INTERIM RESEARCH UPDATE: IMPROVED MANAGEMENT OF STORED PULSES

PAMI

ALBERTA PULSE GROWERS

AUGUST 2018

Project Description

Year one of a two-year study on storage of pulses is complete. The overall objective of the project is to better define best management practices for the storage of pulses. The specific objectives are:

- To determine the effect of airflow rate on drying and cooling rates of peas and lentils
- To investigate if airflow rate has an effect on pea and lentil quality (germination)
- To verify that existing information on resistance to airflow is accurate for peas and lentils so producers can make informed decisions on fan size selection
- To verify that existing information on the equilibrium moisture content of peas and lentils is accurate so producers can make informed decisions on fan operation

Airflow Rate, Drying & Cooling

The Canadian Grain Commission has published guidelines and information on the temperature and moisture content (MC) required to minimize the risk of spoilage during storage. For peas, the target MC is 16%. For red lentils, the target MC is 13%. For all grain types, the target temperature is 15°C or lower.

Blowing air through grain is the most common method to control temperature in the bin. If the grain is tough (but not wet), then blowing ambient air through grain can also result in moisture removal. Using air for temperature control is known as aeration while using ambient air for drying is known as natural air drying (NAD). Year 1 trials were completed using lentils and peas; the effect of airflow rate on the drying and cooling rates can be seen in the following charts.

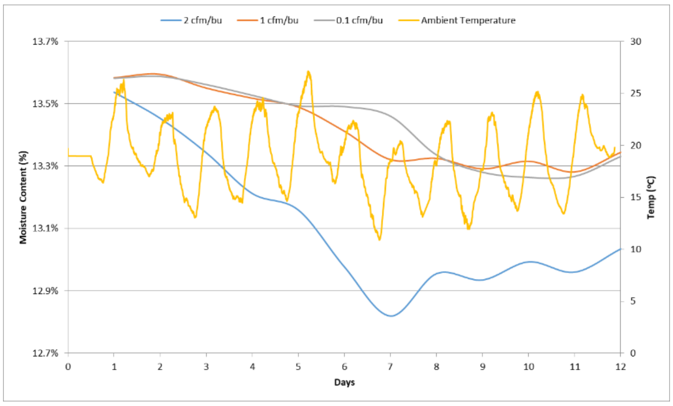

Figure 1. Average moisture content and ambient temperature throughout the red lentil drying trial (August 14 to 25, 2017).

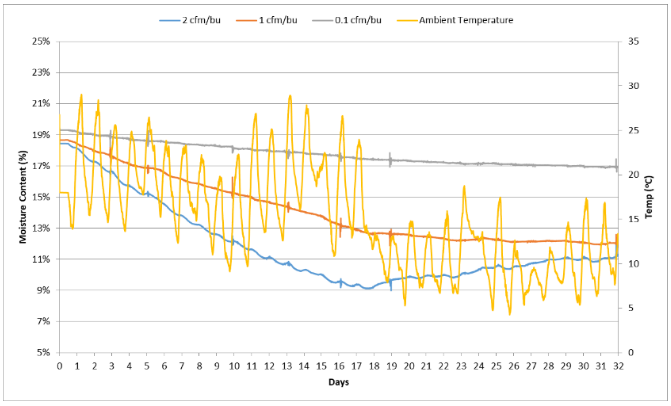

Figure 2. Average moisture content & ambient temperature throughout the pea drying trial (August 26 to September 27, 2017).

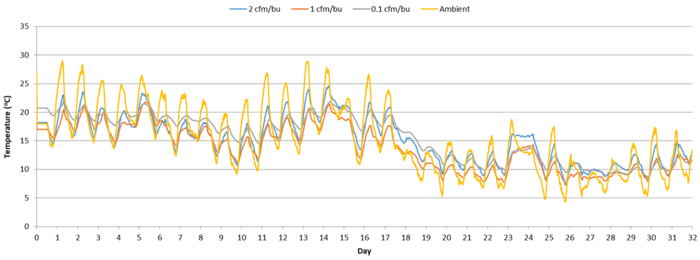

Figure 3. Ambient temperature compared to average grain temperature in the bin throughout the pea drying trial (August 26 to September 27, 2017).

