

DOUBLE CROP ROTATIONS WITH WINTER CEREALS AND CORN SILAGE OR FORAGE SORGHUM

Sarah Lyons and Quirine Ketterings

T.F. Kilcer, S. Ort, S. Fessenden, S. Swink, G. Godwin, J. Hanshar, K.J. Czymmek, J.H. Cherney, D. Cherney and participating farmers, consultants and extension educators



Cornell Nutrient Management Spear Program
Department of Animal Science



Outline

- Introduction to double cropping
- Winter cereals
 - Yield and quality
- Economics of double cropping rotations with corn silage
- Forage sorghum as an alternative to corn silage
 - Yield, quality, and timing of harvest
- Preliminary conclusions
- Next steps



Dairy Forage Production in New York

- Typically in the Northeast we have one main crop per growing season
 - Corn silage (3-4 years) and alfalfa and/or grass hay (3-4 years)
- Can we grow more than one crop per year, spread production risk, keep the ground covered, and increase yield?



Double Cropping

- Two crops per year
- Environmental benefits of cover crops
 - Erosion control, nutrient uptake, organic matter
 - Safer fall manure applications
- Addition of forages
 - Increased yield/acre
 - Emergency forage



Double Cropping Challenges

- Timely planting and harvesting
 - Late corn silage harvest
 - Early onset of frost in Northeast
 - Optimize yield and quality
- Influence on summer crop
 - Late planting of main crop (corn silage)
 - Could cause reduced yields
 - Shorter season variety?
 - Alternative summer crop?



Major Questions

1. What are the most economic rates of nitrogen (MERNs) for winter cereals at green-up in the spring?
2. What can we expect from winter cereals in terms of yield and quality?
3. Is double cropping economically feasible?
4. What are the most economic rates of nitrogen for forage sorghum, and what can we expect in yield and quality over time?

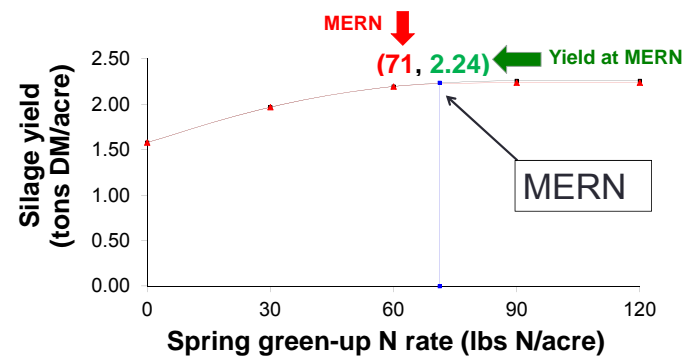
Outline

- Introduction to double cropping
- Winter cereals
 - Yield and quality
- Economics of double cropping rotations with corn silage
- Forage sorghum as an alternative to corn silage
 - Yield, quality, and timing of harvest
- Preliminary conclusions
- Next steps



Most Economic Rate of Nitrogen (MERN)

- Plot dry matter yield against N rate to produce a response curve (quadratic regression)

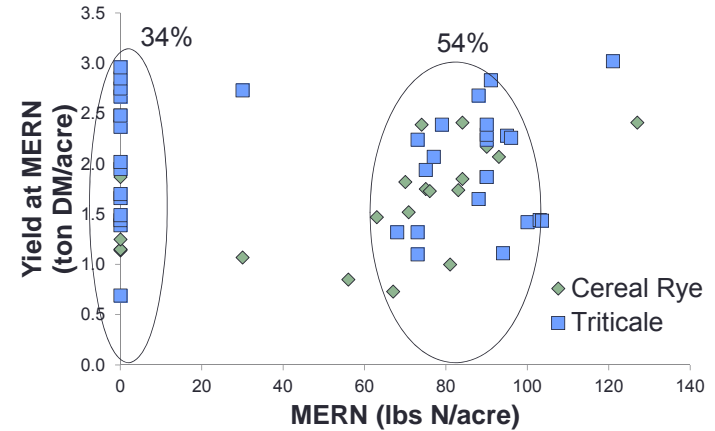


Winter Cereal MERN

- Winter cereals harvested at flag leaf stage in spring
- Harvest dates ranged from May 6 – May 29

