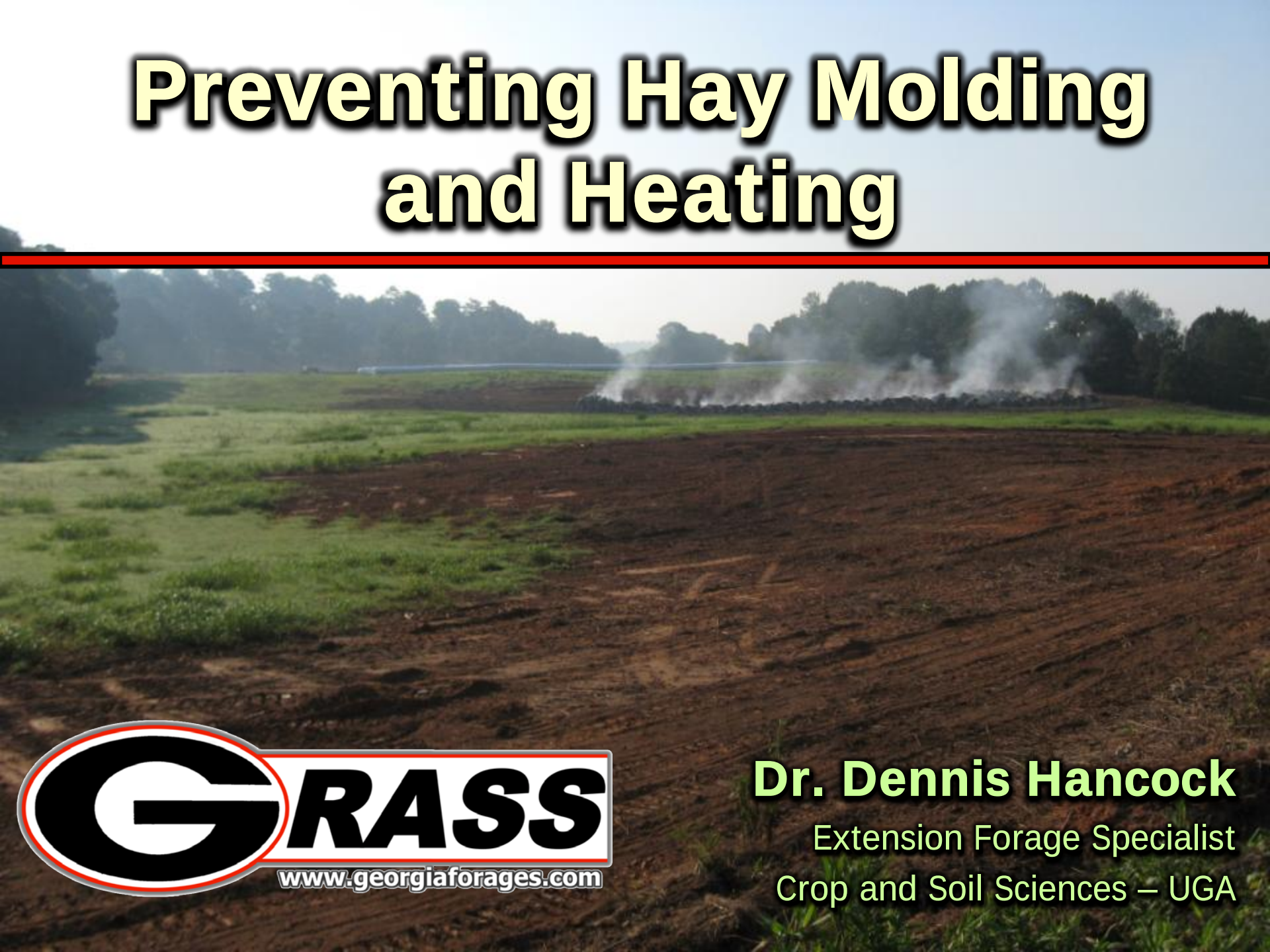
Preventing Hay Molding and Heating



GRASS
www.georgiaforages.com

Dr. Dennis Hancock
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Crop and Soil Sciences – UGA

