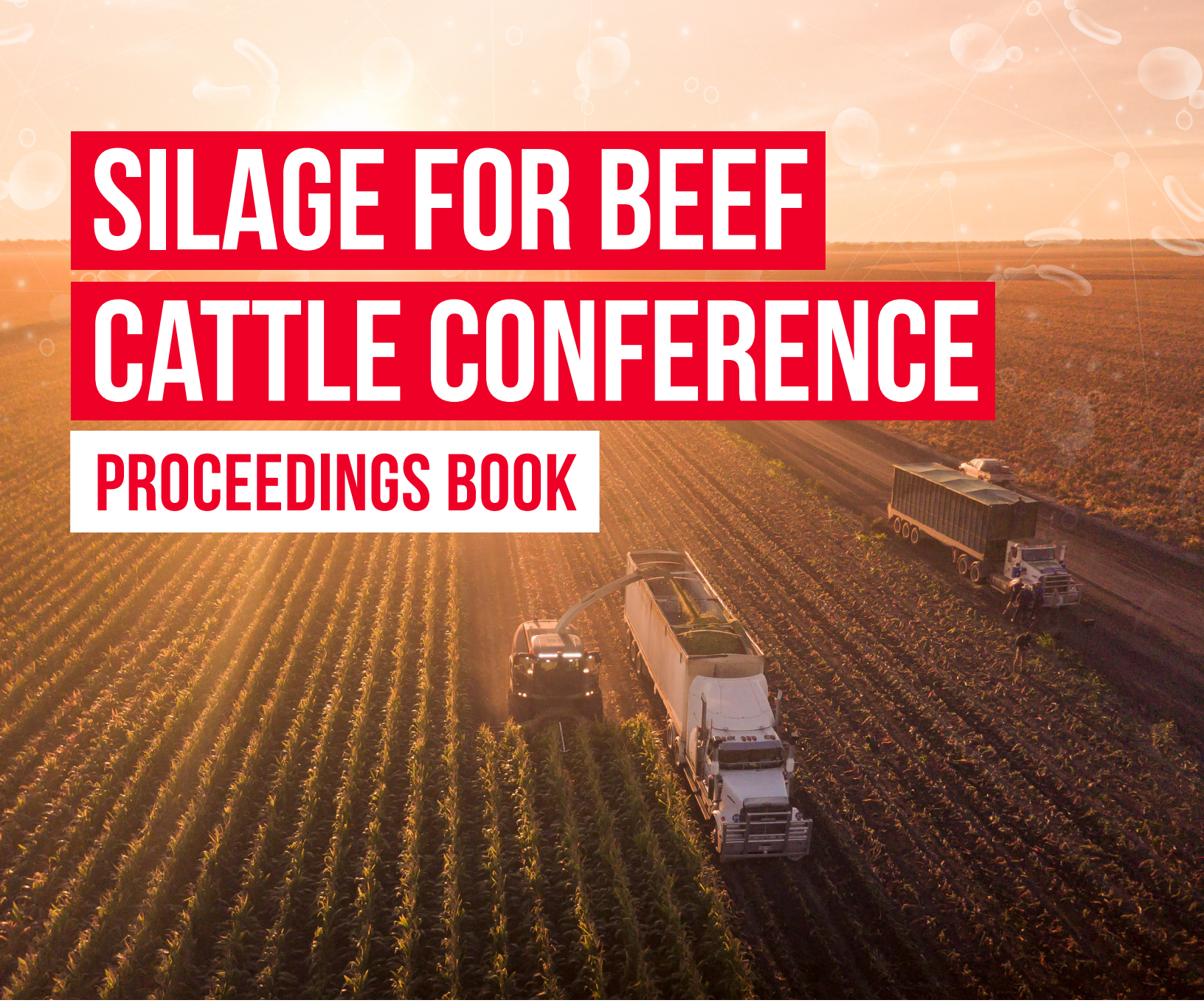
SILAGE FOR BEEF CATTLE CONFERENCE

PROCEEDINGS BOOK



Thursday, June 18, 2026

Eastern Nebraska Research, Extension & Education Center
1071 County Road G, Ithaca, NE 68033

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LALLEMAND

LALLEMAND ANIMAL NUTRITION

IOWA STATE UNIVERSITY
Extension and Outreach
Iowa Beef Center

THE 6TH BIENNIAL

SILAGE FOR BEEF CONFERENCE

AGENDA

8:00 AM **Registration and Welcome**
Aimee Wertz-Lutz,
Iowa Beef Center Director and Iowa State University Extension Feedlot Specialist

8:30 AM **Busting Three Myths Around Developing an Effective Agriculture Safety Program**
Mike Keenan
Keenan Safety Consulting

9:30 AM **Silage Safety, Planning, Pile Design**
Renato Schmidt, Ph.D.,
Forage Products Specialist,
Lallemand Animal Nutrition

10:30 AM **Break**

10:45 AM **Mycotoxins Occurrence, Analysis, and Implications in Silage**
Katie Raver, MS, PAS
Rock River Labs

12:00 PM **Lunch**

1:00 PM **Using Winter Hardy Small Cereals for Silage**
Mary Drewnoski, Ph.D.,
Professor & Beef Systems Extension Specialist

2:00 PM **What is the Energy Value of Corn Silage Today?**
Galen Erickson, Ph.D.,
Nebraska Cattle Industry Professor of Animal Science & Beef Feedlot Extension Specialist

3:00 PM **High Moisture Corn Particle Size Effect on Energy Values**
Kassidy Buse, Ph.D.,
Dairy Technical Services,
Lallemand Animal Nutrition

SPEAKERS

KASSIDY BUSE, PH.D.

Dairy Technical Services, Lallemand Animal Nutrition

Dr. Kassidy Buse, a seasoned professional in the animal science and nutrition field, holds a master's and doctorate degree in Ruminant Nutrition from the University of Nebraska-Lincoln. With a focus on forages, particularly in lower-lignin alfalfa, and extensive research in feed preference studies, she brings a wealth of specialized knowledge and a passion for advancing the intersection of animal behavior, digestibility and nutrition.

MARY DREWNOSKI, PH.D.

Professor & Beef Systems Extension Specialist Animal Science
University of Nebraska - Lincoln

Dr. Mary Drewnoski joined the Department of Animal Science in 2014 as an Assistant Professor and currently serves as a Professor and Nebraska Extension Beef Systems Specialist. Her research focuses on improving the sustainability and profitability of beef production systems through the integration of cover crops, annual forages, and crop residues into grazing systems. By addressing producer-identified challenges, she aims to reduce feed costs, enhance soil health, and optimize land use for cattle operations. This work provides practical solutions that benefit both cattle producers and the environment.

SPEAKERS

GALEN ERICKSON, PH.D.

Nebraska Cattle Industry Professor of Animal Science & Beef Feedlot Extension Specialist

Dr. Galen Erickson joined the Department of Animal Science as an Assistant Professor and Extension Beef Feedlot Specialist in 2001 and has served as a professor since 2010. He was named the Nebraska Cattle Industry Professor of Animal Science in 2012 and was appointed as the Director of the Beef Innovation Hub in 2022. His beef cattle nutrition research focuses on use of byproducts for growing and finishing beef cattle, use of grain and silage for cattle, and the interaction between nutrition, management, and environmental issues including air quality and nutrient management.

MIKE KEENAN

Keenan Safety Consulting LLC

Mike started his career at Gallagher (formerly Grace Meyer Ins.) as a Certified Construction Safety and Health Technician specializing in construction risks. Mikes' work shifted to commercial agriculture and food manufacturing. In 2018, Mike assumed the role of Managing lead for Gallaghers National Risk Control for Food and Agriculture Working Group. Mike served on numerous national and regional boards and committees.

After retiring from full-time work at Gallagher in September 2024, Mike began working with several prior insurance clients through his LLC. Mike works on various specialty projects such as:

- OSHA compliance / response
- Safety Leadership training for new managers
- Property risk control
- Onsite hazard assessments

Mike enjoys working with companies to develop safety and health strategies that enhance efficiencies while protecting valuable assets, including human capital and property. Mike also helps clients make sense of complex regulations to assist employers in compliance with OSHA regulations without sacrificing productivity and efficiency.

SPEAKERS

KATIE RAVER, MS, PAS

Animal Nutrition Technical Services Director
Rock River Laboratory, Inc.

Growing up in rural Illinois, Katie Raver developed a passion for agriculture at a very young age. While attaining her undergraduate degree in animal science at the University of Illinois, she immersed herself in the dairy industry. After completing her undergraduate degree, she completed a summer internship at Rock River Laboratory and further developed her passion forage and feed quality. Upon returning to the University of Illinois for her master's degree in Ruminant Nutrition with Dr. Phil Cardoso, she was able to further explore these interests as her graduate work focused on forage quality and fungal disease. She then moved to Texas after finishing her degree. She has been at Rock River Laboratory for 5 years and in her current role as animal nutrition technical services director she oversees technical support and development. Her interests include forage quality assessment and understanding how environmental and management conditions impact forage quality. She also has a deep seeded interest in exploring ways to improve feed efficiency on farms and how data can be used to maximize the value of feeds on farms.

RENATO SCHMIDT, PH.D.,

Forage Products Specialist, Lallemand Animal Nutrition

Dr. Renato Schmidt has a dairy/beef cattle farm background and is originally from Brazil, where he obtained a B.Sc. degree in Agronomy and a M.Sc. degree in Animal Sciences. He moved to the US to earn his Ph.D. in Animal Sciences from the University of Delaware with Dr. Limin Kung Jr. He worked on innumerous experiments evaluating the effects of different additives on the fermentation of forage crops and specifically developed a methodology to study microorganisms during ensiling using molecular techniques. He's authored and co-authored 18 peer-review manuscripts, 33 scientific abstracts, and 51 technical articles. He joined LANNA as Forage Products Specialist in February/2008 and has given technical/scientific talks in Brazil, Canada, Mexico, Costa Rica, Nicaragua, Scotland, Czech Republic, England and throughout the USA.

BUSTING THREE MYTHS AROUND DEVELOPING AN EFFECTIVE AGRICULTURAL SAFETY PROGRAM

Mike Keenan

Notes

Busting Three Myths Around Developing an Effective Agricultural Safety Program
Mike Keenan
Keenan Safety Consulting LLC

SAFETY FIRST
Myth #1

Safety First is a Lie

- How many of you wrote your Business Plan with Safety at the very top

#1 SAFETY

Safety First Is a Lie

- In Agriculture our # 1 hazards are the # 1 essentials for production

Safety is the prevention of human pain and suffering due to work related injuries and illness

Definition of Safety

- The state of being safe; freedom from the occurrence or risk of injury, danger, or loss.
- The quality of averting or not causing injury, danger, or loss.
- The action of keeping safe.

