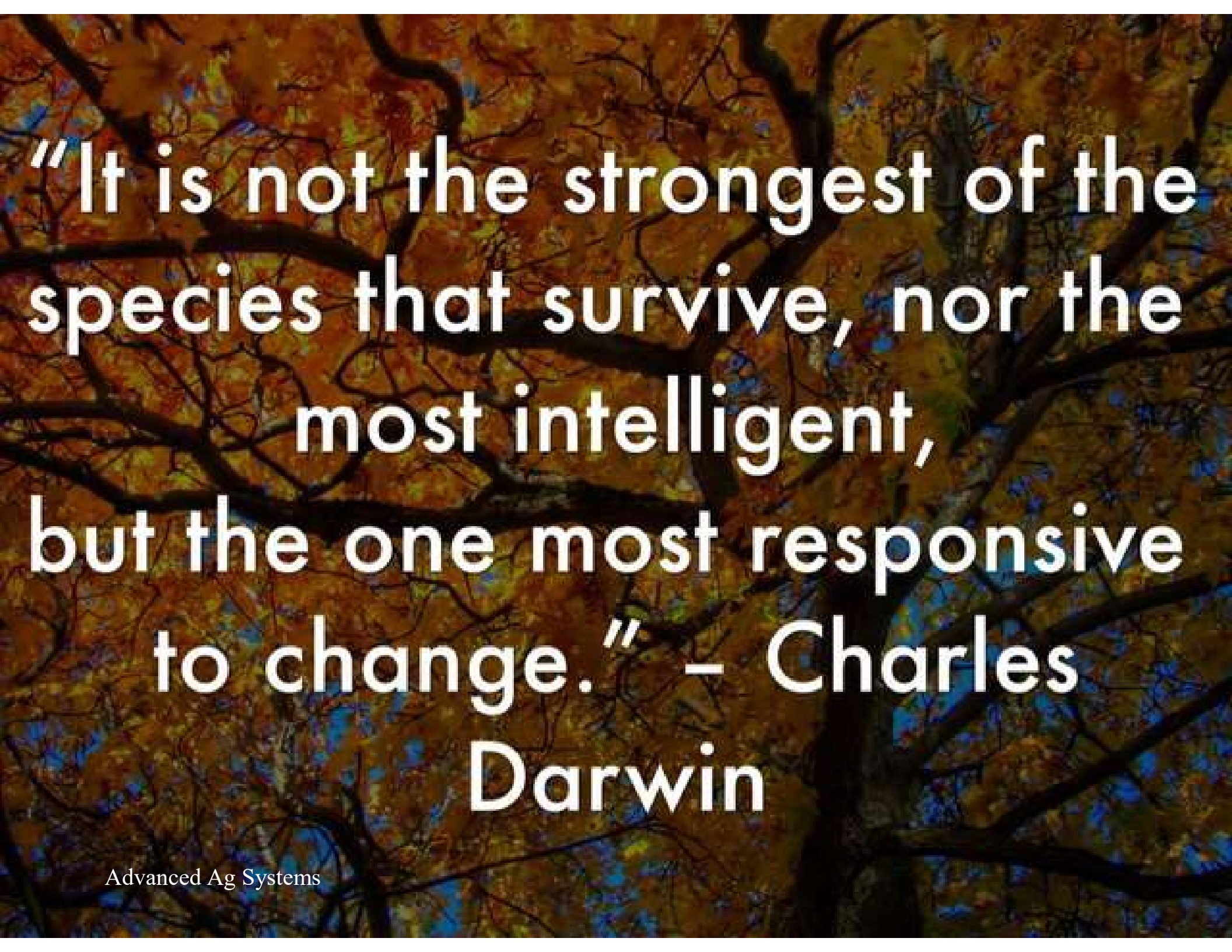




Rotations: the forgotten impact on Improving Yields, Controlling Pests and Increasing Soil Health

Tom Kilcer
Advanced Ag Systems LLC
www.advancedagsys.com

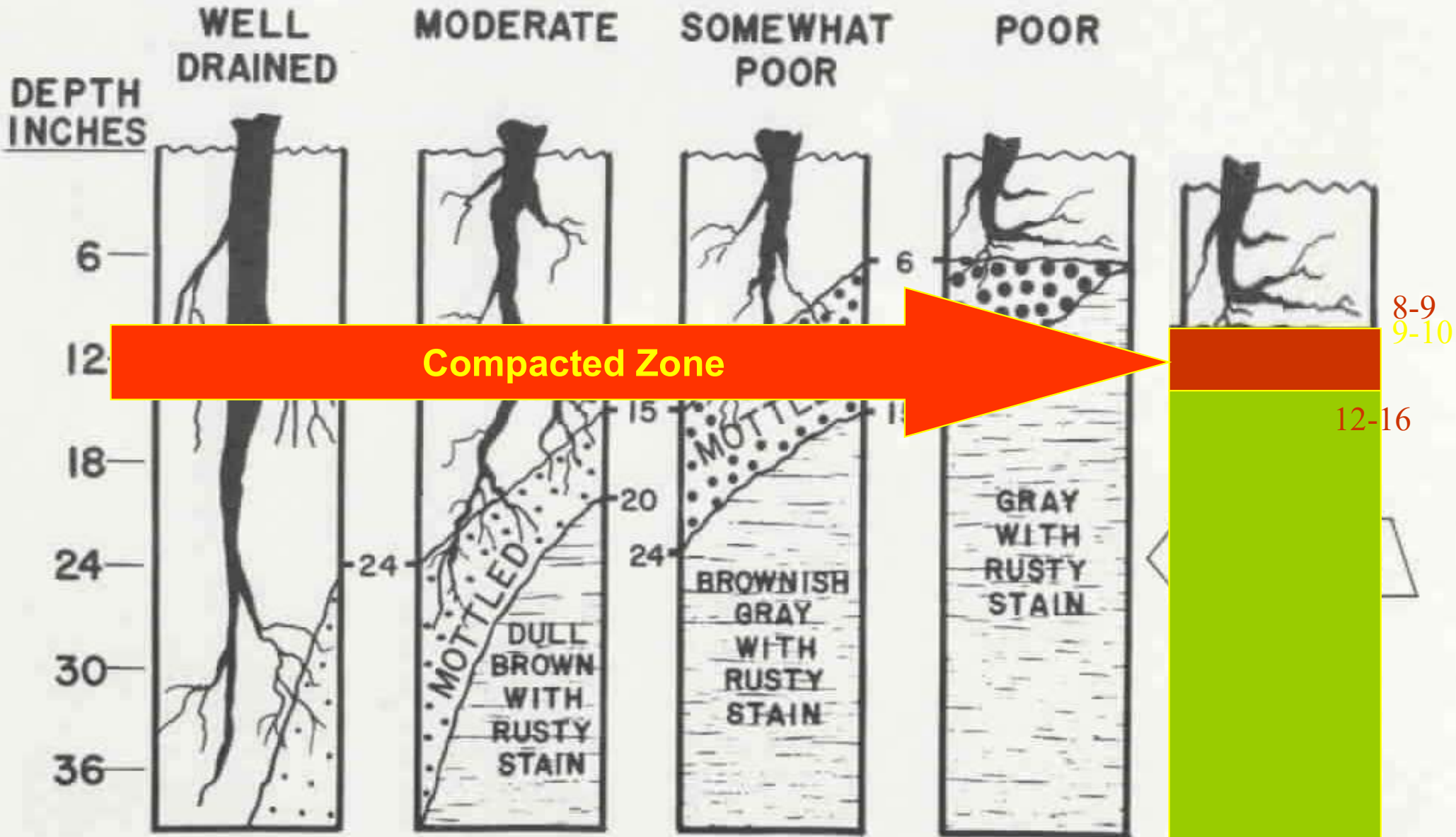


“It is not the strongest of the species that survive, nor the most intelligent, but the one most responsive to change.” – Charles Darwin

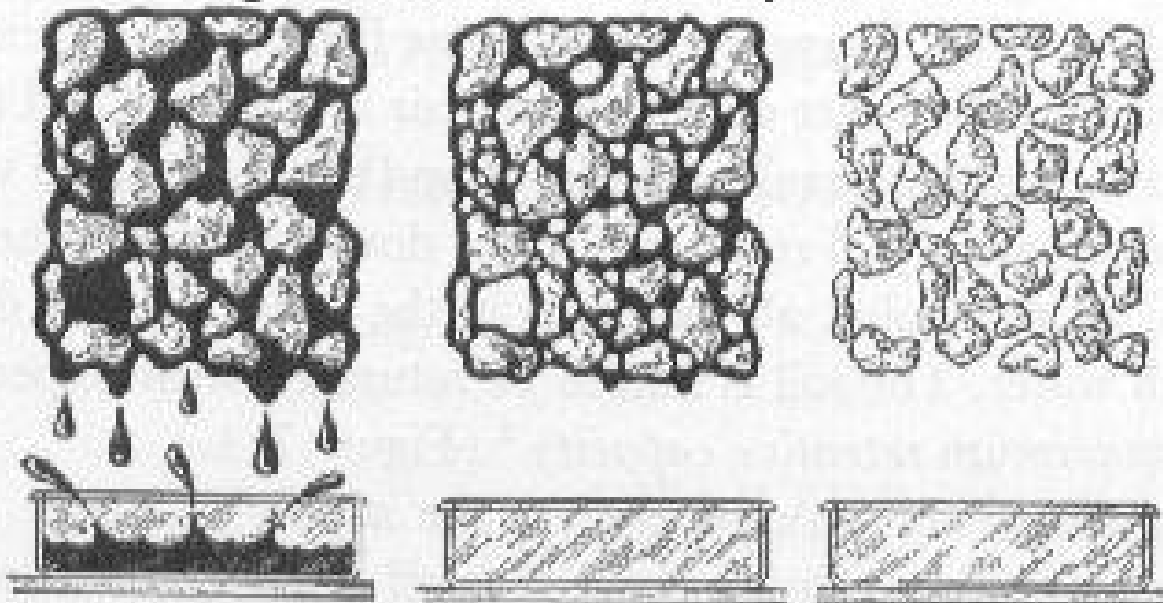
**Genetics Can Open
Doors to Higher Yields**

**Soil Management
Determines How Open
That Door Will Go**

SOIL DRAINAGE CLASS



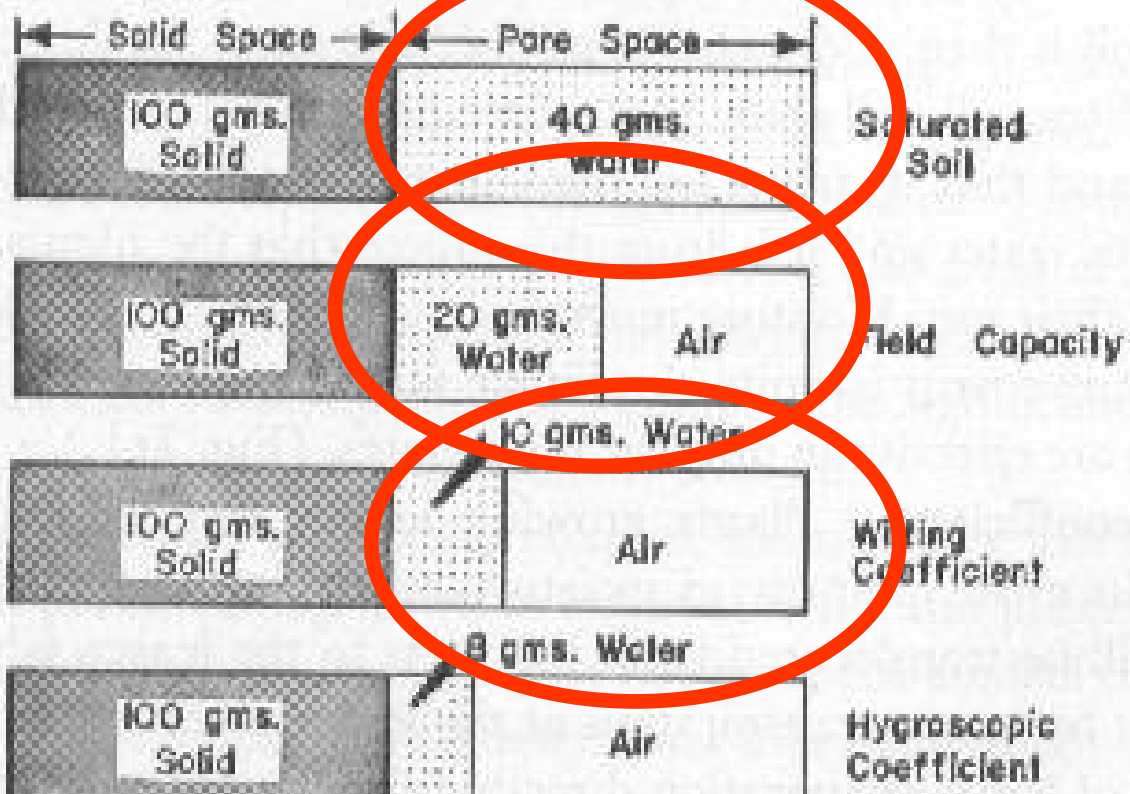
Irrigation on Western Farms publication



Saturation

Field Capacity

Wilting Point



Wilt Point

Field Capacity

Unavailable Water

Plant Available Water

Sand

Gravitational Water

Unavailable Water

Well Structured Loam

Plant Available Water

Unavailable Water

Dense Silty Clay

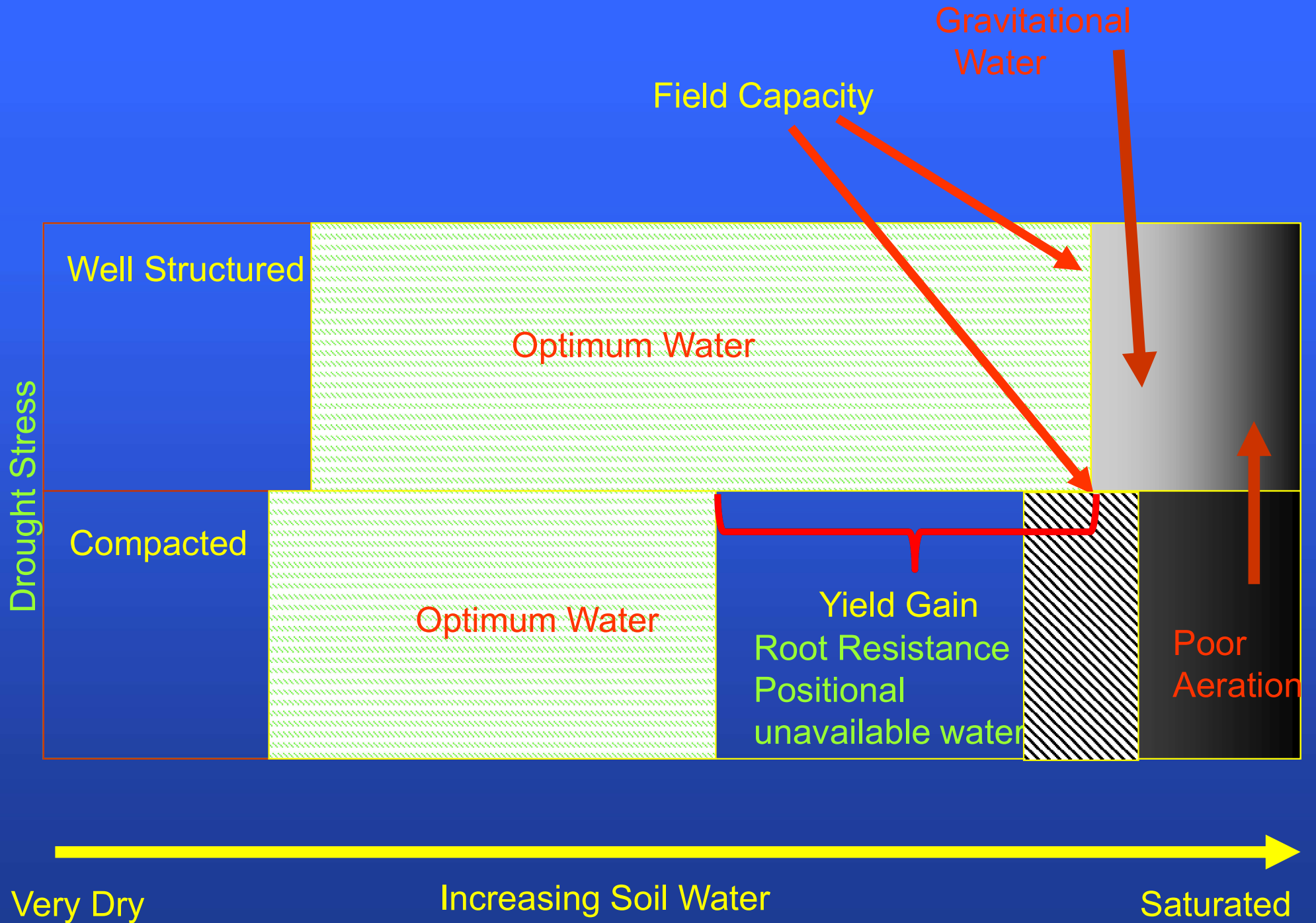
Plant Available Water

Very Dry

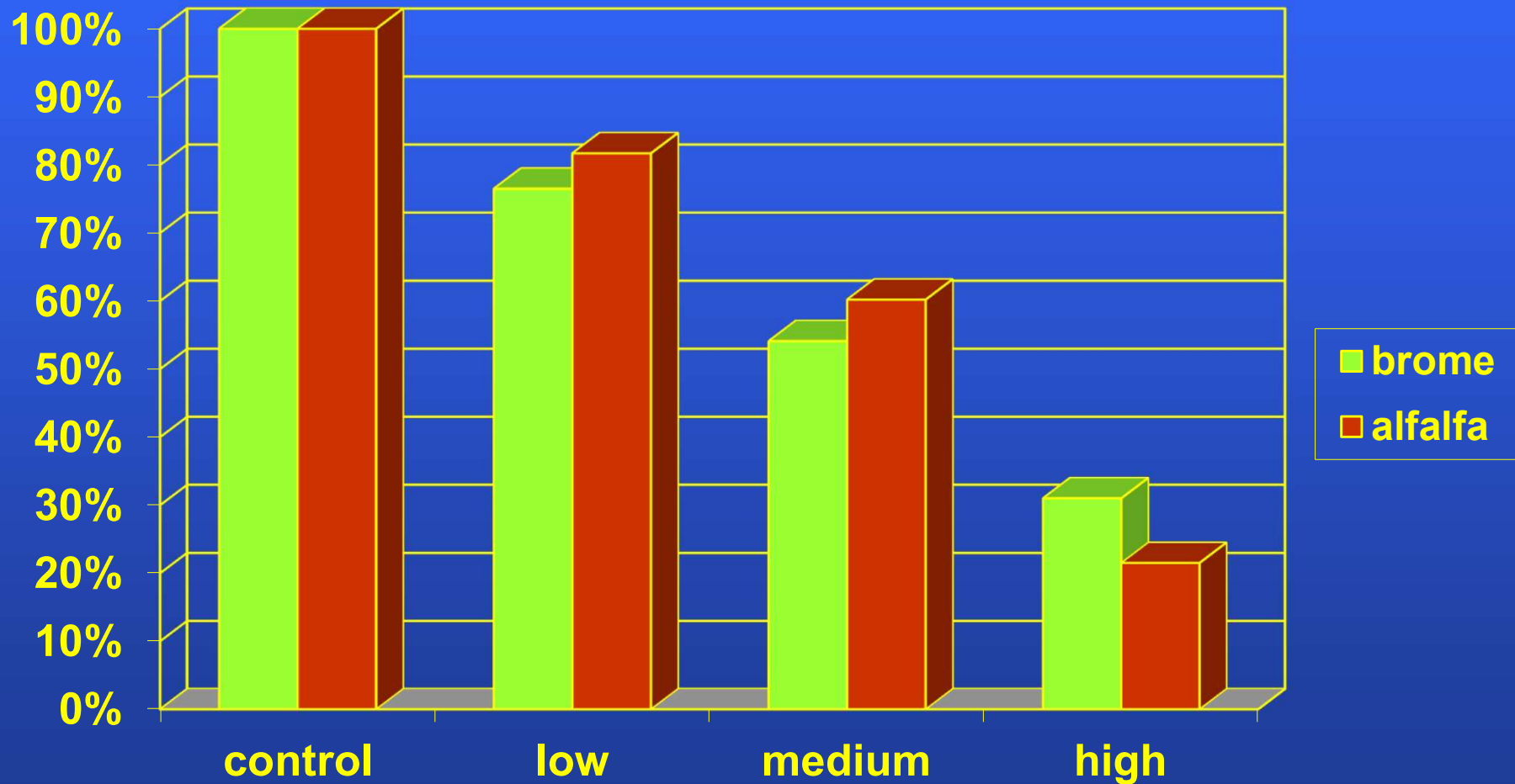
Increasing Soil Water

Saturated



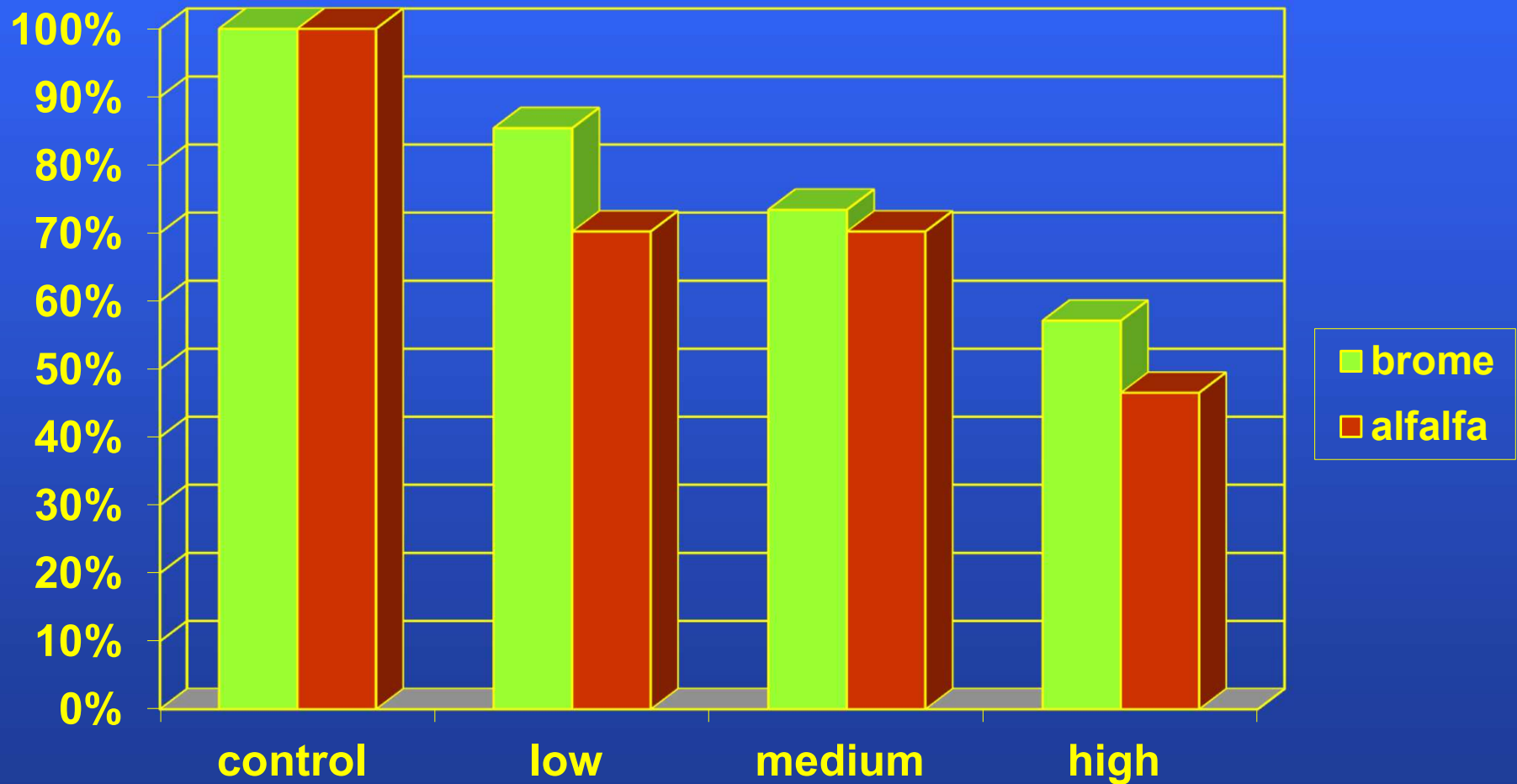


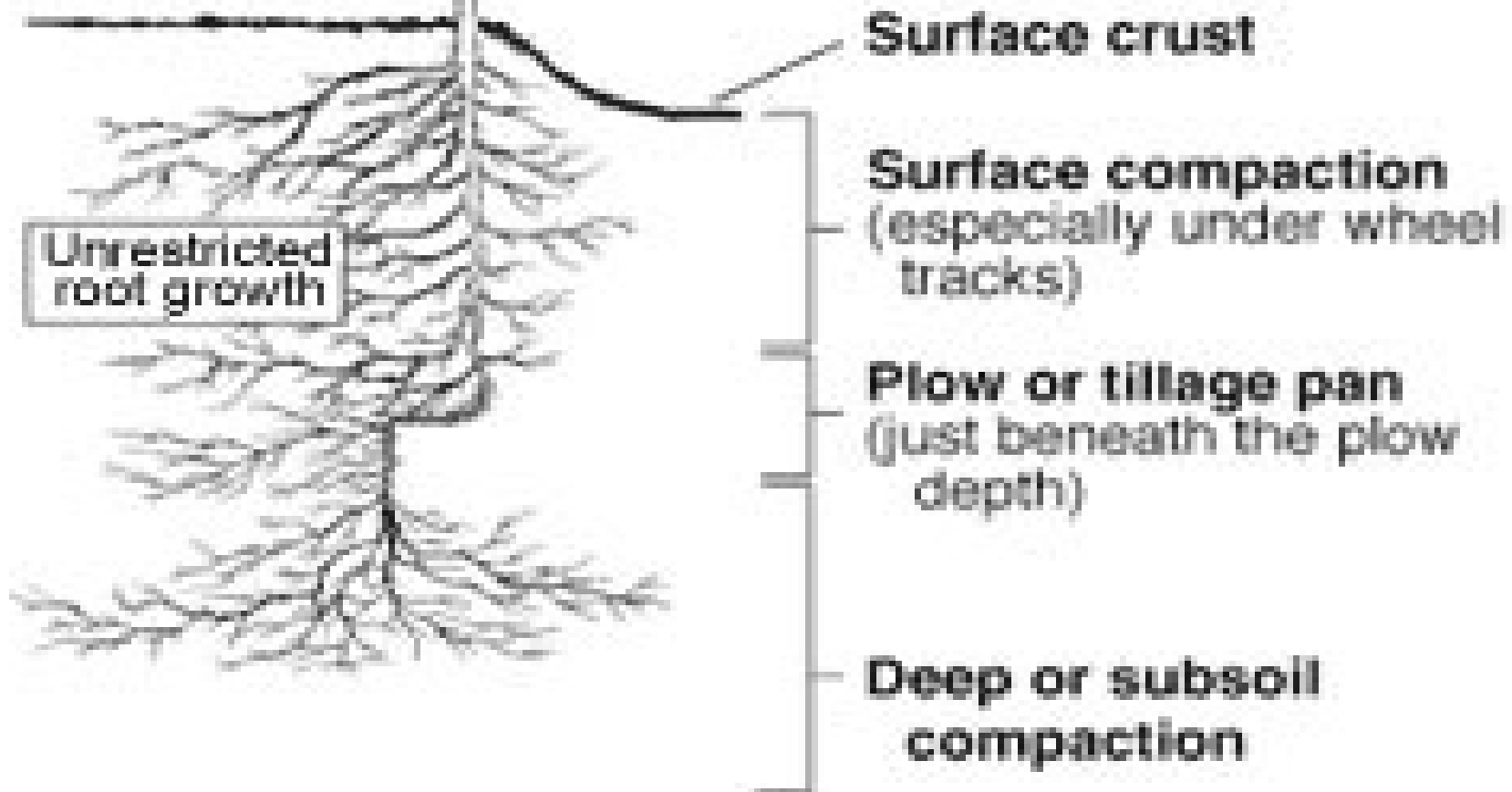
Impact of Compaction on Haycrop Yields in Clay



Vegetables grown In Sand?

