Adaptive High Stock Density Grazing

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John Zinn, USDA NRCS


105

Importance of Grass

- Covers 40% of Earth's surface.
- Covers 70% of world's agricultural area.
- 4th largest plant family in the world.
- More than 11,000 different species.
- 90% of grass' bulk is underground.
- "Grass prevents erosion by binding to the soil".

Importance of Large Ruminants

- Ruminants have a unique gift of being able to covert cellulosic vegetation into nutrition.
- Microbes in gut of ruminants work similar to microbes in the soil.
- Ruminants do not digest grass, microbes do.
- Large ruminant impact on land is vital.

What is AHSD Grazing?

- Adaptive High Stock Density (AHSD) Grazing is defined as:
  - A uniquely flexible grazing system designed to facilitate maximum flexibility in land use and forage utilization, while optimizing animal performance and soil health goals.
- Also known as Adaptive Multi-Paddock (AMP) Grazing.

- AHSD grazing relies on the basic tenets of keen observation and fencing portability.
- Stock densities and animal movement frequency can be altered throughout the annual grazing cycle in order to adjust to changes in climate, forage dry matter (DM) production, animal performance and soil health objectives.

Key Benefits

- Increased forage dry matter production on a seasonal and annual basis.
- Enhanced animal performance.
- Significant improvements in soil health, including:
- Increased water infiltration rates and soil water retention.
- Increased soil aggregation, improved soil tilth, and reduction in soil compaction.
- Reduced erosion and runoff.
- Increased soil microbial population and microbial balance.

Key Benefits, Con't.

- Greater plant diversity through "tapping" of latent seed bank.
- Increased atmospheric nitrogen fixation through plant legumes and N-fixing soil bacteria – nodulating and non-nodulating.
- Reduced reliance on inorganic fertilizers.
- Incremental increases in soil organic matter and CEC.

Key Benefits, Con't.

- Natural soil pH buffering capacity.
- Incremental increases in livestock carrying capacity.
- Greater plant species and wildlife species diversity.
- Improvement in earthworm, soil level arthropods, and pollinator insect populations.

Research Results

- Frequent livestock rotations increase forage biomass production and improve soil & environmental health (Savory, 2008).
- Increased stock density results in greater soil OM (Schuman et al. 1999; Conant et al. 2003).
- Extended periods of rest between grazing periods allows for optimum recovery of forages and increases overall forage dry matter (DM) production (Montazedian & Sharrow, 1990).

Research Results

- Overgrazing reduces forage regrowth and biomass both through repeated grazing of the same plant in a short amount of time and through excess removal of plant material in the same grazing event (Cullen, et.al. 2006; Phillip, et. al., 2001).

Research Results

- With increased grazing intervals, plants have more time to recover from prior grazing events and more effectively restore leaf area and root reserves, thus increasing forage biomass production (Phillip, et.al, 2001).

Research Results

- Improved grazing management strategies also had positive impacts on soil biota, soil chemical and physical properties, water infiltration and retention, soil aggregation and soil carbon fractions (Teague, et.al, 2011; Conant, et.al, 2003; Leake, et.al, 2004).

AHSD Methodology

- Involves first determining goals and objectives of your grazing program and then designing and implementing an annual grazing strategy that allows goals and objectives to be optimally achieved.
- The primary purpose of AHSD grazing is to utilize variable high stock densities throughout a grazing season to effectively realize accomplishment of key benefits.

- Stock densities will vary depending on soil and forage conditions, management constraints, and goals.
- Practitioners should strive to achieve stock densities of at least 250,000 pounds per acre at least once annually.
- Many current AHSD grazers have effectively used stock densities exceeding 500,000 lbs. /acre, followed by long rest periods, to rapidly build soil organic matter (OM), increase soil water infiltration rates, tap into the latent seed bank, and apply “natural” fertilizer in the form of animal manure and urine.

- The key to successful implementation of such high stock densities is to allow the livestock to consume no more than 40-50% of total available forage DM before moving forward into a fresh grazing paddock.
- Temporary grazing paddocks can be constructed (using electrified polywire and tread-in posts) that contain the appropriate amount of forage dry matter needed to support the stock density desired.

Stock Density Calculations

- If you have 3000 lbs per acre of available forage DM and want to utilize 50% and leave 50% trample:

- 3000 x 50% = 1500 lbs DM available for 24 hour period.

Stock Density Calculations

- Assume 100 head of 1200 lb lactating beef cows.
- Assume 3.5% DM consumption needed daily.
- 1200 x 3.5% = 42 lbs forage DM/hd/day.
- 100 x 42 = 4200 lbs DM needed daily for herd.

Stock Density Calculations

- If you have 1500 lbs DM available per acre and need 4200 lbs DM daily, then average paddock size:

- 4200/1500 = 2.8 acres needed per day.
- Stock density = 1200 x 100 = 120,000 lbs
- 120,000 lbs/2.8 = 42,857 lbs/acre.

Stock Density Calculations

No. Moves Per Day	Stock Density Per Acre (lbs/ac)	Paddock Size (acres)
1	42,857	2.8
2	85,714	1.4
3	128,571	0.93
4	171,428	0.7
5	214,285	0.56
10	428,570	0.28

What Do Higher Stock Densities Look Like?

Adaptive High Stock Density Grazing

250,000 lbs per Acre


150,000 lbs per Acre


500,000 lbs per Acre

1,000,000 lbs per Acre

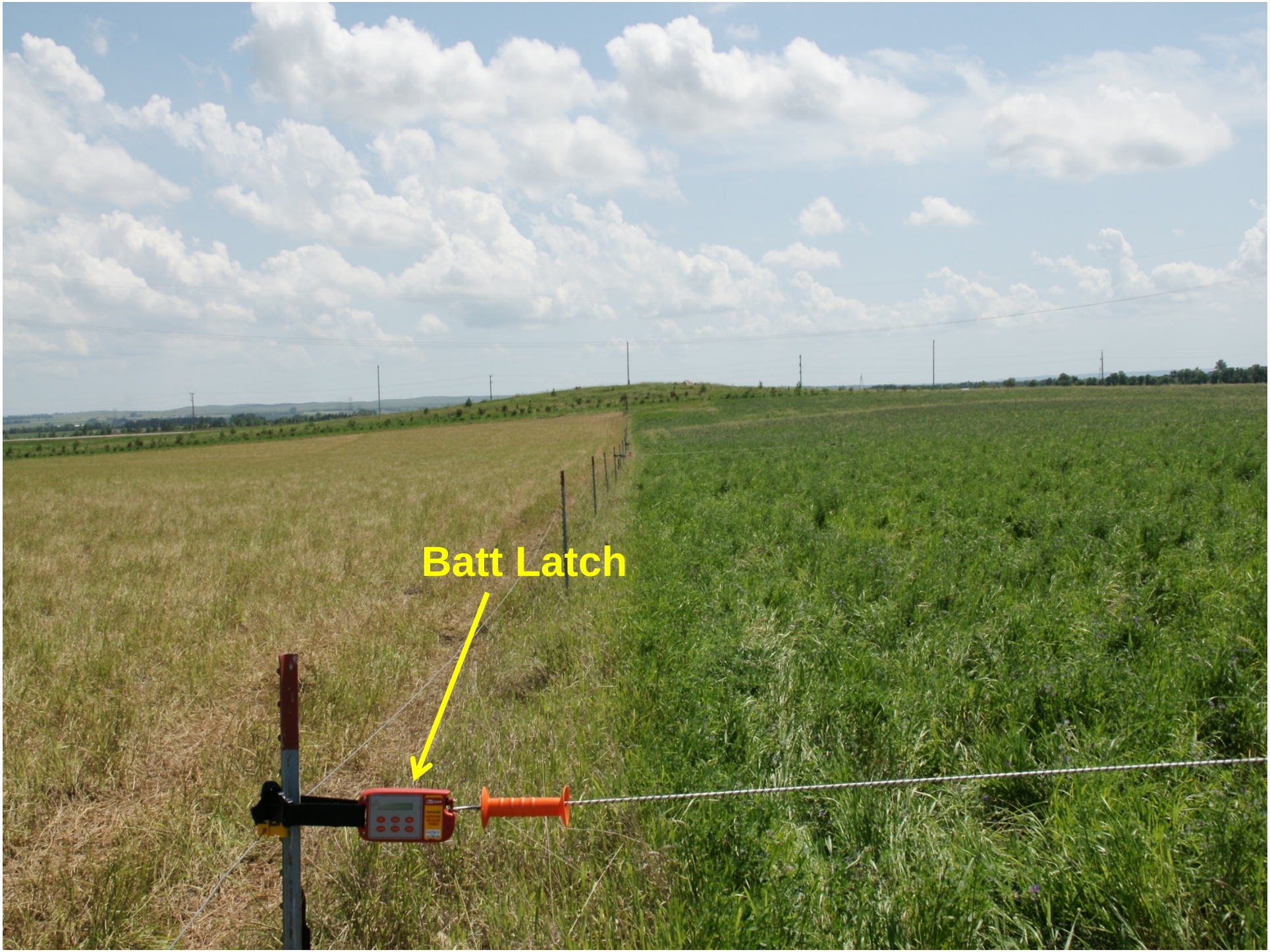
Moving the “Mob”