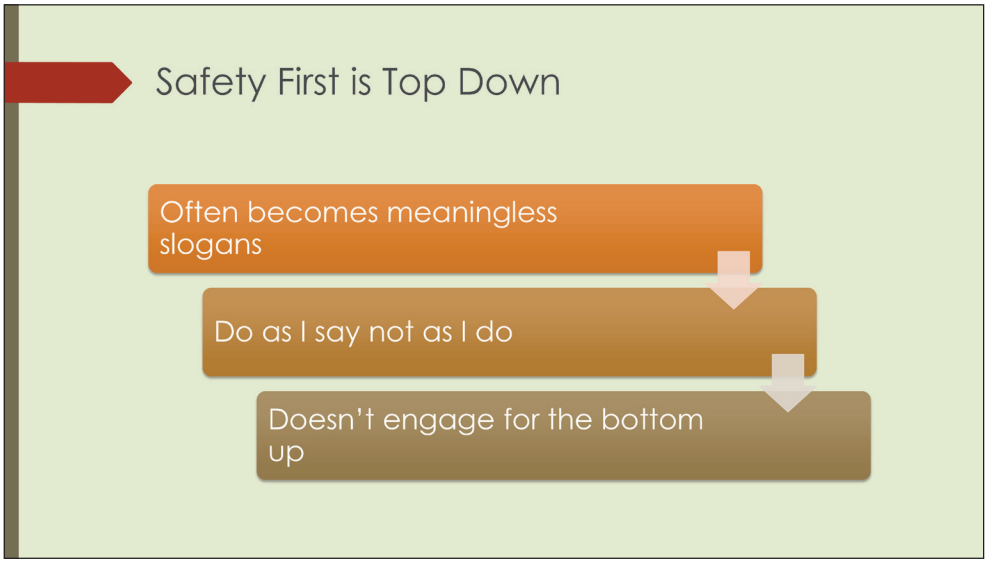
Hazard related to Risk

Hazards always exist

Risks can increase or decrease

- Risk can be measured
- Risk can be managed
- Risk can be controlled
  - Elimination
  - Replace or Substitute
  - Engineering
  - Administrative
  - Protective measures such as PPE

Understanding and Managing Risk
Managing Risk is an Essential part of all our operations
Managing Risk is more effective and meaningful way to build our program


Safety First is Top Down
Often becomes meaningless slogans
Do as I say not as I do
Doesn't engage for the bottom up

Safety is everyone's reasonability All the Time

Leadership is essential

Management must Lead safety

Employee engagement at all levels

The Most Effective Safety Programs are Built Around OSHA Compliance

Myth #2

OSHA Standards are the minimum
OSHA Standards do not adequately address the hazards unique to Agriculture
OSHA Standards exempt many hazards common in agriculture
Confined Space
Fall Protection
Lock Out Tag Out

OSHA's Ag Standards 1910.26

Confusion over the Agricultural Exemptions

10 or few employees

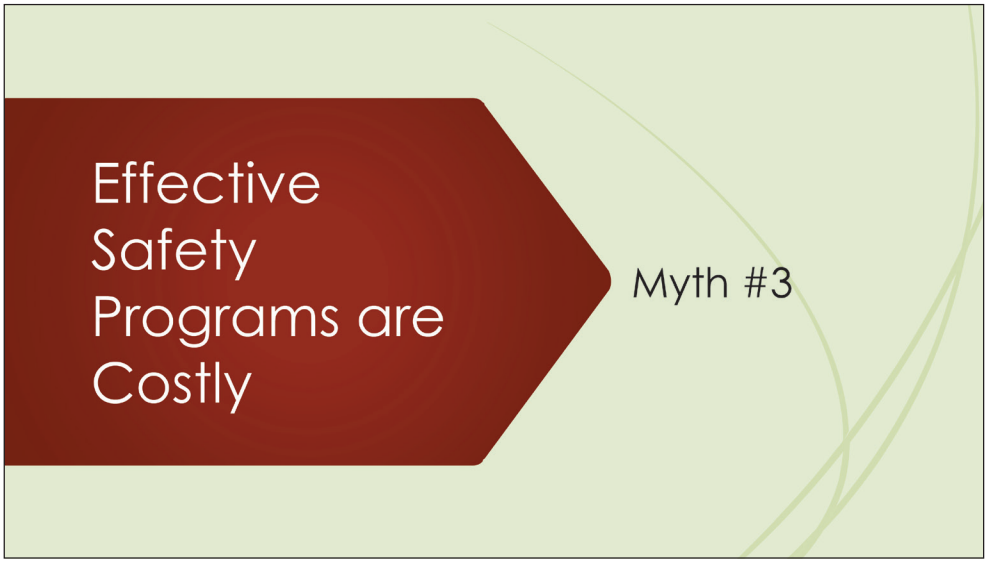
Meant for Family Farms with limited number of nonfamily employees

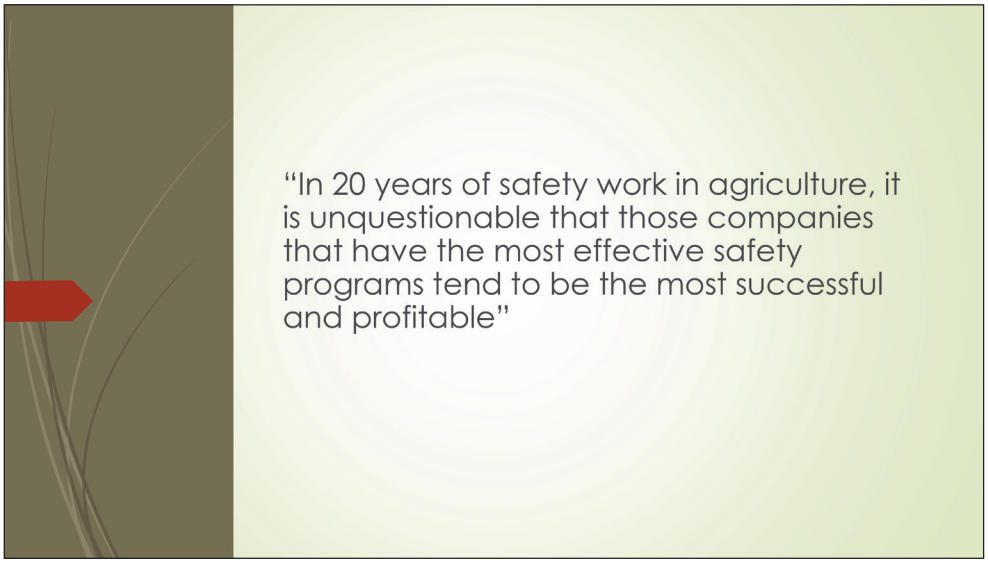
Understanding and Addressing Specific Hazards is More Effective than relying on OSHA Standards alone

Industry Best Practices

Feedyard 15 Program

Written programs that specifically address unique hazards


Effective Safety Programs are Costly
Myth #3


"In 20 years of safety work in agriculture, it is unquestionable that those companies that have the most effective safety programs tend to be the most successful and profitable"

Days Away Restricted or Transferred

Industry	Recordable Cases	Total DART	Days Away	Transfer or Restriction	Other Recordable
Private Industry	2.6	1.5	0.9	0.5	1
Construction	2.2	1.3	0.9	0.4	0.9
Residential	2.9	1.6	1.3	0.3	1.3
Non-Residential Building Construction	1.9	1.2	0.8	0.4	0.7
Agriculture Fishing and Forestry	3.9	2.5	1.4	1.1	1.4
Dairy Cattle and Milk Production	3.2	2.4	1.7	0.7	0.9
What is your rate?					

Productivity negative side

- Do you have any extra employees?
- Who replaces those who can't work?
- Training new replacement staff
- Loss of institutional knowledge
- Now you're paying two people to do one person's job.
- Morale issues
- When you get behind "stuff" happens

Dollars & Cents
Work Injury Costs - 2023
COST
total in 2023 ---- $176.5 billion
per worker ------ $1,080
per death ------ $1,460,000
per medically consulted injury ----- $43,000
The true cost to the nation, employers, and individuals of work-related deaths and injuries is much greater than the cost of workers' compensation insurance alone. The figures above show National Safety Council estimates of the total economic costs of work-related deaths and injuries.

Lost Time Due to Injuries
Time Lost Due to Work-Related Injuries - 2023
DAYS LOST
total in 2023 ------ 103,000,000
due to injuries in 2023 ------ 70,000,000
due to injuries in prior years --------- 33,000,000
in future years from 2023 injuries --- 55,000,000
Days lost estimates do not include time lost by people with nondisabling injuries or other people directly or indirectly involved in the incidents.

How do you measure Safety
HOW DO WE MEASURE SOMETHING THAT DIDN'T HAPPEN
WHAT DATA CAN WE USE
HOW DO WE SET SAFETY GOALS

The ROI in Safety can be measured
Work Comp Insurance Experience Mod Rating / Premiums
OSHA 300 Logs
Days Away From Work
Days Restricted
Days Transferred from assigned roll
Employee Turnover Rate
Equipment Repairs and Down Time

What about the things that hard to quantify

- Employee moral
- Community Goodwill
- Markets for our products (Social Marketing)
- Employees that want to work for the best companies

Silage Safety

Busting Three Myths Around Developing an Effective Agricultural Safety Program

Mike Keenan

Busting Three Myths Around Developing an Effective Agricultural Safety Program

Mike Keenan

SILAGE SAFETY, PLANNING, AND PILE DESIGN

Renato Schmidt, Ph.D.

Notes

Safe Design and Management of Silage Piles

Renato J. Schmidt, Ph.D.
Tech. Services / Forage Products
rschmidt@lallemand.com

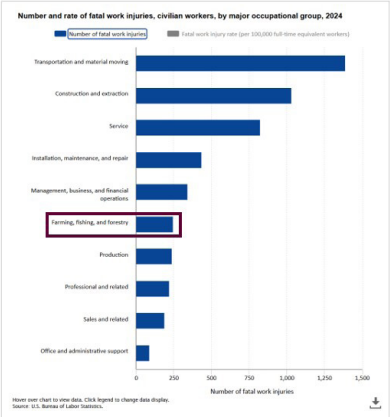
LALLEMAND ANIMAL NUTRITION ■ SPECIFIC FOR YOUR SUCCESS 06/18/2026 LALLEMAND 1

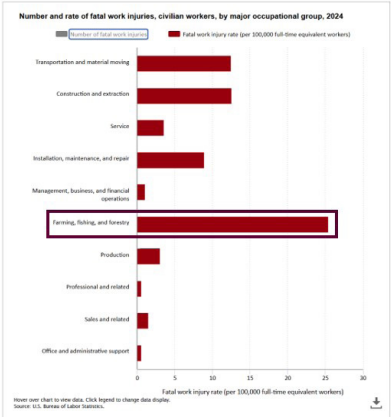
Introduction

- Objective of ensiling: to retain most of the original nutrients and DM of the plant at the time of harvest, and create a stable product
- Piles are inexpensive but losses can be > 50% without adequate design and proper management
- The increase in pile size and inappropriate design pose additional hazards to workers and elevate the probability of accidents

LALLEMAND ANIMAL NUTRITION ■ SPECIFIC FOR YOUR SUCCESS LALLEMAND 2

Safety should be everyone's highest priority!





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https://www.bls.gov/charts/census-of-fatal-occupational-injuries/number-and-rate-of-fatal-work-injuries-by-occupation.htm (2026)

LALLEMAND 3

Prevention is the key to safety

- The biggest risk around silage is **complacency** – the more we work around silage, the more comfortable we become, and it's easy to forget the hidden dangers
- Regular meetings and safety trainings with everyone involved in silage management should take place

LALLEMAND ANIMAL NUTRITION ■ SPECIFIC FOR YOUR SUCCESS

LALLEMAND 4

Personnel

- Insufficient breaks, long hours, not enough sleep, meals, hydration?
- Extra "help" (unprepared, untrained)
  - Friends, family members, youth
- Personal protective equipment (ear plugs, gloves, goggles)
- Large clothes, long hair
- Pre-harvest meeting!

LALLEMAND ANIMAL NUTRITION ■ SPECIFIC FOR YOUR SUCCESS LALLEMAND 5

Pre-harvest meeting – items for discussion

- Thorough inspection of the harvesters, trucks and tractors
- Safety inspection
- Field monitoring for DM determination/ harvest time
- Particularities of each crop, inoculant choice
- Challenging situations during harvest – what to do?
- Storage unit design/management
- Importance of packing and covering

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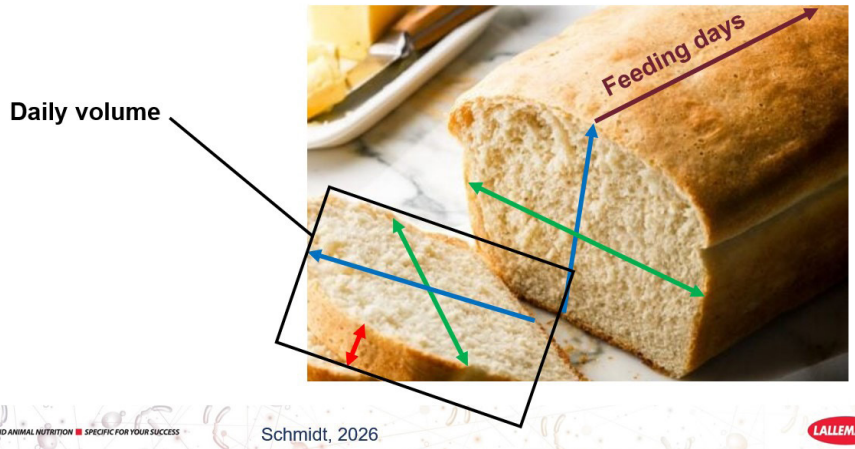
Think of a loaf of bread when start dimensioning your silo



