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TMR Delivery and Variability on the Farm

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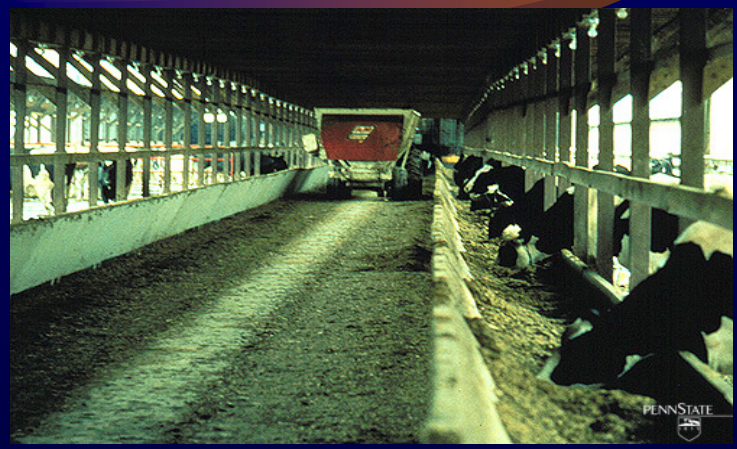
Workshop Outline

- Presentation (25 min)
  - TMR acronyms
  - Uniformity among batches
  - Uniformity within batches
  - Questions to ask about mixers
  - Monitoring delivered TMRs
  - Experiments worth considering
- Particle Size Analysis (20 min)
- Statistical Analysis Example (20 min)
- Discussion, Questions, & Answers



Goals of TMR Delivery

- Consistent blend in the feed bunk
  - over time
  - across location
  - despite feedstuff changes
- Proper particle size
- Low labor & equipment cost
- Long equipment life & low energy use