Compaction on Haycrop Yields





Seconds to Compact: Decades to Recover

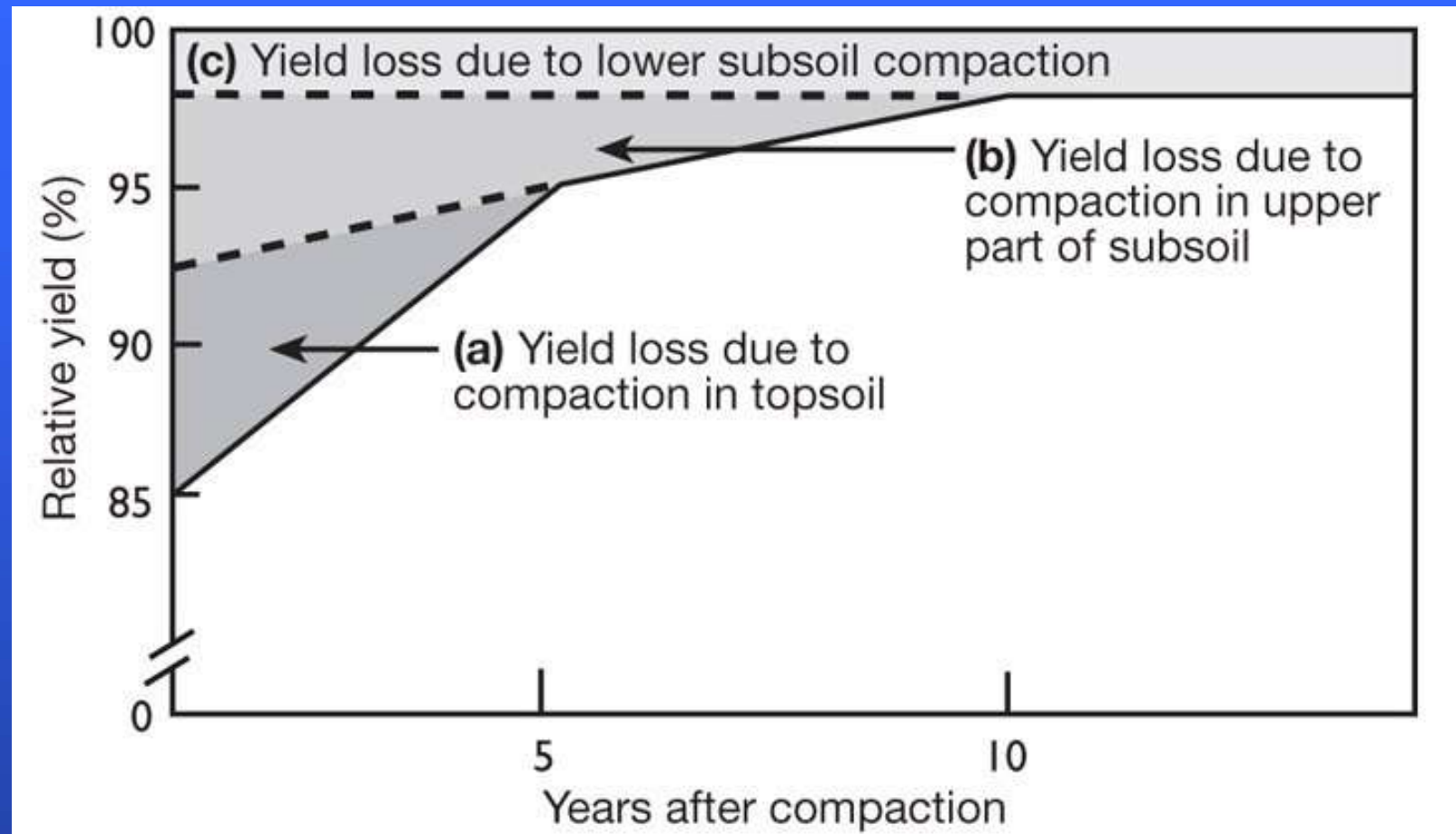


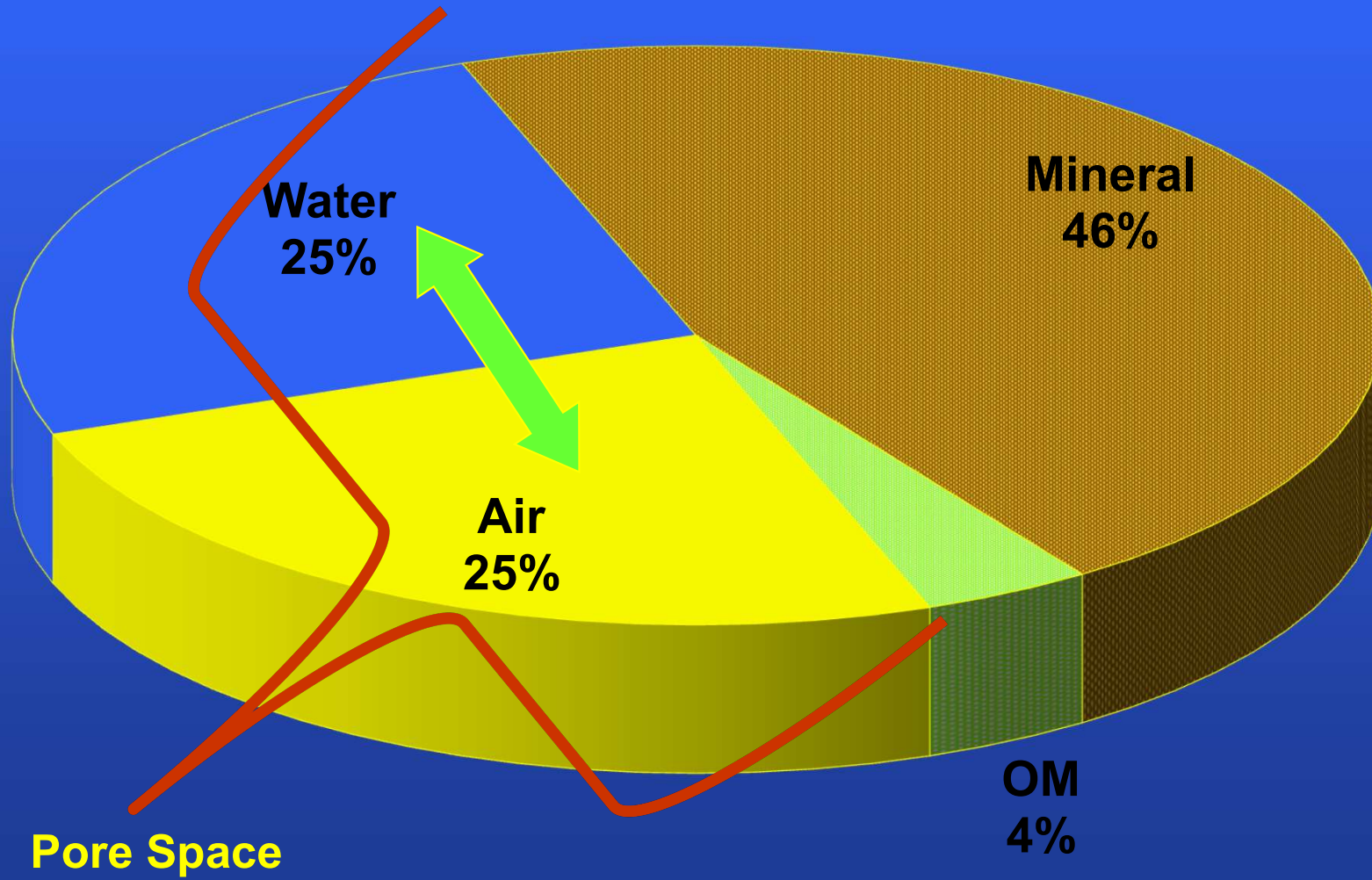
Figure 3. Relative crop yield on compacted soil compared to non-compacted soil with moldboard plowing. One-hundred percent of fields in multiple locations in northern latitudes were wheeled four times with 10-ton axle load, 40-psi inflated tires. Hakansson, I. and R. C. Reeder. 1994. "Subsoil compaction by vehicles with high axle load--extent, persistence, and crop response." *Soil Tillage Research* 29:277-304.



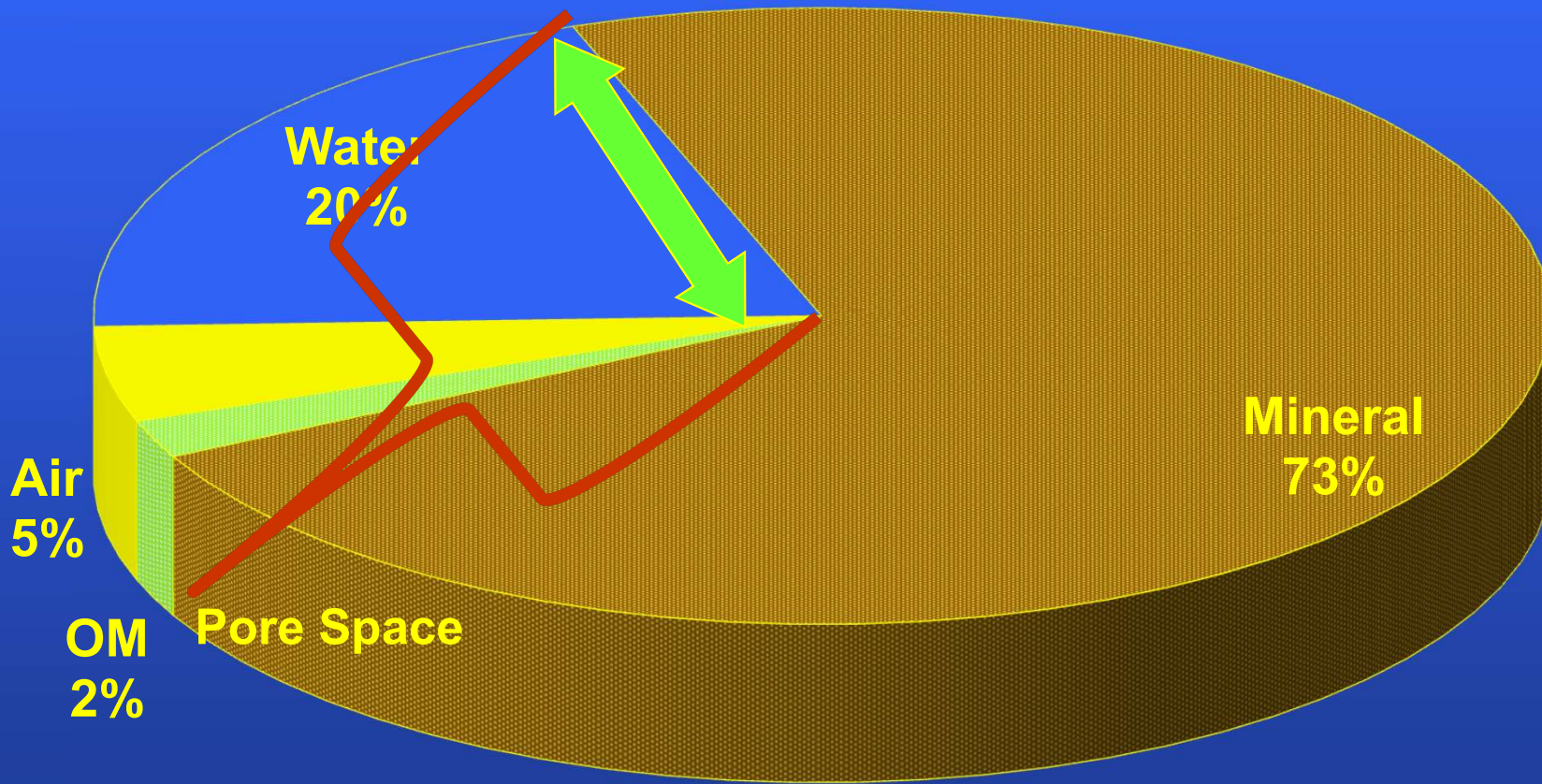


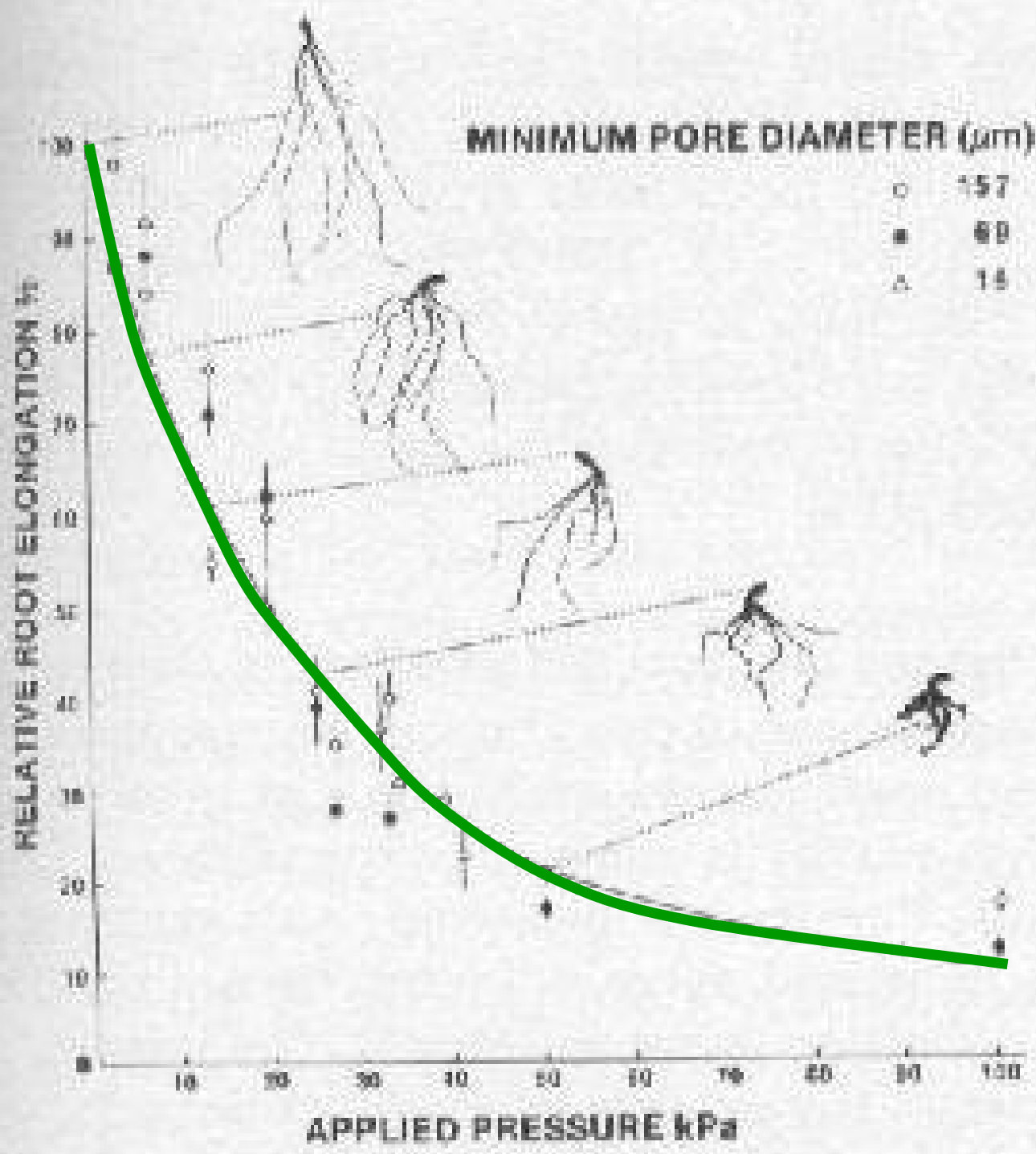


Soil Makeup



Compacted Soil Makeup

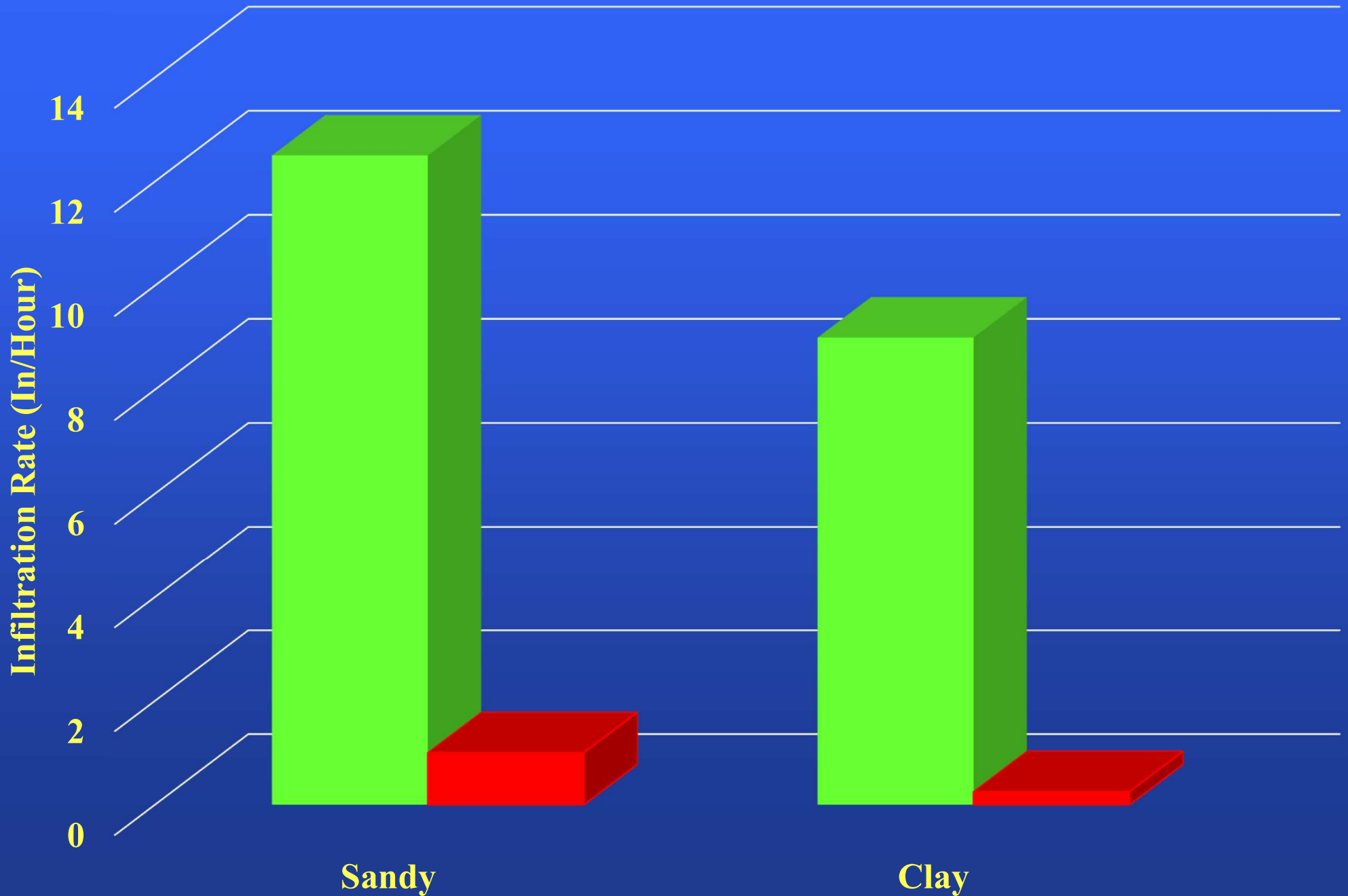


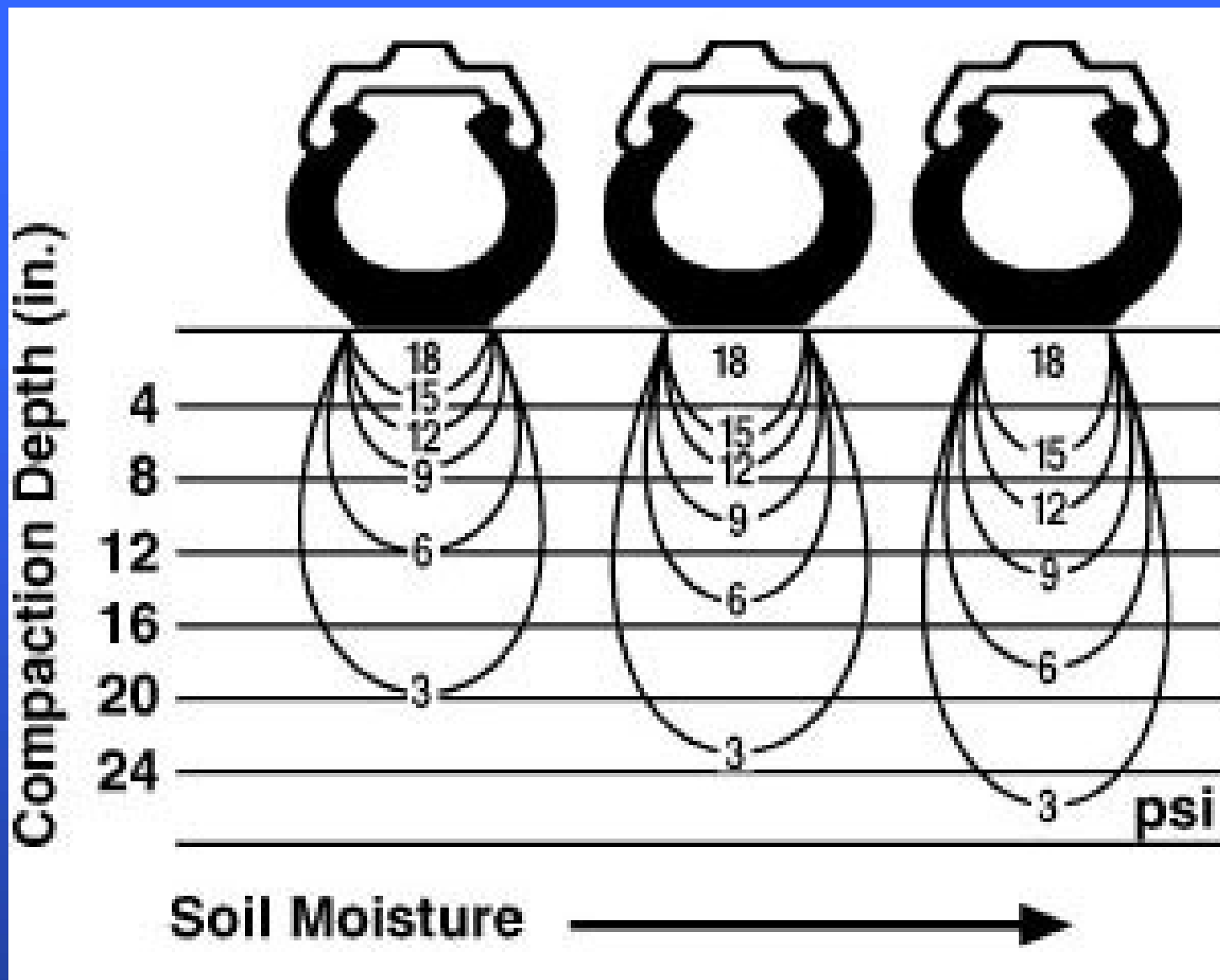


Russell and Goss, 1974

Effect of Compaction on Infiltration Rate

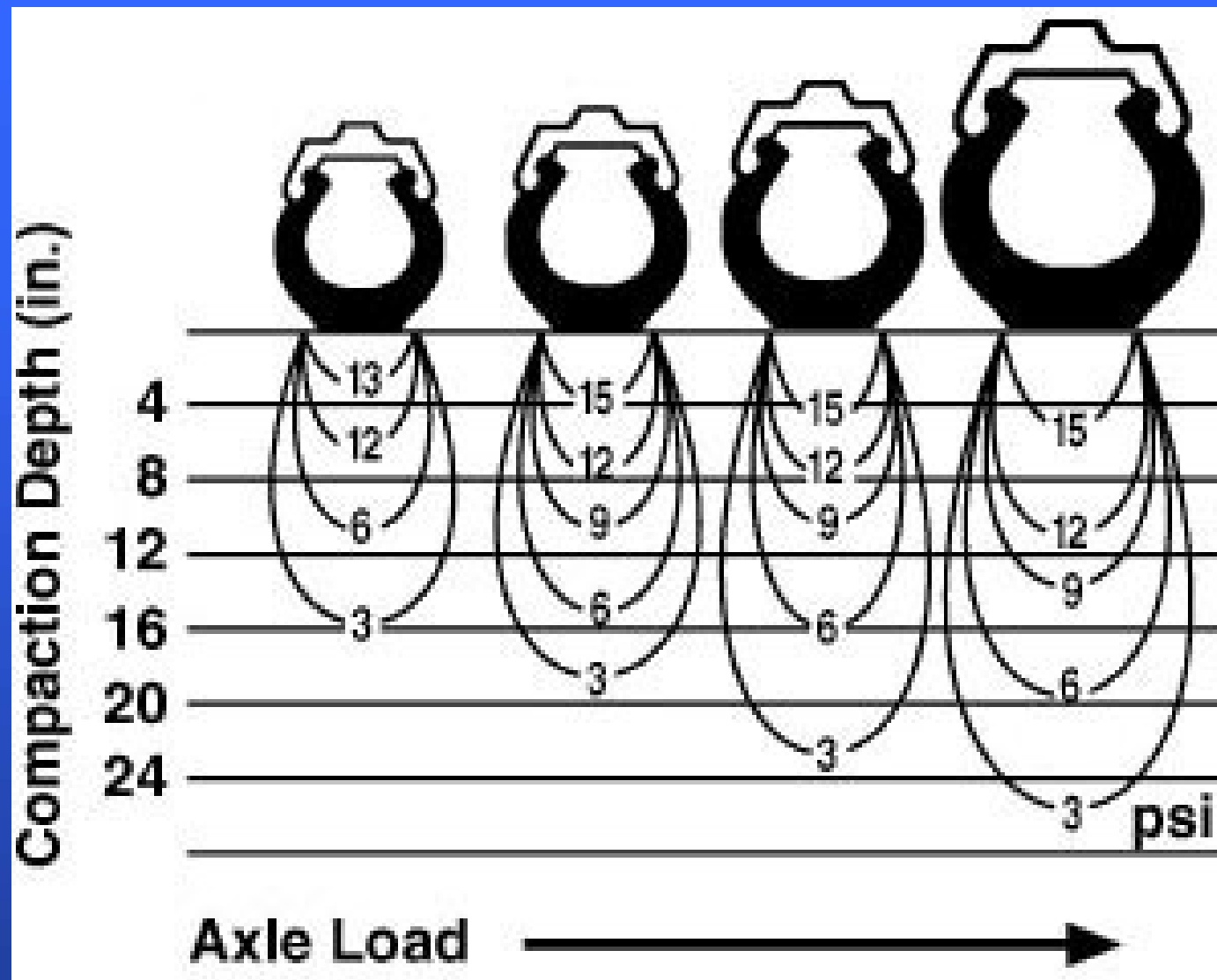
■ Native ■ Compacted





Adapted from Soehne, 1958

Figure 9. Depth of compaction as soil moisture increases. (Tire size 11x28, load 1,650 lbs., pressure 12 psi.)



Adapted from Soehne, 1958

Figure 8. Depth of compaction as axle load increases. (Tire pressure remained at 12 psi for all tire sizes.)

Top Soil Compaction

Tire Choice Makes a Difference



BIAS TIRE FOOTPRINT



RADIAL TIRE FOOTPRINT

All Tire Pressure *Less Than 15 psi*



Sprayers with narrow tires, high pressure, cause permanent compaction

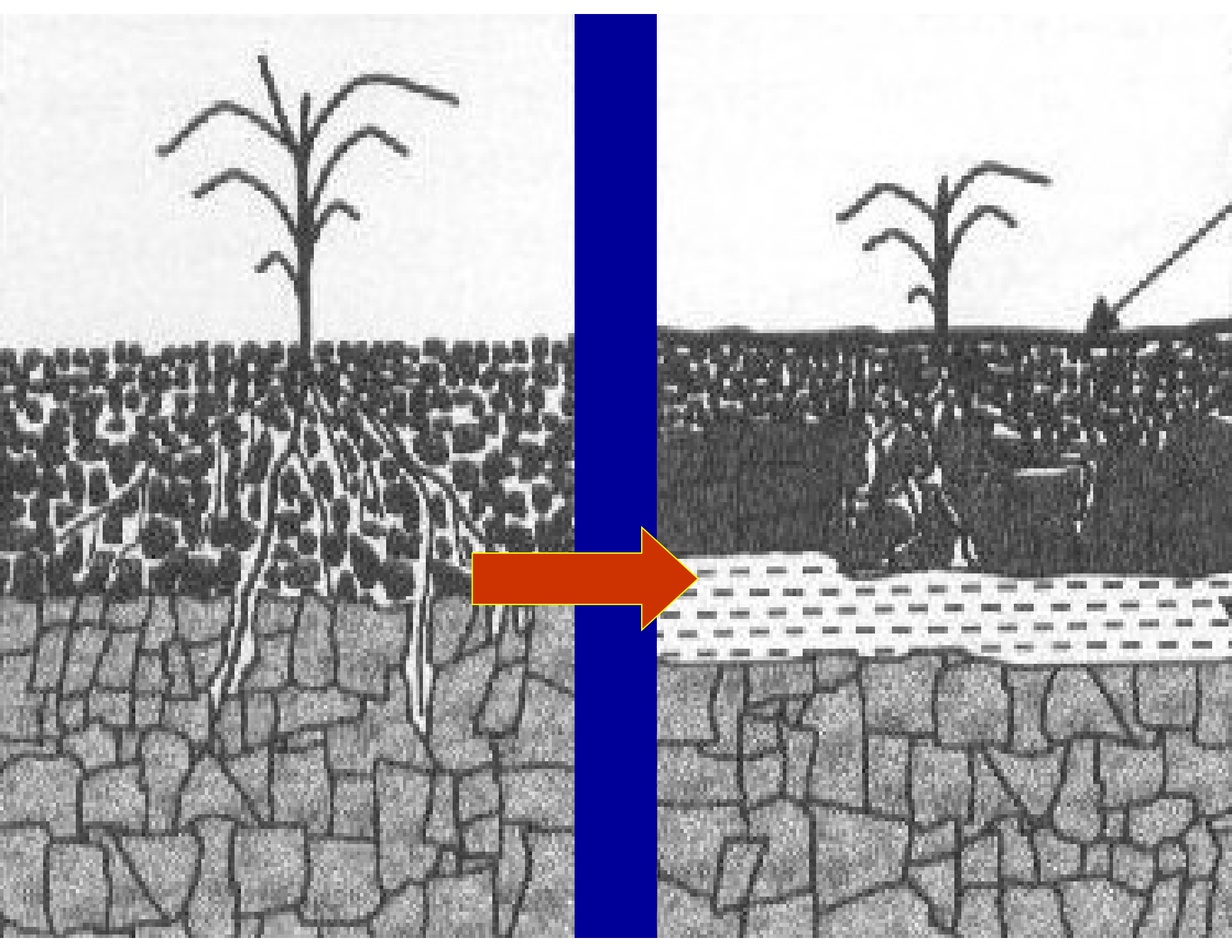


Equipment	Axle load tons per axle
Slurry tanker – 4,200 gal.	10-12
Slurry tanker – 7,200 gal.	17-18
6-row combine, empty	10
12-row combine, empty	18
12-row, full with head	24
720 bu. grain cart, full, 1 axle	22
Beet cart, full	24
Grain cart, 1,200 bu., 1 axle	35-40
Grain cart, 1,200 bu., 2 axle	17-20
4WD tractor, 325 HP, front axle	13
4WD tractor, 200 HP, front axle	7.5
MFWD tractor, 150 HP, rear axle	6.5

A photograph showing a hole dug into the ground. A wooden stake is stuck vertically into the soil on the left side of the hole. To the right of the hole, there is a piece of white material, possibly a plastic bag or a piece of fabric, partially buried. The ground is dark and appears to be soil or mud. There is some green grass and weeds around the hole. The text is overlaid in yellow on the right side of the image.

