Using Manure Evaluation as a Diagnostic Tool for Feeding Programs

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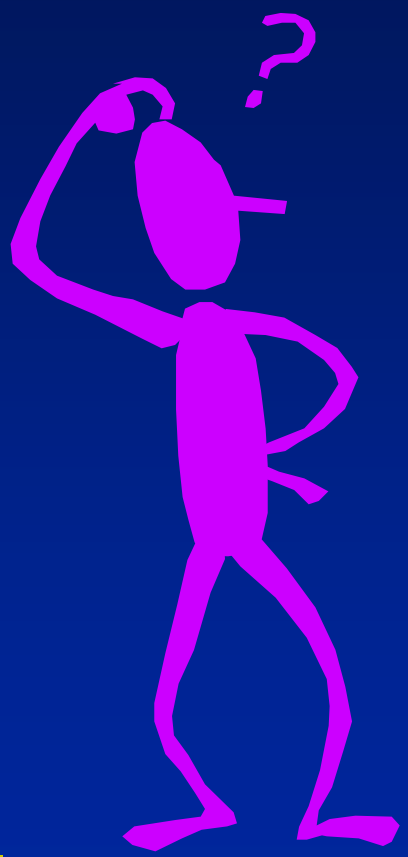
Why evaluate manure?

Manure evaluation is a good way to look at the interaction of the cow and her ration. **When used in context with the other things we evaluate,** it can give you an idea of how well the rumen is functioning and where and how well feeds are being digested. There's a sound, biological basis for why manure looks the way it does.

It’s not “normal” just because we’re used to seeing it that way.

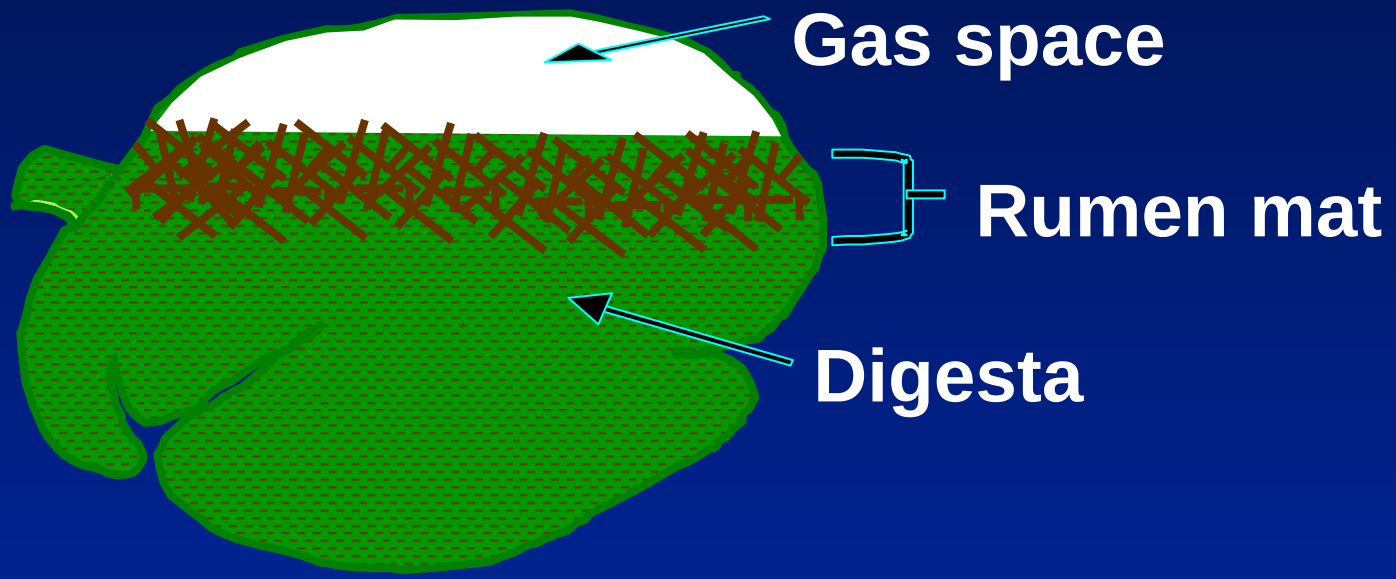


Just because we are used to seeing manure look one way doesn’t mean that it’s normal. To help us reach our goals for milk production and herd health, we need to learn what is normal or acceptable. Manure can be used as an objective measure of what is really happening in the herd, because . . .


The cows are always right!
We are really the only ones who know exactly what's going on.

How can manure tell you what's happening in the rumen?

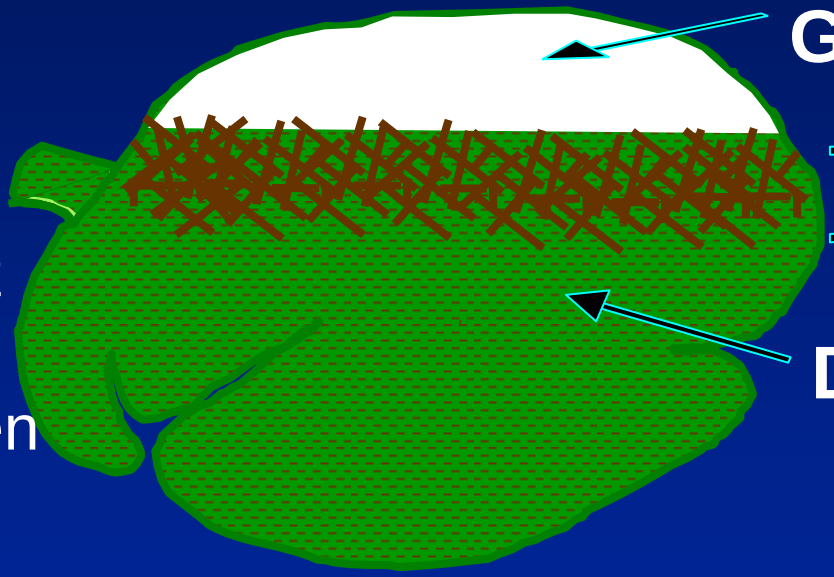
Rumen function determines particle size in manure.



Rumination and digestion by microbes in the rumen break down fiber and feed particle size. If the cow does not eat enough fiber (chewable and total) to maintain rumination and rumen function, feed can pass out of the rumen more quickly and in larger particles than it should; if this happens, it is not as well digested.

Rumen function determines particle size in manure.

For the rumen to work well, cows must eat enough chewable and total fiber to maintain rumination and prevent ruminal acidosis. The mat of fiber in the rumen retains feed for more complete digestion.



