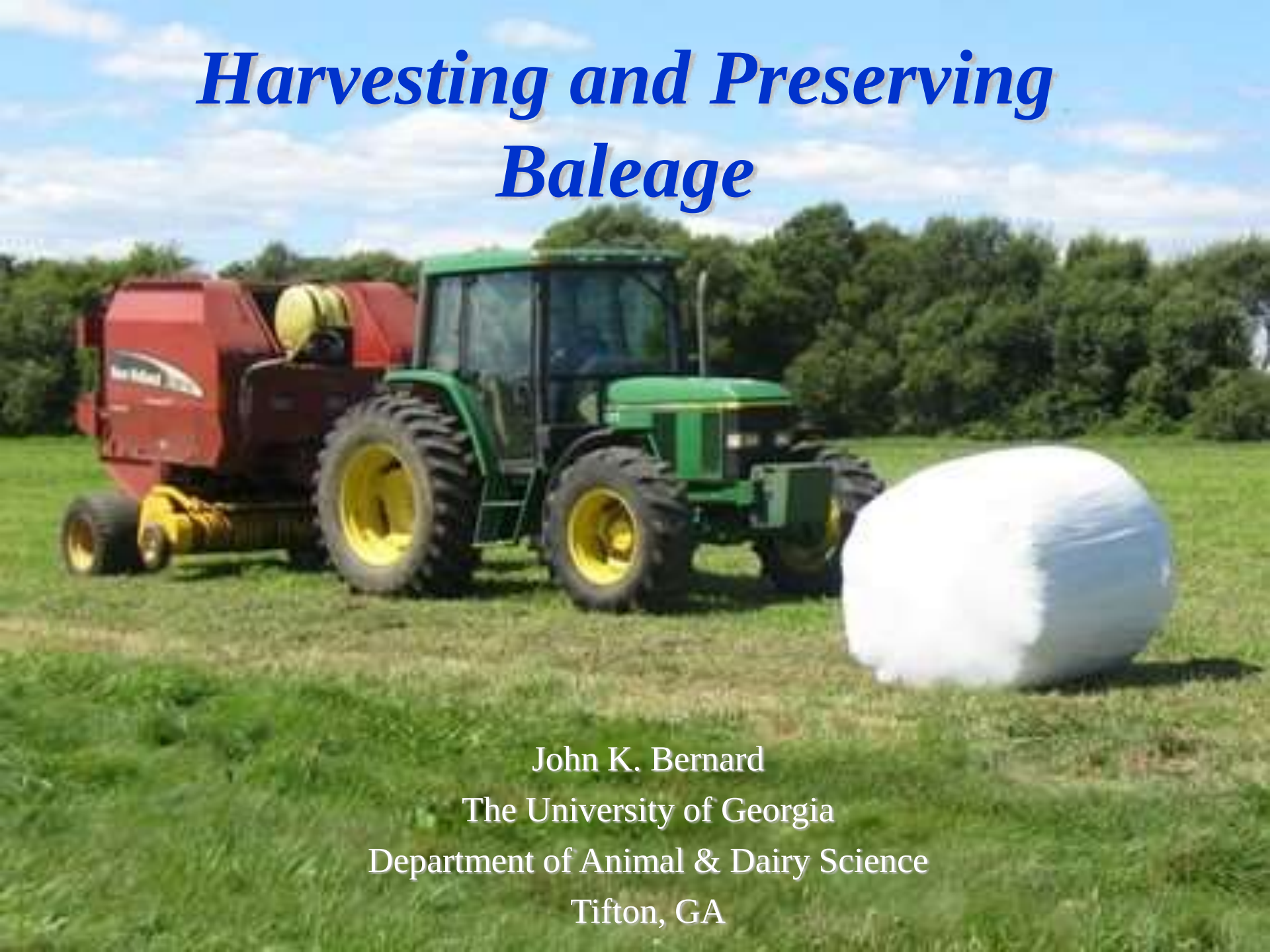
Harvesting and Preserving Baleage



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"You remember the Irishman who said that all whiskey was good but that some whiskey was better than others? It is so with ensilage." -*W.D. Hoard*

Forage Production Goals:

1) To harvest the highest quality forage possible with 2) miniminal nutrient lost 3) so we can minimize purchased feed cost as much as possible and 4) optimize animal performance and health.