**Pans Need To Be
Removed**

**Freezing and Thawing
does NOT**



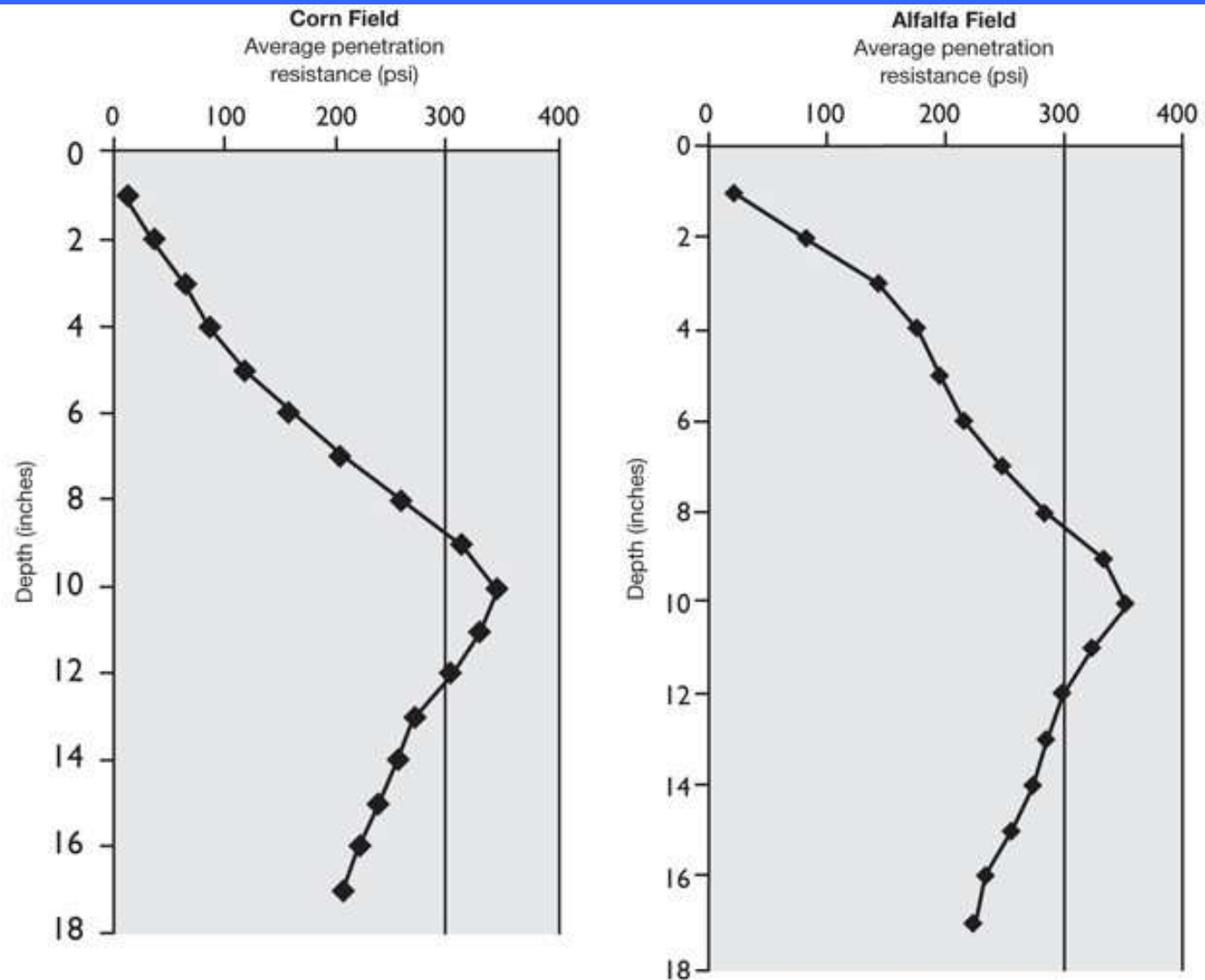
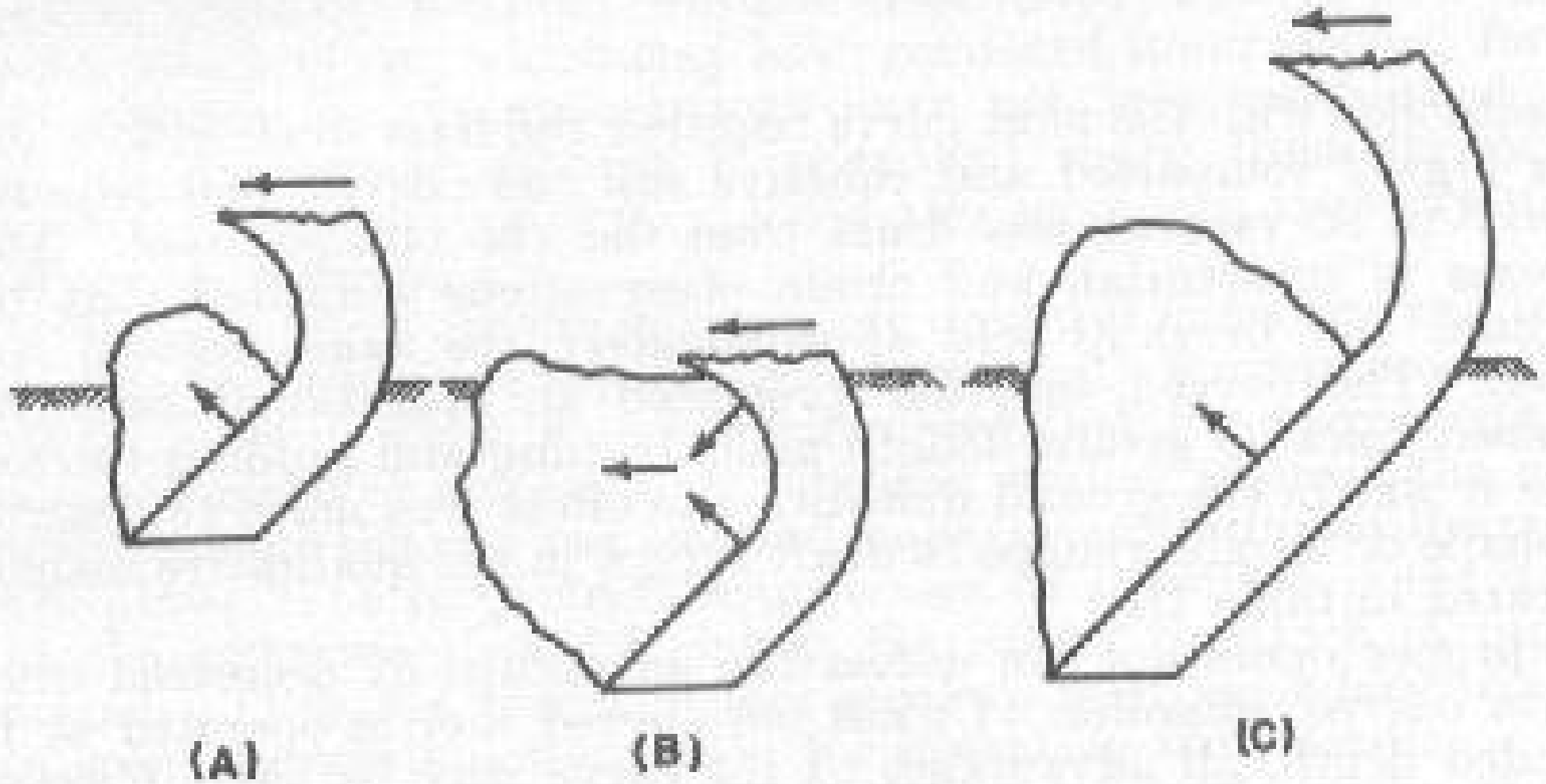


Figure 4. Penetration resistance on a PA dairy farm that used chisel/disking for field preparation. A pan was detected just below the depth of chisel plowing.

**New Zealand: Deep Tillage
without a change in the rest of the
tillage/planting system
is a waste of time**

Removing compaction
by chiseling deeper??

NO!!!

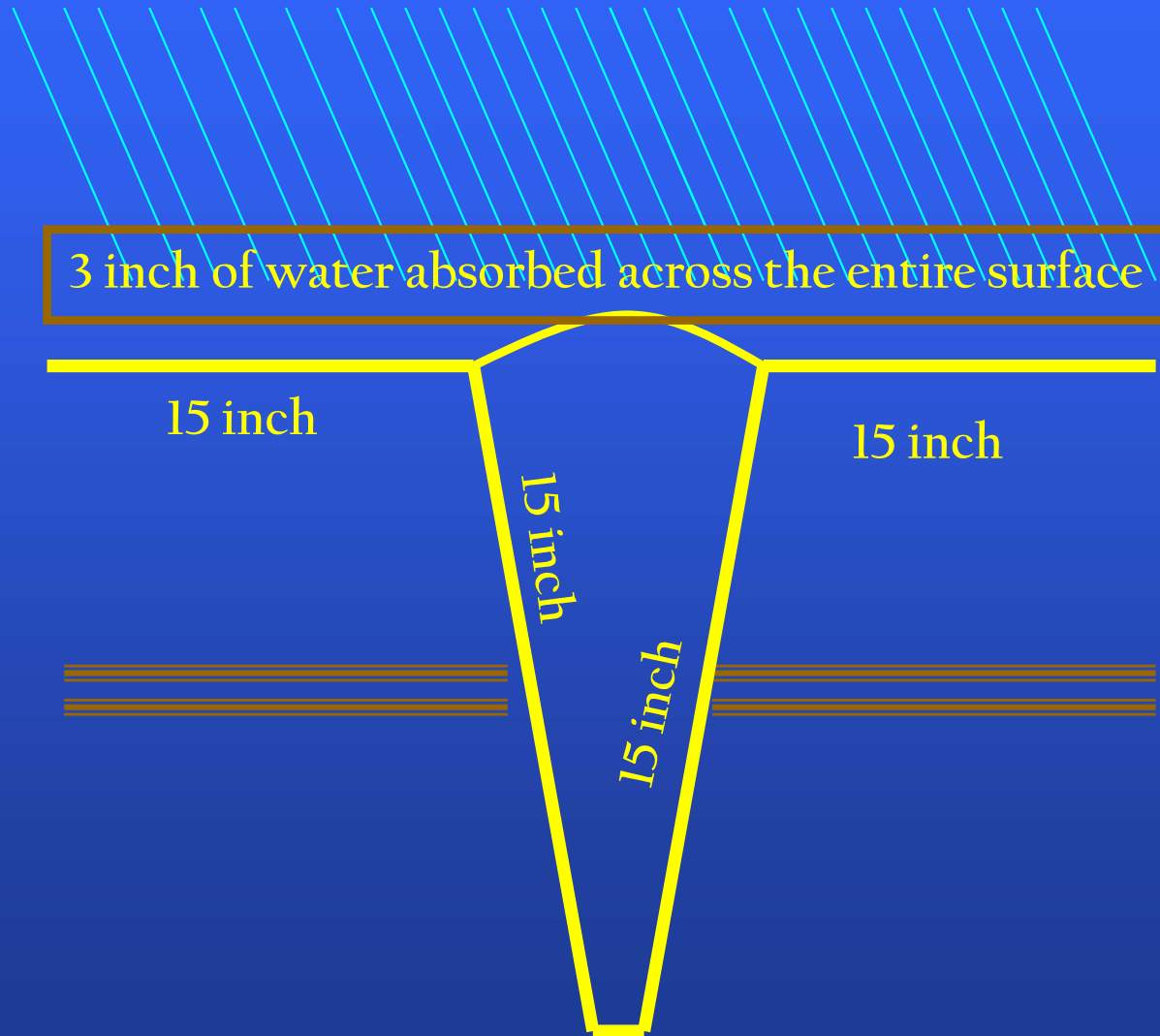


Gill and Vanden Burg, 1968

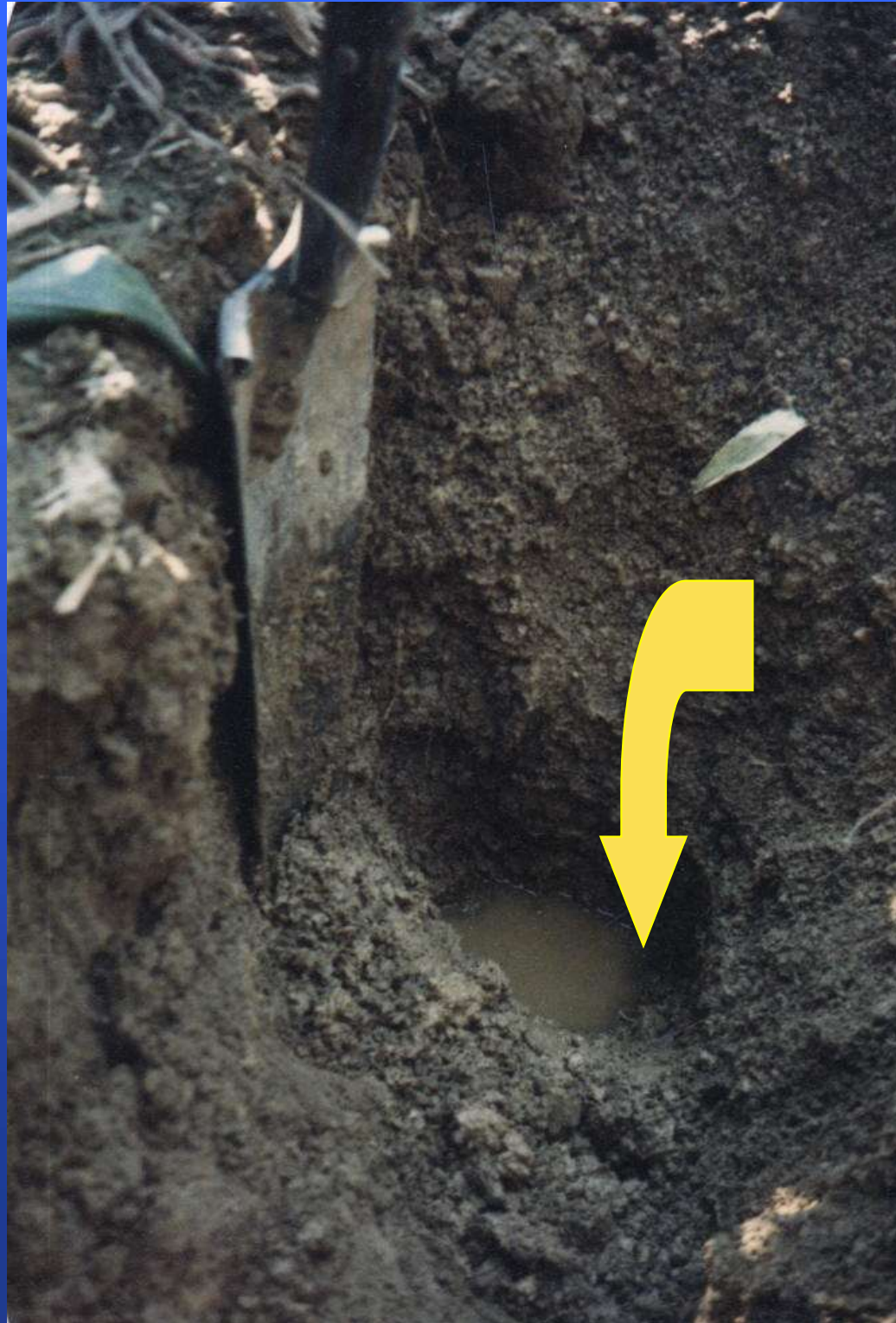




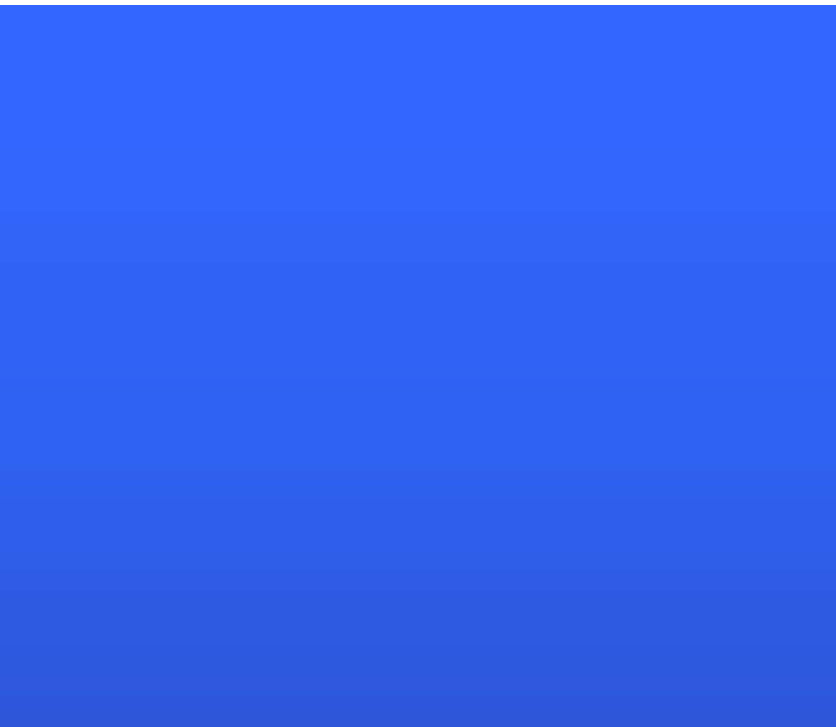
Deep Zone Til



Acetylene buildup











**RIPPED 17 in.
ZONE TILLED**

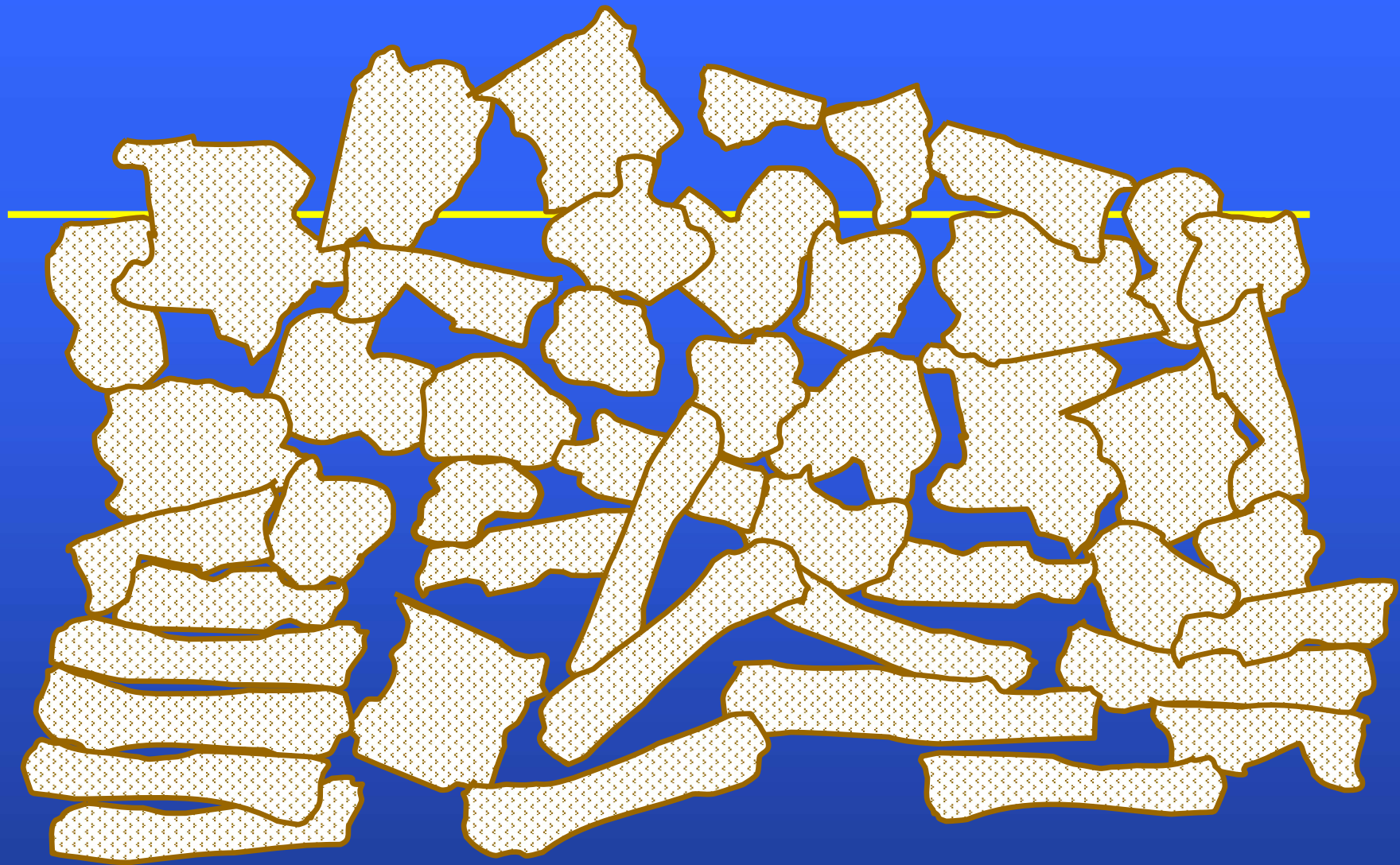


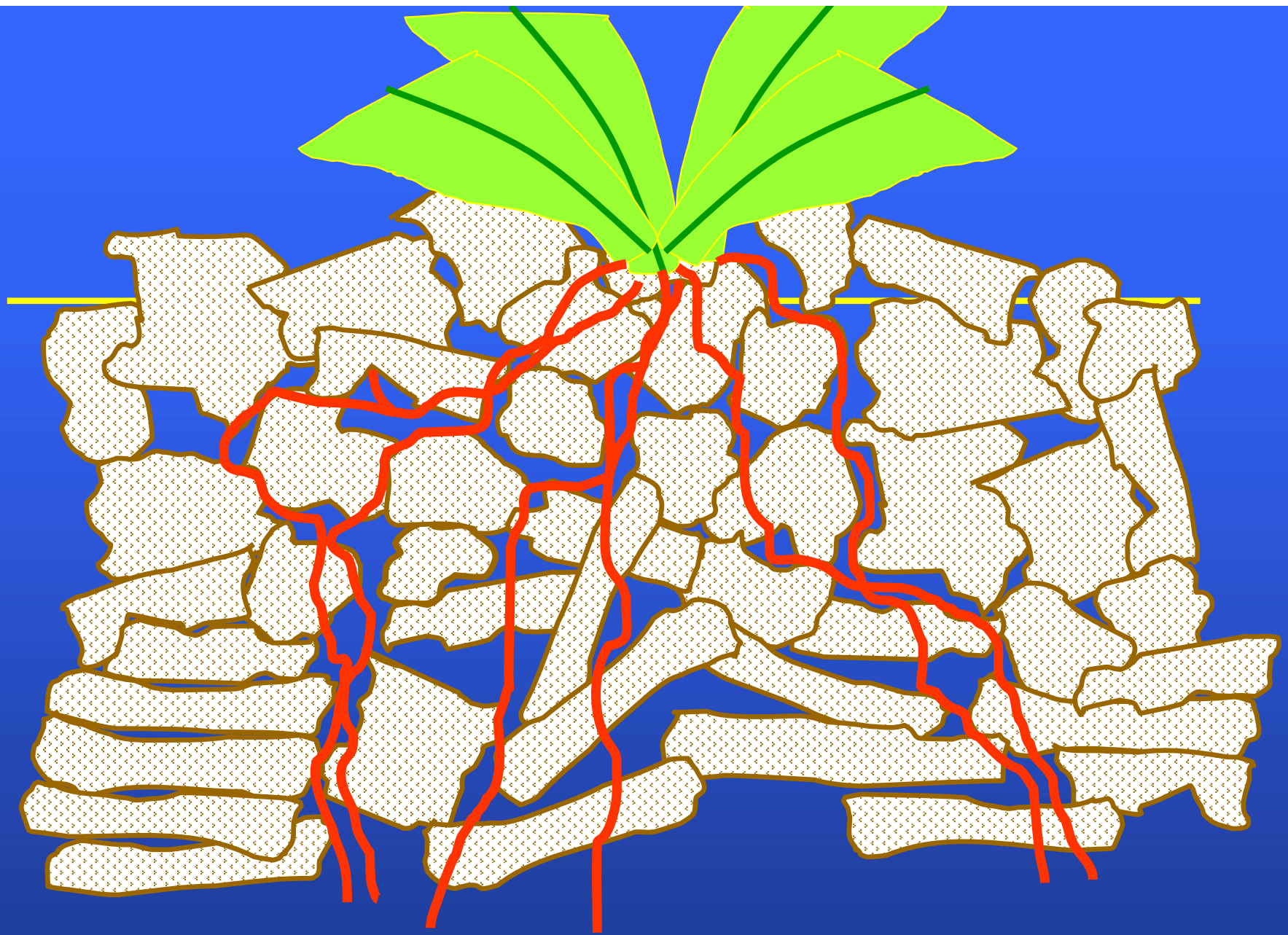
**CONVENTIONAL
TILLED**

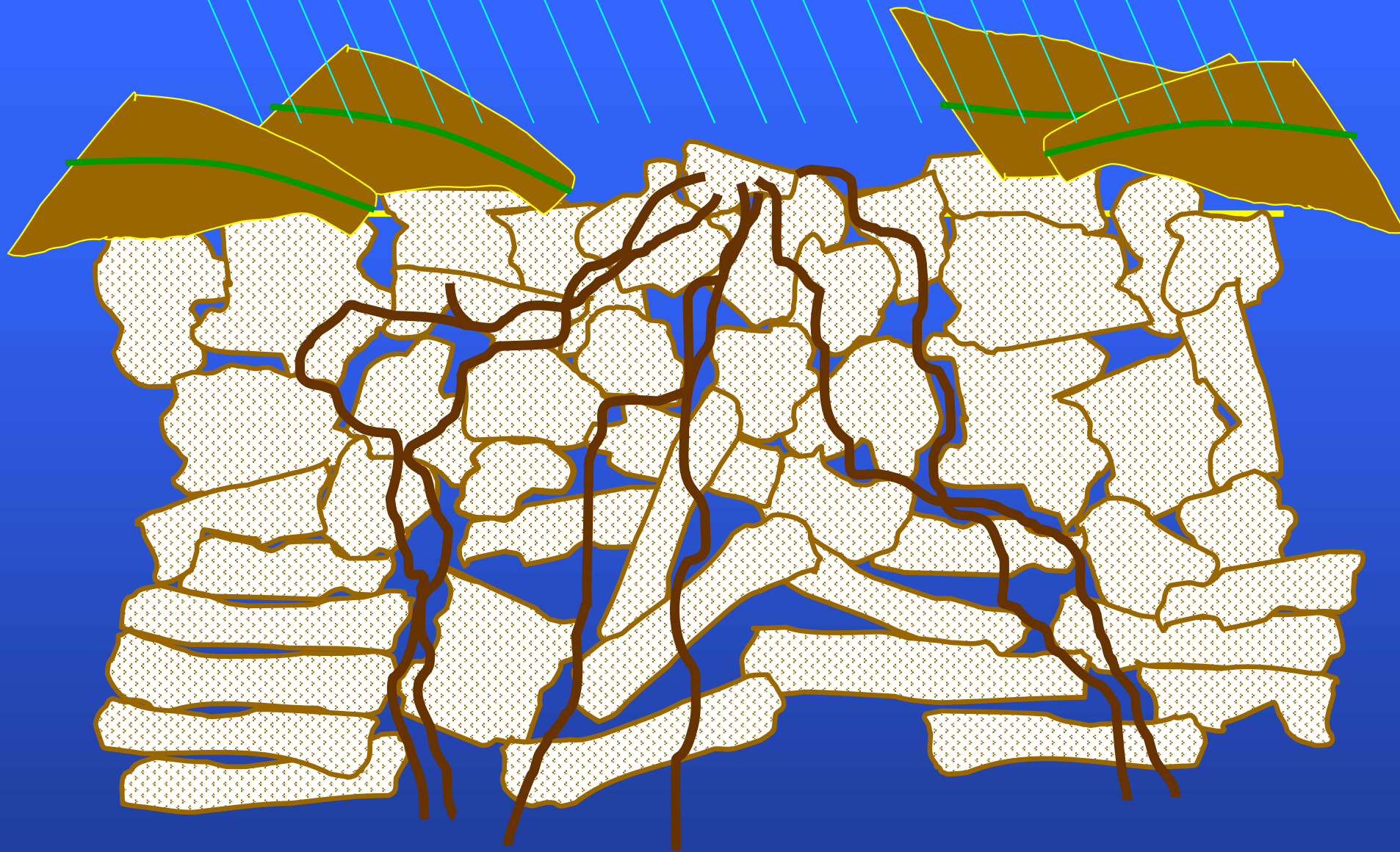
Deep Tillage is NOT Magic

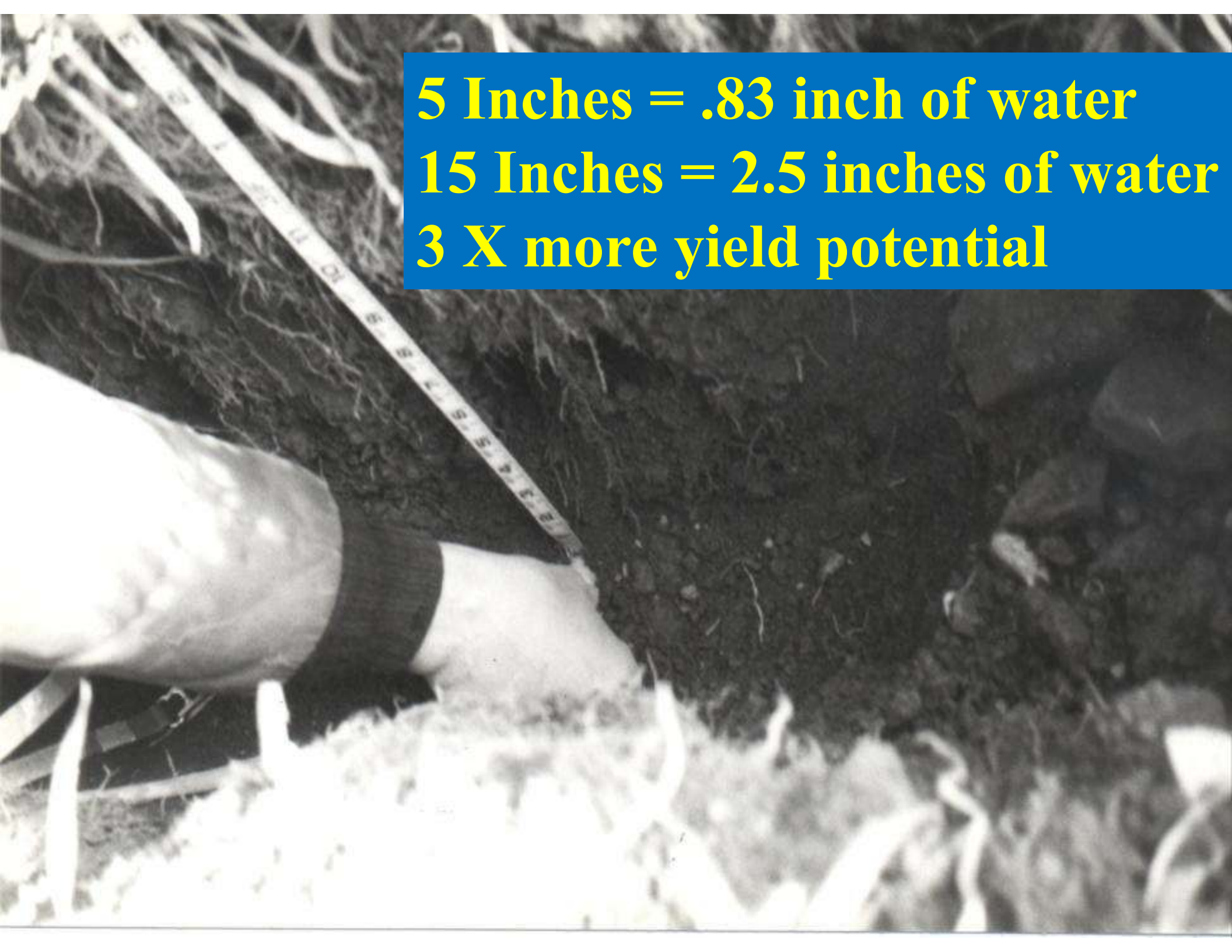
You need to use Common Sense!



