

When the high-pressure area is moving in from the west, clear and colder weather anticipated, with the probability that the early morning temperature will permit the formation of frost—the most important elements to be considered, in determining whether or not frost will occur injurious to growing crops—are as follows:

(1) Has rain recently fallen, and what is the condition of the soil relative to the amount of moisture contained?

(2) What are the natural properties of the soil relative to the slow or rapid loss of heat by radiation?

(3) To what degree of heat has vegetation been subjected during the period immediately preceding?

The early fall frost injurious to tender crops occurs with the observed town or telegraph minimum temperature ranging from 40° to 50°, because, when the early morning temperature in the town falls much lower than 40°, it is usually so late in the season that all crops are gathered, or, if not gathered, they have been destroyed ere this condition arrives. At the time, then, that frost-warnings are of the most benefit, we have to deal with the air at temperatures considerably above the freezing-point, and to recall that a deposition of frost requires that the temperature of the top soil, or that of vegetation, be reduced to the freezing point. This, of course, is accomplished by conduction and radiation of heat, which takes place more rapidly from the soil and vegetation than it does from the lower stratum of air to the higher.

Anything that will seriously interfere with a rapid loss of heat after nightfall will tend to prevent the formation of frost. Moisture does this, and if the soil be well charged it partakes greatly of the stability of water as to temperature, and cools but little, if any, below the temperature of the superincumbent air, and no frost will occur even though all other favourable conditions of clearness, gentle winds, and cool air obtain. Even a small amount of moisture, say one-half inch of rainfall, will give ample protection if well distributed and precipitated within the twenty-four hours previous. But when severe drought conditions are prevalent, injurious frosts may occur when the telegraphic temperatures do not show a reading within ten degrees as low as in the first case.

I believe that, when estimating the probability or severity of frost, sufficient weight has not been given to the dryness or wetness of the soil, and the resultant dissipation or conservation of heat, and I call special attention to the point as one of the means for improving the forecast.

I have in mind two typical cases. In the first a high-pressure area attended by clear and cool weather drifted from the westward until it covered the State. No rain had fallen with the passage of the low-pressure area immediately preceding it; hence the ground was in excellent condition for the rapid loss of heat during the night, and a consequent lowering of the temperature of vegetation to the freezing point. Considerable damage was done to cranberries in unflooded marshes. In the second case a high-pressure area of slightly greater weight and slightly lower temperature covered the region about ten days later, but it was preceded within a few hours by a light but well-distributed fall of rain, averaging about one-half an inch, and no frost occurred. In both cases the wind was gentle from the north-west, and the nights were clear. With slightly lower air temperature and higher barometer in the second condition, heavier frost would have occurred than in the preceding case, had it not been for the thinly spread moisture of the timely rain conserving heat at the surface of the earth.

Might not this principle be carried further in the improvement of the forecast? Assuming that the caloric energy of the sun is a constant factor, the earth receives each year the same amount or intensity of heat, and as the atmosphere is warmed mainly by contact with or radiation from the earth, seasonal variations of temperature which are marked departures from the normal might result from abnormal terrestrial surface conditions with respect to the conservation of this constant solar energy over large continental areas. Here the excessive or deficient rainfall during the preceding seasons should receive careful consideration. The subject is one that requires deeper and more detailed investigation than the length of this paper will permit.

I find that the minimum temperatures in cranberry marshes during abnormally dry seasons often fall 15° below the temperatures telegraphed from the cities and towns within a few miles of the marshes. This is due to the fact that when the loose, spongy peat, of which the marsh is composed to the depth of several feet, has dried out, the radiation of heat during the night is very rapid, and is not counterbalanced by

conduction and connection from the marsh. The temperature, therefore, in cranberry marshes is at all times much lower than that which obtains in marshes composed of heavy black muck, where it preserves a more equable condition, such as is common to air resting over a considerable body of water. A dry cranberry marsh does not, therefore, enjoy that immunity from frost enjoyed by wet marshes and watery lands. But when the ditches are flooded from the reserve water supply on receipt of a frost warning, the water quickly percolates through the peat composing the marsh, and the rapid loss of heat by radiation is checked and the frost averted.

The amount of heat to which vegetation has been subjected immediately before the frost condition, and the temperature under which it had made its growth, will in a great measure determine the extent of damage to ensue.

By carefully considering the principles herein enunciated, I will say that in 1894, twelve out of fourteen official forecasts of frost were fully verified—a much greater percentage of accuracy than has ever been attained by simply considering air conditions alone.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

ON Friday, the Chancellor of the Exchequer received at the Treasury a large deputation in support of a memorial praying that increased aid may be given to the English University Colleges, ten in number, and to University College, Dundee, which at present receive among them an annual grant of £15,000. Sir M. Hicks Beach, in reply, said there was no question that the existing grant of £15,000 would be continued; but he thought that in accordance with the recommendations of two Parliamentary committees a competent inspector should be appointed to visit annually each college receiving a grant, and report on its efficiency, its success, and its financial position. Till such an inspector should have reported, he did not think it possible for him to consider the increase of the grant.

It is satisfactory to be able to note that the question of the education of mine managers, assayers, and engineers in Australia is actively discussed in the most recent Government reports on mines for several of the Colonies. In Victoria, mining schools have long been established at Ballarat and Bendigo, with branches at the more important mining centres in the Colony. Certificates of competency to act as mine managers are given by these schools, although the holding of such by mining engineers is not compulsory by law. In like manner in Tasmania, similar certificates are given after a Governmental examination. As the Under-Secretary for Mines of Queensland observes in his latest annual report, "the implication is that a certificated mining manager is preferable in the eye of the law to one who has no such credentials." In 1893 a school of mines in connection with Sydney University was founded by the New South Wales Government, and £10,000 spent in the erection of a suitable building, which has just been completed. The teaching staff has been formed at a small cost by utilising the services of the professors paid by the University, and lectures and practical instruction are now being given in chemistry, metallurgy, assaying, geology, mineralogy, and all branches of mining to an increasing number of students. Up to the present Queensland alone, among the more important Colonies, has established no mining school; but, State aid having been promised to well-supported schemes in any mining centre, the reproach will probably soon be removed. Indeed, some progress has already been made towards establishing a technical school at Brisbane. With regard to the effect of such schools, the Under-Secretary of Mines for New South Wales remarks, in his Report for 1894: "It is hoped that the establishment of the School of Mines will result in the gradual improvement in the methods of mining, as practised in this Colony, by providing a class of managers who will have had the advantage of a thorough scientific training, and who will only need a few years' practical experience to qualify them as mining engineers of the highest efficiency. The ultimate result must be an increased development in the mining industries of this country." In view of this feeling on the part of the Government officials of the various Colonies, it is evident that the compulsory possession of a certificate of competency by Australian mine managers is almost within sight.