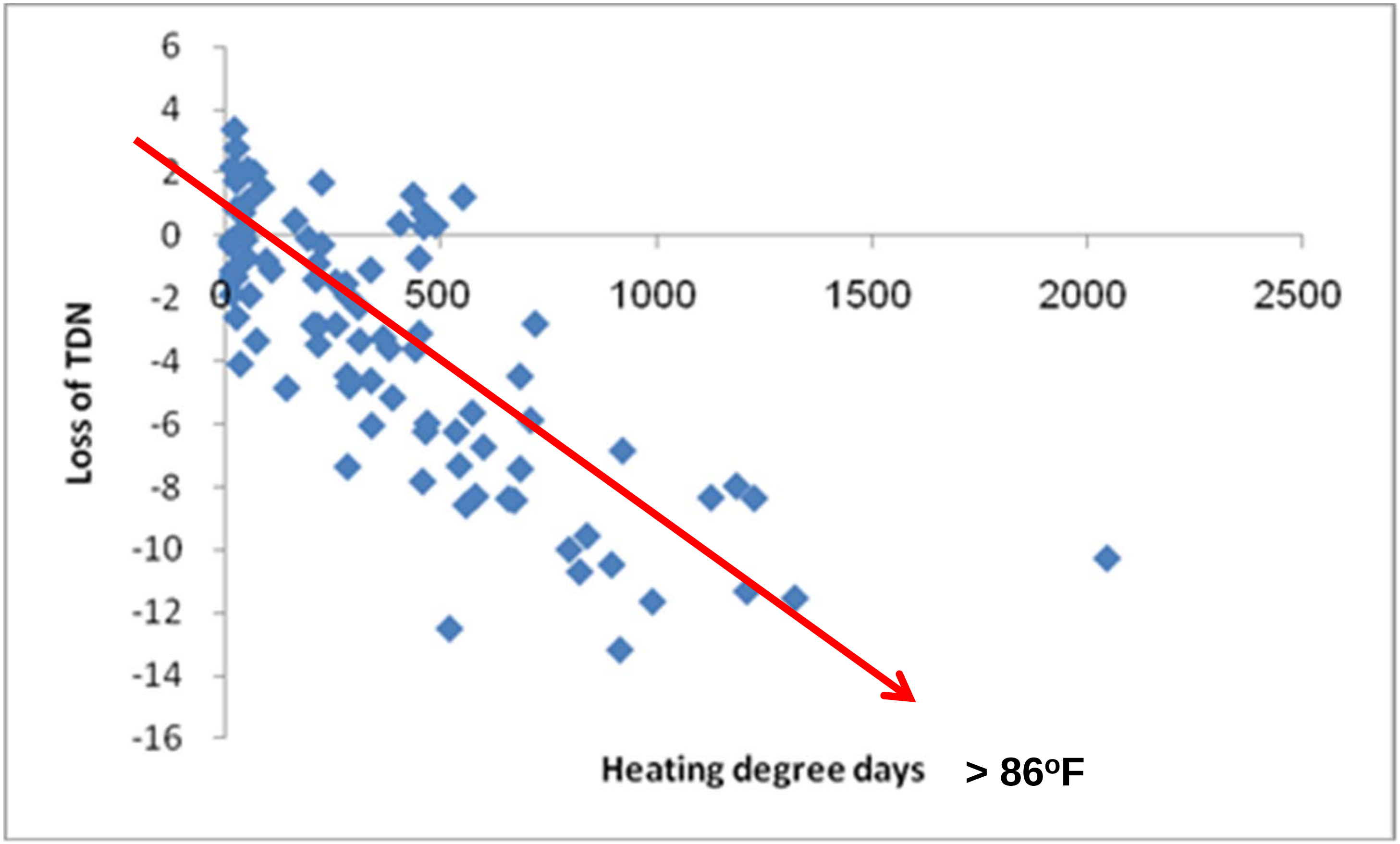
Reducing Heat Damage in Hay and Haylage

Dr. Dan Undersander
University of Wisconsin

TDN loss as result of heating damage



Heat damage loss in farmer samples

Predicted TDN loss on farmer samples from 3 forage testing laboratories		
TDN losses	Number of samples	Percentage (%)
	Set 1	
<0	225	22.5
0-4.0	219	21.9
4.0-8.0	298	29.8
8.0-12.0	195	19.5
>12.0	63	6.3
Total	1000	100
	Set 2	
<0	457	73.9
0-4.0	103	16.7
4.0-8.0	50	8.1
8.0-12.0	8	1.3
>12.0	0	0
Total	618	100
	Set 3	
<0	229	11.5
0-4.0	572	28.7
4.0-8.0	873	43.8
8.0-12.0	314	15.7
>12.0	6	0.3
Total	1994	100