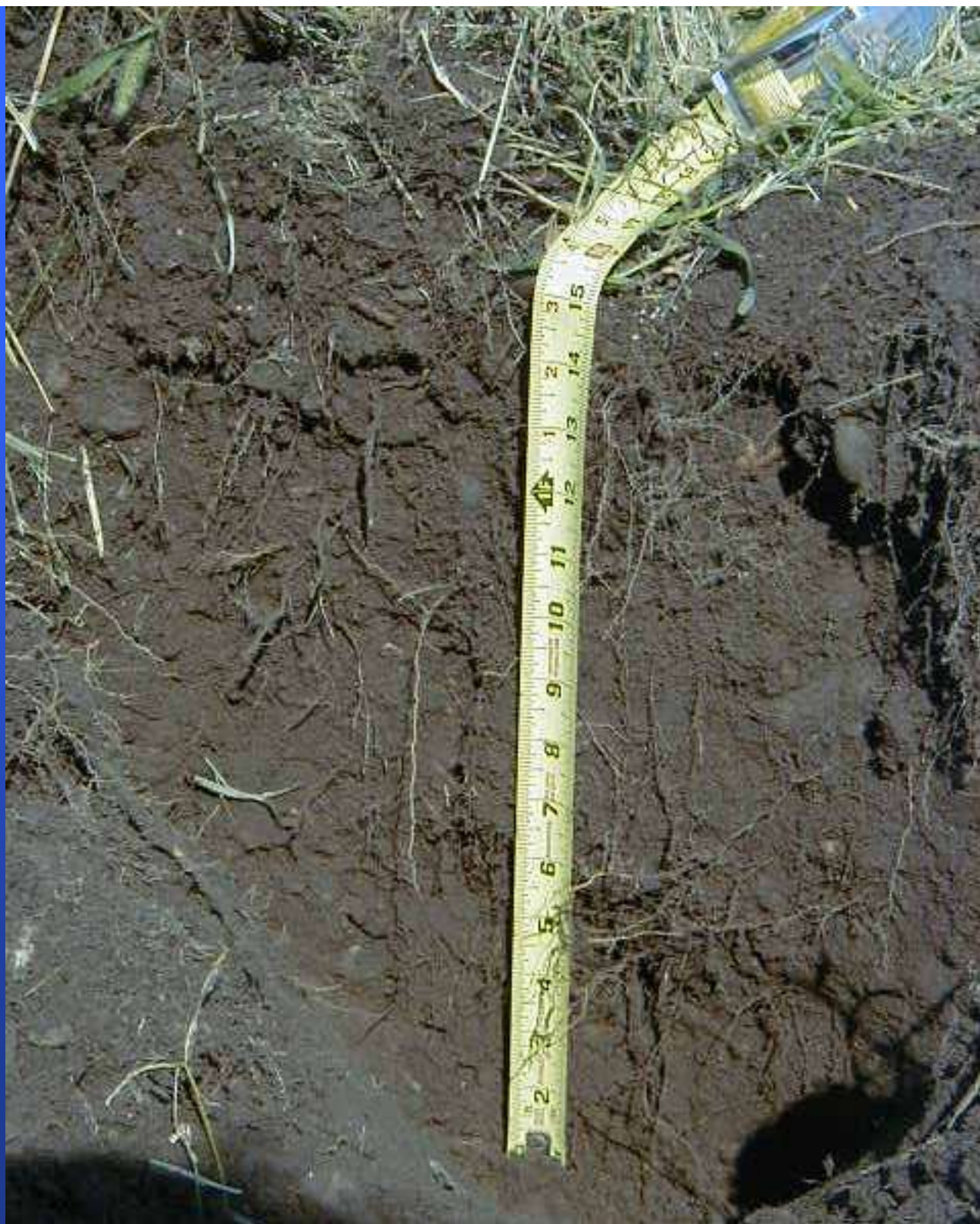








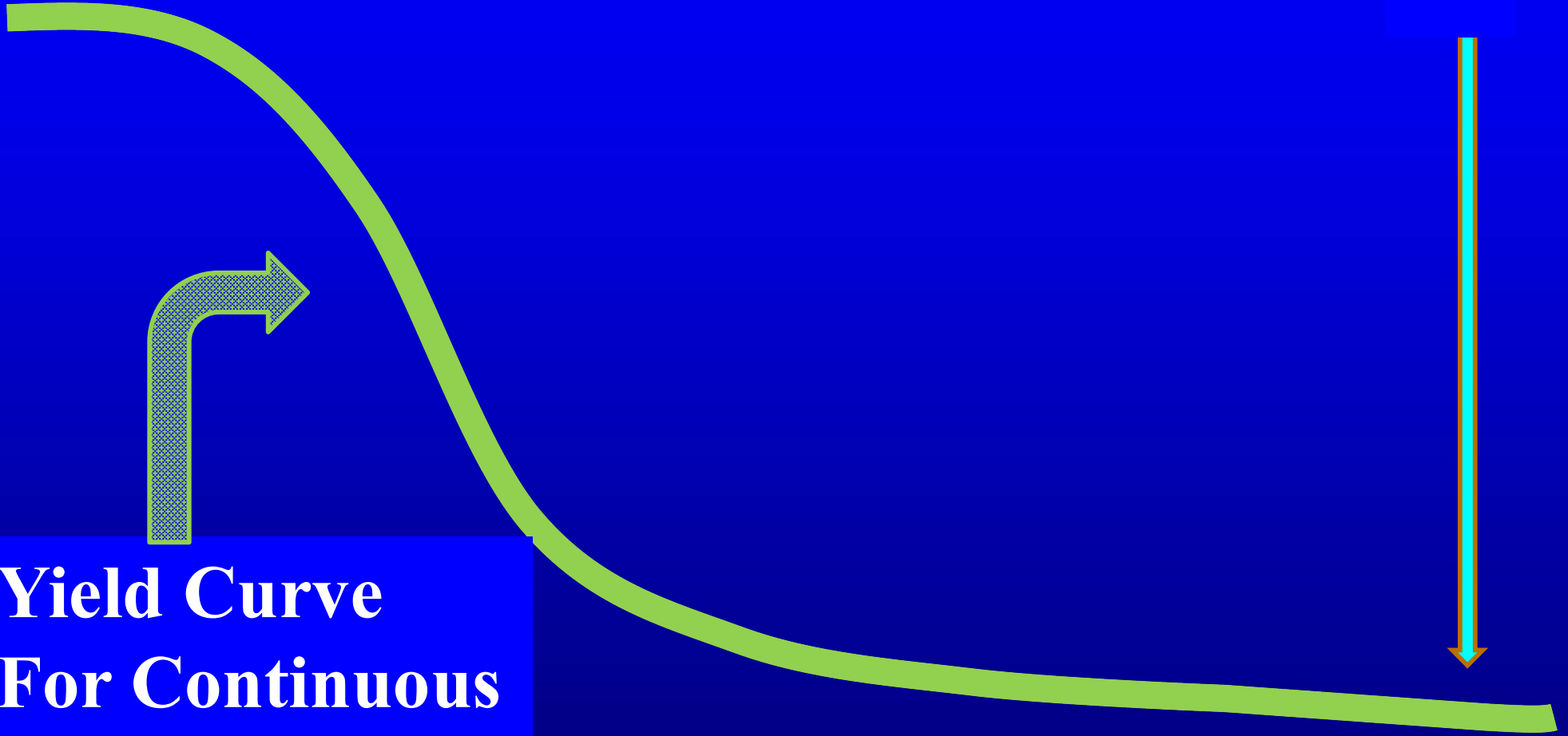
5 Inches = .83 inch of water
15 Inches = 2.5 inches of water
3 X more yield potential



**Yield Curve
For Continuous
Cropping
System**

Years

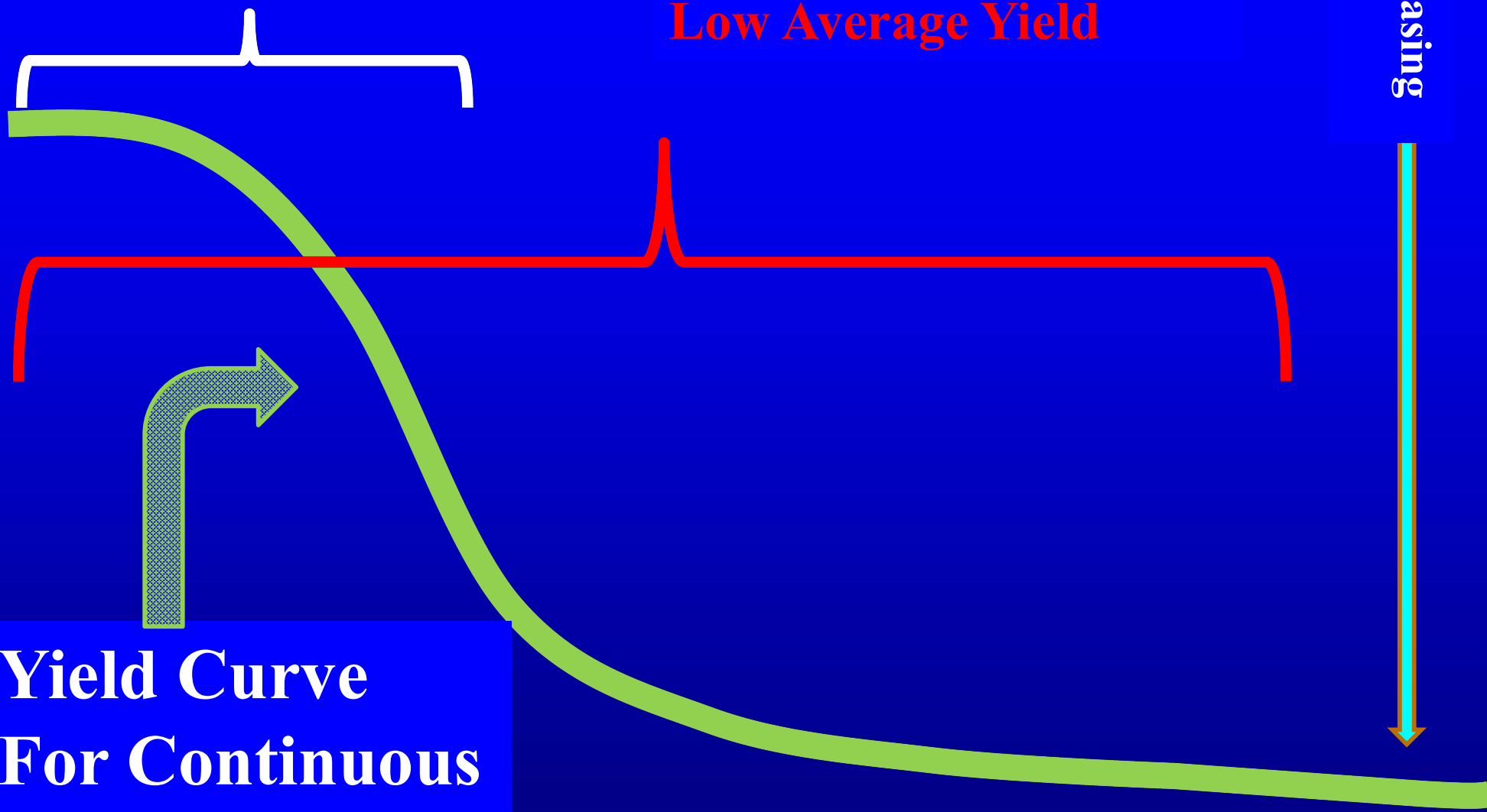
**Decreasing
Yield**



**Short Rotation
High Average Yield**

**Long Rotation
Low Average Yield**

**Decreasing
Yield**



**Yield Curve
For Continuous
Cropping
System**

Years

Rotations Factors

- Soils type
- Slope/erosion hazard
- Crop Choice Annual/Perennial
- Legume / supplies nitrogen
- Long Term Grass / needs nitrogen/manure
- Market for product produced

Diversified rotations with three or more crops exhibited **6.1** and **7.9%** greater SOC, **6.5** and **7.9%** greater active carbon, and **10.7** and **11.6%** greater potentially mineralizable nitrogen PMN relative to two-crop rotations or monocultures, respectively.

Aggregate stability was significantly greater under diversified rotations (**35.5%**) relative to two-crop rotations (**30.6%**) and monoculture (**30.8%**).

Veum et al 2022 Agronomy Journal

1:Tools of Rotation

Winter Forages are Cover Crops on Steroids:

- **Cover Crops cost money: long term return**
- **Winter Forage makes money that year.**
- **Keep soil covered (and on the field) year around**
- **Build soil structure all year with living root exudates**
- **Sequester nutrients in living organic matter**
- **Maximize successful no-till; saving time, soil, fuel**
- **Never leave a window for weeds to start**

Early Forage Next Year



Fermented Winter Triticale Forage Samples

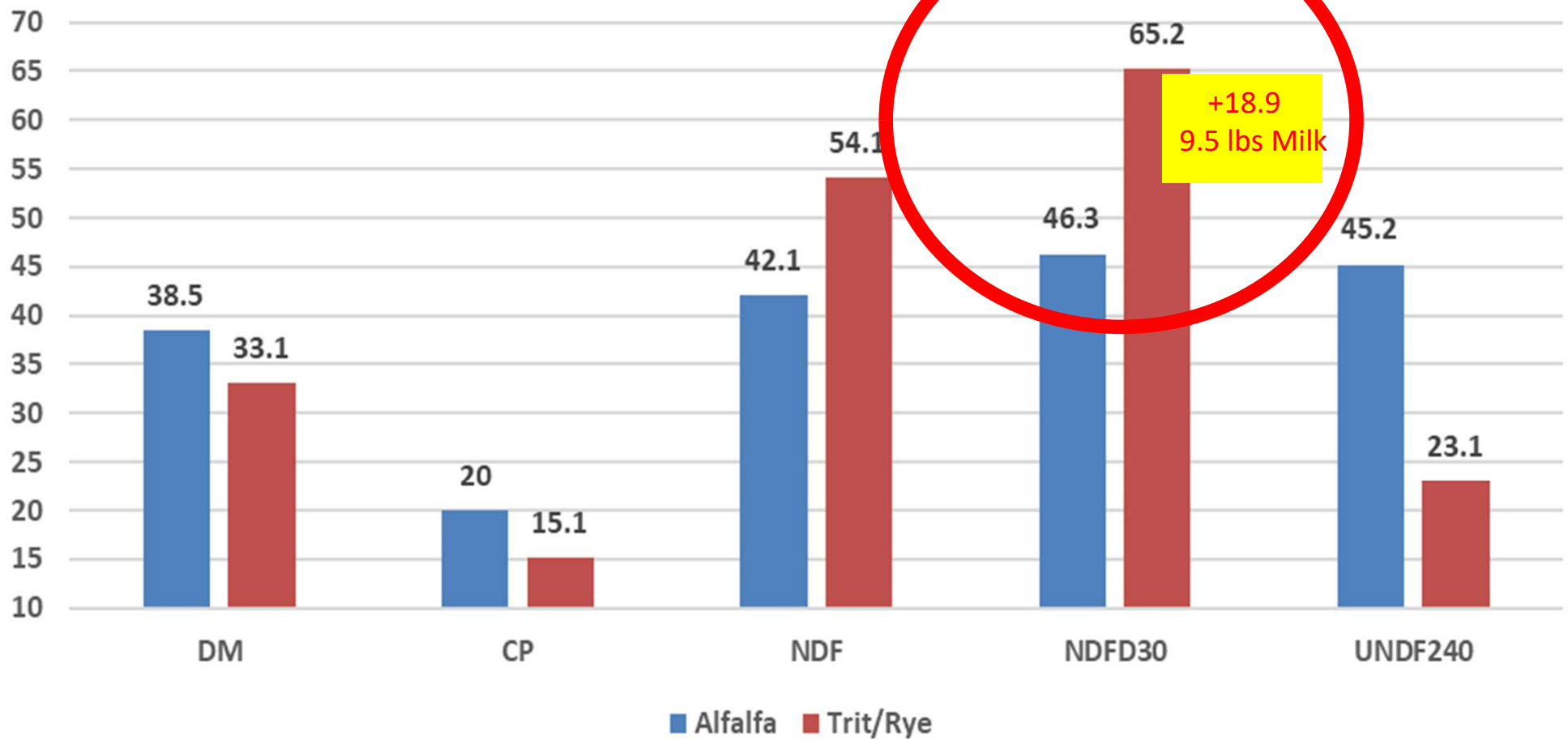
	Average	Low	High
Crude Protein	20.35	19.71	21.07
ADF	25.42	24.06	27.53
aNDFom	37.91	35.88	40.12
Ash	7.61	7.38	7.93
Lignin	1.02	0.44	1.87
Sugar	6.16	4.81	7.11
Starch	4.60	2.6	5.48
NDFD 30	68.21	65.57	70.21
TTNDFD	66.45	64.11	69.44
RFQ	193	176	206
Kd%/hr	5.74		
Nel	0.75	0.731	0.762

+ Sulfur

**As Good As
BMR Corn**

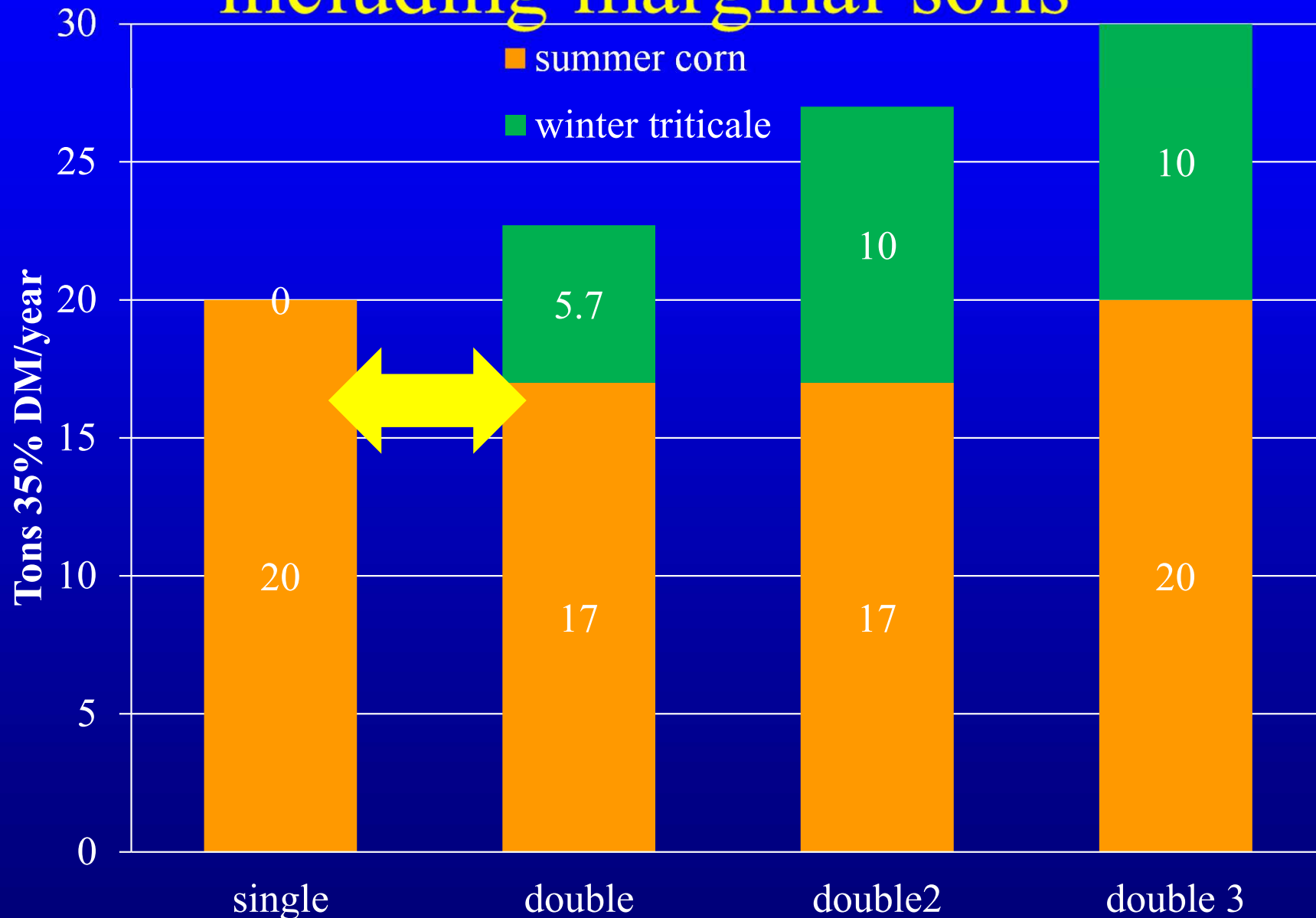
**Eliminates
Summer
Slump**

Comparing Alfalfa and Triticale/Rye PA & MD 2018-2021



Research by John Winchell, Alltech

Directly Increases Total Yield 25 – 35% including marginal soils



Winter Forage Triticale

Planted in Fall



Harvested in Spring



Oct week 1

Sept week 1



Sept week 2

10 Day – 2 Weeks before Wheat Grain



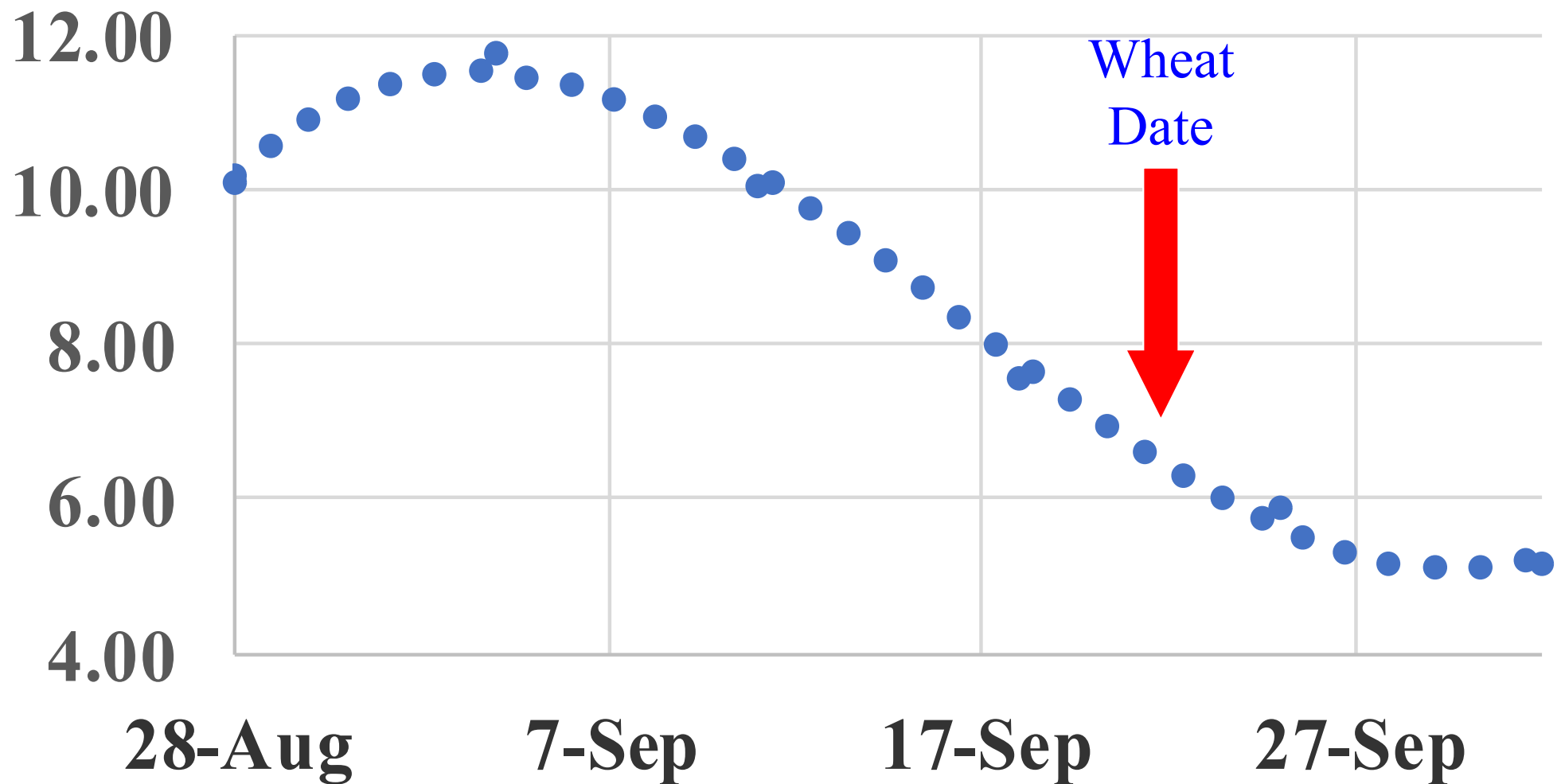
Sept week 3



Sept week 4

Tillers = Yield Potential

Number of Tillers/plant by Planting Date





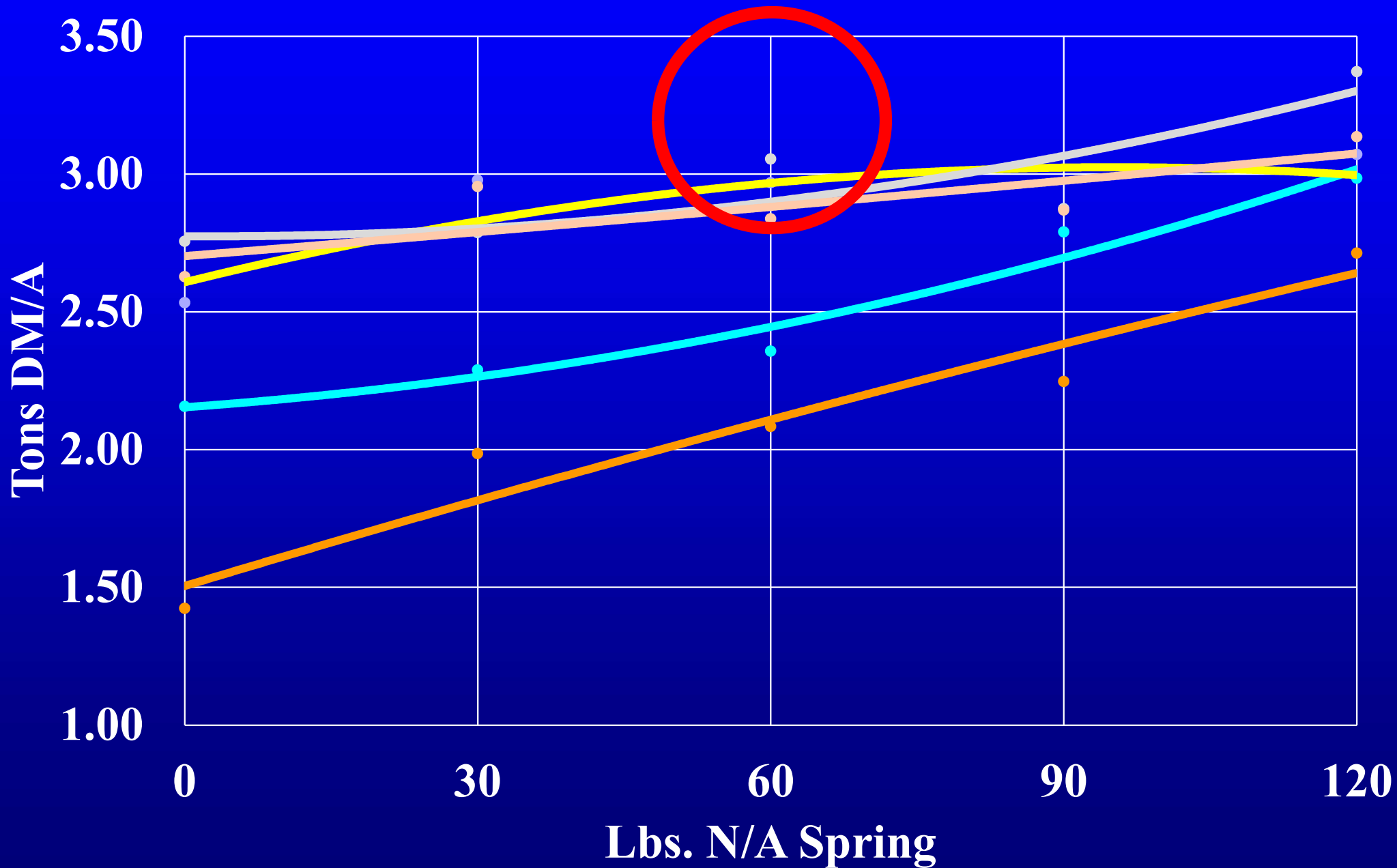
**Yield/Soil Benefits Accrue
According to Fall Biomass
Produced**

