UTILIZING HAY STORAGE TECHNIQUES TO IMPROVE FORAGE QUALITY AND ANIMAL PERFORMANCE

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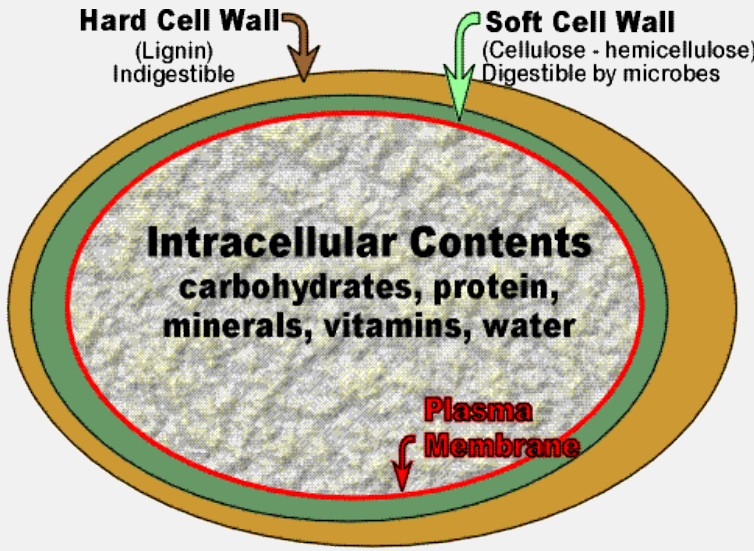
OUTLINE

1. Introduction
   - Importance of hay storage
   - Previous research
2. Hay storage trial

HAY STORAGE

- Minimize DM losses
- Maintain soluble carbohydrate content
- Minimize changes in ADF and NDF
- Minimize changes in CP and ADICP
- Maintain NDFD and RFQ



MONTANA STORAGE

Single-stack (SS)

Pyramid (PYR)

Mushroom (MSH)

Why is our study unique?

HAY STORAGE LOSSES

1. Dry matter loss
2. Forage nutrient quality loss
3. Animal performance loss

DRY MATTER LOSSES

Significant in round bales stored outside and uncovered

- **0.8-40%** (Anderson et al., 1981; Huhnke, 1988, Belyea et al. 1985)

South Dakota
- 1 year
- Uncovered

Canada
- 1 year
- Tarped
- Oxidation, weathering, and molding

Missouri
- >1 year
- Covered storage for PYR and MSH, but not for SS

	Dry Matter Loss (%)		
	South Dakota	Canada	Missouri
IN	--	6%	2.5%
SS	0.8%	40%	15%
PYR	10.3%	30%	5.8%
MSH	--	--	6.6%

(Chisholm et al., 1980; Wickes and Cochrane, 1982; Atwal et al., 1984)

FORAGE NUTRIENT QUALITY LOSSES

- Weathering and leaching of soluble CHO's
  - Increases ratio of structural to non-structural CHO's
  - Decreased forage quality

Location	Storage	CP (%)	ADF (%)	Digestibility (%)	Source
South Dakota	SS	5.65	---	39	Chisholm et al. (1980)
	PYR	5.41	---	32	
Canada	SS	17	41	---	Atwal et al. (1984)
	PYR	17	43	---	
	INSIDE	16	36	---	
Hawaii	SS	8	45	45	Chung and Verma (1991)
	INSIDE	8	43	48	

ANIMAL PERFORMANCE LOSSES

OUTSIDE VS. INSIDE

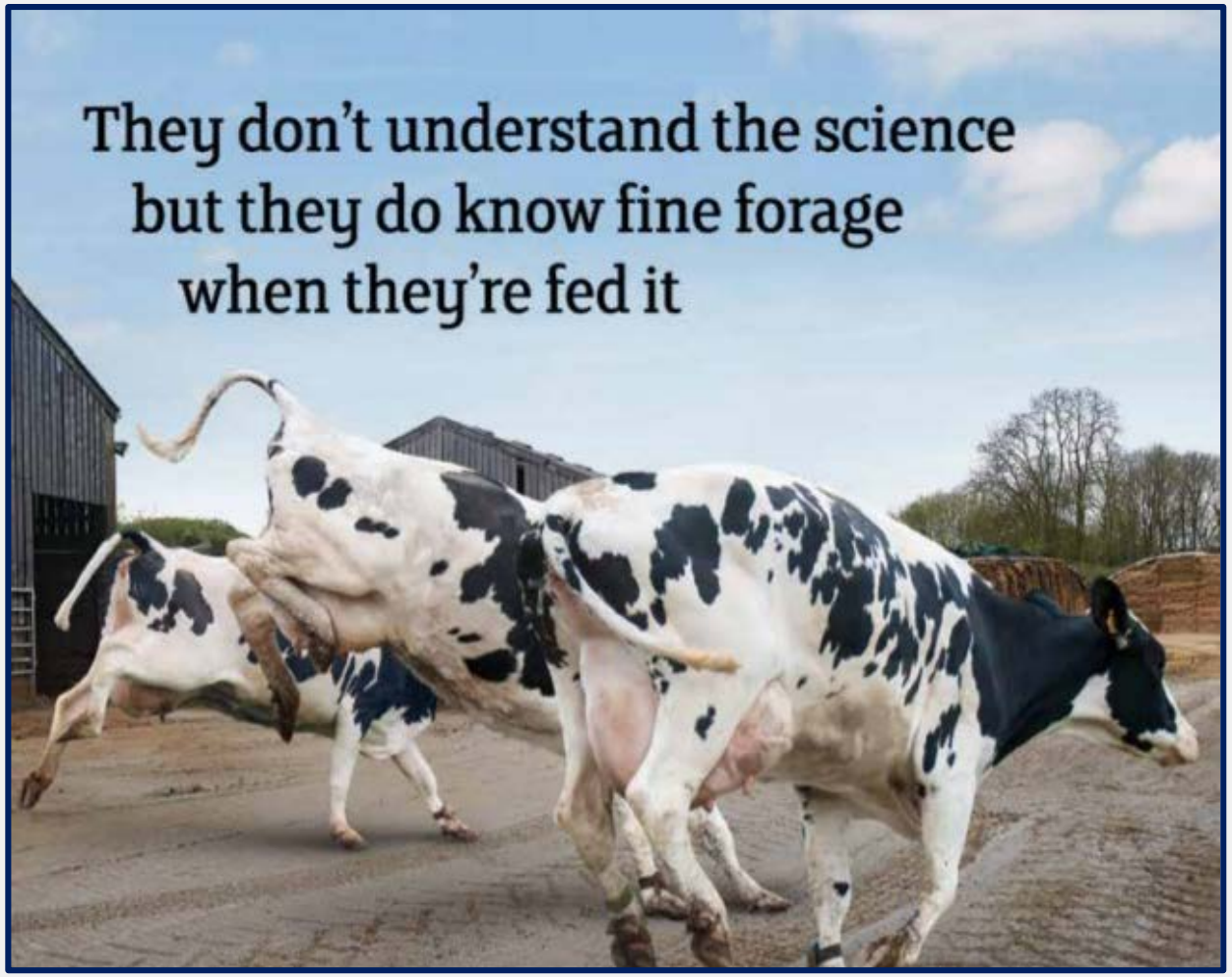
	Animal Refusal (%)		DM + Handling + animal refusal (%)		Feeding + storage (%)		DMI (% BW)		ADG (kg/day)		Source
	Out	**In**	**Out**	**In**	**Out**	**In**	**Out**	**In**	**Out**	**In**	
Louisiana	23	1.2	65	3.5	---	---	---	---	---	---	Verma and Nelson (1983)
Missouri	---	---	---	---	40	15	2.11	2.35	0.4-0.5	0.6-0.7	Belyea et al. (1985)
Canada	---	---	---	---	---	---	1.4	2.1	---	---	Atwal et al. (1984)

* Hay stored outside were stored in a SS

Hay storage is IMPORTANT!

