It is important that the fundamental principles of these eddies be understood, since the weather changes experienced from day to day depend almost wholly upon the development and drift of these high-pressure and low-pressure eddies, or, as they are better known, highs and lows. The two eddies are easily distinguishable the one from the other; for, while traveling eastward in the same general direction, they rotate in opposite directions. The high-pressure eddy always follows in the track of the low-pressure eddy. In the high-pressure eddy—in which the air is cold and clear, and in which the degree of cold is nearly proportional to the rise of the barometer—the air is drawn downward near the center of the eddy, and forced outward in all directions from the center along the surface of the earth. This eddy at times is two thousand miles in diameter. In the low-pressure eddy—in which the air is warm, humid, and often rainy or snowy—the surface air is drawn inward from all directions toward the center. Thus, the alternate passage of highs and lows controls our weather conditions.

About six-sevenths of our low-pressure eddies move from the Rocky mountains eastward. They vary from the gentle whirls to storms of considerable intensity. Their average diameter is about one thousand miles. The West Indian hurricane, which comes up from the tropics and skirts along our Atlantic shore-line, has a diameter of rotation less than one-half that of the usual low-pressure eddy; but its velocity of rotation is much greater. Many of these hurricanes have a diameter of only three or four hundred miles; but their velocity of rotation is very often one hundred miles per hour, although their rate of translation, as they move northeast along our coast, is seldom greater than thirty miles per hour.

Twenty-five years ago mariners on our Great Lakes and seaboard depended on their own weather lore to warn them of coming storms. Then, although the number of craft plying on our waters was much less than now, every severe storm that swept the lakes or Atlantic coast left destruction and death in its wake, and for days afterward the dead were cast up by the receding waves, and the shores were lined with wreckage. Happily this need not now be the case, for the Weather Bureau of the Department of

Agriculture is ever watching the changes of atmospheric conditions and giving the mariner warning of coming storms. Each observer telegraphs instantly to the central office whenever the instruments at his station show unusual agitation. By this means the inception of many storms is detected when the regular morning and evening reports fail to give notice of their origin.

Some idea of the vast interests floating in Atlantic ports may be had when it is stated that 5,628 transatlantic steamers, with an aggregate of 10,076,148 tons, and 5,842 sailing craft, aggregating 2,105,688 tons, enter and leave ports on the Atlantic seaboard during a single year. The value of their cargoes is more than a billion and a half of dollars. Our coastwise traffic also is enormous. In one year more than 17,000 sailing vessels and 4,000 steamers enter and leave ports between Maine and Florida. Their cargoes are estimated to be worth \$7,000,000. From these facts one can roughly measure the value of the marine property which the Department of Agriculture, through the work of the Weather Bureau, aims to protect by giving warning of approaching storms.

It is the dream of the meteorologist that some day he will be able accurately to forecast the weather weeks and months in advance. But so far this much-to-be-desired object can be realized only in a dream. What a wonderful conservation of human energy would result were it possible to tell the farmer when the great corn and wheat belts would have abundant rain during the next growing season, or when droughts would parch the vegetation, or truthfully to inform the planter of the south that the approaching season would be favorable or unfavorable to the production of cotton! Effort would be withheld in one part of the country and prodigious energy exerted in another.

When our extensive system of daily observation has been continued for another generation a Kepler or a Newton may discover such fundamental principles underlying weather changes as will make it possible to foretell the character of coming seasons. If this discovery be ever made it will doubtless be accomplished as the result of a comprehensive study of meteorological data of long periods covering some great area like the United States. At any rate we are certainly now laying the foundation of a great system which will adorn the civilization of future centuries.

At the present time I know of no scientific man who essays to make long-range weather predictions, and I would especially caution the public against the imposture of charlatans and astrologists, who simply prey upon the credulity of the people. As storms of more or less intensity pass over large portions of our country every few days during the greater part of the year, and as it is seldom that the weather report does not show one or more storms as operating somewhere within our broad domain, it is easy to forecast thunderstorms about a certain time in July or a cold wave and snow about a certain period in January and stand a fair chance to become accidentally famous as a prophet. You may select any three equidistant dates in January and forecast high wind, snow, and cold for New York city and stand a fair chance of having the fraudulent forecast verified in two out of three cases; provided that you claim a storm coming the day before or after one of your dates to be the storm which you expected.

