On-Farm Survey of Combine Grain Losses in Canola Fields Across Western Canada

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ABSTRACT

Canola is one of Canada's most important and lucratively grown oilseed crops. Every year, producers throughout Western Canada seek to minimize their harvest losses to maximize crop yields. A producer's total grain loss during harvest can be attributed to three main sources: environmental loss, header loss, and combine loss. Earlier field research has reported total average canola losses across Canada at approximately 5.9% of a producer's total yield (Gulden et al., 2003). However, presently little to no information exists in literature on how much of the 5.9% is attributed to combine losses. Grain losses are an unfortunate reality that must be managed by producers every year to mitigate their financial losses. As such, there exists a need to quantify and better understand combine grain losses in canola fields across Western Canada. This paper reviews combine loss data collected from 31 different canola field locations across Alberta, Saskatchewan, and Manitoba. A total of 50 combines were tested, averaging losses of 1.3bu/ac (72.9kg/ha) or 2.8% of total yield.

Keywords*: Combine loss, Yield loss, Canola, On-Farm Survey, Western Canada*

INTRODUCTION

Canola production is an essential part of the Canadian economy, contributing roughly $26.7 billion dollars in revenue and 250,000 jobs annually (Canola Council of Canada, 2016). Approximately 43,000 farms grow canola in Canada (Canola Council of Canada, 2016), with the majority of production concentrated in the western prairies (Alberta, Saskatchewan, Manitoba). **Table 1** lists the major canola-producing provinces and their respective total harvested areas for 2017, 2018, and 2019.

Table 1. Harvested areas of canola in Canada, by province and year (Statistics Canada, 2018).

Harvested Area of Canola (acres) [ha]			
Province	**2017**	**2018**	**2019**
Saskatchewan	12,680,000 [5,131,400]	12,244,00 [4,955,000]	11,377,300 [4,604,200]
Alberta	6,890,000 [2,788,300]	6,679,200 [2,703,000]	5,820,800 [2,355,600]
Manitoba	3,155,000 [1,276,800]	3,379,100 [1,367,500]	3,208,600 [1,298,500]

Grain losses can be attributed to three main sources: environmental losses, header losses, and combine losses. Environmental losses occur prior to cutting or gathering crop and are typically caused by animal activity or aggressive weather such as hail or wind. Header losses occur during windrowing, picking-up swaths, or when straight cutting and may be a result of lodging, seed shatter, or cutter bar losses (Srivastava et al. 2006). Combine losses occur during combining and refer to the grain that has passed through the combine and is discarded with the chaff and straw after threshing, separating, and cleaning. A regional study conducted by Gulden et al. (2003) surveyed canola fields in Western Canada and revealed an average total harvest loss of 5.79% (2003). This number also falls within the reported ranges surveyed by Cavalieri et al. (2016). The extensive work performed by both of these parties provided crucial information about the total canola losses across Western Canada. However, there exists limited data elsewhere in the literature that benchmarks the current average combine grain losses across Western Canada. The main objective of this survey was to quantify the average combine losses experienced by producers and obtain a deeper understanding of the causes of canola combine losses by determining which parameters and variables are statistically likely to have an effect.

METHODOLOGY

Survey Population

Outreach events and social media platforms were used to increase public awareness of combine losses and gather voluntary participants for this study. PAMI, Canola Council of Canada, and SaskCanola networks were utilized to reach a large cross-section of Western Canadian canola growers. An online survey was used to obtain preliminary information from volunteer producers and included farm location, contact information, combine type, canola variety, canola acres, and total acres. In total, 131 canola producers registered to participate, but due to extenuating circumstances (weather, geography, budget, time) only 31 producers were visited (**Figure 1**). The producers that were visited were chosen based on harvest timing, weather conditions, and the ability to accommodate testing during the harvest season; best efforts were made to obtain a sample-set that fairly represented an overall cross section of canola production across Western Canada, including as many brands and types of combines as possible, and testing in both straight-cut and swathed canola fields.