New Move

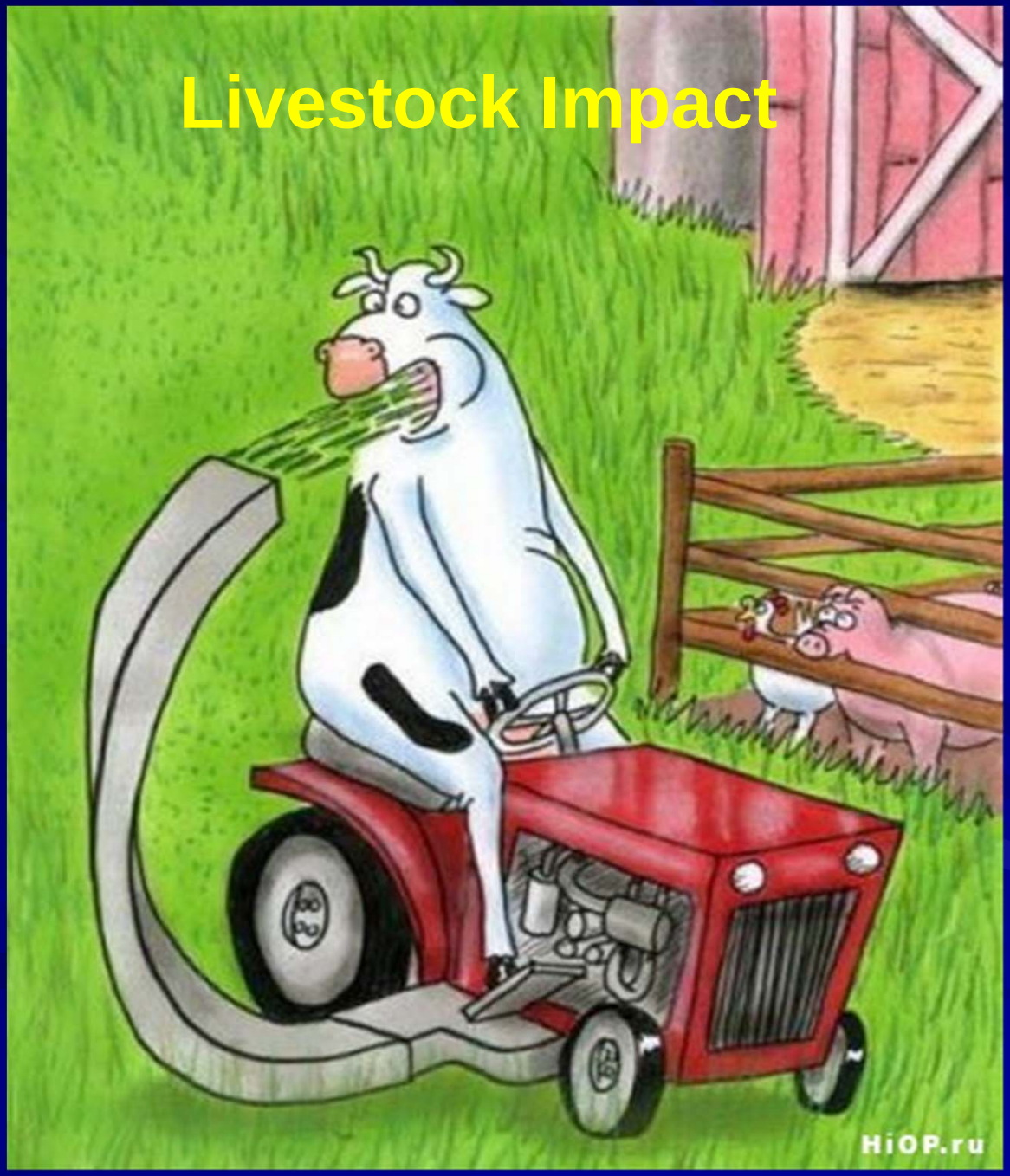
Next Move

Multi-Paddock Construction for Multiple Daily Moves


Spring Gate with Batt Latch


Batt Latch

Livestock Impact



Keys to Effective AHSD Grazing

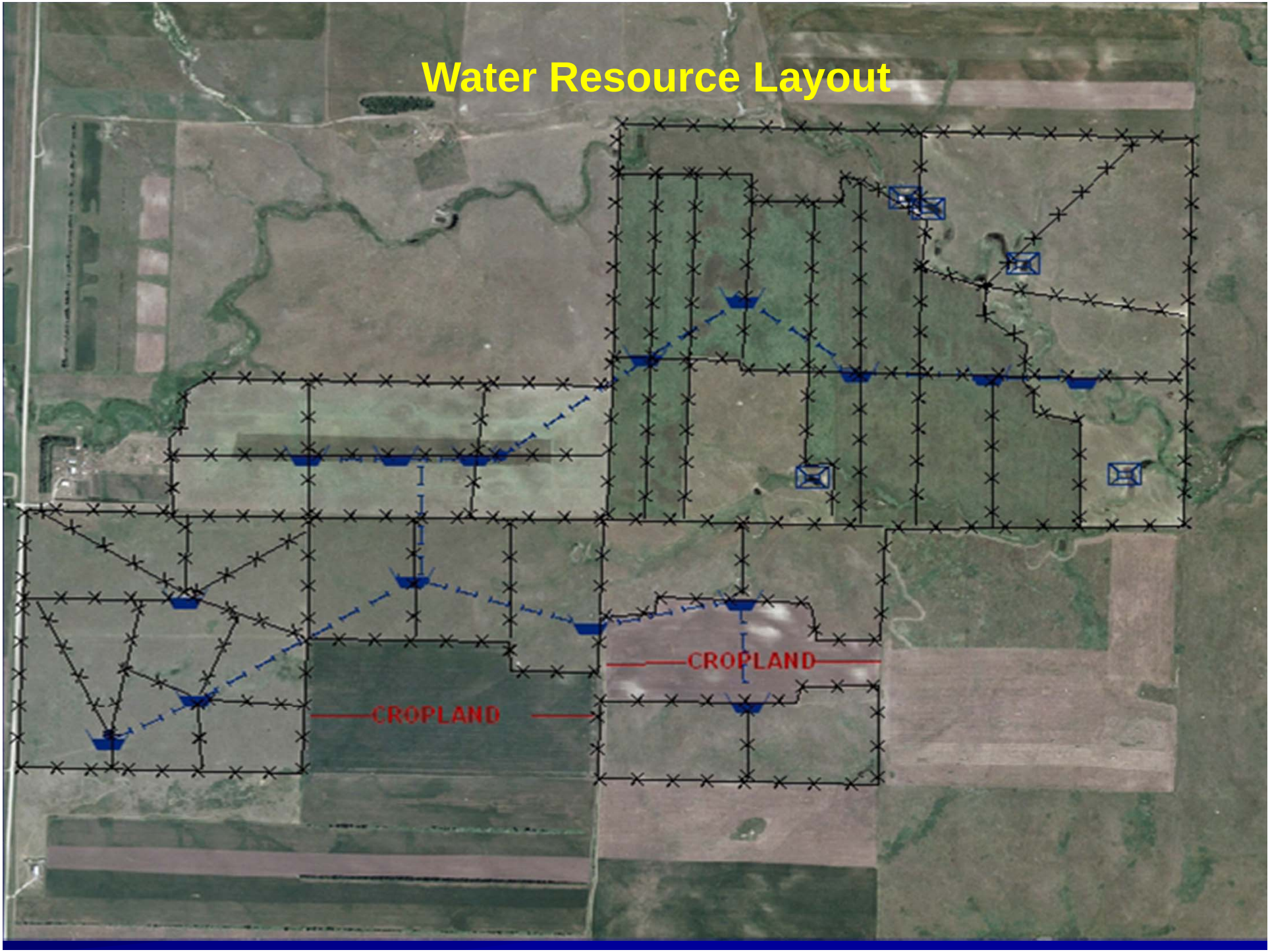
- Determine a starting point
- **Be FLEXIBLE!!!**
- Make frequent moves all year
- At least once a year, use Ultra High Stock Density grazing to improve critical areas
- Start at water source and move out
- **Keen observation**….

Constant Observation

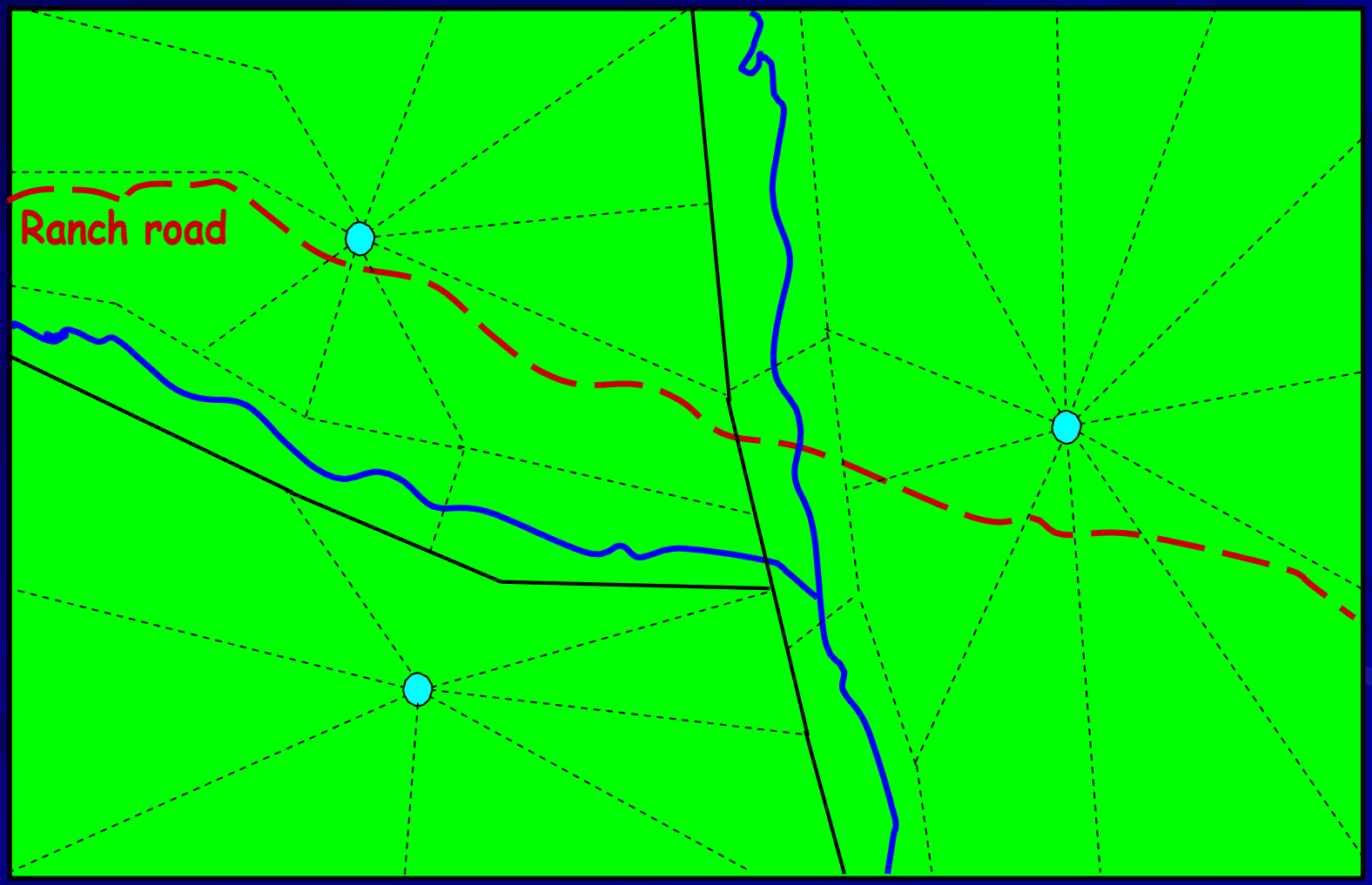
Paddock Designs & Layout


Have a Good Plan
CROPLAND

Water Resource Layout



Planned Multi-Paddock Grazing



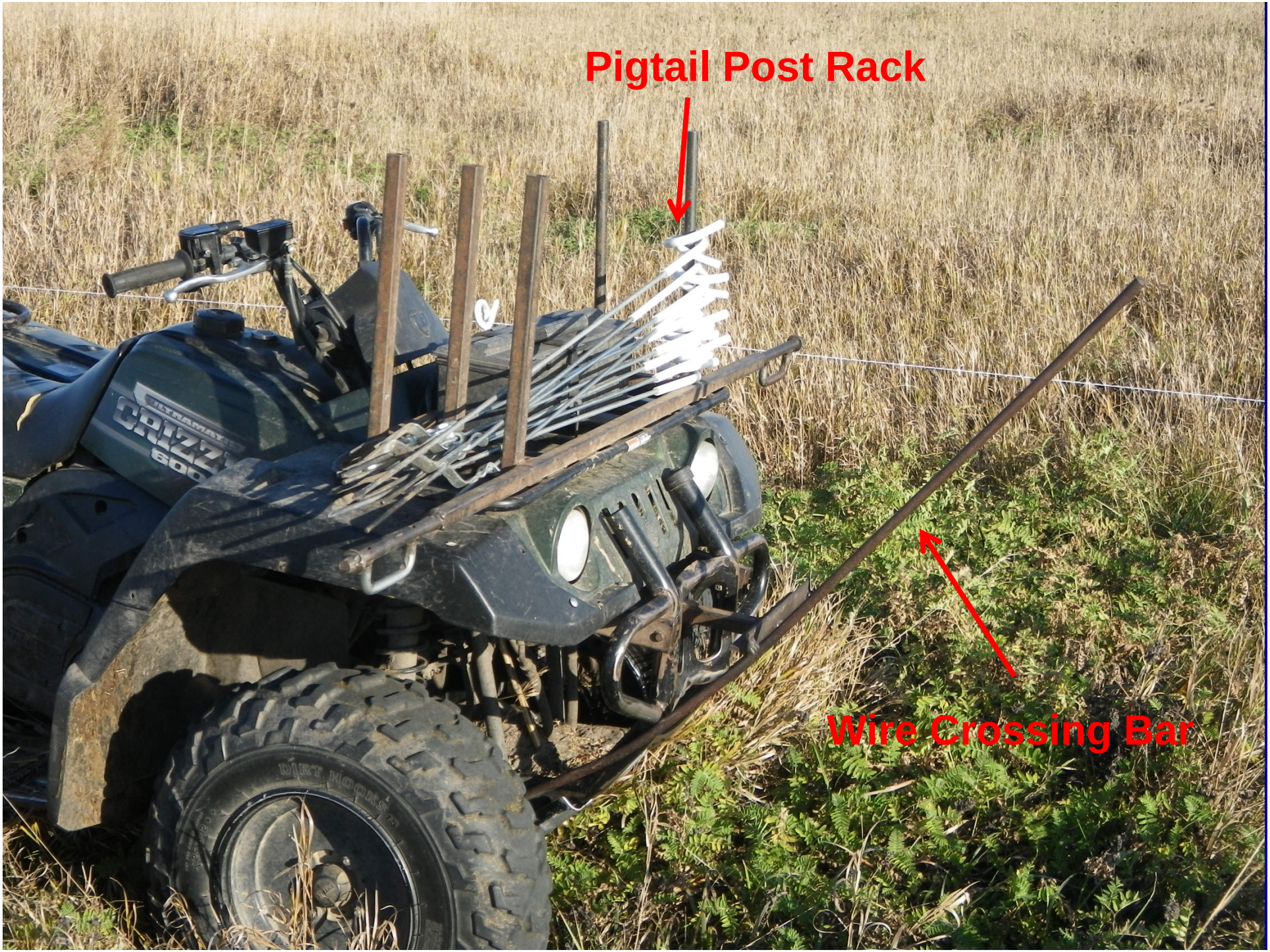
Fencing Cost Estimates

Fence Type	Construction Costs (per foot)	Annual Maintenance Costs (per foot)
Woven Wire	$1.93	$0.33
Barbed Wire (5-strand)	$1.48	$0.25
Hi-Tensile (8-Strand)	$1.24	$0.16
Polywire (1-strand)	$0.20	$0.07

