Comparing Forage Yield, Quality & Cost of Production Between Corn Silage, Annual Ryegrass and A Summer "Cocktail" Mix*

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Objective:

1. Compare forage yield and quality between a modern (Enogen) corn silage (CS) hybrid, multi-cut annual ryegrass (ARG) and a "cocktail" (MIX) of BMR sorghum/sudangrass, Italian ryegrass and three clovers (red, crimson, berseem) after winter rye (WR) as forage.
2. Conduct a cost analysis to compare the economics of each cropping system.
3. Disseminate results and analysis comparing cropping systems to members of the Waupaca County Forage Council, the Natural Resource Conservation Service (NRCS) Upper Fox/Wolf Demonstration Network, as well as UW-Madison Extension faculty and staff.

Background: Following multiple years of wide-spread alfalfa winterkill, low commodity grain prices, wet fields limiting manure spreading options, better understanding and appreciation for better soil health, as well as the chance to diversify forage feed inventories for late-lactation, dry cow and dairy replacement heifers, interest in alternative forage crops and cropping systems has grown significantly. However, limited agronomic and economic data exists to evaluate options, especially when growing a blend of warm and cool-season forage species together in the same field at the same time.

Previous Research: Corn silage (CS) and annual ryegrass (ARG) are widely used forage crops, but little is known about a new "cocktail" mix of BMR sorghum/sudangrass, Italian ryegrass with three species of clover (MIX) mixed and grown together. Can this MIX, planted after a fall cover crop is harvested in the spring as forage, compete agronomical and economical while also providing more manure spreading options during the growing season (vs. CS) and better soil conservation/health as a multi-species cover crop (vs. ARG)?

Design, Methods and Limitations: Two adjacent 10 acre fields at Dan & Ruth Boerst farm near Manawa, WI were used for this study. Both fields (Field "E" east/west) are well-drained fine sandy loam Symco/Hortonville soils with 2.6% organic matter, 6.9 pH, optimum phosphorus (21 ppm) and excessively high potassium (189 ppm). Actual product prices and application costs used for cash expenses paid by the farm. WI custom rates used for all planting and harvesting field machinery operations.

WR seeded Oct 2018 using a no-till drill (2 bu/acre) in field "E" east following corn silage harvest and manure application (4800 gal at $53/acre); harvested as a forage cover crop June 3, 2019. East third of Field "E" east planted no-till back into CS on June 7 at 33,000 kernels/ acre with a modern silage hybrid (109 day Enogen). Volunteer WR regrowth sprayed with glyphosate within a week of planting the corn silage. Dry urea fertilizer (150 lbs. or 70 units N/acre) broadcast June 27 with the corn silage harvested Oct 28, two weeks after killing frost (61% whole-plant moisture).

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The MIX (36 lbs./acre with 21lbs BMR sorghum/sudangrass; 9 lbs. Italian ryegrass; 2 lbs. each Red, Crimson and Berseem Clover) was planted with a no-till drill on June 19 across the remainder of the field ("E" east). Each cutting was harvested and sampled at three locations in the field (first cut July 31 six inches above the ground, mostly sorghum/sudangrass 30-36" tall with 10% voluntary WR; second cut Sept 6 three inches above the ground after Italian ryegrass began heading; third crop Oct 17 just prior to a killing frost, two inches above the ground, mostly vegetative Italian ryegrass with some clover. Dry urea fertilizer (150 lbs. or 70 units N/acre) spread June 27.

ARG was no-till drilled April 21 into WR on the western third of field "E" east. ARG was harvested 3-4" high and sampled five times (June 25; July15; Aug 12; Sep 6; Oct 17) from late vegetative to early heading, usually 20-24" tall (except last cutting, Oct 17 all vegetative 10-12" tall). Dry urea fertilizer (150 lbs. or 70 units N/acre) was applied two days after first cutting (June 27) with liquid manure (8900 gal/acre) surface applied July 17, two days after the second cutting.

