Effects of feeding brown midrib dwarf pearl millet silage on lactational performance and enteric methane emission in dairy cows

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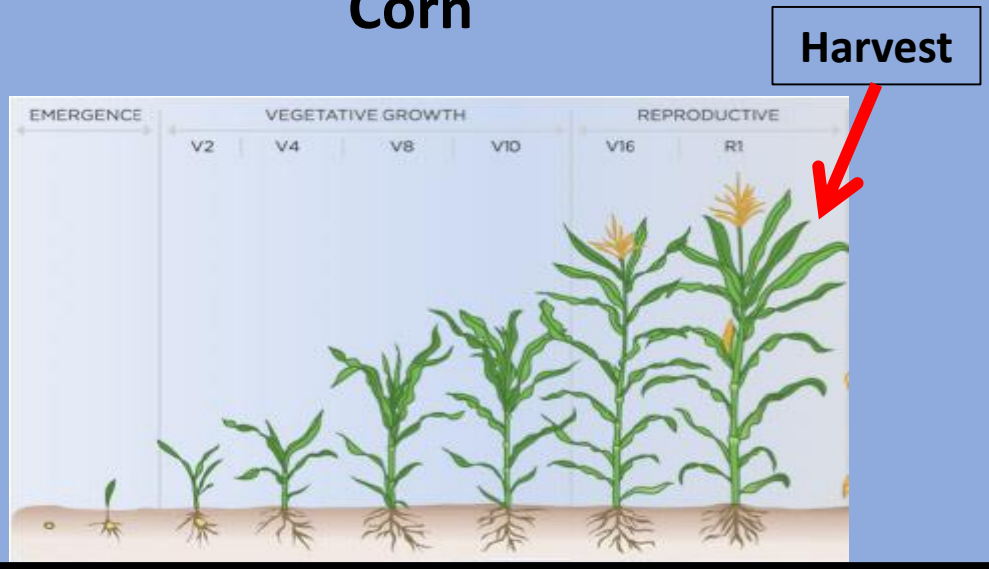
Conventional Forage Strategy

- Relatively simple and proven

Corn



Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.

Potential growing season

Cool season | Warm season | Cool season

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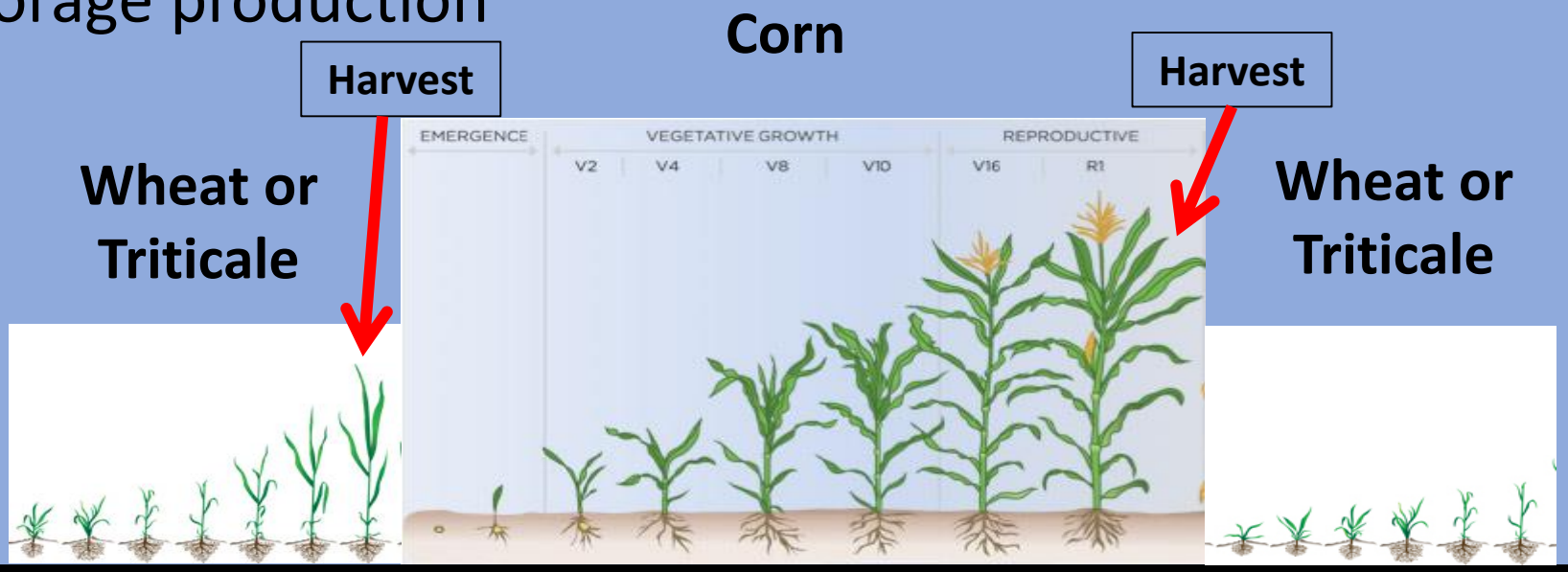
Alternative Forage Strategies

