1988

Monitoring Natural Air Corn Drying—A Demonstration Project

Richard O. Pierce
University of Nebraska-Lincoln

Gary L. Zoubek
University of Nebraska-Lincoln, gzoubek1@unl.edu

Monitoring Natural Air Corn Drying— A Demonstration Project

Richard O. Pierce, Gary L. Zoubek
ASSOC. MEMBER
ASAE

ABSTRACT

A demonstration project is described where natural air corn drying performance was monitored weekly and drying results were printed in a local newspaper. The newspaper articles also gave management recommendations for the upcoming week. Similar demonstration projects can be conducted using the procedures described in this paper.

INTRODUCTION

Natural air drying is a drying method well suited to Nebraska weather conditions, and is one which is popular with Nebraska farmers. About 20% of the grain dried in Nebraska is dried using natural air. While natural air drying systems can be simple to manage, variations in system design, bin filling rates, and year-to-year weather conditions often complicate the process. Problems typically occur when system airflow rates are inadequate and when a bin is overloaded with grain which is too wet. Extensive research has been conducted in Nebraska to define system drying capabilities and develop management techniques (Pierce and Thompson 1979, 1982 and Pierce, 1986). This information has been summarized for farmer use (Pierce and Thompson, 1985), but unusual weather conditions still create confusion regarding proper management procedures.

One such weather related problem occurred during the 1985 to 86 drying season. Damp, overcast conditions during August delayed corn maturity and resulted in a situation where grain moisture contents remained high late into the fall. Then, record cold temperatures during November, 1985 prevented the movement of a fall drying zone through the grain. As a result, many natural air drying bins still held corn at 20% to 22% moisture content on March 1, 1986. This contrasts to a more normal situation where corn moistures would be reduced below 18% by mid-December.

A preliminary computer simulation analysis indicated that a bin of 20% moisture corn could be successfully dried in the spring if drying fans were turned on by March 1, about 2 weeks earlier than normal, and run continuously until drying was completed. A major concern was that farmers would not realize the severity of the problem they faced and wait too long before turning on fans in the spring. A second concern was that they would attempt to save energy by operating fans only on warm, low-humidity days, a practice which greatly increases the chance of spoilage at the grain surface.

A natural air drying demonstration project was conducted in Antelope County, a major corn producing county located in northeastern Nebraska, to help area farmers cope with this unusual drying situation. Antelope County was selected as the site for the demonstration project because of a high concentration of natural air drying systems in the area, because the problem was particularly severe in northeastern Nebraska, and because area farmers had expressed interest in such a project at a winter grain storage meeting. Overall objectives of the demonstration project were to increase farmer awareness of the problem, offer timely management information, and demonstrate drying performance when using recommended fan management procedures.

PROJECT INITIATION

The approach selected for the demonstration project was to monitor corn moisture contents in four drying bins on a weekly basis and to use local newspapers to keep area farmers updated on drying progress. The newspaper articles were also used to discuss specific drying problems and provide management recommendations for the upcoming week. The State Extension Grain Drying Specialist and the Extension Agent-Agriculture for Antelope County worked together to locate farmer cooperators, sample corn moisture contents and chart drying progress, and prepare a weekly news release. The following procedures were used for the various phases of the project.

Farmer Cooperators

Farmer cooperators were solicited in the Extension Agent's weekly newspaper column. There was no response to the request for cooperators the first week, but 12 farmers responded to a second article. An initial bin sampling was conducted on March 4 and 5 to reduce the number of cooperators to a more manageable level. Four bins were selected for the study based upon initial corn moistures, airflow rates, and the likelihood that drying would be completed without spoilage. System design information is presented in Fig. 1 for the four bins selected for the study. Airflow rates were estimated using reported fan performance data and ranged from 0.8 to 1.4 m^3/min-t. Corn moisture profiles varied for the bins depending upon harvest moisture contents and past fan management.

Article was submitted for publication in May, 1987; reviewed and approved for publication by the Food and Process Engineering Institute in September, 1987. Presented as ASAE Paper No. MCR 87-117.

This manuscript has been assigned Journal Series Number 8336, Agricultural Research Division, University of Nebraska.

The authors are: R. O. PIERCE, Assistant Professor and Extension Agricultural Engineer, Agricultural Engineering Dept., and G. L. ZOUBEK, Extension Agent—Agriculture, University of Nebraska, Lincoln.