Inside stored hay is the best method followed by the SS and PYR

MSH is not common in the literature



DRY MATTER AND FORAGE QUALITY LOSSES ASSOCIATED WITH STORING LARGE ROUND BALES OUTSIDE AT VARYING GEOGRAPHIC LOCATIONS IN THE STATE OF MONTANA

Objectives

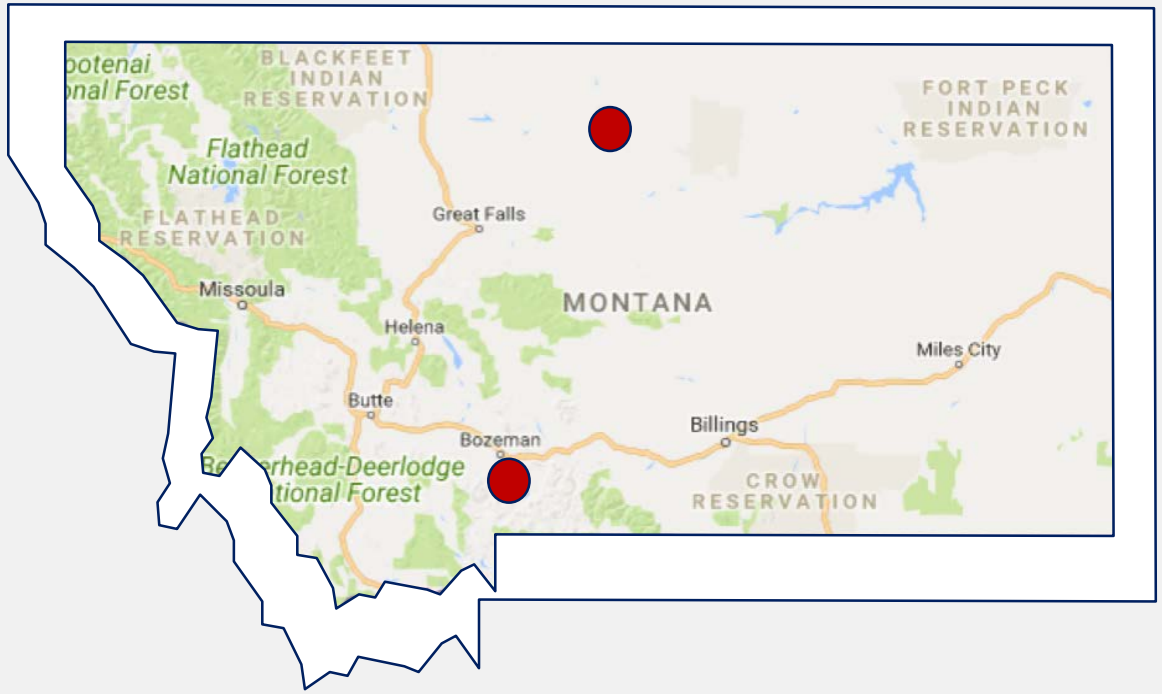
- Quantify DM and forage quality losses associated with three different methods of outdoor round bale hay storage at two different sites in Montana

- Determine which OUTDOOR hay storage method is the best for varying Montana conditions

MATERIALS AND METHODS

Location Year 1

- Bozeman Agricultural Research and Teaching Farm (BART farm)
- Northern Agricultural Research Center (NARC)



MATERIALS AND METHODS

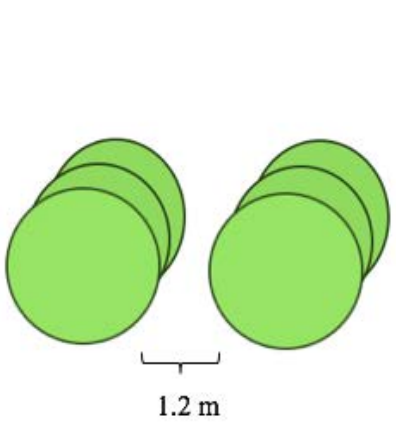
Harvest and Baling

- 100% grass hay
- Moisture = 12-15%
- Plastic net wrapping
- BART: Vermeer 605M round baler, avg bale weight = 906 lbs
- NARC: Case IH RB565 round baler, avg bale weight = 1420 lbs

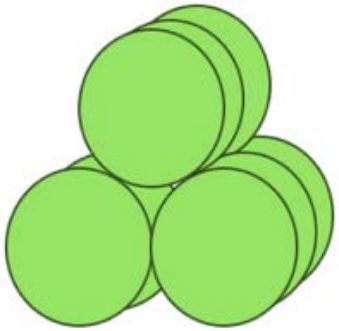
MATERIALS AND METHODS

Storage

- 11 days post baling
- Initial and final weights were taken to evaluate DM loss
- Directly on soil
- BART: July – Mar (9 months)
- NARC: Sept – Mar (7 months)

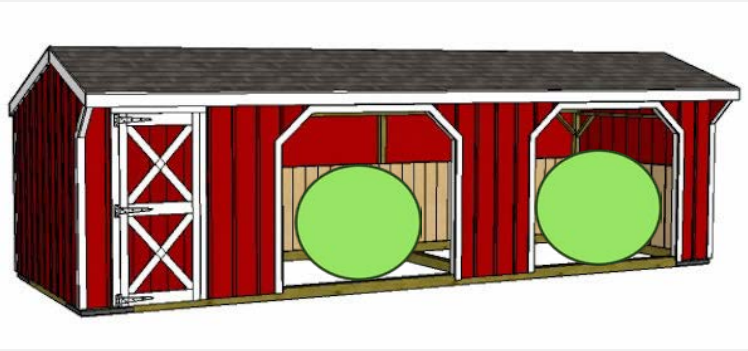


Single-stack (SS) n = 6 (per site)



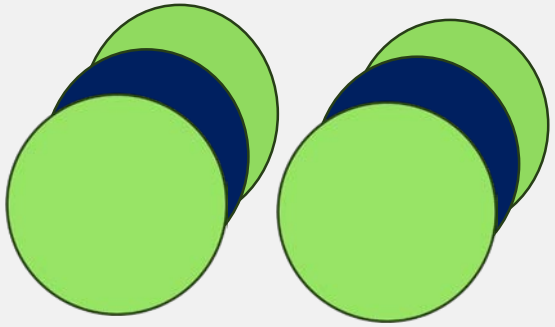
Pyramid (PYR) n = 9 (per site)

Mushroom (MSH) n = 12 (per site)



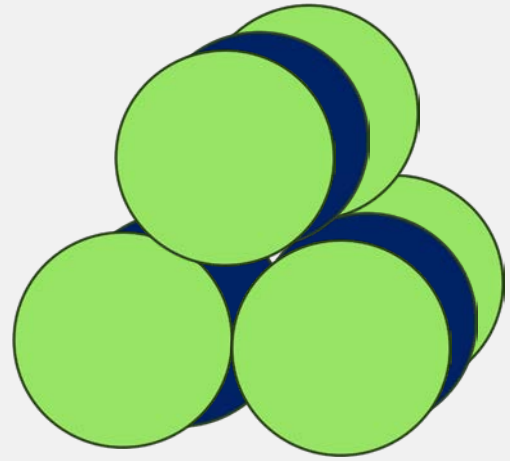
Inside (INSIDE) n=2 (per site)

