Corn Intercropping

2019-2021 D6

Cost, yield, and quality trends in corn intercropping systems

Project Lead:	Manitoba Beef & Forage Initiatives
MBFI Location(s):	Brookdale Farm
Start Date:	2019 Status: Concluded

Background

Using standing corn (*Zea mays*) as part of a winter grazing system has seen increased interest and adoption on the Canadian prairies[1]. Keeping cattle on the land over winter returns nutrients to the land and decreases yardage costs[1]. Beef producers have concerns regarding utilization, wastage, acidosis, and supplementation requirements while corn grazing[1]. Corn provides high yields for grazing but is low in protein and requires protein supplementation for a balanced diet. Intercropping, or seeding a secondary crop between corn rows, is proposed to increase overall yield and provide protein for grazing beef cattle. Intercropping research shows little effect on corn yields[2]. One study concluded that intercropping corn with alfalfa (*Medicago sativa*) increased total biomass compared to both species in a monoculture[3]. Wider row spacing is used by producers to increase the amount of sunlight available to the intercrop[4] and shows increased intercrop yield[3]. An intercrop has the potential to provide enough protein to reduce or eliminate additional protein supplementation while on corn grazing[5]. In Manitoba, McGeough and Lawley found a corn intercrop system can provide sufficient nutrition for beef cows[6].

Manitoba Beef & Forage Initiatives has demonstrated corn intercropping in 2019, 2020, and 2021. In 2019, corn was all seeded at 30” row spacing, and an old disc drill was modified to seed the intercrop in between the rows. Interest in this demonstration led to an expanded trial in 2020, where two corn varieties were compared and a 60” row spacing was added[7]. Discussion around impact of leaf structure led to a leafy, flowery corn variety being included in the 2021 demonstration[8].

This summary report examines trends in yield and forage quality in the three years of the trial and determines cost of production for each year.

Objectives

For each year of corn intercropping:

1. Compare differences in corn yield between each year and treatment
2. Compare differences in between row yield between each year and treatment
3. Compare differences in corn quality between each year and treatment
4. Compare differences in between row quality between each year and treatment
5. Determine cost of production for each year and treatment.

Project Design and Methods

Crop establishment

Three variables are manipulated in this intercropping project: corn variety, row spacing, and presence of an intercrop. By year, the following treatments were applied:

Table 1. Corn intercropping treatments by year.

Year	Corn Variety	Row Spacing (inches)	Between Row Treatment
2019	Mix of varieties	30	No intercrop Intercrop
2020	Pride A4514RR	30	No intercrop Intercrop
		60	No intercrop Intercrop
	Pride AS1037RR	30	No intercrop Intercrop
		60	No intercrop Intercrop
2021	Pioneer 7861 AM	30	No intercrop Intercrop
		60	No intercrop Intercrop
	Pickseed ExPand LF RR	30	No intercrop Intercrop
		60	No intercrop Intercrop

Table 2. Seeding dates and rates by year and corn treatment.

Year	Variety	Row Spacing (inch)	Date Seeded	Seeding rate (plants/acre)
2019	Mix of varieties	30	15-May-19	32,000
2020	Pride A4514RR	30	27-May-20	29,000
2020	Pride A4514RR	60	27-May-20	29,000
2020	Pride AS1037RR	30	27-May-20	32,000
2020	Pride AS1037RR	60	27-May-20	32,000
2021	Pioneer 7861 AM	30	26-May-21	30,000
2021	Pioneer 7861 AM	60	26-May-21	30,000
2021	Pickseed ExPand LF RR	30	26-May-21	32,000
2021	Pickseed ExPand LF RR	60	26-May-21	32,000

In 2019, left over corn seed from other projects was mixed and seeded together. In 2020, a grain corn (Pride A4514RR) and a silage corn (AS1037RR) were chosen for comparison. In 2021, a silage corn (Pioneer 7861AM) was compared to a leafy, flower variety (Pickseed ExPand LF RR). Corn was seeded at recommended rates with an 8-row corn planter. Total area seeded was 5, 7.9, and 7.8 acres for 2019, 2020, and 2021 respectively.

Table 3. Intercrop seed mixes and rates.

Year	Date Seeded	Plant Species	Seeding Rate (lb/ac)
2019	4-Jul-19	Italian Ryegrass	3.5
		Yellow Blossom Sweet Clover	1.5
		Hairy Vetch	4
		Forage Rape	1
2020	12-Jul-20	Winter Triticale	30.03
		Fall Rye	0.41
		Oats	0.63
		Italian Ryegrass	1.24
		Hairy vetch	4.46
		Yellow Blossom Sweet Clover	0.53
		Berseem Clover	0.35
		Chicory	1.18
		Plantain	1.18
		Tillage radish	0.08
		Forage rape	0.35
		Hercules turnip	0.007
		SunHemp	0.05
2021	2-Jul-21	4010 Peas	16.25
		Fababeans	48.75
		Italian Ryegrass	10.83
		Berseem Clover	1.08
		Brassica	1.08

Each year, fertilizer and herbicide were applied based on soil testing and field scouting. All corn varieties chosen were Round-up Ready to allow for in-crop spraying. Prior to seeding the intercrop, the field was sprayed to control weeds between corn rows. Intercrop seeding occurred when the corn was between

Figure 1. Modified disc drill seeding the corn intercrop. Right: 60" row spacing, July 12 2020. Left: 30" row spacing, July 2 2021. Photos by Jordan Dickson.