- Utilize the full growing season
- Increase forage production



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Potential growing season

Cool season | Warm season | Cool season

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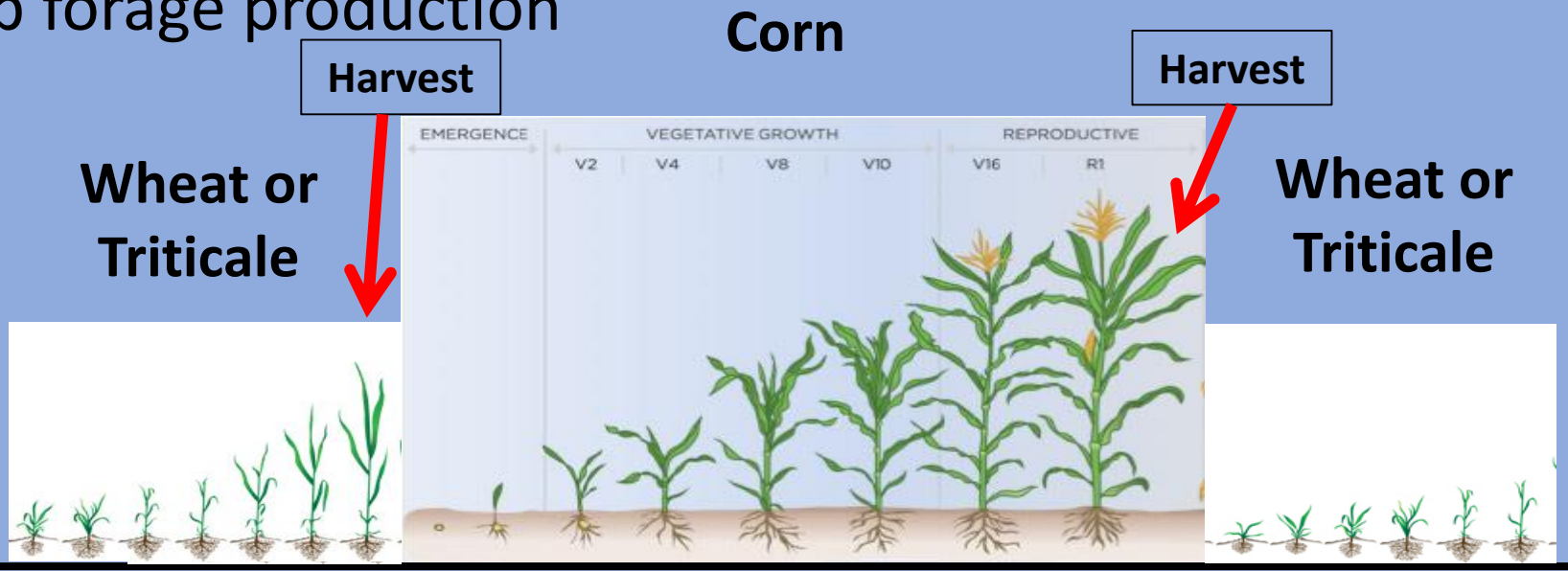
Alternative Forage Strategies

- Growing season too short for cover crop forage production



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Potential growing season											
Cool season				Warm season						Cool season	