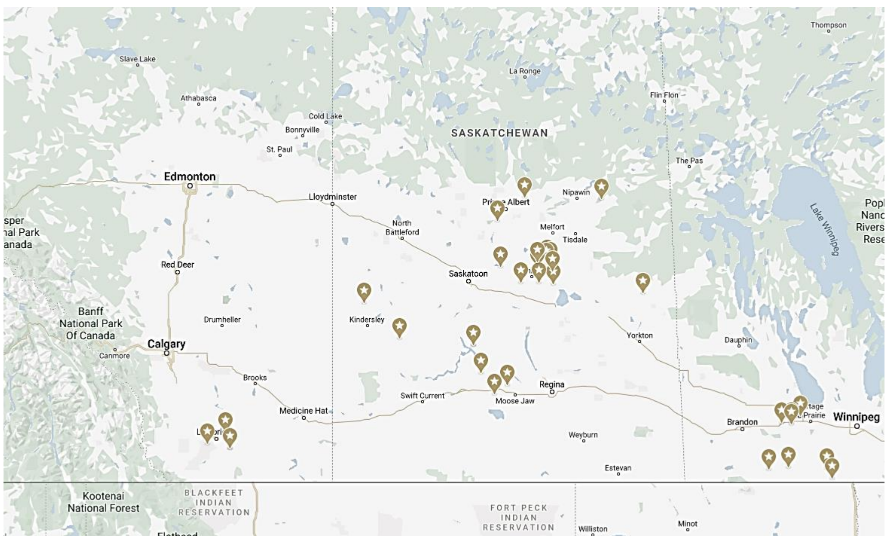

Figure 1. Distribution of canola producers who participated in combine loss study. Images produced and modified using Google Maps platform.

Testing Procedure

Drop pans were used to measure combine losses while in the field; these drop pans were attached to the rear of the combine below the machine's separation and cleaning system using built-in electromagnets. Once released, the pans would drop to the ground and collect any refuse material (chaff, seed, etc.) exiting the rear of the combine. This project used drop pans supplied by Bushel Plus and Schergain (**Figure** 2), both of which complied with the test methodology; pans models were alternated between fields. The catch area for the Bushel Plus and Schergain pans were 4.11 ft^2 (0.38 m^2) and 5.27 ft^2 (0.49 m^2), respectively. These areas were considered when measuring losses.

Figure 2. Drops pans used to measure losses. a) Bushel Plus b) Schergain. Images sourced and adapted from (Bushel Plus, n.d.) and (Schergain n.d.).

Before testing was conducted, an in-field survey was completed with the participating producers to gather additional information around test conditions. This survey included data related to

- weather conditions (relative humidity, ambient air temperature, wind speed),
- crop information (seeding date, seeding rate, canola variety),
- harvest method (swathing, straight-cut),
- combine information (make, model, year, type, hours, photograph of combine),
- harvest information (yield, discharge width, canola moisture content), and
- combine settings (fan speed, rotor/cylinder speed, sieve opening, ground speed).

After collecting preliminary information, PAMI field-test personnel used the following test procedure to measure combine losses:

1. Producer was asked to disengage the chopper and spreader, if feasibly possible.
2. PAMI personnel worked with the producer to safely attach a drop pan to their combine. The drop pan was attached to either the back axle or belly of the combine where canola would not be prematurely collected.
3. The combine operator would reach a steady state (minimum 20 seconds) before the remote-control key fob was used to drop the pan.
4. When safe to do so, PAMI personnel retrieved the drop pan, and the sample was cleaned of excess material other than grain (MOG). The canola was then stored in a labeled container for weighing, and the discharge width of the straw and chaff was measured.

For each unique combine, three drop test repetitions were completed. A biosecurity protocol was developed using the Canola Council of Canada field entry policy (Canola Council of Canada) to avoid bio-contamination between test fields. Safety meetings were held with the producer/combine operator before every field test to ensure operator safety.

Loss Calculation

Canola in the collected loss samples was separated from the straw and chaff and weighed; discharge width (i.e., the width of the dropped straw swath) was recorded for each replicate and cut width (i.e., header width) was provided by the combine operator. Canola combine losses were calculated using Equation (1).

$$L = \frac{m * W_{dis}}{A_{pan} * W_{cut} * \rho_{canola}} * C \tag{1}$$

Where:

L = Combine Loss (bu/ac).

m = Mass of Canola (g): Grain collected during loss test.