The other extreme…

Picture Credit: G.J. Charlet III, Clinton, LA Vol. Fire Dept. via flickr.com

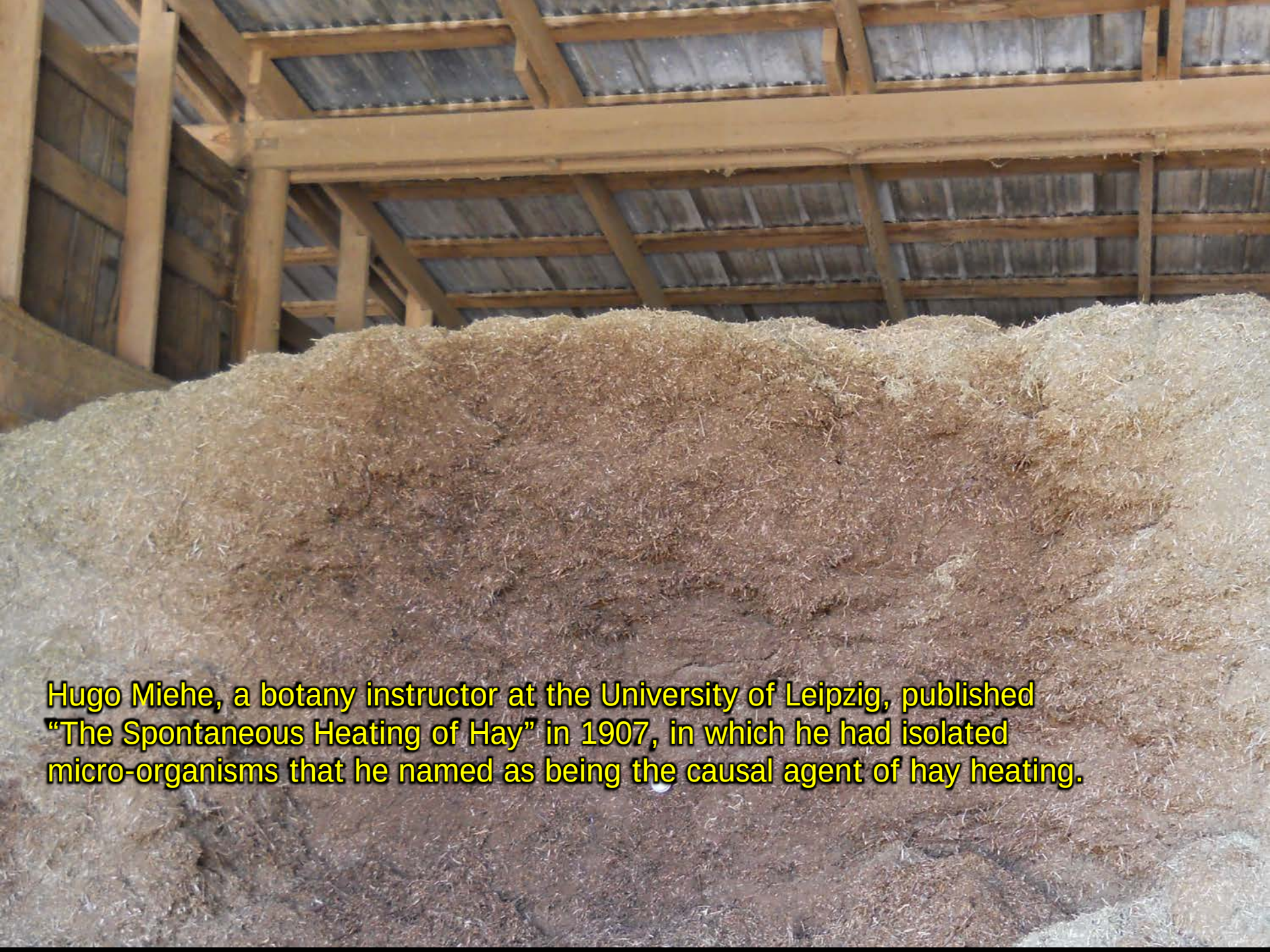
Nothing New Under the Sun

Columella, 1st century Roman historian:

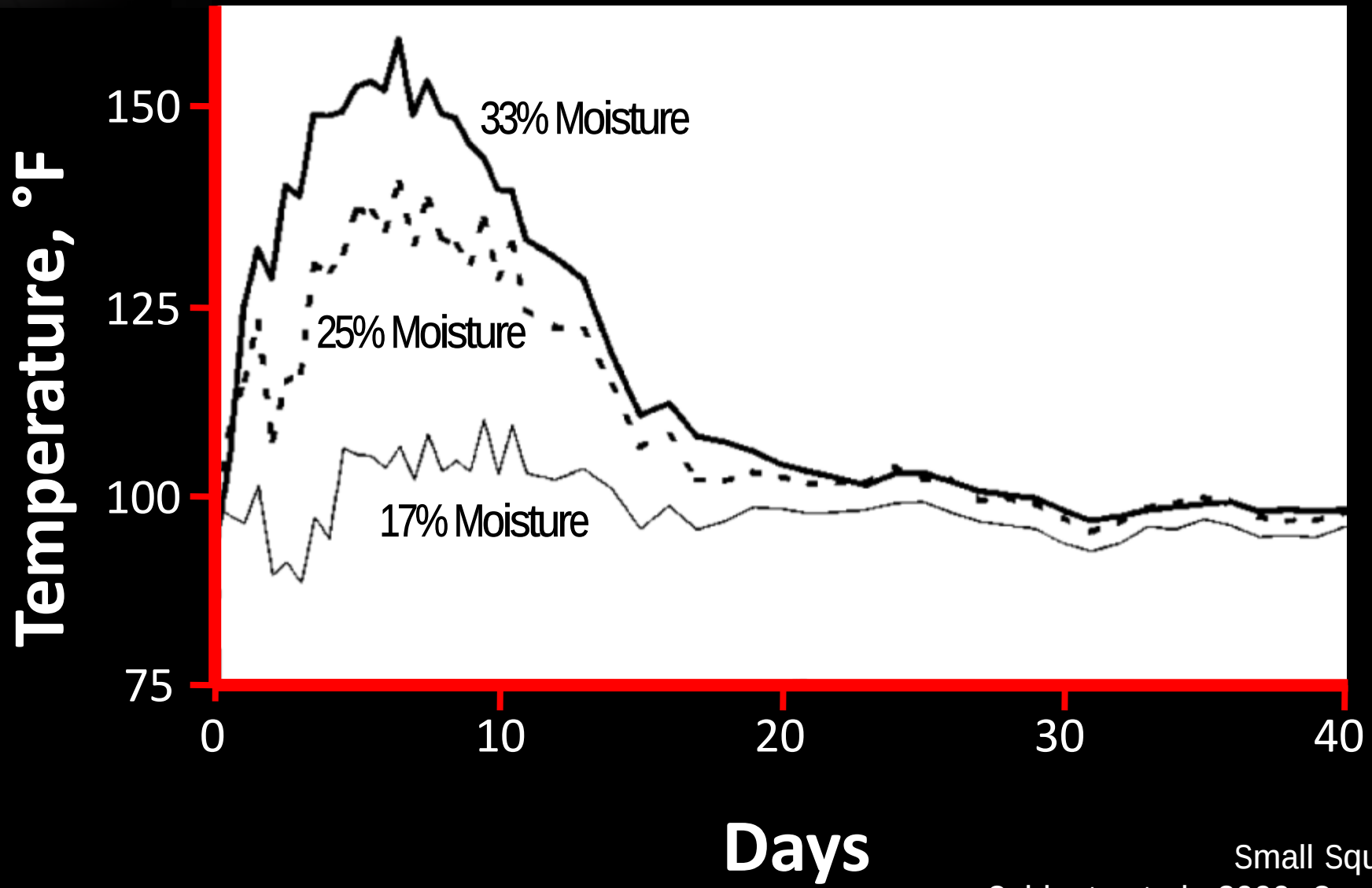
"(Hay must) *not be gathered either too dry or too green. In the former case, if it has lost all its juice, it is only good for bedding; in the latter case, if it retains too much of its juice, it rots on the scaffold and, when it has become hot, often ignites and catches fire."*

