Agriculture Demonstration of Practices and Technologies (ADOPT)

Project Final Report

The final project report should be made available electronically (MS Word). Additional data tables and or graphs may be submitted in spreadsheet format. Due to formatting, printing and distribution requirements, final reports will not be accepted as PDF documents. Completed reports must be returned by email to Evaluation.Coordinator@gov.sk.ca.

Project Title: Resubmission: Effect of Land Rolling Timing on Barley Grain and Silage Yield

Project Number: ADOPT#20220396 (ECRF) and ADOPT#20220397 (WARC)

Producer Group Sponsoring the Project: None

Project Location(s): *Provide the name or number of the rural municipality, nearest town or legal land location if possible. Provide the name of any cooperating landowner(s).* Yorkton and Scott, Saskatchewan

Project start date *(month & year):* 4/1/2023

Project end date *(month & year):* 2/1/2024

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Abstract *(maximum 200 words)*

Detail key elements from the project objectives, methodology, results and conclusions to provide a short concise summary of the project. List extension activities such as field days or workshops and include the number of people who visited the project.

Trials were established near Yorkton and Scott to demonstrate the importance of properly timing land rolling operations as they pertain to barley grain and greenfeed (silage) yield. Rolling early 1-3 days post-seeding was ideal in this study as yields and quality of barley grain and forage were the same as the unrolled check. However, rolling at this stage may cause soil crusting and erosion issues. The literature recommends rolling barley at the 2-3 leaf stage. In this study, rolling at the 2-3 leaf stage caused a significant 15% forage yield decline at the Yorkton site. However, rolling at this stage did not result in a yield or quality loss for barley greenfeed at Scott or for barley grain at either location. Issues were observed when rolling was delayed to the 1st node stage. Grain protein was significantly decreased by 0.35% at Yorkton, and greenfeed yields were significantly reduced by 13 to 22% depending on the location. While no significant reductions in grain yield were observed, Scott had a numerical loss of 8%, which is substantial. Rolling at the 1st node stage should not be done. Rolling barley should occur just after

seeding or at the 2-3 leaf stage. Rolling should not occur when the crop is just emerging as breaking the coleoptile can adversely affect crop development. Rolling in the heat of the day when plants are dry and wilted will reduce the risk of crop damage and spread of leaf disease. The trial was highlighted at the Scott Field Day in July (120+ attending). While this trial was not covered at the ECRF/Suncrest college field day (80 attending). A Youtube video covering the results was recently posted. https://www.yout194ube.com/watch?v=__8UEv46q6E

Project Objectives

Provide a short statement outlining the project objectives. Identify the key concept this project was designed to demonstrate. For example, you might use a statement such as *"This project was intended to demonstrate and compare the benefits of……" or "The objective of this project was to demonstrate the impact of…."*

This project demonstrated the importance of properly timing land rolling operations as they pertain to barley grain and greenfeed (silage) yield.

Project Rationale

Briefly describe why this project is of interest to local producers. Why is it important to have this project? What are the potential beneficial outcomes? What is the perceived need?

Land rolling can ease harvest of barley by pushing rocks down into the earth and reducing the risk of equipment damage. Land rolling can also result in greater greenfeed yields, as the crop may be cut at a lower level. Harry Brook, former crop specialist at the Alberta Ag-info Centre says rolling barley can also increase dry matter yield by increasing "stooling" [1]. However, rolling should occur at the proper stage to reduce soil issues and damage to the crop. Land rolling can pulverize soil, increasing the risk of erosion or creating crusting issues that interfere with crop emergence. Therefore, it is not recommended to land roll before crop emergence. Land rolling when the crop is just emerging is not ideal either as this can potentially interfere with emergence by damaging the coleoptile [2]. Ideally, cereals should be rolled at the 2-3 leaf stage. Early morning rolling should be avoided as turgid plants are more easily broken and dewy mornings can spread leaf disease [1]. Ideally, plants should be rolled in the heat of the day when soils are dry to avoid uprooting plants, and when wilted plants are less likely to be broken. Rolling with an empty roller (no water ballast) is sufficient. Crops should not be rolled within a few days before or after herbicide application as this may weaken plants and accentuate crop injury. In general, rolling after the 3-4 leaf stage is considered late and should be avoided.