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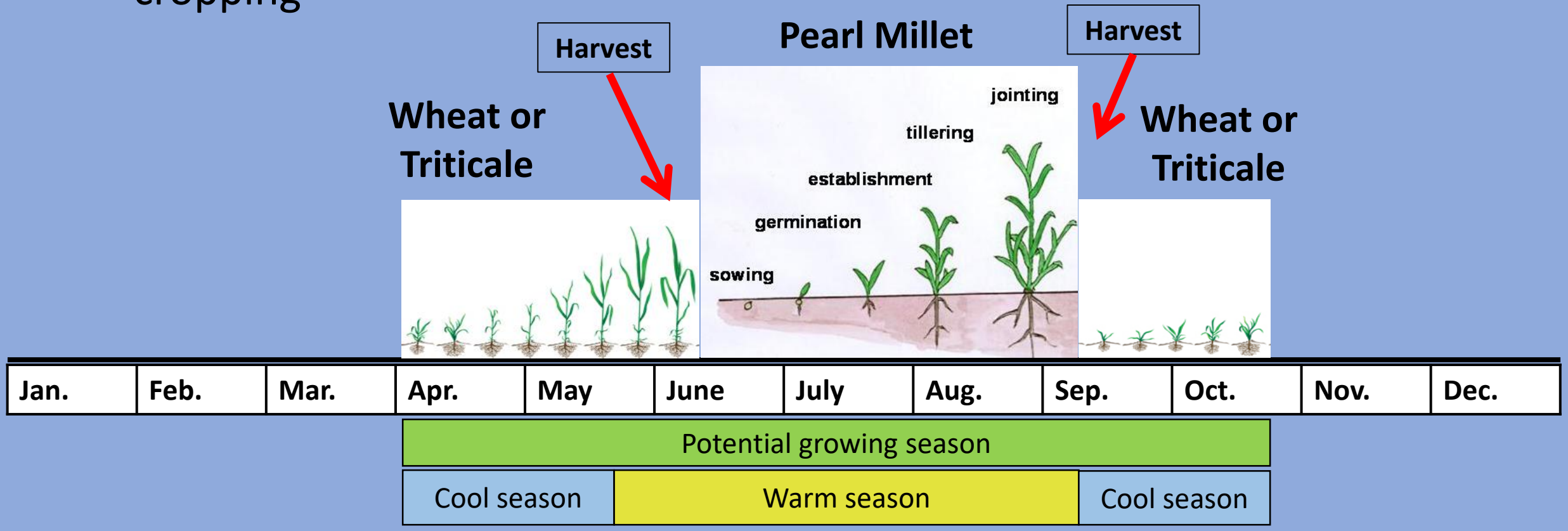
Alternative Forage Strategies

- A better match for double cropping



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Hypothesis and Objectives

- *Hypothesis:* BMR dwarf pearl millet can be utilized in **lactating** dairy cow rations to increase crop diversity, when the silage is harvested at the appropriate stage

- *Objective:* To demonstrate that **BMR pearl millet** silage can replace corn silage and maintain milk yield when included at 10% of the diet dry matter