Pliny the Elder, 1st century Greek historian:

"When the grass is cut, it should be turned towards the sun and must never be stacked until it is quite dry. If this last precaution is not carefully taken, a kind of vapor will be seen arising from the rick in the morning, and as soon as the sun is up it will ignite to a certainty and so be consumed."

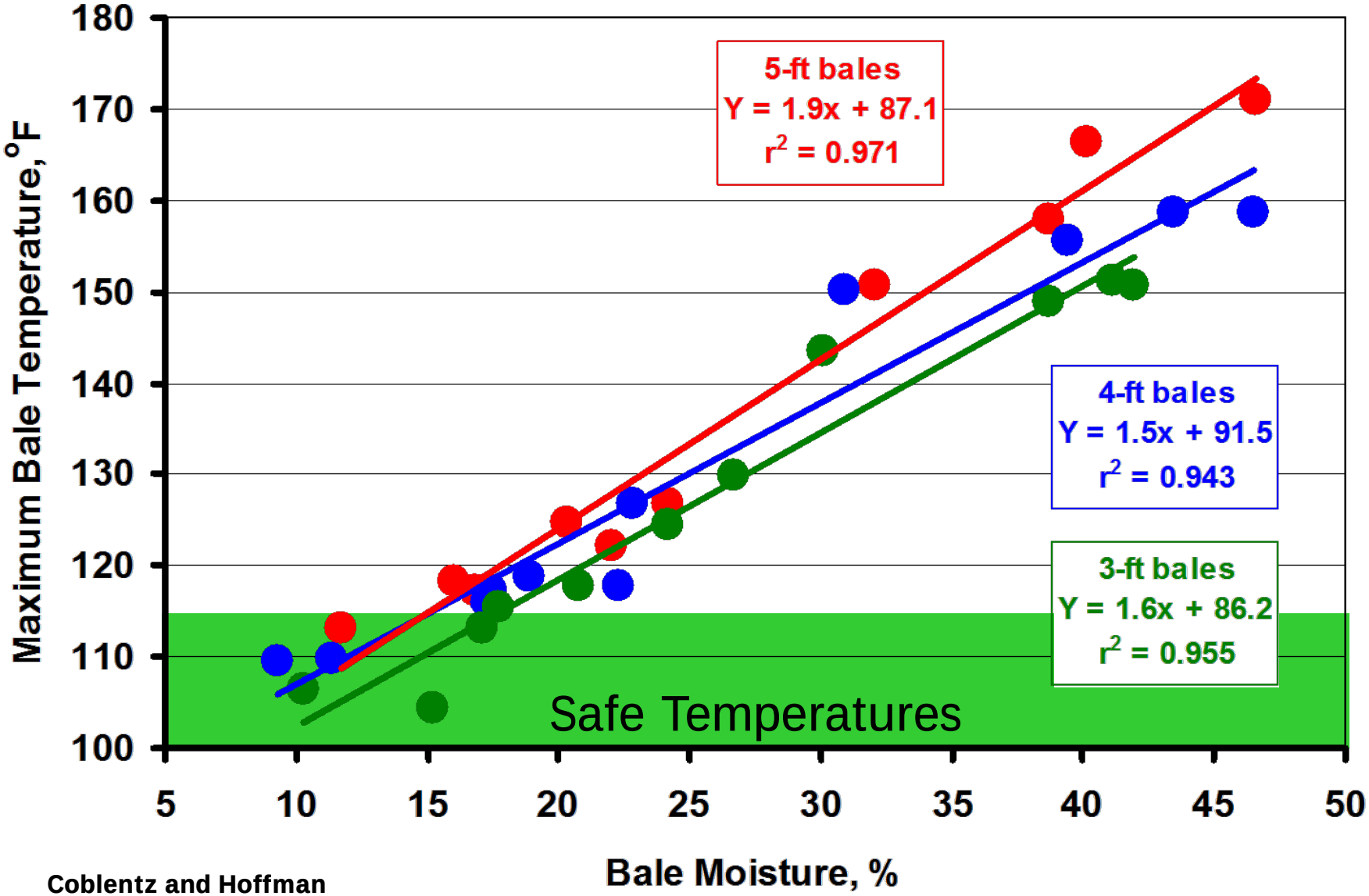

Hugo Miehe, a botany instructor at the University of Leipzig, published
“The Spontaneous Heating of Hay” in 1907, in which he had isolated
micro-organisms that he named as being the causal agent of hay heating.