Studies from Farming Smarter out of Lethbridge determined that the 1-3 leaf stage for barley would be the optimal rolling window to maximize yield and minimize soil erosion [3]. While rolling late at the 1st node did not significantly reduce yield, it did significantly reduce grain protein and lower TKW. Rolling at this stage also caused noticeable stress to plants and resulted in a 10 cm reduction in plant height.

Land rolling can ease harvest and increase forage production by allowing for a lower cut or by potentially stimulating tiller production. However, land rolling can also reduce grain and forage yield of barley if the timing based on crop staging or environmental conditions is off. This project intends to create discussion around these factors and to demonstrate the importance of properly timing land rolling operations for barley grain and greenfeed operations.

Literature Cited

[1]Roll On, Cropping. Alberta Seed Guide June 28, 2019 https://www.seed.ab.ca/roll-on-cropping/

[2]Rolling wheat and Barely after emergence. The Growing Point. Alberta Barley. https://www.albertawheatbarley.com/the-growing-point/articles-library/rolling-wheat-and-barley-after-emergence?setcommission=alberta-barley

[3]Barley Still on a Roll. Farming smarter. https://www.farmingsmarter.com/barley-rolling-research/

Methodology

Fully describe how the project was set up and run. You should provide enough information so that any reader can understand what you did, and where and when you did it. From that they can determine if your report has any relevance to their own operation. For example, your description should include all relevant items such as 1) the number and size of any field plots, 2) what was seeded, 3) what treatments were applied to the plots, 4) the schedule or timing of any relevant activities such as seeding, treatment application or harvest, and 5) what was measured to evaluate the success of any treatment. If your project dealt with animals, you should be sure to include 1) the number of animals in each trial group, 2) the treatment or procedure applied to each group, and 3) what was measured to evaluate the success of each treatment.

At Yorkton and Scott, two small trials were established at each site as Completely Randomized Block Designs with 4 replicates. All trials were "small-plot" but plot size varied depending on equipment available at each location. Trial 1 was taken for grain (Table 1) and trial 2 was harvested for greenfeed at the soft dough stage (Table 2). Treatment timings for land rolling both trials are the same. Land rolling timings of 1-3 days post-seed, 2-3 leaf stage, and 1st node stage were compared against an unrolled check. To avoid confounding factors, rolling did not occur in early morning or within 3 days of herbicide application. Seeding implements and roller weights varied between locations but rollers were not excessively heavy. Trials were seeded with a 10-foot Seedmaster drill on 12-inch row spacing at Yorkton. At Scott, the drill was a Fabro with a knife opener on 10-inch row spacing. At each site, grain and forage yields were harvested using a plot combine and forage harvester, respectively. All plots within a trial were fertilized based on soil test recommendations for a grain or greenfeed barley. Dates of operations and applied inputs are listed for all trials and locations in Tables 3 and 4.

Table 1. Land Rolling Timings for Barley Harvest for Grain (Trial 1)

#	Timing of Land Rolling	Harvested
1	Untreated-Not Rolled	For grain
2	1-3 days post-seed	For grain
3	2-3 leaf	For grain
4	1st node	For grain

Table 2. Land Rolling Timings for Barley Harvest for Greenfeed at Soft Dough (Trial 2)		
#	**Land Rolling Timing**	**Harvested**
1	Untreated-Not Rolled	For greenfeed
2	1-3 days post-seed	For greenfeed
3	2-3 leaf	For greenfeed
4	1st node	For greenfeed

Table 3. Dates of operations for grain trial locations		
Operation in 2023	**Yorkton**	**Scott**
Pre-seed herbicide (if needed)	None	Glyphosate + AIM May 11
Seed trial	May 12	May 12
Emergence Count	May 31	May 20
In-crop herbicide	Prestige June 5 Axial June 12	Axial Ipak June 2 Butril M June 13
Roll trt 2 (1-3 days post seed)	May 12	May 15
Roll trt 3 (2-3 leaf)	May 25 (2 leaf stage)	May 29
Roll trt 4 (1 st node)	June 9	June 12
In-crop fungicide	Trivapro June 27	None
In-crop Insecticide	None	Decis July 7
Crop Height	June 24	July 27
Lodging (0-9)	August 15	August 14
Grain Yield: Corrected for dockage and to 13.5% seed moisture content	August 15	August 14