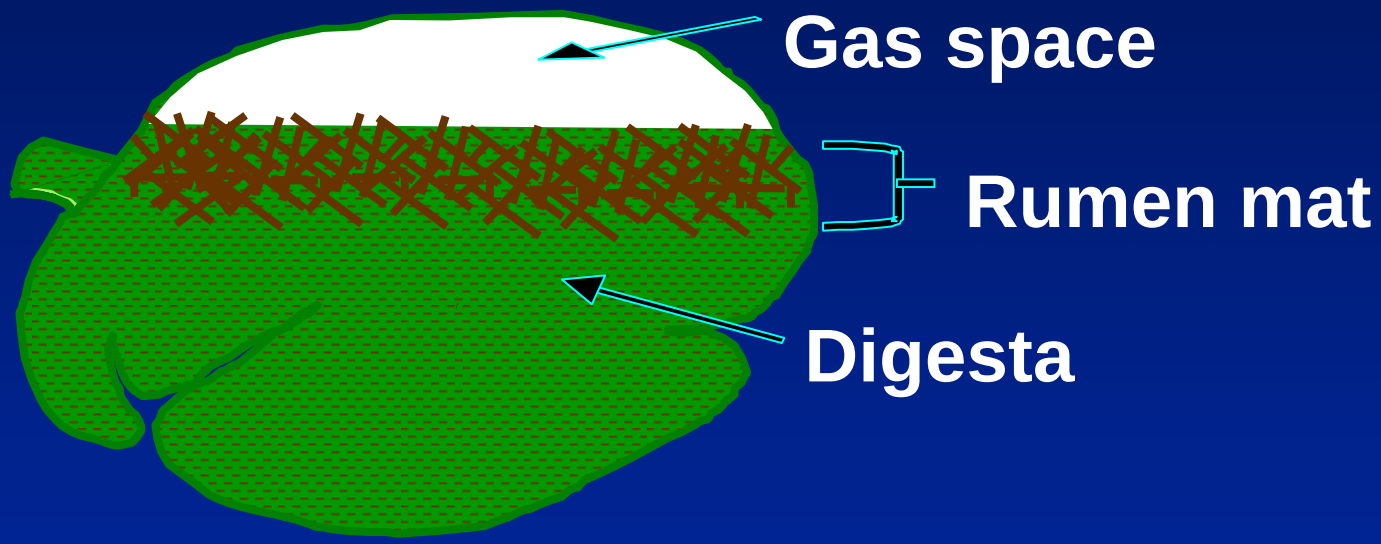
If the rumen is working well, you should see:

-- Few feed particles in the manure more than 0.5 inches long

-- & little recognizable feed (cottonseed with lint, green grass, etc.).

-- 50% of cows not sleeping, eating, drinking should be ruminating.

Rumen function determines particle size in manure.



High producing cows do eat more and rumen contents pass down the digestive tract more quickly, so more undigested feed may show up in the manure. But do not use this as an excuse for accepting poor rumen function that is due to other causes.

Where does feed digest?

Rumen (Fermentation)

Crude Protein
Carbohydrates (NDF & NFC)

Small Intestine (Enzymes)

True Protein
Starch
Lipids

Cecum & Large Intestine (Fermentation)

Crude Protein
Carbohydrates (NDF & NFC)

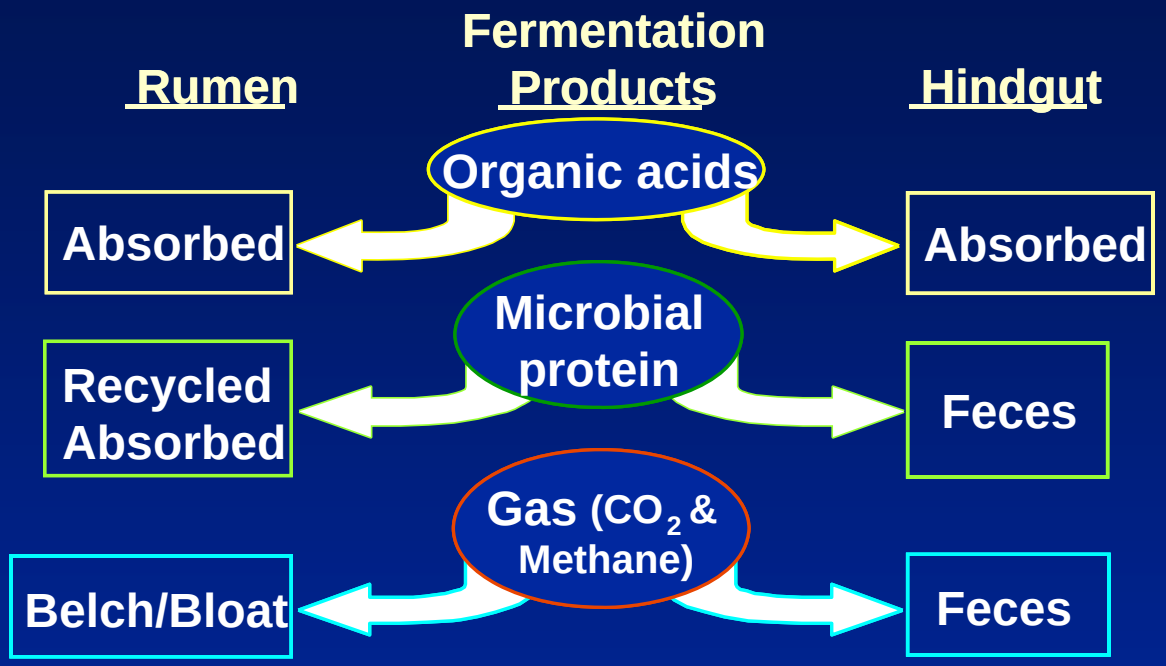
One of the reasons manure looks the way it does is because of where feed digests. Some nutrients can be digested in the rumen, some in the small intestine, and some in the hindgut (cecum and large intestine). The extent to which feed ferments in the large intestine alters the way manure looks.