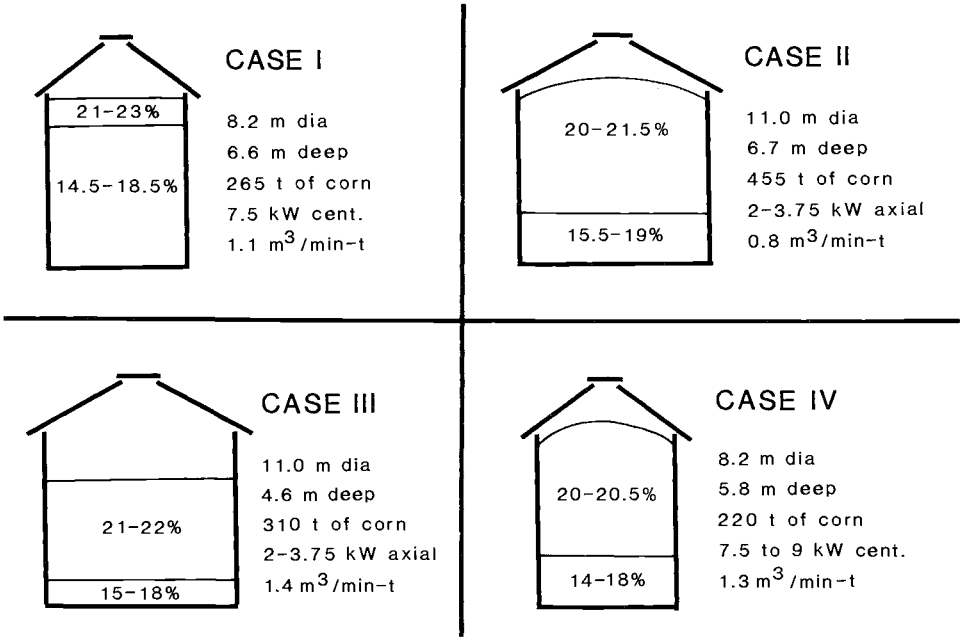

Fig. 1—System design information and corn moisture contents on March 4 at the start of the demonstration project.

In Cases II, III and IV, the systems had been managed to keep the corn cool over the winter months with little attempt at advancing the drying front. Because of a higher initial corn moisture content, the fan in Case I had been operated extensively over the winter months to advance the drying front as far as possible through the bin. Warmer than normal winter temperatures made this an acceptable fan management alternative. Because the corn in Case I had been held at warmer temperatures over the winter, the corn at the surface was beginning to smell musty. However, no visible mold growth was evident in any of the bins. Fines were extensive in all bins except the one in Case II, where the corn had been screened as it was loaded into the bin. The grain surface was leveled for Cases I and III and peaked for Cases II and IV.

Monitoring Drying Performance

Each of the test bins was probed once a week to determine corn moisture contents. A Cargill Probe-A-Vac pneumatic grain sampler was used to take corn samples at 0.6 m depth intervals. Samples were taken at a location approximately 1.2 m from the center of the bin. An Agronmatic MK II portable moisture meter was used to measure corn moisture contents. Sampling was completed and the corn moisture profile was updated before leaving the bin. Corn temperatures were checked at the grain surface. Three to four hours were required to complete moisture sampling, including the time required to drive between bin sites.

Newspaper Article Preparation

Several area newspapers were contacted to determine their willingness to publish a news article describing the demonstration project and follow-up with weekly updates of drying performance. It was anticipated that drying would be completed in 4 to 5 weeks, requiring that the papers print four to five articles. The *Neligh News and Leader,* the most widely distributed paper in Antelope County, agreed to publish the series of articles.

A high priority was placed upon getting corn moisture content information into the newspaper within 1 or 2 days of when the bins were sampled. The following procedure was used in preparing the weekly news article.

1. A preliminary news release was prepared in Lincoln by the specialist and sent via AGNET, an interactive computer system, to the county extension office prior to the sampling date.
2. After sampling, moisture profiles were updated and the news release was revised as needed before being delivered to the newspaper.
3. The newspaper modified the news release into an interview format and occasionally incorporated general news releases before publishing the article.

This procedure was adopted to overcome coordination problems created by the specialist being located 240 km from the demonstration site. Typically, the news release was delivered to the newspaper by mid-afternoon of the day that samples were taken and appeared in the newspaper the following day.