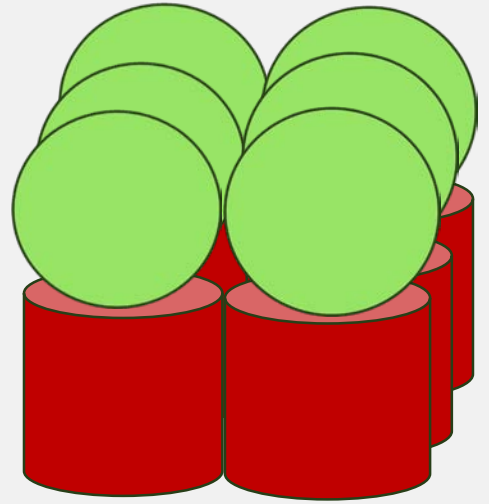
MATERIALS AND METHODS



Forage Quality Loss Evaluation

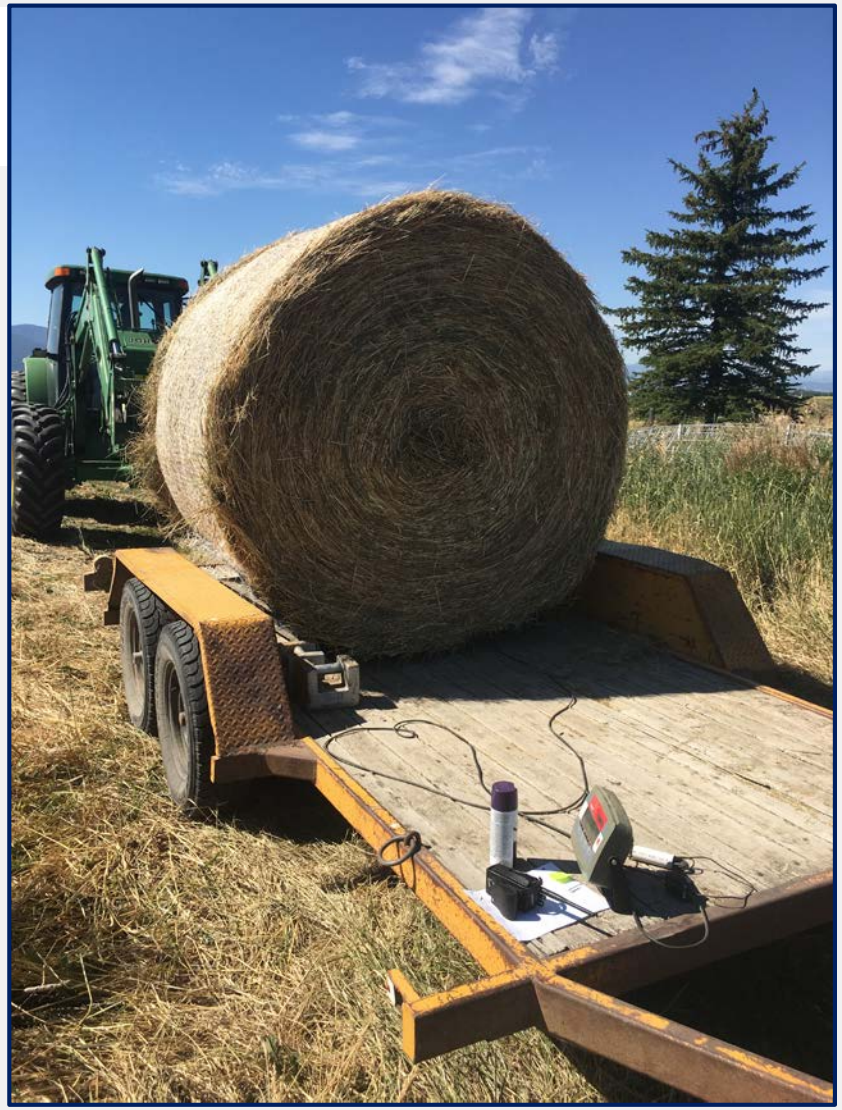
- 2 depths: 6” and 12” cores
- Bale placement evaluated
  - SS.I, SS.O, PYR.I, PYR.O, MSH.T, MSH.B, INSIDE
- Analyzed using wet chemistry for:
  - DM
  - CP and ADICP
  - ADF and NDF
  - NDFD48
  - TDN
  - RFQ





RESULTS

Dry Matter Loss



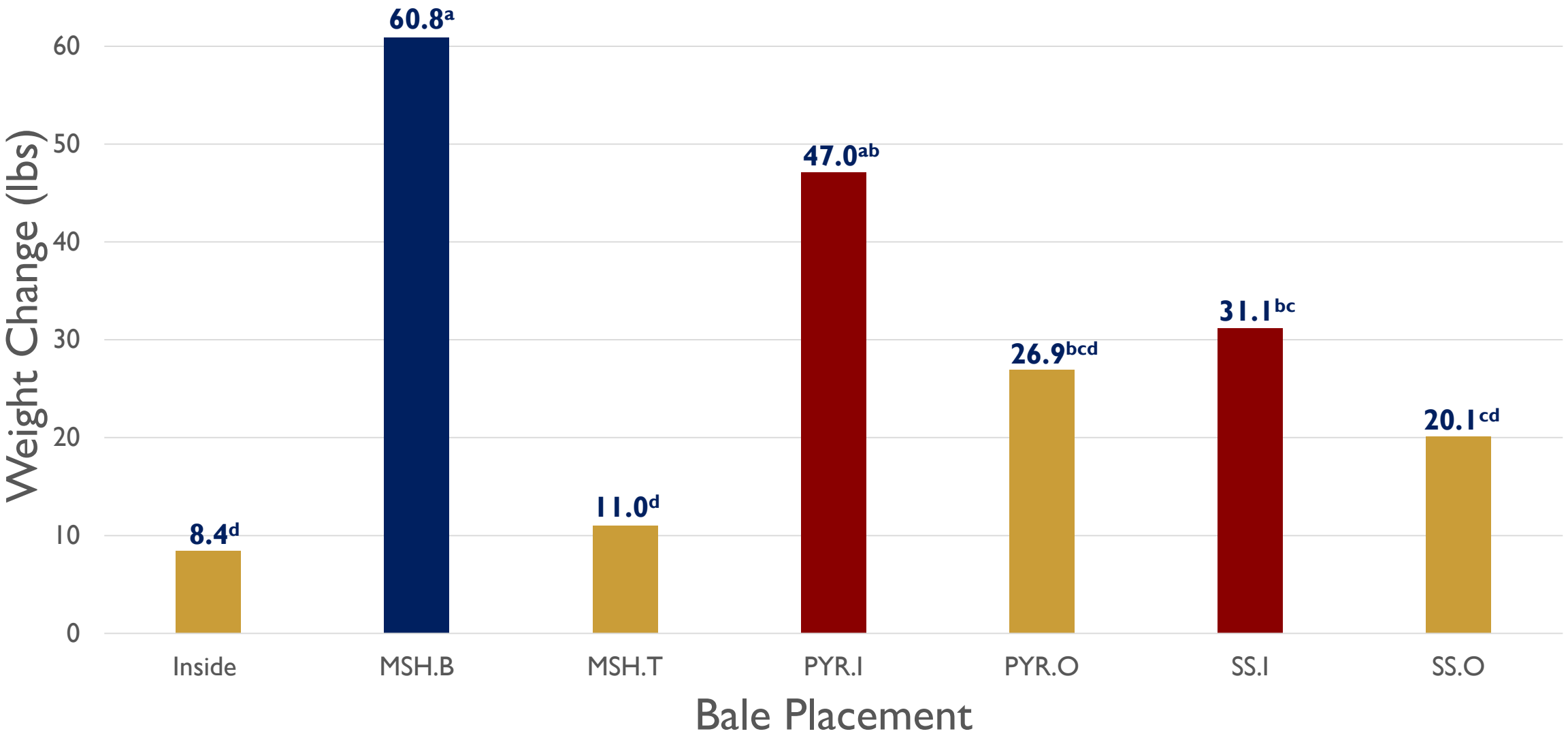
RESULTS

Weight change (DM basis) for bales stored inside a barn (INSIDE), on the bottom of the mushroom formation (MSH.B), on the top of the mushroom formation (MSH.T), on the inside of the pyramid formation (PYR.I), on the outside of the pyramid formation (PYR.O), on the inside of the single-stack formation (SS.I), or on the outside of the single-stack formation (SS.O) in Bozeman, MT (BART) and Havre, MT (NARC)

	BART		NARC	
Bale Placement	Wt Change (lbs)	% Change	Wt Change (lbs)	% Change
INSIDE	8.4^{d}	<1	96.8^{a}	6.4
MSH.B	60.8^{a}	6.3	16.1^{b}	1.2
MSH.T	11.0^{d}	1.2	46.7^{ab}	3.2
PYR.I	47.0^{ab}	4.9	55.8^{ab}	3.8
PYR.O	26.9^{bcd}	2.9	32.2^{ab}	2.2
SS.I	31.1^{bc}	3.3	70.1.^{ab}	4.7
SS.O	20.1^{cd}	2.2	29.1^{ab}	2.1

^{a,b,c,d} Within a row, means without a common superscript differ ($P \leq 0.10$)

Weight Change at BART



RESULTS

- Hay nutrient content
- Percent change

Changes in quality for large round bales stored inside a hay barn (INSIDE), as a mushroom formation (MSH), as a pyramid formation (PYR), or as a single-stack formation (SS) in Bozeman, Montana for nine months

		Storage Method				*P* value
Quality	Date	INSIDE	MSH	PYR	SS	% Change
DM (%)	Start	93.6	92.6	92.3	93	
	Finish	93.2	92.8	92.9	93	
	Average	93.4[a]	92.7[b]	92.6[b]	93[ab]	
	% Change	-0.48	0.22	0.65	-0.02	0.2966
CP (%)	Start	10.1	11.1	11.7	11.1	
	Finish	10.5	11.6	11.9	10.8	
	Average	10.3[b]	11.4[ab]	11.8[a]	10.9[ab]	
	% Change	4.06	5.16	1.47	-2.05	0.7706
ADICP[1] (%)	Start	1.2	1.6	1.5	1.4	
	Finish	1.4	1.6	1.5	1.4	
	Average	1.3	1.6	1.5	1.4	
	% Change	23.83	2.62	-0.59	-1.38	0.3428
ADF (%)	Start	43	43.5	41.7	42.9	
	Finish	41.7	43.9	42.9	42.5	
	Average	42.4[b]	43.7[a]	41.8[ab]	42.7[ab]	
	% Change	-3	1.05	0.84	-0.77	0.8341
NDF (%)	Start	63.1	64.5	60.9	61.4	
	Finish	60.5	62.5	58.4	61	
	Average	61.8[ab]	63.5[a]	59.6[b]	61.2[ab]	
	% Change	-4.05	-2.75	-4.18	-0.66	0.8861
NDFD48[2] (%)	Start	38.1	39	36.9	36.3	
	Finish	37.3	37.7	35.8	37.8	
	Average	37.7	38.4	36.4	37.1	
	% Change	-2.04	-3.29	-3.05	4.06	0.2279
TDN (%)	Start	54.7	54.5	55.2	55.35	
	Finish	55.5	53.7	55.4	55.1	
	Average	55.1[ab]	54.1[b]	55.3[a]	55.2[a]	
	% Change	1.47	-1.35	0.46	-0.44	0.7621
RFQ[3]	Start	123	119.5	126.3	120.8	
	Finish	129	116.8	135.3	127.3	
	Average	126[ab]	118.1[b]	130.5[a]	124[ab]	
	% Change	5.05	-1.13	8.91	6.2	0.7783