How do we influence forage quality?

- ✓ Select varieties shown to produce high quality forage
  - Grass vs. legume
  - Cool season vs. warm season
  - Yield potential
  - Disease and pest resistance
  - Fiber digestibility

- ✓ Use good agronomic practices
  - Fertility management
  - Weed control
  - Pest and disease management
  - Timely irrigation

How do we influence forage quality?

- ✓ Timely harvest and storage
  - Stage of maturity
  - Best management practices
    - Wilt forages
    - Proper length of chop and sharp knives
    - Use a proven inoculate to facility proper fermentation
    - Pack/wrap tightly and seal
      - Repair any holes in plastic ASAP
- ✓ Good silage management during feedout

Challenges to harvesting high quality forage!

- ✓ Weather is not always favorable for drying forage!
- ✓ Forage frequently matures while waiting for favorable conditions to make hay.
- ✓ Much easier to harvest at the desired stage of maturity as silage or baleage.

Forage quality of ryegrass harvested as silage, baleage, or hay

	Storage Method		
	Silage	Baleage	Hay
DM, %	36.2	33.5	87.5
	-------- % of DM --------		
CP	19.2	19.8	13.1
NDF	58.1	56.2	70.5
IVDMD	79.2	78.7	71.1
NE_l, Mcal/lb	0.64	0.64	0.56

McCormick et al., 2002

Performance of lactating cows fed ryegrass silage, baleage, or hay

	Storage Method		
	Silage	Baleage	Hay
DMI, lb/d	40.1	37.5	40.6
3.5% FCM, lb/d	63.5	60.3	58.3
Fat, %	3.50	3.55	3.43
Protein, %	3.37	3.31	3.26

McCormick et al., 2002

Baleage

Harvesting grass or legumes as a high moisture forage is common in many areas of the world

- Limited drying opportunities
- Allows harvest to be completed faster

Advantages of baleage

+ Minimizes the risk of poor drying conditions
+ Lower field DM losses
+ More nutrients are preserved
+ Lower labor cost as process is more mechanized
+ When stored properly, more consistent forage quality

Disadvantages of baleage

- May require upgrading equipment
  - Baler suitable for making baleage
  - Equipment to lift and handle bales safely
- Challenge to avoid increased ash content of forage
- If holes in plastic are not sealed, forage will spoil
- Disposal of plastic
- Transportation cost are high compared with hay
- Cost per ton are higher
  - However if improved quality is achieved, should realize either improved production or lower feed cost

Economics

Baleage systems are most economical when winter annuals are harvested along with summer forages.

- Equipment used across more acres (tonnage)
- Allows harvest of higher quality forage compared with waiting on adequate drying conditions

Custom Harvesting

Harvesting and Storing Forage

- ✓ Stage of maturity to harvest forage
- ✓ DM content for harvesting
- ✓ Cutting forage to reduce particle length
- ✓ Inoculate
- ✓ Bale tension/packing
- ✓ Wrapping/covering

Stage of maturity

- ✓ Yield and nutrient content changes with advancing maturity
  - DM yield increases
  - CP decreases
  - Fiber (NDF) increases
  - Fiber digestibility (energy) decreases

- ✓ Harvest at stage of maturity that provides nutrients needed for the production level you expect from your cattle.

Total Dry Matter Yield

	Barley	Oats	Rye	Wheat
	---------- Ton/acre ----------			
Vegetative	**1.30**	**1.12**	**1.02**	**1.41**
Boot	**3.06**	**1.92**	**2.32**	**2.96**
Heading	**4.42**	**2.75**	**3.59**	**3.42**
Milk	**4.77**	**3.34**	**3.61**	**4.48**
Soft Dough	**5.10**	**3.90**	**3.79**	**4.61**
Hard Dough	**5.64**	**3.42**	**3.91**	**4.58**