September 9

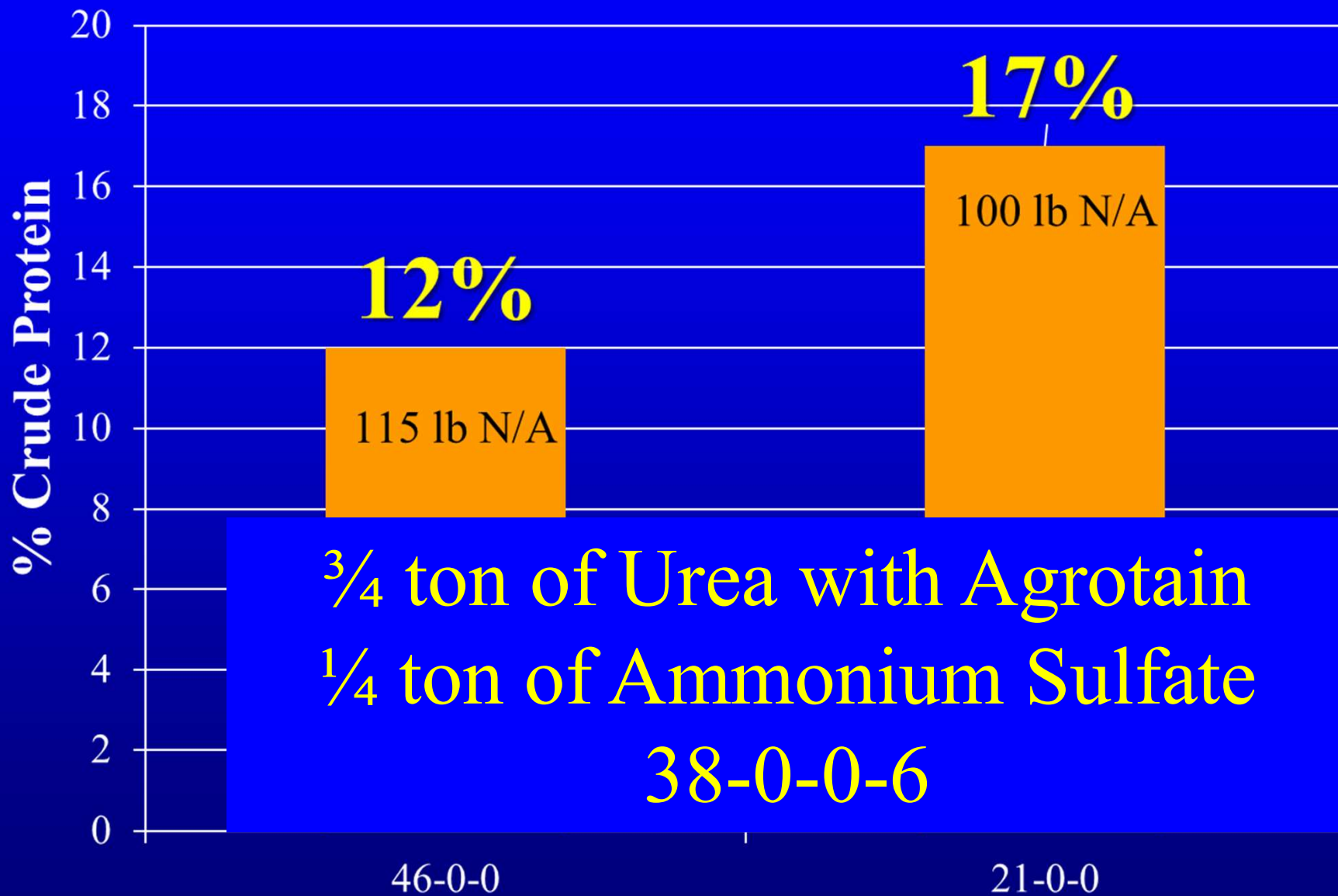
October 6

Yield by Fall and Spring Nitrogen

• 0.0 • 30 • 60 • 90 • 120



Impact of Sulfur on Protein





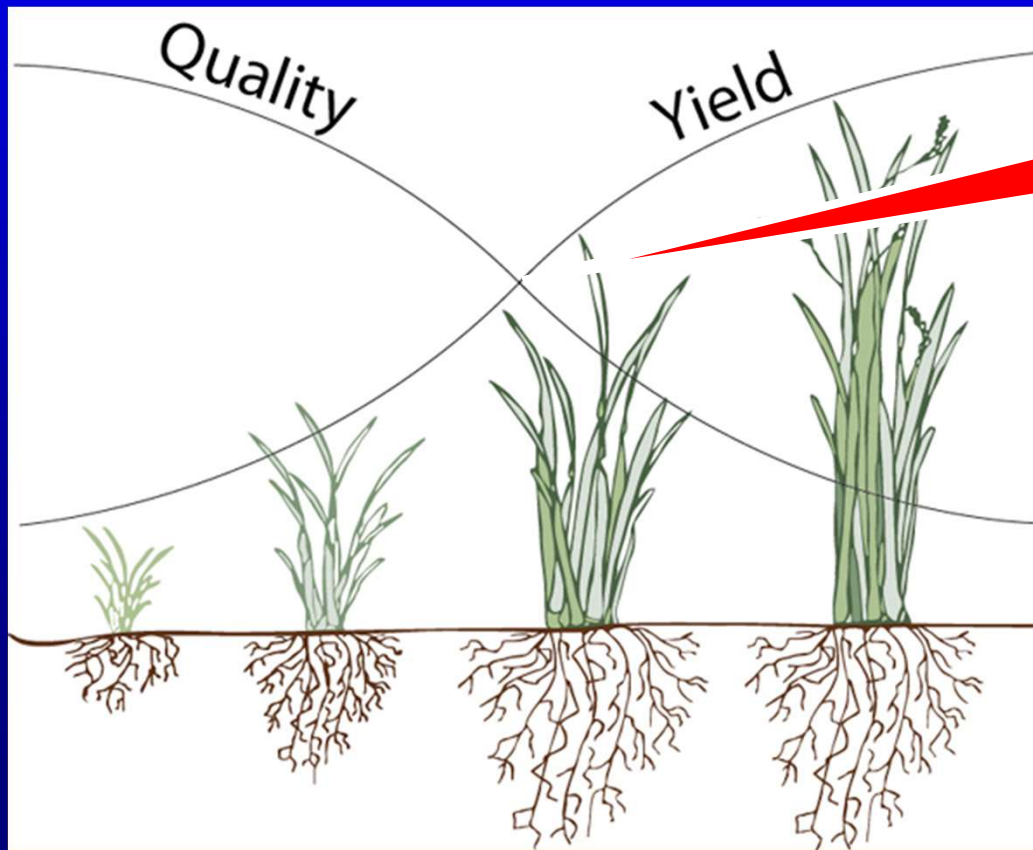
3 Way Seed Treatment

Control No Seed Treatment

**Seed treatment with on
time planting yielded
15% more than not
treated seed at right**

**Late plantings yielded
up to 28% more with
seed treatments
compared to none.**

There is a trade off between quality and yield for winter grain forage



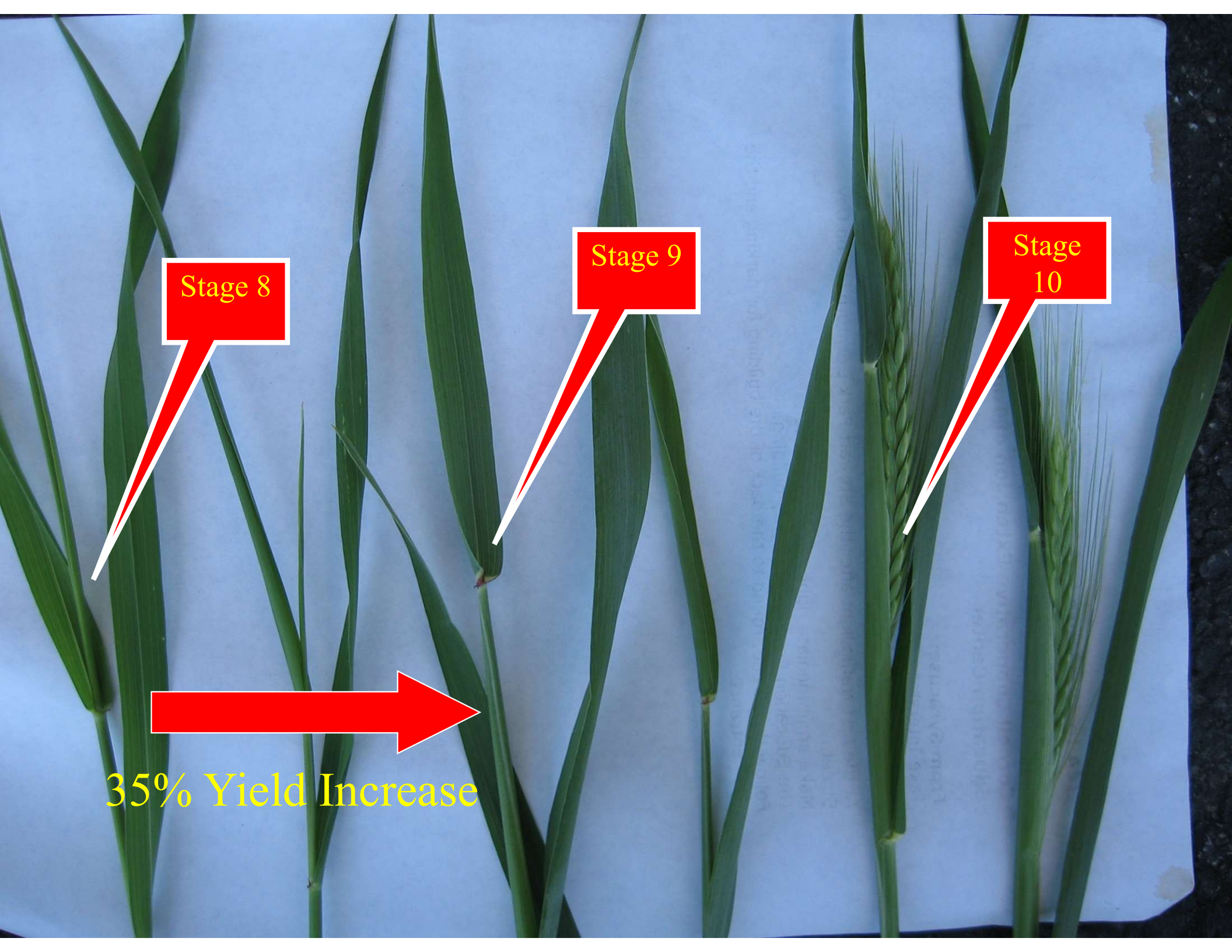
Stage 9
Flag Leaf

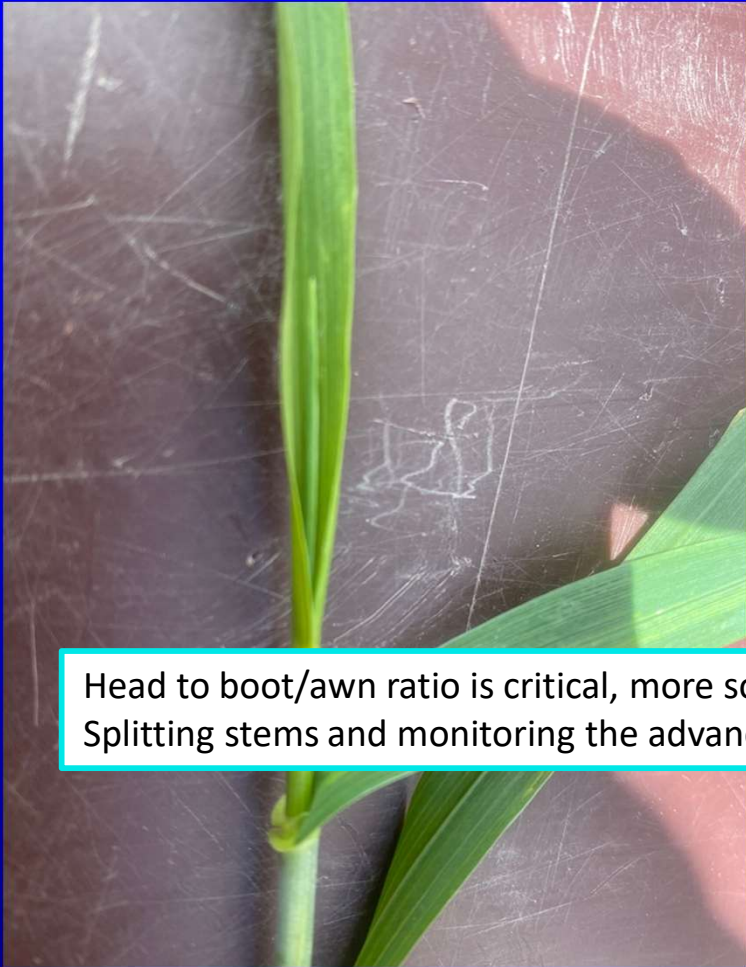
Stage 8

Stage 9

Stage 10

35% Yield Increase



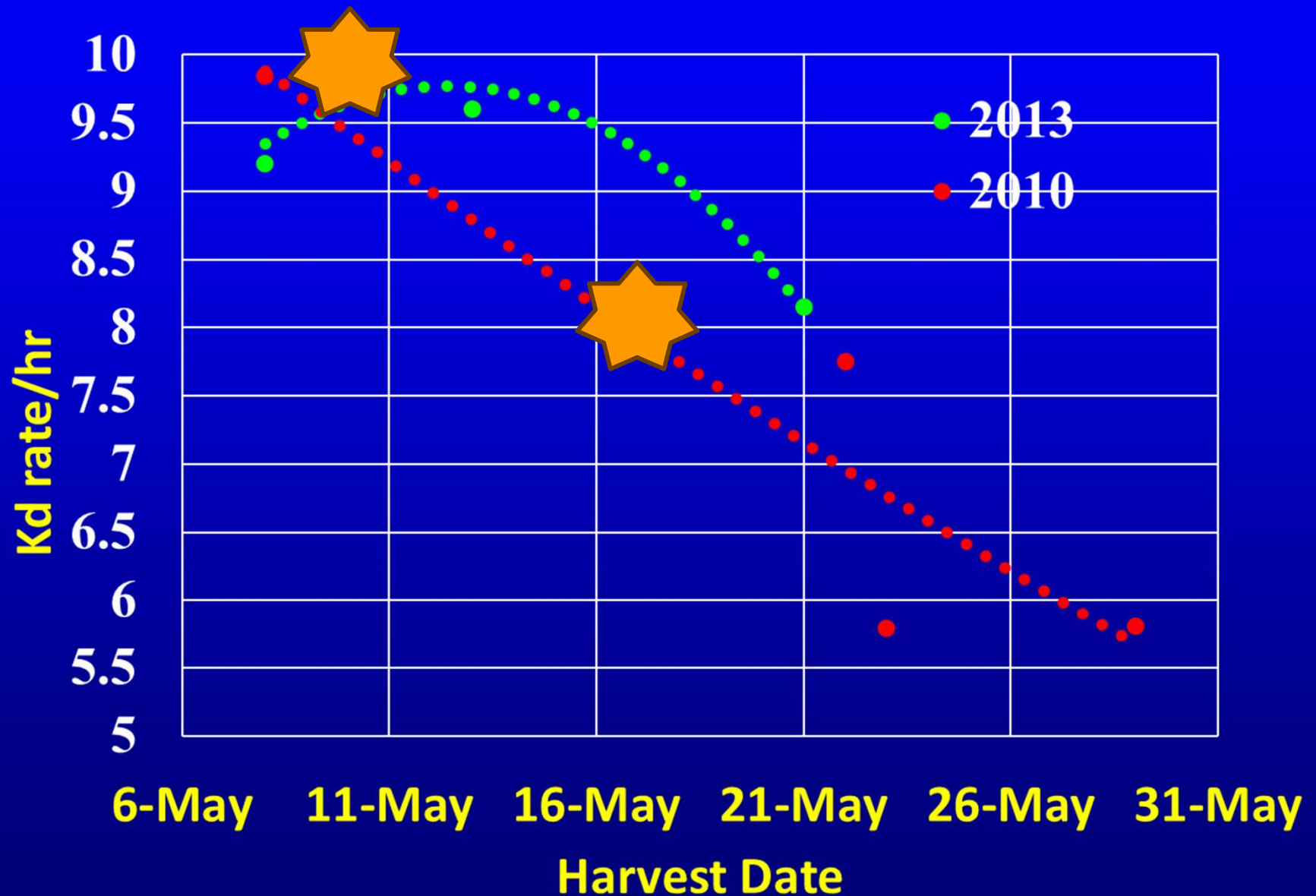


Head to boot/awn ratio is critical, more so than the flag leaf position
Splitting stems and monitoring the advancement of head progression



John Winchell, Alltech 2023

Change in Feed Quality



- Also wanted to let you know that our cows have never milked and tested better than now with feeding triticale.
- It's awesome feed!
- Milking 90-95 lbs with 4.2- 4.3 fat
- Roger, Ontario, Canada

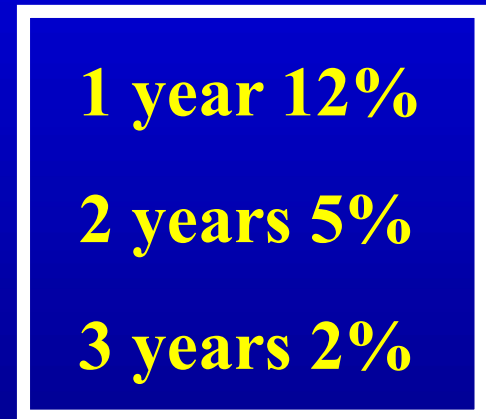
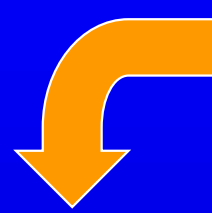
3: Tools of Rotation

- **Shallow manure injection is a money, soil, fertilizer saver**
- **Keep fertilizer on/in the field**
- 8,000 gal manure surface spread is 42 lbs. of organic N/A available that year.
- Incorporated is + 120 NH₄-N = 162 lbs. N/a
- +120 = \$120/acre for each crop
- \$120/A winter forage + \$120/A corn/sorghum =
- \$240/acre saving each year.

Manure N Release

Urine N

Feces N



Incorporate or lose it

35% available this full year. Not available for winter forage



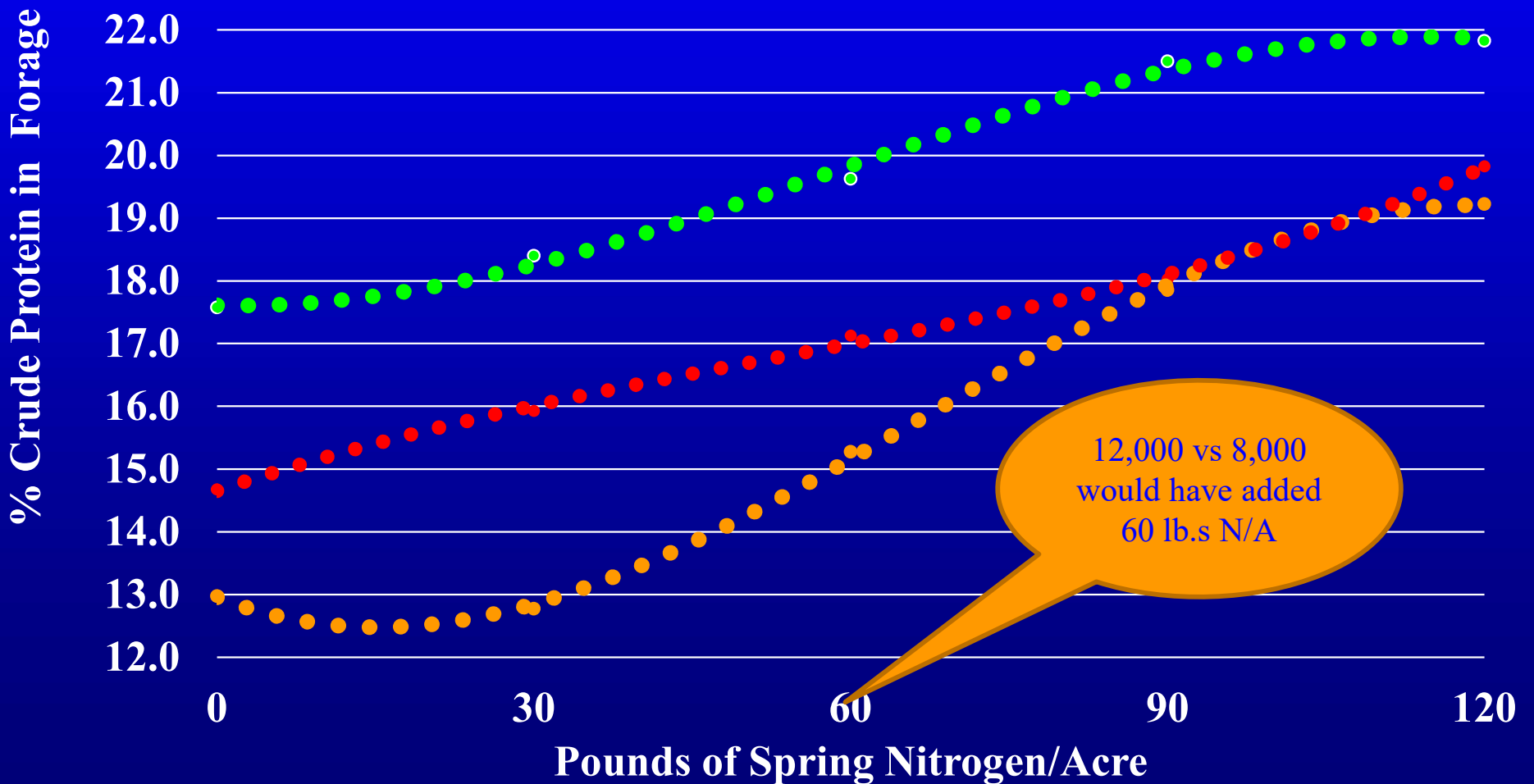
Zoske Manufacturing

www.bazookafarmstar.com

Cornell Cooperative Extension in Kosselaer Co.

Crude Protein x Manure x N rate

- Early Plant No Manure
- Preplant Manure Early Plant
- Early Plant Inject Manure Late



12,000 vs 8,000
would have added
60 lb.s N/A



**Winter Forage or
Intensive Managed
Grass
Inject manure in
November to
Freeze up**

**5,000 gal = 26 N organic
plus 75/Acre NH₄
\$101 Savings/A
Run 4 Deg instead of 6
<3 mph
Minimizes stone lift
15 inch spacing**



**We Do NOT Suggest
Topdress Manure
on stands in fall or spring**

We have had some horrible results from manure contamination in high sugar forage



Improves Structure Benefits Next Crop

Corn grain increased yield 4 – 7%

Soybeans 3yr avg. increased yield 8 – 15%

Nitrate in drainage water reduced 21-38%

Surface permeability in clay loam increased **7X!**

Double Crop System



**Manure
Till/Plant Annual**



**Manure
Till/Plant
Triticale**

**Shorter Season Corn, New Seedlings,
BMR Sorghum**



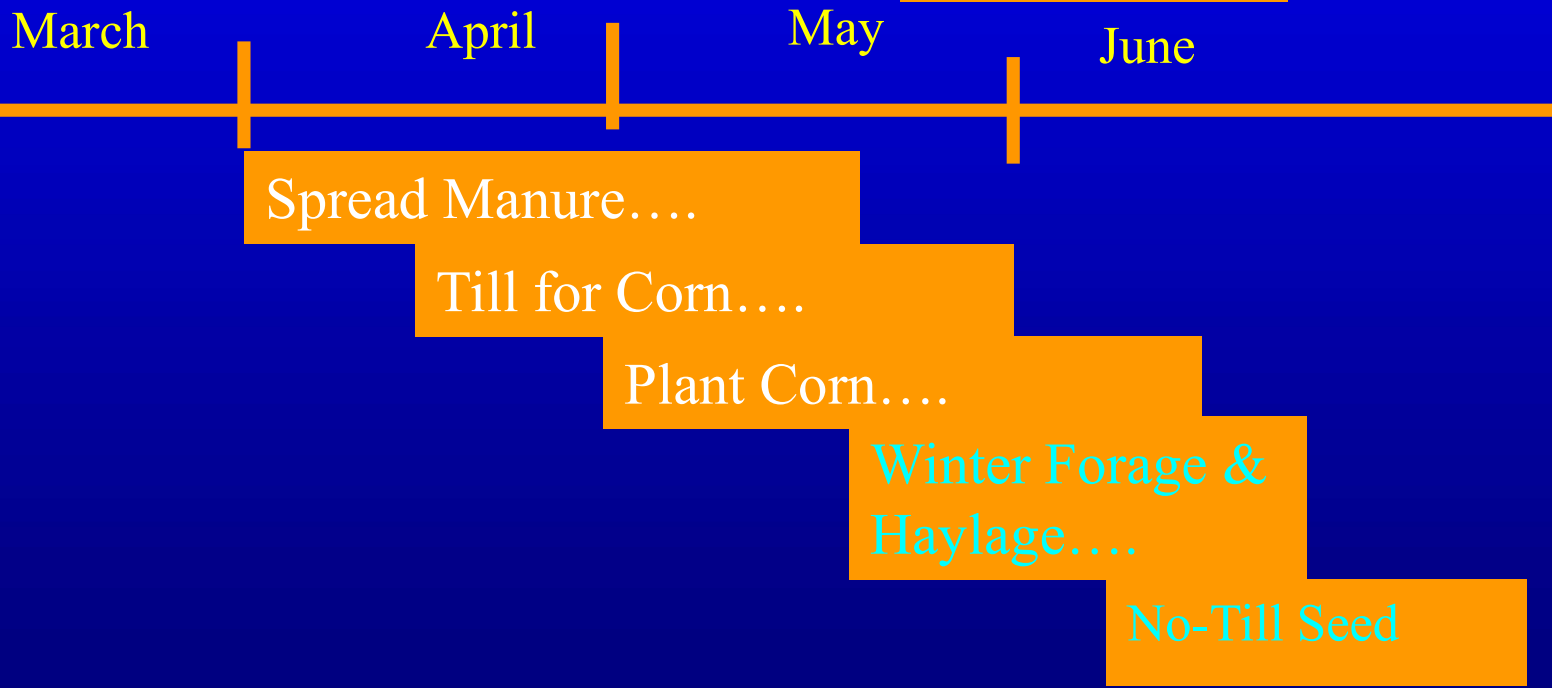
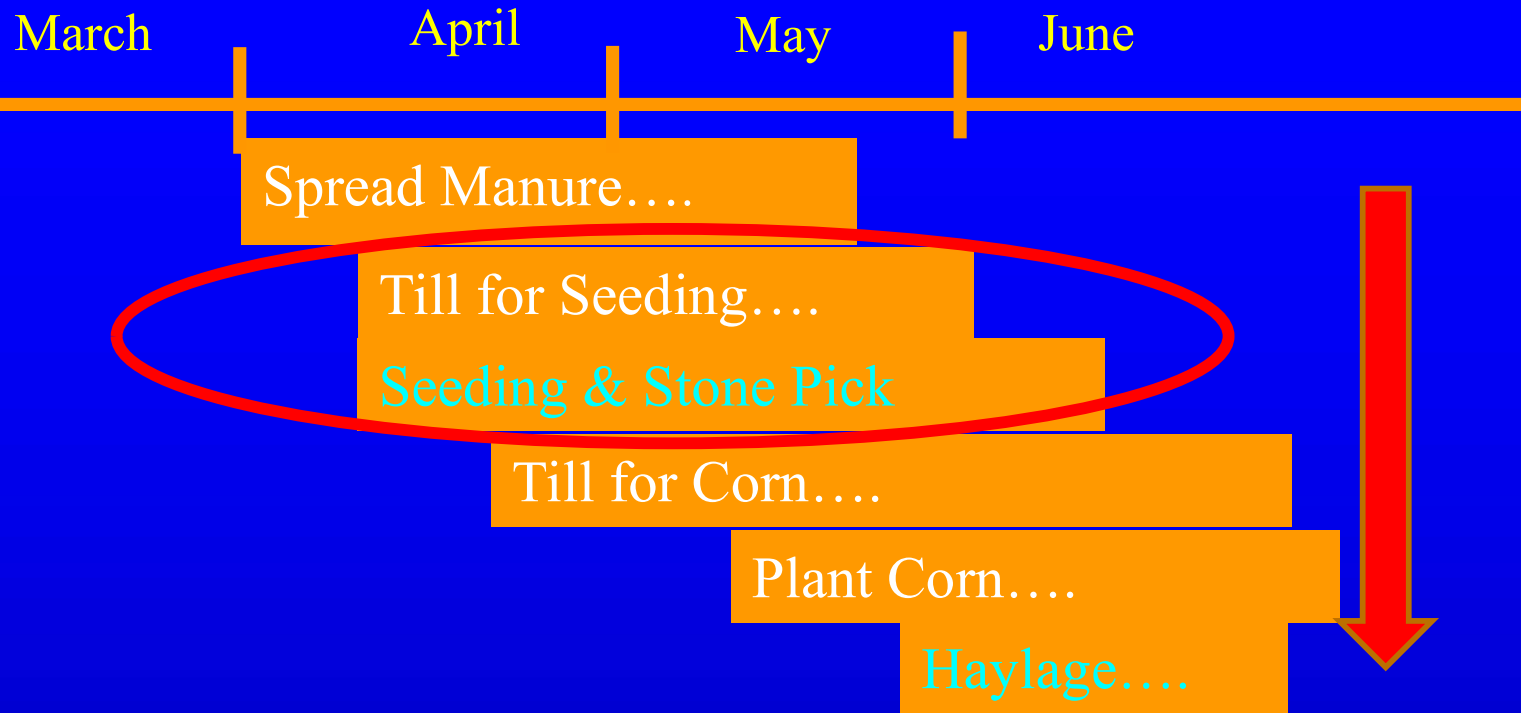


Strip Till or Zone Till Negates Allelopathy on Corn as significant (>50 mm) rainfall does



2: Tools of Rotation

- June Seeding
- After Corn Planting
- After Haylage
- Into Triticale Stubble



**New Seeding
Soybeans**





Alfalfa

Red Clover

Soybean

- Reduces Seeding Risk
- Increases Seeding Year Yield
- Stops Erosion Loss
- Inhibits Weeds
- Moves work load from April to early June
- Increases rotation



**NO-Till into
Triticale Stubble**

**Chisel Plow, Disked,
Rolled, Seeded**



Red Clover

New Look at an Old Crop

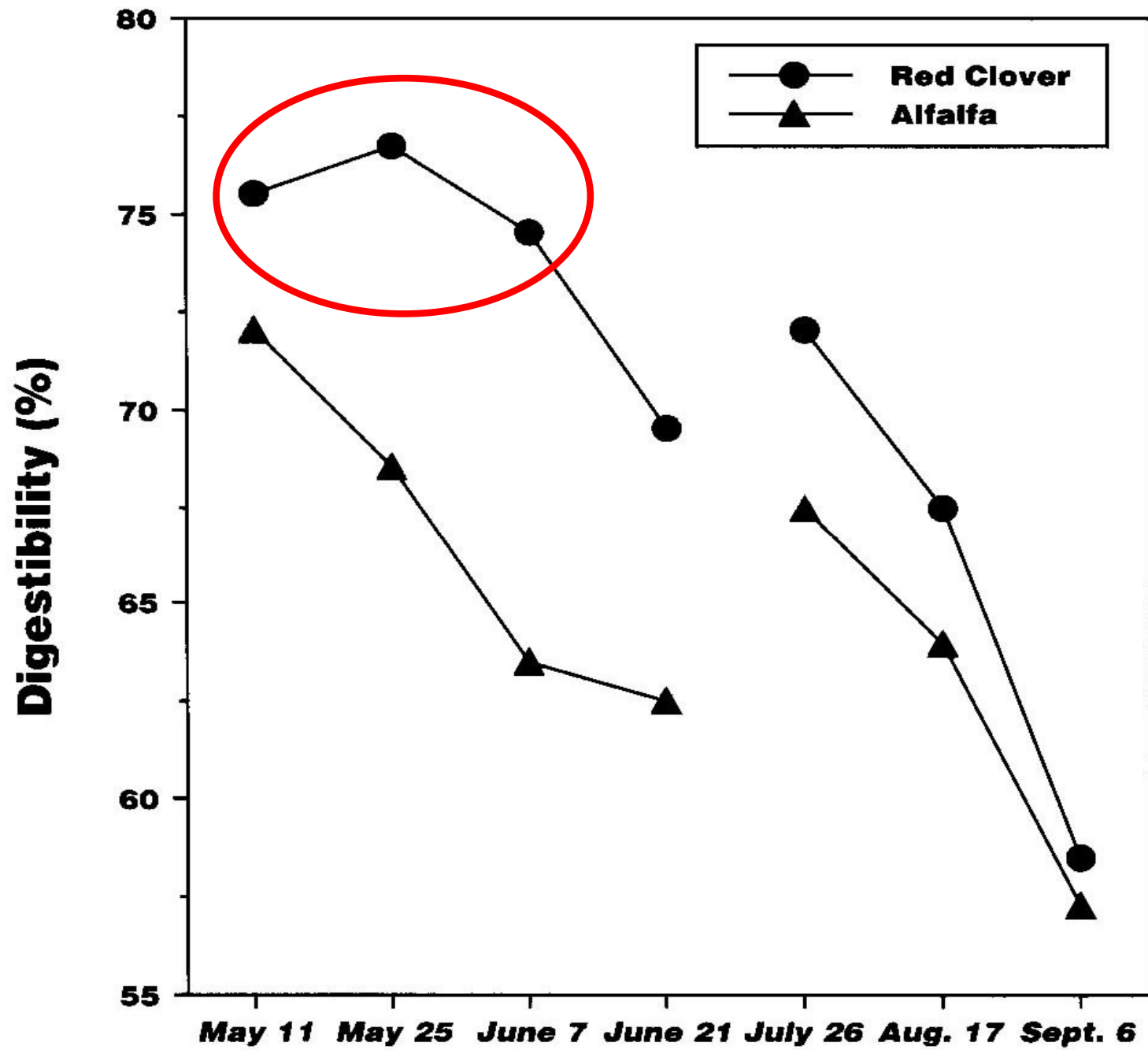
40% of Northern lake soils
Majority of soils of Jefferson Co.
Hudson Valley lake soils
Southern tier upland soils
75-85% of Delaware Co soils



Red Clover

Better Forage Than Alfalfa ?