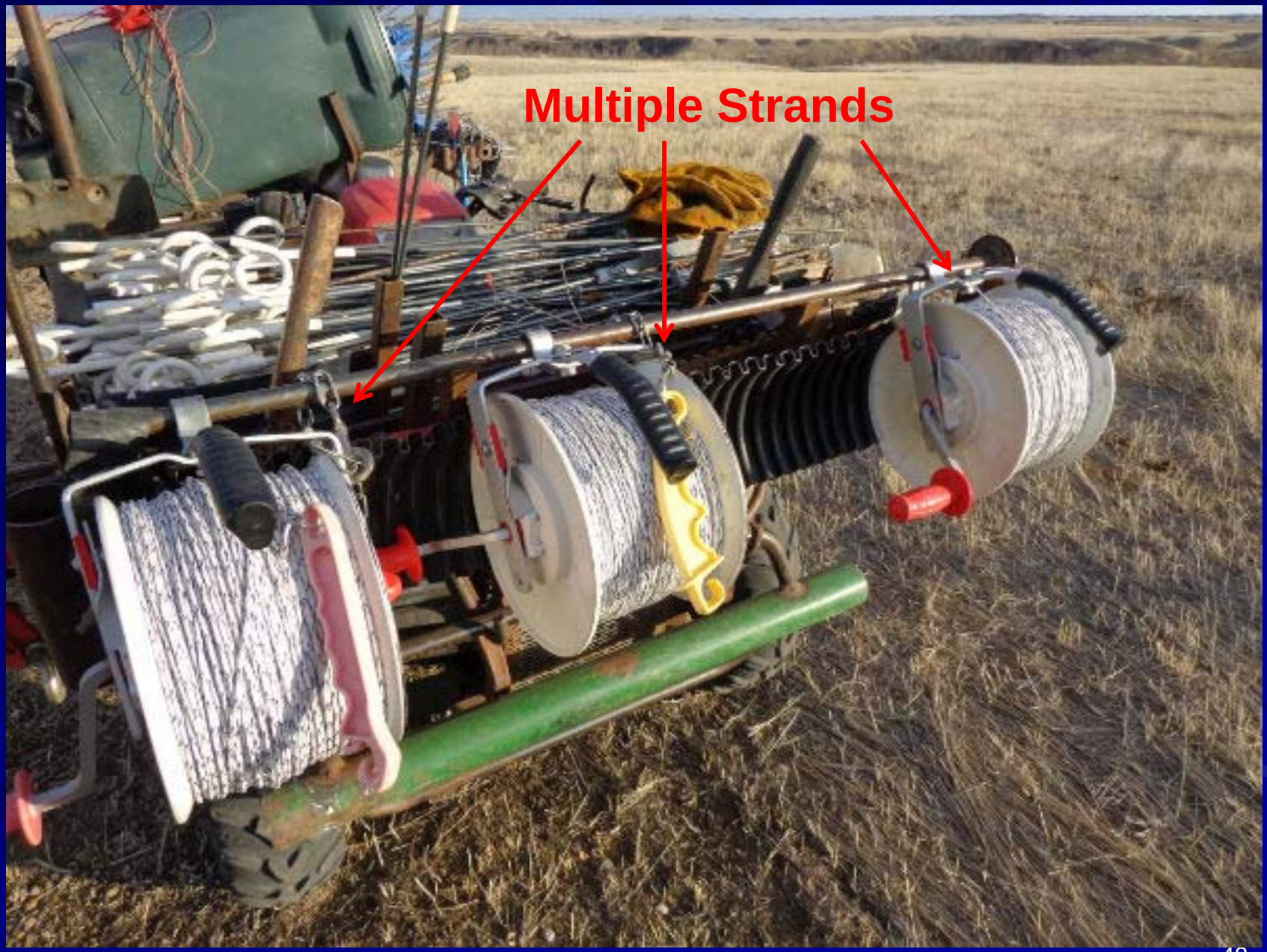
Equipment

Variety of Ways to Get Job Done

Allen's Fencing Rig

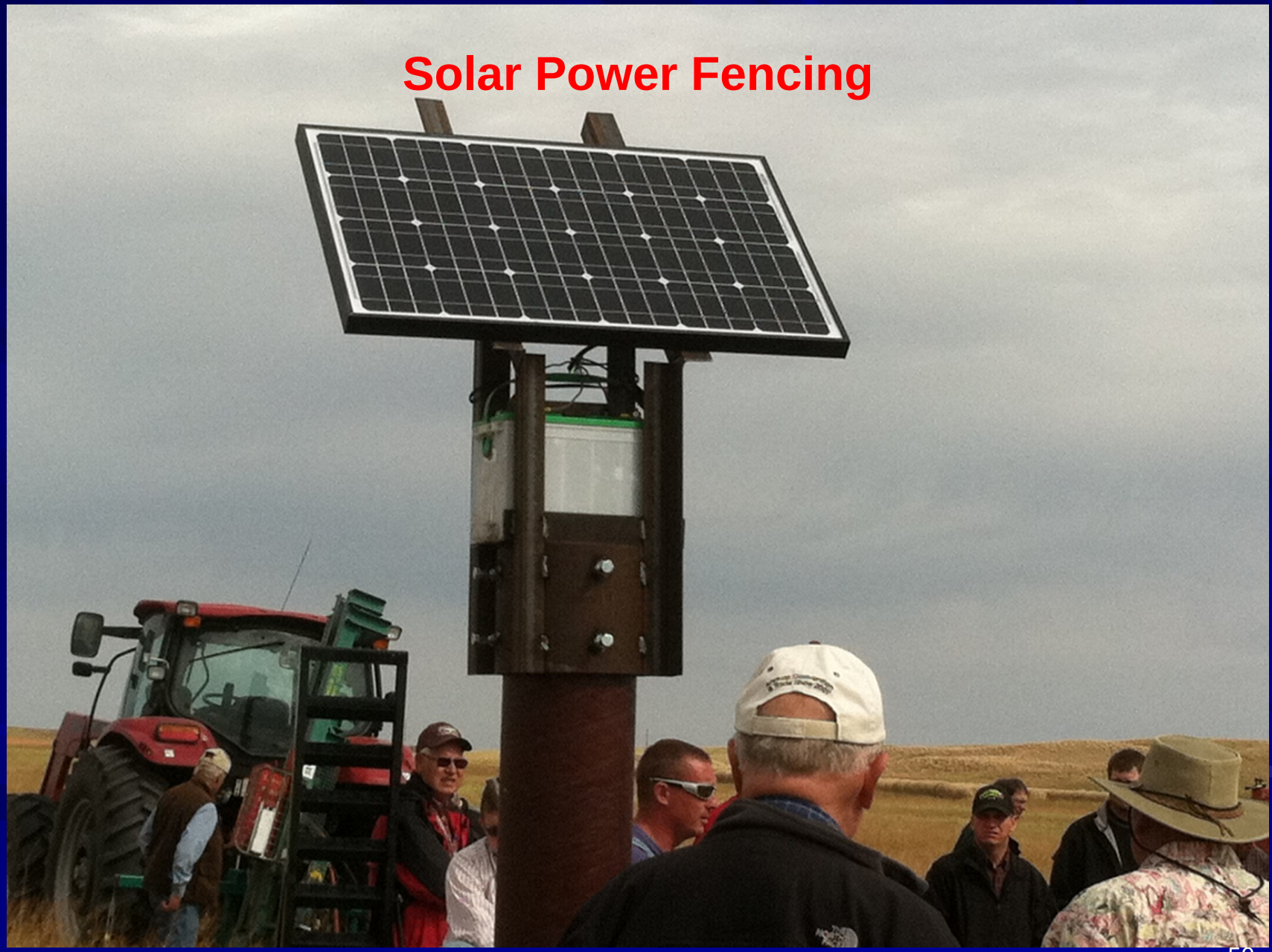

Pigtail Post Rack
Wire Crossing Bar


RANCHER


Multiple Strands

Getting Serious in the Sandhills

Solar Power Fencing



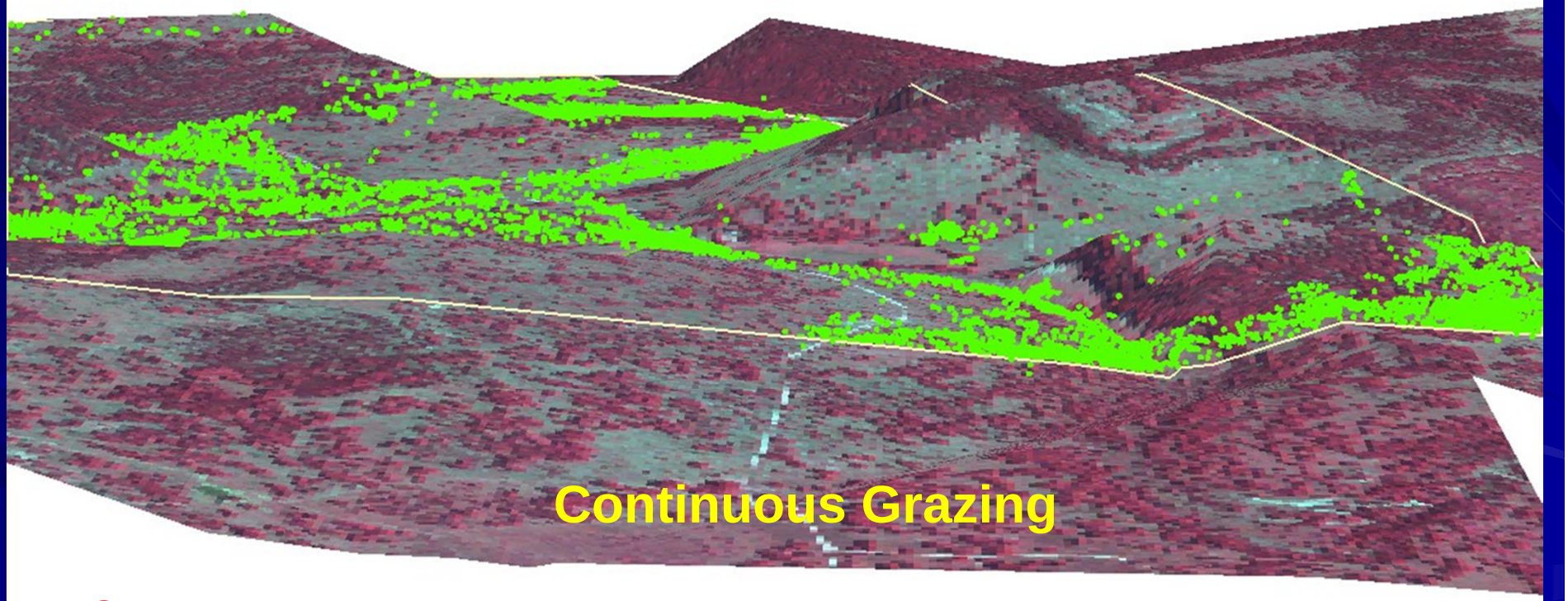
Solar Power Fencing

Research

GPS Collared Cows – Grazing Study

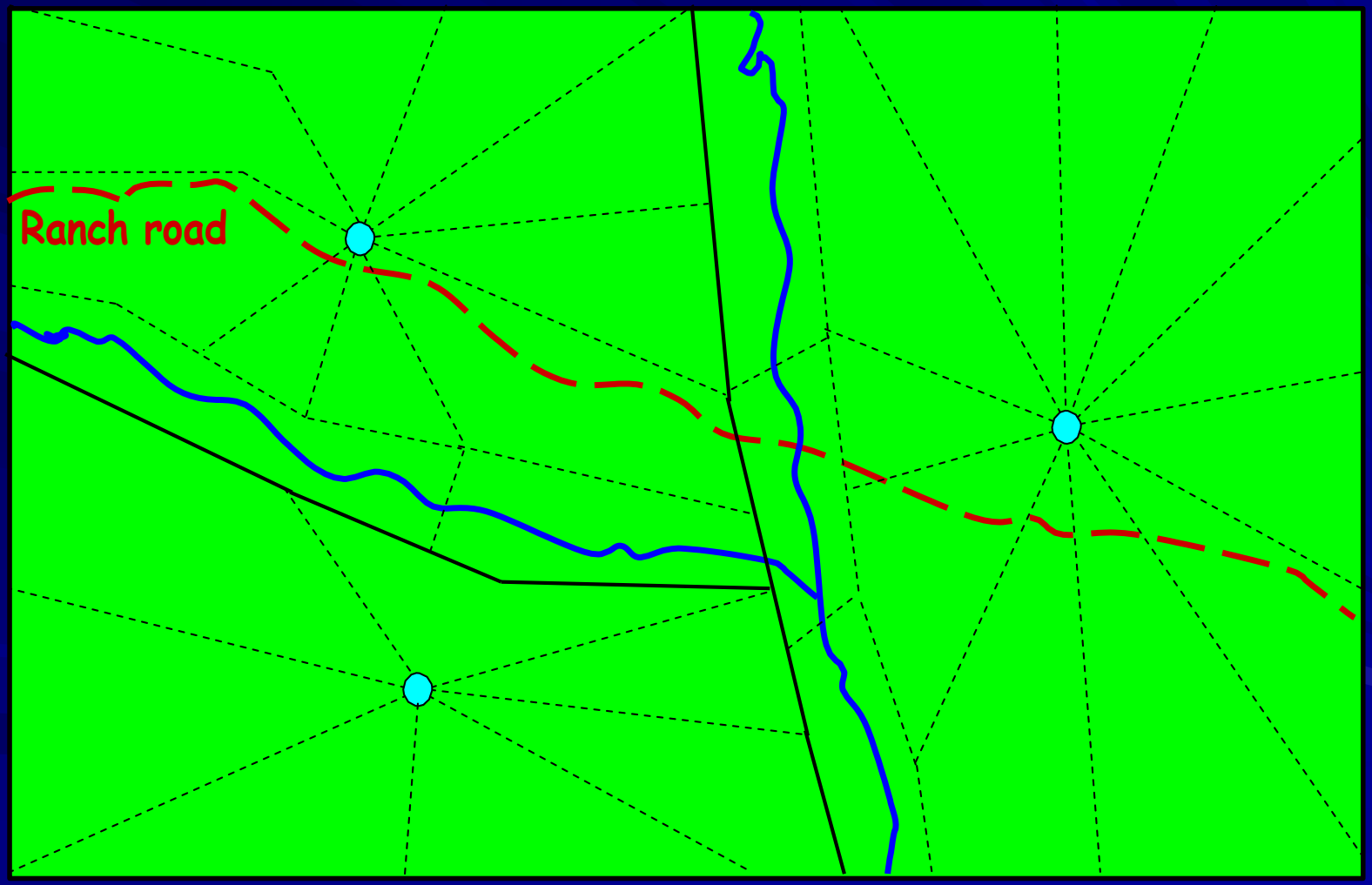
1. 39% area used
2. 41% GPS points on 9% area
3. SR: 21 ac/cow
4. Effective SR: 9 ac/cow