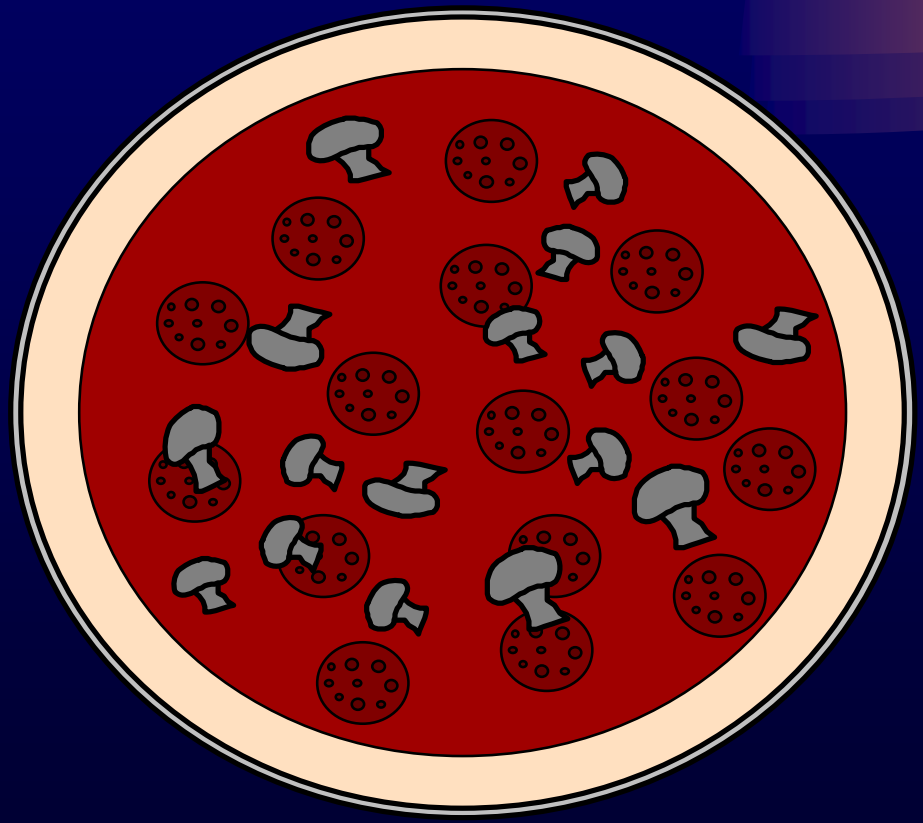
Grammar of Acronyms

- TMR
- MTR
- MPR
- PMTR
- TMTR

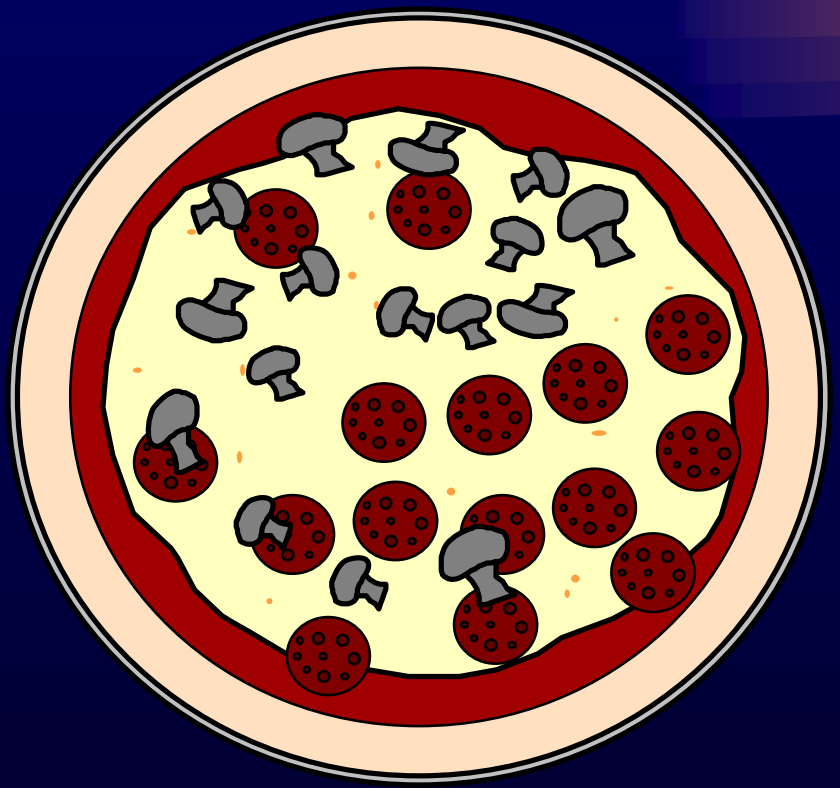
Grammar of Acronyms

- TMR Total Mixed Ration
- MTR Mixed Total Ration
- MPR Mixed Partial Ration
- PMTR Partially Mixed Total Ration
- TMTR Totally Mixed Total Ration