Table 4. Dates of operations for greenfeed trial locations

Operation in 2023	Yorkton	Scott
Pre-seed herbicide (if needed)	None	Glyphosate + AIM May 11
Seed trial	May 12	May 12
Emergence Count	May 31	May 20
In-crop herbicide	Prestige June 5 Axial June 12	Axial Ipak June 2 Butril M June 13
Roll trt 2 (1-3 days post seed)	May 12	May 15
Roll trt 3 (2-3 leaf)	May 25 (2 leaf stage)	May 29
Roll trt 4 (1 st node)	June 9	June 12
In-crop fungicide	Trivapro June 27	None
In-crop Insecticide	None	Decis July 7
Crop Height	July 24	July 27
Lodging (0-9)	July 24	August 2
Grain Yield: Corrected for dockage and to 13.5% seed moisture content	July 24	August 2

Results *(you must provide the following information)*

Present and discuss any project results, including any data or measurements taken to evaluate the demonstration. Include things that didn't appear to work. These results are just as important to share. List extension activities such as field days or workshops. List the activity, the date it occurred, and the number of people who attended.

Both Yorkton and Scott were warmer and drier in 2023 than their long-term average temperatures (Tables 5 & 6). However, soil moisture reserves were enough at each site to produce average yields.

Table 5. Mean monthly temperatures amounts along with long-term averages[z] for the 2023 growing season at 2 sites in Saskatchewan.

Location	Year	May	June	July	August	Avg. / Total
		----------*Mean Temperature (°C)* ----------				
Scott	2023	14.9	17.2	17.1	17.4	16.7
	Long-term	***10.8***	***14.8***	***17.3***	***16.3***	***14.8***
Yorkton	2023	14.1	19.4	16.8	17.8	17.0
	Long-term	***10.4***	***15.5***	***17.9***	***17.1***	***15.2***

[z]Yorkton long-term average (1981-2010). Scott long-term average (1985-2014)

Table 6. Precipitation amounts along with long-term averages for the 2023 growing season at 2 sites in Saskatchewan.

Location	Year	May	June	July	August	Avg. / Total
		---------- *Precipitation (mm)* ----------				
Scott	2023	16.6	81.8	29.7	31.7	159.8
	Long-term	***38.9***	***69.7***	***69.4***	***48.7***	***226.7***
Yorkton	2023	20	83.4	17.4	72.6	193.4
	Long-term	***51***	***80***	***78***	***62***	***272***

[z]Yorkton long-term average (1981-2010). Scott long-term average (1985-2014)

Effect of Land Rolling on Barley Height

Early rolling either 1-3 days post-seed or at the 2-3 leaf stage did not affect plant height of the grain or forage barley at either Yorkton or Scott (Table 7). While statistically signification differences were not detected between timings at Yorkton, rolling at the 1st node stage numerically reduced crop height by 2 cm for the grain barley (AAC Synergy) and by 4 cm for the forage barley (CDC Maverick). At Scott, late rolling at the 1st node stage significantly reduced crop height by 6 cm for grain barley and by 5 cm for the forage barley. Lodging did not occur for any treatment at either location as both locations were dry in 2023 (data not presented).

Table 7. Effect of Land Rolling Timing on Barley Height at Yorkton and Scott

Timing of Land Rolling	Crop Height (cm)			
	Harvested for Grain[1]		Harvested for Greenfeed[2]	
	Yorkton	Scott	Yorkton	Scott
Untreated-Not Rolled	65.7	66.4 a	84.8	86.7 a
1-3 days post-seed	65.9	67.5 a	84.0	87.5 a
2-3 leaf	65.3	66.0 a	83.7	89.4 a
1st node	63.8	60.9 b	80.4	81.3 b
Lsd 0.05	NS	3.3	NS	5.0