- Clover in high forage (>65%) diets of high producing dairy cows has feed value equal or exceeding alfalfa (Dr. Hoffman, U of Wisconsin)
- Contains polyphenol oxidase enzymes; inhibit protein breakdown for more bypass protein (25-35%) than alfalfa (15-25%): lower cost rations
- inhibits hyper-ammonia rumen bacteria (Dr. Flythe, ARS) from breaking protein to inefficiently utilized ammonia, increasing the metabolizable energy for milk

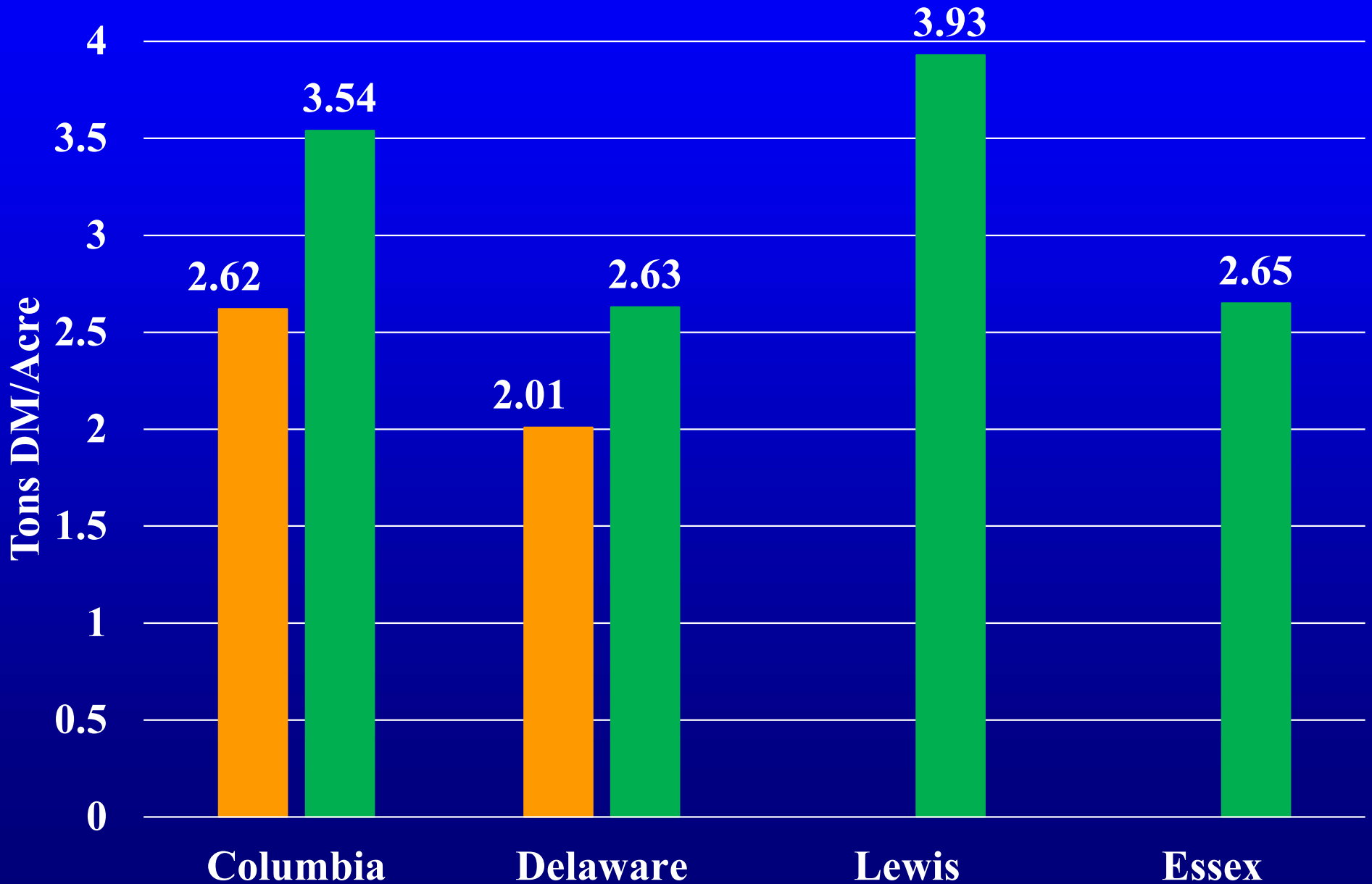


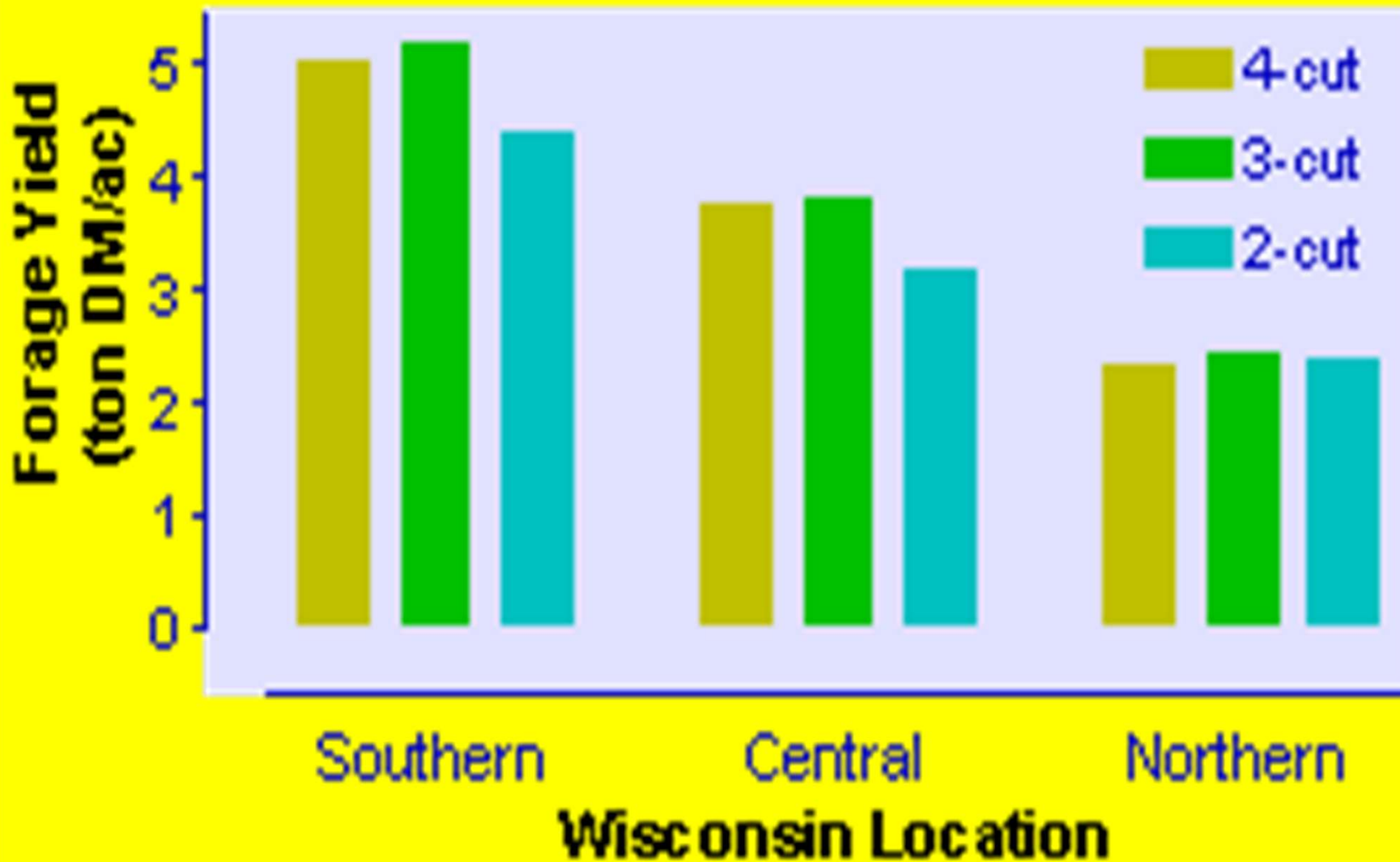
Date of 40 NDF by Regression Analysis					GDD ^{F41} to reach date of 40 NDF		Percent Clover GDD ^{F41} to reach 40 NDF was over Alfalfa GDD ^{F41} at 40 NDF	Date of 750 GDD ^{F41} for <u>predicted</u> 40 NDF alfalfa
	Alfalfa	R2	Clover	R2	Alfalfa	Clover		
Columbia	5-Jun	94.6	6-Jun	97.2	833	855	3%	30-May
Delaware	24-Jun	88	16-Jun	93.3	1000	847	-15%	11-Jun
Lewis	24-Jun	95.3	27-Jun	88.9	928	998	8%	16-Jun
Willsboro			24-Jun	90.2		997	-	15-Jun
All Sites	Determined by Regression Analysis:				901	923	2%	
			All Sites R ²		88.3	85.9		

Date of 40 NDF by Regression Analysis					Forage Height inches at date of 40 NDF	
	Alfalfa	R2	Clover	R2	Alfalfa	Clover
Columbia	5-Jun	94.6	6-Jun	97.2	35	34
Delaware	24-Jun	88	16-Jun	93.3	31	28
Lewis	24-Jun	95.3	27-Jun	88.9	36	33
Willsboro			24-Jun	90.2		26
All Sites	Determined by Regression Analysis:				35	33
	All Sites R ²				74.8	63.1

1st Cut Yield DM T/A @ 40 NDF Harvest

■ Alfalfa ■ Clover





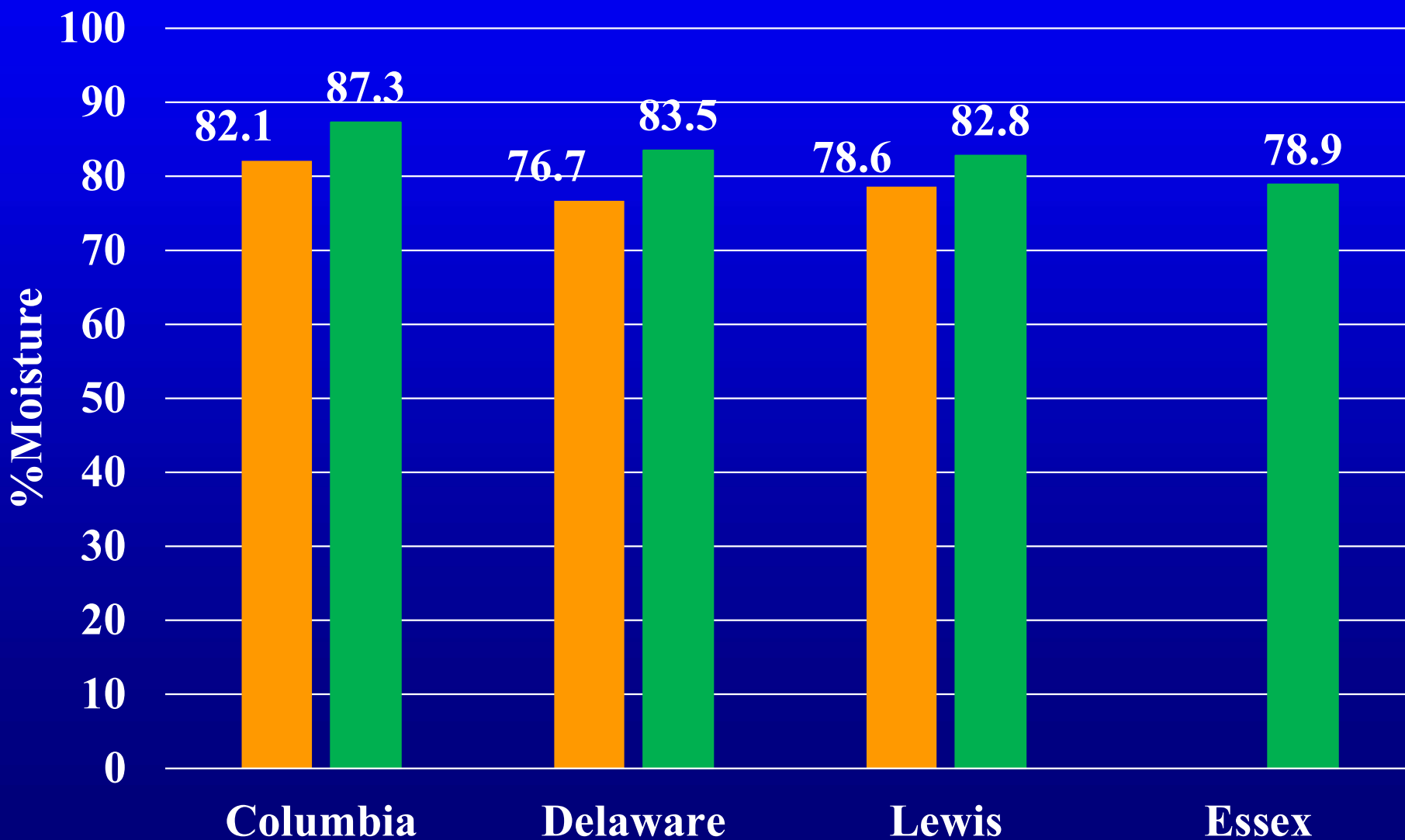
25% Reduction in Machinery Cost

We Don't Grow
Red Clover
Because it
Does NOT Dry

Whole Plant Moisture at Optimum Harvest Date

Average 5.4% more moisture

■ Alfalfa ■ Clover

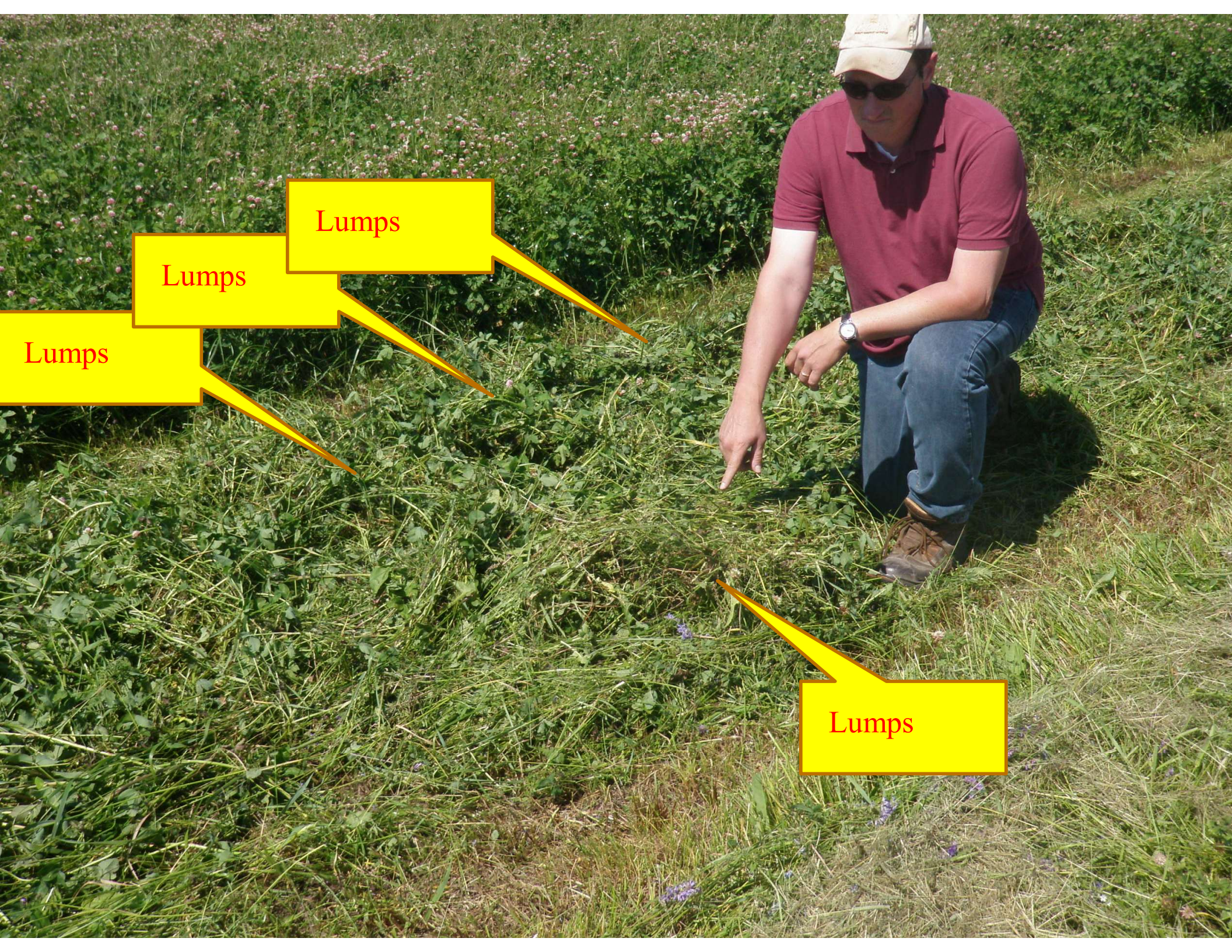


Is it the
Red Clover

or

how we manage it?

**What About
Wide Swath
for Red Clover?**



Lumps

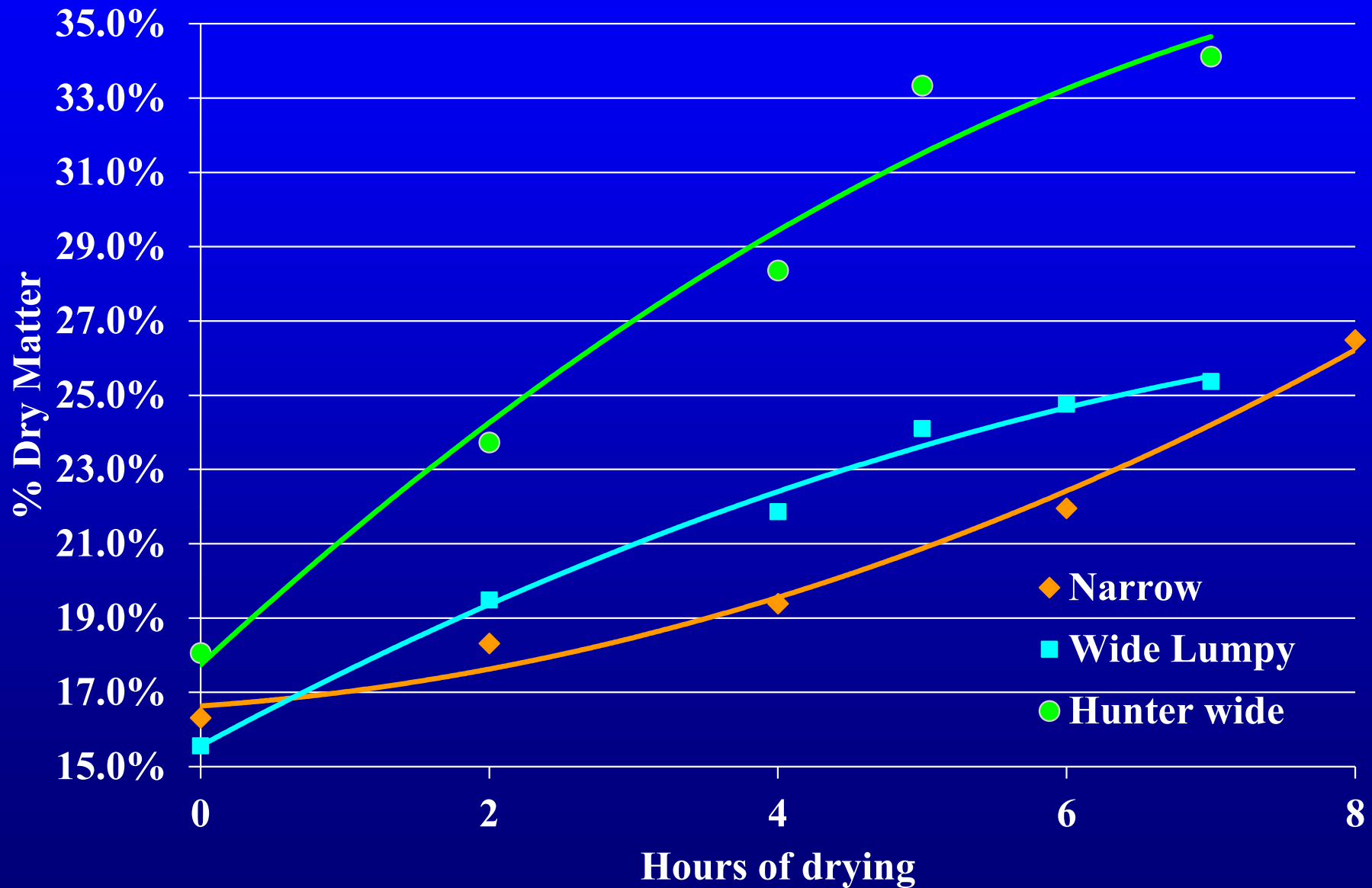
Lumps

Lumps

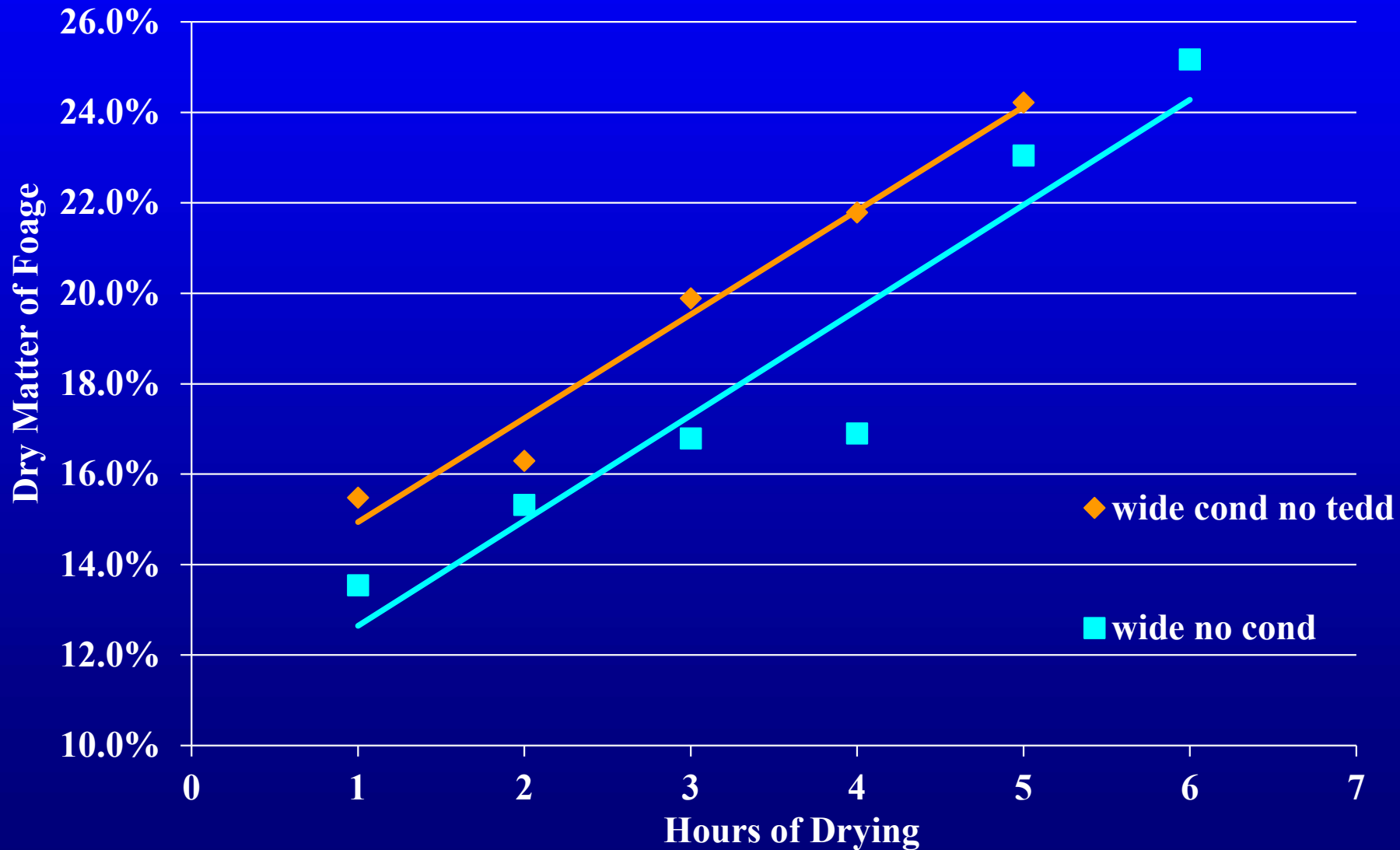
Lumps



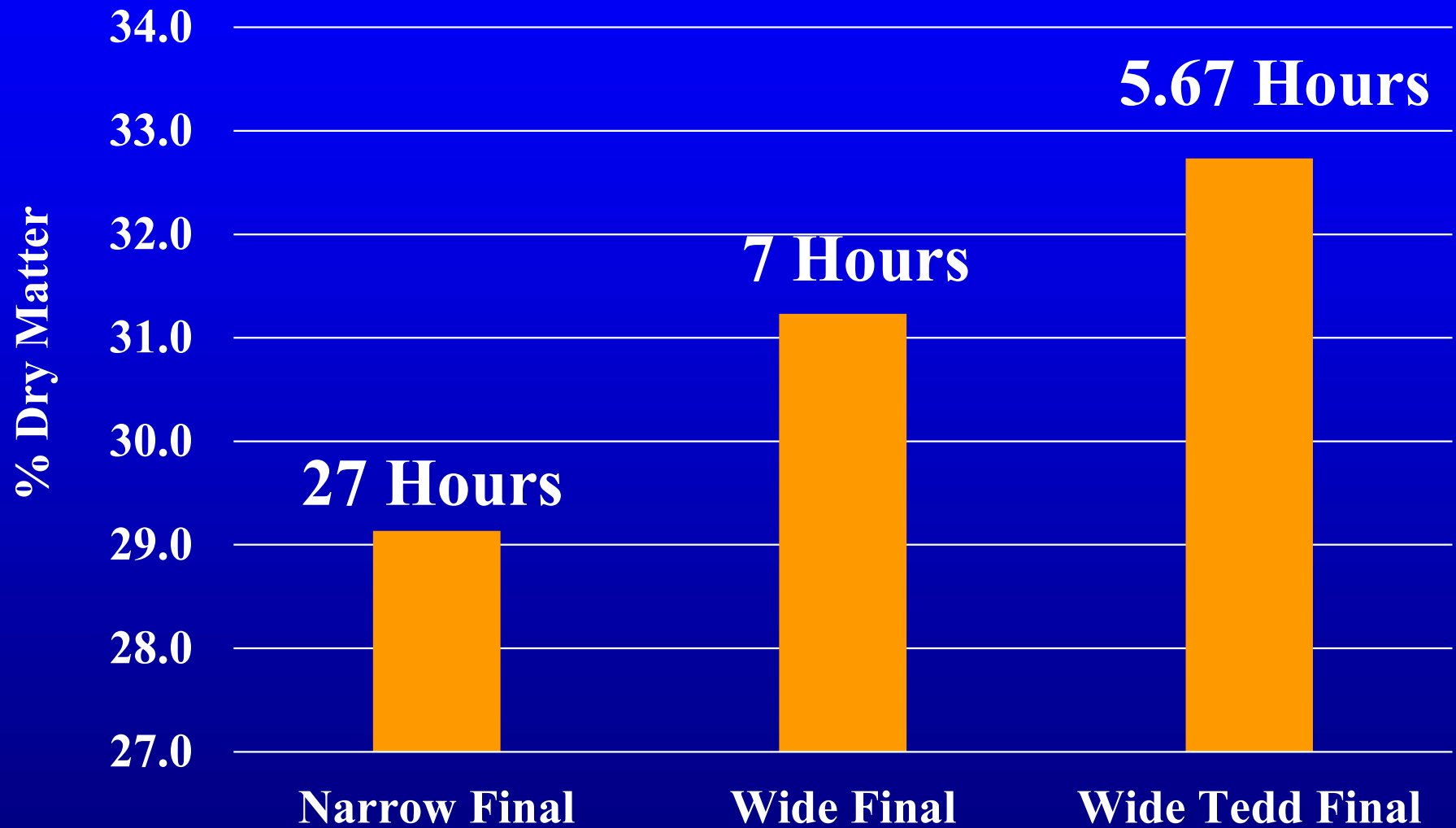
Drying Rate Lump vs Uniform



Is Conditioning Helpful?