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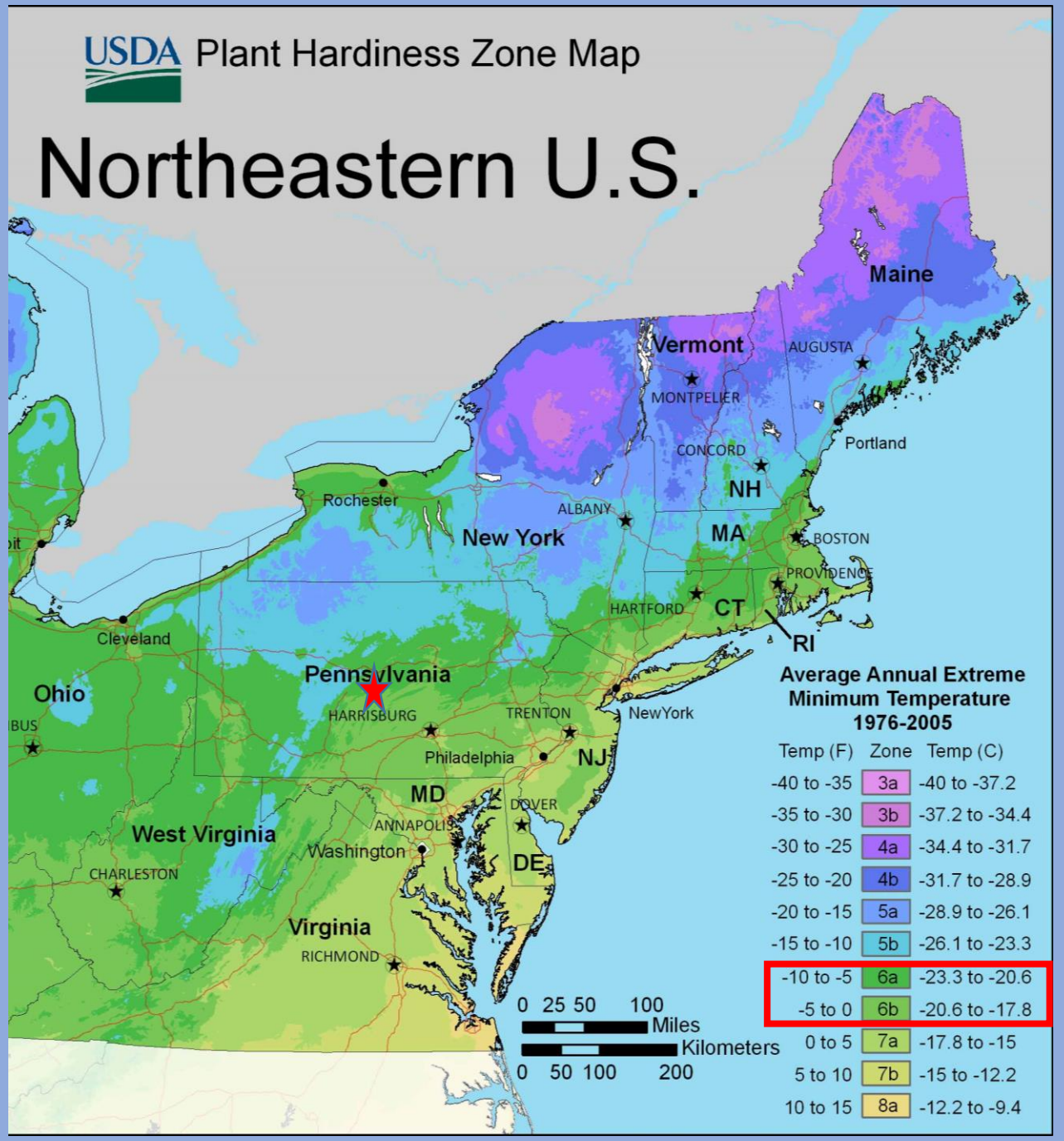
Study Location

- Research was conducted to apply to dairy farmers in the northeastern U.S.
- The study crops were grown in central Pennsylvania (40° N) with a USDA hardiness zone 6
  - Around a -21° C minimum temp
- Typically 150 frost free days



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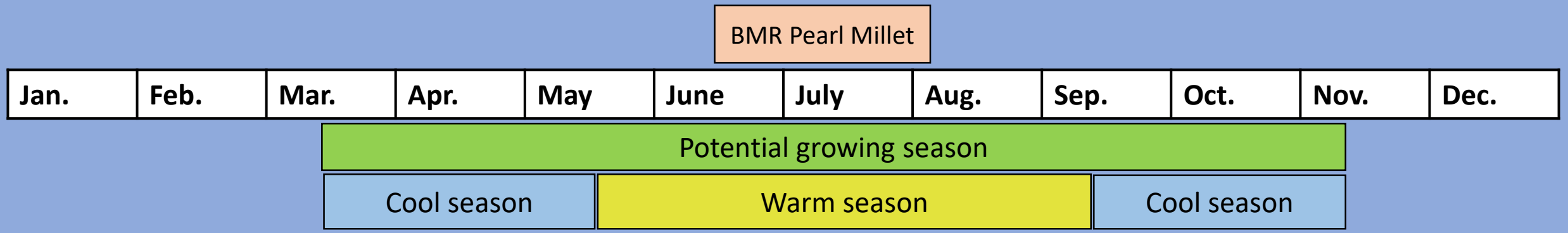
Alternative Forage