[1]Malt Barley Variety is AAC Synergy. [2]Forage Barley Variety is CDC Maverick

Effect of Land Rolling on Barley Grain and Forage Yield

Grain yield was not significantly affected by rolling at either Yorkton or Scott (Table 8). However, rolling at the 1st node stage numerically decreased grain yield by 428 kg/ha (8 bu/ac) at Scott, which is substantial. For greenfeed yields, rolling at 2-3 leaf stage and later significantly reduced greenfeed dry yield at Yorkton (Table 8) by 572 kg/ha or 15%. Delaying the rolling to the 1st node stage further reduced the yield loss to 827 kg/ha or 22%. At Scott, greenfeed yield was also significantly reduced by 913 kg/ha or 13% when rolling was delayed to the 1st node stage. Detecting a forage yield reduction at Yorkton when rolling at 2-3 leaf stage was unexpected. This is considered an ideal timing to roll barley and damage at the time of rolling appeared minimal as the ridges left by the Seedmaster© protected the seedling from being rolled flat. Rolling occurred in the same direction as seeding.

Table 8. Effect of Land Rolling Timing on Barley Grain and Forage Yield at Yorkton and Scott

Timing of Land Rolling	**Crop Yield**			
	Harvested for Grain[1] (kg/ha)		**Harvested for Greenfeed[2] (dry kg/ha)**	
	Yorkton	**Scott**	**Yorkton**	**Scott**
Untreated-Not Rolled	4669	5057	3925 a	7027 a
1-3 days post-seed	4676	5068	3630 ab	7225 a
2-3 leaf	4549	4971	3353 bc	7210 a
1st node	4826	4629	3098 c	6114 b
Lsd 0.05	NS	NS	464	379

[1]Malt Barley Variety is AAC Synergy

[2]Forage Barley Variety is CDC Maverick

Effect of Land Rolling on Barley Grain and Forage Quality

Statistical differences between treatments for forage protein, metabolizable energy (ME), total digestible nutrients (TDN) and acid detergent fiber (ADF) were not detected (Tables 9 and 10). For grain protein, statistically significant differences between treatments were only detected at Yorkton. At this location, grain protein was significantly reduced by 0.35% when rolling was delayed to the 1st node stage (Table 9). While it may be a little surprising that protein was reduced without affecting yield, this was the same result "Farming Smarter" out of Lethbridge reported in their barley grain rolling study. When they rolled barley at the 1st node stage, they could not detect a yield impact but found grain protein was reduced by 0.6%. Perhaps the barley in both trials were high on their N response curves. If so, a reduction in N uptake from rolling could affect protein level without causing a noticeable yield loss. This is a reasonable assumption for the Yorkton site, as the grain protein for the unrolled barley was near 12.5%. A protein level this high suggests yield was maximized by applied N. However, the same cannot be said for the Farming Smarter study as unrolled barley grain protein was only 11.5%.

Table 9. Effect of Land Rolling Timing on Barley Grain and Forage Protein at Yorkton and Scott

Timing of Land Rolling	Protein (%)			
	Harvested for Grain[1]		Harvested for Greenfeed[2]	
	Yorkton	Scott	Yorkton	Scott
Untreated-Not Rolled	12.48 a	13.1	8.5	13.1
1-3 days post-seed	12.65 a	13.1	8.2	13.1
2-3 leaf	12.48 a	13.3	8.7	13.3
1st node	12.13 b	13.1	9.0	13.1
Lsd 0.05	0.31	NS	NS	NS

[1]Malt Barley Variety is AAC Synergy

[2]Forage Barley Variety is CDC Maverick

Table 10. Effect of Land Rolling Timing on Digestible Energy (DE), Total Digestible Nutrients (TDN) and Acid Detergent Fiber (ADF) for Forage Barley at Yorkton and Scott

Timing of Land Rolling	Yorkton			Scott		
	DE (Mcal/kg)	TDN (%)	ADF (%)	DE (Mcal/kg)	TDN (%)	ADF (%)
Untreated-Not Rolled	3.2	71.6	25.3	3.3	74.0	23.1
1-3 days post-seed	3.1	71.2	25.7	3.4	72.0	25.0
2-3 leaf	3.1	71.1	25.7	3.1	71.1	25.8
1st node	3.2	71.9	25.0	3.2	73.5	23.5
Lsd 0.05	NS	NS	NS	NS	NS	NS

Extension

The trial was highlighted at the Scott Field Day in July (120+ attending). While this trial was not covered at the

ECRF/Suncrest college field day (80 attending). A Youtube video covering the results was recently posted. https://www.yout194ube.com/watch?v=__8UEv46q6E

Conclusions and Recommendations

Describe what was learned from the demonstration. Highlight any significant conclusions and provide recommendations for the application and adoption of the project results. Be sure that you have presented the relevant data to support your conclusions. Identify any further research, development and communication needs, if applicable.