TDN losses of farmer submitted samples to forage testing laboratories

TDN losses (% of DM)	Number of samples	Percent of total
<0	911	25
0-4.0	894	25
4.0-8.0	1221	34
8.0-12.0	517	14
>12.0	69	2
Total	3612	

With corn at $4.50/bu,
TDN is 7¢/lb

TDN losses of farmer submitted samples to forage testing laboratories

TDN losses (% of DM)	Number of samples	Percent of total	$/ton Loss
<0	911	25	0
0-4.0	894	25	0 - $5.60
4.0-8.0	1221	34	$5.60 - $11.20
8.0-12.0	517	14	$11.20 - $16.80
>12.0	69	2	>$16.80
Total	3612		

With corn at $4.50/bu,
TDN is 7¢/lb

1 lb corn x $4.50 per bushel = $0.08
1 lb corn x 85% DM x 8.5% = 0.07 lb. CP
0.7 / 48% CP SBM x $450 per ton SBM = $0.03 value of CP in 1 lb corn

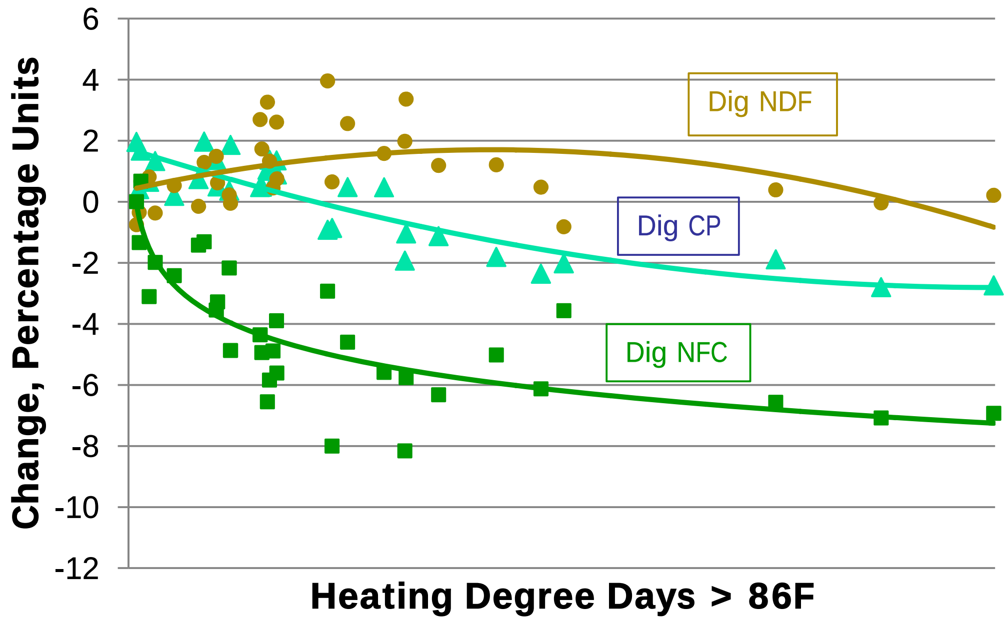
$0.08 - $0.03 = $0.05 value of TDN in 1 lb. corn