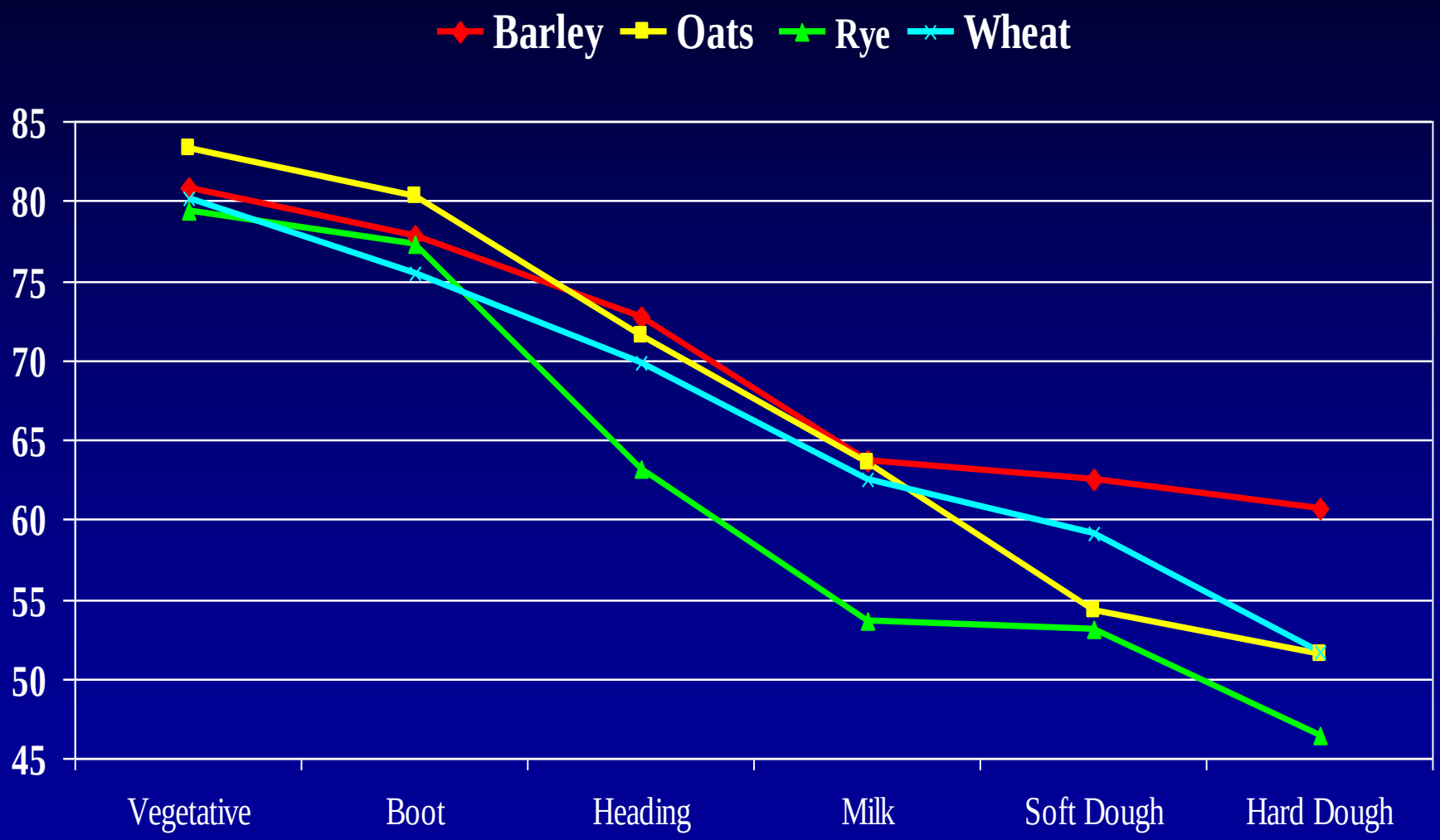
Adapted from Edmisten. 1985. NCSU MS Thesis.
Multiple cuttings were made from vegetative through heading.