V5-6 stage (fifth to sixth leaf collar visible) with a modified disc drill. Row spacing of the intercrop seeder is 10 inches. The seeder was modified to fit in between corn rows without damaging existing corn plants (Figure 1). A variety of forage species were mixed and seeded simultaneously to a depth of 0.5-0.75 inches (Table 3). Within each year, the same intercrop seed mix was seeded for all intercrop treatments.

Sampling Methods

In a corn intercropping system, corn provides most of the biomass cattle consume. Entire corn plants were sampled along 17.4 feet of the same row, cut at 5cm above the ground. The entire sample was weighed. Per cent dry matter was taken from the forage quality sample and used to determine dry matter of the corn biomass sample. Dry biomass is used to calculate corn yield.

Between row biomass provides supplemental forage and nutrients to cattle. To the west of each corn sample, one biomass sample of the between row plants was taken from a $0.25m^2$ area. The dry weight of each sample was used to calculate the between row yield.

Three whole corn plants were collected for a quality sample and weighed wet. A shift in sampling method occurred in 2020. In 2019, whole corn plants were shipped to Central Testing Laboratory for analysis. In 2020 and 2021, the three corn plants were chopped in a woodchipper prior to shipping for quality analysis. Per cent dry matter from the forage quality analysis was used to determine the dry weight of the whole biomass sample. Feed analysis is based on the whole corn plant; residue left after grazing indicates cows graze selectively, leaving a higher proportion of stalk than leaf or cobs. Actual feed consumed is likely higher quality than feed analysis would indicate.

Each dried between row forage biomass sample was chopped and sent to Central Testing for forage quality analysis.

Weather

Weather data was collected from the onsite weather station maintained by Manitoba Agriculture and Resource Development[9,10,11].

Table 4. Weather summary. Summaries from the Manitoba Agriculture Crop Report.

		Total Growing Degree Days		Corn Heat Units		Rainfall	
Year	Dates	Value	% of Normal	Value	% of Normal	Value	% of Normal
2019	May 1 – Oct 29	1466	93	2468	95	466	138
2020	May 1 – Oct 18	1595	102	2660	104	385	117
2021	May 1 – Oct 11	1774	114	2888	114	294	91

Grazing Management

Cows were allocated 2-4 days worth of corn. Alfalfa hay was supplemented prior to moving into a new allocation to supplement protein and reduce the risk of acidosis due to high grain consumption on a new feed. Utilization of the intercrop was impacted by snow cover in 2019 and 2021. In 2020, the corn intercrop project was grazed prior to snowfall. For all years, cows were mid-gestation. The nutrition rule

of thumb for cows in mid-gestation is 7% crude protein and energy requirement of 55% Total Digestible Nutrients[10].

Table 5. Grazing summary.

Year	Date On	Date Off	Total Grazing Days	Number of Cows	Animal Unit Days per acre	Number of bales fed
2019	6-Dec-19	6-Jan-20	31	49	380	8
2020	16-Nov-20	4-Dec-20	18	150	375	25
2021	5-Dec-21	29-Dec-21	24	129	459	24

Cost of Production

Input costs are calculated on a per acre basis. Actual input costs are used for seed, fertilizer, and herbicide. User fees for Manitoba Beef & Forage Initiatives are used for field work equipment and labour costs. Total cost of crop establishment can be compared across years and between treatments.

Grazing costs were determined for the entire project by year as grazing was not differentiated by treatment. Grazing costs include crop establishment, number of bales supplemented, tractor and labour for feeding bales, and tractor and labour for fence set-up. A bale feeding system is shown for comparison. Bale price was calculated for each year from the cost of producing bales onsite.

Results

Corn intercropping has occurred for three years (2019, 2020, 2021). While there is variability between years, the combined data point to some trends in corn intercropping. The between row samples provide low yield compared to the corn and is not always available as forage to cattle depending on snow cover. Therefore, forage provided by the intercrop should be considered supplemental and not be depended on to meet the nutritional needs of the grazing cows. To take advantage of the supplemental forage provided by the intercrop, grazing prior to snowfall is recommended.