West Texas Ranch

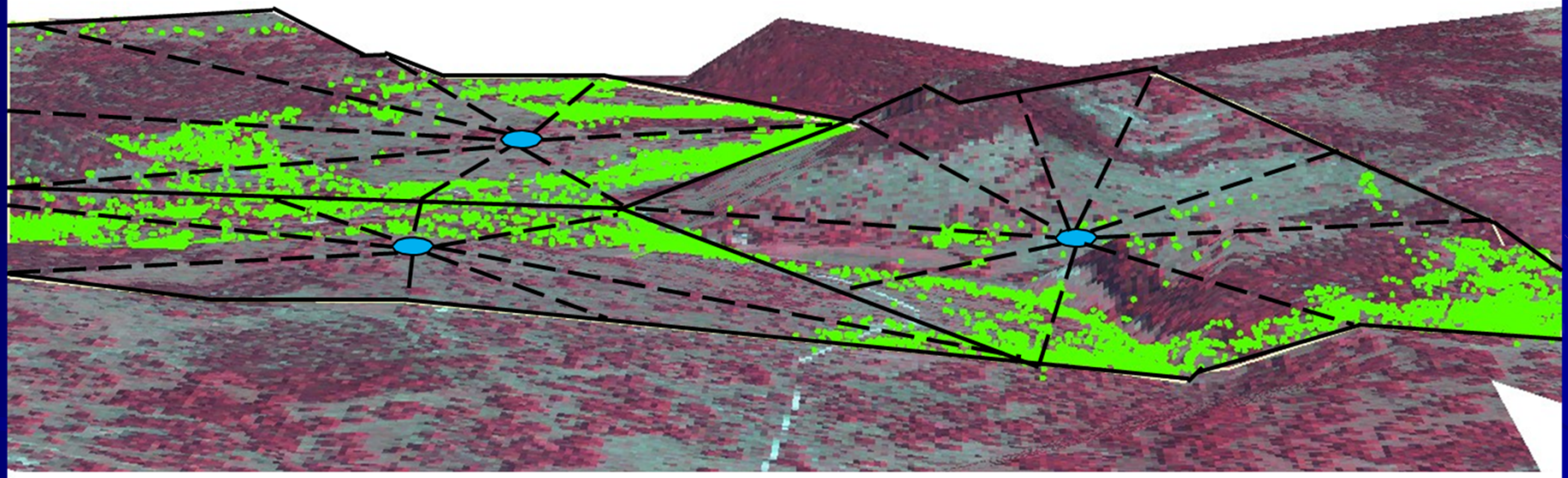


Courtesy: R. Teague, TAMU

Planned Multi-Paddock Grazing



Planned Multi-Paddock Grazing



Under Planned Multi-Paddock Grazing Practices Carrying Capacity Increased from 21 ac/cow to 9 ac/cow.

Courtesy: R. Teague, TAMU

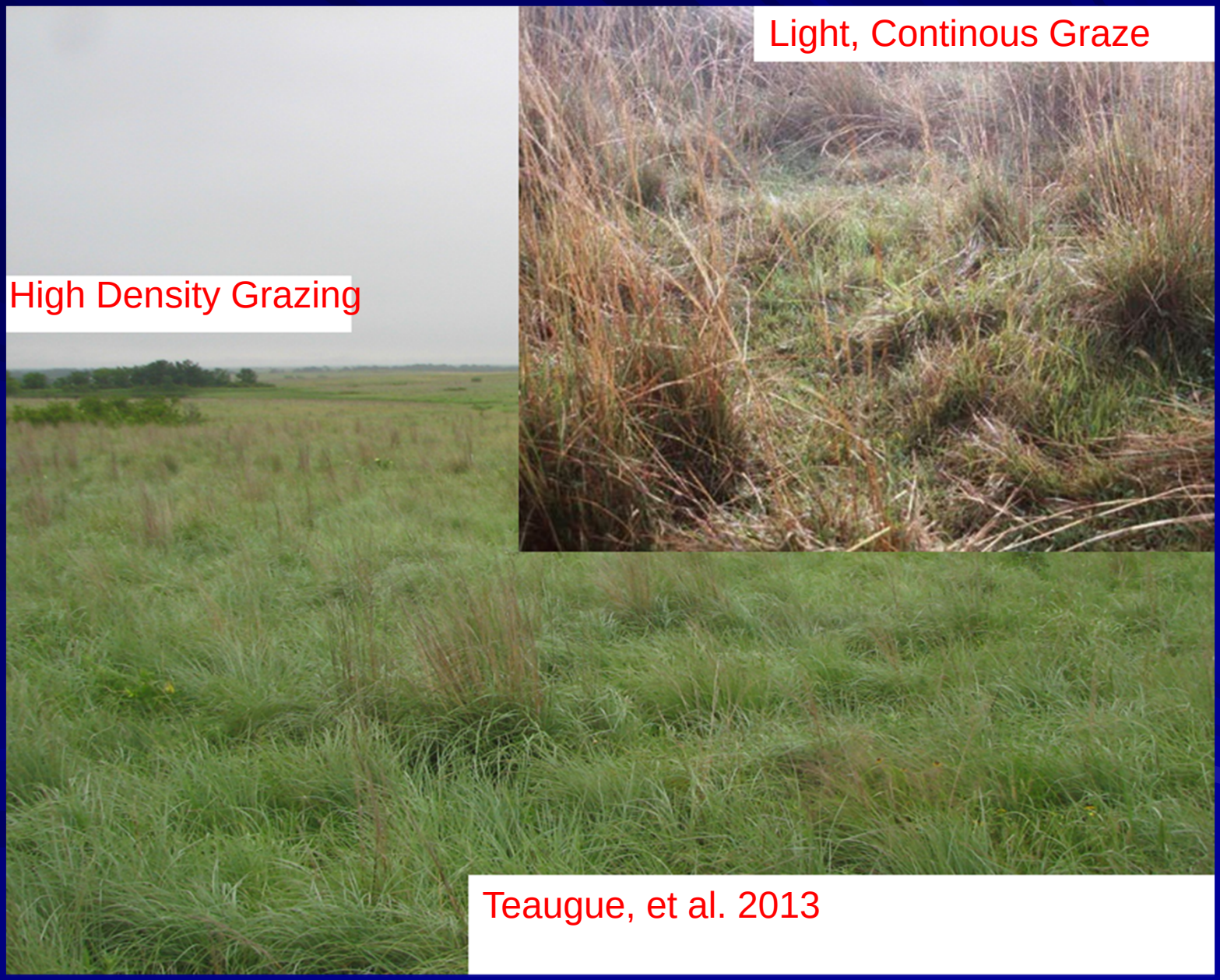
Length of recovery periods

With moderate use in the growing season:

- In wetter tallgrass areas (30+ inches of rain)
  - Recovery of 45 in wetter years to 90 days in drier years
- In mixed grass prairie(18 - 25 inches of rain)
  - Recovery of 50 in wetter years to 120 days in drier years
- In short grass prairie (12 - 15 inches of rain)
  - Recovery of 90 in wetter years to 150 days in drier years
- In arid rangelands (< 15 inches of rain)
  - Recovery of full growing season or more

Based on some published science and experience

Teague et al., 2013

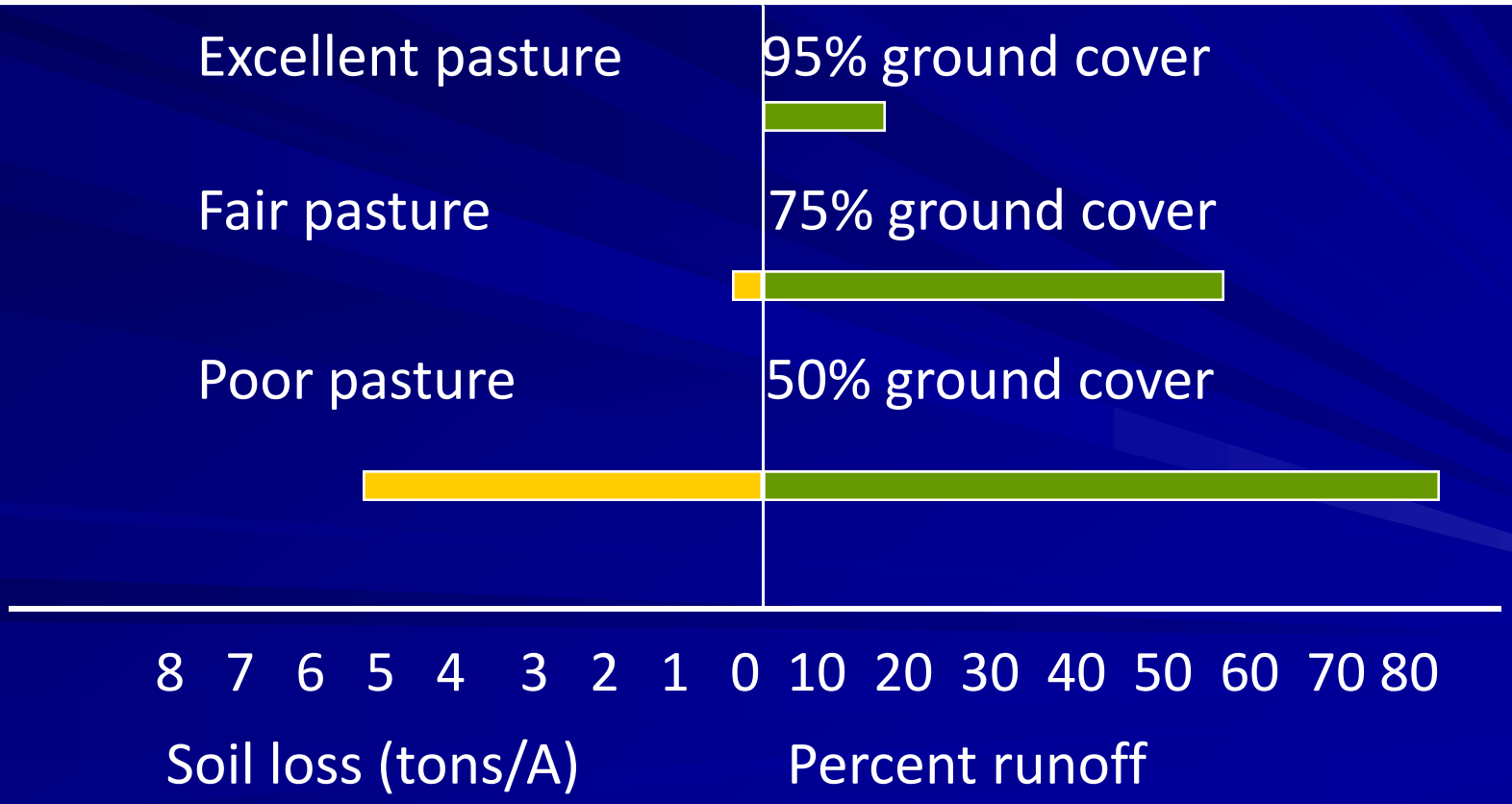

Light, Continous Graze
High Density Grazing
Teaugue, et al. 2013

Pasture Cover Impacts Infiltration and Runoff

3 inches of rainfall in 90 minutes, 10% slope, silt loam soil

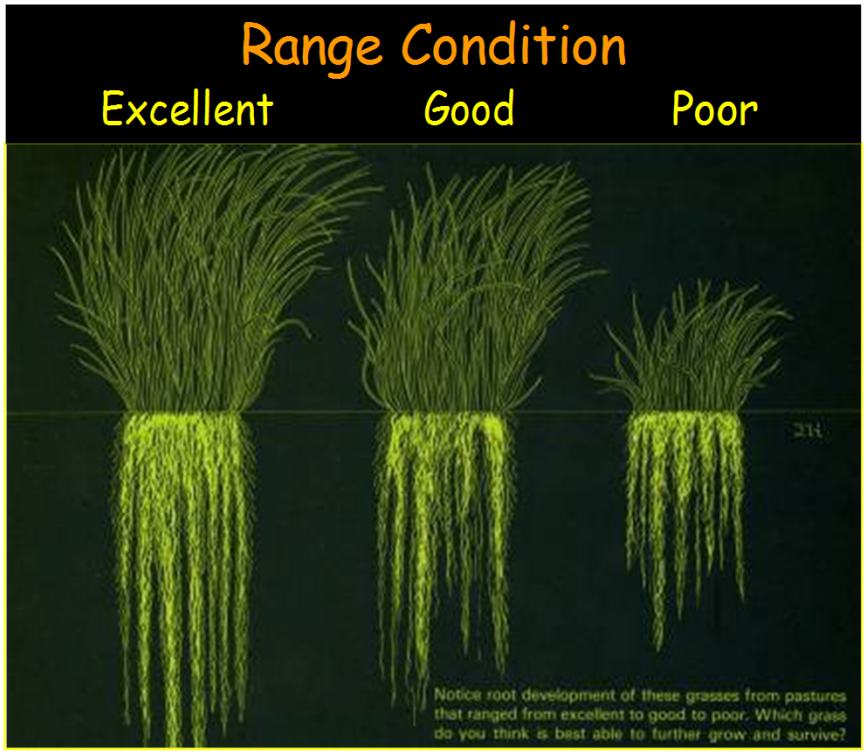
(University of Nebraska & USDA-SCS, 1937)