In Vitro Dry Matter Digestibility

	Barley	Oats	Rye	Wheat
	---------- % ----------			
Vegetative	**80.80**	**83.35**	**79.40**	**80.20**
Boot	**77.75**	**80.30**	**77.35**	**75.50**
Heading	**72.70**	**71.55**	**63.15**	**69.85**
Milk	**63.70**	**63.60**	**53.60**	**62.50**
Soft Dough	**62.55**	**54.30**	**53.15**	**59.15**
Hard Dough	**60.75**	**51.50**	**46.40**	**51.65**

Adapted from Edmisten. 1985. NCSU MS Thesis.

In vitro DMD


Barley
Oats
Rye
Wheat
85
80
75
70
65
60
55
50
45
Vegetative
Boot
Heading
Milk
Soft Dough
Hard Dough

IVDMD Yield

	Barley	Oats	Rye	Wheat
	---------- Ton/acre ----------			
Vegetative	**1.1**	**0.9**	**0.8**	**1.1**
Boot	**2.4**	**1.5**	**1.8**	**2.2**
Heading	**3.2**	**2.0**	**2.3**	**2.4**
Milk	**3.0**	**2.1**	**1.9**	**2.8**
Soft Dough	**3.2**	**2.1**	**2.0**	**2.7**
Hard Dough	**3.4**	**1.8**	**1.8**	**2.4**

Adapted from Edmisten. 1985. NCSU MS Thesis.
Multiple cuttings were made from vegetative through heading.

Changes in nutrient content of annual ryegrass with advancing maturity

	CP	WCS	ADF	NEl
	---------- % of DM ----------			
Late vegetative	18.8	15.4	27.6	0.75
Boot	18.7	26.6	33.1	0.68
Bloom	13.1	26.5	35.6	0.64
Milk/dough	11.9	24.3	35.4	0.64
Mature	8.6	11.6	39.2	0.60

McCormick et al. 2002

Effect of stage of maturity of wheat silage on milk production

Item	Early	Late	P
NDFD, %	29.4	23.7	
DMI, lb/d	48.3	48.5	NS
Milk, lb/d	79.4	72.3	<0.001
Fat, %	2.45	2.79	<0.001
Protein, %	2.97	2.98	NS

Early = mid-flowering
Late = end of milk stage

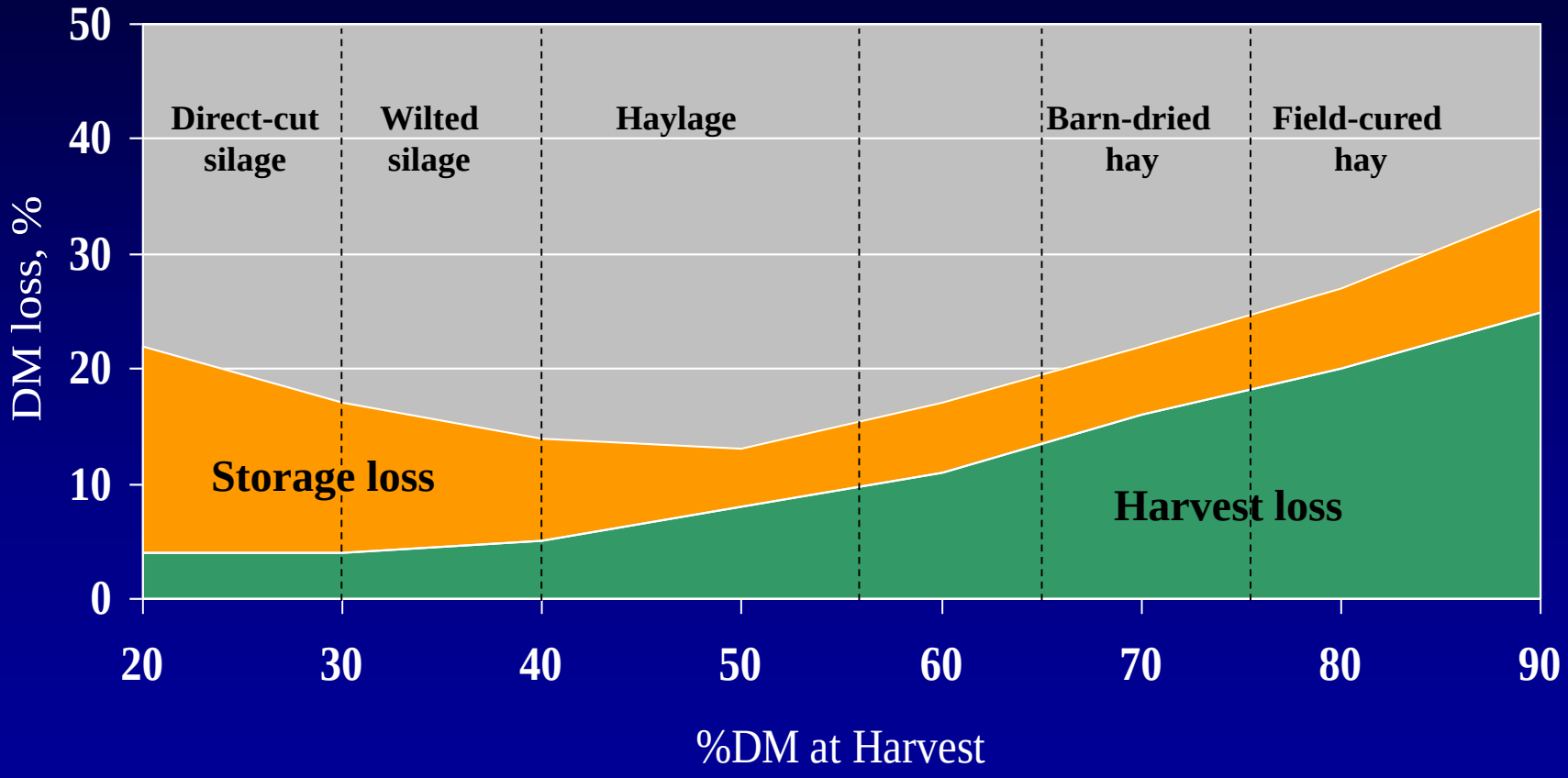
Arieli and Adin. 1994. JDS 77:237-243.