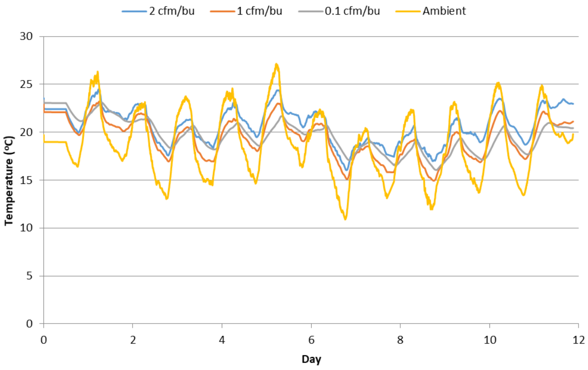

Figure 4. Ambient temperature compared to the average grain temperature in the bin throughout the red lentil drying trial (August 26 to September 27, 2017).

HOW LONG SHOULD I RUN MY FANS TO DRY LENTILS OR PEAS?

Fan run time depends on airflow rate, starting moisture content, and ambient conditions. For the lentil trial (Figure 1), only the high airflow rate (2 cfm/bu) achieved a “safe to store” moisture content of 13% within the 12 day trial. Based on the drying trend for both the 0.1 and 1 cfm/bu airflow rates, those lower airflow rates may also have achieved 13% moisture content eventually, provided the ambient conditions remained stable. For this trial, the high airflow rate achieved a “safe to store” moisture content within 5 or 6 days with the high airflow rate, but the starting moisture content was only 0.5% above the target moisture content.

For the pea trial (Figure 2), the starting moisture content was 3% above the “safe to store” moisture content of 16% MC. With this trial, the high airflow rate (2 cfm/bu) achieved 16% within 4 days, the medium airflow rate (1 cfm/bu) achieved 16% MC within 9 days, but the low airflow rate (0.1 cfm/bu) did not get the moisture content to a “safe to store” condition within the 32 day trial. After day 18, the ambient temperature dropped which affected the air’s capacity to dry. In fact, the high airflow rate resulted in some rewetting during this period which was due to a combination of airflow rate, ambient air conditions, and the fact that the peas were very dry when the cooler air was passed through it.

HOW LONG SHOULD I RUN MY FANS TO COOL LENTILS OR PEAS?

As shown in Figures 3 and 4, the cooling rate is highly dependent on ambient temperature. If the goal is to cool the grain, run the fans when the average ambient temperature is cooler than the grain. To estimate the required number of fan hours to equalize grain temperature with air temperature, divide the number 15 by your airflow rate in cfm/bu. For example, with 0.5 cfm/bu. it will take 15/0.5 = 30 hours of fan operation.

To learn more about measuring airflow rate for your bins and fans, go to pami.ca/storage

Effect of Airflow Rate on Grain Quality

Germination tests were completed to provide a preliminary assessment of the effect of airflow rate on grain quality. Theoretically, high airflow rates could result in repeated shrinking and swelling cycles which could affect the seed quality.

Based on these preliminary results, airflow rate did not have an effect on germination rate, although the medium airflow rate resulted in a significantly lower germination rate for the lentils. For the lentils, the samples collected near the plenum had a higher germination rate than samples collected from the middle of the bin while the opposite was true for the peas. The fact that the peas had a lower germination rate than the lentils was not surprising given that the peas were stored at a higher moisture content than recommended whereas, the lentils were very close to dry when the trial began. For the year two trials, seed quality will be assessed by a third-party lab and will include germination, vigour, and grade ratings. Also, in year two an undried sample will be sent for analysis as a baseline comparison.

Table 1. Results from germination test of lentils and peas after drying trial.