W_{dis} = *Discharge* Width (ft): Width of dropped or spread chaff and straw. Measured in field.

W_{cut} = Cut Width (ft): Obtained from producer; swather width or straight-cut header width.

A_{pan} = Catch Area (ft^2): Area of drop pan used for testing.

ρ_{canola} = Canola Density (lb/bu): 50 lb/bu

C = Conversion factor: $\frac{43{,}560 \frac{ft^2}{ac}}{453.6 \frac{g}{lb}}$

Equation (1) uses the weight of the collected canola sample as the primary means for determining losses; however, it should be noted that there are other suitable methods available to producers that instead use volume and seed count.

Data Analysis

For the purpose of data analysis and organization, the variables to be investigated were split into three groups: environmental variables, harvest and crop variables, and equipment variables.

Environmental variables included ambient temperature, relative humidity, weather conditions (cloud cover), wind speed and direction, as well as the time of day the test was conducted. **Table 2** lists each of these variables, along the boundaries used for data analysis, the sample size within each boundary grouping, and additional notes on how the data was obtained.

Table 2. Environmental variables investigated during the project.

Combine Loss Variable	Variable Boundaries	Number of Combine Test Repetitions (n)	Notes
Ambient Temperature	< 73.4ºF (23.0˚C)	96	Obtained using calibrated monitor.
	≥ 73.4ºF (23.0˚C)	36	
Relative Humidity (RH)	< 45% RH	108	Obtained using calibrated monitor.
	≥ 45% RH	24	
Weather Conditions	Sunny (Low Cloud Cover)	33	Observed by field tester at time of test.
	Partially Cloudy (Partial Cloud Cover)	60	
	Cloudy (High Cloud Cover)	39	
Wind Speed	<9.3 mph (15km/h)	60	Obtained from nearest Environment Canada weather station
	≥ 9.3 mph (15km/h)	72	

Wind Direction	Cross wind, tail wind, head wind, quarterly tail wind, or quarterly head wind	N/A	Based on the direction of travel of the combine and wind direction.
Time of Harvest	Morning: Before 12:00 PM	9	Observed by field tester at time of test.
	Afternoon: 12:00 PM to 5:00 PM	114	
	Evening: After 5:00 PM	9	

Harvest and crop conditions relate to decisions the producer made regarding harvest practice, canola variety, and canola moisture content at time of harvest. Producers determined whether to straight-cut or swath their canola based on the variety of canola seeded and the weather conditions experienced during harvest. Many of the registered producers had initially planned to straight-cut their canola; however, due to weather conditions, they instead made the decision to swath. These decisions by the participating producers caused disparity between the total number of straight-cut tests compared to the total number of swathed tests. It should also be noted that each producer may have had a different method for determining their canola moisture content at time of harvest. **Table 3** lists each of these variables, along the boundaries used for data analysis, the sample size within each boundary grouping, and additional notes on how the data was obtained.

Table 3. Harvest and crop variables investigated during the project.

Combine Loss Variable	**Variable Boundaries**	**Number of Combine Test Repetitions (n)**	**Notes**
Harvest Practice	Straight-Cut	30	Practice determined by producers.
	Swathed	102	
Canola Variety	Shatter Resistant	87	Obtained from producer.
	Non-Shatter Resistant	45	
Grain Moisture Content	Dry: <10.1%	81	Determined and provided by producer; categories based on guidance from Canadian Grain Commission (2016)
	Tough: 10.1% to 12.5%	36	
	Damp: >12.5%	15	

The goal of this project was to observe and collect data from producers during tests that represented their normal operating conditions. As best as possible, the same combine settings were maintained for all three repetitions for each combine. It should be noted that the combine manufacturer and type (conventional, rotary, or hybrid) was not considered when investigating these settings. **Table 4** lists each of these variables, along the boundaries used for data analysis, the sample size within each boundary grouping, and additional notes on how the data was obtained.