Species	n	% Sites MERN = 0	MERN > 0 Minimum (lbs N/acre)	MERN > 0 Maximum (lbs N/acre)	MERN > 0 Average (lbs N/acre)
Cereal Rye	21	24%	30	127	77
Triticale	38	39%	30	121	86

Winter Cereals: Yield Expectations

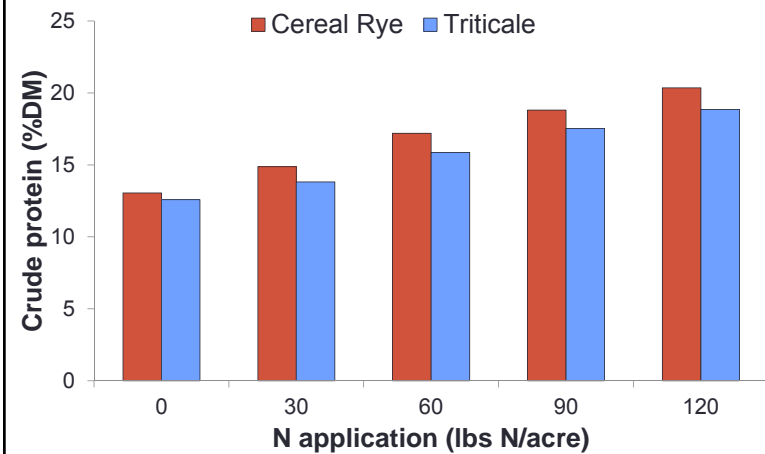


Winter Cereals: Yield Ranges

- What could be causing this drastic range in MERNs and yields at the MERN?
- Soil fertility and manure history

Species	Average Soil Phosphorus		Average Soil Nitrate	
	MERN = 0 (lbs/acre)	MERN > 0 (lbs/acre)	MERN = 0 (lbs/acre)	MERN > 0 (lbs/acre)
Cereal Rye	34	17	5.5	4.4
Triticale	46	34	5.4	4.0

Winter Cereals: Crude Protein



Winter Cereals: Crude Protein

N rate (lbs/acre)	Minimum %CP	Maximum %CP	Average %CP
0	7	23	13
30	7	21	14
60	8	25	16
90	9	28	18
120	11	27	19

Winter Cereals: Forage Quality

- Average quality parameters at the MERN

Species	CP	NDF	ADF	IVTD	NDFD ₄₈
	% of DM				
Cereal Rye	16.7	52.3	28.1	87.9	77.1
Triticale	15.5	51.8	27.8	88.0	77.2

- *Species were grown on separate farms and separate fields

CNCPS Inputs

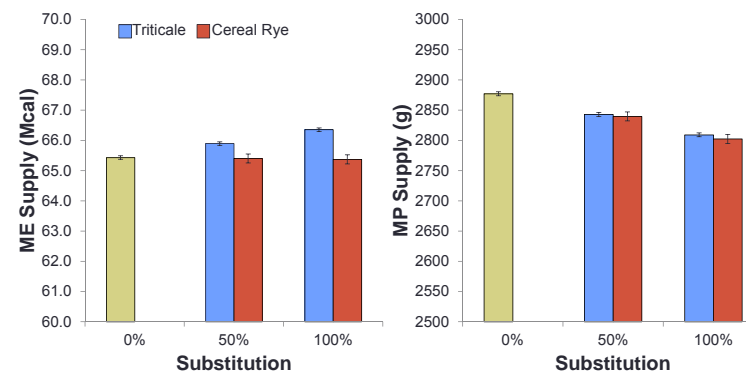
- Winter cereal quality results were included in a theoretical ration for a NY dairy
- Control ration was balanced to meet all animal requirements
- Winter cereals were substituted at different % of the total alfalfa silage in the diet

Animal Inputs	
Milk production	88 lbs/day
Mature weight	1,650 lbs
Age	65 months
Days since calving	120 days