[a,b] Within a row, means without a common superscript differ ($P \leq 0.10$)

[1] ADICP: acid detergent insoluble crude protein; [2] NDFD48: 48-hour neutral detergent fiber digestibility; [3] RFQ: relative forage quality

Changes in quality for large round bales stored inside a hay barn (INSIDE), as a mushroom formation (MSH), as a pyramid formation (PYR), or as a single-stack formation (SS) in Havre, Montana for seven months

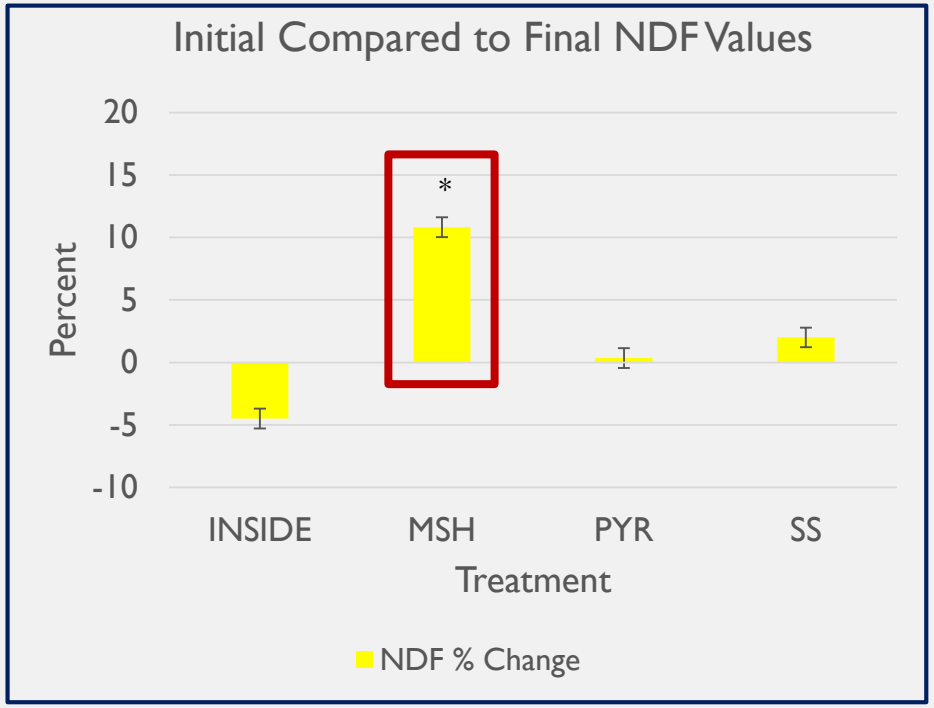
		Storage Method				*P* value
Quality	Date	INSIDE	MSH	PYR	SS	% Change
DM (%)	Start	93.1	93	93.1	93.1	
	Finish	94.2	93.8	94.4	93.9	
	Average	93.7	93.4	93.7	93.5	
	% Change	1.18	0.83	1.45	0.89	0.2457
CP (%)	Start	12.7	12.1	11.4	12.1	
	Finish	11.6	12.1	11.4	12.2	
	Average	12.2^{ab}	12.1^{a}	11.4^{b}	12.1^{a}	
	% Change	-8.7	0.76	0.28	0.3	0.4824
ADICP[1] (%)	Start	1	1	1	0.8	
	Finish	0.9	2.5	1.1	1	
	Average	1	1.8	1	0.9	
	% Change	-6.15	148.12	8.1	27.53	0.1895
ADF (%)	Start	38.7	38.8	39.2	34.1	
	Finish	38.1	43.5	40.3	36	
	Average	38.4^{a}	41.2^{a}	39.7^{a}	35^{b}	
	% Change	-1.54	12.11	2.97	5.52	0.2783
NDFD48[2] (%)	Start	41.4	38.9	39.8	35.9	
	Finish	37.8	39.8	37	36.7	
	Average	39.6^{a}	39.4^{a}	38.4^{ab}	36.3^{b}	
	% Change	-8.69	2.37	-6.62	2.45	0.2304
RFQ[3]	Start	152.5	146.5	143.3	163.8	
	Finish	147	111.5	136	156.8	
	Average	149.8^{ab}	129^{c}	139.6^{bc}	160.3^{a}	
	% Change	-3.6	-24.03	-5.08	-4.16	0.1523

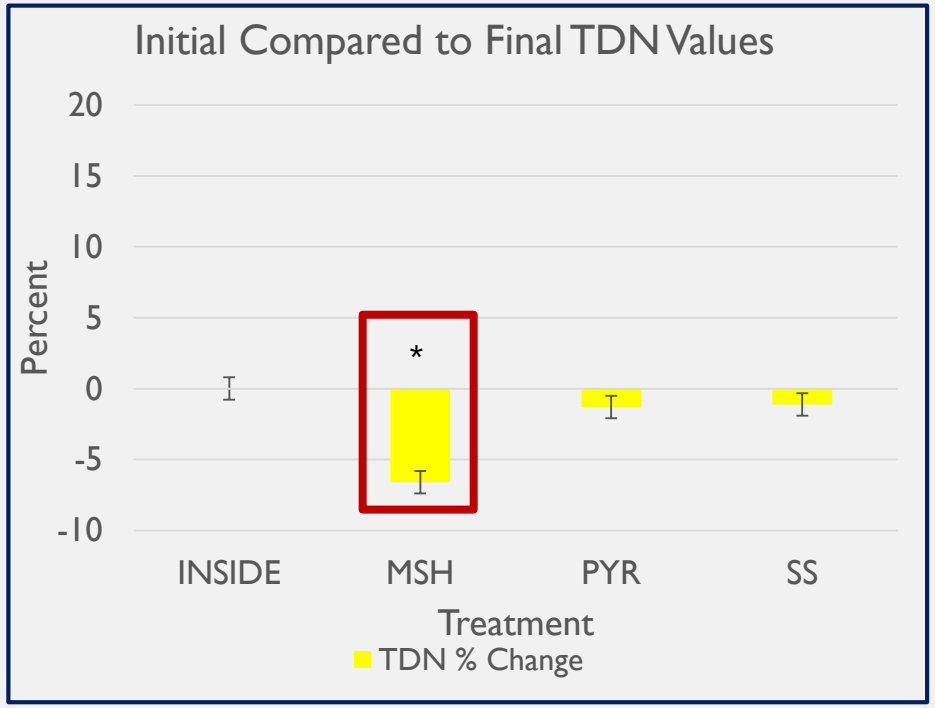
^{a,b,c} Within a row, means without a common superscript differ ($P \leq 0.10$)

Changes in quality for large round bales stored inside a hay barn (INSIDE), as a mushroom formation (MSH), as a pyramid formation (PYR), or as a single-stack formation (SS) in Havre, Montana for seven months

			Storage Method			P values	
Quality	Date	INSIDE	MSH	PYR	SS	Treatment *date	% Change
NDF (%)	Start	60	58.4	59.6	53.9	0.0314	
	Finish	57.3	64.7	59.7	54.9		
	Average	58.7^{b}	61.5^{a}	59.6^{ab}	54.4^{c}		
	% Change	-4.5^{a}	10.8^{b}	0.35^{a}	2^{a}		0.0327
TDN (%)	Start	57.9	57.8	57	60.1	0.098	
	Finish	57.9	54	56.3	59.5		
	Average	57.9^{a}	55.9^{b}	57^{ab}	59.8^{c}		
	% Change	0.01^{a}	-6.6^{b}	-1.3^{a}	-1.12^{a}		0.0751