Table 4. Equipment variables investigated during the project.

Combine Loss Variable	**Variable Boundaries**	**Number of Combine Test Repetitions (n)**	**Notes**
Combine Ground Speed	< 4.3 mph [6.9 km/h]	123	Obtained from producer.
	≥ 4.3 mph [6.9 km/h]	9	
Grain Feed Rate	< 350.0 bu/hr [7.9 MT/hr]	6	Calculated using yield, cut width, and ground speed.
	≥ 350.0 bu/hr [7.9 MT/hr]	123	

Combine Loss Variable	Variable Boundaries	Number of Combine Test Repetitions (n)	Notes
Fan Speed	< 725 RPM [12 Hz]	63	Obtained from producer.
	≥ 725 RPM [12 Hz]	69	
Rotor/Cylinder Speed	< 660 RPM [11 Hz]	75	Obtained from producer.
	≥ 660 RPM [11 Hz]	48	
Concave Clearance	< 0.87 in [22.10 mm]	72	Obtained from producer.
	≥ 0.87 in [22.10 mm]	54	
Upper Sieve Opening	< 0.47 in [11.94 mm]	42	Obtained from producer.
	≥ 0.47 in [11.94 mm]	81	
Lower Sieve Opening	< 0.20 in (5.08 mm)	90	Obtained from producer.
	≥ 0.20 in (5.08 mm)	42	
Combine Age	1993 to 2005	33	Obtained from producer.
	2006 to 2014	57	
	2015 to 2019	42	
Separator Hours	< 1,000	27	Obtained from producer.

The ground speed and grain feed rate groups were found based on the value at which a significant difference was observed. The grain feed rate was calculated using Equation (2).

$$F_r = Y * S * W_{cut} * b \quad (2)$$

Where:

F_r = Grain feed rate (bu/hr)

Y = Crop yield per unit area of land (bu/ac)

S = Ground speed of the combine (mph)

W_{cut} = Cut Width (ft)

b = Conversion factor: $\frac{5{,}280\ (\frac{ft}{mile})}{43{,}560\ (\frac{ft^2}{ac})}$

For fan speed, rotor/cylinder speed, concave clearance, upper sieve opening, and lower sieve opening, the average observed value was used to set the boundaries for data analysis. The ranges for combine age and separator hours were determined based on the number of samples in each grouping, which sought to obtain an even split between the three.

ANALYSIS

The data analysis for this project was conducted using Minitab 18 Statistical Software. Statistical analysis was used to determine whether differences observed in the data are due to the measured variables or due to random variability. A statistically significant result concludes that the difference exhibited is highly likely to be due to the treatment itself. The loss data was tested for normality; if the data set was determined to not follow a normal distribution, a Box Cox transformation was completed before completing the data analysis. For most of the variables considered, an analyses of variance (ANOVA) was completed to determine the effect of each variable on the observed losses. If a P-value of less than 0.05 was observed, the null hypothesis was rejected with a 95% confidence. If necessary, a Tukey means separation was conducted to determine where the significant difference existed. For all statistical analysis, a 95% confidence level was used.

It is important to note that the majority of the data collected for this project – particularly the combine settings – were obtained from producers and not measured by PAMI field-test personnel; therefore, the accuracy of this data is dependent on the calibration methods used by each producer. Not every producer was able to provide a complete data set, therefore, the number of data points (n) in each data set may vary between variables. For each analysis, the number of data points will be included to show how many of the test repetitions fall into each sample group.

The discharge method for each combine test was chosen by the producer. If the chopper and spreader could be easily disengaged, the producer was encouraged to drop the straw; however, if the chopper and spreader was an aftermarket addition or could not be easily disengaged, the test was completed while spreading the straw. The disadvantage of spreading during loss testing relates to the unpredictability of the distribution of grain throughout the discharged material. When dropping the straw, the majority of the losses will be found within the dropped discharge width. When the discharged material is spread, the drop pan collects only a fraction of the total material discharged, and unless the canola is evenly distributed throughout the discharge width, the collected sample may not be truly representative of the entire density of lost grain. During this project, 44 of the combine tests were completed with dropped material and 6 were completed with spread material. For the data analysis, only the 44 combines that dropped their straw were analyzed. Each of these 44 combine tests involved three repetitions, for a total of 132 data points.