Yield

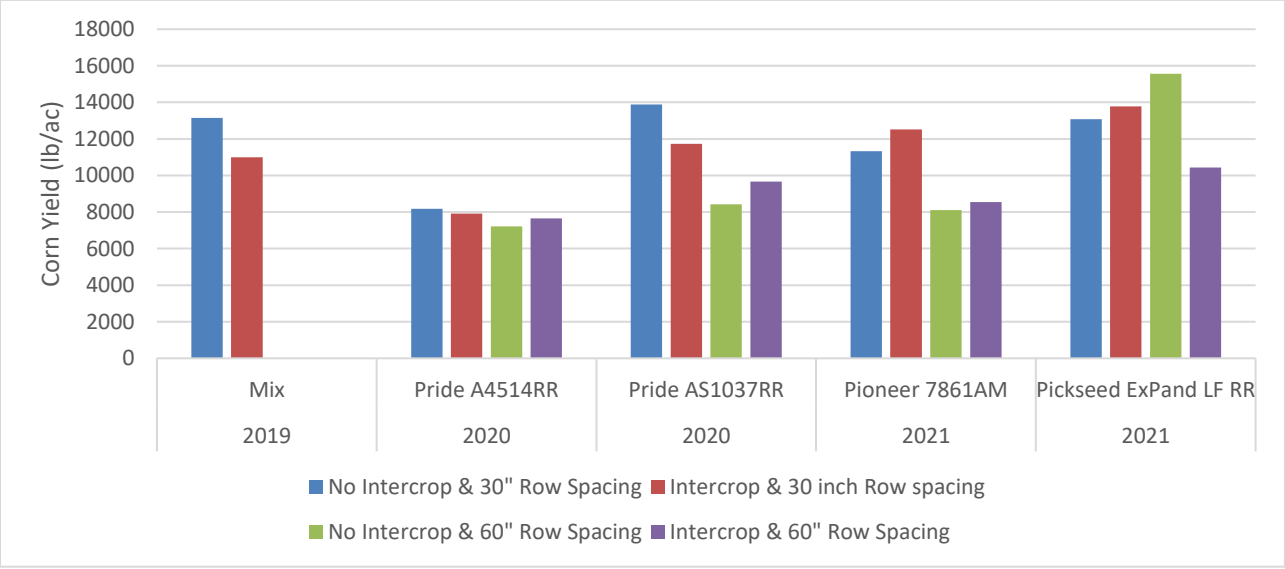

Figure 2. Corn yield by year, corn variety, row spacing, and between row treatment.

Corn yield tends to be higher in the treatments with 30” row spacing (Figure 2). The 60” rows have twice the number of seeds in the same row and competition between plants reduces yield. Corn yield is not consistently negatively impacted by the presence of an intercrop, suggesting that an intercrop can be grown in place of weeds and providing potential extra forage for cattle grazing.

Between row yield is always higher in the 60” rows due to more available sunlight (Figure 3). The intercrop does not always yield more than the weeds in the no intercrop treatment. To improve the impact of seeding an intercrop between corn rows, focus on species that provide higher forage quality for grazing cows or species that provide soil health benefits.

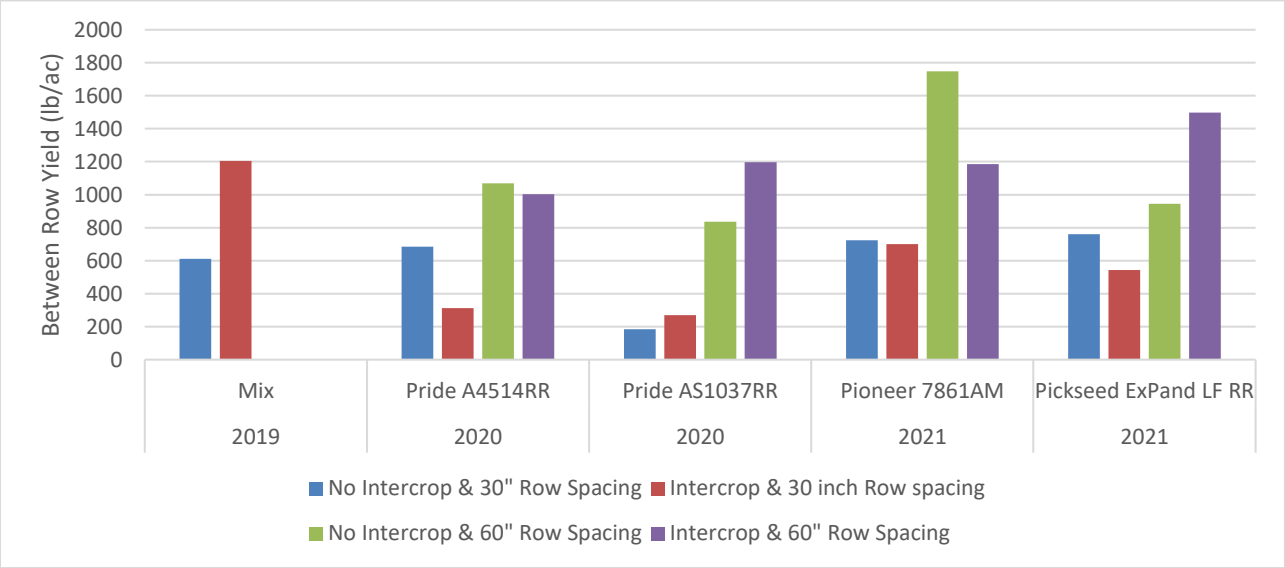

Figure 3. Between row yield by year, corn variety, row spacing, and between row treatment.

Quality

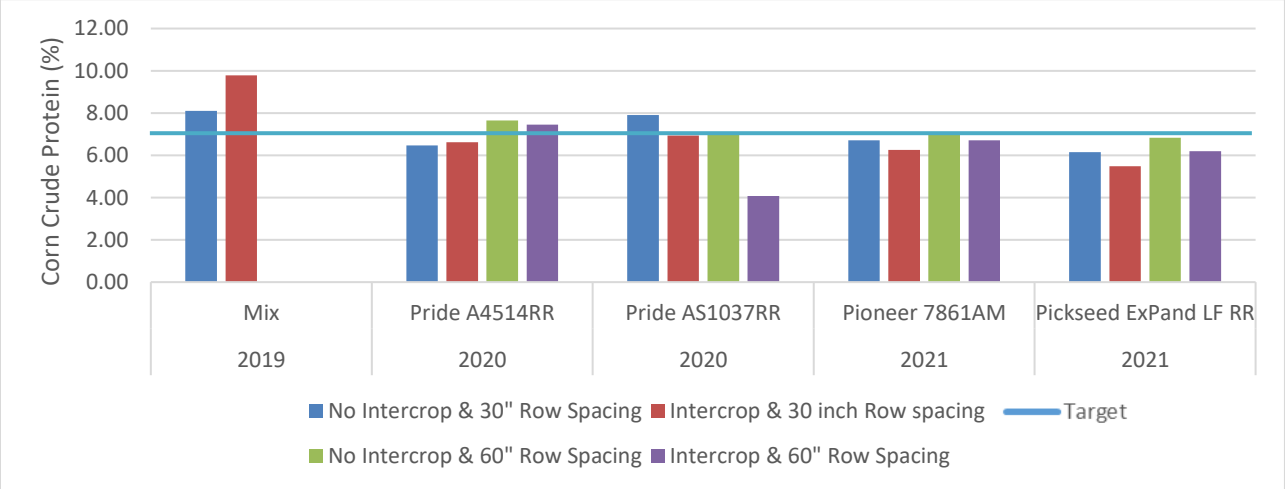

Figure 4. Crude protein of whole corn plants by year, corn variety, row spacing, and between row treatment.