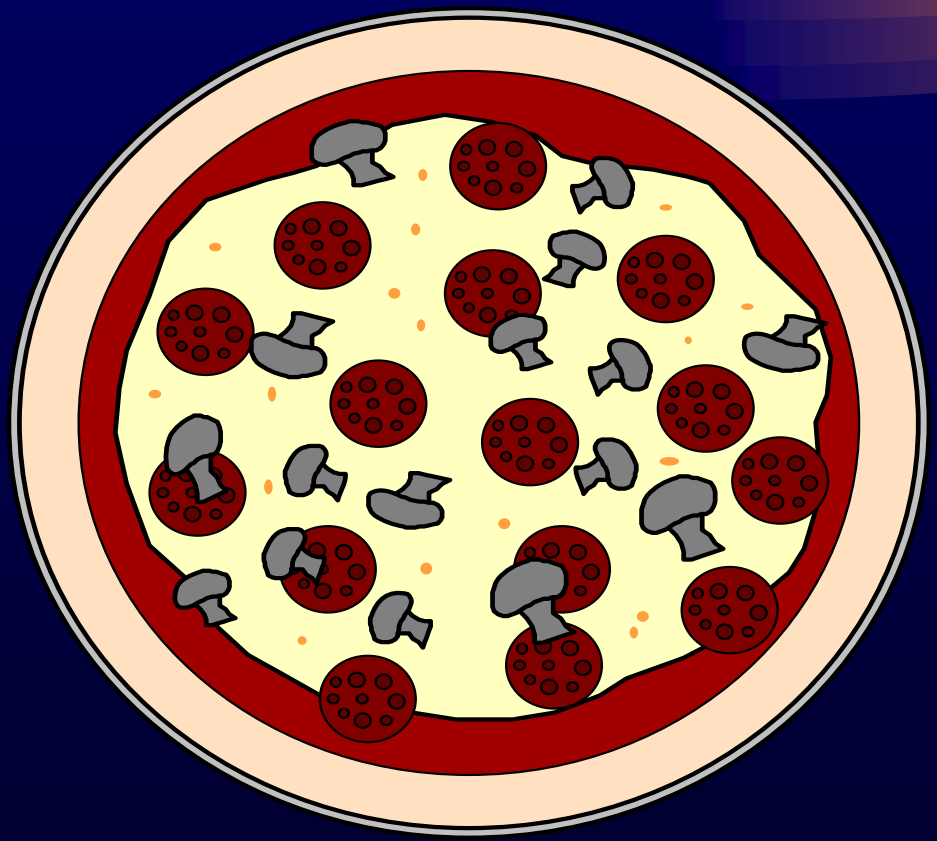
MPR



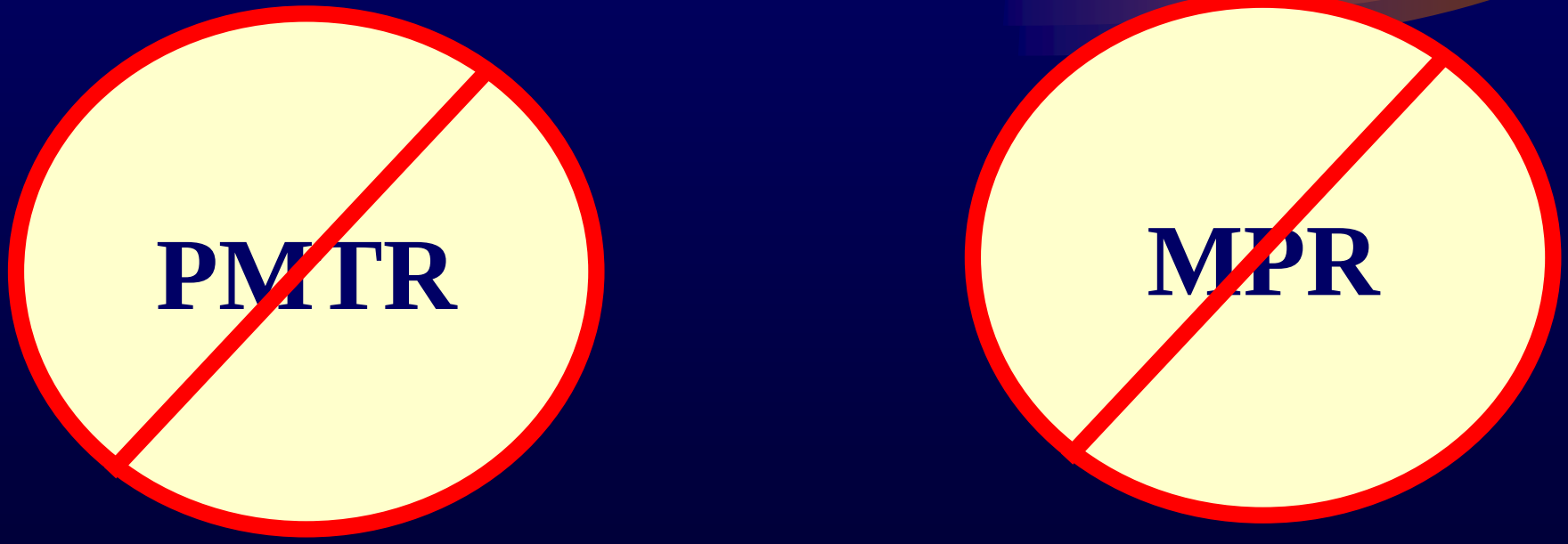
PMTR



TMTR



Acronym conclusion



You can’t afford it!

Uniformity AMONG Batches

- In a ration with 5 ingredients, there are 15 reasons for the ration NDF, CP, NE_L, or other characteristic to be different than the target!
  - DM content (%)
  - Nutrient concentration (% of DM)
  - Amount in the mix (lb as is)

Uniformity AMONG Batches

$$NDF_{ration,\%} = \frac{\sum_{feeds} AMT_{lb} \times DM_{fraction} \times NDF_{\%}}{\sum_{feeds} AMT_{lb} \times DM_{fraction}}$$

Uniformity AMONG Batches

- **Monitor**
  - ingredient nutrient concentrations
  - ingredient DM concentrations
  - particle size reduction
- **Control**
  - amounts in the ration
  - mixing protocol (fill order & mixing time)

Variation AMONG Batches

- EXAMPLE 1
  - Ration with:
    - haycrop silage
    - corn silage
    - grain premix

  - Haycrop silage moisture goes up (a 5 to 10 percentage point swing over a week time span is certainly possible)

Variation AMONG Batches

- EXAMPLE 1 (haycrop moisture increases)
  - Consequences if no corrective action is taken
    - less haycrop DM in ration
    - lower protein in the ration
    - higher energy concentration in the ration
    - likely reduced effective fiber in the ration
    - more grain consumption than planned
  - Corrective action: adjust amounts in the ration

Variation AMONG Batches

- EXAMPLE 2
  - Ration with:
    - haycrop silage
    - corn silage
    - grain premix

  - Haycrop silage quality goes up
    - higher CP
    - higher NE_L, lower NDF

Variation AMONG Batches

- EXAMPLE 2 (haycrop quality increases)
  - Consequences if no corrective action is taken
    - higher CP in ration