RESULTS AND DISCUSSION

Field testing was conducted between August 22 and October 18, 2019, and although 50 combines were tested, only 44 combines from 29 producers were tested with dropped straw. Since the results obtained from combines with spread straw may not be truly representative of actual losses, only combines that dropped straw were used for the data analysis. The following points describe the breakdown of tests completed on the 44 combines that dropped their straw:

- Province: Saskatchewan: 30; Manitoba: 9; Alberta: 5
- Combine manufacturers: 6; combine models: 35
- Conventional: 2; rotary: 39; hybrid: 3
- Canola seed companies: 7
- Canola varieties: 12; shatter resistant: 6, non-shatter resistant: 6
- Swathed loss tests: 34; straight-cut loss tests: 10
- Dryland loss tests: 39; irrigated land loss tests: 5

Table 5 provides an overview of the general data that was collected for all 44 combines tested. This table provides a high-level overview of the farming operations that are represented within this project.

Table 5. General summary of data collected during project.

Variable	Minimum	Maximum	Average
Measured Losses, bu/ac (kg/ha)	0.2 (11.2)	4.1 (229.8)	1.3 (72.9)
Percent of Total Yield Lost, %	0.4	10.7	2.8
Ambient Temperature, °F (°C)	33.8 (1.0)	84.0 (29.0)	62.6 (17.0)
Relative Humidity (%)	20	71	39
Wind Speed, mph (km/h)	1.9 (3.0)	21.1 (34.0)	16.0 (25.7)
Total Seeded Area, ac (ha)	600 (243)	60,000 (24,281)	7,702 (3,117)
Seeded Canola Area, ac (ha)	180 (73)	14,000 (5,666)	2,617 (1,059)
Seeding Date	24-Apr-19	27-May-19	12-May-19
Canola Seed Rate, lb/ac (kg/ha)	2.5 (2.8)	5.0 (5.6)	4.5 (5.0)
Row Spacing, in (cm)	7.0 (17.8)	15.0 (38.1)	10.3 (26.2)
Swathing Date	9-Aug-19	26-Sep-19	31-Aug-19
Swather Width, ft (m)	24.5 (7.5)	40.0 (12.2)	32.6 (9.9)
Spray Date	19-Aug-19	16-Sep-19	2-Sep-19
Straight-Cut Header Width, ft (m)	30.0 (9.1)	40.0 (12.2)	36.4 (11.1)
Harvest Date	22-Aug-19	18-Oct-19	24-Sep-19
Combine Ground Speed, mph (km/h)	2.0 (3.2)	5.0 (8.0)	3.2 (5.1)
Grain Feed Rate, bu/hr (MT/hr)	265.0 (6.0)	1,170.0 (26.5)	625 (14.2)
Canola Moisture Content (%)	6	17	10
Yield, bu/ac (MT/ha)	30.0 (1.7)	90.0 (5.0)	48.0 (2.7)
Fan speed, RPM [Hz]	500 (8)	1,000 (17)	725 (12)
Rotor/Cylinder Speed, RPM (Hz)	440 (7)	1,100 (18)	660 (11)
Concave Clearance, in (mm)	0.20 (5.08)	2.24 (56.90)	0.87 (22.10)
Upper Sieve Opening, in (mm)	0.24 (6.10)	0.71 (18.0)	0.47 (11.94)
Lower Sieve Opening, in (mm)	0.06 (1.52)	0.51 (12.95)	0.20 (5.08)

Figure 3 shows a histogram for calculated combine losses for all 44 combines that dropped their straw.