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Schmidt, 2026

LALLEMAND 7

Feed-out rate for proper pile design

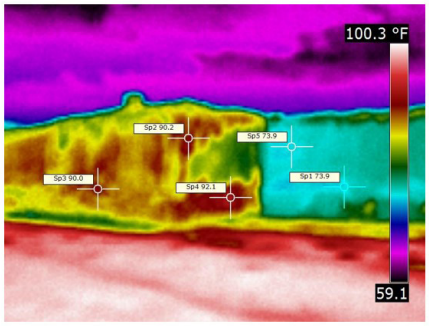
- When first designing the pile, use a face removal rate of 12 in/day
- Remove a minimum 6 in/day of the entire face – more in hot weather and for drier/ poorly packed silages
- Do not fill higher than unloading equipment can safely reach

LALLEMAND ANIMAL NUTRITION ■ SPECIFIC FOR YOUR SUCCESS

Kung, 2006; Clark et al., 2008

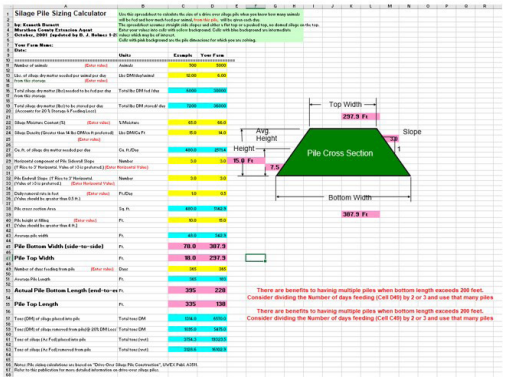
LALLEMAND 8

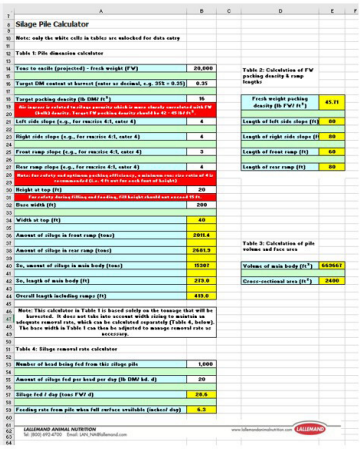
Proper pile width to avoid multiple open faces



Schmidt, 2009

Planning: pile sizing calculators

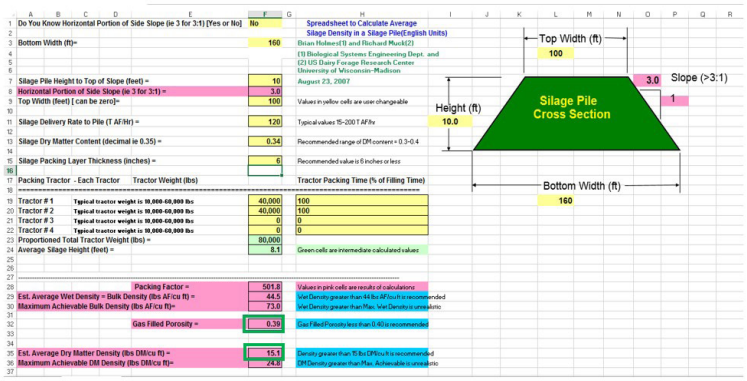




https://fyi.extension.wisc.edu/forage/harvest/#sstorage

Charley & Holmes, 2015

Planning: pile density calculator



1	Do You Know Horizontal Portion of Side Slope (ie 3 for 3:1) [Yes or No]	No	Spreadsheet to Calculate Average
2			Silage Density in a Silage Pile(English Units)
3	Bottom Width (ft)=	160	Brian Holmes(1) and Richard Muck(2)
4			(1) Biological Systems Engineering Dept. and
5			(2) US Dairy Forage Research Center
6			University of Wisconsin-Madison
7	Silage Pile Height to Top of Slope (feet) =	10	August 23, 2007
8	Horizontal Portion of Side Slope (ie 3 for 3:1) =	3.0	
9	Top Width (feet) [can be zero]=	100	Values in yellow cells are user changeable
10			
11	Silage Delivery Rate to Pile (T AF/Hr) =	120	Typical values 15-200 T AF/hr
12			
13	Silage Dry Matter Content (decimal ie 0.35) =	0.34	Recommended range of DM content = 0.3-0.4
14			
15	Silage Packing Layer Thickness (inches) =	6	Recommended value is 6 inches or less
16			
17	Packing Tractor - Each Tractor Tractor Weight (lbs)		Tractor Packing Time (% of Filling Time)
18	----------		----------
19	Tractor # 1 Typical tractor weight is 10,000-60,000 lbs	40,000	100
20	Tractor # 2 Typical tractor weight is 10,000-60,000 lbs	40,000	100
21	Tractor # 3 Typical tractor weight is 10,000-60,000 lbs	0	0
22	Tractor # 4 Typical tractor weight is 10,000-60,000 lbs	0	0
23	Proportioned Total Tractor Weight (lbs) =	80,000	
24	Average Silage Height (feet) =	8.1	Green cells are intermediare calculated values
25			
26			
27	----------		
28	Packing Factor =	501.8	Values in pink cells are results of calculations
29	Est. Average Wet Density = Bulk Density (lbs AF/cu ft) =	44.5	Wet Density greater than 48 lbs AF/cu ft is recommended
30	Maximum Achievable Bulk Density (lbs AF/cu ft)=	73.0	Wet Density greater than Max. Wet Density is unreasonable
31			
32	Gas Filled Porosity =	0.39	Gas Filled Porosity less than 0.40 is recommended
33			
34			
35	Est. Average Dry Matter Density (lbs DM/cu ft) =	15.1	Density greater than 15 lbs DM/cu ft is recommended
36	Maximum Achievable DM Density (lbs DM/cu ft)=	24.8	DM Density greater than Max. Achievable is unreasonable
37			

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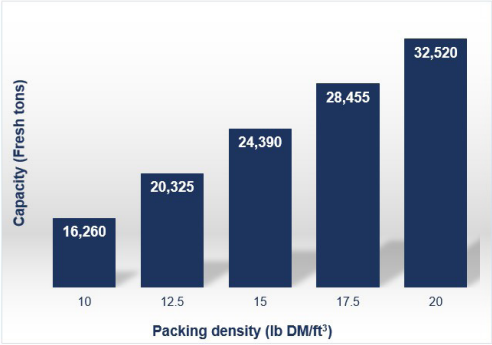
https://fyi.uwex.edu/forage/harvest/#sstorage

LALLEMAND 11

Better the packing job, higher the tonnage stored per area

- UW pile capacity calculator
  - 35% DM
  - 100' W × 400' L × 20' H
  - 3' dome
  - 4:1 run:rise (sides)
  - 50' front ramp
  - 50' back ramp



LALLEMAND ANIMAL NUTRITION ■ SPECIFIC FOR YOUR SUCCESS

https://fyi.extension.wisc.edu/forage/harvest/#sstorage

LALLEMAND 12

Pile location and area preparation

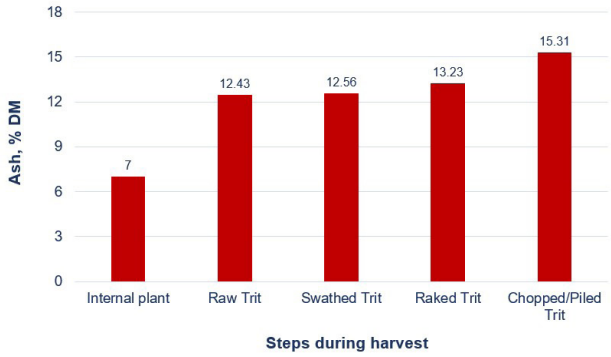
- Allow access throughout the year (weather)
- Near enough to the feeding/ commodity area
- Enough maneuvering space
- 1% slope to allow rainfall and seep drainage
- Base preparation:
  - Concrete or asphalt (best); macadam/crush stones?
  - Maintain the base, cover holes and cracks, and smoothen the surface

LALLEMAND ANIMAL NUTRITION ■ SPECIFIC FOR YOUR SUCCESS

Clark and Holmes, 2008

13

Tract the source of dirt contamination to minimize it



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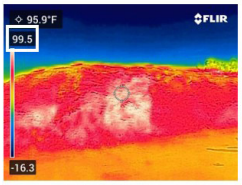
Leonard and Schmidt, 2024

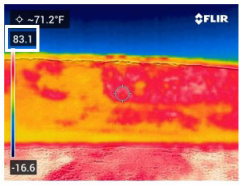
14

Open face direction and sun exposure

Corn silage



Winter crop silage



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Silva, 2025

LALLEMAND 15

Equipment operation

- Coordinate traffic during harvest
  - Packing route? Collisions?
- Travelling on roadways – use proper lighting and safety reflective signs
  - Avoid busy hours of traffic
- ROPS, safety belt
- Never repair any machinery while it is running…!!

https://www.wbay.com/2020/07/23/driver-killed-passenger-seriously-hurt-in-collision-with-farm-equipment/

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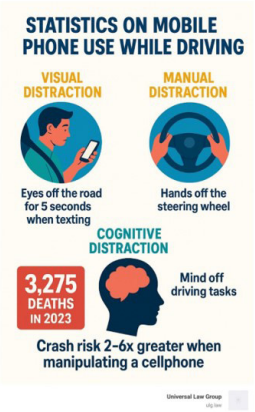
LALLEMAND 16

Cell phones – establish a communication protocol

- Reduced awareness, distraction
  - Failure to pay attention to hazards, coworkers, or equipment
- Slower reaction time
  - Slips, moving equipment
- Hands occupied
  - Improper grip on handrails, ladders, or tools
- Loss of balance
  - Stairs - even while walking



LALLEMAND ANIMAL NUTRITION ■ SPECIFIC FOR YOUR SUCCESS LALLEMAND 17

Fill silage piles safely

- Establish a driving procedure to prevent collisions when two or more pack/push tractors are used – and for a fast rate of harvest
- Raise the truck's dump body only when the vehicle is on a firm surface
  - Trucks become less stable as the bed is raised

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Equipment rollover

- Tractor rollovers are the single deadliest type of injury incidents on farms in the US
- How can they happen?
  - Machinery breakdown
  - Uneven ground, soft spots
  - Steep ramps/slope
  - Overfilled trucks
  - Human error

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LALLEMAND 19

Pack safely

- Communicate effectively with those around you
- Load and pack forage uniformly to help prevent roll-overs during filling, especially if tractors need to be backed up steep slopes (to prevent roll-backs)
- Packing tractor operators should always form a progressive wedge of forage

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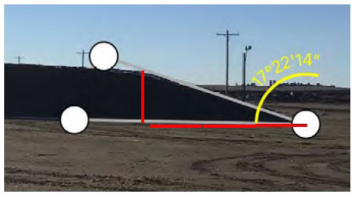
LALLEMAND 20

Fill silage piles and bunkers safely

- Maintain a run to rise ratio of 4:1 or 3:1, which is equivalent to a 16 to 18º angle, on the sides and ends of a drive over pile for safety and better packing job
- Only trained and experienced personnel should be allowed to operate silage equipment

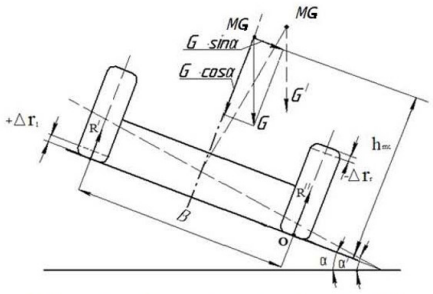


LALLEMAND ANIMAL NUTRITION ■ SPECIFIC FOR YOUR SUCCESS LALLEMAND 21

A push-up pile with 45° side-angles (!)

LALLEMAND ANIMAL NUTRITION ■ SPECIFIC FOR YOUR SUCCESS LALLEMAND 22

Driving along a slope affects the weight distribution and it is not safe!