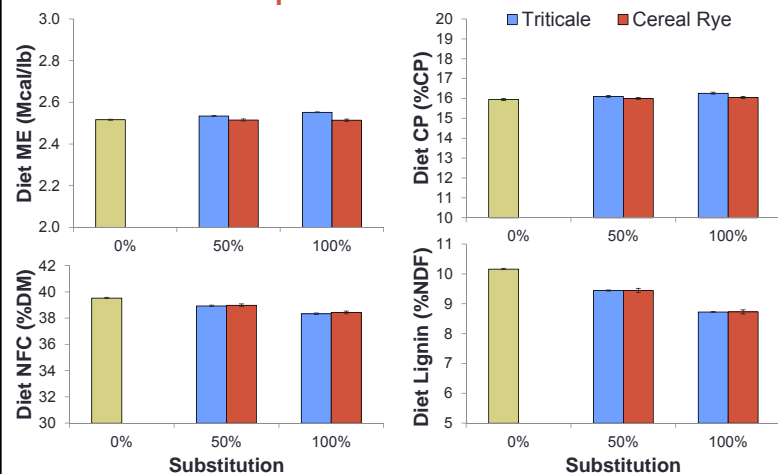
Control Diet	
Corn silage (30% DM, 41%NDF)	Citrus pulp, dry
Alfalfa silage (20% CP, 40% NDF, 17% LNDF)	Corn gluten feed, dry
Corn grain ground fine	Blood meal
Soybean meal	MinVit
Soybean hulls	Trace Mineral Premix
Cottonseed fuzzy	Soy plus

CNCPS Output: ME, MP

- Triticale or cereal rye substituted for 0, 50%, or 100% of the alfalfa haylage in the TMR

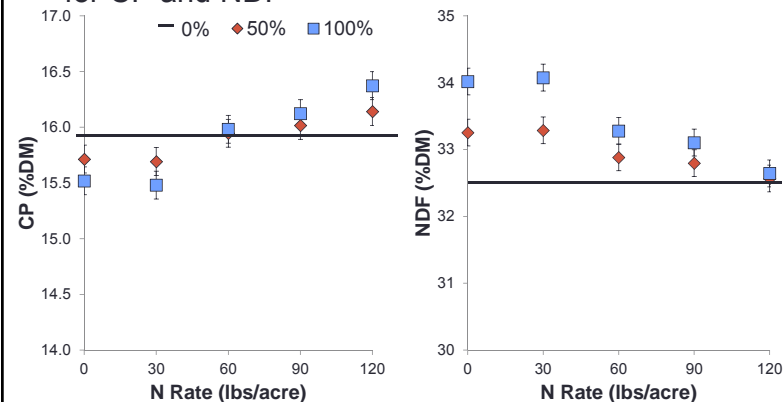


CNCPS Output



CNCPS Output

- Interactions between N rate and % substitution for CP and NDF



Summary

- MERNs for winter cereals averaged **70-90 lbs N/acre** but 34% of sites did not need extra N
- Yields at the MERN range from 0.7-3 tons DM/acre, averaging **1.6-2 tons DM/acre**
- Crude protein increased with N application, and ranged from 7-28% CP across all N rates, with an average of **15-17% CP** at the MERN
- When substituted for alfalfa silage in CNCPS, increasing percentage of triticale slightly increased ME supply, decreased MP supply, and decreased dietary lignin.

Outline

- Introduction to double cropping
- Winter cereals
 - Yield and quality
- Economics of double cropping rotations with corn silage
- Forage sorghum as an alternative to corn silage
 - Yield, quality, and timing of harvest
- Preliminary conclusions
- Next steps



Economics of Double Cropping

- What are the winter cereal **yield targets** that would help make winter cereal double crops a profitable change?
- What are the brake-even yields that take into account the **costs of production** and **changes in profit** associated with double cropping?

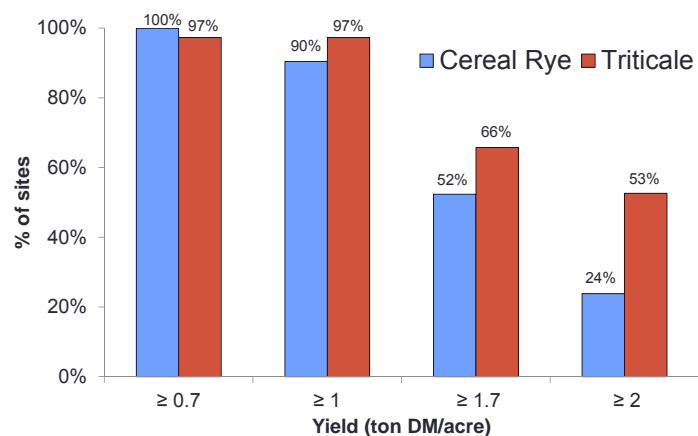
Economics of Double Cropping

Break-Even Winter Cereal Yields

	No impact on corn silage yields	1 ton DM/acre reduction in corn yield
	ton DM/acre	
No additional N fertilizer	0.7	1.7
With 75 lbs DM/acre MERN	1.0	2.0