- BMR Pearl Millet (Exceed)
  - Planted; June 15th, 2016
  - Harvested; Aug. 3rd, 2016
  - Ensiled in a 7-ft diameter Ag bag
  - Dry matter yield: 2.8 t/ha
  - Harvested at flag leaf visible
  - Cutting height: 11.5cm



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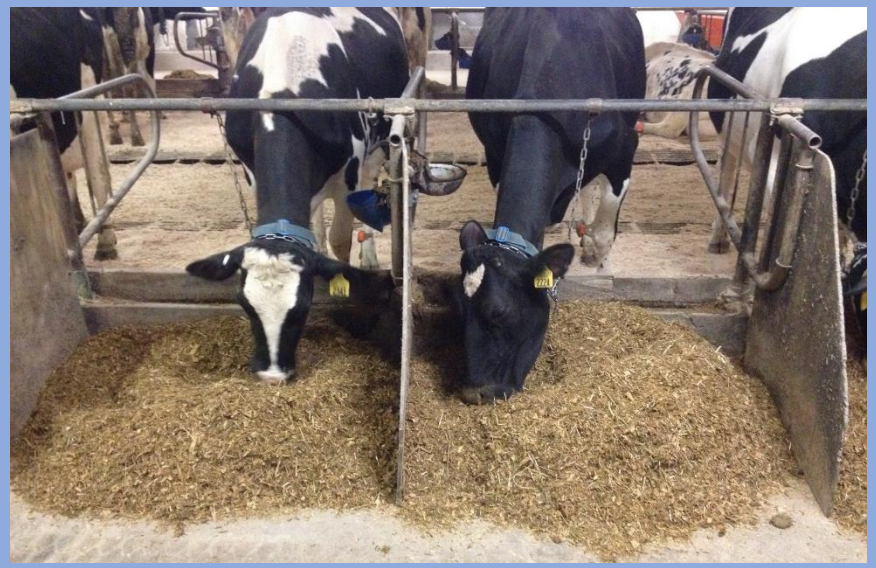
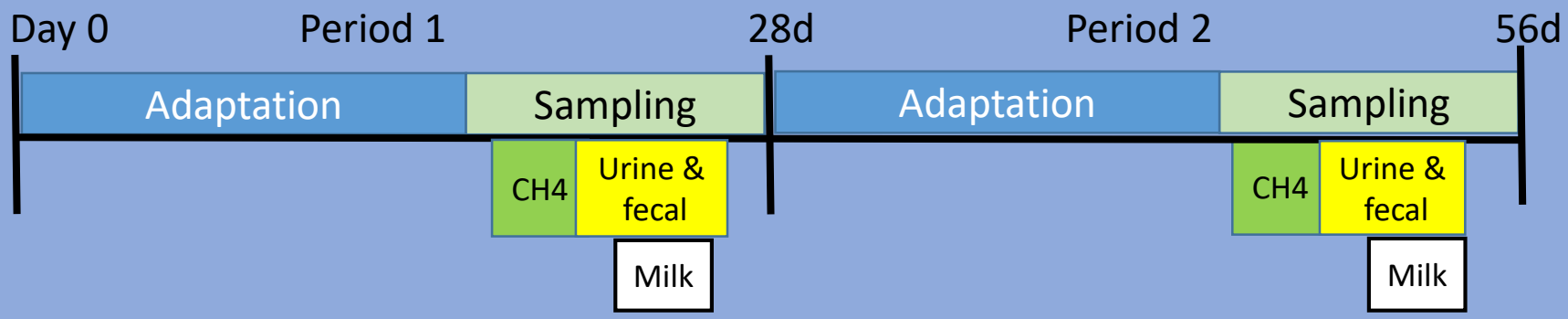
Experimental Design

- 16 lactating Holstein cows (DIM 65 ± 21 d, BW 630 ± 71 kg)
- Crossover design experiment with 2 periods
- Tie-stall housed; twice daily milking
- Fed a TMR once daily at 8AM; ~10% orts