Schematic of change in centre of gravity (MG) vector direction due to the load redistribution when changing the angle of the slope

Slope	Grade	Angle	Packing wt. (lb.)*
Flat	0	0.0°	20,000
1:10	10%	5.71°	19,900
1:5	20%	11.3°	19,620
3:10	30%	16.7°	19,160
2:5	40%	21.8°	18,560
1:2	50%	26.6°	17,880
1:1	100%	45.0°	14,140

* - Packing weight is the weight measured perpendicular to the ground: i.e. the effective packing weight

LALLEMAND ANIMAL NUTRITION ■ SPECIFIC FOR YOUR SUCCESS

Gorshkov *et al* 2019

LALLEMAND 23

Considerations about silage additives

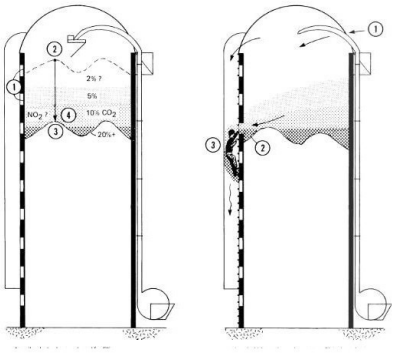
- Formulations with enzymes
  - Potential allergic reactions
- Chemical additives
  - Corrosiveness
  - Handle safely, use proper PPE
  - Keep it away from sources of heat

LALLEMAND ANIMAL NUTRITION ■ SPECIFIC FOR YOUR SUCCESS

LALLEMAND 24

Silo gases

- Silo gases are mostly produced around two weeks of ensiling
- Carbon dioxide (CO_2)
  - Odorless, colorless, tasteless
  - The presence of CO_2 may be detected as a heat haze or shimmering effect



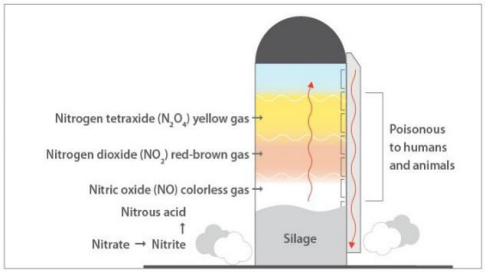
LALLEMAND ANIMAL NUTRITION ■ SPECIFIC FOR YOUR SUCCESS

Canada Plan Service (1988)

LALLEMAND 25

Silo gases

- Nitrogen dioxide (NO_2)
  - "The" silo gas
- Nitrate accumulation in the plants
  - Drought, hail, frost, soil fertility imbalance (N)
  - Accumulates in the bottom of the plants
- Ensiling reduces nitrates in ~ 40%



LALLEMAND ANIMAL NUTRITION ■ SPECIFIC FOR YOUR SUCCESS

Griswold (2020)

LALLEMAND 26

Silo gases

- NO_2 is highly toxic
  - Heavier than air
  - Orange coloration
  - Smells like laundry bleach
- Converted to HNO_3 (lungs) –
  - Corrosive to the bronchioli
  - Pulmonary edema (8 – 30 h)
- Bronchiolitis obliterans (10 – 30 d)
- Fatality rate: 9 – 20%

LALLEMAND ANIMAL NUTRITION ■ SPECIFIC FOR YOUR SUCCESS LALLEMAND 27

Create a safe silage face during feedout

- Never dig the bucket into the bottom of the silage. This can create an overhang
- Never drive parallel to, and in close proximity of, the feedout face of an over-filled pile

LALLEMAND ANIMAL NUTRITION ■ SPECIFIC FOR YOUR SUCCESS LALLEMAND 28

Create a safe silage face during feedout

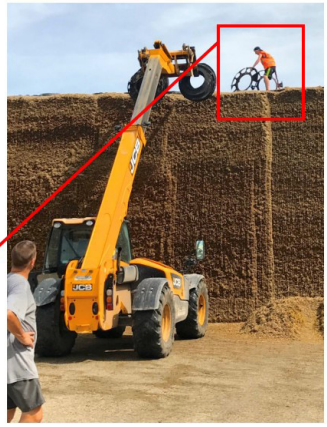
- Use a concave movement to avoid the formation of overhangs
- Keep the face smooth and clean
- Never stand closer to the face less than 3 times its height
- Never take core samples if the feedout face is more than 8 ft tall

LALLEMAND ANIMAL NUTRITION ■ SPECIFIC FOR YOUR SUCCESS

LALLEMAND 29

Face management

- Use caution when removing plastic, tires or gravel bags from drive-over piles, especially near the walls and edge of the feedout face.
  - When working in or on an over-filled pile, always wear a harness connected to a safety line



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LALLEMAND 30

Create a safe silage face during feedout

- Do not "pitch" spoiled silage. It is simply too dangerous to remove spoilage from the top of bunker silos and piles
  - Only remove spoiled silage with equipment operated safely from ground level
- Post warning signs to ensure visitors and bystanders observe this rule

LALLEMAND ANIMAL NUTRITION ■ SPECIFIC FOR YOUR SUCCESS

LALLEMAND 31

Silage avalanches

- Avoid packing against old silage
- Crop type, chop length
- Moisture infiltration
- Changes in crop DM%
- Filling strategy
- Packing density
- Feedout management

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LALLEMAND 32

Spoiled and contaminated silages

Don't smell or touch deteriorated silage!

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LALLEMAND 33

Careful when removing plastic and tires

- Tire / bags and plastic removal
- Tripping and falling over
- Stagnant water
- Mosquitoes, hornets, spiders, snakes…

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LALLEMAND 34

I'm inside the pick-up truck, it's OK…

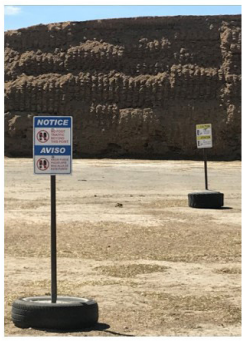
- It takes 15,000 to 25,000 lb. of weight to crush the cabin
- Considering 40 lb./ft^3 density (FM), and assuming 20,000 lb. of weight from an avalanche, the equivalent volume needed to crush the cabin is:
  - **500 ft^3, or roughly an 8×8×8-ft cube**

Kludt, 2026

LALLEMAND ANIMAL NUTRITION ■ SPECIFIC FOR YOUR SUCCESS 35

Some key safety points to take away

1) Be aware of your surroundings
2) Keep a safe distance
3) Have a buddy with you
4) Fill silos safely, be careful
5) Maintain bunkers and piles carefully
6) Feed-out correctly
7) Inspect cautiously
8) Be wary of silo gases



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Silage Safety, Planning, and Pile Design

Renato Schmidt, Ph.D.

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MYCOTOXINS OCCURRENCE, ANALYSIS, AND IMPLICATIONS IN SILAGE

Katie Raver, MS, PAS

Notes

Mycotoxins Occurrence, Analysis, and Implications in Silage

Katie Raver, MS, PAS

Importance of mycotoxins in the industry

Mycotoxins represent a major economic challenge to the beef industry. Not only do mycotoxins represent potential health and efficiency concerns, but they can also cause increased dry matter and nutritive losses in the feedstuffs themselves. Current estimates based on a three-year study are that over 81% of feed produced in the Americas, Europe and Asia have some degree of mycotoxin contamination, and globally, greater than 30% of feed is co-contaminated with mycotoxins (Magnoli et. al., 2019) (Ogunade et. al., 2018).

Mycotoxins are secondary metabolites produced by fungi. Although thousands of fungal metabolites have been identified and hundreds of mycotoxins have been classified, only a small number are regulated by government agencies. In ruminant production, the most important mycotoxins are associated with *Aspergillus, Alternaria, Fusarium,* and *Penicillium* species. Mycotoxins can occur in both commodity feeds and forages, but ensiled feeds are a particular concern for producers (Jouany and Diaz, 2005). One study from the Netherlands found that ensiled forages contributed three times more to mycotoxin intake than dry feeds.

Common mycotoxins and their origin

Most regulated mycotoxins include aflatoxins, deoxynivenol, HT-2, T-2, fumonisins, zearalenone, ochratoxins, and alkaloids. As mentioned previously, mycotoxins are secondary metabolites of these fungal species and are produced during stress conditions (Bandyk, 2024). While some of the toxins are produced primarily during the crop growth stage, others may be produced in the ensiling or storage phase of forage production. *Fusarium spp*. and *Aspergillus spp.* represent risk for preharvest contamination, while toxigenic mold from *Aspergillus spp* and *Penicillium spp.* Although it is common to test feeds for both molds and mycotoxins, presence of mold in a sample does not necessarily indicate mycotoxin presence, nor does presence of mycotoxins indicate presence of mold. These fungal species thrive in a variety of environments and different climates that lead to their production are described in Table 1.

Common fungal species, their respective toxins, and favored climate conditions for growth.

	Toxins	Location	Stability	Climate
Fusarium Spp.	DON, Zea, Fumonisins, T2, enniatins, beauvericin	Field	Stable/Debated	Cool, damp, ear and stalk rot
Claviceps purpurea	Ergot Alkaloids	Field	Debated	
A. flavus	Aflatoxins	Field/Storage		Hot, Humid, Drought
A. parasiticus	Aflatoxins	Field/Storage		Hot, Humid, Drought
P. ochracues	Ochratoxin A	Storage	Stable/Degraded	Acid Tolerant, Cool/Wet
P. verrucosum	Ochratoxin A	Ensilage	Stable/Degraded	Acid Tolerant, Cool/Wet
P. roqueforti, paneum	Roquefortin. Mycophenolic acid	Ensilage	Stable	Acid Tolerant, Cool/Wet
A. Fumigatus	Roquefortin. Mycophenolic acid	Ensilage	Stable	Hot, Humid, Drought
Monascus ruber	Manacolin, Citrinin	Ensilage	Stable/Degraded	

Impact of mycotoxins on cattle performance

Impact of mycotoxins vary based on various factors including age of cattle, physiological state, and other nutritional and environmental stress factors. Many mycotoxins impact young growing cattle to a greater extent than mature cattle due to the less developed rumen. Bacteria in a fully functional rumen can break down many of the mycotoxins, however rumen metabolites of the parent mycotoxin can be equally as toxic. Impacts of mycotoxins and detoxification vary based on the compound.

Aflatoxin

Although there are several aflatoxins produced including B1, B2, G1, and G2, however, B1 has garnered the most attention. This is due to its status as a potent carcinogen. It has been reported that incidence and concentration of Aflatoxins are relatively low compared to other mycotoxins (Ogunade et. al., 2018). This trend is also observed in the Rock River Laboratory commercial database. Degradation of AFB1 in the rumen has been documented to vary between ~40% to nearly 0%. Additionally, in vitro studies have found impaired digestion when rumen fluid was dosed with 1-10 ppb of AFB1 (Jouany and Diaz, 2005).

Symptoms of aflatoxicosis include decreased intake, rough coat, and enlarged liver. Reduced feed efficiency and increased liver size has been documented in steers and cattle fed a diet containing 100-600ppb (Ogunade et. al., 2018). More recent work has found lambs consuming 2 ppb led to failure of acquired immunity, influencing the animal's ability to handle bacterial and parasitic infections.

Deoxynivenol (DON)

A properly functioning rumen has a high capacity for detoxification of DON. Studies have found that after 24 hours of DON dosing only 30% of the compound was absorbed by the animal. In the rumen, DON is degraded to DOM-1. When tracked throughout the system very little amounts of DOM-1 were found in milk, showing no to little transfer activity to milk. Studies have suggested that DON can also be useful as a marker for other toxic compounds.

Effects of DON include depressed intake, diarrhea, decreased reproductive efficacy, and depressed immunity. At very high consumption levels a vomiting like reaction can be observed (Bandyk, 2024). Beef cattle have exhibited capacity to tolerate relatively high levels. Levels of 18ppm of DON have been fed for extended periods with no impact on daily gain, feed efficiency, or dry matter intake (Jouany and Diaz, 2005). However, it is worth noting that depressed rumen pH, or impaired fermentation may impact the ability of the rumen to detoxify DON.

Impact of mycotoxins on cattle performance

T-2

T-2 is one of the most potent mycotoxins for ruminants. T-2 is degraded to HT-2 in the rumen. The majority of detoxification of T-2 is done via protozoa, and T-2 is shown to reduce protozoal protein 83% in a 6-hour incubation (Jouany and Diaz, 2005). T-2 toxin has been associated with gastrointestinal stress, intestinal hemorrhage, and immune suppression. When fed at 17ppm calves exhibited decreased intake and average daily gain, however when fed at 10ppm or below similar effects were not observed (DiCostanzo et. al., 1996).

Fumonisins

There are 28 different forms of fumonisins identified, however fumonisins in the B class are considered the most toxic (Ogunade et. al., 2018). Several fumonisins are commonly identified in testing including FB1, FB2, and FB3. Fumonisins are poorly degraded in the rumen, which makes them particularly concerning, however absorption is thought to be low. FB1were observed to only have been 10-18% degraded after a 72-hour incubation period, however in vitro digestion work showed little to no impact of FB1 on dry matter digestibility.