The presence of an intercrop does not impact the crude protein in the neighbouring corn (Figure 4). Crude protein in the corn remains low or borderline compared to the nutritional needs of pregnant beef cows (7% crude protein)[12].

Total digestible nutrients (TDN) of whole corn plants does not follow a consistent pattern for either row spacing or between row treatment (Figure 5). All varieties and treatments provide adequate TDN for a pregnant beef cow (55% TDN)[12].

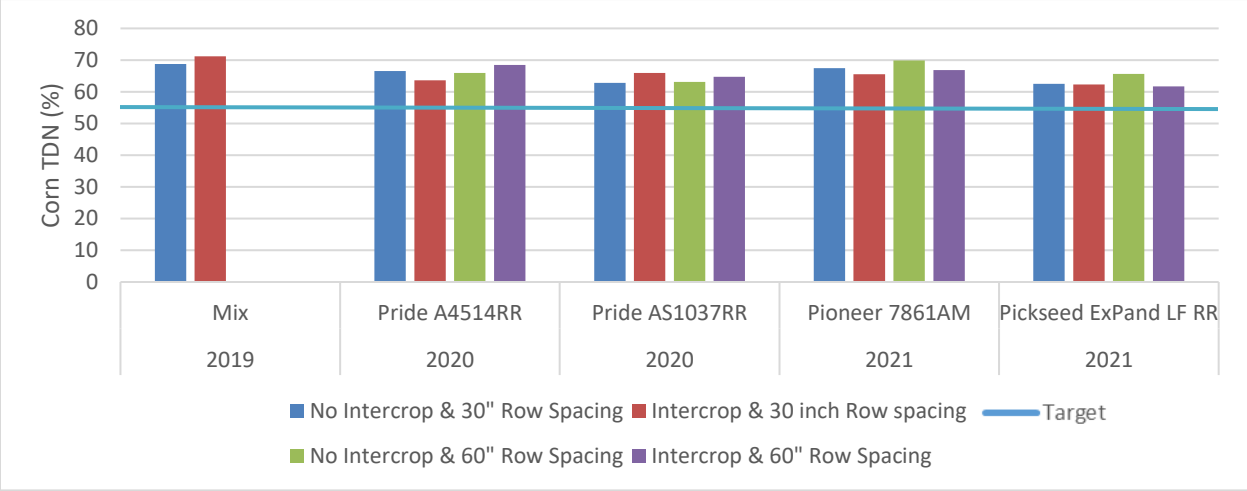

Figure 5. Total Digestible Nutrients of whole plant corn by year, corn variety, row spacing, and between row treatment.

Treatments with an intercrop show higher crude protein than treatments with no intercrop (Figure 6). Legumes were key components of the intercrop blends in each year to increase protein available to cows through the intercrop.

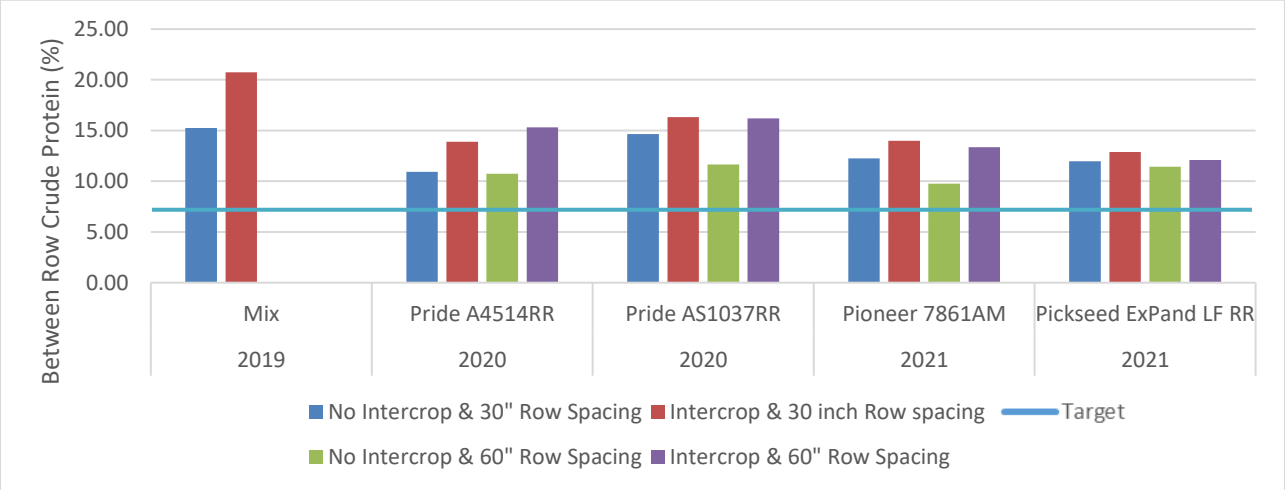

Figure 6. Between row crude protein by year, corn variety, row spacing, and between row treatment.