> The amount of rain you receive is not nearly as important as the amount of rain you are able to capture and put to use.
>
> - Kit Pharo



Decrease drought impacts

% Leaf Volume Removed	% Root Growth Stoppage
10%	0%
20%	0%
30%	0%
40%	0%
50%	2-4%
60%	50%
70%	78%
80%	100%
90%	100%



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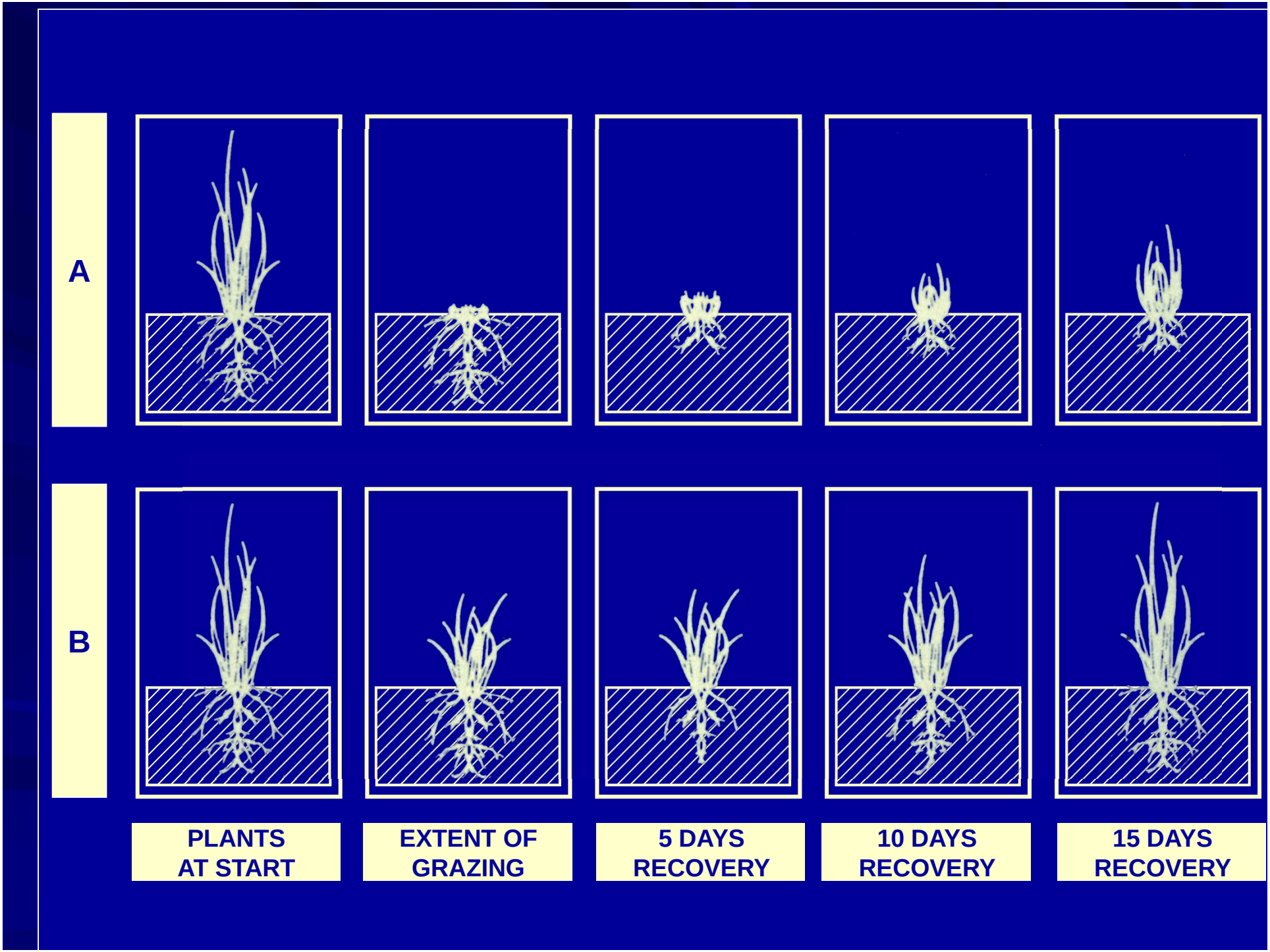

A
B
PLANTS AT START
EXTENT OF GRAZING
5 DAYS RECOVERY
10 DAYS RECOVERY
15 DAYS RECOVERY

Soil Carbon Data

- Three farms sampled in Mississippi:
  - Fall 2014
  - Farm Descriptions:
    - AHSD Grazing for 5 years
    - High Level Conventional Grazing Management
      - CG – Good - 50+ years
    - Low Level Conventional grazing management
      - CG – Poor - 30+ years
    - All same soil types

Soil Carbon Data

- Soil pits dug in random locations at each farm. Same topography.
- Each pit 3 feet deep and 3 feet square.
- Collected soil samples within every 6 inch section.
- Noted root growth and structure.
- Noted soil life, texture, aggregation.

Soil Carbon Data – Soil pH

Horizon	AHSD	CG - Good	CG - Poor
1	7.9	5.9	5.5
2	7.9	5.8	5.6
3	7.9	6.2	5.3
4	7.8	6.3	5.1
5	7.8	6.8	5.1
6	7.9	7.0	4.9

Soil Carbon Data – Total Soil Carbon

Horizon	AHSD	CG - Good	CG - Poor
1	4.67	1.64	1.36
2	4.00	1.88	1.37
3	2.95	1.03	0.40
4	2.04	1.02	0.54
5	1.71	0.38	0.40
6	1.42	0.41	0.34

Soil Carbon Data – Soil Organic Matter

Horizon	AHSD	CG - Good	CG - Poor
1	4.26	3.28	2.72
2	3.22	3.76	2.74
3	3.10	2.06	0.80
4	2.98	2.04	1.08
5	2.80	0.76	0.80
6	1.98	0.82	0.68

Soil Carbon Data – Carbon Assessment Per Acre

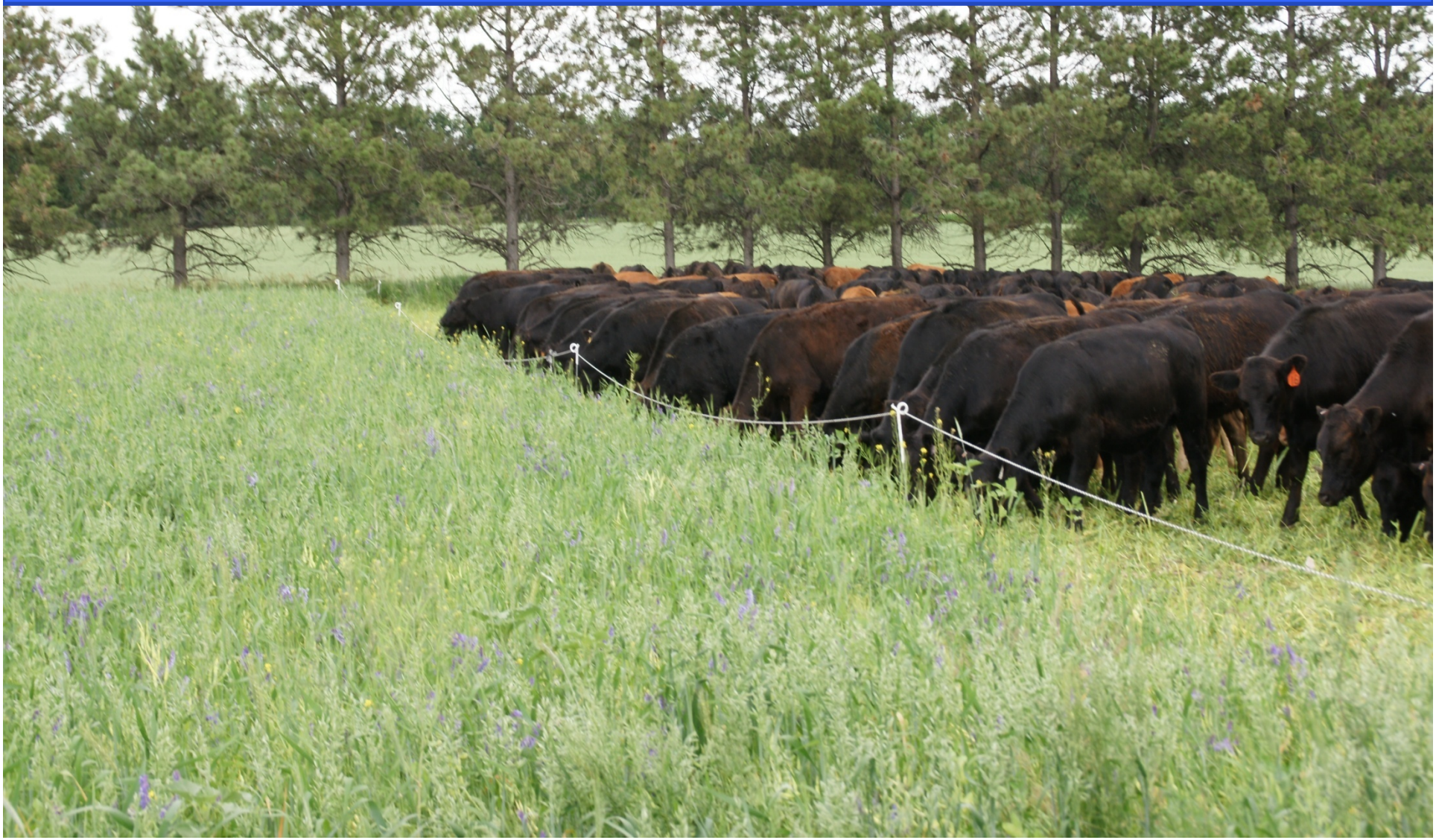
Farm Descrip	Carbon (kg/sq meter	Carbon (Ton/ac)	Carbon (Ton CO2 Equiv)
AHSD	12.69	51.41	188.13
CG – Good	7.09	28.71	105.07
CG - Poor	5.47	22.16	81.09

Case Studies

Gabe Brown - ND

- 1991 – Purchased land in ND that was heavily tilled for decades.
- Synthetic fertilizers & herbicides used regularly.
- Starting SOM – 1.7% - 1.9% with water infiltration rates of only ½ inch per hour.
- Now – SOM of 11+%. Water infiltration rates exceed 10+ inches per hour.

Livestock and Cocktail Cover Crops Used As Tool for Land Improvement



Forage DM Yield in High vs. Low Microbial Activity Fields

Variable	High Microbial Activity	Low Microbial Activity
Dry Matter (lbs/ac)	8573	2559
Crude Protein (%)	11.9	7.9
TDN (%)	69.4	55.7

Source: USDA NRCS Mandan, ND.

Mississippi Farm

Condition at Purchase

Implemented Strategy

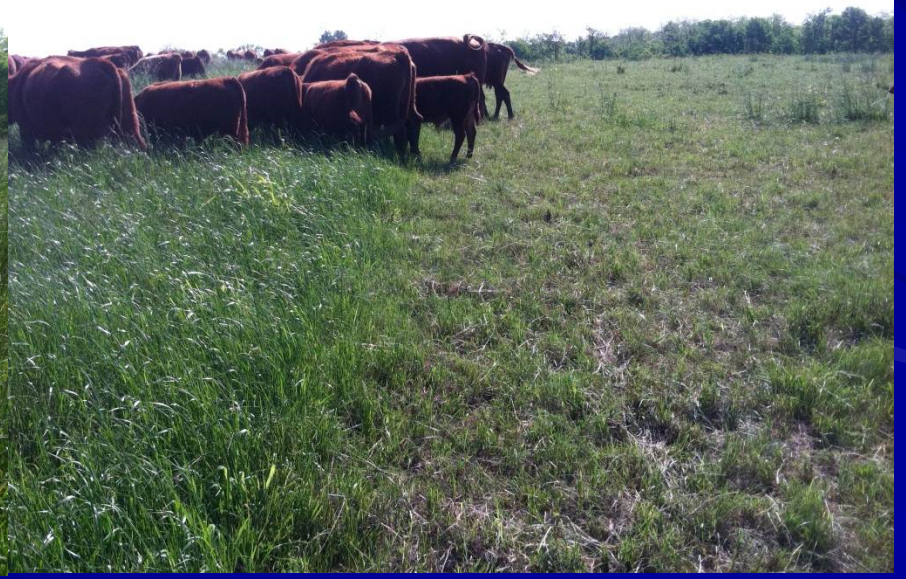
- Bale Grazing 1st winter.
- High Stock Density/Short Duration Grazing.
- Long rest periods.
- Strategic use of soil microbials.