1 lb corn x 85% DM x 85% TDN = 0.72 lb TDN in 1 lb corn

$0.05 / 0.72 = $0.07 per lb TDN

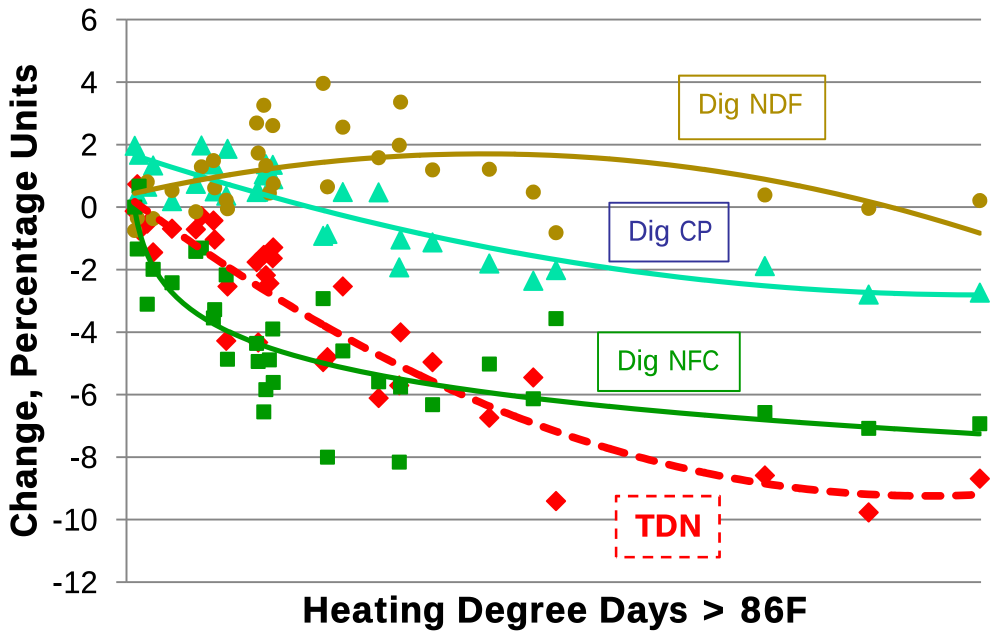
Randy Shaver 9/25/13

Results of Malliard Reaction



Results of Malliard Reaction

- TDN = dNFC + dCP+ 2.25*FA + dNDF – 7



Forage Preservation

- Storage – Processes to be controlled or inhibited:
  - Mold growth – molds grow at above 20% moisture:
    - Consume nutrients, sugars, starch
    - Respiration causes heating →hay fires
    - Produce toxins detrimental to animal health and decrease food intake
    - Produce spores - if inhaled cause lung disease
    - Presence reduces value of hay sold

Fungi Identified on Stored Forage

- Actinomycetes
- Aspergillus
  - glaucus
  - flavus
  - fumigatus
  - repens
  - versicolor
- Emericella
  - nidulans
  - rugulsa
- Eurotium
  - amstelodami
- Fusarium
- Mucor
- Penicillium
  - aufantiogriseum
- Unidentified Yeast

Storage Fungi

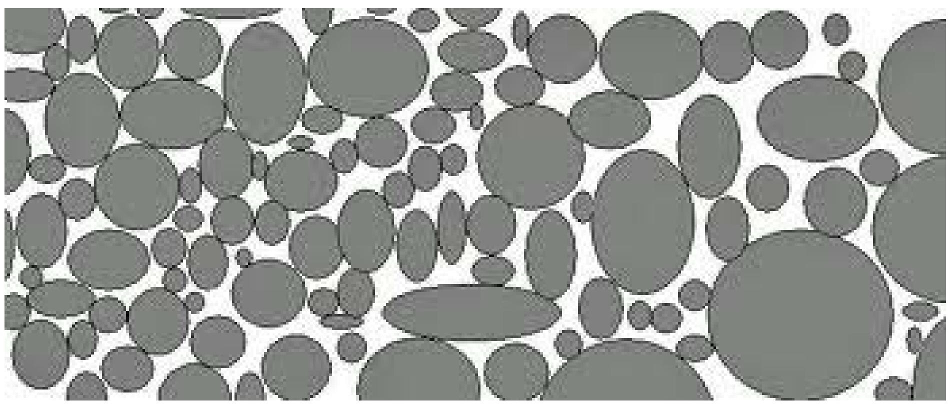
- The greatest species diversity occurs in forage that has not heated
- The major factor influencing species dominance is peak storage temperature

Potential Health Hazards of Fungi

Fungi	Health effect
Actinomycetes	respiratory disease, delayed allergic reactions
Absidia	mycotic abortions
Alternaria	immediate allergic reaction
Aspergillis fumigatus	mycotic abortion respiratory disease delayed allergic reactions
Cladosporium	immediate allergic reaction
Mucor	digestive tract ulceration
Penicillium	delayed allergic reaction
Yeast	mycotic mastitis