Impacts on ruminants include impacts on liver function (enzymes GGT and AST) and reduced performance likely due to reduced feed intake. Nephrotoxic effects have also been observed when beef cattle were fed 148 dietary ppm of total fumonisins for a 31-day period. Similar results were observed in calves (Gallo et. al., 2015).

Ochratoxin A (OTA)

OTA is highly degraded in the rumen, mostly by rumen protozoa and is converted to ochratoxin-alpha which is less toxic. In calves orally dosed OTA was excreted in the urine as ochratoxin-alpha. Although some OTA may bypass rumen degradation, there is little evidence of risk for transferring into milk or tissue (Gallo et. al., 2015). Degradation of OTA should be considered pH sensitive, thus if high levels of grain are fed this can lead to decreased degradation efficacy.

Main impacts of OTA include weight loss, increased body temperature, dehydration, polyuria, and even death. However, degradation of OTA in the rumen makes toxicity highly unlikely in ruminants. Toxicity has been observed in lambs and goats receiving 1-33mg OTA/kg (Jouany and Diaz, 2005). Studies have also shown synergistic effects with zearalenone.

Impact of mycotoxins on cattle performance

Zearalenone

Zearalenone is a highly prevalent mycotoxin with some estimates that upwards of 40% of feed is potentially contaminated with zearalenone. The majority of zearalenone is degraded in the rumen, however, it is degraded into alpha-zearalenone which is 4 times more oestrogenic than zearalenone. Protozoa are primarily responsible for the degradation of zearalenone.

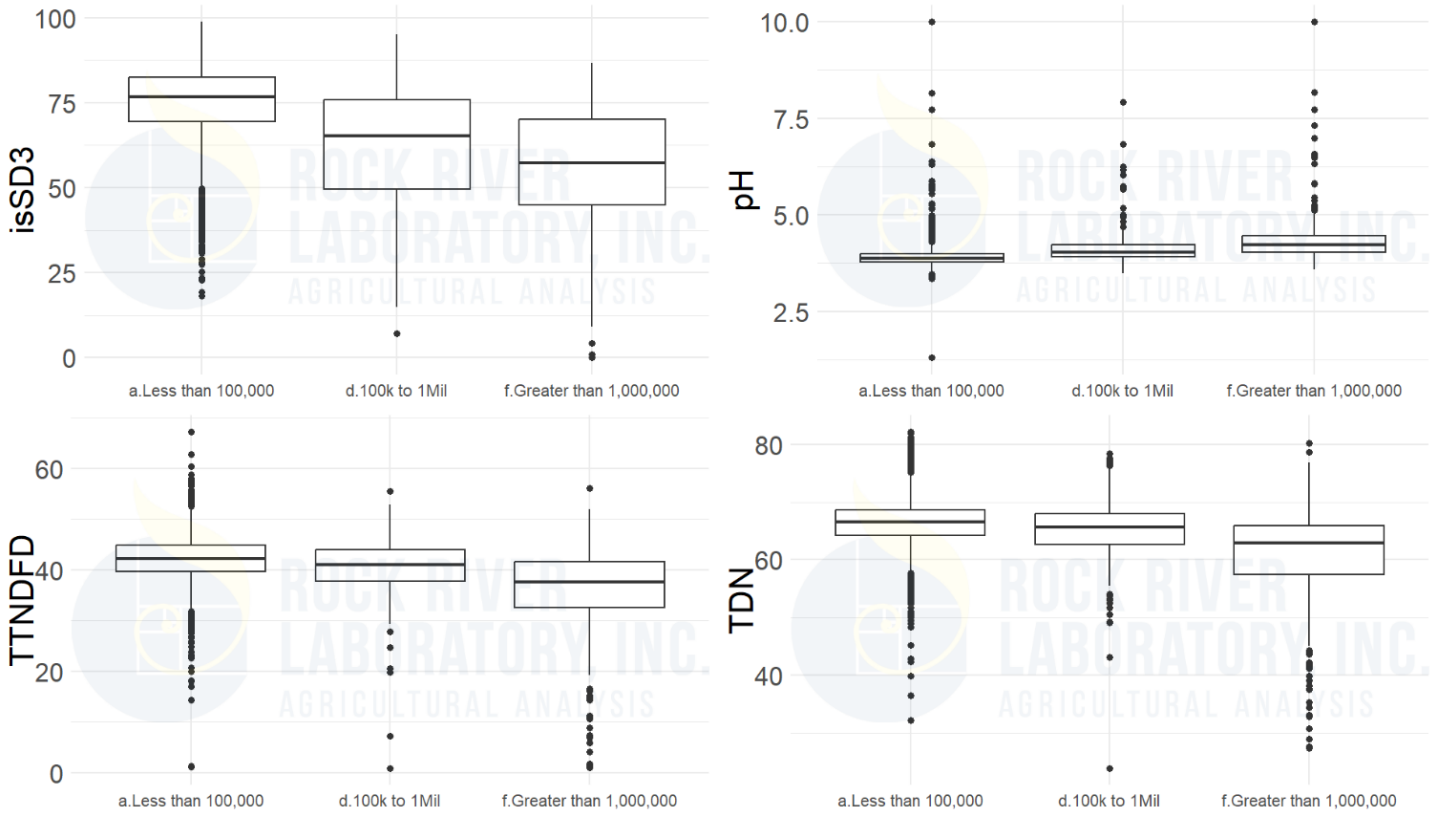
The primary concern of zearalenone contamination are reproductive impacts. These include embryo survival, hypertrophy of female genitalia, decreases in LH, and progesterone, decrease testosterone production in males, and infertility. Reproductive failure in ruminants has been observed at levels of 750 ppb of zearalenone fed concurrently with 500ppb of DON. Nutritional and co-occurrence with other synergistic mycotoxins may impact the levels at which negative impacts are observed.

Table 2. Regulatory and suggested guidelines for allowable levels of toxins in feed

Toxin	Agency	Regulatory Level Breeding	Regulatory Level Finishing	Suggested level
Aflatoxins	FDA	100 ppb	300 ppb	
DON	FDA	10 ppm	10 ppm	
Total Fumonisin	FDA	15 ppm	30 ppm	
Zearalenone	NA	NA	NA	5 ppm
Ochratoxin	NA	NA	NA	5 ppm
T-2 and HT2	NA	NA	NA	500 ppb

Impact of mycotoxins on silage quality

Not only do mycotoxins represent a concern for cattle health, presence of mycotoxins in silages can also be indicative of poor-quality ensiling and increased risk for dry matter loss in silages. Molds only grow in the presence of oxygen in silage, so minimizing aerobic exposure is critical to decreasing mycotoxin risk in ensiled feed. Molds also uptake nutrients during their growth and multiplication in the silage leading to decreased nutrient content. Primary growth substrates include WSC and fat (Haerr, 2015). Furthermore, recent data analysis completed by Rock River Laboratory, Inc. showcased that higher levels of mold in corn silage were associated with lower starch disappearance values, higher pH, decreased fiber digestion, and decreased TDN values. This is showcased in Figure 1. below.



In the field, heavy fungal infection is often associated with decreases in yield and nutritive content of silage. Additionally, when heavy loads of fungal pathogens are present, dry matter increases quite quickly making harvest and management of this silage quite challenging.

New developments in mycotoxin research

Several new developments have been pivotal in our understanding of the impacts and complexity of mycotoxins in feeds and silages. One of these is our understanding of mycotoxin stability in silages. Although we have previously understood that molds can grow and produce mycotoxins in ensiled feed, changes to existing mycotoxin levels were unknown. Recent research has shown that in poorly ensiled feed, DON content increased during the first 90 days of ensiling. This increase was linked to the conversion of D3G, a DON precursor, into DON. This primarily occurs under aerobic conditions. Additionally, there is evidence that BMR varieties of corn silage can have higher accumulation of DON overall (Chibuogwu, et. al., 2024). Finally, a critical understanding is that Fusarium is not only present as an ear rot, but can also present as a stalk rot, which can lead to the production of DON.

Another critical aspect of mycotoxin understanding is the degree and implication of co-occurrence of mycotoxins. Although it has been understood that most silages have one mycotoxin present, more work has shown that those silages with a single mycotoxin present are likely to have others present as well. A 2021 study published by Weaver et. al. that out of >1000 corn silage samples tested in the US >96% were found to have more than one mycotoxin present. The most present group was emerging mycotoxins, while DON was found in 88% if samples and fumonisins were detected in 67% of samples. The most common co-occurrence in corn silage was that of DON and fusaric acid, and fusaric acid with fusarium toxins. Examination of the Rock River Laboratory database shows that corn silage tested in the last 7 years (~2500) >60% of silage samples tested positive for one or more mycotoxin.

Emerging mycotoxins also warrant further discussion and exploration. Although we commonly discuss 8 to 10 of the most researched mycotoxins, our understanding of the impact of toxins outside of these is increasing. The study by Weaver assessed 35 different mycotoxins. Although the biological implications of these compounds have not been extensively studied further investigation is warranted on their individual and combined effects when fed alongside other mycotoxins. It is thought that these emerging mycotoxins may have impacts on rumen microbiota and may have potential to impact the immune system of animals (Gallo, 2025).

Other considerations

Clinical indication of a pathogen or toxin represents a complex balance between the load of the pathogen and toxin and other stressors that may impact the animal's response to the pathogen or toxin. The uniqueness of ruminants makes this of particular importance, because cattle are reliant on the rumen to detoxify mycotoxins. Conditions that decrease rumen function such as acidosis, heat stress, depressed DMI, or feed restriction can also impact the rumen microbe's ability to detoxify these compounds leading to increased susceptibility to clinical and subclinical impacts. Additionally, increased passage rate of high intake animals may decrease the amount of time available to degrade the mycotoxin which can allow more to pass into the lower gut (Bandyk, 2024). This can be exacerbated by conditions such as environmental stressors that increase risk for leaky gut which can allow toxins a path through the intestine to directly enter the bloodstream. Large amount of starch passage into the hind gut may also increase gut permeability and increase the risk for clinical impacts of mycotoxins.

Additionally, other nutritional factors such as yeasts are often found in co-occurrence with mycotoxins in silage. Yeasts have been well documented to depress rumen function, which represents the potential to reduce toxin degradation (Santos, et. al., 2015). Special consideration should be given to silages that are high in yeast that also contain moderate levels of mycotoxins.

Management of mycotoxins

Preventative management of mycotoxins includes both field and storage measures. Reducing risk of fungal infection in the field alongside proper silage management and harvest practices are key to reducing mycotoxin risks. Recent increases in strip till or no till practices have increased risk of fungal infection, as organic matter left in the soil can harbor pathogens which can become active in consecutive years. Additionally, use of fungicides can greatly reduce the risk of fungal disease and subsequent mycotoxin production. Although fungicides are costly, the cost can easily be made up with reduction in yield loss if fungal infestation does occur. Work done at the University of Illinois also showcased increase nutritive value in corn silage treated with fungicide (Haerr et. al., 2015).

When harvesting silage, limiting exposure to air and covering the pile quickly is essential. Proper packing density will decrease air pockets in the silage, reducing the risk for mold growth and mycotoxin production in the silage. Additionally, these measures also help to establish and maintain a low pH, which is essential for keeping the silage preserved over time. This will also help decrease the risk of other negative pathogens in the silage such as yeast or bacteria species. Inoculants can also help in achieving a desirable pH and maintaining stability over time. Inoculants may also decrease the amount of mold growth in the silage and thus decrease the risk of mycotoxin production in the ensiling phase. Upon feeding out minimizing aerobic exposure with proper facing techniques.

If mycotoxins are present in feed, minimizing exposure of cattle to secondary environmental and nutritional stressors can decrease the risk for subclinical and clinical impacts. If silage tests are positive for moderate to high levels of mycotoxin, further tests should be considered on all feedstuffs to rule out other potential toxin sources and synergistic impacts between toxins. Where possible target feeds with higher levels of contamination to low-risk groups. Feed contaminated feed alongside other forages that are not contaminated to dilute feed to safe levels.