Total digestible nutrients (TDN) is generally higher between rows where an intercrop was planted (Figure 8). This trend was less consistent in 2021 but remained true in the 30” row spacings. Dry

conditions and poor establishment may have impacted the growth of the intercrop and reduced TDN in the plants.

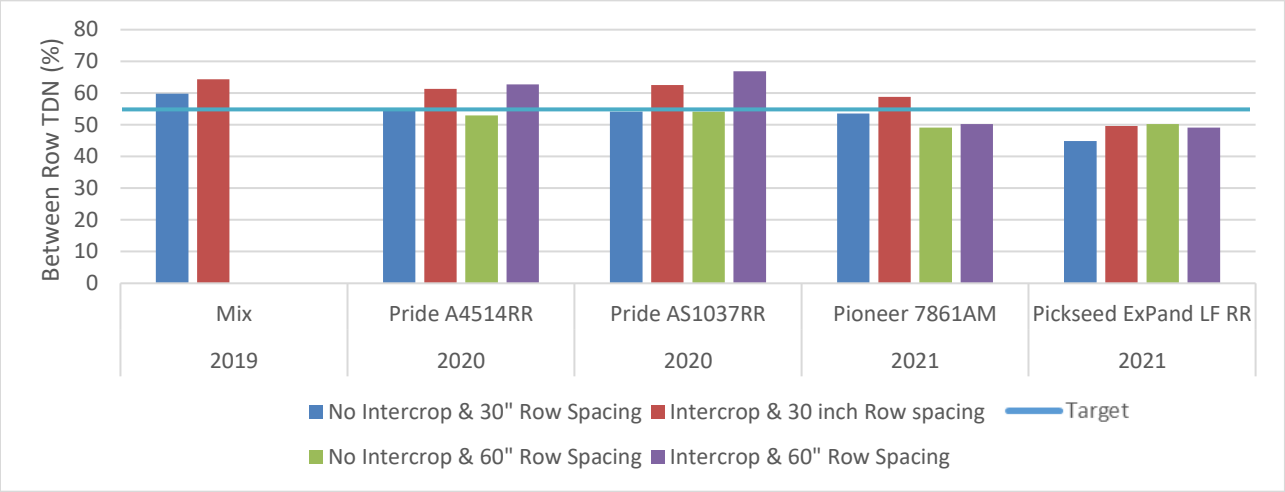

Figure 7. Total Digestible Nutrients of between row forage by year, corn variety, row spacing, and between row treatment.

Cost of Production

Cost of establishing the crop each year varies due to input prices and input rates. The addition of the intercrop increases cost per acre regardless of other treatments as there is a second seeding cost and second input cost (Figure 8). Costs are further broken down in the Appendix (Table 8).

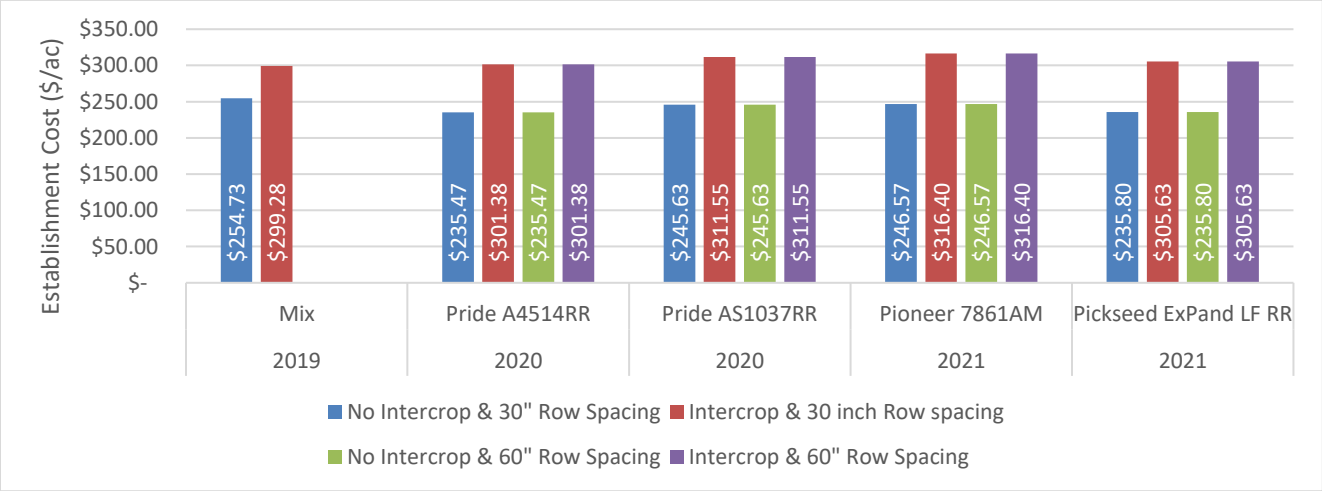

Figure 8. Establishment costs ($/ac) by year, corn variety, row spacing, and between row treatment.

Treatments were not fed separately; numbers are calculated for the entire system. Input costs and yield impact the cost of feeding cattle on any system. Cost of making a bale is calculated yearly from the hay produced onsite. In each year, grazing the corn intercrop cost less per cow per day than feeding hay (Table 6).

Equivalent costs for feeding bales to the same group of cows over the same period was calculated as a comparison to the corn grazing costs. Bales were allocated at 2.5% of the cow's body weight and estimated at 10% bale wastage. The same bale price was used for both systems.