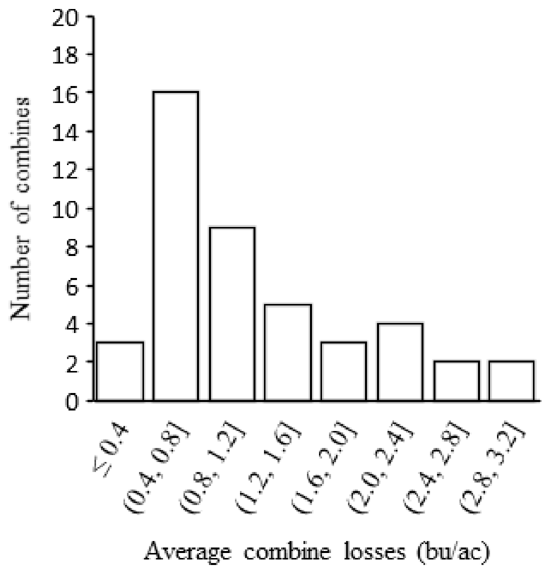

Figure 3. Histogram of average calculated combine losses.

Environmental Effects

The results from this project revealed that ambient temperature, relative humidity, and weather conditions all had a significant impact on canola combine losses. Time of harvest, wind speed, and wind direction did not have a significant impact on combine losses during this project. Time of harvest is closely connected to ambient temperature and relative humidity, and on an individual basis is expected to impact losses, however, since testing for this project spanned from August to October, the optimal harvest time would have differed as the project progressed into late fall. Table 6 shows the variables that were found to have a significant impact on canola combine losses, along with the observed losses. For all other variables investigated (not included in table), no significant differences were observed in the data collected from the 2019 harvest season. While some of these loss differences may not seem large on a practical scale, they still show that environmental conditions need to be monitored and settings optimized as harvest conditions change.

Table 6. Summary of results.

Combine Loss Variables	P-Value	Variable Boundaries	Average Losses (bu/ac)	Number of Combine Test Repetitions (n)	Conclusions
Ambient Temperature	0.001	< 23.0˚C	1.4	96	Significantly lower losses experienced with higher ambient temperature.
		≥ 23.0˚C	0.8	36	
Relative Humidity	0.04	< 45% RH	1.2	108	Significantly lower losses experienced with lower relative humidity.
		≥ 45% RH	1.6	24	
Weather Conditions	0.00003	Sunny	1.0	33	Significantly lower losses experienced with sunny conditions compared to cloudy and partially cloudy compared to cloudy.
		Partially Cloudy	1.1	60	
		Cloudy	1.7	39	

Combine Loss Variables	P-Value	Variable Boundaries	Average Losses (bu/ac)	Number of Combine Test Repetitions (n)	Conclusions
Harvest Practice	0.04	Straight-Cut	1.5	30	More testing required to better understand results.
		Swathed	1.2	102	
Canola Variety	0.01	Shatter Resistant	1.3	87	More testing required to better understand results.
		Non-Shatter Resistant	1.1	45	
Ground Speed	0.0005	< 4.3 mph	1.2	123	Significantly lower losses experienced with slower ground speed. Take note of small sample size for higher ground speed results.
		≥ 4.3 mph	2.2	9	
Grain Feed Rate	0.0007	< 350.0 bu/hr	0.5	6	Significantly lower losses experienced with lower grain feed rate. Take note of small sample size for lower grain feed rate.
		≥ 350.0 bu/hr	1.3	123	
Combine Age	0.0001	1993 to 2005	0.8	33	Regarding losses, a well-set older combine can outperform a poorly set newer combine.
		2006 to 2014	1.5	57	
		2015 to 2019	1.3	42	

Harvest and Crop Effects

The results from this project revealed that harvest practice (swathed, straight-cut) and canola variety (shatter resistant, non-shatter resistant) had a significant impact on canola combine losses, while canola seed moisture content did not. Due to the harvest conditions experienced in fall 2019, not all shatter-resistant varieties were straight-cut. Error! Reference source not found. shows the variables that were found to have a significant impact on canola combine losses, along with the observed losses. For all other variables investigated (not included in table), no significant differences were observed in the data collected from the 2019 harvest season.