    - higher energy concentration in the ration
    - likely reduced effective fiber in the ration
    - more grain consumption than necessary
  - Corrective action: rebalance ration & formulate accordingly

Variation AMONG Batches

- EXAMPLE 3
  - Ration with:
    - haycrop silage
    - corn silage
    - grain premix

  - Corn silage amount swings widely from batch to batch

Variation AMONG Batches

- EXAMPLE 3 (corn silage amount varies)
  - Consequences if no corrective action is taken
    - inconsistent energy concentration in the ration
    - inconsistent protein concentration in the ration
    - inconsistent effective fiber in the ration
    - intake is inconsistent and likely decreases
  - Corrective action: meter in more consistently or vary other ingredients proportionally

Variation AMONG Batches

- EXAMPLE 4

Fill order #1	Fill order #2
haycrop silage	grain premix
corn silage	corn silage
grain premix	haycrop silage

Mixer (which is designed to do some particle size reduction) is run during filling

Variation AMONG Batches

- EXAMPLE 4 (varied fill order)
  - Consequences if no corrective action is taken
    - inconsistent particle size distribution in the ration
    - inconsistent effective fiber in the ration
  - Corrective action: Implement a consistent mixing protocol

Uniformity WITHIN Batches

- Mixer capacity
  - select for minimum batch size
  - select for maximum batch size
- Mixer management
  - fill order
  - mixing time
  - particle size reduction

Mixer Sizing

Don't overlook the obvious

- Size for maximum batch size
- Size for minimum batch size
- Maybe not all groups get the same number of batches per day
- Most mixers don't work well when "full" (likely 70% full -- the fine print is always most important!)