Bale Moisture Effects Bale Temp



Small Squares
Coblentz et al., 2000. Crop Sci.

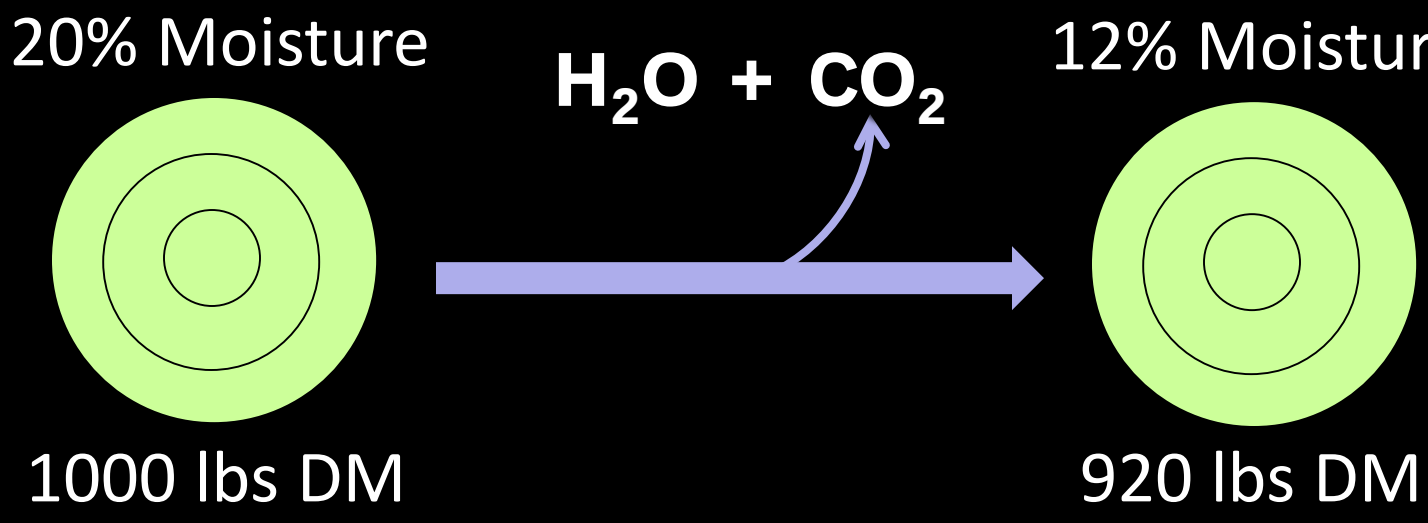
Maximum Internal Bale Temperature (Coblentz and Hoffman, 2009)