Although this data shows that the harvest practice and canola variety both had a significant impact on losses, there are many other variables that may have also impacted the results. For example, the length of time that producers allowed their canola to dry down may vary, and the length of time between spraying desiccant and combining may vary. These variables could easily have impacted the outcome, and additional research is required to fully understand the results.

Equipment Effects

The results from this project revealed that ground speed, grain feed rate, and combine age had a significant impact on canola combine losses. Fan speed, rotor/cylinder speed, concave clearance, upper sieve opening, and lower sieve opening for each combine were recorded, but these factors cannot be analyzed across the entire data set due to the unique characteristics of different combine models. Separator hours did not have a significant impact on combine losses during this project. Error! Reference source not found. shows the variables that were found to have a significant impact on canola combine losses, along with the observed losses. For all other variables investigated (not included in table), no significant differences were observed in the data collected from the 2019 harvest season.

It should be noted that only three combine tests, with nine total repetitions, were completed at ground speeds greater than or equal to 4.3 mph (6.9 km/h), additional testing is required to fully understand the most efficient ground speed to manage losses and efficiency. The grain feed rate sample set also had only two combine tests, with six total repetitions completed for the lower rate grouping. The only detectable significant difference occurred with a grain feed rate boundary of 350.0 bu/hr (7.9 MT/hr). The large sample inequality between the two groups should be noted when taking this data into consideration. It is clear there is a balance between productivity and losses that must be managed.

While on an individual basis, fan speed, rotor/cylinder speed, concave clearance, upper sieve opening, and lower sieve opening can have a very drastic impact on the losses a producer experiences, in a wide data set, covering a large range of harvest conditions, it is apparent that no one fan speed or concave setting can be attributed to losses. The most optimized settings will inevitably differ depending on weather conditions, crop conditions, and combine type.

These results from combine age highlight the importance of optimizing a combine for the conditions, regardless of the age of the equipment. It also implies that operator familiarity with a piece of equipment may be important; for example, a producer who has been using the same combine for many years may have an advantage when adjusting that particular combine in different conditions to minimize losses. Overall, the results obtained by analyzing the equipment variables revealed that adjusting and optimizing a combine for the conditions and crop are essential and are an important method of reducing losses.

CONCLUSION

Grain losses are an inevitable and unfortunate element to every producer's harvest. Understanding the different variables that impact losses can help producers make more informed decisions about the equipment they use and the practices they employ. The objective of this project was to gain a better understanding of canola combine losses in Western Canada and to understand how they contribute to total losses experienced by producers. The following conclusions were identified during this project:

1. The average canola combine losses for the cross-section of producers in this study were 1.3 bu/ac (72.9 kg/ha), representing an average of 2.8% of total yield.
2. Financial losses attributed to combine losses were an average of $12.35/acre ($30.52/ha) across the surveyed producers, based on a canola price of $9.50/bu ($418/MT).
3. Significantly higher combine losses were measured during tests with:
   - Lower ambient temperature (<73.4ºF [< 23.0˚C])
   - Higher relative humidity (>45%)

- Increased cloud cover
- Straight-cut harvest method (compared to swathed)
- Shatter resistant canola varieties (compared to non-shatter resistant varieties)
- Higher combine ground speed (≥ 4.3 mph [6.9 km/h])
- Higher grain feed rate (≥ 350.0 bu/hr [7.9 MT/hr])

4. To decrease combine losses, adjusting and optimizing a combine for the conditions is essential. Environmental and weather conditions should be carefully monitored when harvesting, and combines should be set according to these conditions, regardless of combine age, type, or manufacturer.

It is recommended that more research be conducted in the area of combine losses. Future projects should build on the results from this project and focus on specific variables identified as having the potential to impact combine losses. More research is required to understand why straight-cut and shatter resistant canola tests experienced higher losses, when compared to swathed, and non-shatter resistant varieties, respectively. A narrowed scope with controlled parameters could provide more visibility on certain variables, further enhancing our understanding of which variables truly impact combine losses. The second recommendation includes further research on the two other types of harvest losses: environmental losses and header losses. Investigating all loss types would provide a complete picture of the losses experienced by producers, thereby allowing them to make educated decisions on how to most effectively manage their farming operation.

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