Hanchar et al. (2015). Double cropping winter cereals for forage following corn silage: costs of production and expected changes in profit for New York dairy farms. *What's Cropping Up?* 25(4).

Economics of Double Cropping



Summary

- Breakeven winter cereal yields range from 0.7 to 2 tons DM/acre depending on fertilizer needs and possible impact on corn silage yield (shorter season variety).
- Nearly 100% of winter cereals met the 0.7 breakeven yield (no impact on corn, no added N) in our trials.
- Double cropping can be profitable but crop needs to be managed as a crop.

Outline

- Introduction to double cropping
- Winter cereals
 - Yield and quality
- Economics of double cropping rotations with corn silage
- Forage sorghum as an alternative to corn silage
 - Yield, quality, and timing of harvest
- Preliminary conclusions
- Next steps



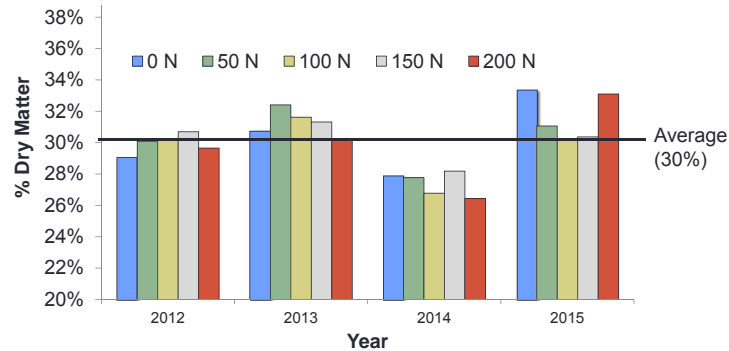
Forage Sorghum

- Benefits of forage sorghum:
 - Shorter growing season
 - Drought resistant
 - Competitive yields
 - High nutritional value
- BMR brachytic dwarf variety
 - BMR: Less lignin production = higher quality
 - Brachytic: Branching
 - Dwarf: Shorter plants, helps reduce likelihood of lodging



Forage Sorghum: Dry Matter Content

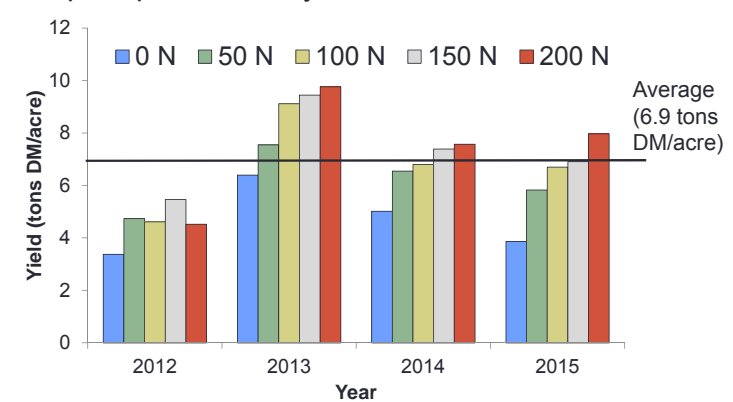
Dry matter not impacted by N rate; averaging 30%



- Sorghum was harvested at soft dough stage (Stage 7)