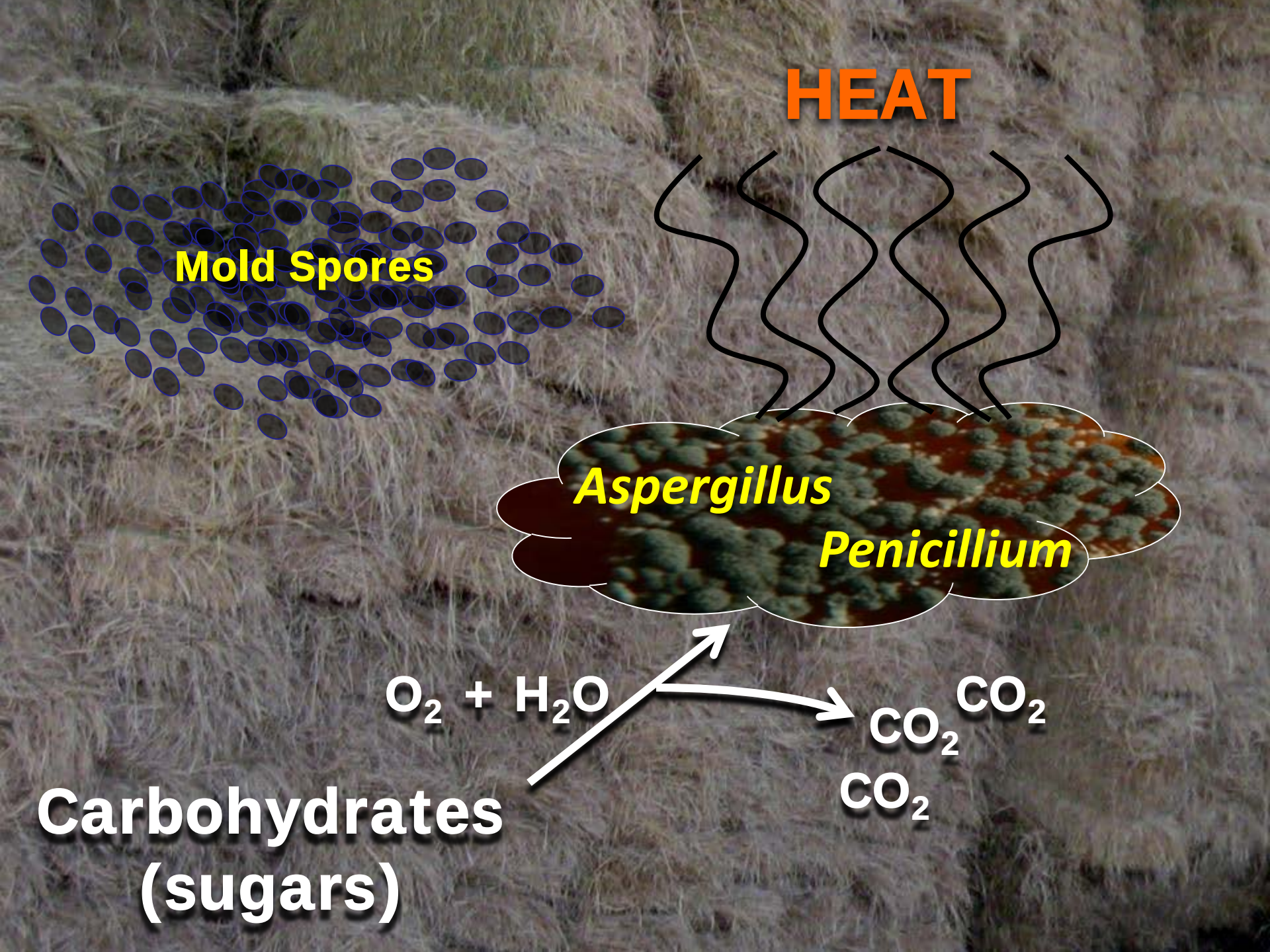


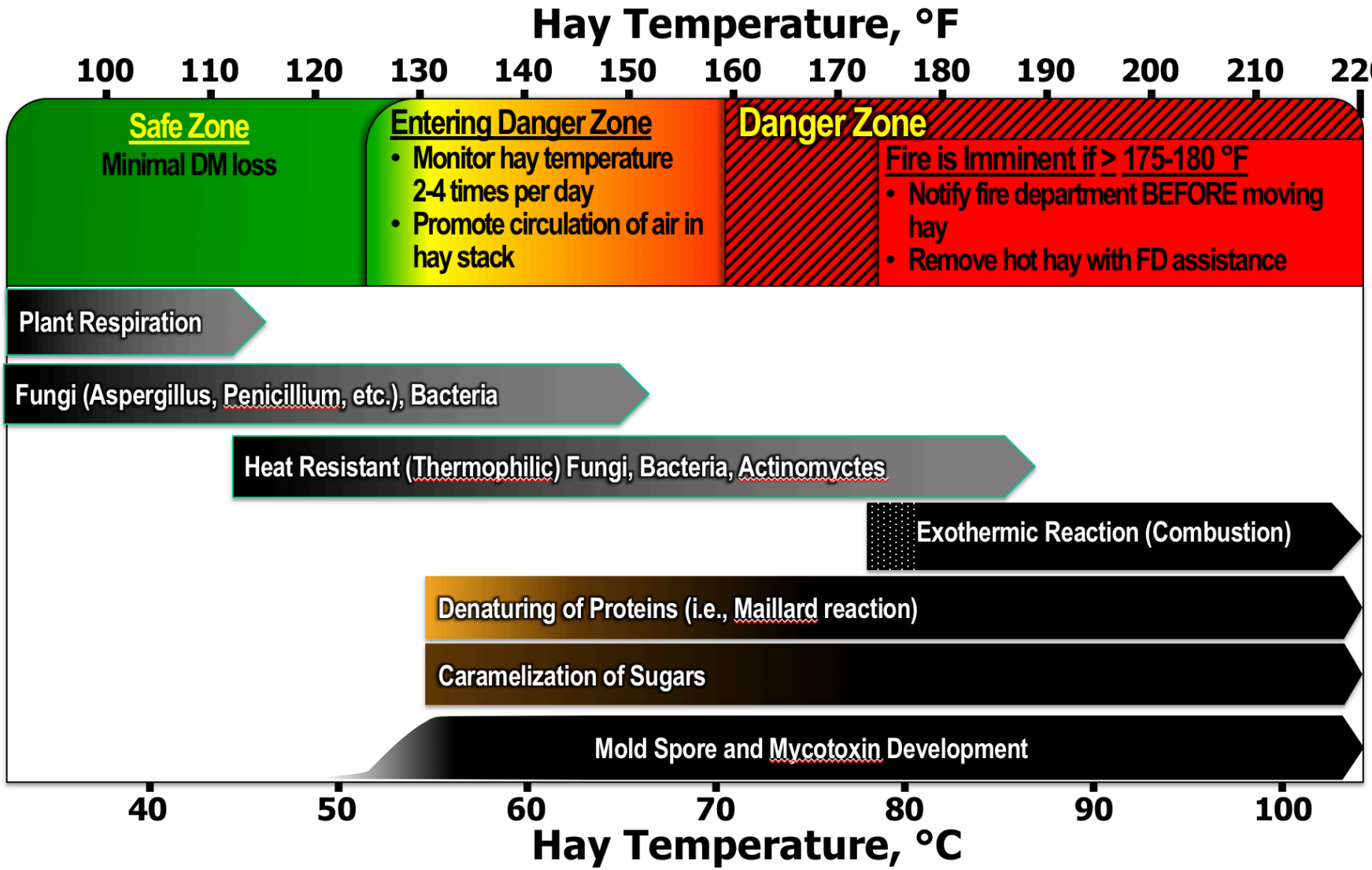
Coblentz and Hoffman (2009)