Multiple (3) small plot harvests were used to collect WR (June 5), ARG (June 25, Sep 6) and MIX (Sep 6) forage yield and quality data. Other cuttings (ARG July15, Aug 12, Oct17 and MIX July 31 & Oct 17) collected from the windrow immediately behind the farm self-propelled haybine at three locations in the field. Each sample area was less than 400 ft^2 and replicated three times for each cutting with a bias toward more uniform areas in the field (cool, wet soil caused varied growth across the field).

Fresh forage quality samples were also collected from each yield sample, frozen and delivered to the UW Soil and Forage Analysis Laboratory (SFAL) for wet chemistry analysis. CS forage yield was measured at harvest (10/28) by hand cutting a 8'8" long single row ($1/2000^{th}$ of an acre) and weighing fresh whole corn plants from three locations in the field. CS forage quality samples were randomly taken from three dump truck/wagons immediately after unloading at the bunker, then frozen and delivered to SFAL for wet chemistry analysis.

Results, Summary and Implications: Table 1 shows yield and forage quality information (alfalfa "ALF" added for reference using WI Alfalfa Yield & Persistency Project 2007-18 data).

Table 1. "Cocktail Mix" Field Demo Forage Yield & Quality. 2019 Boerst Farm, Manawa WI.

Forage Crop	TDM / Acre	CP	NDF	NDFD 30hr	RFQ	LBS Milk / TDM*	LBS Milk / Acre*
Winter Rye (WR)	0.7	12	48	71	130	3300	2,600
Corn Silage (CS)	7.3	7	43	61	~	3600	25,900
"Cocktail" (MIX)	3.9	16	45	69	180	3000	11,200
Annual Ryegrass (ARG)	4.1	16	50	62	150	2800	11,200
Alfalfa (ALF)**	4.4	22	39	48	170	2900	12,800

** Values rounded to the nearest "100" using MILK 2006 (CS) and MILK 2016*

*** Estimates using WI Alfalfa Yield & Persistency Project 2007-2018 data.*

Similar forage yield (3.9 - 4.4 TDM/acre) and quality (2800-3000 LBS Milk/TDM) were observed between ARG, MIX and ALF. Winter rye also provided good quality forage (3800 LBS Milk/acre), but with a much lower yield (0.7 TDM/acre) from only a single cutting. Combining WR (LBS Milk/acre) with each treatment, both the MIX and ARG are similar in yield to alfalfa, but only about half the yield of corn silage.

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The analysis in Table 2 also shows an economic advantage for corn silage following winter rye with production cost per unit of output ($/TDM) significantly lower than the cocktail mix, annual ryegrass or alfalfa. Substituting the MIX or ARG forage for a blend of CS or ALF in a diet for early or mid-lactation dairy cows may not result in major changes to the diet supplements due to their high digestibility and moderate protein levels.

Table 2. "Cocktail Mix" Field Demo Forage Yield & Quality. 2019 Boerst Farm, Manawa WI.

	Winter Rye & Corn Silage	Winter Rye & Cocktail Mix	Winter Rye & Annual Rye	Alfalfa
Forage Crop Yield & Expense	**8.0** (0.7 + 7.3)	**4.6** (0.7 + 3.9)	**4.8** (0.7 + 4.1)	**4.4**
Seed $/Acre [2]	$123 ($30 + $93)	$83 ($30 + $53)	$44 ($30 + $14)	$15
N $/Acre ($0.46/ LB) [3]	$74 (urea 2x)	$32 (urea 1x)	$32 (urea 1x)	$0
K_2O $/Acre ($0.32/ LB) [3]	$0	$0	$0	$43 (Half K_2O Removal)
Fertilizer Spreading $/Acre [4]	$67 (manure 1x urea 2x)	$60 (manure 1x urea 1x)	$150 (urea 1x manure 2x)	$113 ($K_2O$ 1x manure 2x)
Herbicide & Spraying $/Acre [5]	$12 (glyphosate 1x)	$0	$0	$4 (glyphosate 1x/4)
Soil Testing & Scouting $/Acre [6]	$17	$17	$17	$17
Operating Interest or Opportunity Cost $/Acre [7]	$23	$15	$19	$16
Planting & Tillage $/Acre [8]	$40 (planting 2x)	$40 (planting 2x)	$40 (planting 2x)	$5 (planting 1x/4)
Harvest $/Acre [9]	$215 ($70 + $145)	$280 ($70 x 4)	$420 ($70 x 6)	$280 ($70 x 4)
Future Nitrogen credits[10]	$0	- $18	- $18	- $20
Cost $/Acre **$/TDM**	$570 / Acre **$70 / TDM**	$510 / Acre **$110 / TDM**	$704 / Acre **$147 / TDM**	$476 / Acre **$108 / TDM**