NDF: neutral detergent fiber

NFC: nonfiber carbohydrates

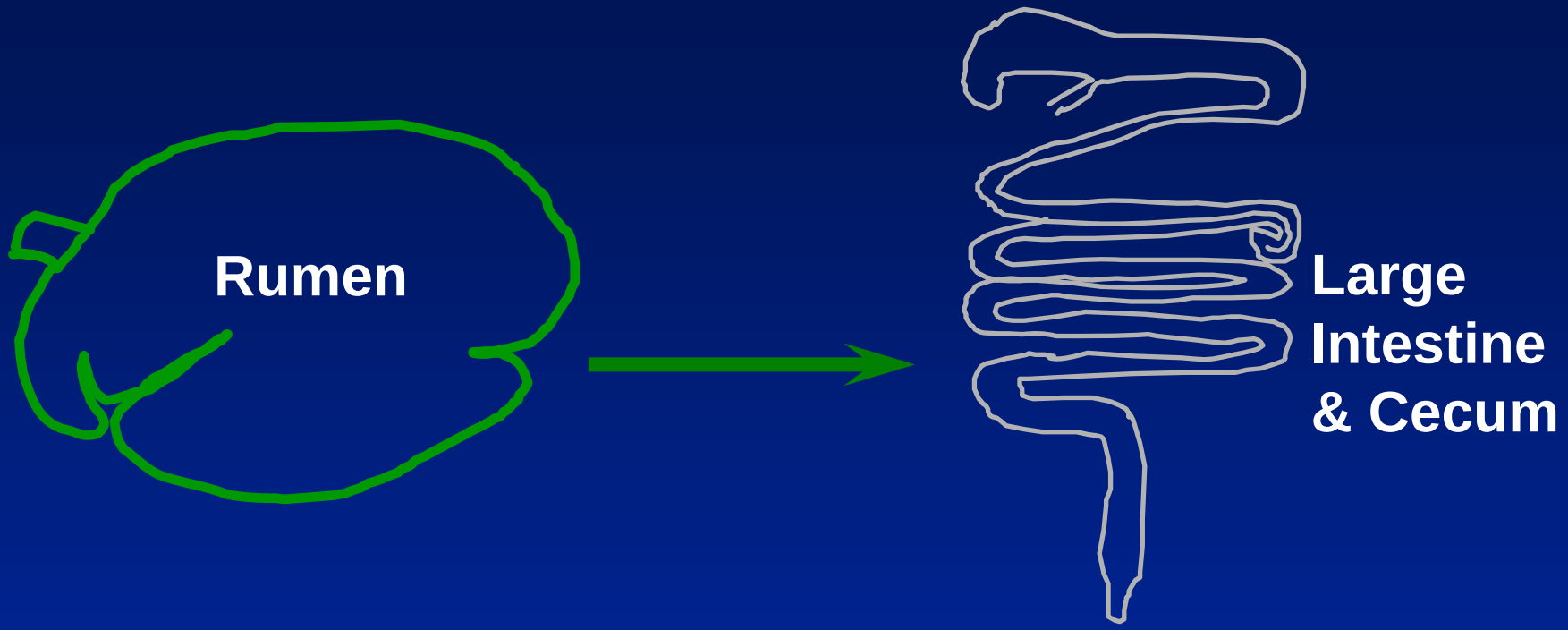
Fates of fermentation products.

Fermentation of feed by microbes in the rumen or hindgut (cecum & large intestine) produce the same basic products: organic acids, microbial cells (containing protein), and gas.



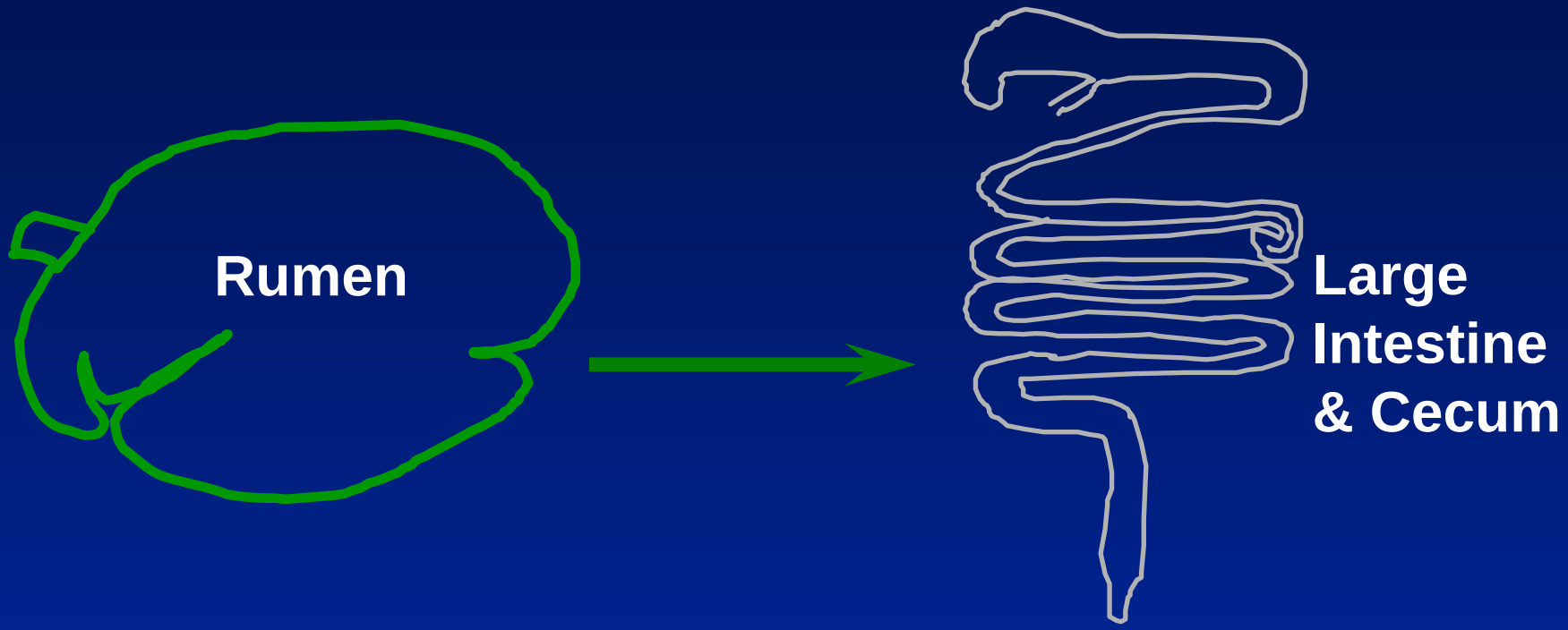
Microbial protein produced in the rumen provides high quality protein to the cow, but if made in the hindgut, it goes out in manure: site of digestion can change nutrient supply. In hindgut or rumen organic acids can be used by the cow, but the hindgut is not as buffered and can't handle the acidity as well as the rumen can.

Where does the feed ferment?



When the rumen is working well, more feed ferments there and less passes to be digested in the small intestine or fermented in the hindgut (cecum and large intestine). Some hindgut fermentation is normal.

Where does the feed ferment?



When the rumen is not working well, more undigested feed passes out, and can increase fermentation in the hindgut. Increased hindgut fermentation with its increases in gas and acid production will change the consistency and appearance of manure. Excessive hindgut fermentation can cause diarrhea, foamy manure, or mucin casts (when the gut is damaged).

Evaluating manure:

This very foamy manure with the tiny pieces of grain in it shows what manure looks like when there is gas production from too much hindgut fermentation. The manure can have a low density from the amount of trapped gas bubbles, or else it can appear as very bubbly diarrhea. Often, manure like this comes out of cows in a solid stream.

If you have ever tapped a cow for bloat, you've seen the gassy rumen contents come out in a solid stream -- that's essentially what the foamy manure can look like.

Evaluating manure:

"Lots" of undigested feed coming through in the manure suggests problems with rumen function, feed processing, or feeding management. This undigested feed never had a chance to be converted to milk, and so reduces feed efficiency (milk / feed intake).