^{a,b,c} **Within a row, means without a common superscript differ (P ≤ 0.10)**

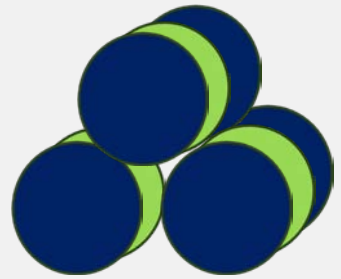


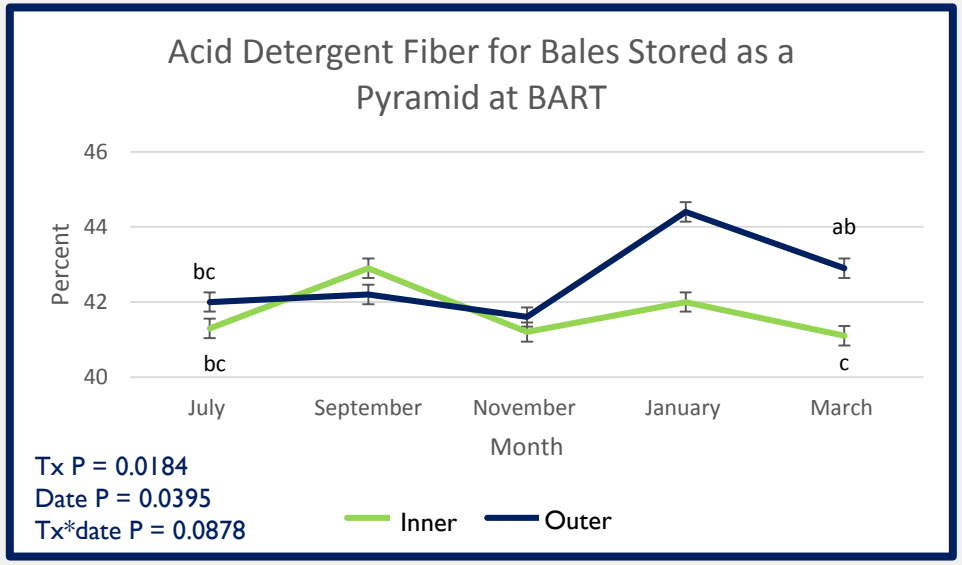


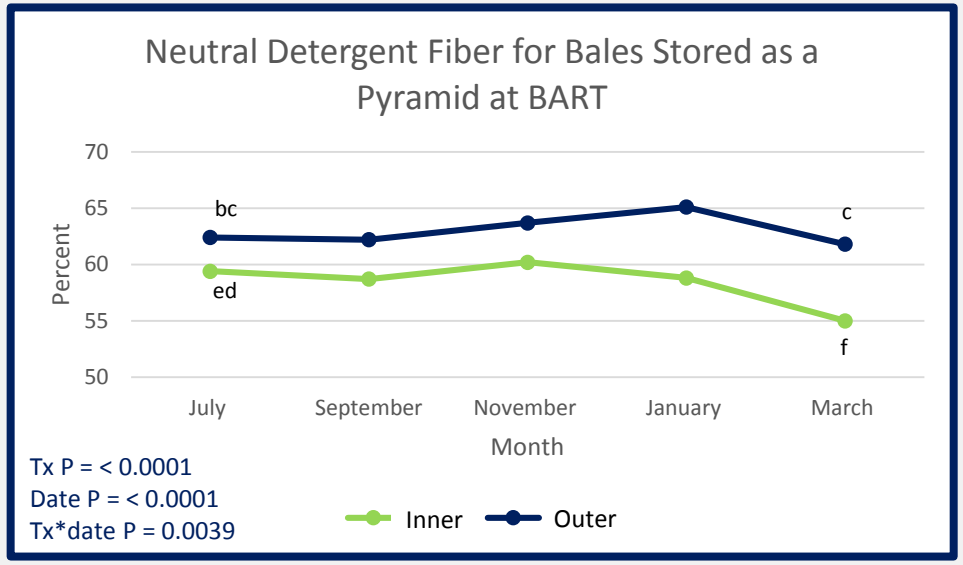
RESULTS

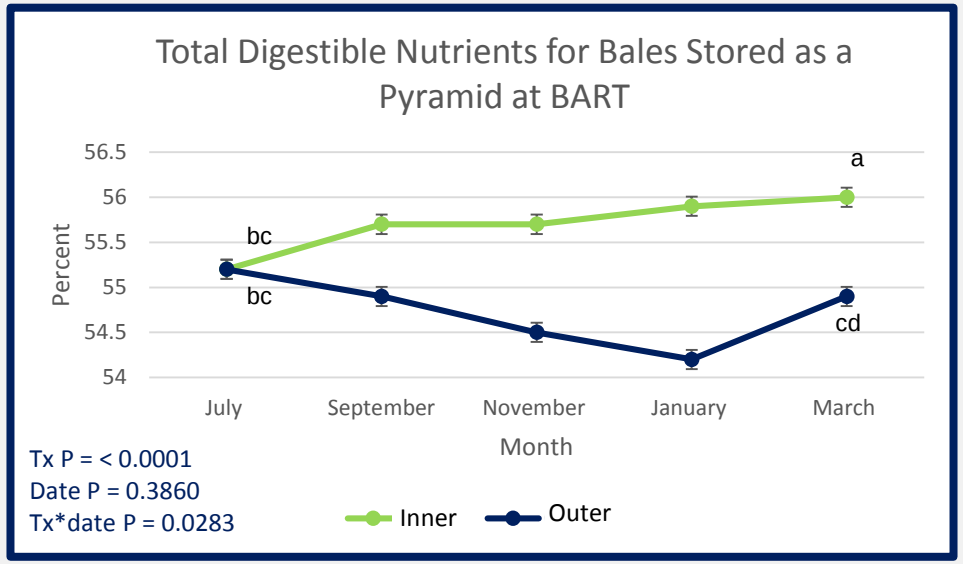
Nutrient quality based on bale placement