Forage Sorghum: Yield

Crop responds to N; yield <4 to 10 tons DM/acre



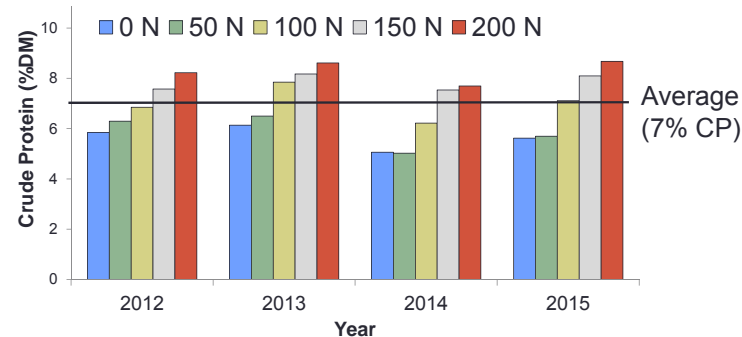
Forage Sorghum: MERN

- 3 out of 8 sites: MERN = 0
- 2 sites: MERN >200 lbs N/acre
- 3 sites: MERNs ranging from 100 – 215 lbs N acre
 - *The site requiring 215 lbs received two additional N rates, 250 and 300 lbs/acre, in 2015.
- Yields at the MERN ranged from 5 - 10 tons DM/acre
- Average across four years 7.5 tons DM/acre



Forage Sorghum: Crude Protein

Additional N increases crude protein of the forage



Sorghum was harvested at soft dough stage (Stage 7)

Forage Sorghum: Quality

On average, 23 lbs N per dry ton of forage

Year	CP at MERN	NDF	ADF	TDN	NDFD ₃₀
% of dry matter					
2012	7.0	-	-	-	-
2013	7.7	51.8	30.6	67.9	-
2014	7.2	-	-	-	-
2015	7.0	48.1	28.1	69.9	29.1

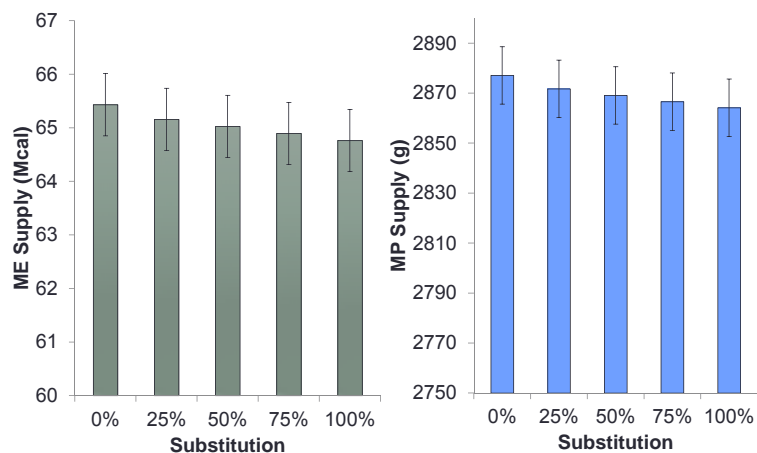
CNCPS Inputs

- Sorghum quality results were included in a theoretical ration for a NY dairy
- Control ration was balanced to meet all animal requirements
- Sorghum was substituted at different % of the total corn silage in the diet

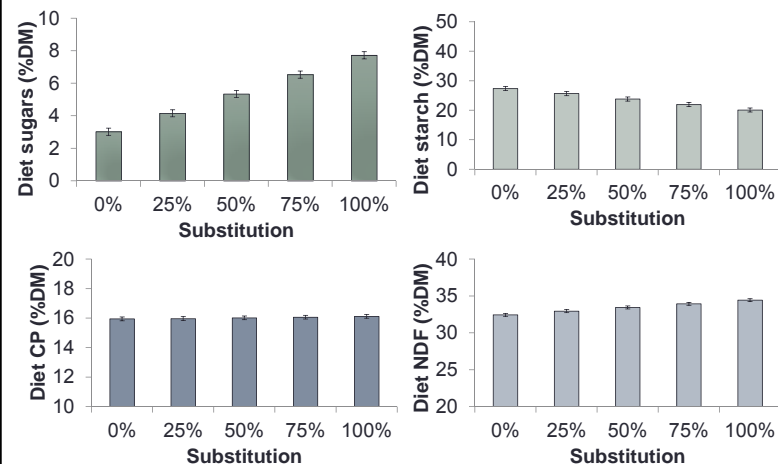
Animal Inputs	
Milk production	88 lbs/day
Mature weight	1,650 lbs
Age	65 months
Days since calving	120 days