Year 1 Grazing Season

Grazing Weeds

Year 2 Grazing Season

Year 3 Grazing Season

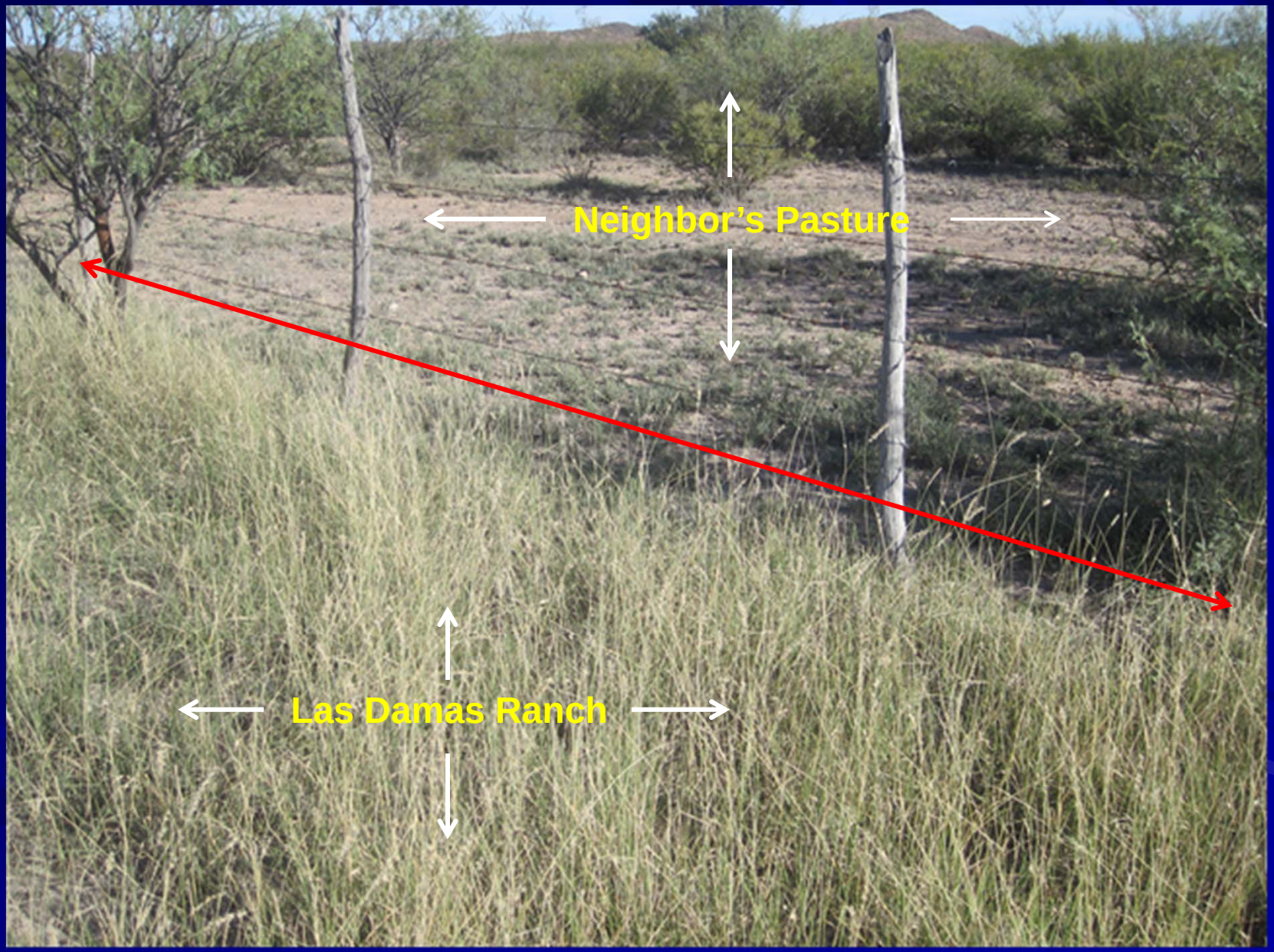


Year 4 Grazing Season

Progress

- Tripled Stocking Rate.
- Forage species increased from less than 3-4 major species to more than 35.
- Soil OM increased from 1.5% to 4.3%.
- Brix increased 400%+.
- Water infiltration and retention increased.
- Increase in earthworms, soil level insects, pollinators, and wildlife.

Las Damas Ranch


Neighbor's Pasture
Las Damas Ranch

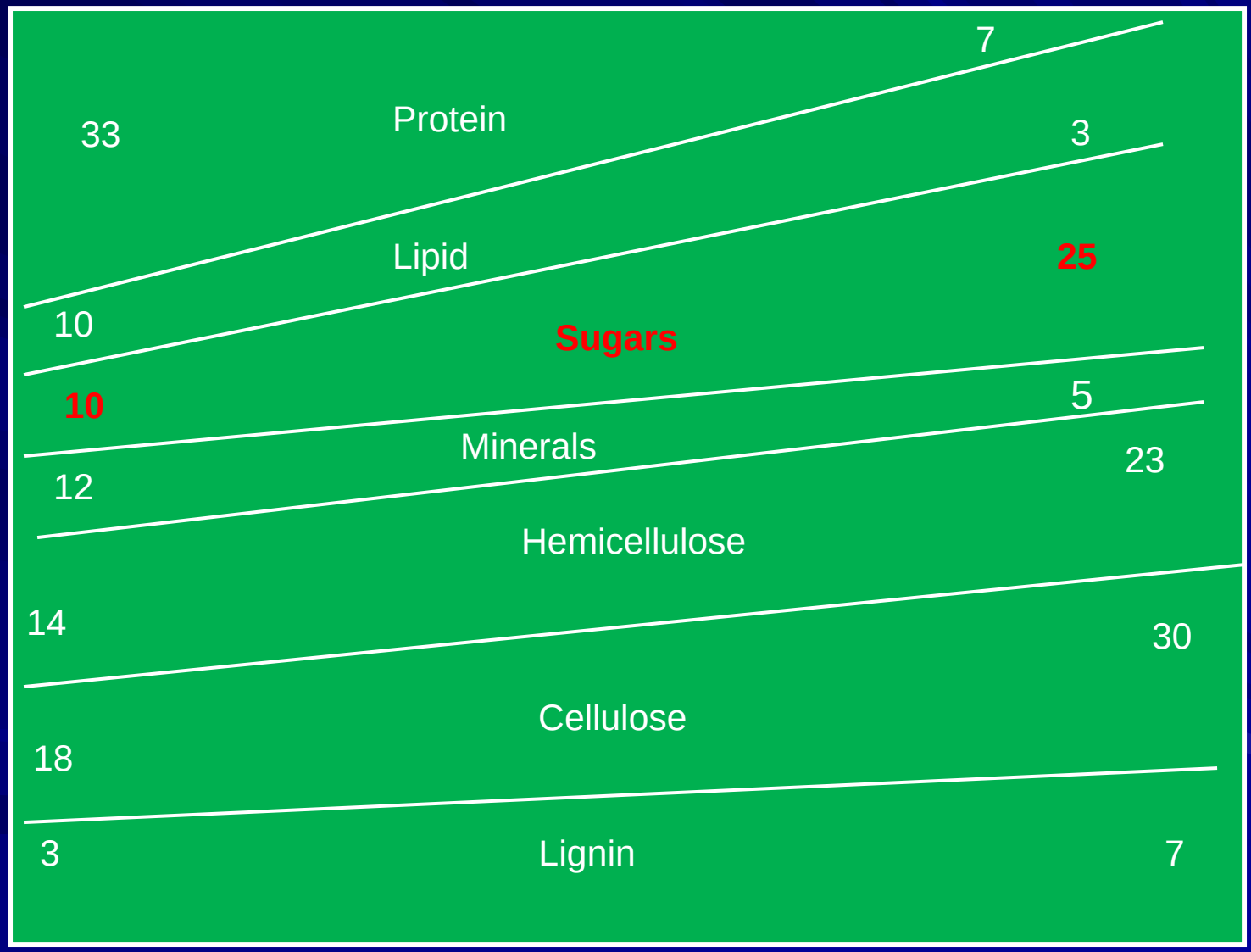

Las Damas Ranch

Background

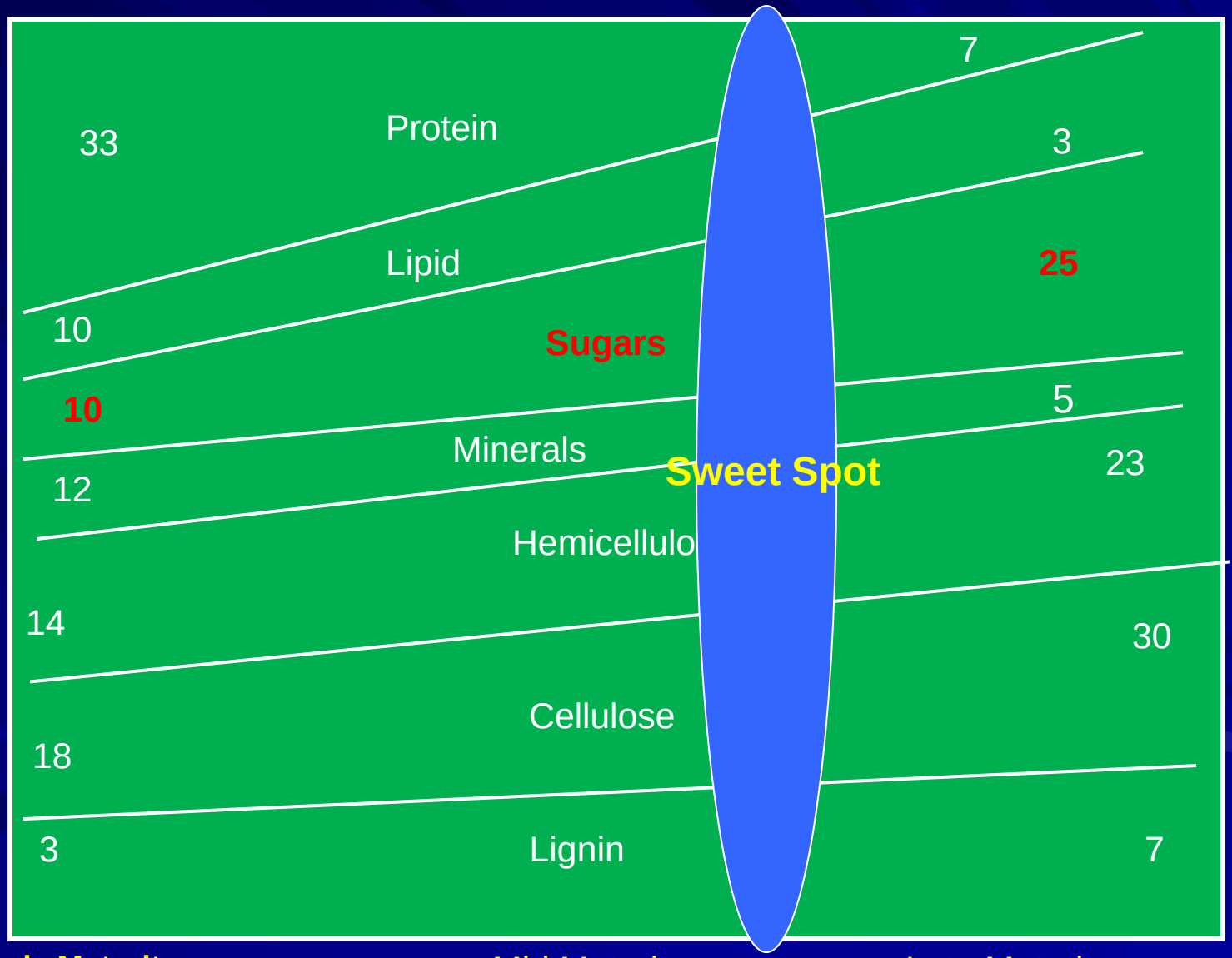
- Typical 11 inch rainfall region.
  - Last 4 years – 10”, 9”, 8”, 5” inches.
- 5 years ago – monoculture of tobosagrass
  - Now = side-oats grama, blue grama, green spangletop, …..
- Run 1 cow/calf per 40 acres.
- Neighbor ranch runs 1 cow/calf per 200 acres.