BART – PYRAMID

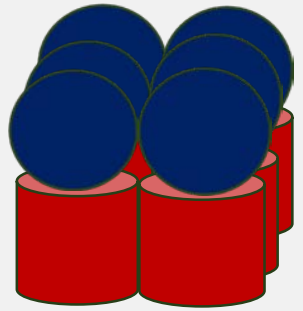


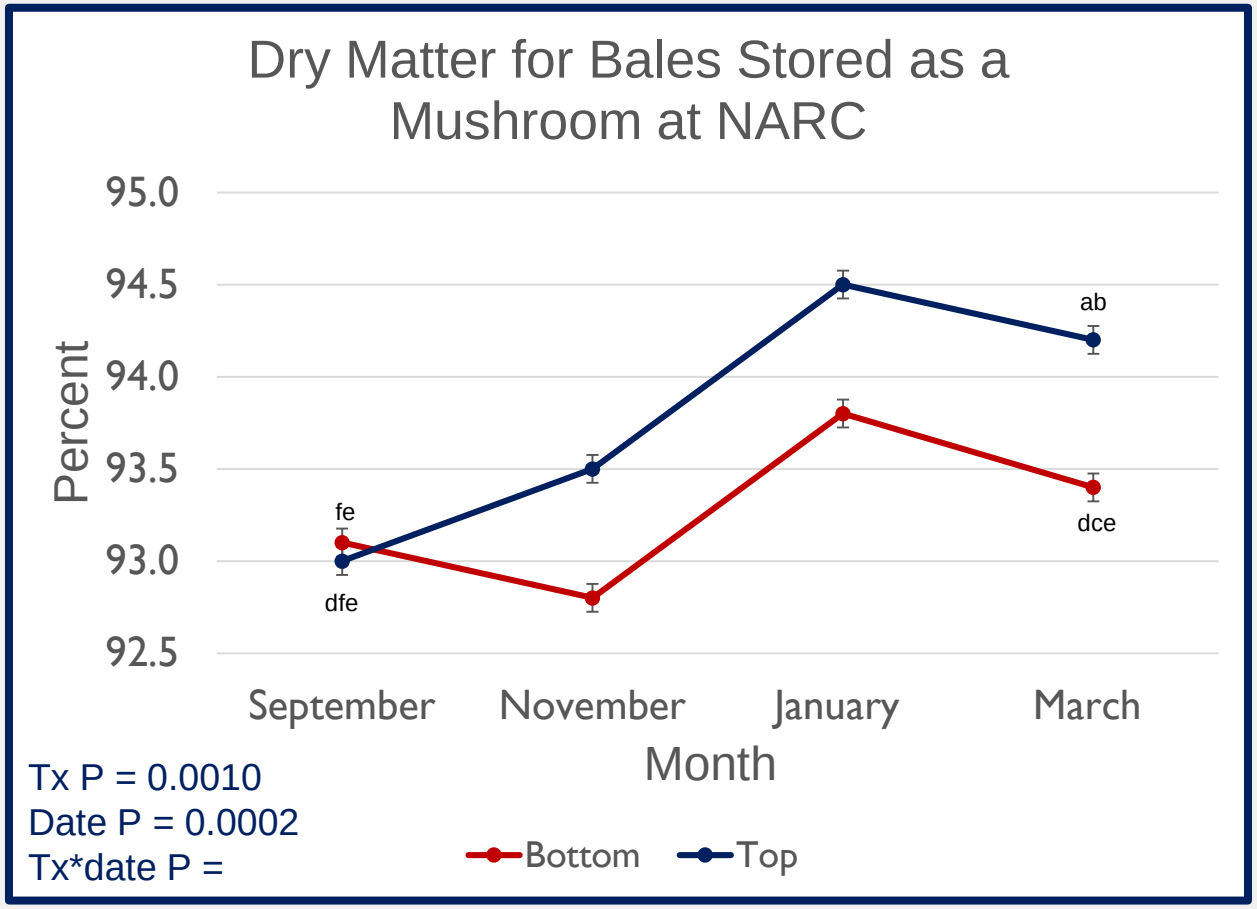


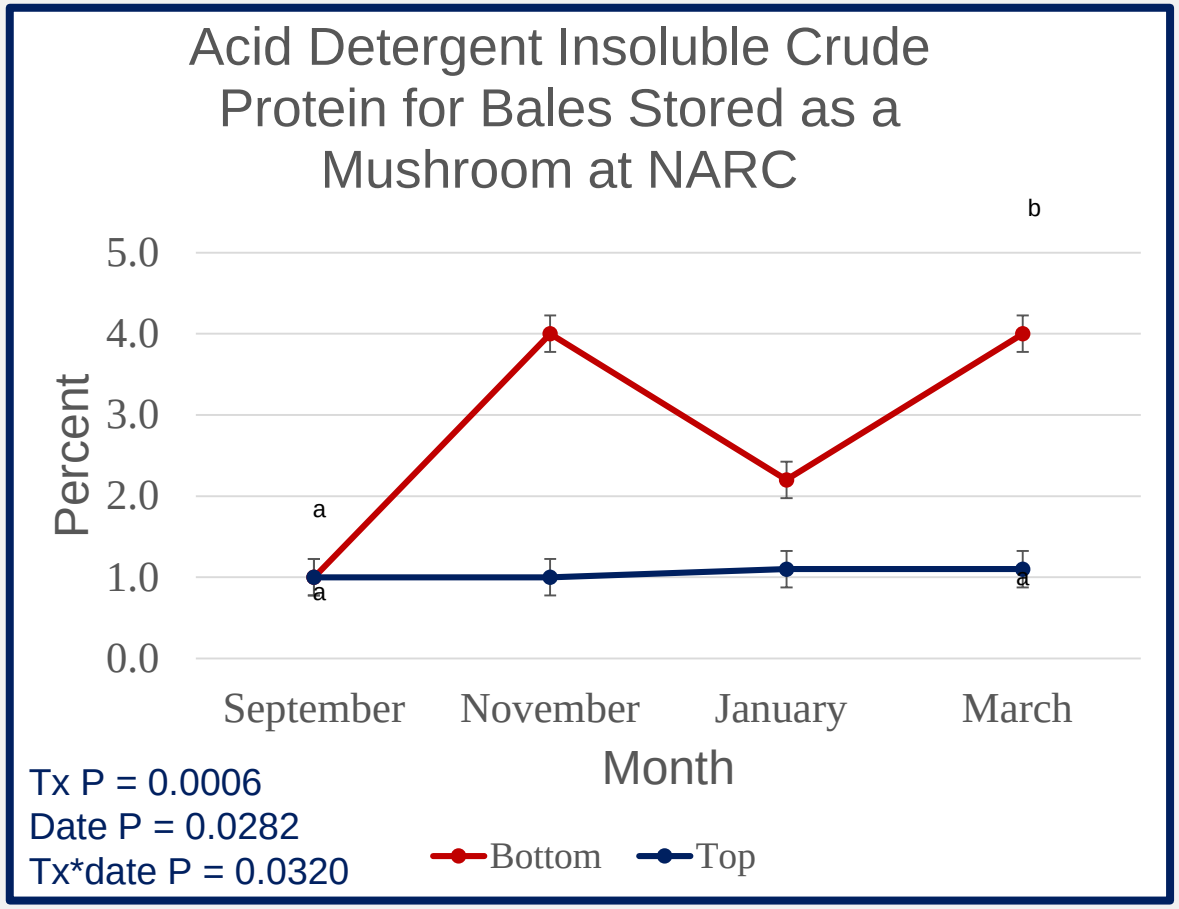




NARC – MUSHROOM







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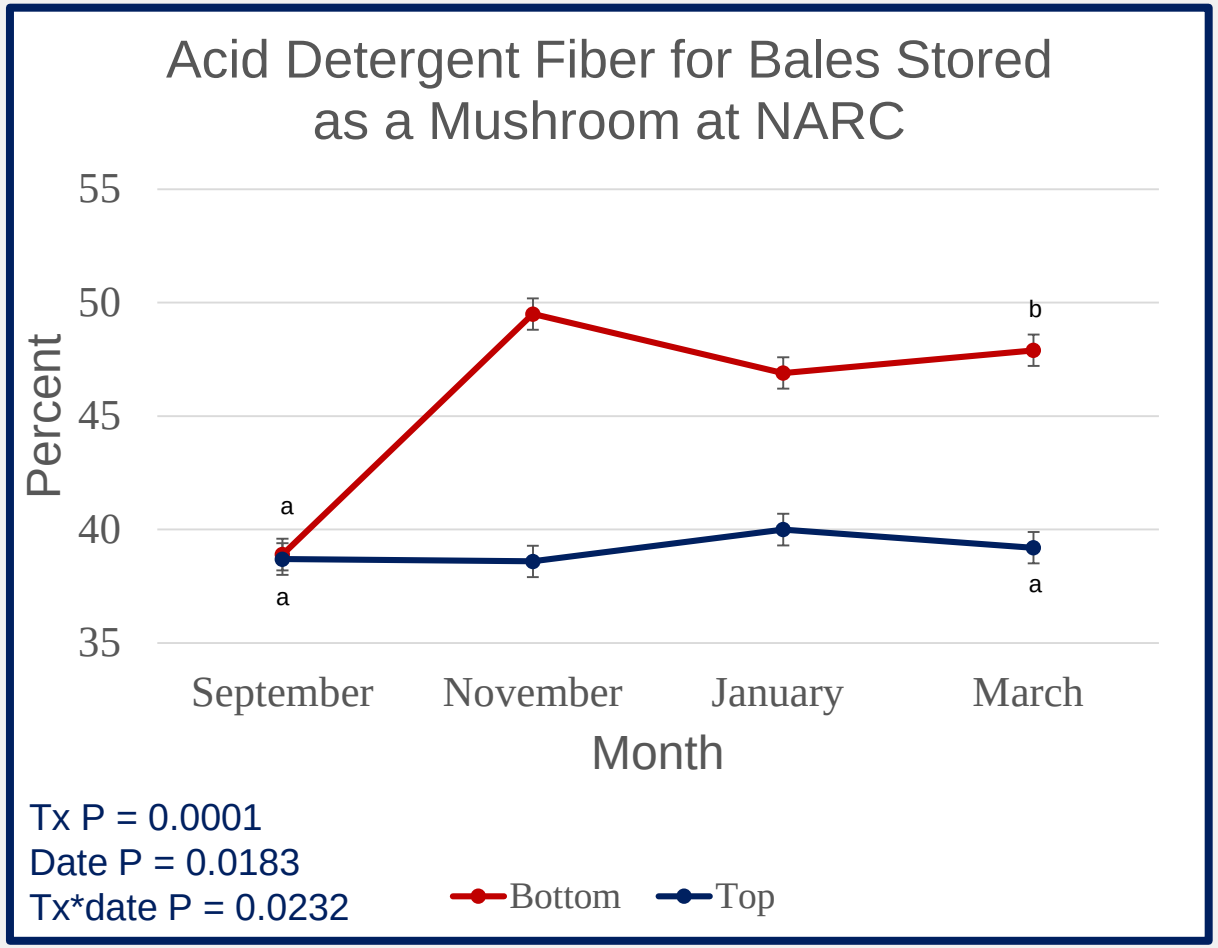