Table 6. Grazing costs on corn intercrop, by year.

	2019	**2020**	**2021**
Average yield (lb/ac)	12980	9934	12684
Total acres planted	5	7.9	7.8
Total cost of crop ($)	$1396.79	$2228.71	$2238.53
Bales fed	8	25	24
Bale cost*	$38.58	$25.73	$33.32
Tractor & labour feeding costs	$434.72	$1289.86	$1165.84
Tractor & labour fencing costs	$501.79	$609.97	$405.08
Total cost for entire feeding period	$2641.91	$4771.69	$4609.13
Number of cows	49	150	129
Number of days	31	18	24
Cost / Cow/ Day	$1.74	$1.77	$1.49
Equivalent bale feeding for the same group of cows over the same period			
Number of bales required	38	76	75
Cost / Cow / Day	$2.11	$2.12	$2.01

**Bale cost determined from cost of making bales the previous summer*

Project Findings

Corn intercropping potentially provides more forage for grazing cattle during fall and early winter. Corn yield is not impacted by the presence of an intercrop, however, 30" row spacing consistently out-yields the 60" row spacing.

Between row yield is highest in the 60" row spacing treatments due to increased available sunlight. As the intercrop treatments do not consistently outyield the no intercrop treatments (weeds), choosing species to meet other goals is recommended. Species with high forage quality or intended to improve soil health will benefit the entire system.

Corn consistently shows low crude protein and high energy. The intercrop generally has higher quality than between row weeds. Further work is required to determine if the intercrop provides sufficient protein to meet the needs of a beef cow without supplemental hay.

Availability of both corn and intercrop can be dramatically impacted by snow and wind. Grazing prior to snowfall is recommended to improve the intake of the intercrop by cattle.

The cost of a corn intercropping production system varies with yield and inputs. For each year of this demonstration, the corn intercropping cost less per cow per day than an equivalent bale feeding system.

Acknowledgements

Thank you to Pioneer, DLF Pickseed, Pride Seeds, Imperial Seeds, Zehgers, Jefferies, and Secan for their generous contribution of corn and intercrop seed.

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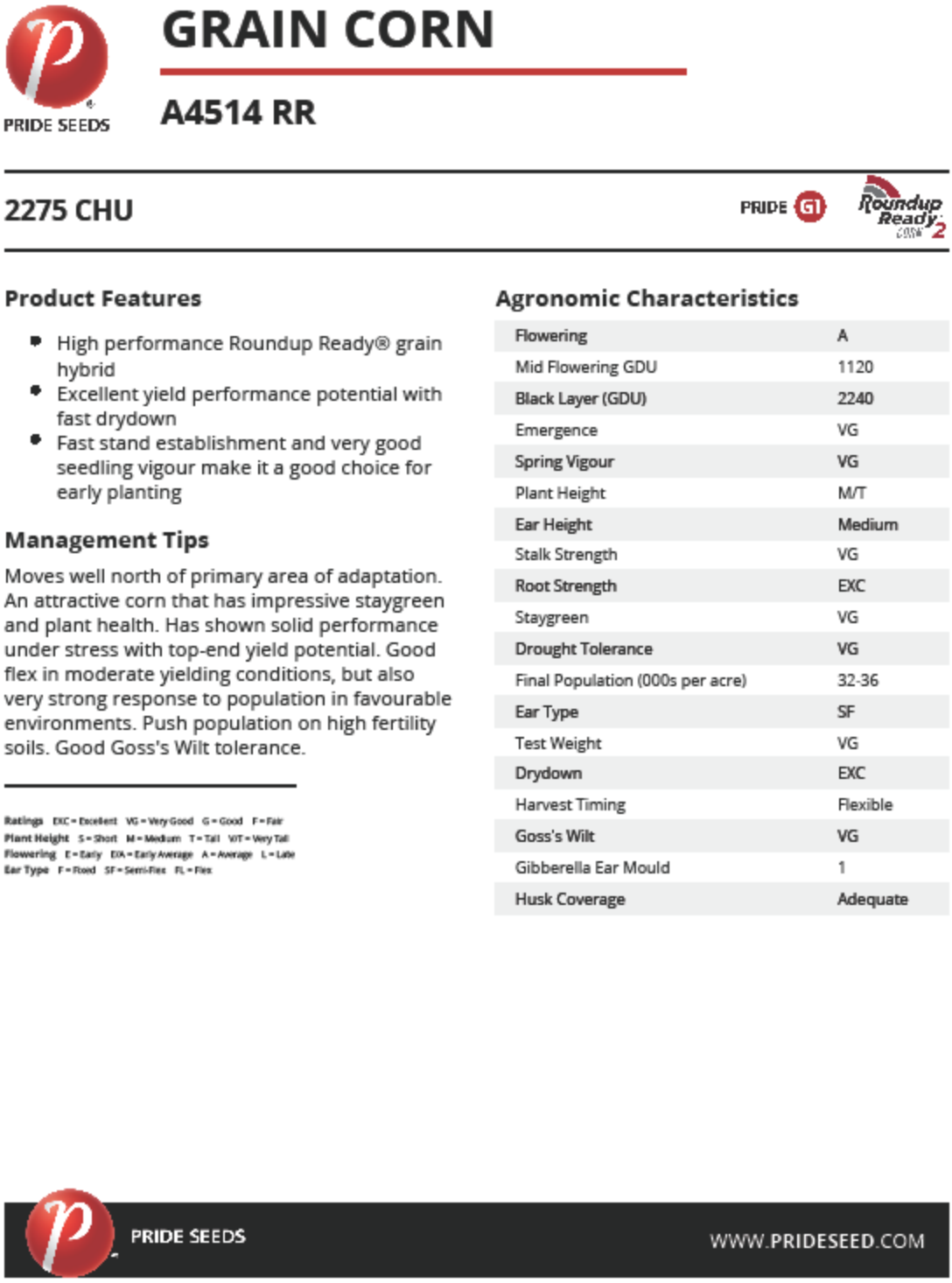
Figures