Heating in Haylage

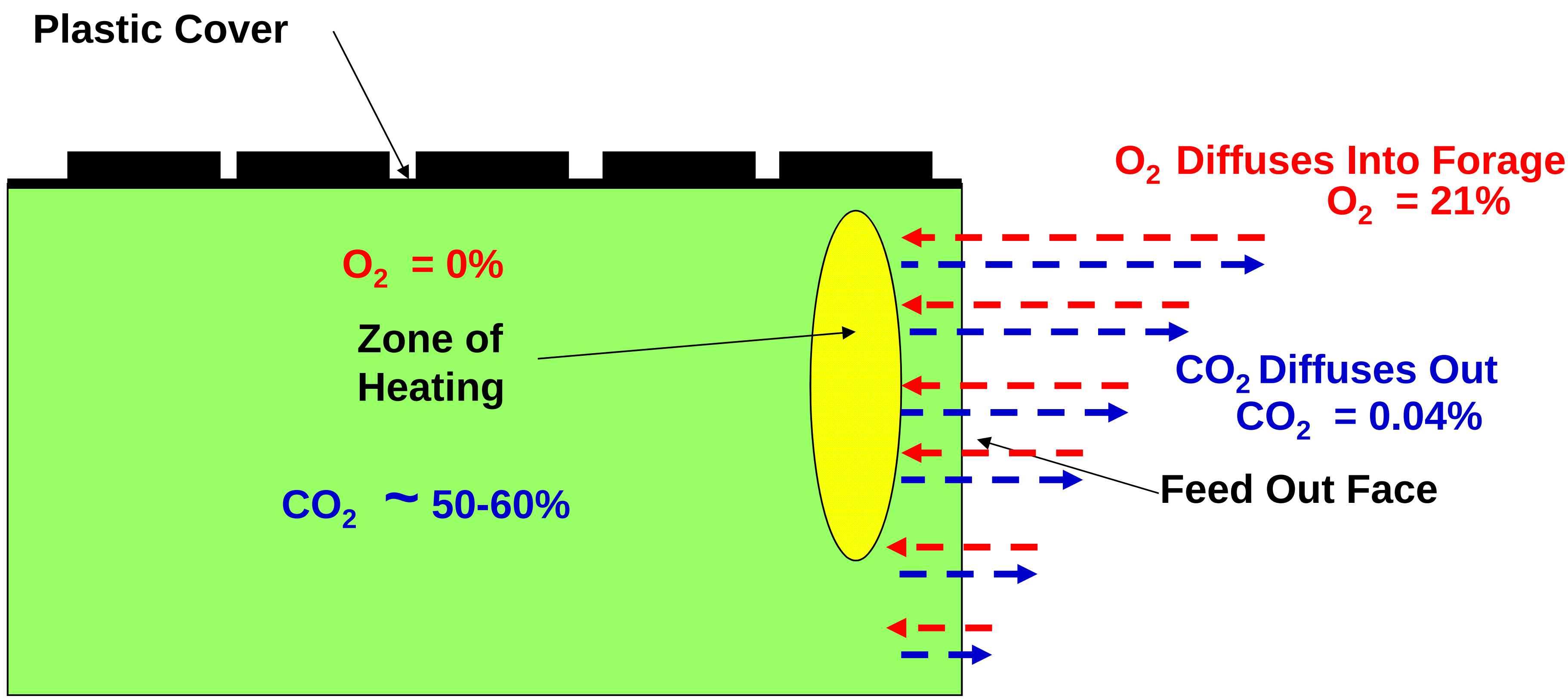
- Heating is reduced with greater packing
- Porosity is a measure of the air spaces in silage
  - Want porosity of less than 0.40
  - ≈ 45 lbs/ft sq^2 at 35% moisture or 15 lbs DM/ft sq^2



Less porosity more porosity

Pack Silage Well

Diffusion Theory



Longitudinal Cross Section of Bunker Silo

Face Cutter Integrated with Bucket

Face Rake

Square Bale Characteristics

Characteristic	Small	Medium	Large
Bale size (inches)	14x18	32x32 30x36	30x48 48x48
Bale weight (lb)	60	600–1250	1500–2500
Density (lb/ft^3)	*Low* 10–18	*Medium* 20–25	*High* 30–45
Tractor Horse Power	60	100	125
Capacity (t/hr)	5	20	40

Moisture for Baling
to prevent mold

Square Bale Size		
Small	Medium (3’ x 3’)	Large (4’ x 4’)
<20%	<16%	<14%

Amount of heating depends on heat transfer conditions.