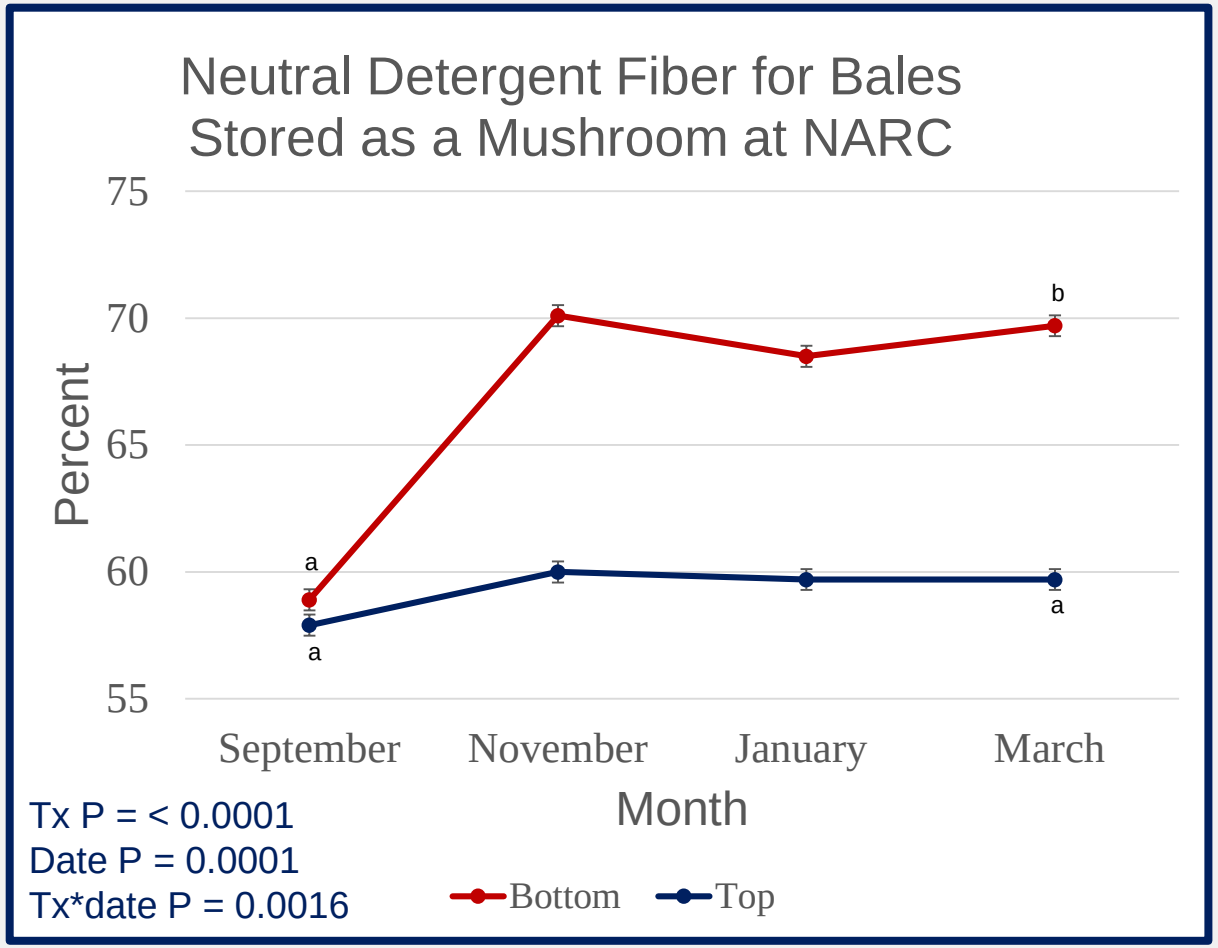

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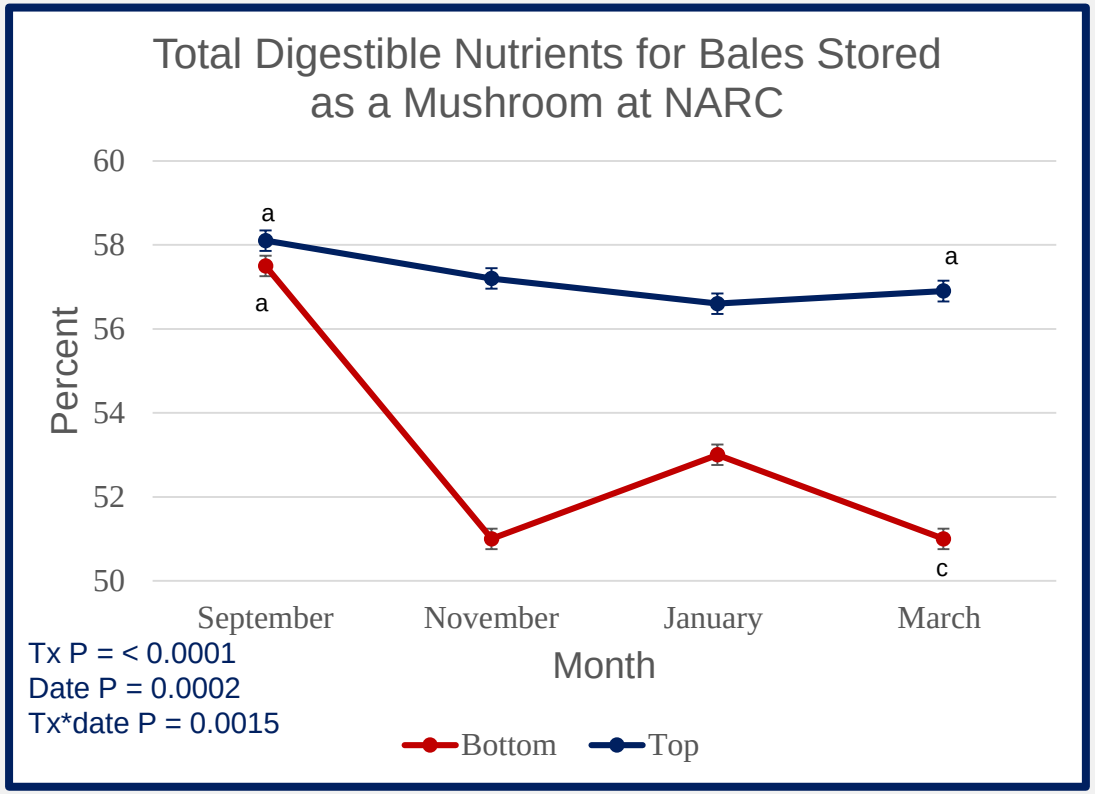
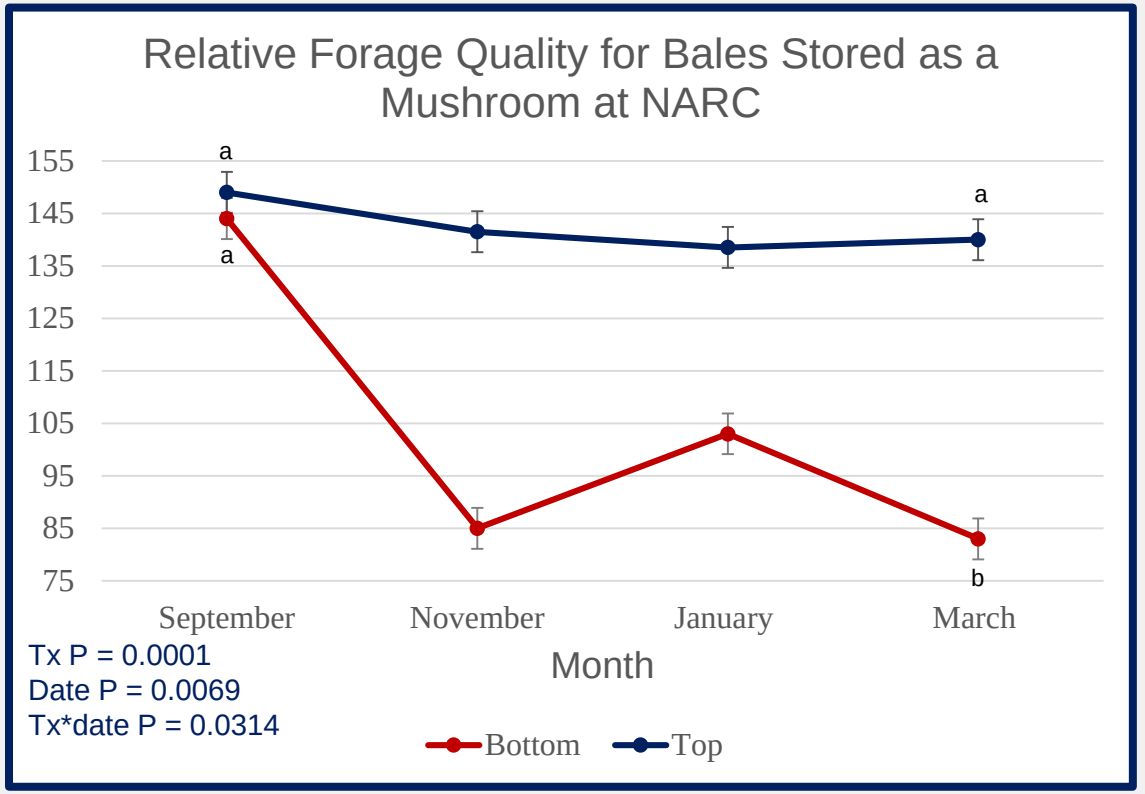