PRIDE SEEDS

GRAIN CORN

A4514 RR

2275 CHU

PRIDE G1 Roundup Ready 2

Product Features

- High performance Roundup Ready® grain hybrid
- Excellent yield performance potential with fast drydown
- Fast stand establishment and very good seedling vigour make it a good choice for early planting

Management Tips

Moves well north of primary area of adaptation. An attractive corn that has impressive staygreen and plant health. Has shown solid performance under stress with top-end yield potential. Good flex in moderate yielding conditions, but also very strong response to population in favourable environments. Push population on high fertility soils. Good Goss's Wilt tolerance.

Ratings EXC = Excellent VG = Very Good G = Good F = Fair
Plant Height S = Short M = Medium T = Tall VT = Very Tall
Flowering E = Early EA = Early Average A = Average L = Late
Ear Type F = Fixed SF = Semi-Flex FL = Flex

Agronomic Characteristics

Flowering	A
Mid Flowering GDU	1120
Black Layer (GDU)	2240
Emergence	VG
Spring Vigour	VG
Plant Height	M/T
Ear Height	Medium
Stalk Strength	VG
Root Strength	EXC
Staygreen	VG
Drought Tolerance	VG
Final Population (000s per acre)	32-36
Ear Type	SF
Test Weight	VG
Drydown	EXC
Harvest Timing	Flexible
Goss's Wilt	VG
Gibberella Ear Mould	1
Husk Coverage	Adequate

PRIDE SEEDS WWW.PRIDESEED.COM

Figure 9. Technical sheet for Pride Seeds corn A4514RR, used for corn intercropping in 2020.

CANTERRA SEEDS

Seed the Difference.™

Technical Bulletin

AS1037RR EDF

Effective Digestible Fibre (EDF) Silage Specific Corn

New introductory choice for high moisture corn or silage feed

- Tall plant with consistent ears that produces flint kernels on white cob
- Excellent silage characteristics, yield and energy content
- Reliable and consistent feed quality at ideal moisture content

OVERALL CHARACTERISTICS	
Silage CHU	2250-2450
RM Range	78-81
Silage Yield	Excellent
Plant Height	Tall
Milk/Tonne	Excellent
Milk/Acre	Excellent
% Total Digestible Nutrients	Excellent
% Starch	Very Good
% Crude Protein	Very Good
Flowering	Average
Emergence	Very Good
Spring Vigour	Excellent
Stalk Strength	Excellent
Root Strength	Excellent
Staygreen	Excellent
Drought Tolerance	Excellent
Ear Type	Fixed
Milk or Beef Tonne	Excellent

Roundup Ready 2

201 1475 Chevrier Boulevard, Winnipeg, Manitoba R3T 1Y7
T 204.989.9750 F 204.487.7682

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Figure 20. Technical sheet for Pride Seeds corn AS1037RR, used for corn intercropping in 2020.

PIONEER

Created: Mar 21 2022

Corn Grain Seed Guide

Brandon, Manitoba (R7A7R3)

Choose Products	Product Name	Heat Units	Technology Segment	Hybrid Family	Market Segment	CRM	Grain Drydown	Stalk Strength	Root Strength	Staygreen	Drought Tolerance	Test Weight	Stress Emergence	Plant Height	Mid-Season Brittle Stalk	Northern Leaf Blight	Head Smut	Anthracnose Stalk Rot	Gibberella Ear Rot
✔	P7861AM	2250	AM, LL, RR2	P7861	YFC	78	3	7	6	5	7	5	4	6	5	6	-	-	-

1 products in this guide

See subsequent pages for complete definitions and disclaimers related to the product descriptions and ratings. All scores of integrated refuge products are based upon the major component.Pioneer® brand products are provided subject to the terms and conditions of purchase which are part of the labeling and purchase documents.? ® Trademarks of Corteva Agriscience and its affiliated companies. ©2022 Corteva Agriscience.

Figure 31. Technical sheet for Pioneer corn 7861AM, used for corn intercropping in 2021.

2022 Technical Data

DLF PICKSEED

PS ExPand LF RR

2725 Heat Units
90 Relative Maturity

KEY FEATURES

- Floury Leafy Corn Silage which provides more rumen available starch
- Roundup Ready® Corn 2 technology
- Very good emergence and early season development
- High dry matter yield
- White cob provides very high feedout and no cob disks

Roundup Ready CORN 2

HYBRID CHARACTERISTICS

Emergence:	Very Good
Seeding Vigour:	Very Good
Flowering:	Medium
Silk:	Medium
Stalk Strength:	Good
Root Strength:	Very Good
Stay Green:	Good
Husk Cover:	Very Good
Stress Tolerence:	Good
Plant Height:	Very Tall
Grain Quality:	Very Good
Grain Type:	Dent
Tip Fill:	Very Good
Test Weight:	Good
Shank Length:	Short
Kernel Rows:	14-16
Maturity:	Medium
Ear Height:	Medium
Ear Flex:	Flex
Dry Down:	Slow
Soil Type:	All
Seeding Rate:	26000-28000
Cob Colour:	White