DM content of forage at harvest

DM content of forage at harvest

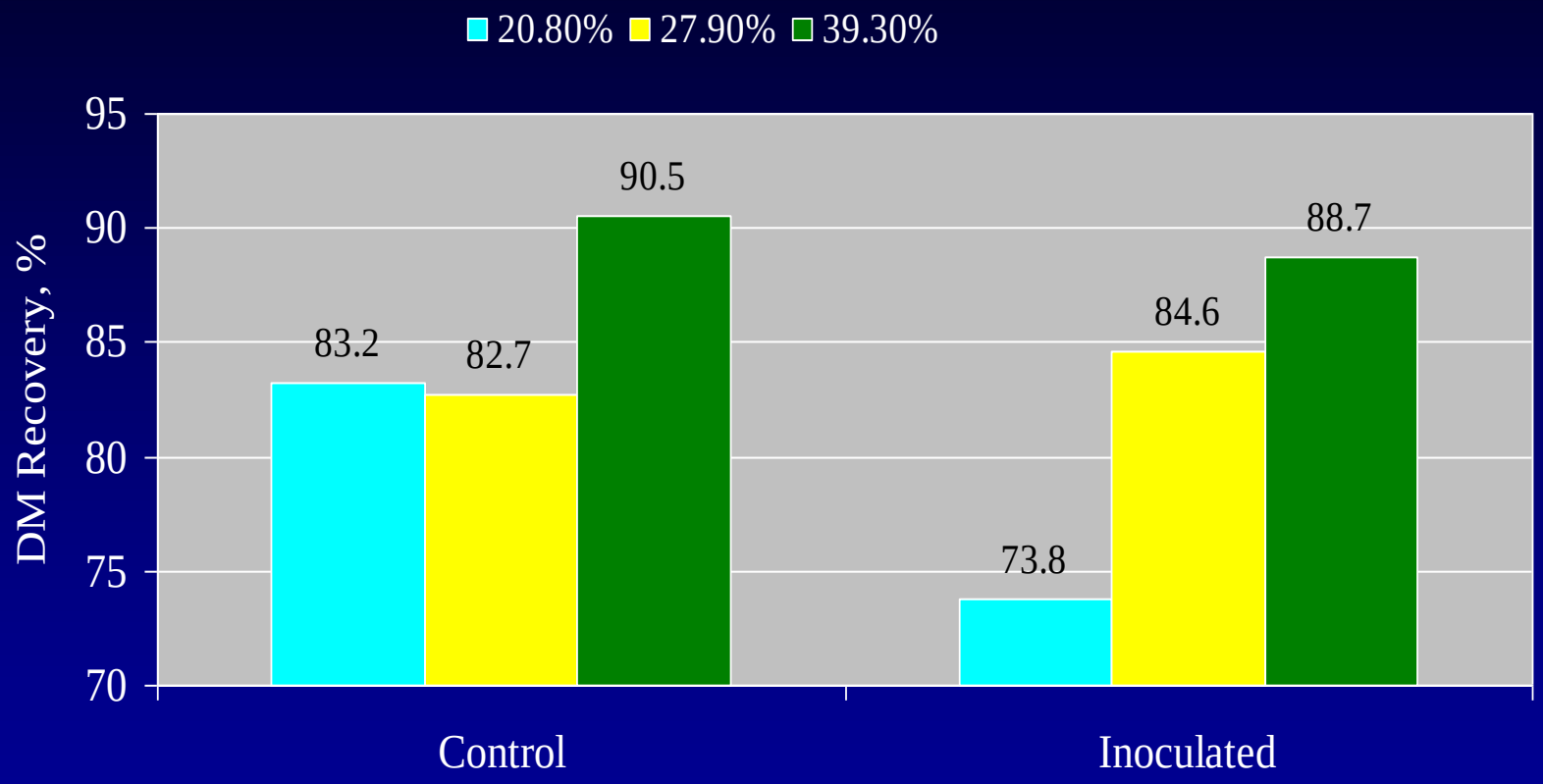
- ✓ The DM content of winter annuals harvest at the desired stage of maturity is very low (<20 to 27% DM)
  - Results in excess seepage
  - Promotes active fermentation which may include:
    - Excess protein degradation and formation of amines, amides, and ammonia
    - Greater potential for clostridia fermentation resulting in high butyric acid concentrations
- ✓ Wilting reduces DM content that will facilitate a more desirable fermentation and reduce nutrient loss (reduced seepage)
- ✓ Caution: Do not wilt forage too much (>60% DM) as this will reduce water soluble carbohydrate concentrations, result in poor fermentation, and reduce nutrient digestibility.

Estimated DM loss during harvest and storage



Hoglund, 1964

Effect of wilting on DM recovery of wheat silage



Linear effect of wilting ($P < 0.05$)

Williams et al. 1995. JDS 78:1755-1765

Effect of wilting on fermentation end products

	Moisture at harvest			
	20.8%	27.9%	39.3%	SE
pH	3.78^{c}	3.92^{b}	4.27^{a}	0.03