Mixer Management

General principles

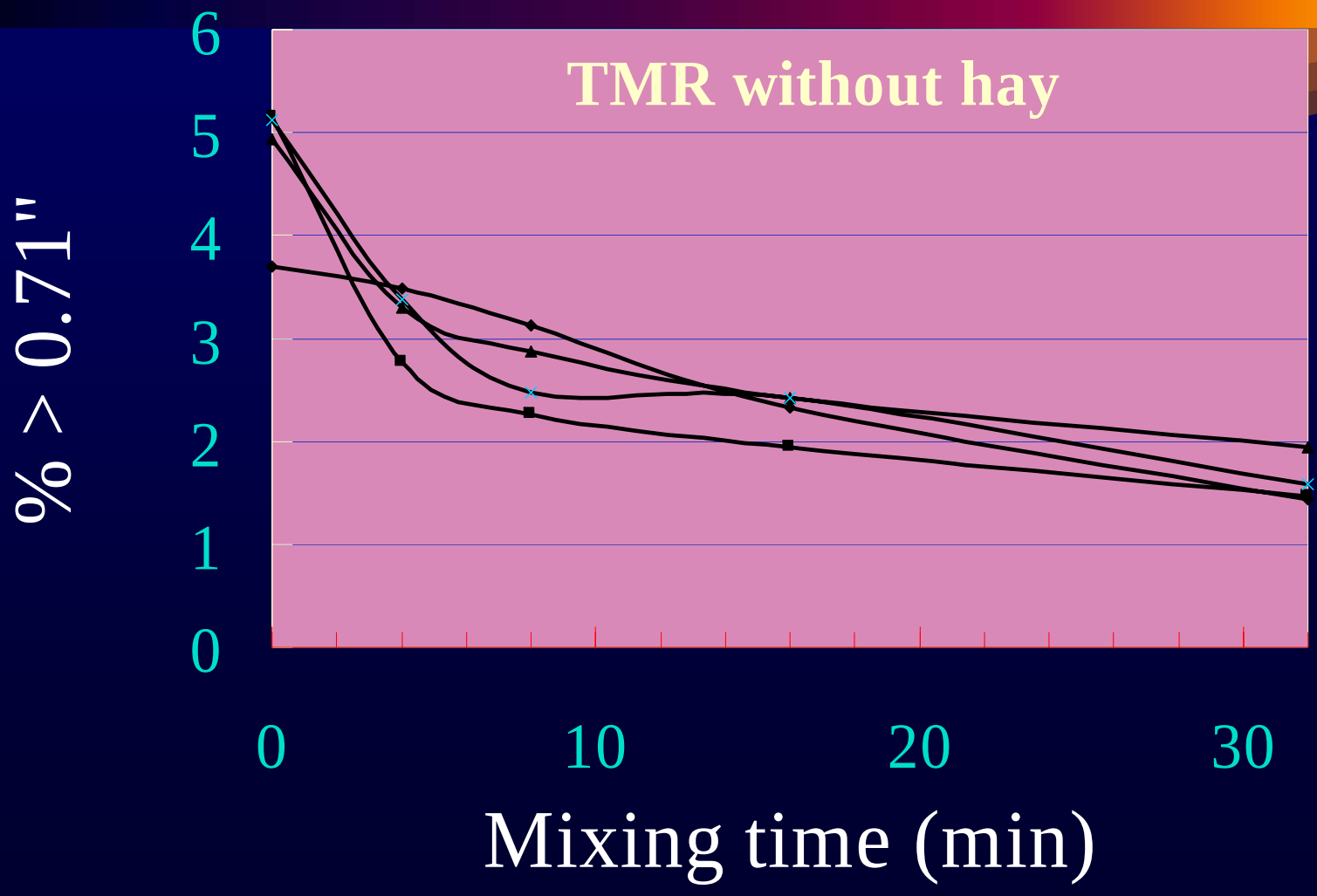
- Mix long enough (assure uniformity)
- Don’t mix too long (avoid excessive wear, particle size reduction, energy & labor)
- Control particle size reduction
- Understand the material flow in the mixer