Losses During Storage

- Even when hay is baled at the target moisture (15% moisture for round bales; 18% for squares), the forage will go through a “sweat” for 2-3 wks.
  - Moisture is driven off, heat is given off, and DM dec.
  - A 1% decrease in moisture ≈ 1% decrease in DM
  - Moisture tends to equilibrate at 12% during storage




HEAT
Mold Spores
Aspergillus
Penicillium
$O_2 + H_2O$
CO_2
CO_2
CO_2
Carbohydrates
(sugars)

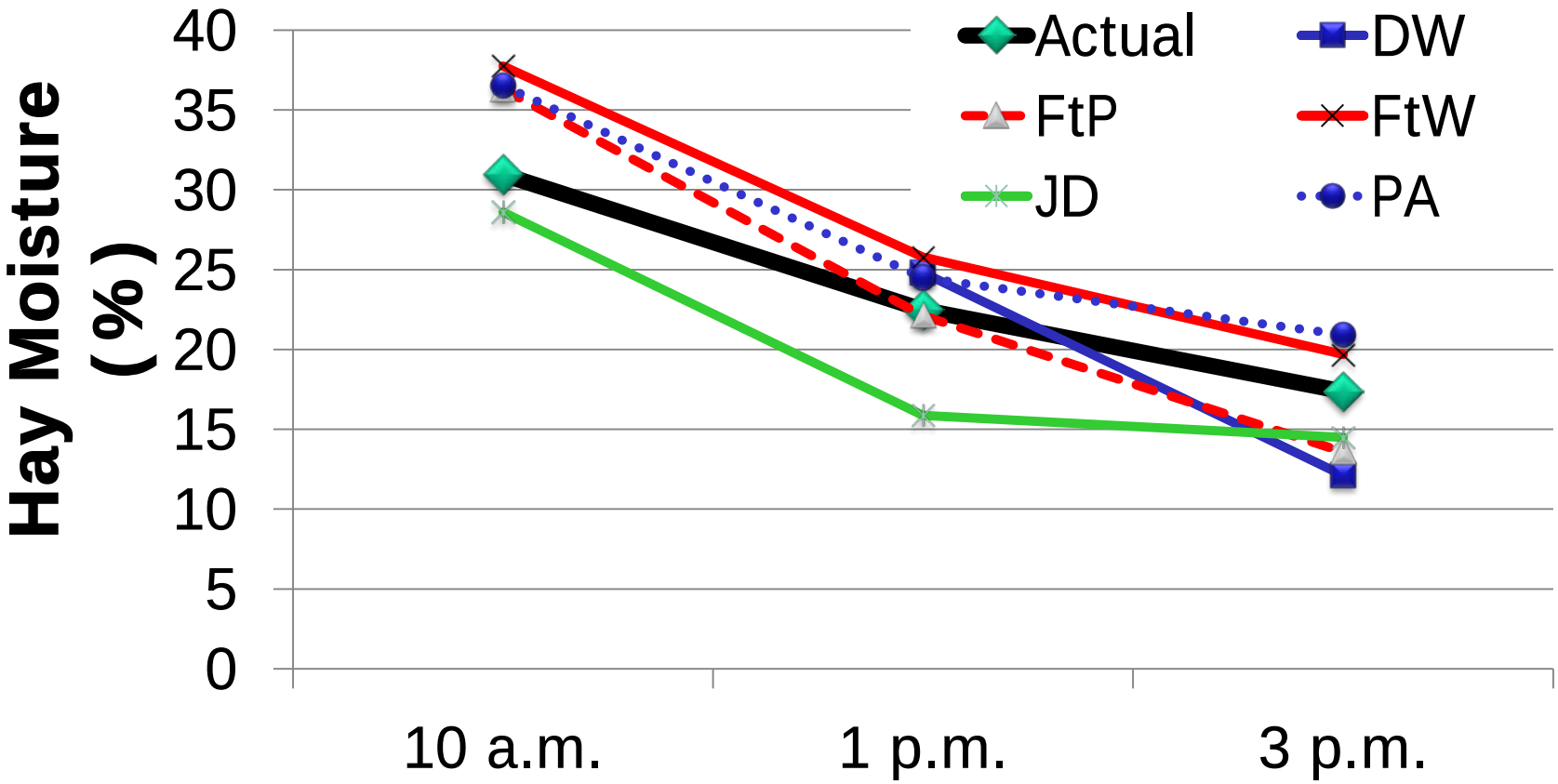

Hay Temperature, °F
100 110 120 130 140 150 160 170 180 190 200 210 220
Safe Zone
Minimal DM loss
Entering Danger Zone
• Monitor hay temperature 2-4 times per day
• Promote circulation of air in hay stack
Danger Zone
Fire is Imminent if ≥ 175-180 °F
• Notify fire department BEFORE moving hay
• Remove hot hay with FD assistance
Plant Respiration
Fungi (Aspergillus, Penicillium, etc.), Bacteria
Heat Resistant (Thermophilic) Fungi, Bacteria, Actinomyctes
Exothermic Reaction (Combustion)
Denaturing of Proteins (i.e., Maillard reaction)
Caramelization of Sugars
Mold Spore and Mycotoxin Development
40 50 60 70 80 90 100
Hay Temperature, °C

Hay Moisture Probe

Hay Moisture Probe

Electrical Conductivity (Resistance)

Accuracy of Various Hay Moisture Probes – 4th cutting



Hancock. Unpublished data.