RESULTS AND DISCUSSION

Drying Performance

Drying results from the first four weeks were excellent for the purpose of demonstrating drying front movement. Corn moisture contents for that period are shown in Table 1, using the same format used in the newspaper articles. The moisture profiles for March 18 and March 24 are particularly interesting. The weather prior to March 18 was rainy and humid, as indicated by increases in corn moistures at the bottom of the bin. However, the humid conditions did little to slow movement of the drying zone and the corn at the bottom of the bin dried back down the following week when drying conditions were more favorable. The week that it rained, two farmers did not wait for the newspaper to come out, but called the extension office directly to check on the effects of the humid weather.

After 1 month of drying, problems with airflow

TABLE 1. CORN MOISTURE CONTENTS FOR THE FOUR TEST BINS AS THEY APPEARED IN THE APRIL 2 NEWSPAPER ARTICLE. (ENGLISH UNITS WERE USED IN THE ARTICLE.)

Case I. An 8.2 m diameter bin filled to a depth of 6.6 m (265 t) equipped with a 7.5 kW centrifugal fan delivering 1.1 m^3/min-t.

Depth, m	Bottom 0	0.6	1.2	1.8	2.4	3.0	3.6	4.2	4.8	5.4	6.0	Top 6.6
	Moisture content, %											
Date												
3/04	14.0	14.0	14.5	15.0	15.0	15.5	16.0	17.5	18.5	21.0	22.0	23.0
3/11	14.5	14.5	15.0	15.0	15.5	15.5	15.5	16.0	17.0	18.5	22.0	23.0
3/18	16.0	16.5	15.5	16.0	15.5	15.5	15.5	15.5	15.5	16.0	19.5	22.5
3/24	14.5	14.5	15.0	15.0	15.5	15.0	15.0	15.0	15.5	15.5	16.5	19.0
4/01	11.5	11.5	12.0	12.0	13.0	13.5	14.0	15.0	15.0	15.0	16.0	21.0

Case II. An 11 m diameter bin filled to a depth of 6.7 m (455 t) equipped with two 3.75 kW axial flow fans (7.5 kW total) delivering 0.8 m^3/min-t.

Depth, m	Bottom 0	0.7	1.3	1.9	2.5	3.1	3.7	4.3	4.9	5.5	6.1	Top 6.7
	Moisture content, %											
Date												
3/04	15.5	17.0	19.0	20.0	20.0	20.0	20.5	21.0	18.5	19.0	20.0	21.5
3/11	15.0	15.0	16.0	17.0	19.0	20.5	20.0	20 0	20.0	19.0	20.0	21.5
3/18	17.0	16.5	16.0	16.5	18.0	20.5	21.0	21.0	20.5	19.5	19.5	20.0
3/24	15.0	15.0	15.5	17.0	16.5	17.5	18.5	19.5	20.0	19.0	19.5	20.0
4/01	12.5	12.0	12.0	13.0	13.5	14.0	16.0	18.0	19.0	19.0	19.0	19.0

Case III. An 11 m diameter bin filled to a depth of 4.6 m (310 t) equipped with two 3.75 kW axial flow fans (7.5 kW total) delivering 1.4 m^3/min-t.

Depth, m	Bottom 0	0.4	1.0	1.6	2.2	2.8	3.4	4.0	Top 4.6
	Moisture content, %								
Date									
3/04	15.0	15.0	18.0	21.0	21.5	21.0	22.0	22.0	22.0
3/11	14.5	15.0	15 0	19.0	20.5	21.0	20.5	22.0	22.0
3/18	16.5	16.5	16.0	16.5	19.0	19.5	21.0	21.5	21.5
3/24	15.0	15.0	14.5	16.0	17.5	20.0	21.0	20.5	20.0
4/01	11.5	11.5	11.5	13.0	15.0	16.0	16.0	17.0	21.5

Case IV. An 8.2 m diameter bin filled to a depth of 5.8 m (220 t) equipped with a 7.5 to 9 kW centrifugal fan delivering 1.3 m^3/min-t.

Depth, m	Bottom 0	0.4	1.0	1.6	2.2	2.8	3.4	4.0	4.6	5.2	Top 5.8
	Moisture content, %										
Date											
3/04	14.0	14.5	15.0	15.5	18.0	20.5	20.0	20.0	20.5	20.5	20.5
3/11	14.5	14.0	14.5	15.0	15.5	16.0	20.0	20.0	20.5	21.0	19.5
3/18	15.5	15.0	15.0	14.5	15.0	16.0	16.5	19.0	20.0	21.0	19.5
3/24	14.0	14.0	14.0	15.0	15.0	15.0	15.0	16.0	18.0	19.0	19.5
4/01	11.5	12.0	12.0	12.5	13.5	14.0	14.5	15.0	18.0	19.0	—

uniformity became evident. Drying fronts were moving through at the bin sidewalls, but were 0.6 to 1.2 m below the grain surface near the center of the bin. The problem was severe enough that an additional 4 to 6 weeks of fan operation was required to dry the corn in the top center of the bins. Non-uniform drying resulted from either concentrations of fines down through the center of the bin or because the grain was peaked. Moldy kernels were noted in the slower drying areas of all four test bins, indicating the severity of the drying situation.