Treatment		**% Germinated**	
		Lentils	**Peas**
Airflow Rate	**Low**	97	73
	Medium	87	84
	High	96	81
Location	**Plenum**	97	75
	Middle	90	83



Loading peas into the 15 bu test bins at PAMI's Humboldt facility (left), Fan and transition duct used for one of the bin-scale airflow assessments with a partner producer (center), Unloading lentils from the 15 bu test bins at the end of the lentil drying trial (right).

Verification of Resistance to Airflow Information for Pulses

Predicted airflow resistance (static pressure) charts for peas and lentils were created based on Shedd's model, which accounts for the effect of grain type, grain depth, and airflow rate on static pressure. Predicted resistance to airflow is shown by the solid lines, while the individual points are those measured; ♦ and ■ markers indicate bin-scale data points, while bench-scale data points are represented by ▲. Each point is the same color as the line it should relate closest to; airflow rates were rounded to the nearest 0.5 cfm/bu.

For lentils the actual static pressure was always higher than the predicted static pressure, particularly at high airflow rates. For peas, all of measured points were similar to the calculated lines except for the high airflow (2.6 cfm/bu) data point.

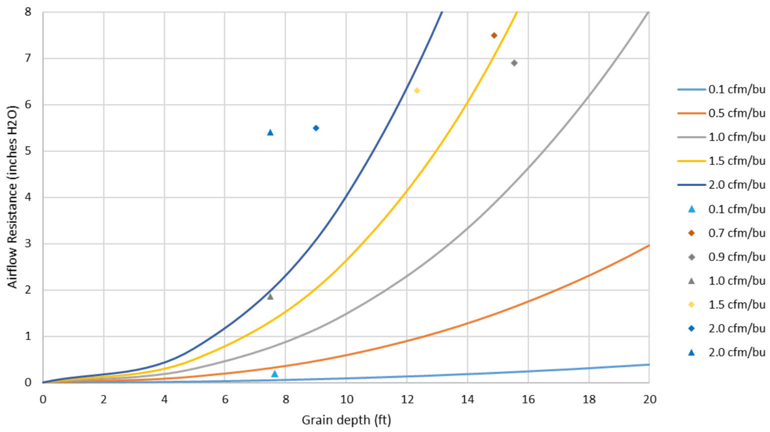

Figure 5. Lentil airflow resistance at various grain depths.

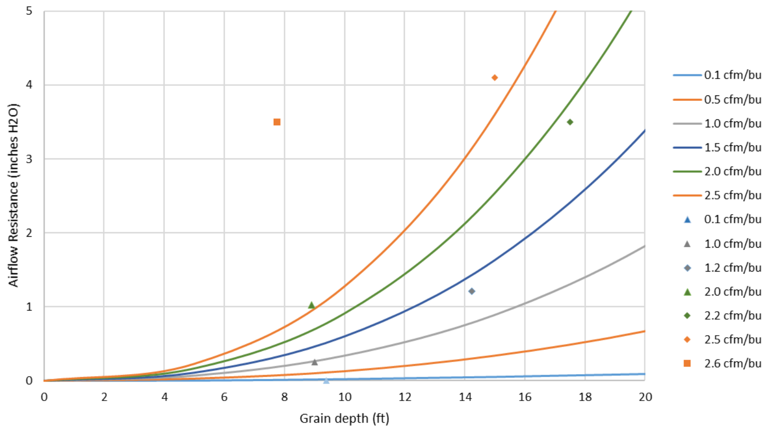

Figure 6. Pea airflow resistance at various grain depths.

Underestimation of the static pressure by Shedd's model (particularly for lentils) is partially due to the fact that the model only accounts for the resistance of the grain and does not account for the resistance of the bin ducting. This data will be verified in year 2 of the trials, however, producers should account for the underestimation when using the static pressure curves to size fans.

Verification of Existing Equilibrium Moisture Content Information

Equilibrium moisture content (EMC) charts are available in literature for peas (modified Henderson model), and red lentils (modified Halsey model) as seen below. These charts predict the MC of the grain based on air temperature and humidity.