When you see recognizable undigested feed such as green grass, orange citrus pulp, or cottonseed with the lint still intact, something is wrong with the rumen – it is not retaining feed for digestion like it should (often from not enough effective fiber/too much starch).

Evaluating manure:

You might also see undigested feed if cows are slug feeding (eating grain or TMR in large meals) or when corn is not ground to a fine enough particle size. If grain needs to be ground more finely, make sure the ration also has enough effective fiber to balance the increase in digestible starch and maintain good rumination & rumen function.

Evaluating manure:

This picture shows a sample of ground corn sieved through official engineering screens. The particles retained on screens 4 and 8 are too coarsely ground and are what is usually seen in manure.

For high-producing cows eating a lot of feed, you may see a bit more grain come through, but ask yourself if it's "reasonable." Evaluating feed efficiency (milk weight/dry matter intake weight) may help you decide whether an improvement in feed digestibility (changing the particle size?) is needed.

Evaluating manure:

When diarrhea is due to a ration problem and not disease, we typically associate it with some type of irritation to the hindgut, possibly from the excess production of acid where it can't be well buffered.

Evaluating manure:

Moldy, spoiled feeds, like this clump of bad silage, can also cause diarrhea to appear sporadically across the herd (not all cows eat the spoiled portion, so not all cows show the signs). Check for spoiled or moldy feeds and do not feed them.

Evaluating manure:

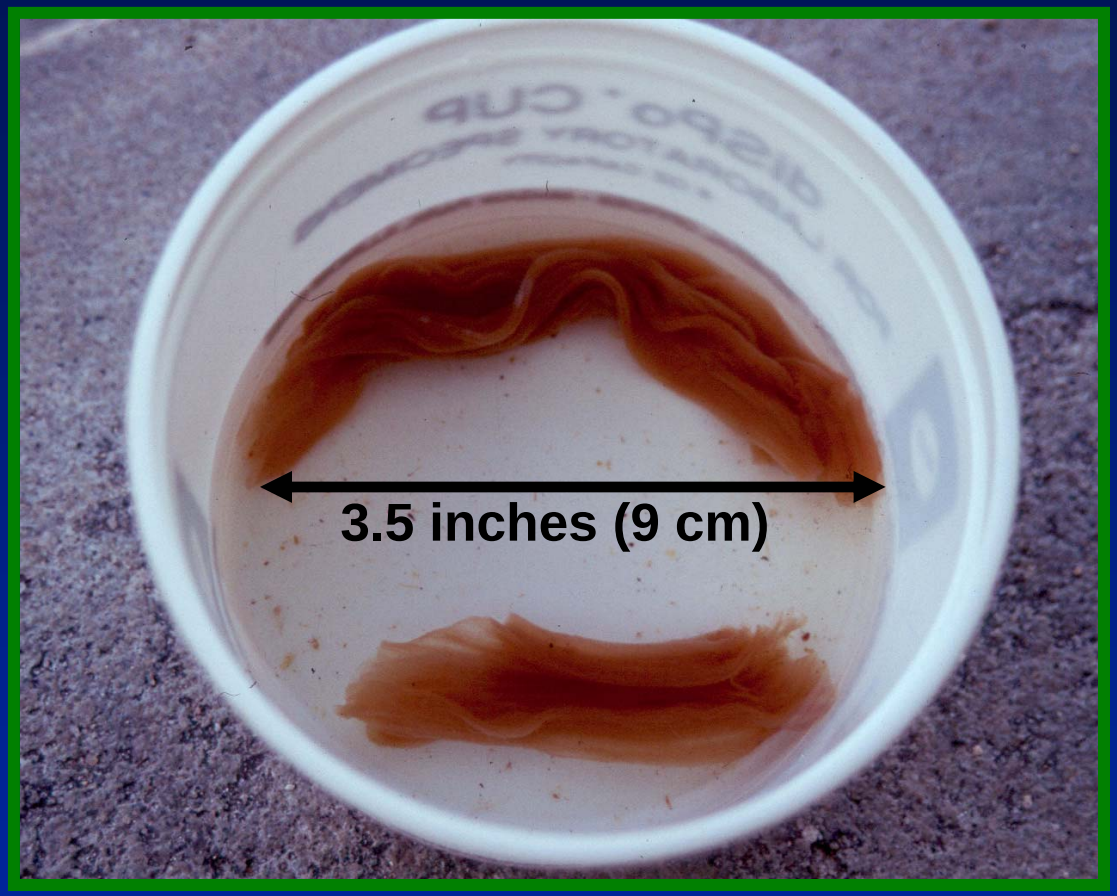
Mucin casts:

Mucin casts are used in beef feedlot management as an indicator of ruminal acidosis. They are shed out of the large intestine. If you drag the tip of your boot across a cow pie, and something moves after your boot has passed, it may be a mucin cast. They can be found in manure of any consistency.

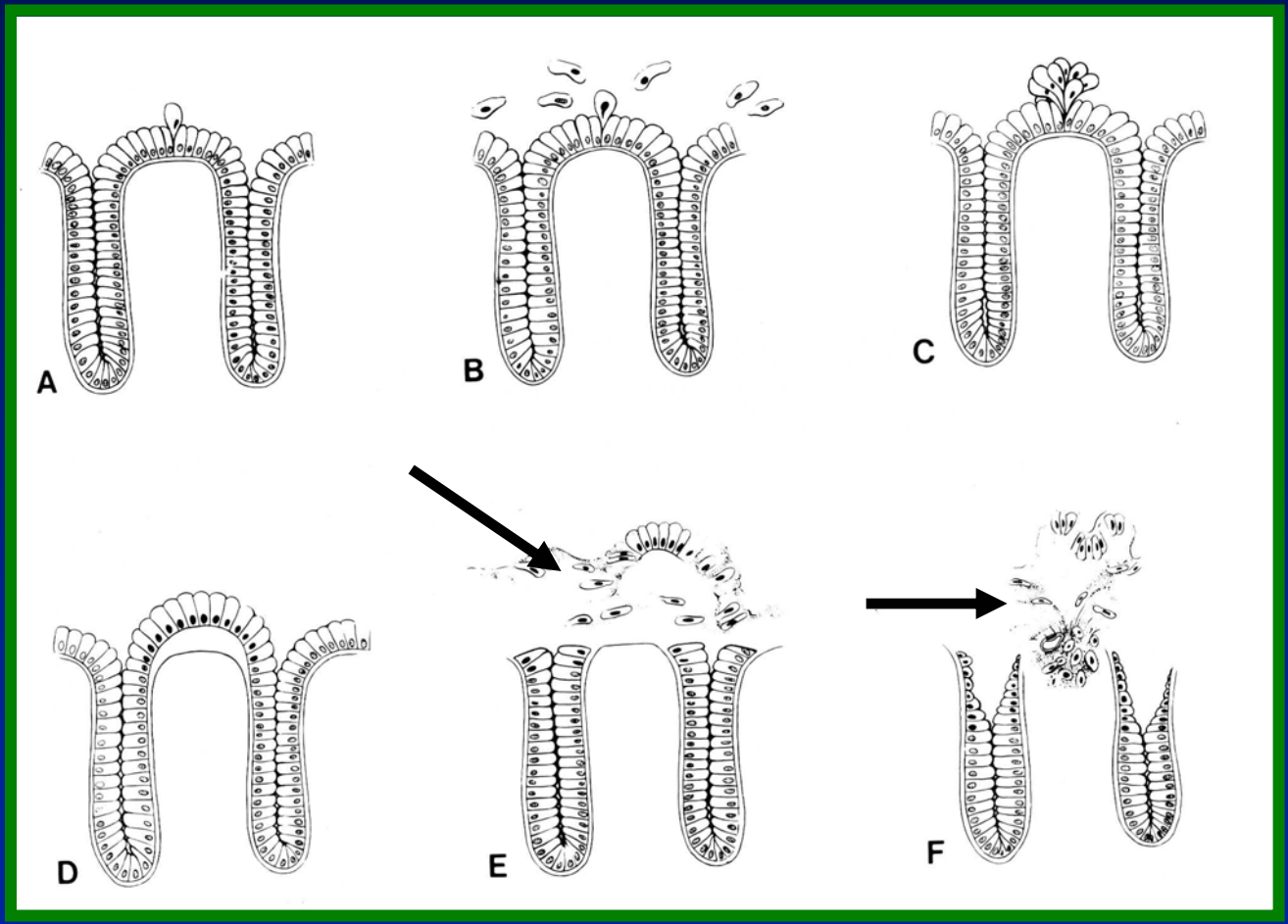
Evaluating manure:

Mucin casts:

This is what mucin casts look like after they've been rinsed in water: much like sausage casings. They can appear as small scraps or pieces that are a foot or more long. They can be brownish like this, grayish, or darker in color.



Mucin casts



Henrikson et al., 1989. Laboratory Investigation 60:72-87. Figure reproduced with permission, ©Nature, http://www.nature.com/

Where do mucin casts come from? If too much acid or possibly endotoxin is formed in fermentation in the hindgut, the normal gut lining **(A)** can be damaged or destroyed **(E, F).** When this damage occurs, mucin, or fibrin produced by the cow covers the damage. The mucin is shed out later. Bottom line: mucin casts are an indication of abnormal damage to the gut.

Evaluating manure:

If a group of cows is all eating the same ration, their manure should be similar (whether it's good, bad or indifferent), except for about 5% of the cows that will have manure different from the rest of the group (that's normal).

If there is much variation in the manure in a group, figure that the cows are not eating the same ration. This is usually due to cows sorting their feed, cows consuming clumps of spoiled feed, or different feeds being offered separately so cows can choose what they eat (they may each choose a different ration).

Getting started with manure evaluation:

- Walk the pens to get an idea of the variation in groups, between groups, and between rations.
- Also keep your eyes open to evaluate rumination (are at least 50% of cows chewing their cuds?), body condition score, eating behavior, etc., as well as manure.
- Collect 4-6 cow-pie samples per group to evaluate for particle size.
- Take samples that give a fair representation of the variation in the group.

Cleaning samples for particle size evaluation:

Step #1

Completely transfer a manure sample (~1 cup) to a kitchen screen*. Rinse the cup and lid completely, and you can put the rinsed sample back into the cup for later comparison against the other samples.

* ~7 inches diameter x 4 inches deep, 1/16th inch to 1 mm openings works well. Don't take it from or put it back in your kitchen…..

Cleaning samples for particle size evaluation:

Step #2

With a gentle force of water, rinse the sample until the water runs clear. You may need to scrape your hand along the inside of the screen to clear it if it plugs. Sometimes you will note clay-like balls of manure (not normal) that plug the screen. Note them, but see if you can rinse them through.

Cleaning samples for particle size evaluation:

Step #3

Finally, after rinsing, you can see the particles hidden in the manure. The finest particles will have washed away, but the large particles are the main concern.

Cleaning samples for particle size evaluation:

Step #4

The best way to clean the screen is to rinse it backwards.

Evaluating screened materials:

Both of these rinsed, dried manure samples came from cows eating a ryegrass silage-based diet. **LEFT:** Small, well-digested particles from a 'good' cow pie. **RIGHT:** Coarse, poorly digested particles from a pool of diarrhea. Both samples came from the same feeding group, suggesting that the cows had been sorting their feed. You do not want to see much coarse material (0.5 inches or longer) in the manure.

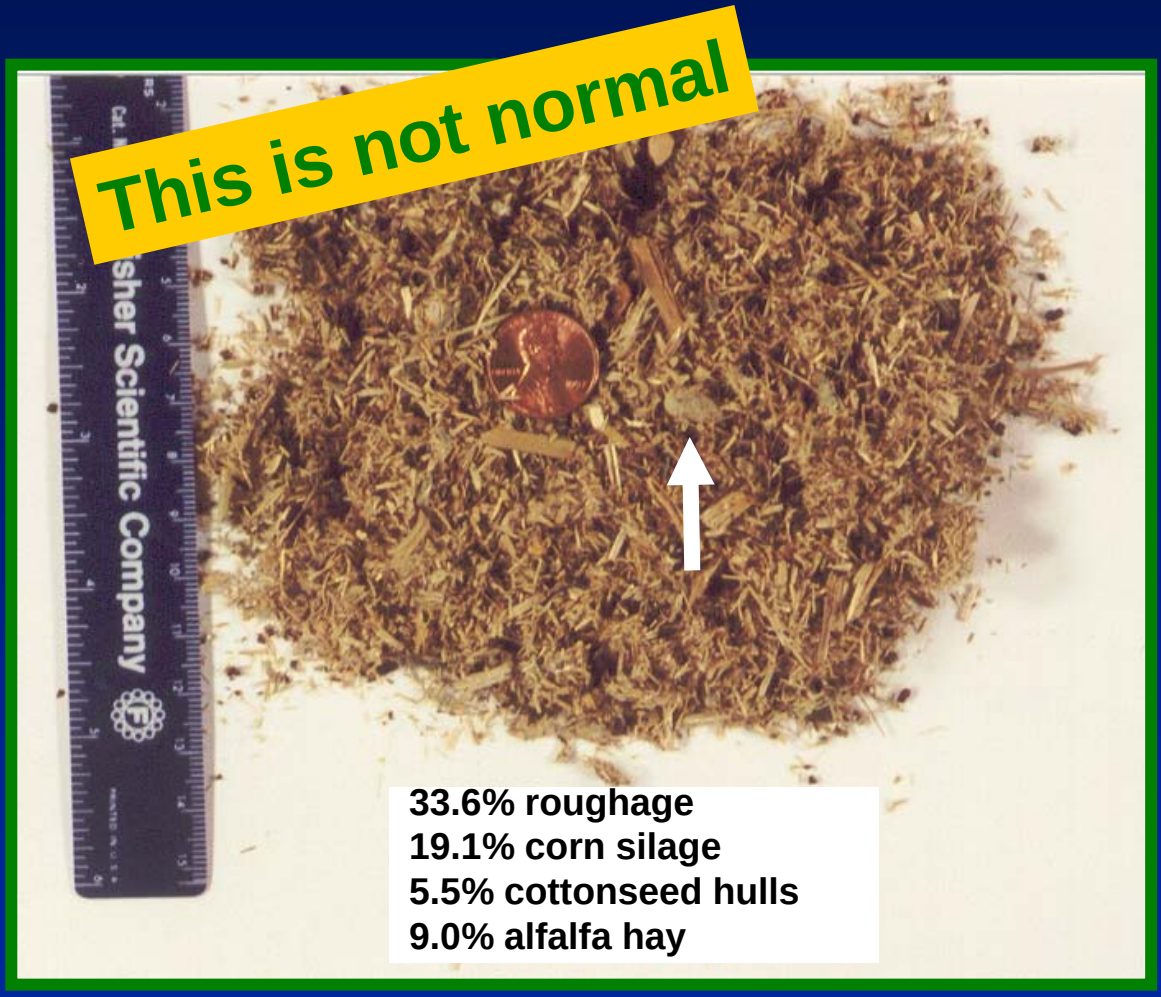
Evaluating screened materials:

The inset picture (at right) is of manure that shows good particle size from a sorghum silage-based diet (short but thicker and not as fine as with the ryegrass-based ration). Particles will look different depending upon the fiber source.

Evaluating screened materials:

In this picture you can see a whole cottonseed with the lint still on it (arrow). Plus, the particle size is rather coarse. With this case, cows not only weren't getting enough effective fiber, they were also sorting their feed.

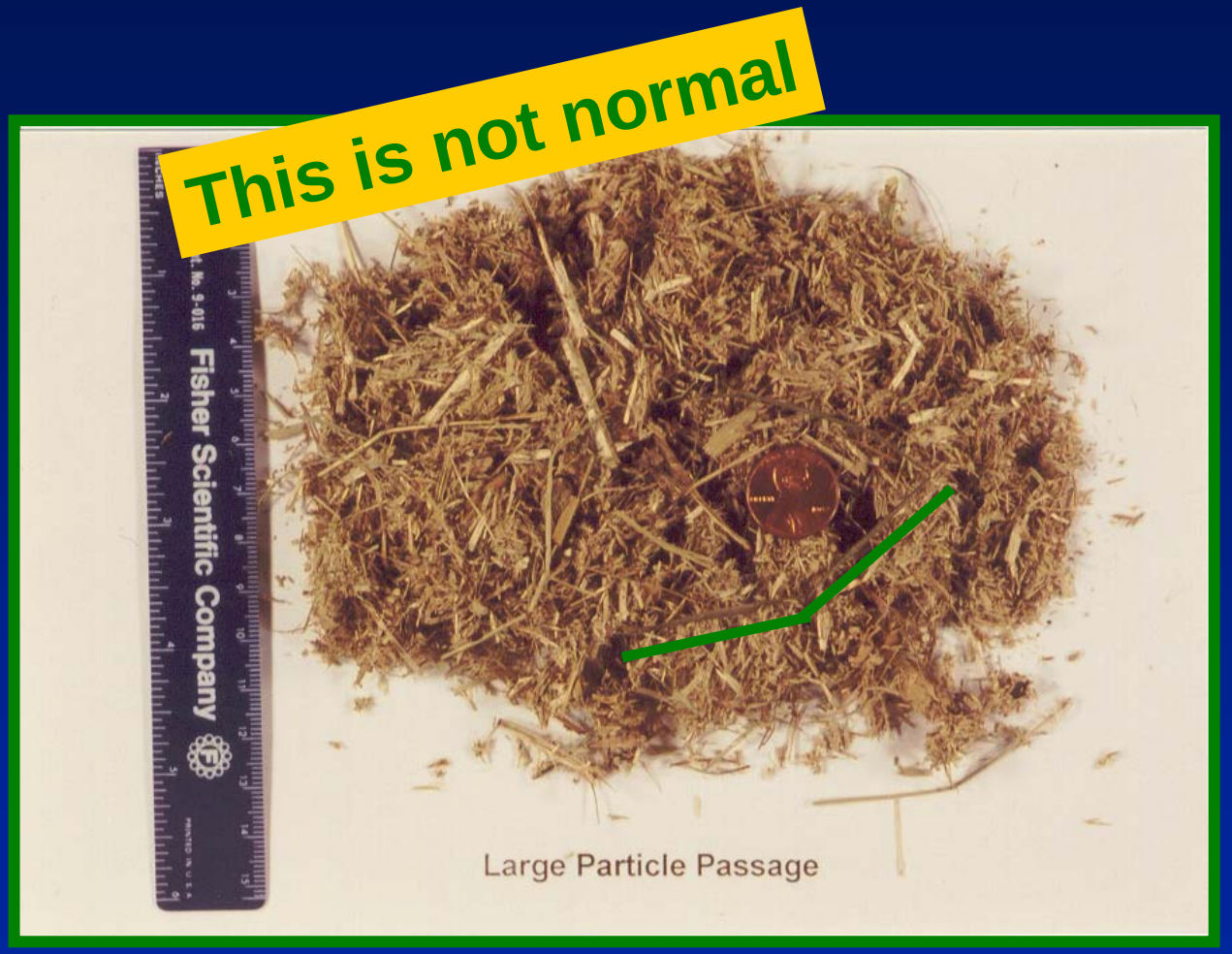
The seed with lint & coarse particles suggests that the feed was not properly retained in the rumen for fermentation.



Seeing cottonseed with no lint is not so much of an issue -- the seed stayed in the rumen long enough for the lint to be fermented.

Evaluating screened materials:

This came from a pool of bubbly, greenish diarrhea; who would have guessed that this coarse material was hidden in it? The very coarse forage in the manure indicates very poor rumen function and a sick cow. You may be able to make out a 6-inch piece (above green line) of bermudagrass hay that managed to make its way through the gut.



Evaluating screened materials:

This shows why it's a good idea to process or properly chop corn silage to nick the grain and make it available to digestion. This grain still had its contents -- starch and protein that wasn't available to the cow. We had to add more corn meal to the herd's ration to make up for the corn grain from the silage that wasn't digestible.