California – Regenerative Grazing

Effects of Stage of Maturity on Pasture Composition



Effects of Stage of Maturity on Pasture Composition

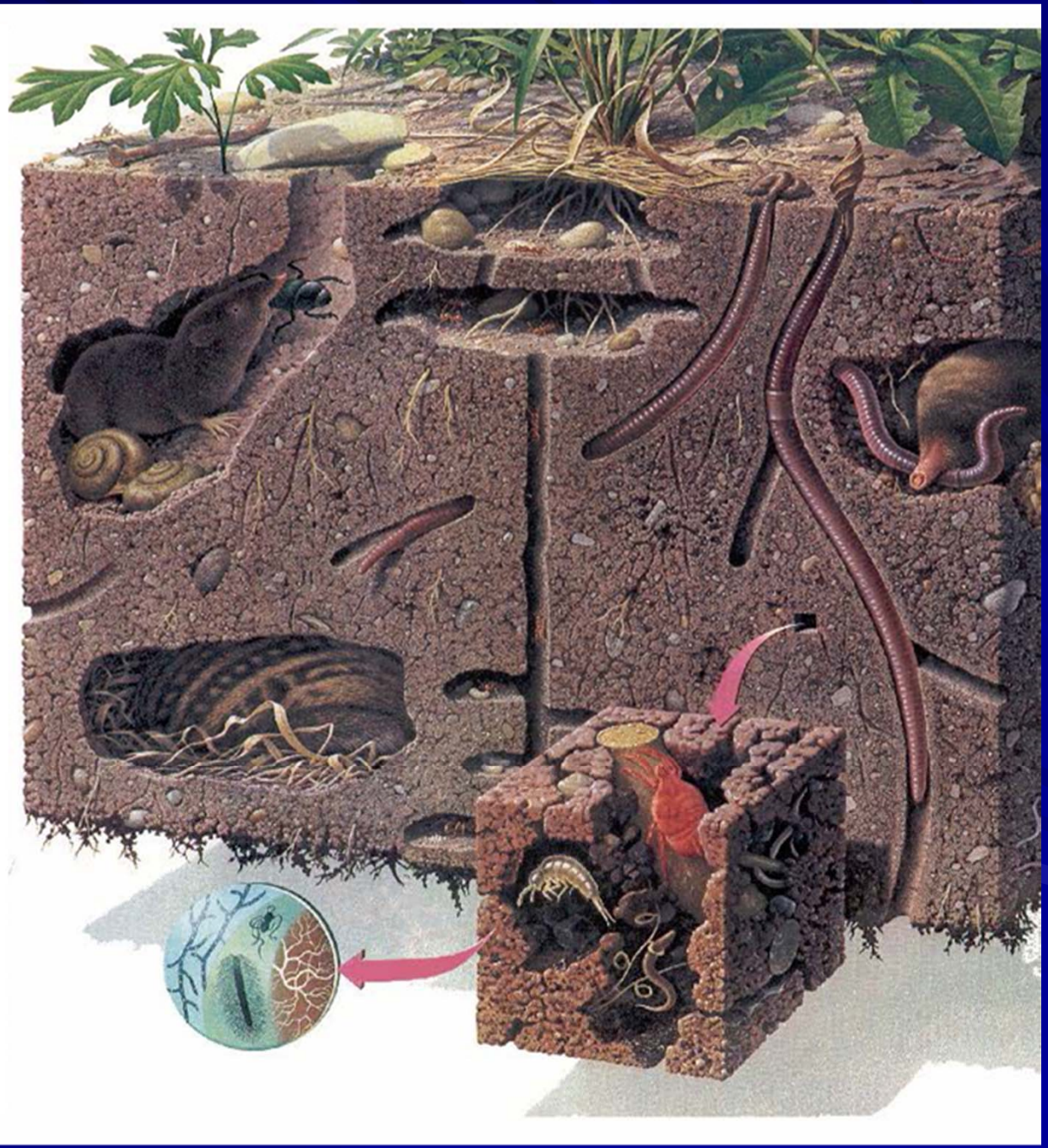


Measurable Benefits

Optimum Soil Health

Type of Organism	number/acre	lbs/acre
Bacteria	800,000,000,000,000,000,000	2,600
Actinobacteria	20,000,000,000,000,000	1,300
Fungi	200,000,000,000,000	2,600
Algae	4,000,000,000	90
Protozoa	2,000,000,000,000	90
Nematodes	80,000,000	45
Earthworms	40,000	445
Insects /arthropods	8,160,000	830

Soil Food Web



- 90% of soil function is mediated by microbes.
- Microbes depend on plants.
- So, how we manage plants is critical.

How Rapidly Can We Build Soil Microbial Population?

TLMB - Start	TLMB - End	No. Years
987 ng/g	6748 ng/g	4
1231 ng/g	8901 ng/g	5
2214 ng/g	11342 ng/g	5
1575 ng/g	9657 ng/g	4
1898 ng/g	8431 ng/g	4

TLMB = Total Living Microbial Biomass

Earthworms

Dung Beetles

Pollinators

The Value of Soil Organic Matter

Can we control runoff with Organic Matter (OM)?

- **2% OM** will hold 32,000 gallons of water or **21%** of a rainfall.
- **5% OM** will hold 80,000 gallons of water or **53%** of a rainfall.
- **8% OM** will hold 128,000 gallons of water or **85%** of a rainfall.

Improved Organic Matter = Reduced Runoff and Clean Water

Organic Matter and Available Water Capacity (inches water/one foot soil)

Percent SOM	Sand	Silt Loam	Silty Clay Loam
1	1.0	1.9	1.4
2	1.4	2.4	1.8
3	1.7	2.9	2.2
4	2.1	3.5	2.6
5	2.5	4.0	3.0

Source: J. Soil and Water Conserv. B. Hudson. 49 (2) 189-194.

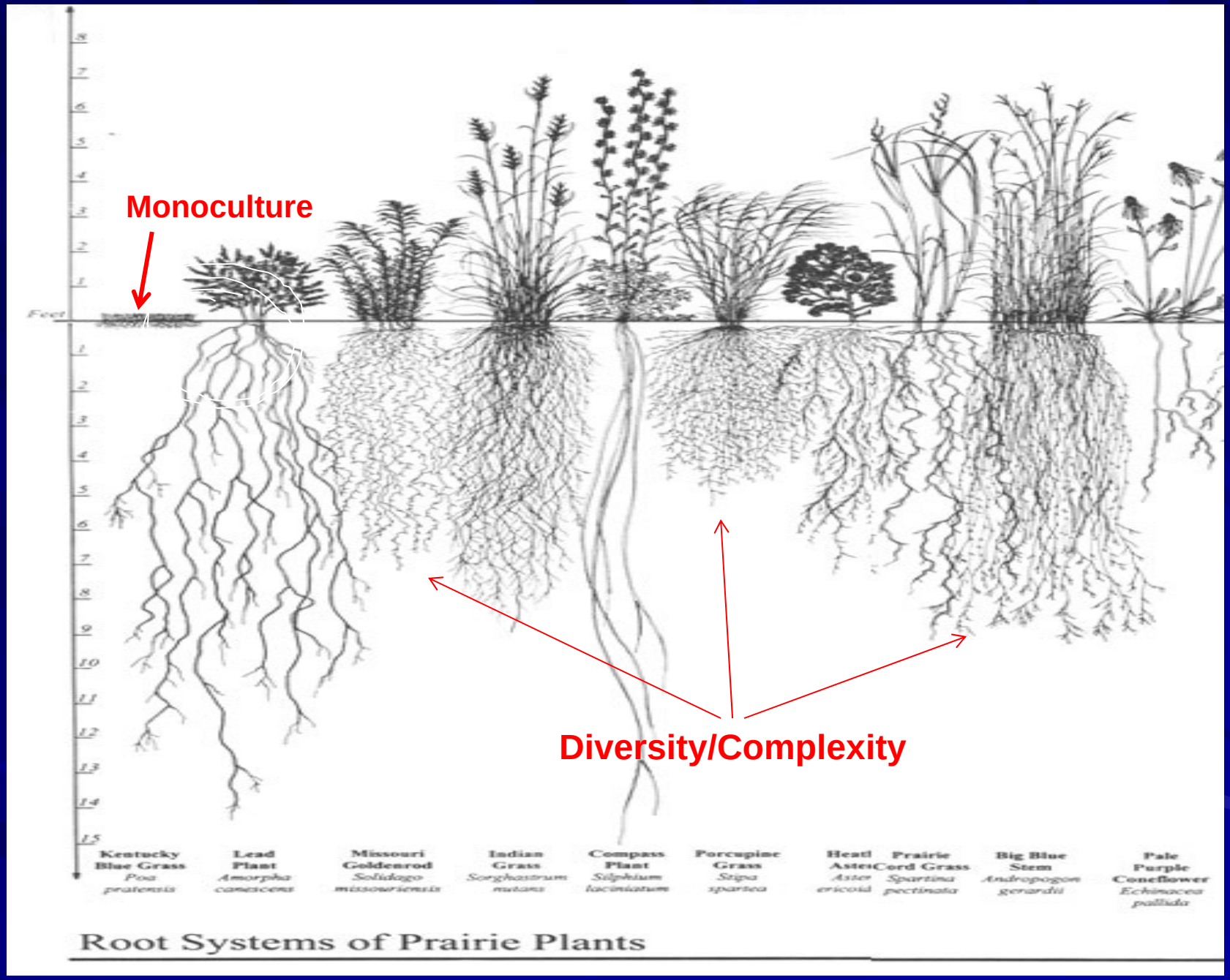
How Rapidly Can We Build New Soil Organic Matter?

Building Soil OM – How Long Does It Take?

- Mississippi – 1.0% - 4.2% (4 years)
- New York – 1.5% - 4.1% (5 years)
- Kansas – 1.6% - 3.9% (5 years)
- Nebraska – 2.1% - 5.5% (6 years)
- Michigan – 2.2% - 6.1% (6 years)
- Wisconsin – 2.3% - 5.0% (4 years)