DISCUSSION

BART

- Overall hay quality (% change) did not differ by treatment
  - Bale placement
    - ADF, NDF, and TDN: PYR.I and PYR.O

NARC

- Overall quality (% change) only differed for NDF and TDN
  - MSH
- Bale placement
  - DM: MSH.B
  - ADICP, ADF, NDF, TDN, RFQ: MSH.B
- MSH is not ideal for conditions at Havre

DISCUSSION

Overall quality of bales after storage varies based on geographical location in Montana

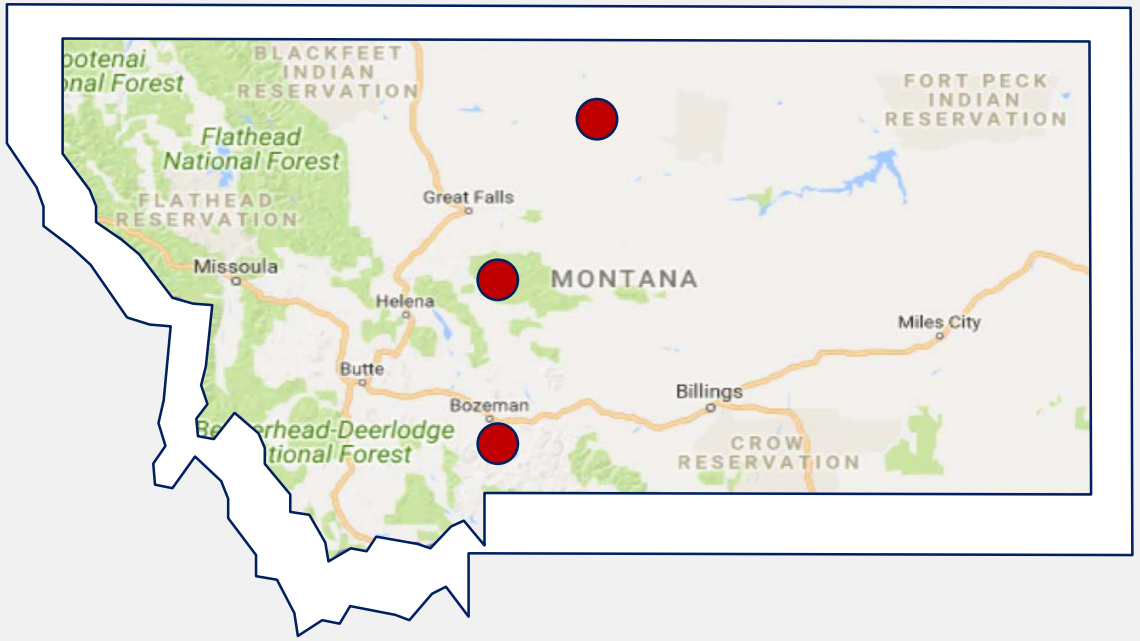
DM and forage quality loss due to:

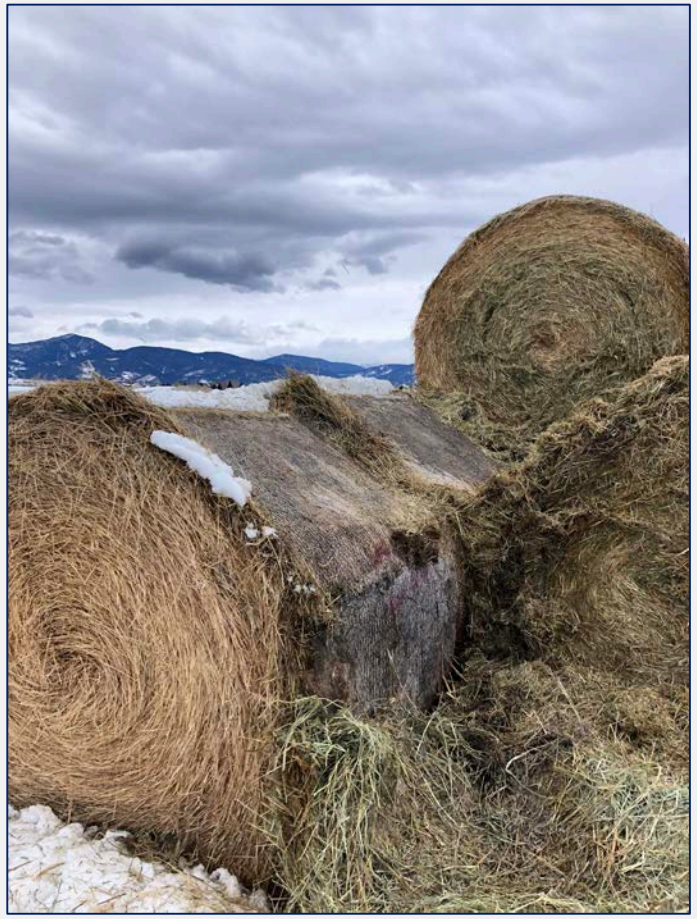
- Precipitation
- Wind speed and direction
- Sun exposure
- Bale density

CONCLUSION

- Indoor stored bales and SS stored bales maintain the most consistent DM and forage quality in Bozeman and Havre, Montana

- Year 2 study
  - Additional location
  - 12” compared to 24” core samples





QUESTIONS?

BALE DENSITY

- BART: 4 lbs/cubic ft.
- NARC: 9 lbs/cubic ft.

WHY 84 DAY FEEDING TRIAL?

- This is the lowest amount of days necessary to determine animal performance parameters

- Resources, we may have ran out of hay

WHAT IS EXPECTED LIGNIN CONTENT IN ALFALFA AT 10% BLOOM?

- Ranges from 5-15% and is less repeatable than ADF and NDF

COST ANALYSIS

- Based on cost, would you recommend this to producers?

- GM HarvXtra = $13-15 per lb
- Conventionally bred = $5-7 per lb
- Conventional = $2-5 per lb

- Milestone Seeds in Billings

- Claimed that Hi-Gest was better across the board for it's cost

WHY HARVXTRA?

- We did research with private company
- However, we recently submitted a grant to test the differences between HarvXtra and Hi-Gest in Montana Environment

PRODUCTION IN TONS

- 1.3 T/acre for both varieties

HOW MUCH PROTEIN DOES A GROWING HEIFER REQUIRE

- Maintenance, and growth requirements
- Growing = 14% because animals are trying to gain muscle during growth

WHAT CONSTITUTES A GOOD QUALITY HAY

- CP > 7% for ruminants
- TDN > 65%
- RFQ values greater than 150
- NDF lower than 40%
- ADF lower than 30%
- NDFD48 ~ 50%
- NDFD240 ~ 65

WOULD IT BE PRACTICAL TO ONLY FEED ALFALFA IN MONTANA

- No, the benefit of using r-lig alfalfa as a Montana producer would mainly be due to a larger harvest window for beef cattle producers.
- Alfalfa would be used as a supplement to meet energy and protein requirements

IF WE FEED LESS WILL ANIMALS RESPOND THE SAME?

- We can't answer that based on this research
- If we feed less animals will most likely meet their nutrient, protein, and energy requirements metabolically.
- However, fill may not be satisfied.

WHY WAS LIGNIN NOT REDUCED BY THE EXPECTED 10-15%

- Seeding year
  - During the seeding year, these plants are using all their resources to grow and create a root carbohydrate system
  - At this time they might not have as much leaf content as post seeding year plants
  - Plants that have already established can work on growing more leaves and already have CHO storage available for their use
- Harvest Date
  - Plants harvested later may have more lignin because of temperatures and less soluble CHOs
  - However, both varieties had a fairly low lignin content

WHAT IS A PRIMARY CONCERN FOR PRODUCERS USING R-LIG ALFALFA?

- Bloat
  - Rapidly digested proteins
  - Lower lignin = more soluble proteins available
- Cost!
  - Mentioned on previous slide