2013 Tests: Final DM and Drying Hours



Swaths only dry on top $\frac{3}{4}$ inch

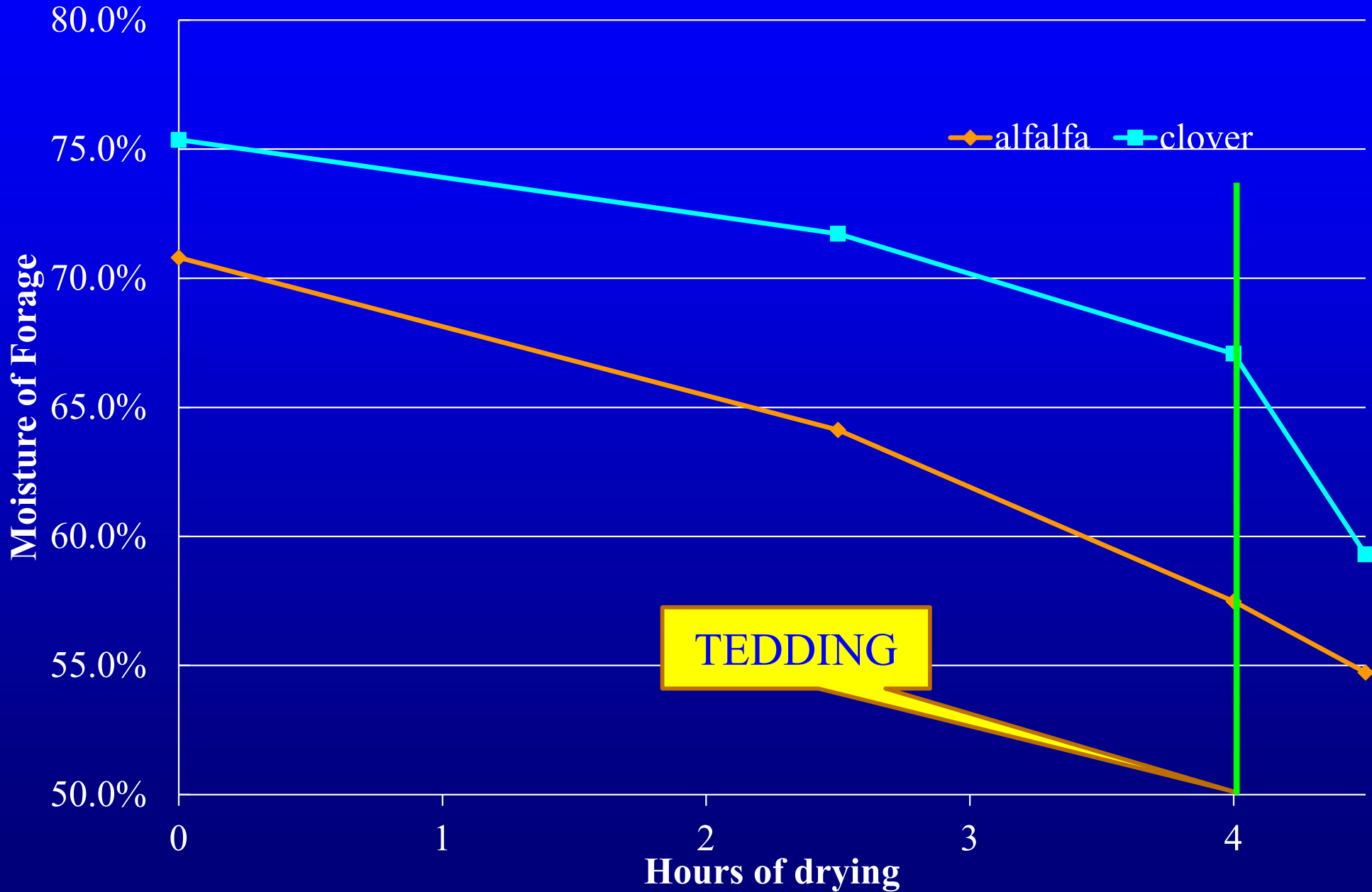


Top after 2 hr drying



Immediately under top

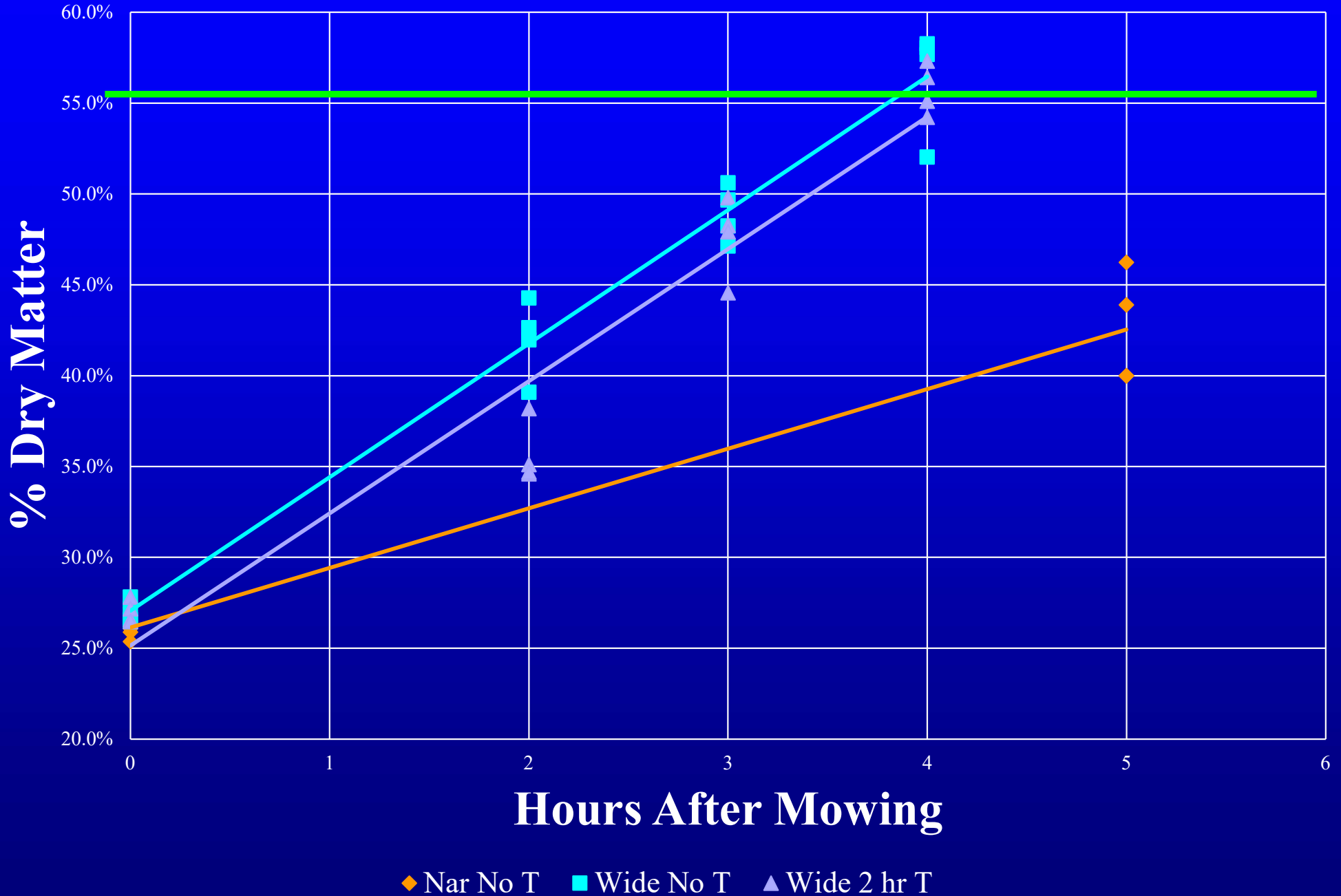
Moisture Reduction of Red Clover vs Alfalfa





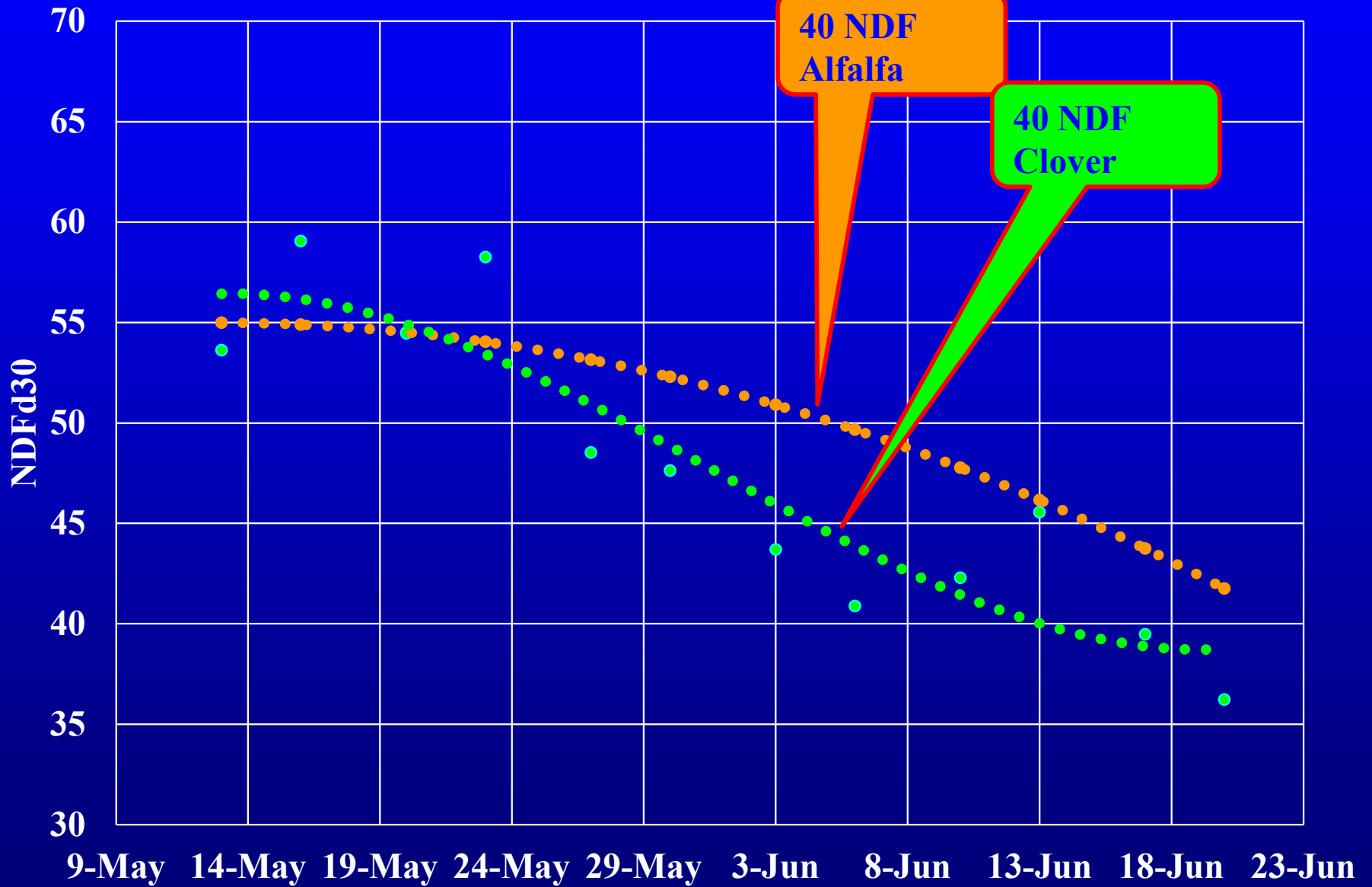
NY *farm viability*
INSTITUTE

2nd Cut Red Clover – Delhi, NY



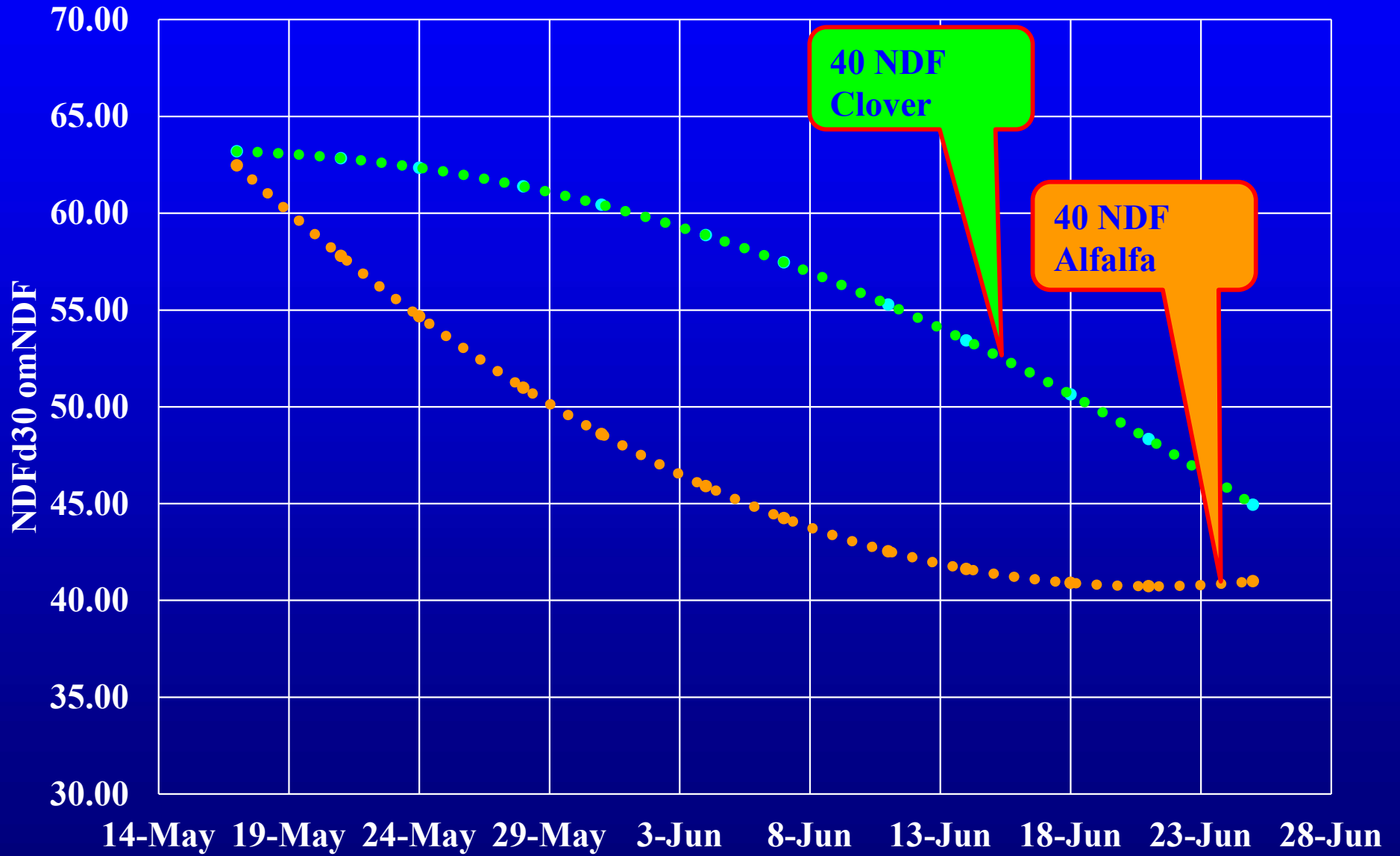
Columbia NDFd30 omNDF

● Alfalfa ● Clover



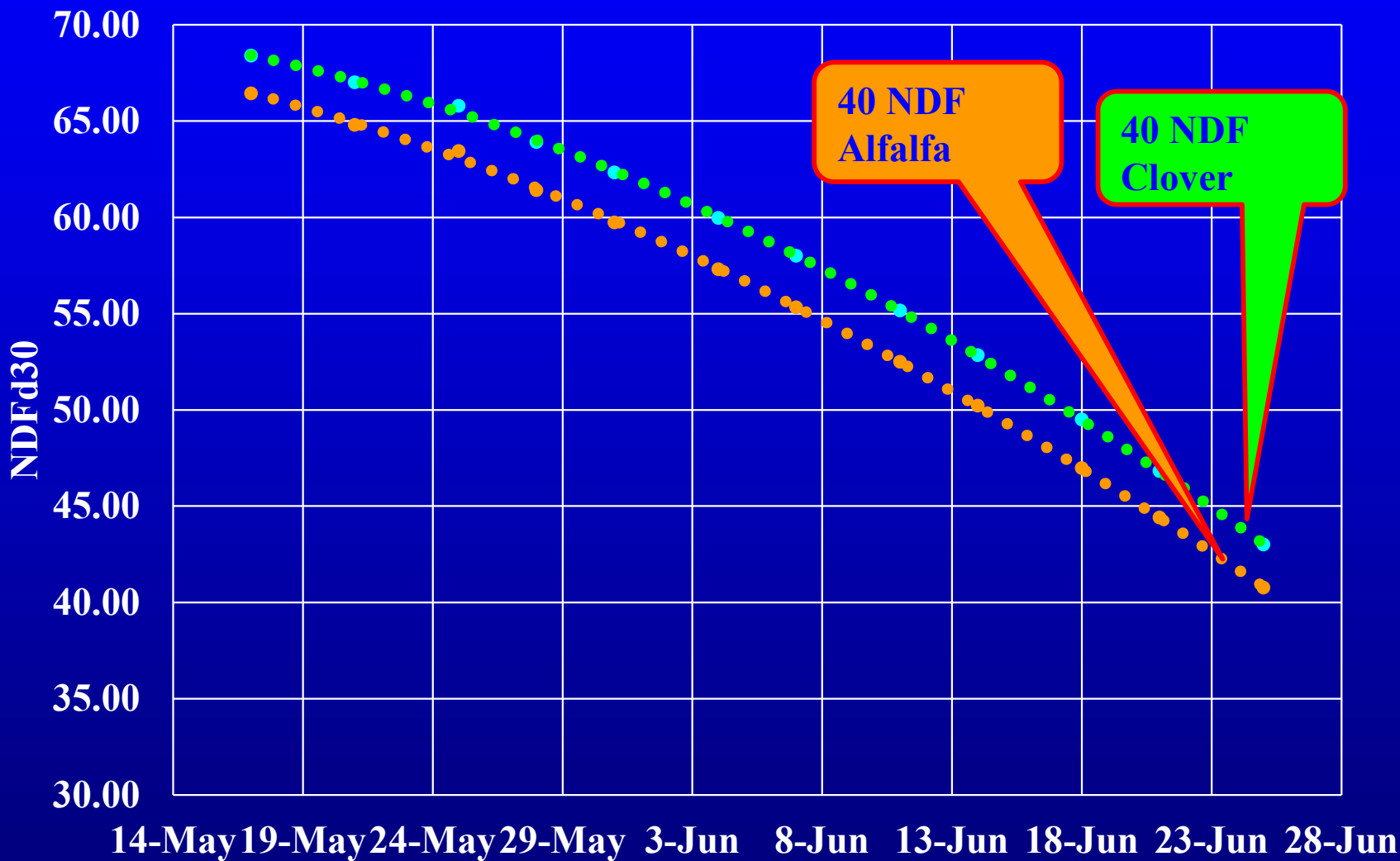
Delaware NDFd30 omNDF

● Alfalfa ● Clover



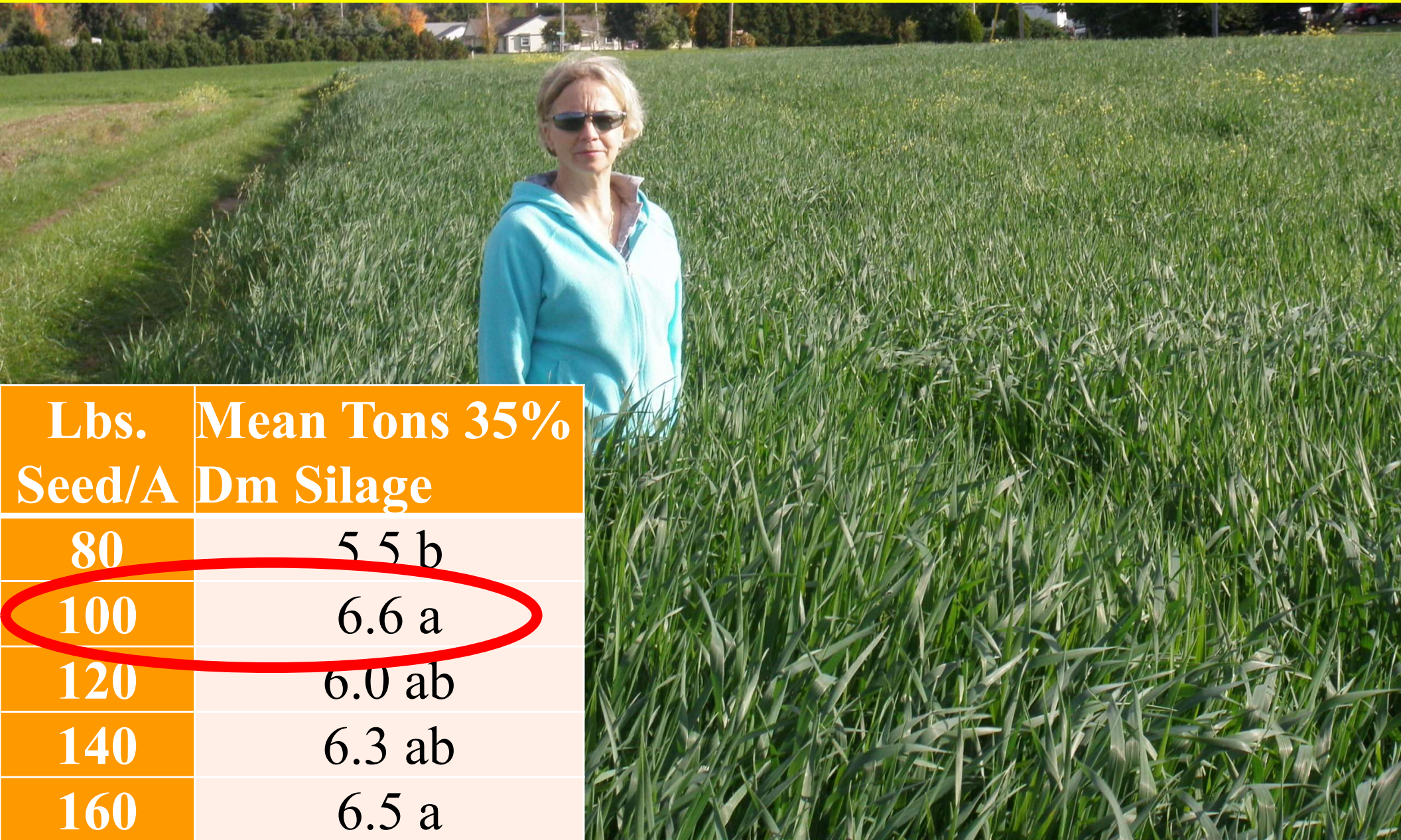
Lewis NDFd30 omNDF

● Alfalfa ● Clover



Pounds Milk Potential Dr. Larry Chase CNCPS 6.5 analysis	Metabolizable Energy ME	Metabolizable Protein MP
Warm early site	Lbs. of Milk	Lbs. of Milk
Alfalfa @40 NDF on June 5	84.0	84.1
Clover @40 NDF on June 6	85.3	80.3
Potential Milk Difference Clover vs Alfalfa	+1.3	-3.8
High elevation, cool site		
Alfalfa @40 NDF on June 24	82.0	82.7
Clover @40 NDF on June 16	86.4	84.5
Potential Milk Difference Clover vs Alfalfa	+4.4	+1.8
Northern, cool, lake effect cloudy site		
Alfalfa @40 NDF on June 24	83.3	82.3
Clover @40 NDF on June 27	83.2	81.5
Potential Milk Difference Clover vs Alfalfa	-0.1	-0.8

Oats for Forage : August 1 Planted October 1 Harvested



Lbs. Seed/A	Mean Tons 35% Dm Silage
80	5.5 b
100	6.6 a
120	6.0 ab
140	6.3 ab
160	6.5 a

Fall Oats: Manured vs Not

Tons DM/A

2.50
2.00
1.50
1.00
0.50
0.00

**+4,000 lbs
Milk/Ton**



manured

control

Spring Oats Fall Planted (Aug 1) Harvested October 1



Fall spring oats, fresh forage, dry matter basis

Crude Protein	17- 20% (N & S)
IVTD 24	85 – 90%
Simple Sugars	>20%
Kd/hr	8 – 12 (not a misprint)

Seeding into Dead Oat Residue



A close-up photograph of a lush green field of triticale and oat plants. The plants are tall and dense, with long, narrow leaves. A wooden ruler is placed vertically in the center of the field, showing measurements in inches and centimeters. The ruler is positioned between the plants, providing a sense of scale. The background is a soft-focus field of similar plants under a bright sky.

End of Summer Last Chance Crop

80 lb Triticale + 100 lbs. Oats

August 1, Oats + Triticale

Harvested by October 1

Winter Triticale harvested in May



**August 1, Oats + Triticale
Harvested October**

Winter Triticale harvested in May



4 inch minimum
cutter bar height



Triticale in Spring after double
planted with August Oats

60 lbs. N/A plus Sulfur
in fall after oat harvest



Triticale in Spring after double
planted with August Oats



Optimize and Maximize the Crops You Have

**Cool season grasses have a growth
spurt in fall**

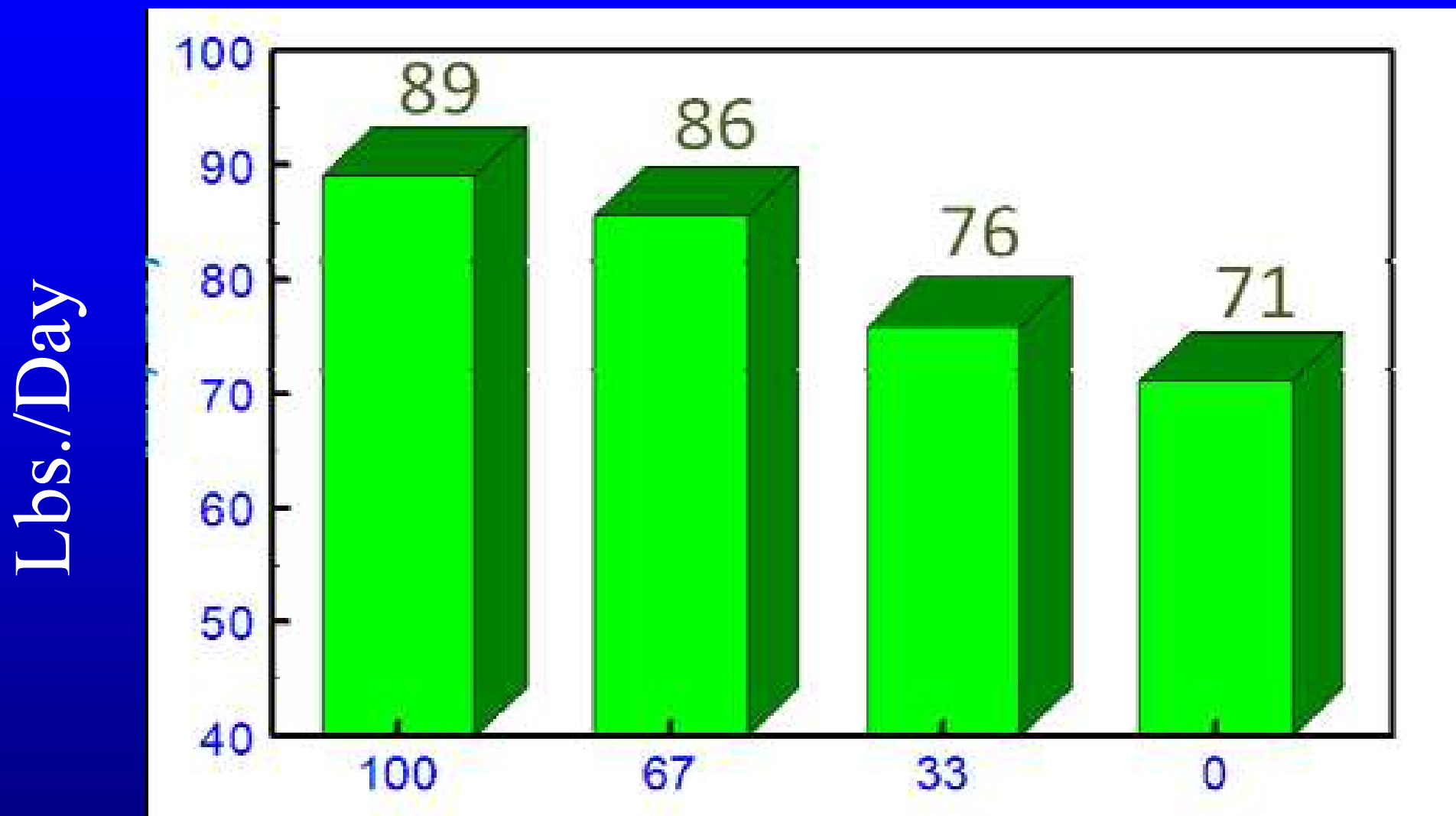
**Feeding it with Nitrogen and
Sulfur will maximize yield**

Maximize Cool Season Grass Production

- Nitrogen (plus Sulfur) **TRIPLED** the total yearly yields on perennial grasses
- Crude protein jumped from 15% up to 21%.
- *This is the first place to put your money this year especially if you are short on forage!*

**2 Ton DM @ 18% CP =
120 lbs N & 20 Lbs. Sulfur**

Daily Milk Production by Diet



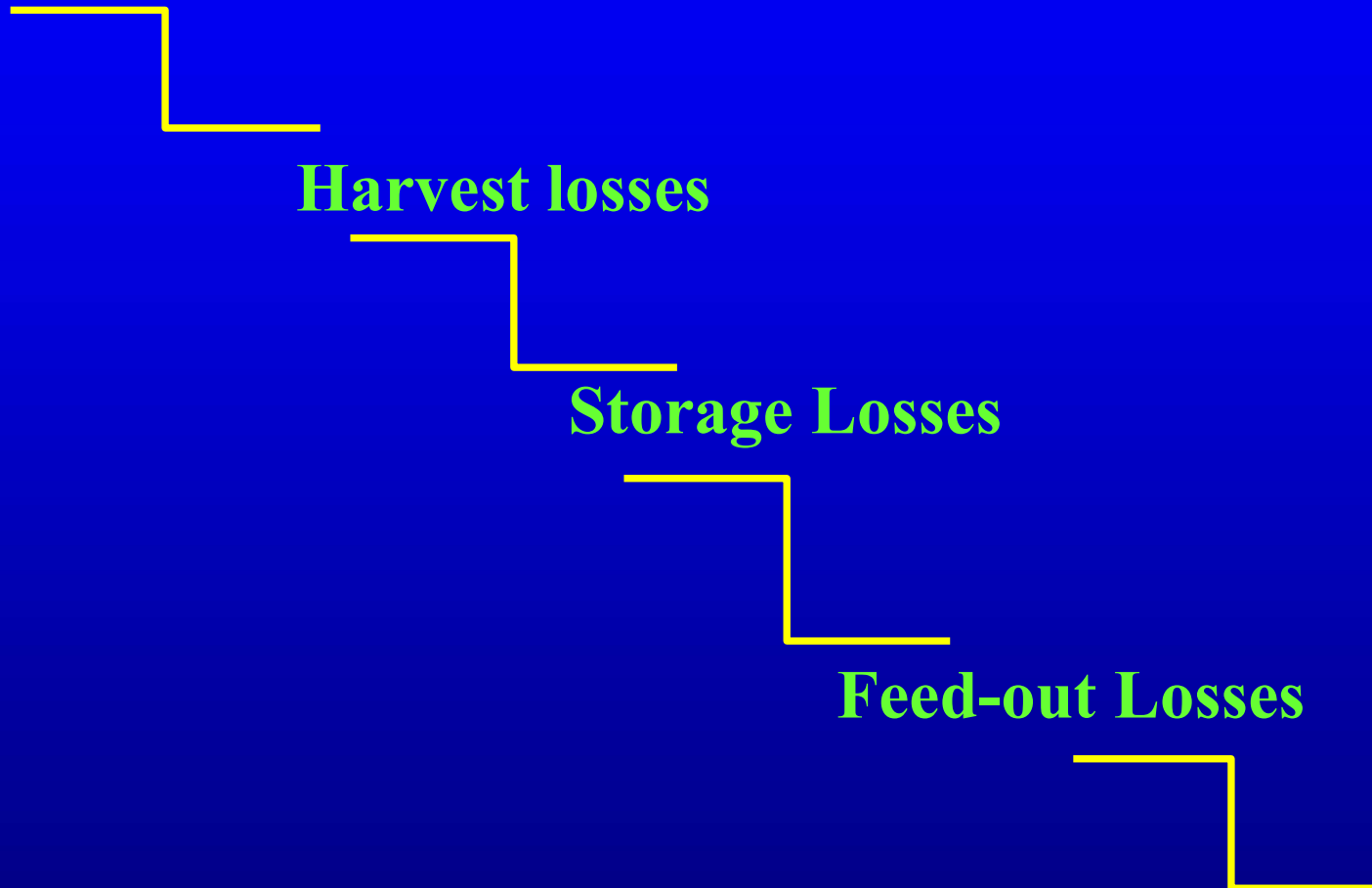
%Forage in Ration that is Grass

Rate of digestion was higher for alfalfa (0.076/hour) than fescue (0.045/hour).
Extent of fescue digestion was considerably higher than that of alfalfa.