In this study, barley grown for either grain or forage could be rolled 1-3 days post-seed without affecting yield or quality. Rolling before emergence might even avoid spreading leaf disease. However, the literature warns that rolling at this time could increase soil crusting and erosion issues. Rolling at the recommended 2-3 leaf stage resulted in a significant forage barley yield loss of 15% at Yorkton. However, yield or quality losses from rolling were not detected for forage barley at Scott or for grain yields at either location. There was a greater chance of reducing yield or quality when rolling was delayed to the 1st node stage. Rolling at this stage significantly reduced forage yields by 13 to 22%, depending on the location. There was also a numerical grain yield loss of 8% at Scott and a 0.35% loss in grain protein at Yorkton. Producers who wish to roll their barley can consider 1-3 days post-seed or at the 2-3 leaf stage but should not consider rolling at the 1st node stage. In addition, rolling as the crop is emerging should also be avoided as this may damage coleoptiles and greatly affect crop development. Rolling in the heat of the day is the best practice as plants will be dry and wilted reducing the risk of damaging the crop and spreading leaf disease.

Sustainable Canadian Agricultural Partnership (Sustainable CAP) Performance Indicators

a) List of performance indicators

Sustainable CAP Indicator	Total Number
Scientific publications from this project (List the publications under section b)	
• Published	0
• Accepted for publication	0
HQPs trained during this project	
• Master's students	0
• PhD students	0
• Post docs	0
Knowledge transfer products developed based on this project (presentations, brochures, factsheets, flyers, guides, extension articles, podcasts, videos). List the knowledge transfer products under section (c)	1

[1] Please only include the number of unique knowledge transfer products.

b) List of scientific journal articles published/accepted for publication from this project.

Title	Author(s)	Journal	Date Published or Accepted for Publication	Link (if available)

c) List of knowledge transfer products/activities developed from this project.

Knowledge Transfer Product or Activity	Event/Location Where Knowledge Transfer Was Conducted	Estimated Number of Producers Participated In Knowledge Transfer	Link (if available)
Youtube video	NA	194 views	https://www.yout194ube.com/watch?v=__8UEv46q6E
Public Speaking and Popular Magazine Articles	These events usually occur a couple years or more after the information has been released on Youtube. This information appears in annual reports.		

Acknowledgements

Include actions taken to acknowledge support by the Ministry of Agriculture, the Canadian Agriculture Partnership (for projects approved between 2017 and 2023) and the Sustainable Canadian Agriculture Partnership (for projects approved between 2023 and 2028).

Was acknowledged at the Scott and Yorkton field days when trials were toured in July. Youtube video also contains an acknowledgement slide showing appropriate logos.

Appendices

Identify any changes expected to industry contributions, in-kind support, collaborations or other resources.

Expenditure Statement

You must provide an expenditure statement showing how ADOPT funds were used. Expenditures must be reported using the budget categories shown in Appendix B of your contract. We recommend that you report your expenditures using the Excel spreadsheet we have developed for this purpose (ADOPT Expenditure Statement.xls). That spreadsheet is available from the research branch project manager or the evaluation coordinator.

Note that the ADOPT contract requires you to retain all receipts and financial records relating to the project for at least six years after the project is completed.

Categories	Total approved Budget. Appendix 'B' of Contract.	Actual Spent on Project
Salaries and Benefits		
· Students	$1,800.00	$1,800.00
· Postdoctoral / Research Associates	$0.00	$0.00
· Technical / professional assistants	$3,600.00	$3,600.00
Sample nutrient analysis	$600.00	$600.00
Rental Costs	$0.00	$0.00
Material and Supplies	$1,500.00	$1,500.00
Project Travel		
· Field Work	$0.00	$0.00
· Collaborations / consultations	$0.00	$0.00
Other		
· Field Day	$0.00	$0.00
· Administration	$150.00	$150.00
· Miscellaneous	$80.00	$80.00
TOTAL	**$7,730.00**	**$7,730.00**