NH_3	2.95^{c}	2.37^{d}	2.11^{d}	0.10
Lactic	81.50^{c}	54.37^{d}	33.80^{e}	4.44
Acetic	26.99^{c}	18.09^{d}	10.58^{e}	2.06
Butyric	1.31	1.47	0.97	0.46
Total VFA	30.29^{c}	20.48^{d}	12.84^{e}	2.48

^{a,b}Means differ due to wilting ($P < 0.01$)

Williams et al. 1995. JDS. 78:1755-1765

What is considered the correct DM content to harvest the forage?

Recommended DM content at harvest

Crop	% DM
Corn silage	32 – 35
Haylage	40 – 45
Baleage	45 – 55
Snaplage	58 – 64
High-moisture corn	64 - 72

Mechanical Conditioning to Wilt Forage

- ✓ Mechanical conditioning
  - Steel fail conditioner is more effective compared with rubber roller or plastic flails
  - Shatter losses are low for grasses with all conditioning equipment, but a roller conditioner supports the lowest losses for alfalfa.

- ✓ Tedding increases drying rates with all conditioning equipment

Borreani et al. 1999. (doi:10.2134/agronj1999.00021962009100030016x)

Chopping or Baling

Either system is good for producing high quality forage. The choice depends on, existing equipment, labor, management, and impact on cost of production.