Mixer Management

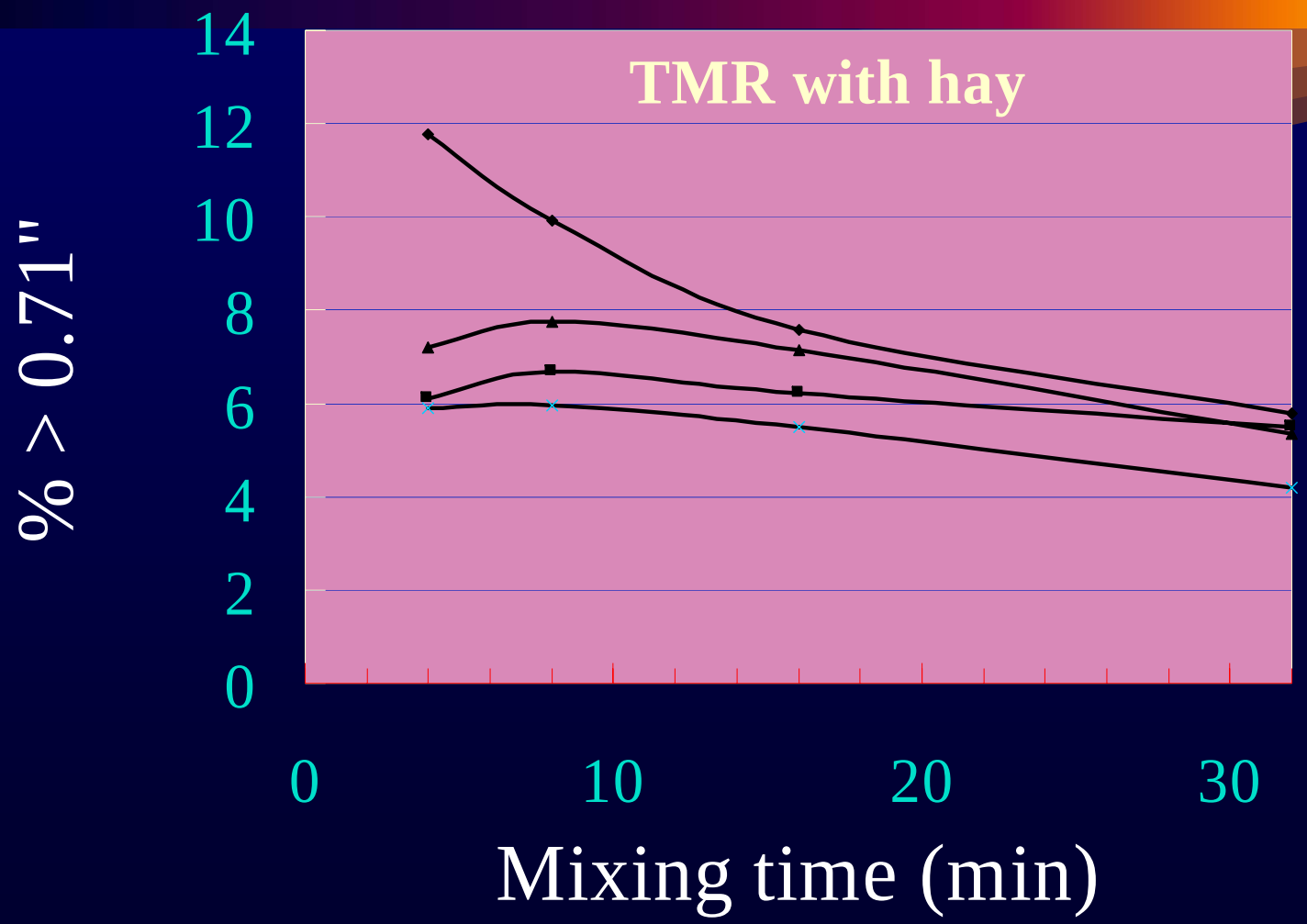
Sample Mixing Protocol

- Mixer off during loading
- Small quantity and liquid ingredients loaded in first
- Haycrop silage loaded last
- Mix 3-5 minutes after filling is complete
- Unload quickly, mixer off except when unloading

Don’t mix too long!



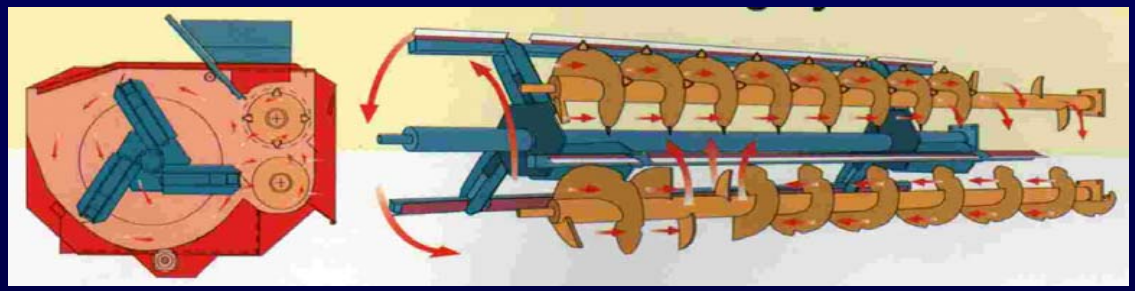
Don’t mix too long!



Questions to Ask about Mixers

(and hypothetical answers)

Q: How does this mixer work?



Questions to Ask about Mixers

(and hypothetical answers)

Q: At what maximum percentage of full capacity is the mixer effective?

A: 75%

R: This mixer requires some empty space for motion of the material to facilitate blending.

Questions to Ask about Mixers

(and hypothetical answers)

Q: Can this mixer blend small batches effectively?

A: No

R: This mixer require a minimal volume of ___% of full capacity so that the material will effectively move and blend.

Questions to Ask about Mixers

(and hypothetical answers)

Q: What is the recommended fill order of solid ingredients?

A: Hay first if applicable.
Other forages next, grains & liquids last.

R: This mixer is designed to reduce particle size of hay. After hay processing is complete, add other ingredients.

Questions to Ask about Mixers

(and hypothetical answers)

Q: Do I need to run the mixer as it is being filled?

A: No.

R: You will have longer mixer life, less particle size reduction, and good blending if you begin blending after the mixer is filled.

Questions to Ask about Mixers

(and hypothetical answers)

Q: Is there a limit to the amount of hay I can put into this mixer?

A: Yes, ___% of the ration.

R: Above this percentage, the mixer cannot effectively process the hay for a uniform blend.

Questions to Ask about Mixers

(and hypothetical answers)

Q: Are there places to avoid when filling the mixer?

A: Yes, do not place concentrates or liquids in the ends.

R: While feed in the ends does move, it is not as effectively blended. Fill the mixer in the center for best uniformity.