Moisture for Baling
to prevent mold

Square Bale Size		
Small	Medium (3’ x 3’)	Large (4’ x 4’)
<20%	<16%	<14%

Round Bale Size		
Small (4’ w x 5’ h)	Medium (5’ w x 5’ h)	Large (5’ w x 6’ h)
<18%	<16%	<16%

Amount of heating depends on heat transfer conditions.

Hay Preservation

- Hay Additives:
  - Drying Agents
    - Enhance field drying
  - Preservatives/inhibitors
    - Increase moisture range for safe storage

Hay Additives

Drying agents	Inhibitors
Potassium carbonate	Ammonia
Calcium carbonate	Urea
Methyl esters	Inoculants
Formic acid	Propionic acid
	Acetic acid
	Buffered acids
	Acid salts
	Ethoxyquin

Note: Not all of the additives listed are effective. Source: Pitt, R.E., 1991.

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Wet Hay – Preserved w/ Acid

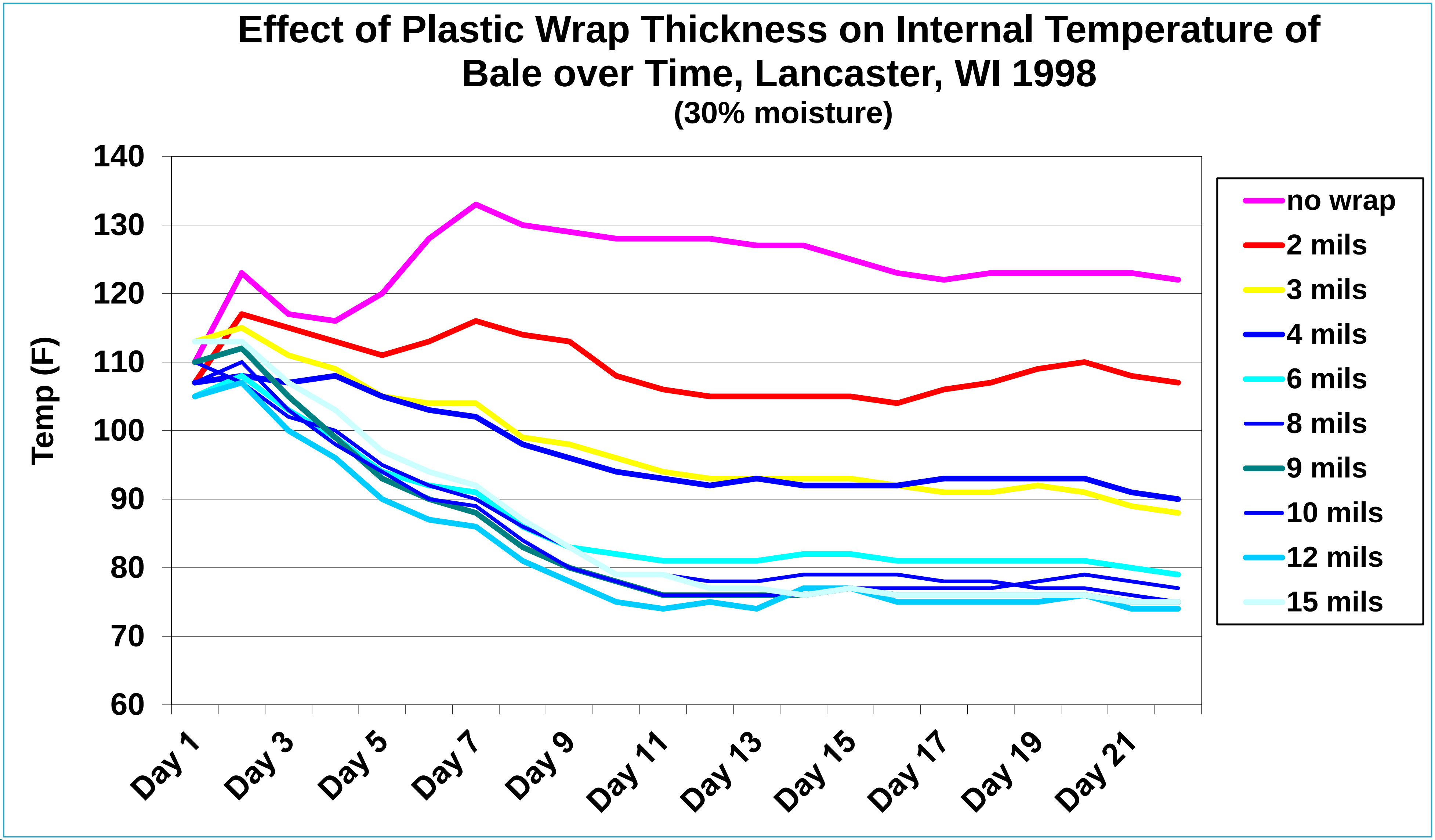
Allowable moisture without heating/spoilage in hay