Chopping

- ✓ Chop for a 3/8 inch theoretical length of chop
  - Longer chop material is hard to pack
  - Extremely fine chop decreased rumination, cud chewing, and salivation
- ✓ Goal: 15 to 20% of particles longer than 1.5 inch
- ✓ Pack forage to eliminate air and seal tight!

Baling

- ✓ Operation of baler
  - Operate at a slow ground speed to make a tight, dense bale (reduces air trapped inside the bale)
  - Use net wrap to cover bale. Do not use sisal twine as the oil may degrade the plastic

- ✓ Use a baler designed for making baleage
  - Stronger frame, heavier bearings, etc.
  - Knife system for cutting forage
  - Include option for applying a silage inoculate

Forage Inoculates

- ✓ Inoculates should:
  1. Promote proper fermentation of forage
     - Quickly drop pH
     - Stimulate lactic acid production
     - Minimize or prevent the production of undesirable fermentation products (butyric acid, excess ammonia, etc.) and mold
  2. Reduce secondary fermentation during feedout
- ✓ Select an inoculate that has research data to support the manufactures claims
- ✓ Inoculate does not replace good management

Fermentation of wheat silage with a bacterial inoculate

	Control	Inoculated	SE
pH	4.06^{a}	3.92^{b}	0.026
NH_3	2.63^{a}	2.33^{b}	0.08
Lactic	54.53	58.58	3.63
Acetic	20.75^{c}	16.35^{d}	1.68
Butyric	1.64	0.85	0.37
Isobutyric	0.47^{a}	0.29^{b}	0.05
Total VFA	24.04^{c}	18.37^{d}	2.03

Means with unlike superscripts differ $^{ab}(P < 0.05)$ and $^{cd}(P < 0.10)$.
Inoculate was a mix of *Lactobacillus plantarum* and *Streptococcus faecium*
Williams et al. 1995. JDS 78:1755-1765

Profile of mixed grass/legume baleage

	Cont[1]	BP	PP	LB+P
pH	4.84^{ab}	4.95^{a}	4.77^{bc}	4.72^{c}
	---------- % of DM ----------			
Lactate	4.77^{ab}	3.30^{c}	5.64^{a}	4.18^{bc}
Acetic	0.89^{ab}	0.52^{c}	0.72^{bc}	0.95^{a}
Propionic	0.05^{b}	0.15^{a}	0.00^{b}	0.01^{b}
	---------- Log cfu/g ----------			
Mold	0.9	1.0	0.7	0.2
Yeast	3.0^{b}	5.5^{a}	5.1^{a}	2.7^{b}

[1]Cont = no additive; BP = buffered propionic acid; PP = *Pediococcus pentosaceus* (90%) + *Propionibacter freudenreichii* (10%); and LP+P = *Pediococcus pentosaceus* (20%) + *Lactobacillus buchneri* 40788 (80%).

Storage

- ✓ Goals:
  - Maintain anaerobic conditions for good fermentation
  - Minimize introduction of air into the forage when opened
  - Minimize nutrient losses
  - Forage is accessible
  - Minimize waste

The good and the ugly

Plastic wrap for baleage

- UV inhibitor, no less than 12 months
- 50 to 75% stretch capability
- 1 mil thickness (minimum)
- Use a minimum of 6 wraps with 50% overlap
- White, black, or green colors
- Use repair tape for this plastic
  - Duct tape does not work!

Wrappers

- Single bale wrapper = 25 to 30 bales per hour
- More plastic
- Easier to sell wrapped

- In-line bale wrapper = 40 to 50 bales per hour
- Uses less plastic


Be sure you think through your plans!

Summary

- ✓ Harvesting forage as baleage can provide excellent forage for feeding cattle.

- ✓ Keys to success are:
  - Harvest at proper stage of maturity
  - Wilt to 35 to 60% DM
  - Inoculate with proven inoculate
  - Wrap/cover as soon as possible
  - Check routinely for holes in plastic


The ladies would like to thank you for your efforts to provide tasty, high quality forage