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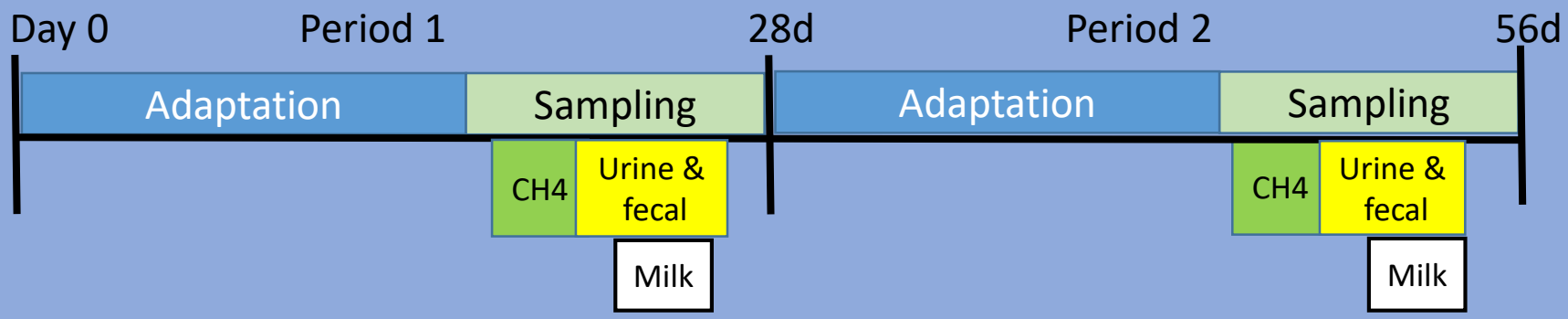
Experimental Design

- Methane sampled using Greenfeed
  - 8 times over 3 days
- Milk sampled at 4 consecutive milkings
- Urine volume estimated with creatinine
- Apparent digestibility estimated using iNDF
  - 8 times over 3 days



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Silage Composition

Item	Forages	
	Corn Silage	Pearl Millet Silage
DM, %	42.2	30.5
NDF	36.8	58.4
ADF	22.3	34.4
Lignin	2.73	2.50
Fat (Ether Extract)	2.58	3.31
CP	7.45	13.2
Soluble Protein	4.55	8.45
Starch	40	0.9
Ethanol Soluble Carbohydrates	1.3	1.95
Ash	3.8	12.9

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Silage Fermentation

Item	Forages	
	Corn Silage	Pearl Millet Silage
DM, %	42.2	30.5
pH	3.79	4.48
Total VFA	7.72	7.52
Lactic	5.90	6.25
Acetic	1.82	1.28
Propionic	0.13	ND
Butyric	ND	ND

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Treatment Diet Ingredients

Ingredient, % of DM	Diet	
	Control	Pearl Millet
Corn silage	50	40
Pearl millet silage	-	10
Alfalfa haylage	6	6
Hay/Straw mixture	4	4
Cottonseed hulls	2	2
Ground corn	10	10
Heat-treated whole soybeans	5.5	5.5
Solvent-extracted canola meal	9	9
SoyPLUS	7.5	7.5
Molasses	4	4
Mineral/Vitamin premix	2	2

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Diet Nutrient Composition

Composition, % of Dry Matter	Diet	
	Control	Pearl Millet
Crude Protein	16.6	17.2 ↑
Rumen Degradable Protein	9.1	9.2
Rumen Undegradable Protein	7.5	7.9
Neutral Detergent Fiber	30.3	32.4 ↑
Acid Detergent Fiber	19.3	20.5
Non-Fiber Carbohydrates	43.9	40.2
Starch	28.0	24.1 ↓
Fat (Ether Extract)	4.6	4.6
Net Energy$_L$, Mcal/kg	1.53	1.54

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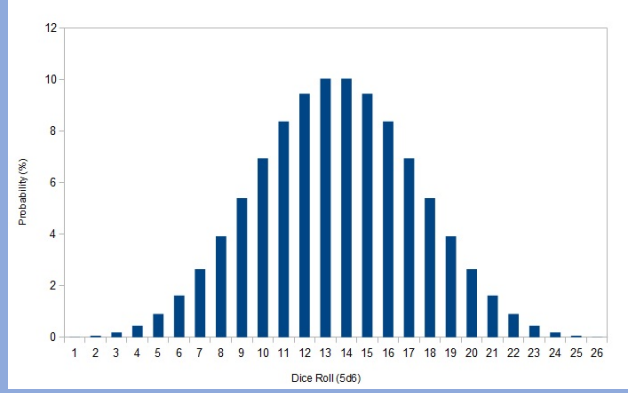
Statistics