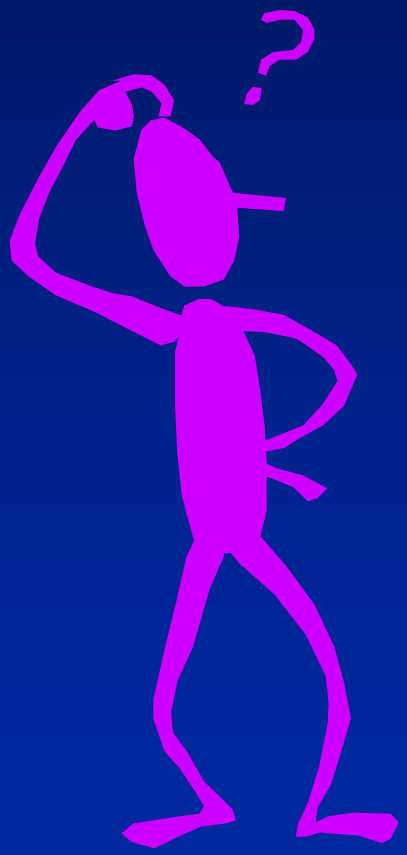
Evaluating screened materials:

Differences in the amount of solids in a set volume of manure largely reflect differences in the amount of gas or liquid in the manure. The more liquid or gas in a manure sample, the less solids remaining after screening. More liquid or gas may suggest more hindgut fermentation. Not unusual to see more liquid or gas with high producing cows, much less with dry cows.

What to look at (besides manure) when evaluating a herd:

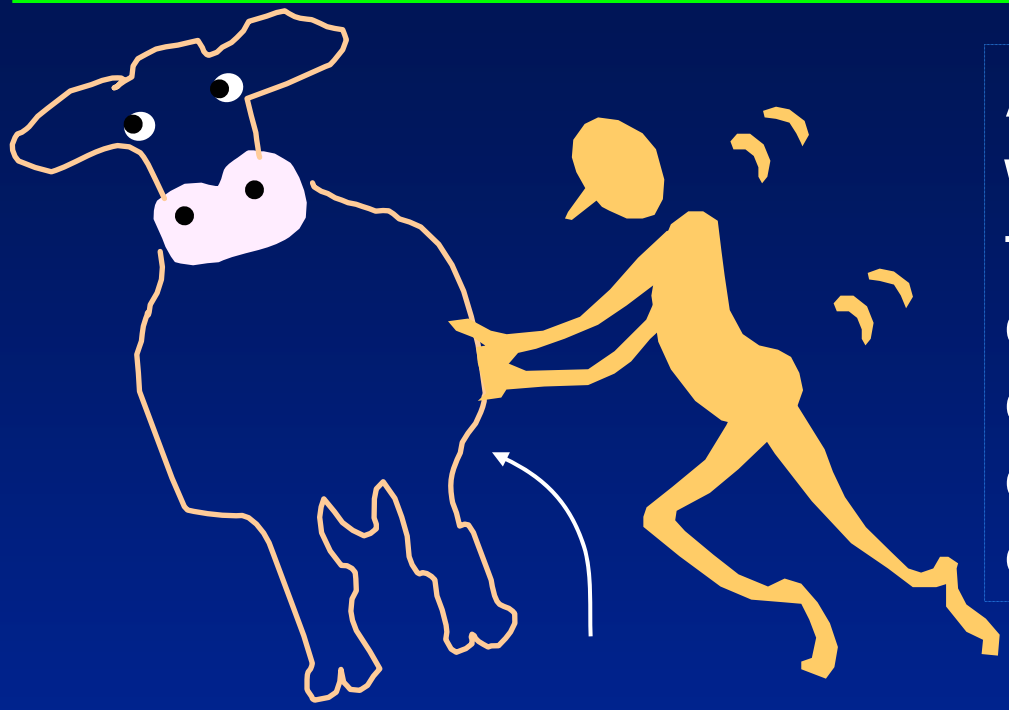
- Cows: Body condition score, coat, lameness, rumination….
- Feed: Mold/dust, analysis, consistency, mixing, existence….
- Bunk: Mold, clean, fresh, heating, mixing, weigh back….
- Water: Clean, fresh, available….
- Facilities: Comfortable, used, clean, ventilated….
- Employees: How they treat the animals….

What could cause what we see?



What the manure looks like	Possible dietary causes (not disease)
Loose manure	●High protein (total or soluble); pasture ●Salts or magnesium oxide in ration ●High water intake (heat stress)
Diarrhea	●Spoiled, moldy feed or silage ●Ruminal acidosis ●Increased hindgut fermentation
Foamy manure or Mucin casts	●Ruminal acidosis ●Increased hindgut fermentation
Large particles, undigested feed	●Cows are sorting feed; slug feeding ●Not enough chewable fiber/forage/feed ●Ruminal acidosis
Manure variable in a feeding group	●Cows are sorting feed; slug feeding ●Spoiled, moldy feed or silage (spoilage does not usually mix uniformly)

What could cause what we see?



Aiming for a ration energy value without due consideration of fiber, effective fiber, and type of energy (starch, fat, sugars, etc.) can cause problems, tipping cows into ruminal acidosis or other digestive upset.

How do we fix it?

Balance the ration for effective fiber, energy types, etc. Don't formulate focused only on the energy value. This also means formulating the ration, and then going back to the cows evaluating what they think of your efforts. Then reformulate the ration or change management as needed to get the desired response.

What could cause what we see?

Cows have very few hobbies, so they sort their feed.

How do we fix it?

Come up with rations that cows can't sort. Lou Armentano (University of Wisconsin) has suggested that if a particle is longer than a cow's mouth is wide, she can sort it. So, chop forages 1 to 2 inches long and mix them in a moist Total Mixed Ration (TMR) that can't be sorted or sifted apart.

If you see cows putting their noses down, nudging the feed around, and then diving for the bottom of the bunk to eat the grain that sifted out, they are trying to sort.