- Depends on heat transfer conditions.
- Can bale without spoilage at higher moisture content if:
  - Cooler air temperatures (e.g. fall vs summer)
  - Smaller bale – less self insulation
  - Single bale vs stack – some growers let bales "sweat" for a couple weeks then stack.

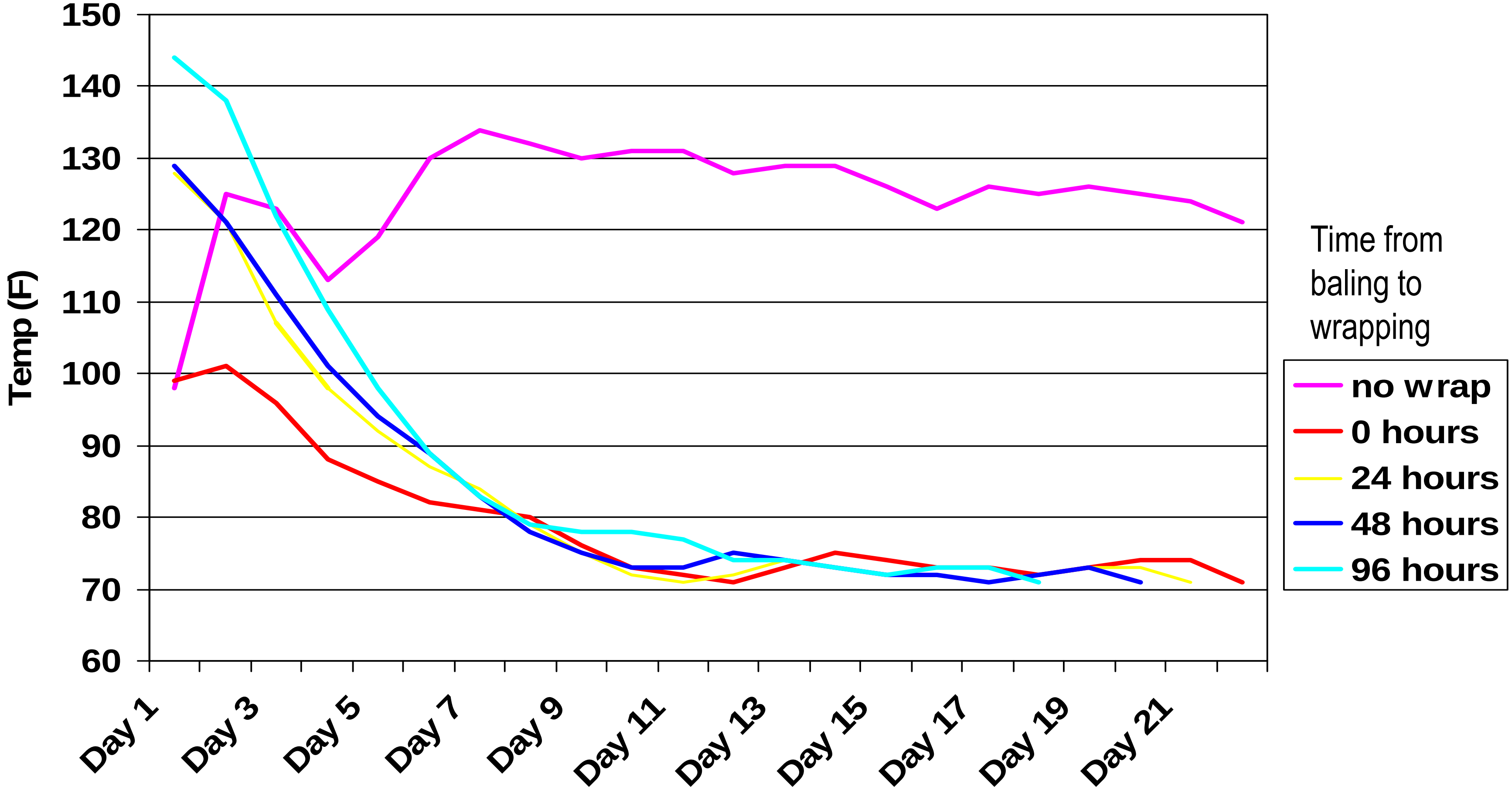




Danger Rotating Arm


Effect of Plastic Wrap Thickness on Internal Temperature of Bale over Time, Lancaster, WI 1998
(30% moisture)
Temp (F)
140
130
120
110
100
90
80
70
60
Day 1
Day 3
Day 5
Day 7
Day 9
Day 11
Day 13