References

Bandyk, C. (2024). Review: Mycotoxins in ruminant livestock production: An underestimated and overlooked risk and opportunity? *Applied Animal Science*, 40, 802-817

Chibuogwu, M. O., Reed, H., Groves, C. L., Mueller, B., Barrett-Wilt, G., Webster, R. W., ... & Smith, D. L. (2024). Influence of hybrid class and ensiling duration on deoxynivalenol accumulation and its derivative deoxynivalenol-3-glucoside while ensiling corn for silage. *Plant Disease*, 108(12), 3631-3638.

Diaz, D. E. (Ed.). (2005). *The mycotoxin blue book*. Nottingham University Press.

Gallo, A. (2025). Control of Regulated and Emerging Silage Mycotoxins. International Silage Conference.

Gallo, A., Giuberti, G., Frisvad, J. C., Bertuzzi, T., & Nielsen, K. F. (2015). Review on Mycotoxin Issues in Ruminants: Occurrence in Forages, Effects of Mycotoxin Ingestion on Health Status and Animal Performance and Practical Strategies to Counteract Their Negative Effects. *Toxins*, 7(8), 3057–3111. https://doi.org/10.3390/toxins7083057

Haerr, K. J., Lopes, N. M., Pereira, M. N., Fellows, G. M., & Cardoso, F. C. (2015). Corn silage from corn treated with foliar fungicide and performance of Holstein cows. *Journal of Dairy Science*, 98(12), 8962-8972.

Haerr, K. J. (2015). The use of corn treated with various applications of foliar fungicide to increase corn silage quality and performance of Holstein cows. (Masters Thesis, University of Illinois at Urbana-Champaign).

Magnoli, Alejandra & Poloni, Valeria & Cavaglieri, Lilia. (2019). Impact of mycotoxin contamination in the animal feed industry. Current Opinion in Food Science. 29. 10.1016/j.cofs.2019.08.009.

Ogunade, I. M., Martinez-Tuppia, C., Queiroz, O. C. M., Jiang, Y., Drouin, P., Wu, F., Vyas, D., & Adesogan, A. T. (2018). Silage review: Mycotoxins in silage: Occurrence, effects, prevention, and mitigation. *Journal of Dairy Science*, 101(5), 4034-4059. [1, 2, 3]

Santos, M. C., Lock, A. L., Mechor, G. D., & Kung Jr, L. (2015). Effects of a spoilage yeast from silage on in vitro ruminal fermentation. *Journal of Dairy Science*, 98(4), 2603-2610.

Weaver, A. C., Weaver, D. M., Adams, N., & Yiannikouris, A. (2021). Co-Occurrence of 35 Mycotoxins: A Seven-Year Survey of Corn Grain and Corn Silage in the United States. *Toxins*, 13(8), 516. https://doi.org/10.3390/toxins13080516

USING WINTER HARDY SMALL CEREALS FOR SILAGE

Mary Drewnoski, Ph.D.

Notes

Using Winter Hardy Small Cereals for Silage

Mary Drewnoski, Ph.D.

Using winter hardy small cereals for silage

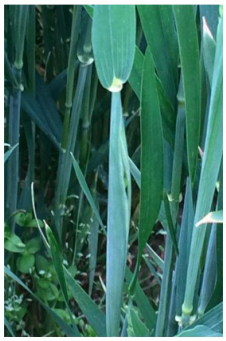
Mary Drewnoski, Beef Systems Specialist, UNL
@cattlenerd

University of Nebraska Lincoln

WHEN TO HARVEST?

Boot stage

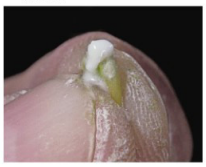
Mid to late May



Pollination

Early June

Milk



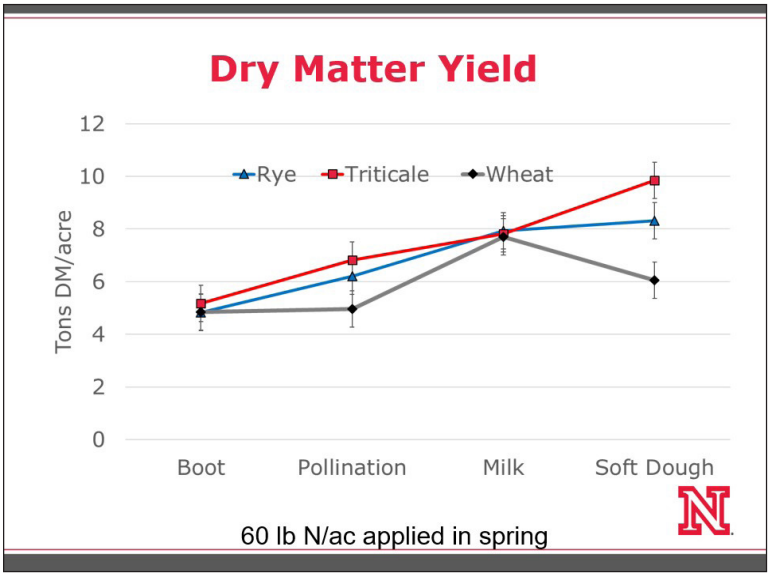
Early June

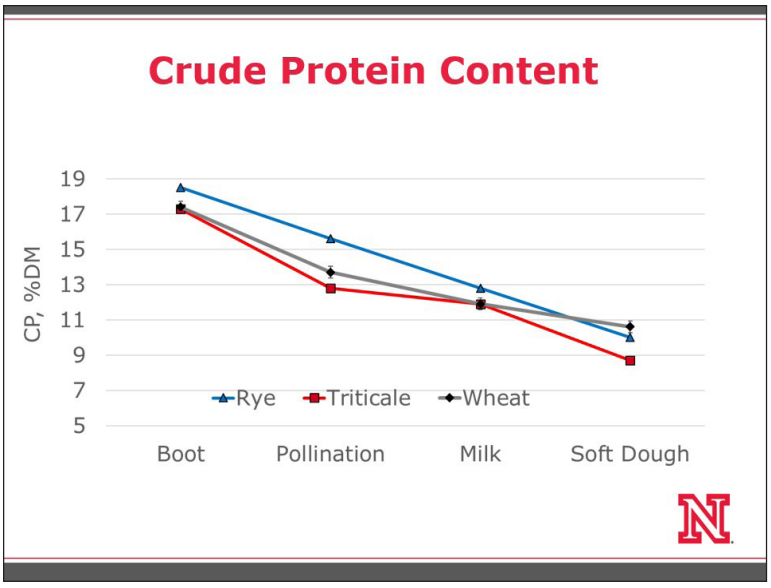
Soft Dough

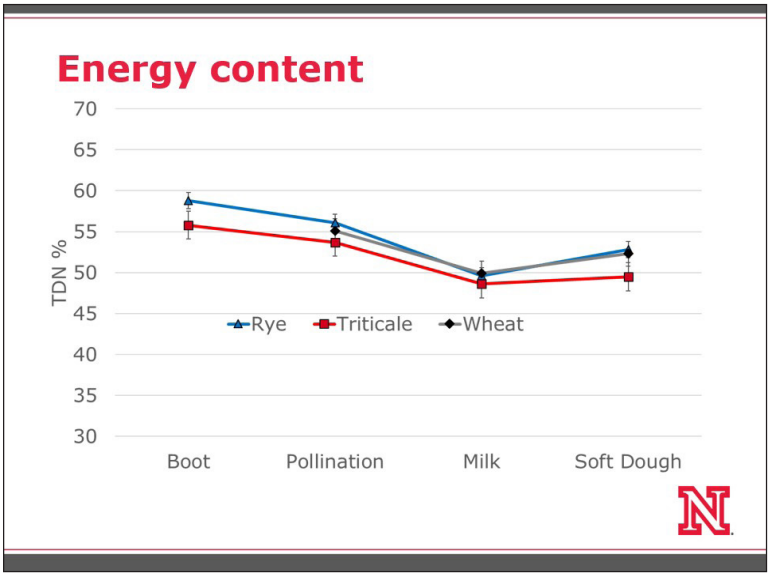
Mid-late June

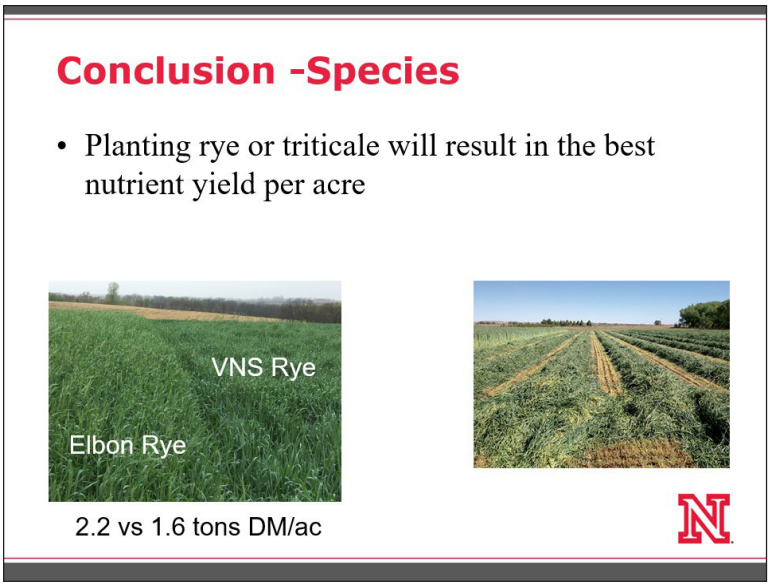
Differences among species?

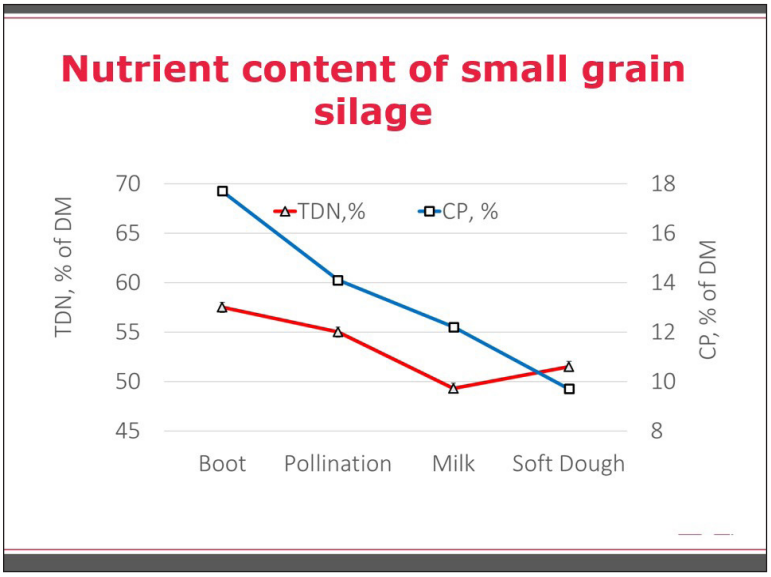
	Wheat	Rye	Triticale
	Days from the start of harvest		
Boot	6	0	3
Anthesis	13	9	13
Milk	25	29	26
Soft Dough	34	37	41

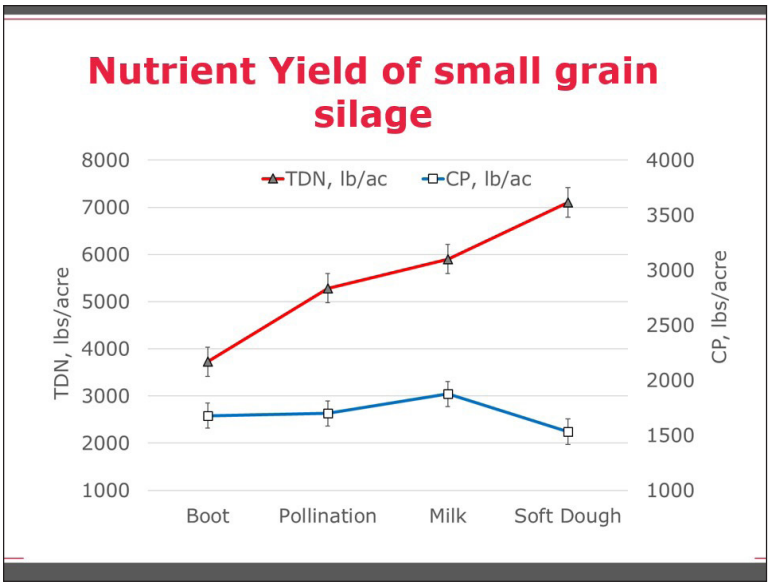

Dry Matter Yield
Tons DM/acre
12
10
8
6
4
2
0
Rye
Triticale
Wheat
Boot
Pollination
Milk
Soft Dough
60 lb N/ac applied in spring


Crude Protein Content
CP, %DM
19
17
15
13
11
9
7
5
Rye
Triticale
Wheat
Boot
Pollination
Milk
Soft Dough


Energy content
70
65
60
55
50
45
40
35
30
TDN %
Rye
Triticale
Wheat
Boot
Pollination
Milk
Soft Dough


Conclusion -Species
• Planting rye or triticale will result in the best nutrient yield per acre
VNS Rye
Elbon Rye
2.2 vs 1.6 tons DM/ac


Nutrient content of small grain silage
TDN,%
CP, %
TDN, % of DM
CP, % of DM
70
65
60
55
50
45
18
16
14
12
10
8
Boot
Pollination
Milk
Soft Dough


Nutrient Yield of small grain silage
TDN, lb/ac
CP, lb/ac
TDN, lbs/acre
CP, lbs/acre
8000
7000
6000
5000
4000
3000
2000
1000
4000
3500
3000
2500
2000
1500
1000
Boot
Pollination
Milk
Soft Dough

Moisture content in field

- Target 65 to 70% moisture (30 to 35% DM)

	Moisture content, %		
	Rye	Triticale	Wheat
Boot	80.9	83.5	83.8
Pollination	78.5	77.9	80.3
Milk	71.0	72.3	73.2
Soft Dough	60.9	64.2	56.8

In most cases wilting is necessary!