The in-grain temperature and humidity data from the Year 1 drying trials were used to calculate the moisture content of the grain using these EMC models and compared with the actual moisture content of the samples collected from those bin locations.

- The modified Halsey model for lentils was consistently 3% to 4% under the actual moisture content.

- The modified Henderson model for peas ranged from 2% under to 5% over the actual moisture content.

Based on this data, these EMC charts may be used as a general guideline to understand how air conditions may affect grain moisture content, but modifications may be required if they are to be used for precise control of fan control systems. In addition, green lentils will likely have a different response to moisture than red lentils; this will be verified in year 2.

EQUILIBRIUM MOISTURE CONTENT FOR **PEAS** (Modified Henderson)

Temp	Relative Humidity (%)										
(°C)	35	40	45	50	55	60	65	70	75	80	85
-2	9.3	10.4	11.5	12.6	13.7	14.9	16.2	17.6	19.1	20.8	22.7
2	9.2	10.2	11.3	12.4	13.5	14.7	15.9	17.3	18.8	20.4	22.4
5	9.0	10.1	11.1	12.2	13.3	14.5	15.7	17.1	18.5	20.2	22.2
8	8.9	9.9	11.0	12.1	13.2	14.3	15.6	16.9	18.3	20.0	21.9
10	8.8	9.9	10.9	12.0	13.1	14.2	15.4	16.8	18.2	19.8	21.8
13	8.7	9.7	10.8	11.8	12.9	14.1	15.3	16.6	18.0	19.6	21.5
15	8.7	9.7	10.7	11.7	12.8	13.9	15.1	16.4	17.9	19.5	21.4
18	8.6	9.6	10.6	11.6	12.7	13.8	15.0	16.3	17.7	19.3	21.2
22	8.4	9.4	10.4	11.4	12.5	13.6	14.8	16.0	17.4	19.0	20.9
26	8.3	9.3	10.2	11.3	12.3	13.4	14.5	15.8	17.2	18.7	20.6
28	8.2	9.2	10.2	11.2	12.2	13.3	14.4	15.7	17.1	18.6	20.5

EQUILIBRIUM MOISTURE CONTENT FOR **RED LENTILS** (Modified Halsey)

Temp	Relative Humidity (%)										
(°C)	35	40	45	50	55	60	65	70	75	80	85
-2	8.9	9.5	10.0	10.6	11.2	12.0	12.8	13.8	15.0	16.5	18.6
2	8.8	9.3	9.8	10.4	11.0	11.8	12.6	13.5	14.7	16.2	18.3
5	8.7	9.2	9.7	10.3	10.9	11.6	12.4	13.4	14.5	16.0	18.0
8	8.5	9.0	9.6	10.1	10.7	11.4	12.2	13.2	14.3	15.8	17.8
10	8.5	8.9	9.5	10.0	10.6	11.3	12.1	13.1	14.2	15.7	17.7
13	8.3	8.8	9.3	9.9	10.5	11.2	12.0	12.9	14.0	15.5	17.4
15	8.3	8.7	9.3	9.8	10.4	11.1	11.9	12.8	13.9	15.3	17.3
18	8.2	8.6	9.1	9.7	10.3	10.9	11.7	12.6	13.7	15.1	17.1
22	8.0	8.5	9.0	9.5	10.1	10.7	11.5	12.4	13.5	14.9	16.8
26	7.9	8.3	8.8	9.3	9.9	10.6	11.3	12.2	13.3	14.6	16.5
28	7.8	8.2	8.7	9.2	9.8	10.5	11.2	12.1	13.1	14.5	16.4

The study will be repeated in 2018 with peas and green lentils to validate the data gathered in year 1 and to observe drying rates with a wider range of ambient conditions. The final report and final research update will be available in August 2019.

This project was supported by Alberta Pulse Growers and the Agriculture Development Fund under the Canada-Saskatchewan Growing Forward 2 bi-lateral agreement.

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Growing Forward 2

A federal-provincial-territorial initiative