Open *Loop Control*

Describe the animals → Characterize the feeds → Balance the ration → Deliver the ration

Closed *Loop Control*

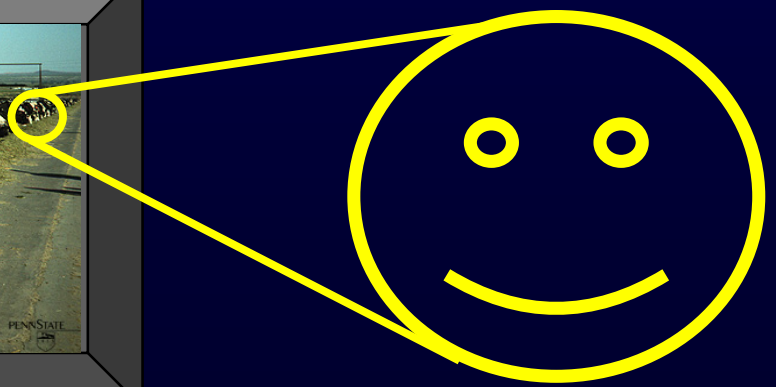
Describe the animals → Characterize the feeds → Balance the ration → Deliver the ration →

Monitor the ration

Closed *Loop Control*

Describe the animals → Characterize the feeds → Balance the ration → Deliver the ration →

Monitor the ration



Monitoring your TMR

- DM content
  - microwave, Koster tester, or drying oven
- Particle size distribution
  - Penn State separator or lab analysis
- Nutrient concentrations
  - Lab analysis
- Tracers in the ration

Be looking for variability ***among*** and ***within*** batches.

Experimenting on the Farm

Rules for on-farm experimenting:

- Replicate, replicate, replicate
- Change one thing at a time
- Be consistent and document what you are doing
- Use appropriate (likely simple) statistics
- Ask for advice when you should

Experimenting on the Farm

1. **Exploring mix uniformity by varying mixing protocol**
   - change fill order
   - change mixing time
   - count revolutions instead of time
   - try not running the mixer during filling & transport (or run it slowly)

Experimenting on the Farm

1. Uniformity ... (how to measure)

- Add a tracer such as whole shelled corn, cotton seeds, corn cobs, or other safe, physically identifiable objects. Look for variation along the bunk.
- Put a large dose of water or soggy grain in a “corner” of the mixer. Measure DM content of samples taken along the bunk.
- Take samples from the bunk for lab analysis

Experimenting on the Farm

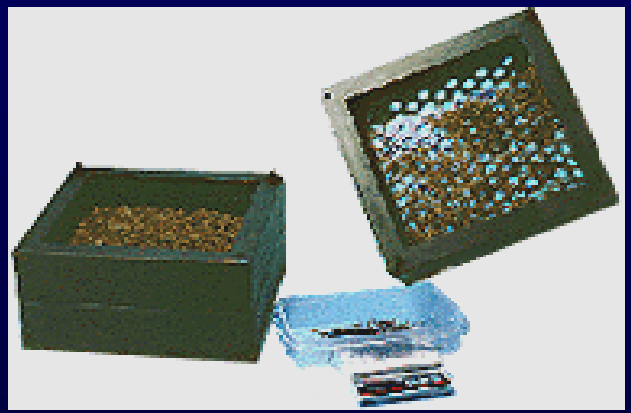
2. Exploring particle size reduction

- "mix" a single forage (vary time and monitor particle size reduction)
- hand mix a mini-ration as a comparison
- compute weighted average particle size distribution from ingredients used

Experimenting on the Farm

2. Particle size ... (how to measure)

- Penn State separator
- Laboratory analysis



Note: To a degree, particle size analysis of samples within a batch (along the feed bunk) can be useful for identifying within batch variation.

Quality Control in TMR Delivery

Where is the weakest link?

Feed sampling

Dry matter content estimation

Mixer management

Lab nutrient analysis

Ration balancing

Bunk management

TMR Delivery ... the Bottom Line

Don’t have any weak links!

Feed sampling

Dry matter content estimation

Mixer management

Lab nutrient analysis

Ration balancing

Bunk management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What's next

First: Measuring particle size distribution (20 min)

Second: An example statistical analysis of TMR variability

Third & before we go: Re-cap, collective discussion, comments, Q&A

Break out the calculator, notepad, pencil!