Conclusions- Harvest

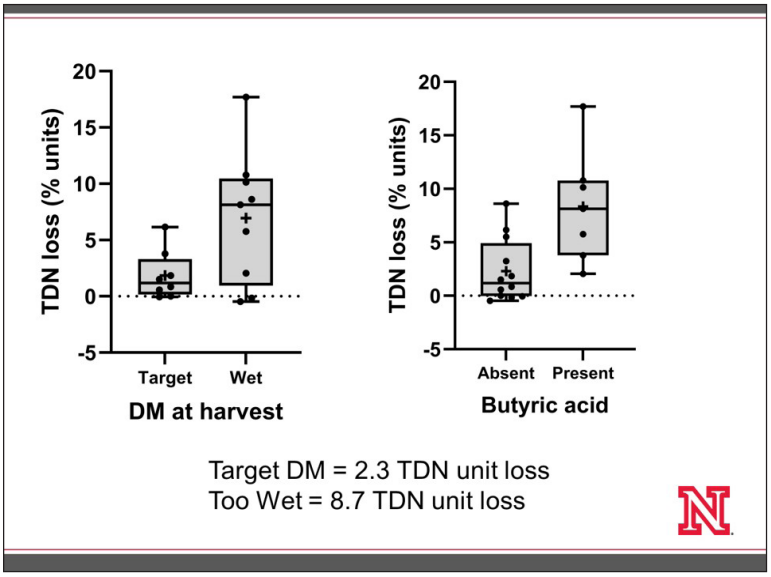
- Highest Quality = boot
- For high quality forage, harvest at pollination has increased yield without sacrificing much nutritive value
- For maximized TDN yield, harvesting at soft dough is a better option

Survey of small cereal silage management of Nebraska producers

Alexa Johnson, Jenny Rees, Ben Beckman, Brad Schick, Gary Lesoing, Erin Laborie, Kim Clark, Connor Bielher, Todd Whitney, Daren Redfearn, Mary Drewnoski

University of Nebraska Lincoln

- 40% of samples were too wet at harvest
  - Needed longer wilting period


TDN loss (% units)
20
15
10
5
0
-5
Target
Wet
DM at harvest
TDN loss (% units)
20
15
10
5
0
-5
Absent
Present
Butyric acid
Target DM = 2.3 TDN unit loss
Too Wet = 8.7 TDN unit loss

Packing

- Target **14 lb DM/ft^3**
- Hollow stem makes packing difficult
  - Producers are not getting it packed well
  - Bunker/driver over piles 5.1 lb DM/ft^3
    - Range 1.3 to 9.0 lb DM/ft ^{3}

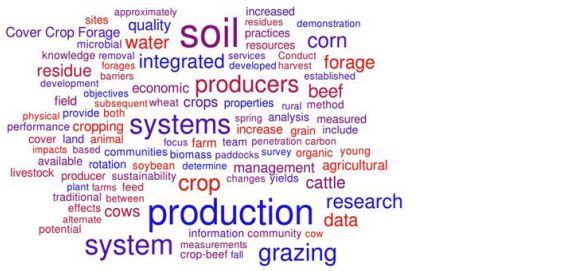
Packing!

- Need to focus on basics
  - **< 6 inch layers**
  - More tractor wt
    - Increase tire pressure

Small grain silage

- When to harvest is about goals
  - Earlier higher quality-low yield-need to wilt
  - Later lower quality-higher yield-direct cut?
- Moisture management and packing is a challenge- need to be diligent

More Questions



WHAT IS THE ENERGY VALUE OF CORN SILAGE TODAY?

Galen Erickson, Ph.D.

Notes

What is the Energy Value of Corn Silage Today?

Galen Erickson, Ph.D.

What is the energy value of corn silage?

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Outline/topics

- What is energy (why does it matter)?
- How is it measured (estimated)
  - Summative equation (lab analysis, then equations to predict)
  - Predicted from fiber content (most labs)
    - How is fiber measured (wet chemistry, NIR)
  - Measured with indirect calorimetry
  - Predicted from cattle performance
- Illustrates importance of protein nutrition in silage growing programs
- Factors influencing energy you get from your corn silage

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Energy

- Water, Energy, Protein, Minerals, Vitamins
- Energy is from carbohydrate or from fat, or from excess protein
- Starch and fiber makes up carbohydrates
- Silage provides starch and fiber
  - Starch: very wet high-moisture corn, probably kernel processed
  - Fiber
    - NDF: measures hemicellulose, cellulose, lignin
    - ADF: measures cellulose and lignin

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Energy

- Calorie vs calorie
  - Calorie is a human measure (1,000 calories)
  - A calorie is the amount of heat to raise a 1 cc of water by about 2 degrees
- In cattle diets and feeds: commonly use Mcal = 1,000,000 calories
- Net energy system?
  - People often say I am feeding a 56 Mcal ration, what does that mean?
- What is TDN?
  - My silage is a 62 TDN vs a 70 TDN, what does that mean?

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What is the Energy Value of Corn Silage Today?

Galen Erickson, Ph.D.

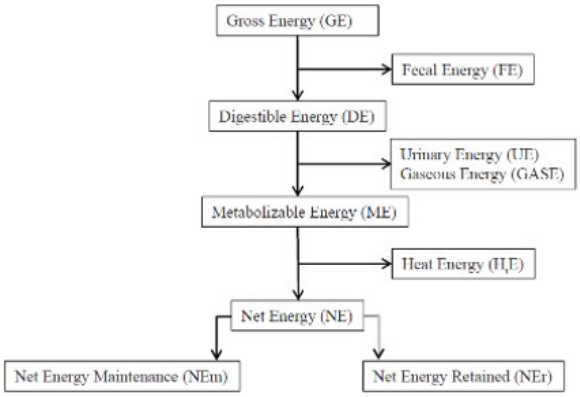
Energy

- Net Energy System (developed in 1950/60s)

- Gross Energy
  - Subtract feces energy (what is coming out)
- Digestible Energy [indicator or used to calculate TDN]
  - Subtract urine energy and gaseous energy (methane)
- Metabolizable Energy
  - Subtract heat increment or heat of fermentation (forage and grains impact)
- Net Energy
  - NEm = net energy for maintenance (always greater for a feed)
  - NEg = net energy for gain (what is left after maintenance)

Energy

- Net Energy System (developed in 1950/60s)



What is the Energy Value of Corn Silage Today?

Galen Erickson, Ph.D.

Feed Analysis

Feed Analysis Report

WARD Laboratories, Inc.

NFTA 2026

Account ID: 50128

UNIVERSITY OF NEBRASKA
0220 3940 FAIR ST
ANIMAL SCIENCE BLDG
LINCOLN, NE 68583-0908

Report Type: Feed
Invoice Number: 1530671
Date Received: 6/2/2026
Date Reported: 6/4/2026
Lab ID: 3210

Results for: GALEN ERICKSON **Sample ID:** JUNE 2025 **Description:** CORN SILAGE

Analysis	As Received	Dry Basis
Moisture, %	0.46	1.00
Dry Matter, %	92.54	100.00
PROTEIN		
Crude Protein, %	7.2	7.7
CARBOHYDRATES		
Acid Detergent Fiber	19.4	20.7
Neutral Detergent Fiber, %	34.5	36.8

Analysis	As Received	Dry Basis
MICRONUTRIENTS		
Calcium, % Ca	0.24	0.25
Phosphorus, % P	0.23	0.25
Potassium, % K	1.01	1.09
Magnesium, % Mg	0.15	0.16
Sulfur, % S	0.10	0.11
Sodium, % Na	< 0.01	0.02
Copper, ppm Cu	4.4	4.7
Iron, ppm Fe	87	94
Manganese, ppm Mn	28	30
Molybdenum, ppm Mo	0.85	0.91
Zinc, ppm Zn	24.8	26.8
CALCULATED VALUES		
Total Digestible Nutrients, %	68.6	73.4
Net Energy Maint, Mcal/cwt	75.78	81.07
Net Energy Gain, Mcal/cwt	47.52	50.80
Net Energy Lact, Mcal/cwt	73.74	78.85
Relative Feed Value	—	164

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Energy Content of Silage

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- Really 4 ways to measure/estimate energy in silage

1. Summative equation:
   - measure protein, fiber, mineral, fat, and 'rest' of the carbohydrate. Multiply by a digestibility for each component and then sum them up.
   - Lab-based

Energy Content of Silage

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2. Predict from ADF %.
   - Most common is:
   - TDN = 88.9 – (0.779 * %ADF)
   - Really developed for forages (grass, alfalfa, applied to silage)
   - Not great, but a predictor
   - Meaningless when applied to fibrous byproducts (ex: distillers grains)
   - How is ADF measured (actual reflux, NIR predicted?)

Silage varies in ADF and ADF digestibility. Using ADF analysis only doesn't account for digestion of fiber (probably minor issue as NDF/ADF/lignin tend to go together)

ADF: 17-30% would capture most (average of 25 +/- 4%; NASEM 2016)

TDN estimated at 69.5 (64-76)

Energy Content of Silage

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3. Measure from calorimetry (usually indirect)

- Very uncommon (costly, lots of work)
- Happen to be doing a project with 400 plus measuring silage growing diet
- Pedro Simeone, Keara O'Reilly, Paul Kononoff (Methane NU project)

- Diet: 80% corn silage; 15% DDGS; 5% supplement

Energy Content of Silage

3. Measure from calorimetry (usually indirect)

	n	Mean	SD	25th quartile	75th quartile
TDN% (DE/4.4)	48	72.92	3.2	70.40	75.36
DE, Mcal/lb	48	1.46	0.06	1.41	1.51
ME, Mcal/lb	48	1.25	0.07	1.21	1.30
ME:DE	48	0.86	0.021	0.85	0.87
CH_4, %GEI	48	6.04	1.158	5.48	6.76

Measures the whole diet

DDGS has about 108 TDN (from performance studies)

Corn silage: 68.3% TDN

Energy Content of Silage

4. Performance calculated from performance

	n	Mean	SD	25th quartile	75th quartile
TDN% (ME/0.82/4.4)	163	69.27	4.6	66.3	69.6
ME, Mcal/lb	163	1.13	0.08	1.09	1.19
NEm, Mcal/lb	163	0.73	0.07	0.69	0.77
NEg, Mcal/lb	163	0.45	0.06	0.42	0.49

Measures the whole diet

DDGS has about 108 TDN (from performance studies)

Corn silage: 63.3% TDN

Energy Content of Silage

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4. Performance calculated from performance

Been lots of growing studies (not many that are straight silage)
Folmer et al., 2001: evaluated GMO hybrids
Weber et al., 2011; evaluated GMO hybrids
Felix et al., 2014; evaluated either urea inclusion or source of protein
Brinton et al., 2019; evaluated kernel processing
Hilscher et al., 2019; evaluated harvest time (silage DM of 37 vs 43)
Hilscher et al., 2022; bmr hybrid or not

Energy Content of Silage

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Reference	Treatment	Silage%	protein	TDN diet	TDN silage	% corn1	% corn2
Folmer et al 2001	Bt 1	90	SBM/urea	72.3	70.9	78.8	85.5
	con 1	90	SBM/urea	71.3	69.8	77.6	84.1
	Bt 2	90	SBM/urea	68.3	66.5	73.8	80.1
	con 2	90	SBM/urea	71.1	69.5	77.2	83.8
Weber et al 2011	Bt corn	80	WDGS 15	71.9	67.0	74.5	80.7
	parent	80	WDGS 15	71.1	66.0	73.3	79.5
	ref 1	80	WDGS 15	70.9	65.8	73.1	79.3
	ref 2	80	WDGS 15	70.3	65.0	72.3	78.4
Felix et al., 2014	urea	79	1.43 urea	77.1	75.0	83.4	90.4
	DDGS	79	18.3 DDGS	80.5	77.6	86.3	93.5
	SBM	79	9.2 SBM	80.5	79.3	88.1	95.5
Felix et al., 2014	11 CP	90	1.37 urea	66.6	64.5	71.7	77.7
	12 CP	90	1.74 urea	64.9	62.7	69.7	75.6
	13 CP	90	2.11 urea	64.4	62.1	69.0	74.9

What is the Energy Value of Corn Silage Today?