COMPANION HYBRIDS

Early - PS ExSeed LF RR (2550 CHU):
Similar – PS ExTreme RR (2675 CHU):
Similar - PS ExPert LF RR (2800 CHU):

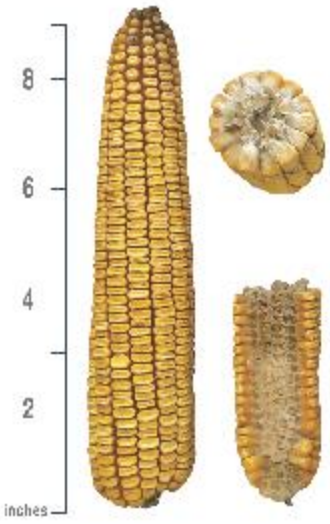

Figure 42. Technical sheet for DLF Pickseed corn PS ExPand LF RR, used for corn intercropping in 2021.

Table 7. Yield and quality of corn and between row samples by year, corn variety, and treatment.

			Corn			Between Row		
Year	Corn Variety	Treatment	Yield (lb/ac)	Crude Protein (%)	Total Digestible Nutrients (%)	Yield (lb/ac)	Crude Protein (%)	Total Digestible Nutrients (%)
2019	Mix of varieties	No Intercrop & 30 inch row spacing	13,150	8.1	68.7	611	15.3	59.8
		Intercrop & 30 inch row spacing	10,994	9.8	71.2	1205	20.8	64.3
2020	Pride A4514RR	No Intercrop & 30 inch row spacing	8,171	6.5	66.6	684	10.9	54.7
		Intercrop & 30 inch row spacing	7,909	6.6	63.6	312	13.9	61.3
		No Intercrop & 60 inch row spacing	7,224	7.7	66.0	1,068	10.7	53.0
		Intercrop & 60 inch row spacing	7,659	7.5	68.4	1,002	15.3	62.8
2020	Pride AS1037RR	No Intercrop & 30 inch row spacing	13,880	7.9	62.8	185	14.6	54.2
		Intercrop & 30 inch row spacing	11,738	6.9	66.0	270	16.3	62.6
		No Intercrop & 60 inch row spacing	8,423	7.0	63.1	835	11.6	54.2
		Intercrop & 60 inch row spacing	9,665	4.1	64.7	1,196	16.2	66.9
2021	Pioneer 7861 AM	No Intercrop & 30 inch row spacing	11,336	6.7	67.4	724	12.2	53.5
		Intercrop & 30 inch row spacing	12,514	6.3	65.5	700	14.0	58.8
		No Intercrop & 60 inch row spacing	8,114	7.1	69.8	1,748	9.8	49.13
		Intercrop & 60 inch row spacing	8,542	6.7	66.8	1,186	13.4	50.3
2021	Pickseed ExPand LF RR	No Intercrop & 30 inch row spacing	13,081	6.2	62.5	760	12.0	44.8
		Intercrop & 30 inch row spacing	13,779	5.5	62.3	542	12.9	49.7
		No Intercrop & 60 inch row spacing	15,567	6.8	65.7	944	11.5	50.2
		Intercrop & 60 inch row spacing	10,436	6.2	61.7	1,497	12.1	49.2

Table 8. Crop establishment costs ($/acre).

Year	Corn Variety	Treatment	Tillage	Fertilizer	Herbicide	Corn Seeding	Intercrop Seeding	**Total Cost**
2019	Mix of varieties	No Intercrop & 30 inch row spacing	18.50	90.50	25.73	120.00	0	**254.73**
		Intercrop & 30 inch row spacing	18.50	90.50	25.73	120.00	44.55	**299.28**
2020	Pride A4514RR	No Intercrop & 30 inch row spacing	18.50	56.96	43.78	116.24	0	**235.47**
		Intercrop & 30 inch row spacing	18.50	56.96	43.78	116.24	44.83	**280.30**
		No Intercrop & 60 inch row spacing	18.50	56.96	43.78	116.24	0	**235.47**
		Intercrop & 60 inch row spacing	18.50	56.96	43.78	116.24	44.83	**280.30**
2020	Pride AS1037RR	No Intercrop & 30 inch row spacing	18.50	56.96	43.78	126.40	0	**245.63**
		Intercrop & 30 inch row spacing	18.50	56.96	43.78	126.40	44.83	**290.47**
		No Intercrop & 60 inch row spacing	18.50	56.96	43.78	126.40	0	**245.63**
		Intercrop & 60 inch row spacing	18.50	56.96	43.78	126.40	44.83	**290.47**
2021	Pioneer 7861 AM	No Intercrop & 30 inch row spacing	0	64.31	49.89	132.38	0	**246.57**
		Intercrop & 30 inch row spacing	0	64.31	49.89	132.38	69.83	**316.40**
		No Intercrop & 60 inch row spacing	0	64.31	49.89	132.38	0	**246.57**
		Intercrop & 60 inch row spacing	0	64.31	49.89	132.38	69.83	**316.40**
2021	Pickseed ExPand LF RR	No Intercrop & 30 inch row spacing	0	64.31	49.89	121.60	0	**235.80**
		Intercrop & 30 inch row spacing	0	64.31	49.89	121.60	69.83	**305.63**
		No Intercrop & 60 inch row spacing	0	64.31	49.89	121.60	0	**235.80**
		Intercrop & 60 inch row spacing	0	64.31	49.89	121.60	69.83	**305.63**