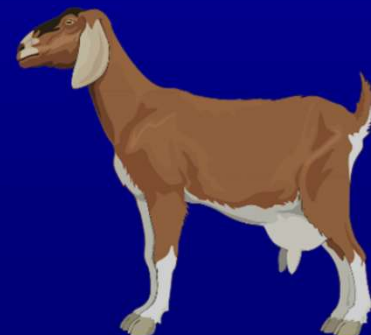
Digestibility of NDF is over 10 percentage units higher for grass silage over legume silage, at either 30 or 48 hours.

Where do You Start,

At Field Time of Harvest



What reaches the Mouth of the Animal



Grass Fields Should be Mostly Green When Cutting is Removed





< than 2 inch

Minimum Tillage Haylage

Is the cutter bar removing the alfalfa regrowth when you start to mow



3.5 Inch

2.5 Inch

1.5 Inch

Photo Sid Bosworth, UVM

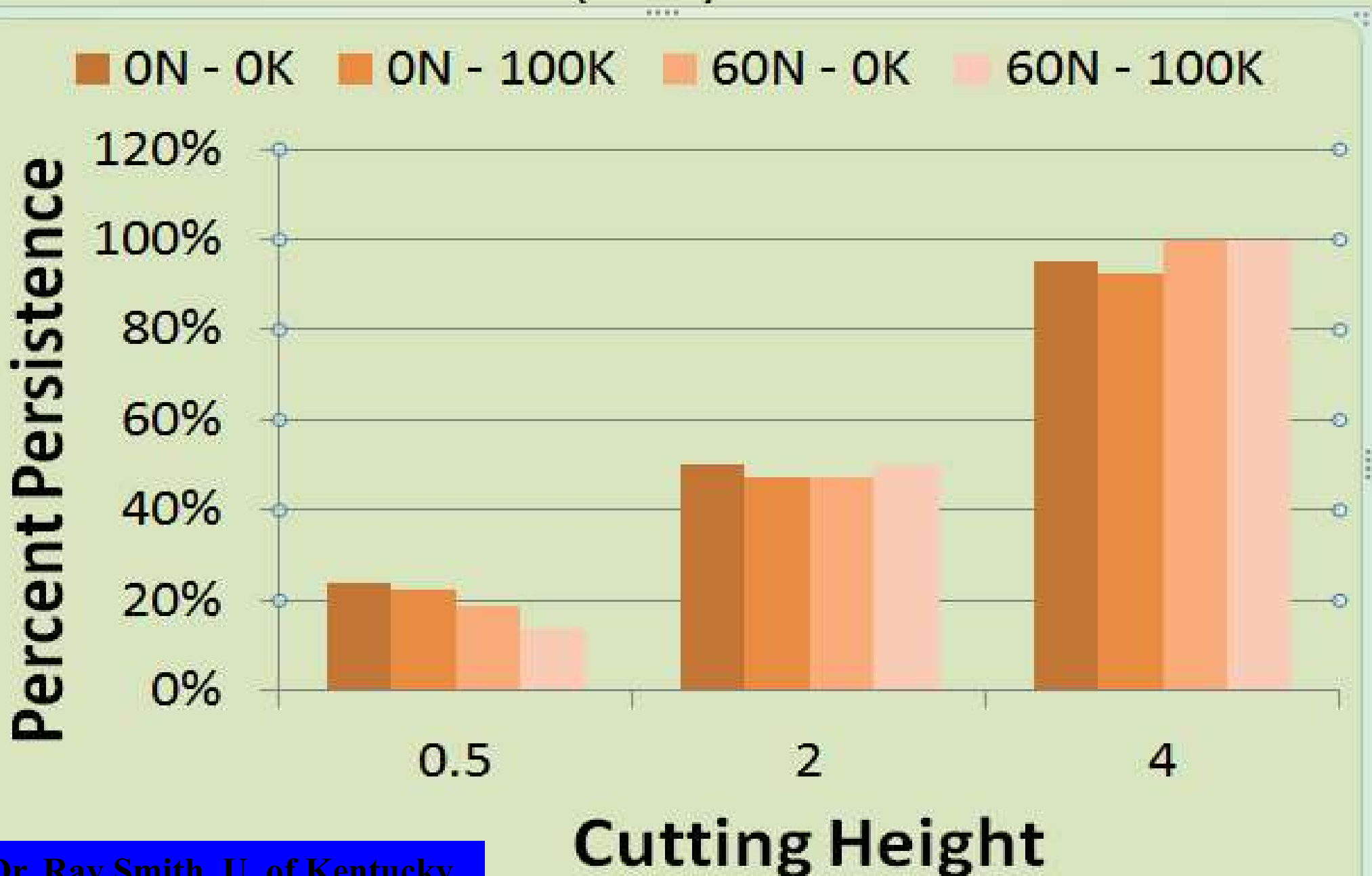
Major Impact on Stand Life/Profit



Dr. Ray Smith, U. of Kentucky

Figure 4. Stand persistence after fifth harvest.

LSD (0.05) = 8%



Miner Institute

- Greenhouse experiment at 2 inch cut height
- Reeds Canarygrass : Completely killed
- Orchardgrass : drastically reduced rate of re-growth
- 4 inch cut height
- Both grew fine
- Reeds Canarygrass was 16 inches in 21 days



Orchardgrass after two years of being cut with a 2-inch stubble.



Orchardgrass after two years of being cut with a 4-inch stubble.

(Brink, USDA- Dairy/Forage Research Lab, 2010)

Sid Bosworth, UVM

Grass Fields Should be Mostly Green When Cutting is Removed



Ash: Sum of

- Original mineral in plant
- Original dirt on plant (splash, flooding)
- Dirt incorporated from disk knives tilling the soil
- Dirt Incorporated from knife updraft
- Dirt incorporated from tedder/merger/rake

So What! It is only a little dirt



Ash Increase from 9% to 11%

**50:50 mix of corn silage and a alfalfa silage
(17 CP/43 NDF) 60% forage (Dr. Sniffin).**

Tilted Knives and Mowing Close

9% vs 11% Ash

- you lose 1.9 lbs of milk compared to the same forage without that much ash
- in 305 days with 1000 cows is 5795 cwt @ \$23/cwt = \$133,285
- It can be made up by more grain, at a price and by money leaving your farm unnecessarily.

9% vs 11% Ash +2%

9 – 13% is average range Alfalfa Silage +4%

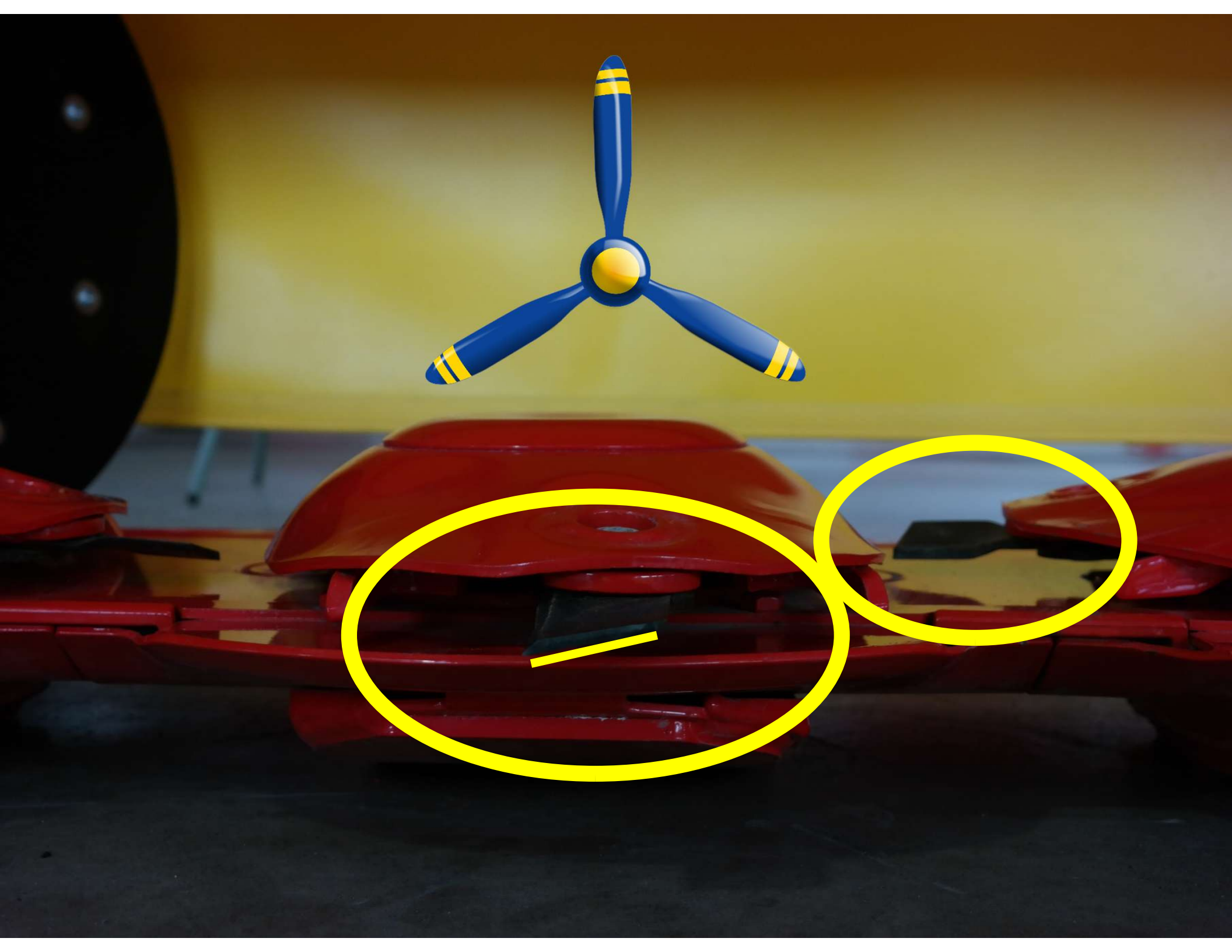
Mostly Legume Silage 8.5 – 12 +3.5%

Mostly Grass 7 – 11 +4

Triticale Silage 7.7 – 14.4 +6.7

Knife and Cutter Drum Design

Designed to lift and cut all down
forage



High Sugar – 20% at harvest

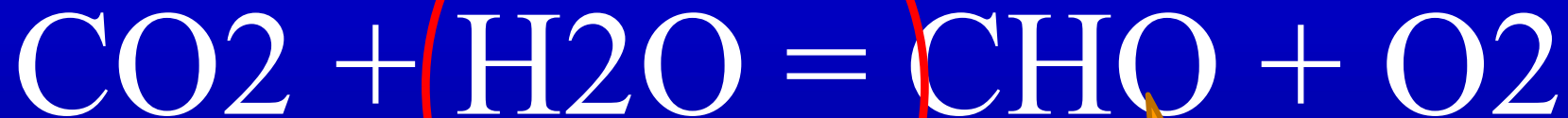
High Yielding : 6 – 14 Tons/Acre in one cut

**Wide Swath Same Day Haylage
is Critical to Capture Forage
Quality**

Biology: Photosynthetic Drying



Swath In Windrow or at Night



In the presence of
Sunshine



Increasing Energy In
Forage





Deflector down



Deflector Up



NEW HOLLAND

⚠ DANGER
Read the operator's manual.
Always use proper safety procedures.
Always wear your seat belt.
Always use proper tie-off technique.
Always use proper fall protection.
Always use proper fall arrest technique.
Always use proper fall rescue technique.



DISCBINE

NEW HOLLAND
1411

Tedding Speeds Drying



Tedder Lumps Do NOT Dry



Tedder Lump – Fast forward speed



Mergers run to fast for material or run to close to the ground – vacuums everything up.



Steve Adsmond, PAS
Richhart Consulting



Wide Swath Dries 3X Faster

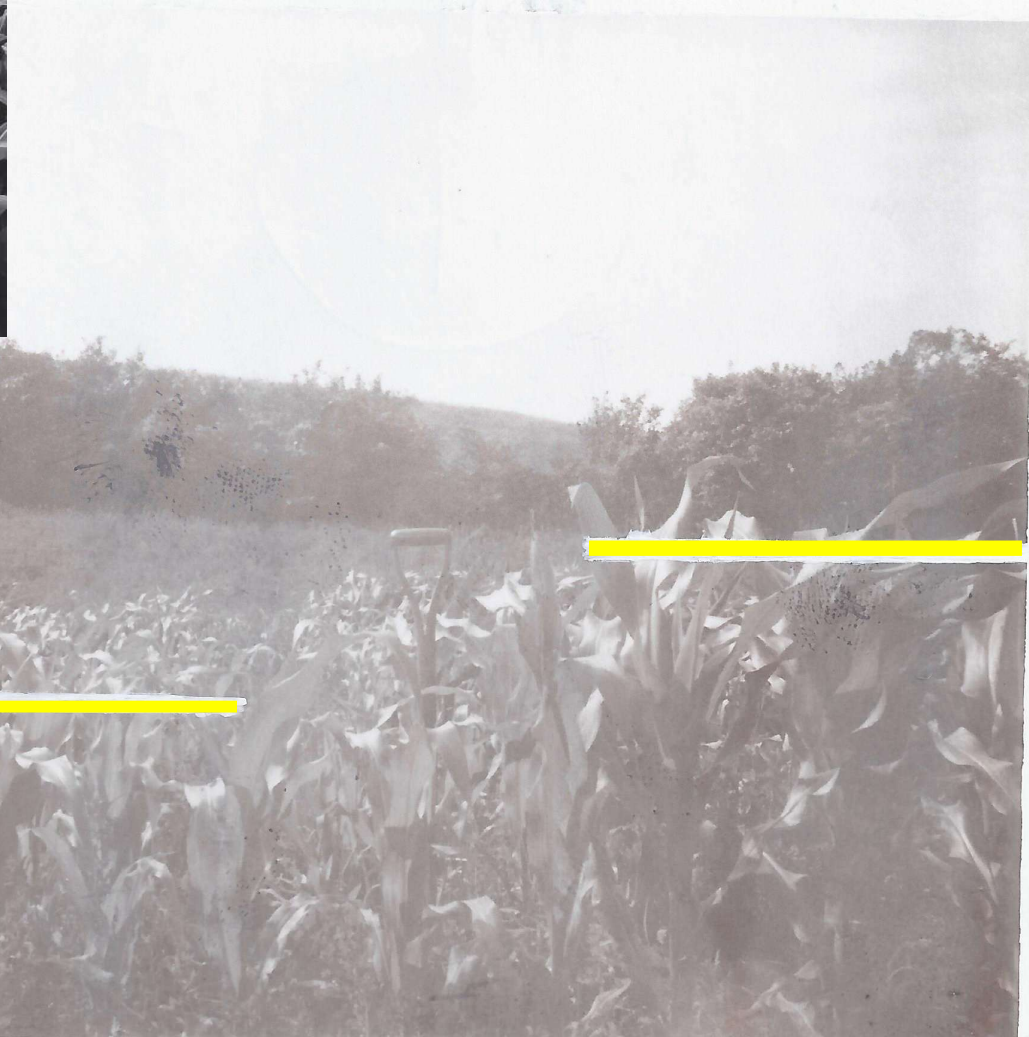
Caution: it can get Too Dry



Merger Controls Moisture

Short Season Corn
Planted No-Till Early,
Harvested as Mature
Corn Silage August 1

Fall (Winter) Kill vs Spring Kill



**17% more
yield**

A photograph of a cornfield with rows of young corn plants. In the background, there is a white house with a grey roof, surrounded by green trees and a grassy lawn. The sky is overcast with grey clouds.

1st Corn Planted - Early April?

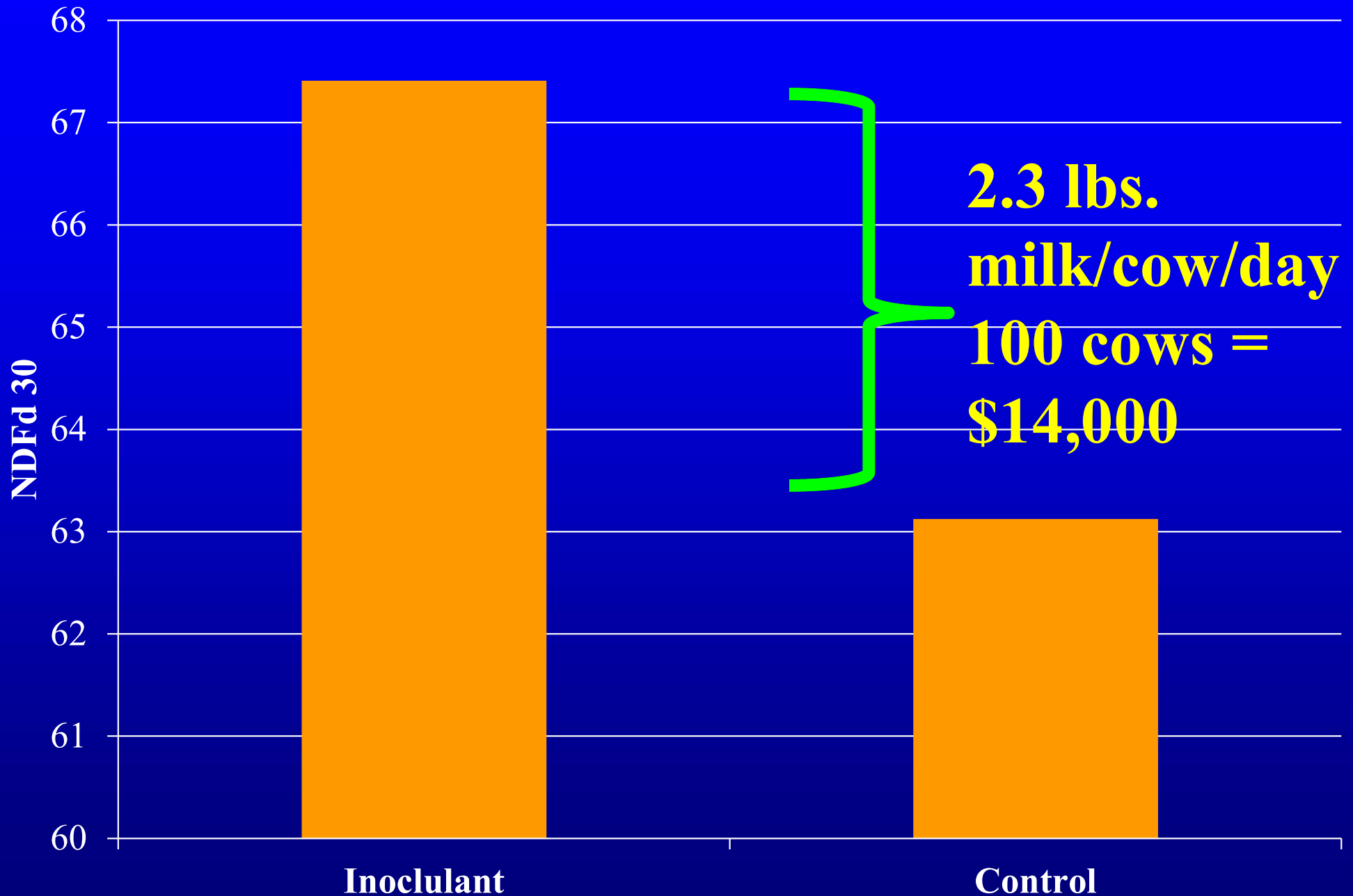


Harvested First Week of August

21.3 Tons 35% DM Silage

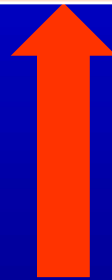
No-Till Alfalfa/Grass Seeding After

BMR Sorghum NDFd 30 With/without Inoculant



USE AN INOCULANT!!!

	NDFd 30	Lignin/NDF
Inoculant 1	67.05 a	7.49 c
Inoculant 2	67.78 a	7.87 b
No Inoculant	63.13 b	8.25 a

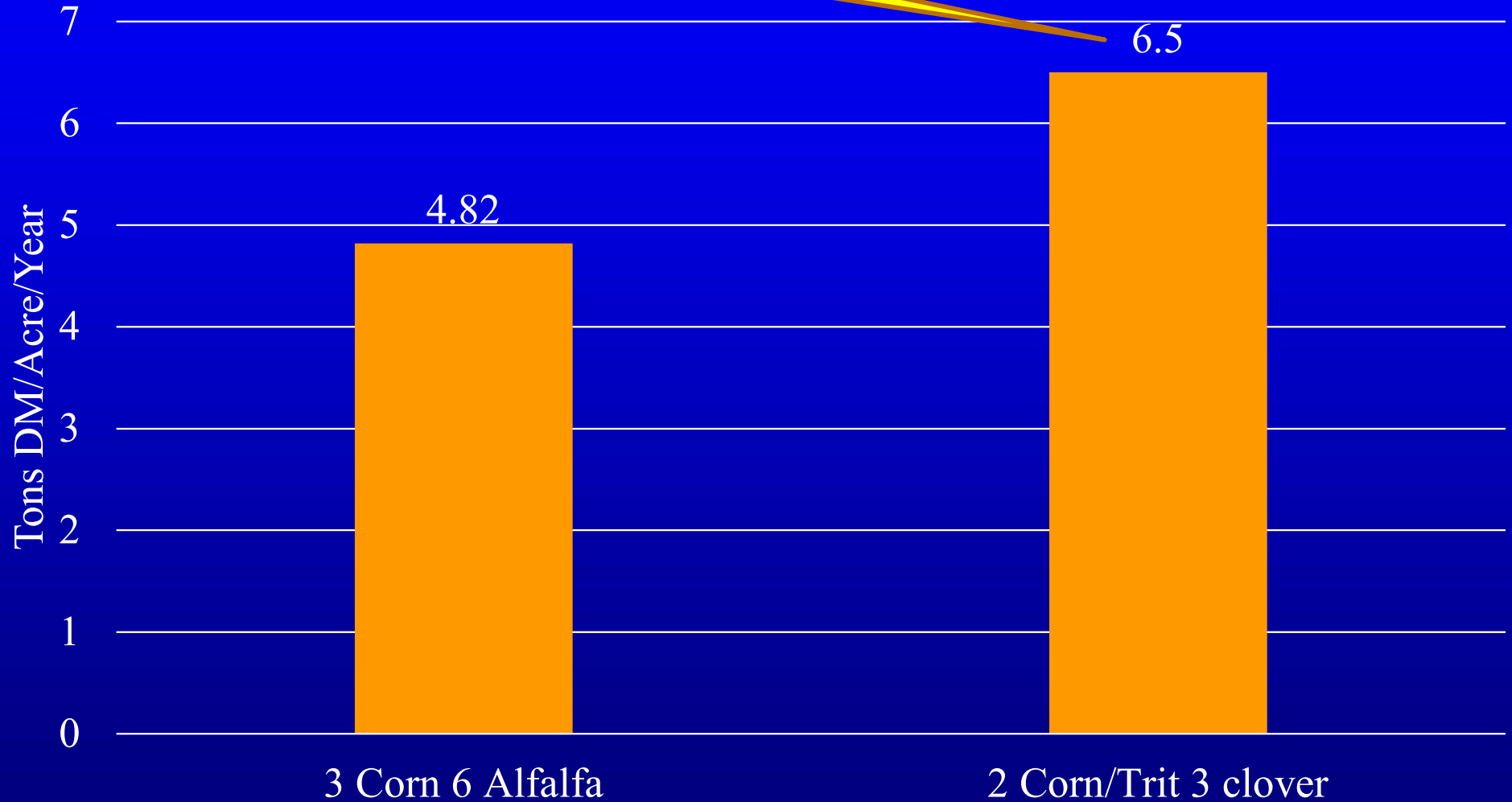


= to 2.3 pounds of milk/cow/day

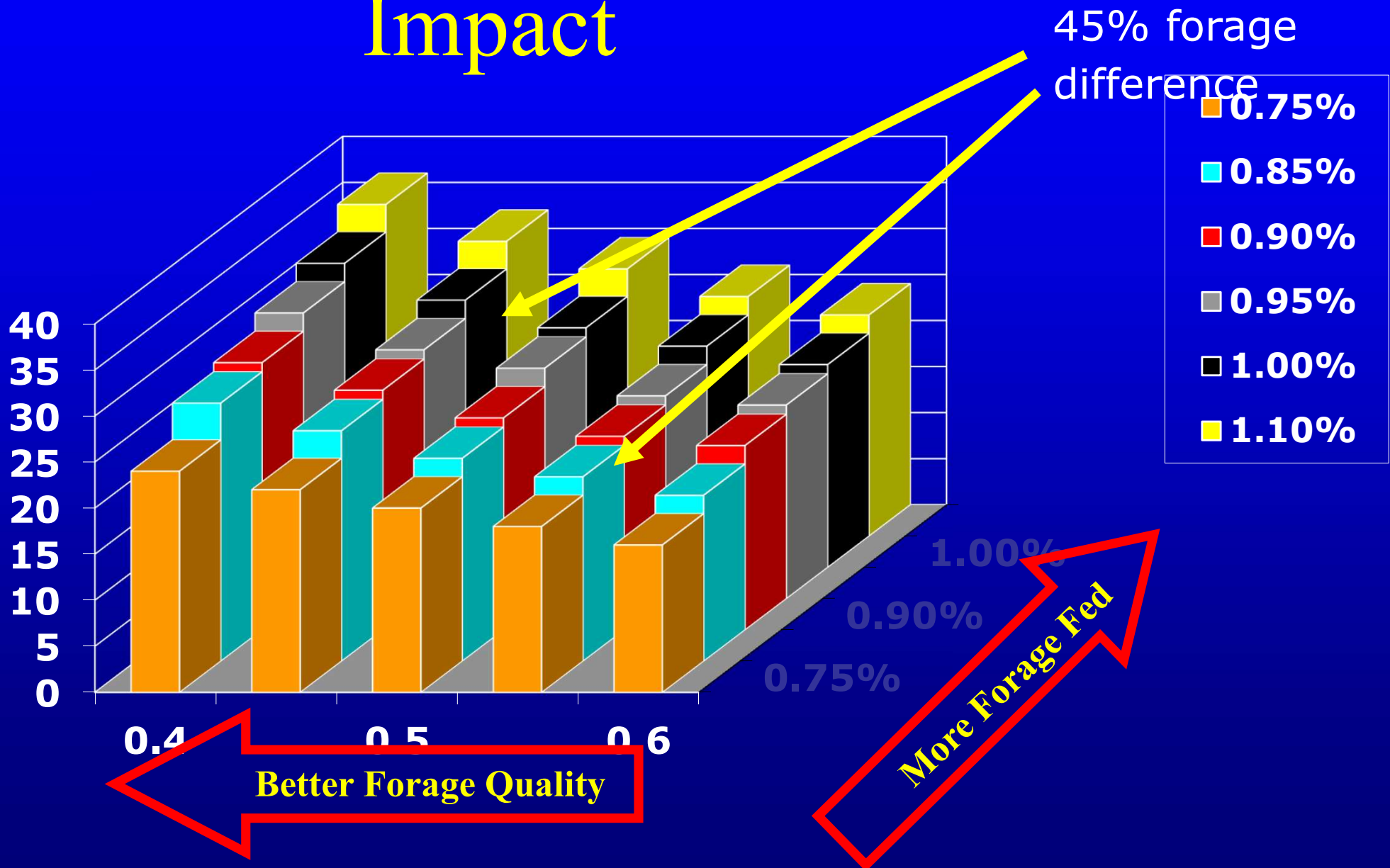
100 Cows @ 305 day lactation @ \$23/cwt - \$16,134

35% Yield Increase

Tons DM/Acre/Year



Quality & Quantity Impact



On Farm High Forage Impacts

- increased butterfat (more money for your milk)
- reduced cost of producing that milk
- improved herd health which has reduced culling
- Heifers are all cost – no return until milked 2 years. Reduced culling reduced number of heifers = less your cost to produce milk.
- **Less metabolic disorders; less acidosis**
- **Fewer foot problems**
- **Lower vet costs**
- **Greater IOFC: ~30% increase**

Benefits of High Forage Diets:
Measured in 14 Case Study Farms
(Chase, 2012)

Advanced Ag Systems LLC

< Open Accounts!

A photograph of a farm scene. In the foreground, a person in a blue jacket and white pants stands on a grassy area with fallen yellow leaves. A paved road runs horizontally across the middle ground. In the background, there is a large white barn with a silver silo, a smaller arched metal structure, and a utility pole with power lines. A vibrant rainbow arches across the sky above the buildings. The sky is dark and cloudy.

Questions?

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