Control Diet	
Corn silage (30% DM, 41%NDF)	Citrus pulp, dry
Alfalfa silage (20% CP, 40% NDF, 17% LNDF)	Corn gluten feed, dry
Corn grain ground fine	Blood meal
Soybean meal	MinVit
Soybean hulls	Trace Mineral Premix
Cottonseed fuzzy	Soy plus

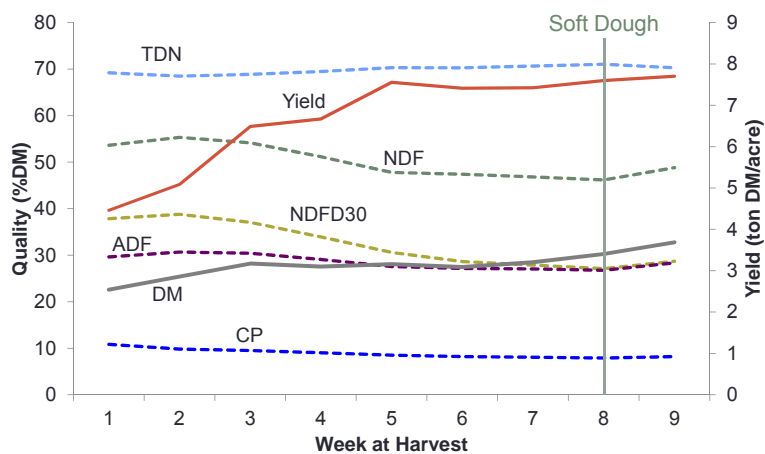
CNCPS Output



CNCPS Output



Forage Sorghum: Timing of Harvest



Summary

- Sorghum can be a valuable alternative to corn silage, especially in drought years
- If harvested at soft dough, dry matter content is comparable to corn silage (30% DM)
- MERNs ranged from **100- >215 lbs N/acre** for N deficient sites (3 sites had MERN = 0)
- Across 4 years, yields at MERN ranged from 5-10 tons DM/acre, and averaged **7.5 tons DM/acre**
- Crude protein at MERN was **7-8% CP**; sorghum took up **~23 lbs N/ dry ton of forage**

Summary (continued)

- Compared with corn silage in a ration, a TMR that includes sorghum supplies **slightly less ME and MP** with increasing inclusion rates
- A sorghum TMR supplies **significantly more sugars and NDF** and **significantly less starch** than does that of corn silage
- **Crude protein is the same** for TMRs with corn silage or sorghum

Outline

- Introduction to double cropping
- Winter cereals
 - Yield and quality
- Economics of double cropping rotations with corn silage
- Forage sorghum as an alternative to corn silage
 - Yield, quality, and timing of harvest
- Preliminary conclusions
- Next steps



Preliminary Conclusions

- Double cropping can be a viable option for dairy farms in the Northeast
- Winter cereal yields at MERN averaged **1.6 – 2.0 tons DM/acre** depending on the species
- Winter cereals are high-quality forages, averaging **16% CP and 77% NDFD₄₈**
- Forage sorghum yielded **5 – 10 tons DM/acre** averaging **30% dry matter** and **7% CP** when harvested at soft dough stage
- Earlier harvest increased quality but reduced yield and increases moisture content

Outline

- Introduction to double cropping
- Winter cereals
 - Yield and quality
- Economics of double cropping rotations with corn silage
- Forage sorghum as an alternative to corn silage
 - Yield, quality, and timing of harvest
- Preliminary conclusions
- Next steps



What's Next?

- Further analysis to determine what causes winter cereal MERNs to be 0 versus 60-100 lbs N/acre
 - Investigate soil fertility and management history
- Further evaluate winter cereals and forage sorghum quality in CNCPS to determine their economic and quality value in a dairy TMR
- Determine the best timing of harvest for forage sorghum to optimize quality, yield, and dry matter content in a rotation with winter cereals
- Directly compare sorghum silage with corn silage in terms of yield and quality

What's Next?

- Survey producers and nutritionists about experiences with growing and feeding of winter cereals and/or sorghum in dairy TMRs
- Volunteers needed!
- Contact Sarah Lyons
<sel248@cornell.edu>



Questions?