The corn settled in the bins as drying progressed. This made it difficult to report drying results in a consistent fashion because grain samples could not be taken at the same depth below the grain surface each week. Similar problems occurred as grain peaks were leveled. To simplify reporting procedures, corn shrinkage at the surface was ignored until depths had decreased by more than 0.6 m as they did in Case IV (Table 1).

A final concern regarding the results was that differences in airflow rate did not have an obvious effect

on drying rate. An airflow rate of 0.8 m^3/min-t (Case II) seemed to dry the corn just as fast as an airflow rate of 1.4 m^3/min-t (Case III). Non-uniform airflow distribution may have been responsible for this problem. The average airflow rate for Case III may actually have been 1.4 m^3/min-t, but the airflow rate near the center where probe samples were taken may have been much lower due to a concentration of fines.

News Articles

The procedure for preparing news articles worked well and was effective in getting information out to farmers while the previous weeks' drying conditions were still fresh in their minds. The moisture profile results provided a lead-in to such topics as grain cleaning, peaking grain, drying times, drying front movement, airflow uniformity, and drying costs.

One problem was that the *Neligh News and Leader* had no obligation to use the news releases, and did drop articles due to a lack of space. A positive note was that several farmers inquired as to why drying results were not printed in those issues. No articles were dropped during the first four weeks of the project when the information was most useful.

It was disappointing that newspapers in surrounding counties did not run the news articles. The drying results were applicable for a much larger area than that actually reached. If this project were repeated, more effort would be directed toward getting newspapers to print the drying results and the accompanying news articles.

Checking Additional Bins

The weekly news article created considerable interest, with many farmers becoming interested in checking corn moisture contents in their natural air drying bins. In response to this interest, an offer to check additional bins on a one-time only basis was made through the agent's newspaper column. Ten area farmers took advantage of the offer to have their grain probed and their drying systems evaluated. Concerns about grain quality were well-founded, with four of the 10 bins checked having airflow rates too low to safely dry 20% moisture corn.

There was considerable variation in the type of system different farmers felt was suitable for natural air drying. Airflow rates for these bins ranged from 0.4 to 1.5 m^3/min-t. Despite this wide variation in airflow rate, all the bins had been filled with 20% corn and were expected to perform the same drying job. The disturbing aspect is that the farmers were operating their fans as recommended in the newspaper articles and were expecting drying performance comparable to that in the test bins. In retrospect, system design requirements should have received more emphasis in the initial news article.

SUMMARY

A natural air drying demonstration project was conducted to provide farmers with management information on how to handle a severe spring drying situation. Specifically, they were faced with the problem of natural air drying corn which was still at or above a moisture content of 20% in early March. The demonstration approach was to monitor farmer cooperator bins and report drying progress in a weekly newspaper article. The news articles were also used to provide management information for the upcoming week.

The project was successful in increasing farmer awareness as to the severity of the situation. The weekly news articles provided a means of getting out timely fan management information. Sampling of bins other than those being monitored weekly helped identify several potential spoilage problems. Overall, the project was well received in the county where the test bins were located.

A negative aspect of the project was that drying results were not as widely distributed as was desired. Only one newspaper carried the weekly news articles. If newspaper coverage of the project could have been more extensive, the total impact of the project would have been much greater.

References

1. Pierce, R. O. and T. L. Thompson. 1979. Solar grain drying in the North Central Region—simulation results. TRANSACTIONS of the ASAE 22(1):178-187.

2. Pierce, R. O. and T. L. Thompson. 1982. Drying scheduling—a procedure for layer filling low-temperature corn drying systems. TRANSACTIONS of the ASAE 25(2):469-474.

3. Pierce, R. O. and T. L. Thompson. 1985. Natural air corn drying. NebGuide G85-760. University of Nebraska, Lincoln, NE 68583.

4. Pierce, R. O. 1986. Economic considerations for natural air corn drying in Nebraska. TRANSACTIONS of the ASAE 29(4):1131-1135.