DRYING GRAIN WITH UNHEATED AIR*

by

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Unfavourable weather in occasional years makes it difficult and sometimes impossible to harvest the prairie grain crop at a moisture content that is safe for long term storage. Severe situations occur at least every ten years and in some parts of the prairie provinces, more frequently. In such problem years there are periods when the farmer could thresh his grain in a tough condition, at a moisture content between 14.5 and 17 per cent, but there is always the inclination to wait for better weather. Sometimes the situation gets worse instead of better and the grain must be harvested in the damp condition or left in the field until spring. The longer the grain lies out, the greater is the loss, not only in actual bushels but in weight per bushel and in grade. It is not uncommon to lose two or three grades when harvest is interrupted by a prolonged spell of wet weather.

HEATED VERSUS UNHEATED DRIERS

Although heated air grain driers became fairly common in 1959, they have not achieved great popularity. Grain trade officials frown on their use because of the danger of damaging the grain by overheating. Farmers are reluctant to purchase them because of the high initial cost.

Unheated air can be used to dry a few thousand bushels of grain if conditions of air temperature and relative humidity are favourable. The major advantages of unheated air drying are that the danger of damaging the grain by overheating is eliminated and that the equipment for drying is much less expensive. Even if weather conditions are not suitable for drying with unheated air, cool air can be blown through the grain at intervals to prevent heating and spoilage. The rate of spoilage depends on the temperature and moisture content of the grain. At temperatures below 40°F mold growth and insect activity are almost non-existent. Although precise data are not available it appears that tough grain can be kept over winter without damage to the milling and baking quality so long as it is kept cold. There is also evidence to suggest that animals make better use of feed grains if the moisture content is in the tough or even damp range. However, germination is impaired if damp grain is frozen. If drying could not be completed in the fall, cold air could be blown through the grain occasionally to prevent spoilage. It could then be fed to livestock through the winter or drying might be completed in the spring when weather conditions were more favourable.

FAVOURABLE DRYING CONDITIONS

Grain can only be dried if conditions of temperature and relative humidity are favourable. Under conditions of a particular temperature and relative humidity grain will gradually dry to a particular moisture content. Figure 1 shows this relationship for wheat at a temperature of 60°F. The precise position of this curve is affected slightly by grain variety and temperature; figure 1 is a composite of the work of several investigators (1, 2, 3, 4, 5, 6). It can be seen from this curve that a relative humidity of 65 per cent or lower is required to dry wheat to a moisture content of 14 per cent. However, wheat at 17 per cent moisture will be dried if the relative humidity is less than 80 per cent. This suggests that some drying can be done almost every day when the grain is damp or near the damp moisture level, but that reasonably good weather is required to complete the drying process.

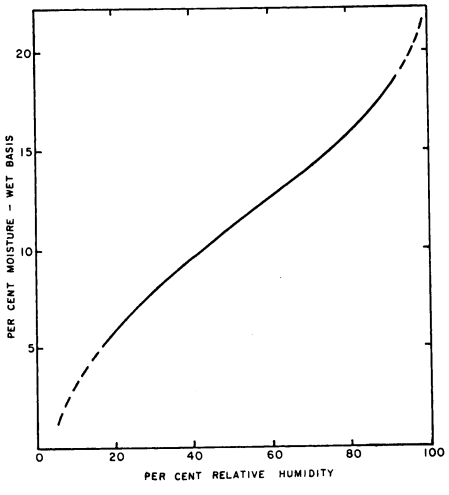

Figure. 1. Equilibruim moisture content of wheat.

WEATHER DATA ANALYSIS

Weather records from past years were examined to determine the actual amount of drying possible. Records of mean monthly temperatures and relative humidities at four times a day were obtained from the Meteorological Service of the Department of Transport. Figure 2 shows the September mean relative humidity at Saskatoon for the period 1953 to 1962. It would appear from this that little drying can be expected at night. During the day the relative humidity was below 60 per cent most years, indicating favourable drying conditions. These curves give only the monthly mean values, which can be deceiving so the continuous records of temperature and humidity maintained by the University of Saskatchewan, Saskatoon were examined. The continuous records showed that the 11 a.m. and 5 p.m. readings are fairly representative of conditions during the day but that monthly mean values cannot be used to accurately estimate the amount of drying possible.