(See field history & footnotes next page)

<u>Summary / Implications</u>:

Although 2019 provided less than ideal field conditions with cool, wet weather limiting opportunities for manure application before, during and after the growing season, results from this field demonstration suggest the "cocktail" MIX and annual ryegrass ARG may be best suited as an alternative forage crop on farms trying to…

- Improve soil health
- Replace dead alfalfa fields
- Expand manure spreading options
- Target forage inventories for replacement dairy heifers, dry cows, late lactation milk cows and/or beef cattle.

Cocktail Mix Forage or Annual Ryegrass in Simulated Lactating Cow Diets (2001 Dairy NRC)
by Matt Akins, UW-Madison Extension Dairy Specialist

Diet inclusion, % of DM	BASE DIET	MIX DIET	ARG DIET
Corn silage	35	25	25
Alfalfa silage	25	15	15
Cocktail mix	.	20	.
Annual rye	.	.	20
HMC	24	25	25
SBM/expeller SBM	9	8	8
Other ingr.	7	7	7
Diet nutrients			
CP, % DM	16.3	16.7	16.6
NDF, % DM	31.2	32.0	32.9
Nel, Mcal/lb DM	0.70	0.70	0.71
Estimated milk, lb/day	93	93	93
Cost, $/day	4.00	4.12	4.35

-1600 lb 3rd lactation cow; 100 DIM; 3.8% fat; 3.1% protein; estimated 59.7 lb DMI
-Replaced equal parts corn silage and alfalfa silage with cocktail mix or annual ryegrass

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Table 2. Footnotes

[1] CS harvested Oct 28; winter rye harvested June 3; cocktail mix harvested July 31, Sept 6 and Oct 17; annual rye harvested June 25, July 15; Aug 12; Sept 6 and Oct 17 (each forage cutting replicated and sampled three times); Alfalfa average annual yield from 103 fields in 16 WI counties (WI Extension Alfalfa Yield & Persistency project 2007-2018).

[2] No-till corn silage (33,000 kernels/acre, $225/bag Enogen seed) June 7; cocktail mix (35#/a) no-tilled June 19 (21 lbs BMR Sorguhm/Sudangrass; 9 lbs Italian Rye; 2 lbs each Red, Crimson and Berseem clover or 35#/a total); Annual Rye no-tilled April 21 (15 lbs/acre) into Winter Rye.

[3] Urea (150 lbs/acre or 70 units @$0.46/unit) broadcast June 27 to corn silage, cocktail mix and annual ryegrass and again to corn silage on July 20. Alfalfa potash application for one-half K_2O removal (133 units @$0.32/unit) with the other half in two liquid manure applications.

[4] Liquid manure surface applied Oct 2018 prior to planting winter rye (4900 gal at $53/acre); liquid manure also applied July 17 after annual ryegrass second cut (8900 gal at $90/acre), and after second crop and third (or fourth) crop alfalfa (4800 gal at $53/acre). All dry fertilizer applications $7/acre.

[5] Glyphosate applied once post-emergence to corn silage (includes product and application); also, once prior to seeding alfalfa (annualized over four years).

[6] Routine soil testing and crop consulting fee.

[7] Operating interest (1% for 8 months) or opportunity cost for direct inputs.

[8] WI Custom Rate for No-till corn planter and grain drill (alfalfa annualized over four years) and no-till drill for planting winter rye in 2018.

[9] WI Custom Rate (mowing, harvesting, hauling) x number of cuttings.

[10] 40 unit first year green manure nitrogen credit following cocktail mix and annual rye; 120 unit first year, plus 50 unit second year nitrogen credit from alfalfa (@$0.46/unit) annualized over three full production years.