- Proc Mixed of SAS 9.4
- *Cow* as a random effect
- Repeated measures, AR(1) covariance structure, used on DMI and milk production data
- Significance at $P \leq 0.05$ and trend at $0.05 < P \leq 0.10$.
- Least squares means are reported

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DMI, Milk Production and Components

Item	Treatment		SEM	*P*-Values
	Control	Pearl Millet		Treatment
DMI, kg/d	29.1	29.0	0.65	0.78
Milk yield, kg/d	51.3	49.6	2.02	<0.001
Milk ÷ DMI, kg/kg	1.77	1.72	0.053	0.01
Milk fat, %	3.47	3.71	0.118	0.06
Milk fat, kg/d	1.79	1.82	0.087	0.65
Milk true protein, %	2.86	2.85	0.050	0.64
Milk true protein, kg/d	1.46	1.43	0.055	0.44
Lactose, %	5.00	4.96	0.035	0.28
Lactose, kg/d	2.55	2.47	0.116	0.23
Milk Urea Nitrogen, mg/dL	11.6	13.3	0.41	<0.001
Energy Corrected Milk, kg/d	46.8	46.6	1.92	0.86
ECM ÷ DMI, kg/kg	1.59	1.56	0.050	0.50

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Enteric Methane & Carbon Dioxide Production

Item	Treatment		SEM	*P*-Values
	Control	Pearl Millet		Treatment
CO_2 kg/d	13.6	14.0	0.42	0.24
CH_4, g/d	396	454	18.4	<0.001
CH_4, g/kg of DMI	13.8	15.7	0.54	<0.01
CH_4, g/kg of ECM	8.28	9.58	0.386	<0.01

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Nutrient Intake and Digestibility

Item	Treatment		SEM	*P*-Value
	Control	Pearl Millet		Treatment
Intake, kg/d				
Dry Matter	29.4	28.8	0.58	0.14
Organic Matter	27.4	26.6	0.54	0.03
Crude Protein	4.86	4.94	0.097	0.23
Neutral Detergent Fiber	8.89	9.33	0.181	<0.01
Acid Detergent Fiber	5.67	5.90	0.115	<0.01
Apparent digestibility, %				
Dry Matter	66.5	64.5	0.38	<0.001
Organic Matter	67.2	65.1	0.38	<0.001
Crude Protein	64.3	61.8	0.55	<0.01
Neutral Detergent Fiber	38.5	41.0	0.65	<0.001
Acid Detergent Fiber	24.9	27.5	1.15	0.02

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Nitrogen Utilization

Item	Treatment		SEM	*P*-Value
	Control	Pearl Millet		Treatment
N Intake, g/d	778	790	15.6	0.23
N excretion & secretion	738	778	18.0	0.01
Urine N	229	254	8.7	0.01
Urinary Urea N	161	187	6.0	<0.001
Fecal N	278	302	7.5	<0.01
Total excreta N (Urine + Fecal)	507	555	13.8	<0.01
Milk N	231	222	5.9	0.02
As % of N intake				
Urine N	29.4	32.2	0.88	0.02
Fecal N	35.7	38.2	0.55	<0.01
Total excreta N (Urine + Fecal)	65.1	70.5	0.96	<0.001
Milk N	29.8	28.2	0.62	<0.01

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Summary

- **BMR Pearl Millet Silage**
  - Harvested at the boot stage
  - Replaced corn silage at 10% of the diet DM
  - Did not affect DMI or yields of components and energy corrected milk
  - Tended to increase milk fat percentage
  - Increased N excretion in feces and urine
  - Increased MUN levels and decreased milk N use efficiency
  - Increased apparent digestibility of fiber but decreased that of DM, OM and CP
  - Increased enteric CH_4 emissions

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Conclusion

- **BMR Pearl Millet silage** at 10% diet appears to be a palatable forage for lactating cows and **did maintain ECM yield**
- Additional starch will have to be supplemented if replacing corn silage
- Pearl millet silage should be considered by farms in the NE U.S. with shorter growing seasons but still wanting to double crop
- Or as an emergency crop in special situations such as a corn crop failure

Thank You

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