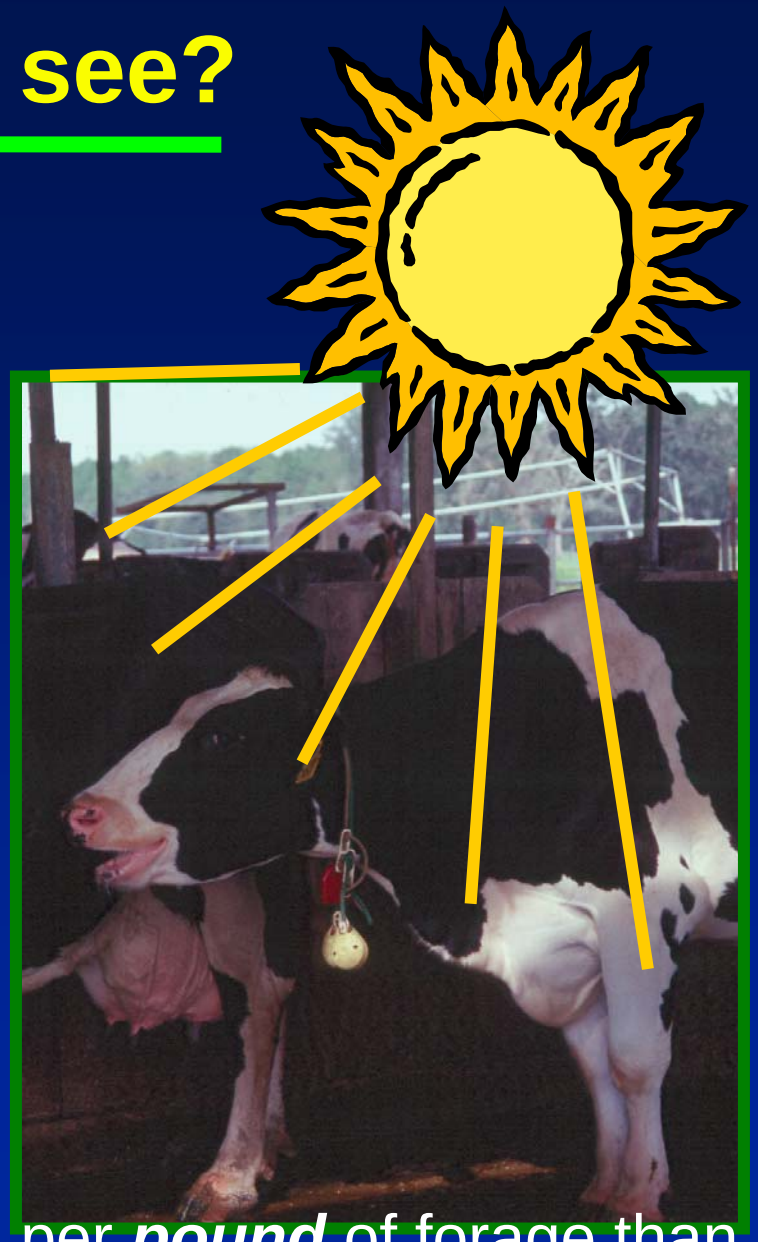
What could cause what we see?

We shouldn't help cows in their search to find ways to sort feed, so this means mixing the TMR correctly in the first place. (Not like in this picture). But also be sure you don't grind the forage finely during mixing so that there's little chewable fiber left.

If you offer feeds separately, cows will eat what they choose, and cows are very poor nutritionists. They can – and have, and will again – eat themselves sick (at least some of them).

What could cause what we see?

Heat stress can cause ruminal acidosis or signs that look like it. Heat-stressed cows slug feed, ruminate less, have lower ruminal pH, and try more vigorously to sort their feed.



How do we fix it?

Use standard heat abatement practices for some relief; modify the diet to reduce risk (more fiber from digestible, palatable forage and reduced starch?*); and just be aware that heat stress predisposes cows to ruminal acidosis.

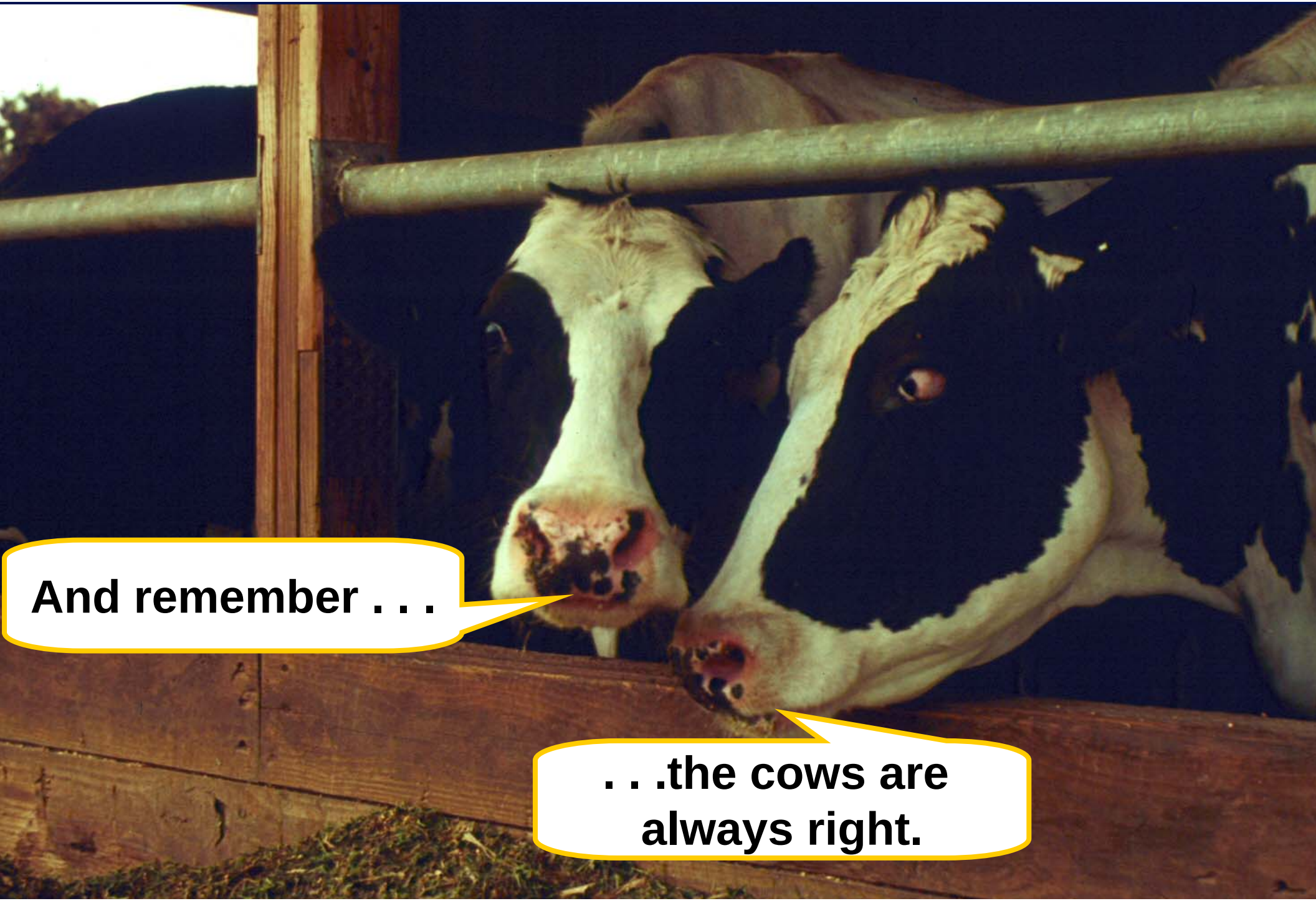
*There are fewer Mcal of heat increment (HI) per ***pound*** of forage than grain, although the ***percentage*** of energy as HI is greater for forage.

In Summary . . .

Manure evaluation is qualitative and should be used with other herd observations to build a case as to what ration or management changes are needed.

- Manure appearance
- Fecal particle size
- Undigested feed
- % Rumination
- Eating behavior
- Animal health
- Production
- Environment
- Management
- Feed efficiency

There are many ration and cow factors that we do not know how to measure, yet, so on-farm observations are essential for best herd and ration management.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