I believe it is impossible for any one to-day to make a forecast, based fairly upon any principles of physics or upon any empiric rule in meteorology, for a greater period than one or two days in winter or for more than two or three days in summer; and there are times in winter when the movements of air conditions are so rapid that it is extremely difficult to forecast even for the space of one day. The Weather Bureau takes the public into its confidence in this matter and does not claim to be able to do more than it is possible to accomplish.

Having reached the highest degree of accuracy possible with our present instrumental readings, it becomes necessary to invade new realms if we desire to improve the character of the forecast and to make it of greater utility. I have long realized this, and several years ago determined systematically to attack the problem of upper air exploration with the hope of being able ultimately to construct a daily synoptic chart from simultaneous readings taken in free air at an altitude of not less than one mile above the surface of the earth. During the past ten years there has been much discussion as to the best means of improving weather forecasts by readings secured at high levels. Many stations have been established on mountain peaks; but, unfortunately, the observations from these places have been of little use to us in making the daily forecast.

It is my opinion that plans previously advocated by many for isolated investigations in the upper air by means of free and uncontrollable balloons, by observers in balloons, or by independent kite stations striving for very great flights, were of little value in getting the information absolutely necessary to the more accurate determination of the mechanics of storms. It is my belief that the only feasible plan is that of simultaneous observations at such uniformly high levels as can be attained with kites at many stations. With only a moderate surface wind our improved kites will now ascend easily to the height of one mile or over, and will carry up an automatic instrument, mainly of aluminum, weighing about two pounds, which records temperature, pressure, humidity, and wind velocity.

The Weather Bureau intends to establish tentatively fifteen or twenty stations between the Alleghanies and the Rocky mountains during the present spring, and to make special effort to secure observations at the same hour at a high level from all the stations, so that the meteorological conditions at that altitude may be compared with those prevailing at the surface of the earth. If we are successful in attaining the desired altitude at enough of our stations each day to give the date from which a synoptic chart can be constructed, we shall then be able to map out not only the vertical gradients of temperature, humidity, pressure, and wind velocity, but also the horizontal distribution of these forces at two levels—one at the earth's surface and the other at the height of one mile. It may be that after this work is done only negative knowledge will be acquired; but, even then, the work will not have been in vain. It will be an instructive study to note the development and progression of storms and cold waves at this high level. At that altitude the diurnal variations cease; there is but little change between the heat of midday and that of midnight; so that storm conditions may be measured without the confusing effects due to immediate terrestrial radiation.

The temperature readings already secured by our use of kites show that in the summer season we live in an extremely thin stratum of warm air; that on the hottest day an ascent of only 500 to 1,000 feet in free air would place a person in a comfortably cool atmosphere; that the temperature at an altitude of 3,000 feet is slightly higher at midnight than at midday; and that changes of wind and of temperature begin at high levels sooner than on the surface of the earth.

It is a problem for the engineer of the twentieth century how to utilize this information so as to give relief during the protracted hot spells of summer to the dense population of great cities, and so that one need not travel to the seashore in order to reach a temperature that is conducive to health and comfort.

INDEX

	PAGES
Annual precipitation chart, 1896.....	25
Annual report.....	5-6
Climate and crop bulletins.....	23-38
Climate and crop review.....	26-27
Climatology of the year 1899.....	6
Dry weather half a century ago.....	60-61
Final crop report, 1899.....	39-41
Historic cold winters.....	58-59
Losses by lightning in 1899.....	53-55
Map, percentage of loss by swine disease.....	45
Map, crop yields and stock by counties.....	46-52
Monthly summaries.....	6-24
Some facts about weather forecasting.....	64-74
Story of a decade.....	42-44
Tornado, hurricane and cyclone.....	55-58
Unnecessary tornado alarms.....	60
What glaciers have done for Iowa.....	61-64