Determining Moisture

Methods:

4. Hay Moisture Testers/Probes
3. By feel (if calibrated).
2. Microwave moisture test

MEASURING THE MOISTURE CONTENT OF FORAGE USING A MICROWAVE OVEN

1. Chop fresh forage into short lengths (< 1 inch) for ease of handling and uniform drying.
2. Weigh out at least 100 grams (3.5 ounces) of chopped forage.
3. Spread forage thinly on a microwave-safe dish and place into microwave. (A cup of water placed in the microwave beside the sample will help prevent the sample from igniting once dry.)
4. Heat for 1-2 minutes and reweigh.
   - If forage is not completely dry, shake and redistribute the sample, and repeat the heating cycle until the sample reaches a stable weight. (Microwaves vary considerably in drying capacity. It is better to dry for short intervals and reweigh until the last two weights are constant, than to overdry and run the risk of burning and damage to oven.) If charring occurs, use the previous weight.
5. Calculate moisture content using the following equation:

$$\% \text{ Moisture Content} = \frac{W1 - W2}{W1}$$

Where: W1 = weight of forage before heating
W2 = weights of forage after heating

Dry matter (DM) is the percentage of forage that is not water. DM equals 100% minus the % Moisture Content.

Adapted from: Southern Forages 4th Edition, Page 303

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1’. Moisture meter within the baler?

HEAT

~~*Aspergillus*~~

~~*Penicillium*~~

$O_2 + H_2O$

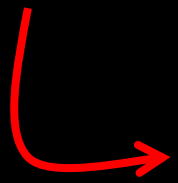
Bacterial Decomposition

CO_2 CO_2 CO_2

Carbohydrates (sugars)

Hay Preservation Additives

- Rock Salt



No effect on mold growth

Increases palatability

Not recommended.

Hay Preservation Additives

- Organic acids
- Buffered acids

Prevents heating, but maintains moist environment for microbial activity.

DM losses often offset DM gains.

Beneficial when moisture is 18 – 25%

Preservatives

Application of Propionic Acid Preservative[1] to Large Square Bales[2] of Alfalfa/Orchardgrass Hay (Coblentz and Coffey, unpublished)

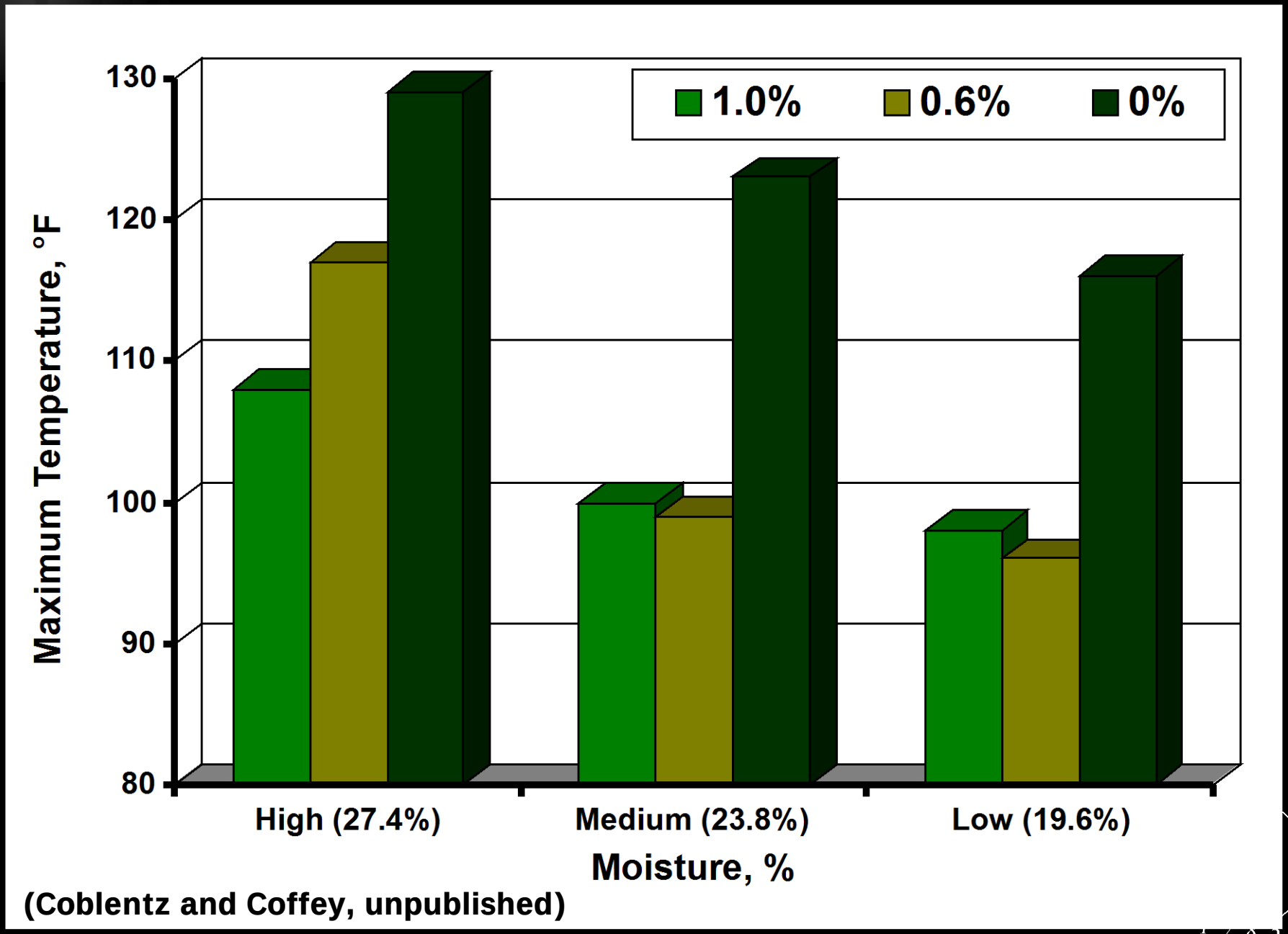
Group	Moisture	Volume	Wet Weight	Dry Weight	DM Density
	%	*ft^3*	*lbs*	*lbs*	*lbs DM/ft^3*
High	27.4	40.7	644	467	11.5
Medium	23.8	40.7	626	476	11.8
Low	19.6	42.1	613	494	11.7
SEM	0.80	0.39	9.3	10.4	0.20