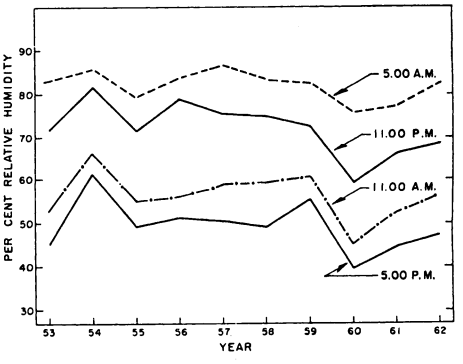

Figure 2. Mean relative humidity for September 1953-1962

Records for September in the years 1951, 1957, 1958 and 1959 were examined in detail. 1951 and 1959 were years of particularly poor harvest weather on the prairies. In 1951 approximately 200 million bushels of grain were dried at terminal elevators, and in 1959 approximately 70 million bushels were dried in this way, even though some 200 heated air dryers were sold to farmers that year. Table I shows the total number of hours during which the relative humidity was below 60 per cent, the average temperature and relative humidity

during these favourable hours and the number of batches of wheat that could have been dried from 18 to 14 per cent moisture, using an air flow of three cfm per bushel. The average values were obtained by planimetering the appropriate area on the record charts. These average values of temperature and relative humidity were used to estimate the number of cubic feet of air required to dry one bushel and from this, the number of hours required for drying with an air flow rate of three cfm per bushel. This estimate of drying time tends to be high, since higher humidities would produce some drying at the beginning of each batch.

TABLE I. DRYING CONDITIONS IN SEPTEMBER

	1951	1957	1958	1959
Number of hours with relative humidity below 60%	134	320	304	292*
Average temperature during these hours	61°	55°	60°	55°
Average humidity during these hours	55%	50%	50%	48%
Number of batches of wheat that could have been dried from 18% to 14% using 3 cfm per bushel	.75	2.2	2.1	1.8

*Two thirds of good drying weather in September 1959 occurred in the first two weeks

It can be seen from table I that some grain drying with unheated air was possible in September of problem years such as 1951 and 1959. However, it also suggests that in problem years grain drying with unheated air would only provide a partial solution. Under such weather conditions it would not be possible to complete drying of all the tough grain that might be harvested.

Table II is similar to table I except that it shows conditions for the month of May in the years 1958 to 1960 inclusive. In comparing the two tables, it is immediately apparent that weather conditions in the spring are much better suited to unheated air drying than are fall weather conditions. In many instances it would have been possible to dry a bin of grain in a week or less.

Although the weather data presented are for the Saskatoon area, perusal of records for the northeast part of the province, where harvest conditions are often worse, indicates that conditions for grain drying are only slightly less favourable there.

FURTHER STUDY REQUIRED

Unheated air grain drying installations on the prairies are scattered, but enough have been used to demonstrate their practicability. Additional research is required on the following aspects.

1. Improved designs for duct work and false floors so as to make the process less troublesome to the farmer.

2. Combinations of grain temperature and moisture content which will permit storage for a few months without damage to the grain.

3. The potential savings in field losses and/or quality which might be obtained by harvesting early and drying with unheated air. Most farmers look upon grain dryers as emergency equipment which might be required one year in ten, rather than equipment which could be used to advantage two years out of three.

4. The feeding of tough and damp grain to livestock.

TABLE II. DRYING CONDITIONS IN MAY

	1958	1959	1960	1961
Number of hours with relative humidity below 60%	580	380	500	460
Average temperature during these hours	60	58	58	61
Average humidity during these hours	50	41	52	50
Number of batches of wheat that could have been dried from 18% to 14% using 3 cfm per bushel	4	3.1	2.9	3.3

SUMMARY

This study suggests that an investment of a few hundred dollars in equipment for drying grain with unheated air might be well worthwhile for farmers in a large part of Saskatchewan. In many cases it would permit earlier harvesting of a few thousand bushels, even though the grain was in a tough condition. This could well mean savings in field losses and/or grade of grain that would repay the cost of equipment in a single year. In years of extremely poor harvest weather, such as occurred in 1951 and 1959, some drying could be accomplished in the fall, and the grain stored safely over winter by blowing cold air through it occasionally. Drying could almost certainly be completed in the spring.

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