Day 15
Day 17
Day 19
Day 21
no wrap
2 mils
3 mils
4 mils
6 mils
8 mils
9 mils
10 mils
12 mils
15 mils

Effect of Timing of Bale Wrapping after Baling on Internal Temperature of Bale over Time,



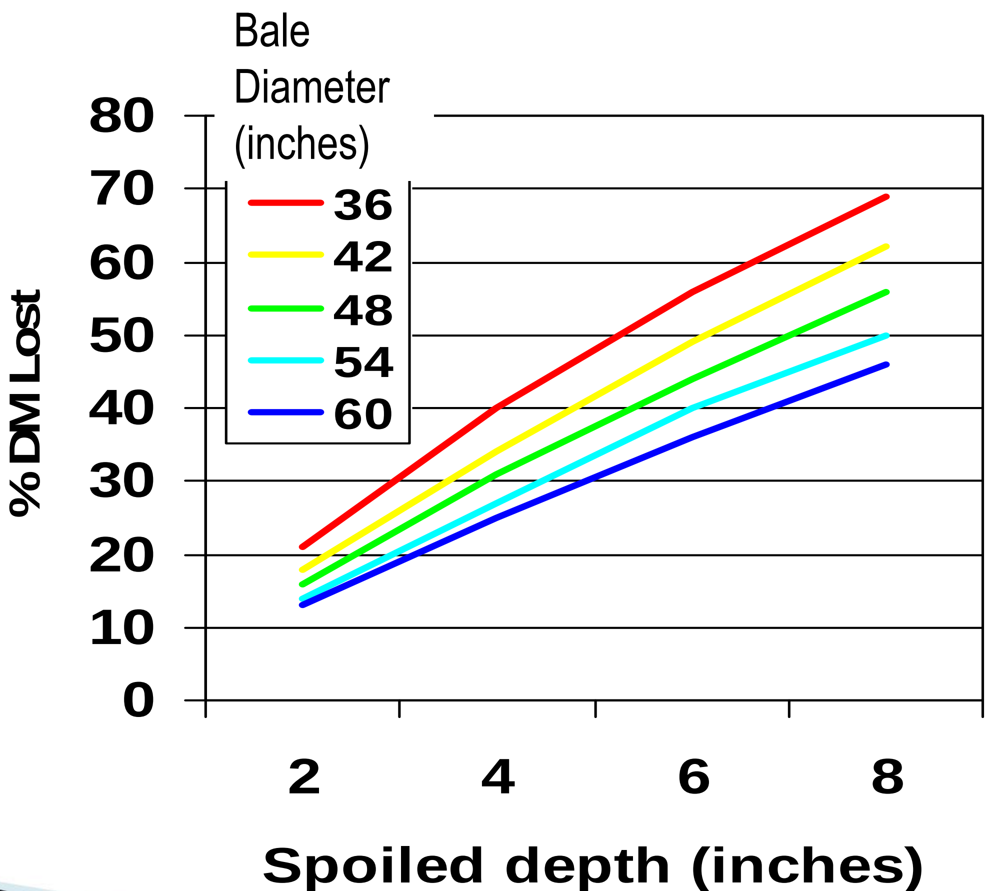
Avoid UV Degradation of Plastic

- Avoid oiled sisal twine
- Plastic, untreated sisal, netwrap
- Buy good plastic wrapping

Hay preservation

- Heating can lead to spontaneous combustion and fires

Forage lost in Round Bales with Different Spoiled Depths



Spoilage greatly increases production costs.