[1] **Rates: 0, 0.6, or 1.0% of fresh weight.**

[2] **Large square bales were 3 x 3 x 6 ft.**

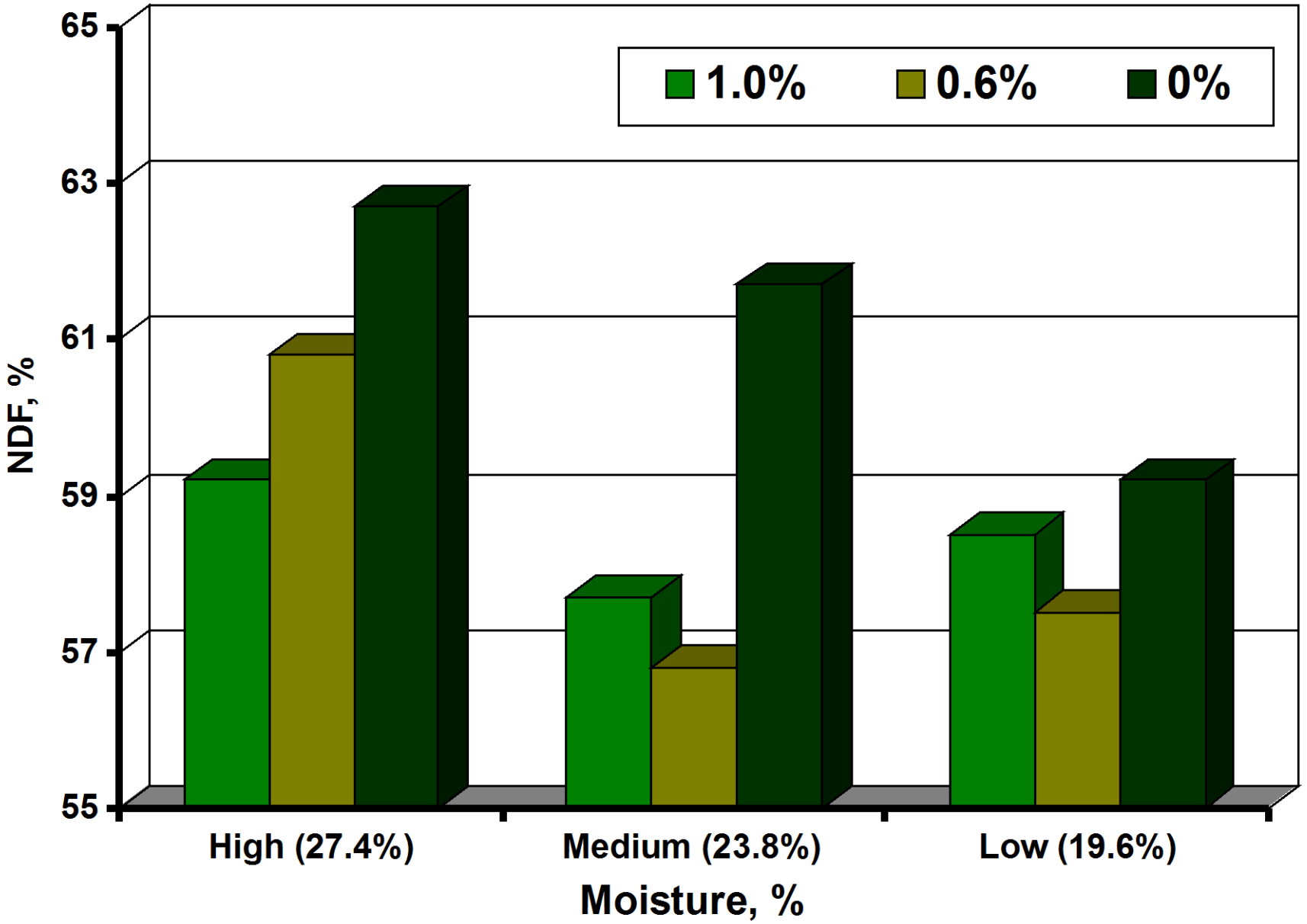
1785

Maximum Temperature



(Coblentz and Coffey, unpublished)

NDF



(Coblentz and Coffey, unpublished)

Organic Acids are Corrosive

Organic Acids are Corrosive

Same baler, 2 months later.

Hay Preservation Additives

- Bacterial/microbial inoculants

Those tested have no consistently demonstrable effect.

Some **have had inconsistent effects (some positive, some no change).**

Effectiveness in Humid South is questionable (high humidity)

Requires real-time moisture measurement (rate adjustment)

Photo credit: Dr. Garry Lacefield, Univ. of Kentucky

Questions?

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1-800-ASK-UGA1

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