Galen Erickson, Ph.D.

Energy Content of Silage

Reference	Treatment	Silage%	protein	TDN diet	TDN silage	% corn1	% corn2
Brinton et al 2019	-KP	80	DDG 15	72.0	67.2	74.7	81.0
	+KP	80	DDG 15	73.9	69.5	77.3	83.8
Hilscher et al 2019	37 DM	88	var. RUP	71.1	69.2	76.9	83.3
	43 DM	88	var. RUP	68.7	66.5	73.9	80.1
Hilscher et al 2022	con	80	MDGS-15	72.8	68.2	75.8	82.2
	Bm3	80	MDGS-15	72.9	68.3	75.9	82.3
	bm3-exp	80	MDGS-15	72.3	67.6	75.1	81.4

Corn silage: 67.9% TDN (S.D. 1.75)

75.4% of corn energy (S.D. 1.9) @ 90 TDN

81.8% of corn energy (S.D. 2.1) @ 83 TDN

TDN Content of Silage

ADF-lab	Calorimetry	Perf-individual	Perf-pens
69.5	68.3	69.3	67.8

Varies by many factors

What does a producer do?

Probably lab-based calculated from nutrient quality (NDF, ADF based)

Measure moisture, and starch good indicator of grain

Recall: % starch divided by 0.70=% corn grain (DM basis)

Factors influencing energy of silage

Item	-KP	+KP		P-value
Initial BW	882	882		0.99
Final BW	1337	1338		0.96
DMI	32.6	31.8		0.04
ADG	4.38	4.38		0.93
F:G	7.45	7.24		0.10
HCW	842	843		0.96
Fat	0.56	0.56		0.70
Marbling	501	501		0.97

18 pens per treatment

2.9% improvement in G:F
Silage is 7.25% better (2.9/0.40)

Ovinge et al., 2018 beef report

Factors influencing energy of silage

Item	-KP	+KP		P-value
Initial BW	674	674		0.79
Final BW	987	996		0.03
DMI	21.6	21.2		0.05
ADG	3.73	3.84		0.03
F:G	5.80	5.52		<0.01

16 pens per treatment
80% of diet DM as silage

5.2% improvement in G:F
Silage is 6.5% better (5.2/0.80)

Brinton et al., 2019 Beef Report

Factors influencing energy of silage

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HARVEST DM/MOISTURE

Item	Treatments 37% DM	43% DM	P-value
Initial BW, lb	597	597	0.9
Ending BW, lb	846	826	0.04
DMI, lb/d	18.0	17.9	0.93
ADG, lb	3.19	2.93	0.01
Feed:Gain	5.63	6.11	<0.01

Growing cattle fed 88% silage (with differing RUP amounts, but no interaction)

Hilscher et al., (2017 beef report)

Factors influencing energy of silage

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HYBRID SELECTION IMPACT-MASTERS CHOICE

Variable	Treatments[1] CON (Farm Choice) n = 8 pens, 96 steers	MC1 (Fiber + Starch) n = 8 pens, 96 steers	MC2 (Fiber) n = 8 pens, 96 steers	SEM	P-value
Initial BW, lb	667	667	667	0.7	0.99
Ending BW, lb	1001[ab]	1011[a]	995[b]	5.1	0.10
DMI, lb/d	22.7[b]	22.5[b]	24.0[a]	0.141	<0.01
ADG, lb	3.98[ab]	4.11[a]	3.92[b]	0.058	0.09
G:F	5.71[b]	5.46[a]	6.13[c]	-	<0.01

[a–c] Means within a row with different superscripts differ ($P < 0.05$)

[1] CON, corn hybrid of Farm Choice silage serves as control; MC1, corn hybrid of MCT6365 RIB silage, selected for greater fiber + starch digestion; MC2, corn hybrid of MCT6733 GT3000 silage, selected for greater fiber digestion

Xiong et al., 2020 beef report

What is the Energy Value of Corn Silage Today?

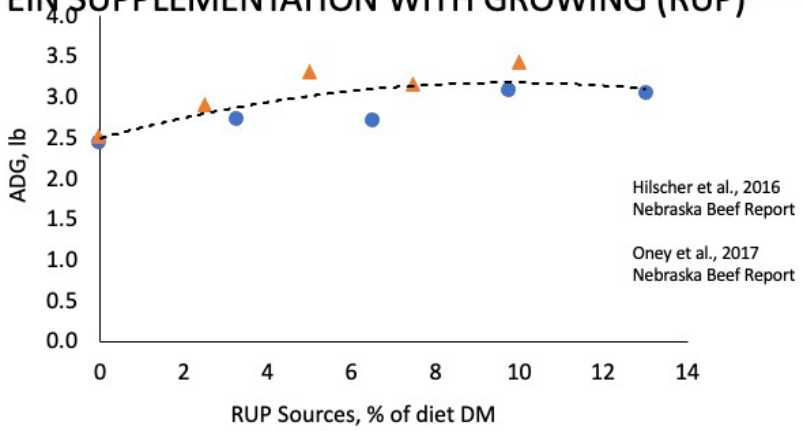
Galen Erickson, Ph.D.

Factors influencing energy of silage

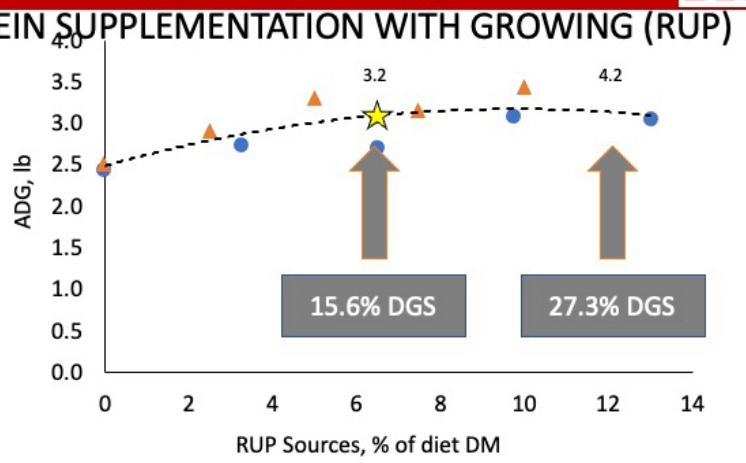
- Corn silage is:
  - 7-8% CP
  - 17.4% RUP (% of CP): Spore et al, 2022 NE beef report
  - 13% RUP (% of CP): Oney et al., 2019 Transl. Anim. Sci.
  - ~35% digestible RUP (not 80%): Oney et al., 2019 Transl. Anim. Sci.

Factors influencing energy of silage

PROTEIN SUPPLEMENTATION WITH GROWING (RUP)



Factors influencing energy of silage



Conclusions (take home)

- You control many things relative to how cattle do on silage
  - Hybrid selection if interested
  - Proper management at ensiling
    - Chop characteristics
    - Kernel processing
    - Packing density
    - Inoculants
    - Covering
  - Proper/best time to harvest
  - Managing face at feeding
  - Put diets together correctly (growing/finishing)

What is the Energy Value of Corn Silage Today?

Galen Erickson, Ph.D.

HIGH MOISTURE CORN PARTICLE SIZE EFFECT ON ENERGY VALUES

Kassidy Buse, Ph.D.

Notes

Accounting for Particle Size Distribution and Ensiling Time Improves Whole-Sample Starch Digestibility Estimates in High-Moisture Corn

Accurate prediction of starch digestibility in high-moisture corn (HMC) is essential for estimating available energy for ruminants. Whole-sample digestibility is commonly estimated through lab procedures by grinding to 6 mm prior to incubation, altering particle size distribution (PSD) relative to feed delivered to the animal. Analysis of sieved fractions assumes additive digestibility, thus not reflecting the non-additive fermentation dynamics of the whole-sample. Objectives of this survey were to evaluate starch digestibility across incubation time points between laboratory and in situ analysis for whole-sample and particle sizes. Additionally, correction factors for PSD estimates of HMC were determined for PSD and incubation time interactions to improve biological accuracy relative to whole-sample in situ digestibility.

Thirty HMC piles were sampled across dairies (n = 4) and feedlots (n = 26) at harvest and across ensiling durations. Whole samples were collected along with sieved samples obtained using the 8mm, 4mm, and bottom trays of the Penn State Particle Separator. Subsamples were analyzed by a third-party lab (Rock River Laboratories; Watertown, WI) by NIR. Additional subsamples of whole and sieved fractions were incubated in ruminally-cannulated beef steers fed a receiving diet for 7, 24, and 36 h. Differences between laboratory and in situ digestibility were evaluated using paired t-tests within fraction and incubation time. Weighted digestibility was calculated from fraction digestibility by proportion of total sample. Relationships between in situ whole sample digestibility and weighted predictions were evaluated using linear mixed-effects models in R (v. 4.5.2) with fixed effects of additive prediction, incubation time, PSD proportions, and time by PSD interactions. Random effects included ensiling time, sample, and steer.

Laboratory 6-mm ground values exceeded in situ digestibility across fractions and incubation times ($P < 0.01$), with the greatest inflation observed in the 8-mm fraction (33.5–35.2 units), intermediate differences for whole samples (24.1–27.1 units), and minimal differences for the bottom fraction (1.6–5.2 units). Uncorrected additive estimates systematically overpredicted whole-sample digestibility by 2.12 units ($P < 0.01$).

Whole-sample digestibility was strongly associated with additive prediction ($P < 0.01$); however, this relationship was significantly modified by PSD and its interaction with incubation time ($P \leq 0.01$). Including PSD and PSD × time terms improved model fit ($P < 0.01$), indicating that particle size distribution altered fermentation dynamics rather than contributing additively to starch disappearance. Incorporation of PSD- and time-based correction eliminated systematic bias (mean bias ≈ 0), reducing prediction error relative to the uncorrected estimates across 720 observations. Whole-sample starch digestibility of HMC appears not to be additive across particle size fractions, and PSD seems to influence fermentation kinetics. Integrating PSD-sensitive correction and laboratory translation might improve the biological fidelity of starch digestibility estimation, possibly enabling supporting more accurate prediction of available energy in ruminant systems.

Table 1. Comparison of in situ digestibility to laboratory digestibility estimates for raw and sieved samples over 7 and 24 h timepoints.

Fraction	Lab	In Situ	Difference	SEM	*P*-value
7 h Incubation					
Raw	78.8	54.7	24.1	1.19	<0.01
8 mm	83.6	50.1	33.5	1.63	<0.01
4 mm	82.0	64.8	17.2	1.10	<0.01
Bottom	87.2	85.6	1.60	0.64	<0.01
24 h Incubation					
Raw	97.6	70.5	27.1	1.27	<0.01
8 mm	98.4	63.3	35.1	1.97	<0.01
4 mm	98.5	79.1	19.4	0.80	0.02
Bottom	98.8	93.6	5.20	0.33	<0.01

ADDENDUM

Notes

LALLEMAND

LALLEMAND ANIMAL NUTRITION