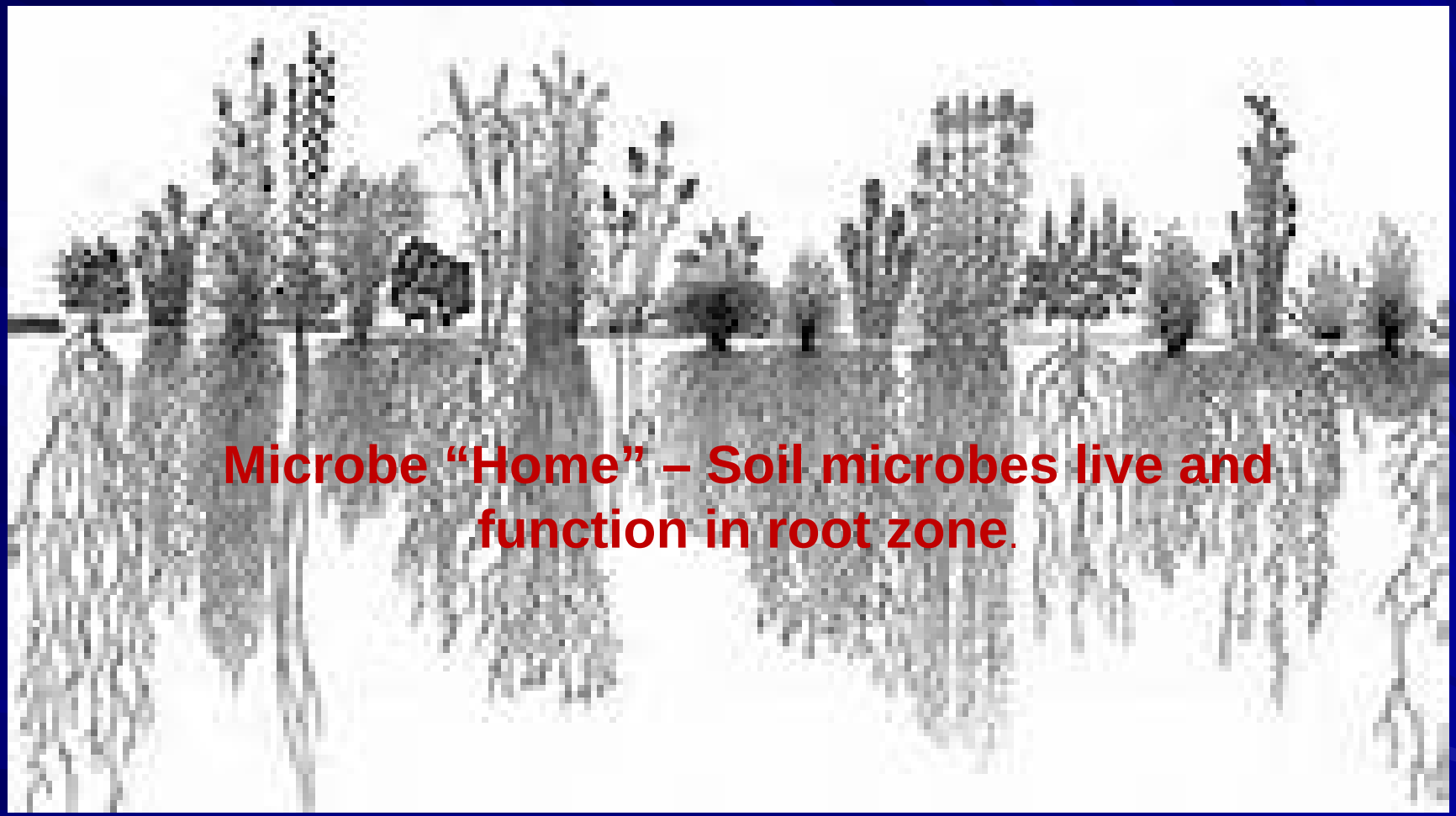
Value of Plant Species Diversity


Diversity Is Key



Root Systems of Prairie Plants

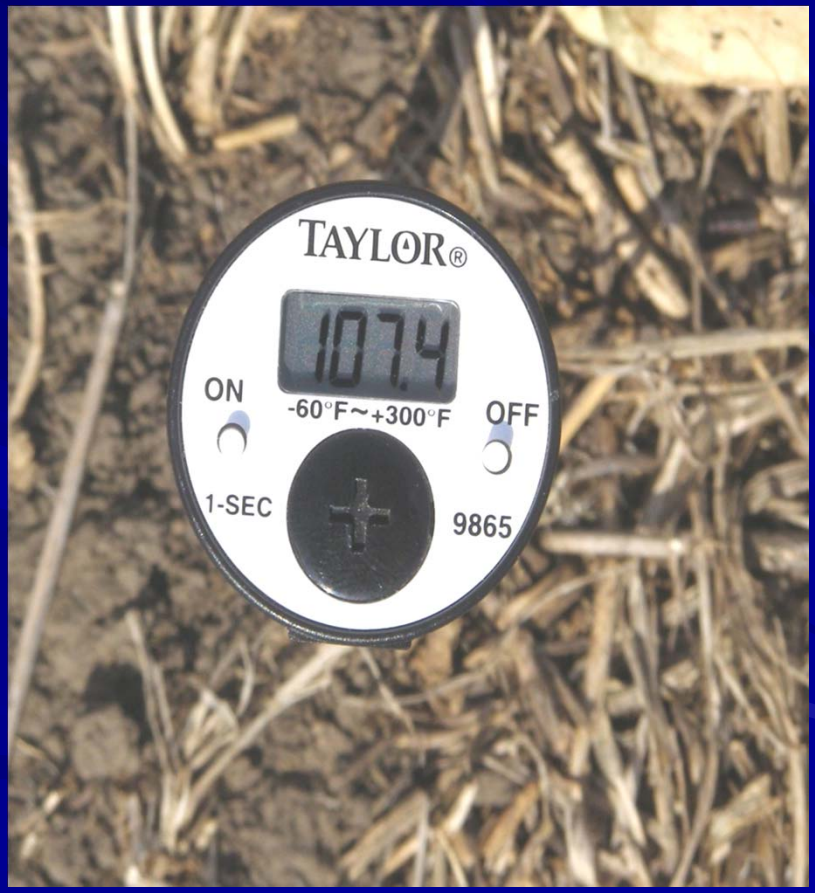
Where Do Majority of Soil Microbes Live & Function?


Microbe “Home” – Soil microbes live and function in root zone.

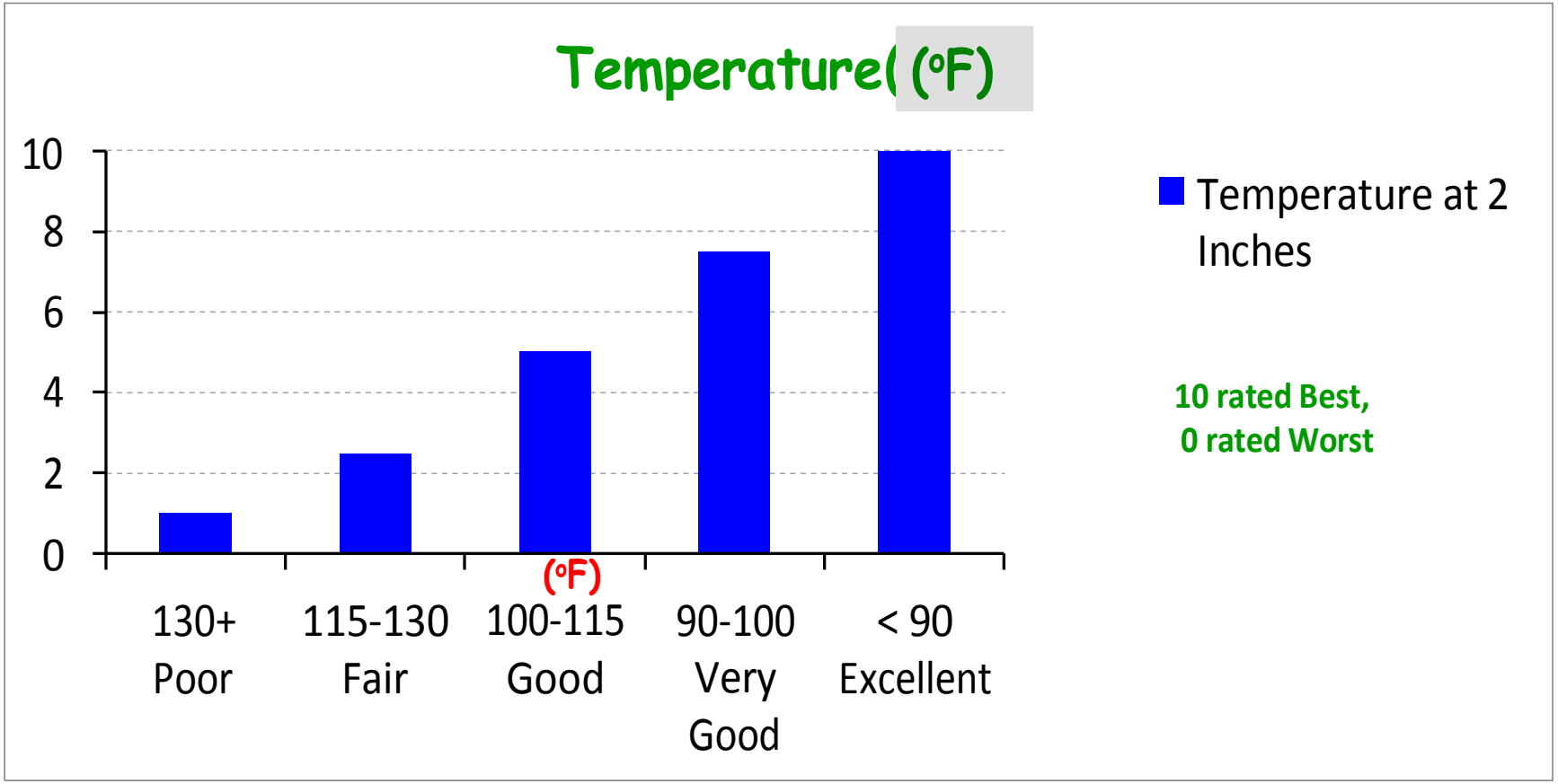
Value of Ground Cover

Soil Temperature

Soil Temperatures



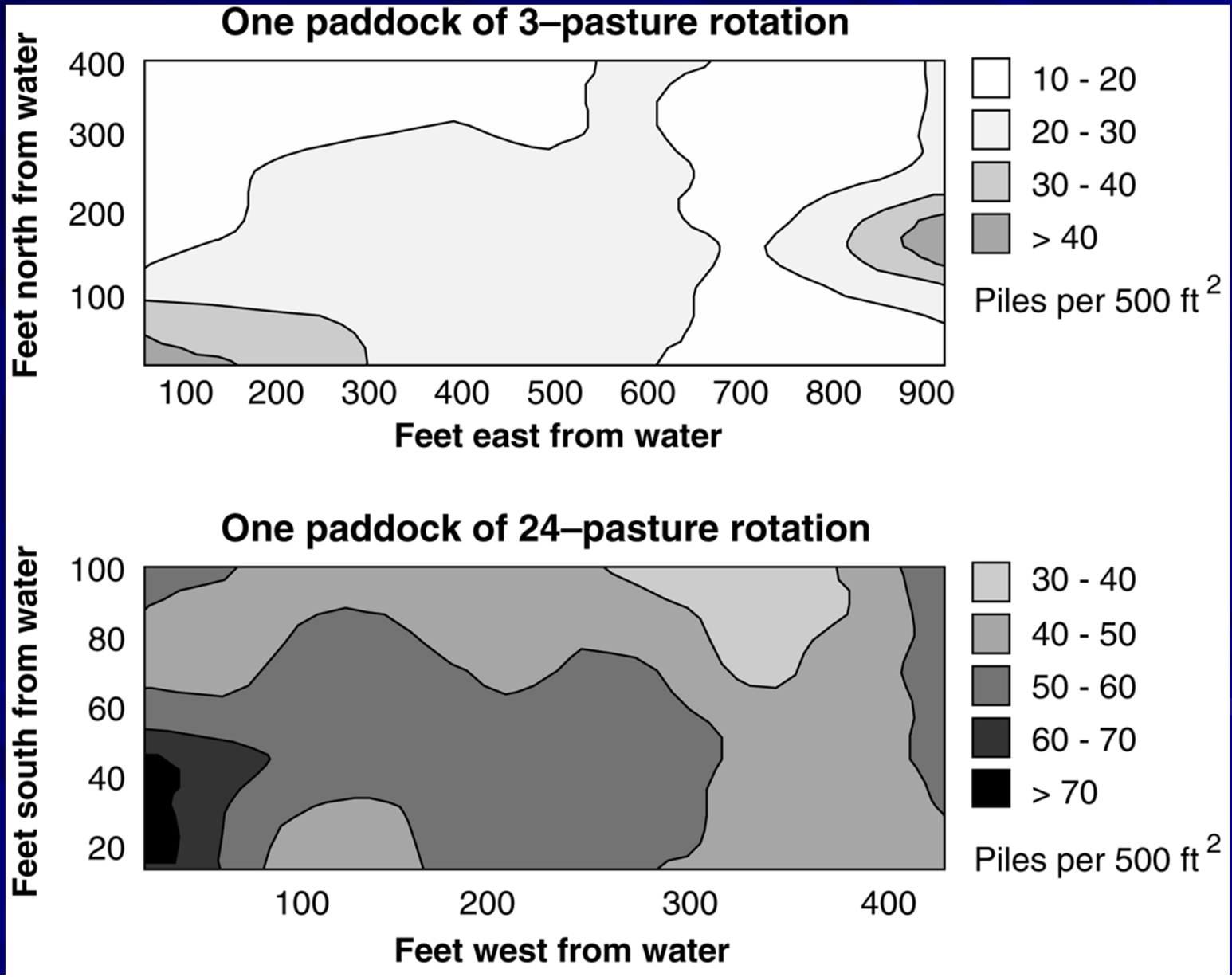
Indicator: Soil Temperature



1. At 70 °F, 100% of Soil moisture is used for growth.
2. At 100 °F, 85% of Soil moisture is lost and 15% is used for growth.
3. At 115 °F, microbes begin to breakdown, and
4. At 140 °F they die.

Value of Manure Distribution Through Multi-Paddock Grazing and Frequent Moves

Manure Distribution



Manure Distribution

Rotation Frequency	Years to Get 1 Pile/sq. yard
Continuous	27
14 day	8
4 day	4 – 5
2 day	2
1 time a day	??

Higher Plant Brix

-

What is Brix?

- Dissolved plant solids include sugars (such a sucrose and fructans), minerals, amino acids, proteins, lipids and pectins.
- About 50-80% of the Brix measurement represents plant sugars, with the remaining portion representing the other plant solids.

Brix Index of Common Forages

Forage	Poor	Avg	Good	Excellent
Alfalfa	4	8	16	22
Ryegrass	6	10	14	18
Sorghum	6	10	22	30
Fescue	2	4	7	12
Bermuda	2	4	6	8

Why High Brix in Forages?

- Research shows that High Brix forages increase animal gains and milk production.
- High Brix Forages also are more drought resistant, freeze tolerant, and more resistant to plant disease and pests
  - (Moorby, 2001).
  - (Moller, 1996).
  - (Downing & Gamroth, 2007; Miller, et al, 1999).
  - (Allison, 2007).
  - (McKenzie, 2007).

Brix Advantage

- Brix 5.0% or less = ADG in low 1's.
- Brix 8-12% = ADG in low to mid-2's.
- Brix 12 – 15% = ADG in mid-high 2's.
- Brix > 15% = ADG in high 2's to 3's.
- Every 1.0% increase in Brix adds 0.1 to 0.3 ADG.

Better Beef

Grass Fed Potential

USDA Prime Grass Finished Beef

Value of Grazing for Wildlife

Grazing Improves Wildlife Habitat

Slide 122

CJ3 Photo Credit Needed

Jones, Conley, 1/14/2014

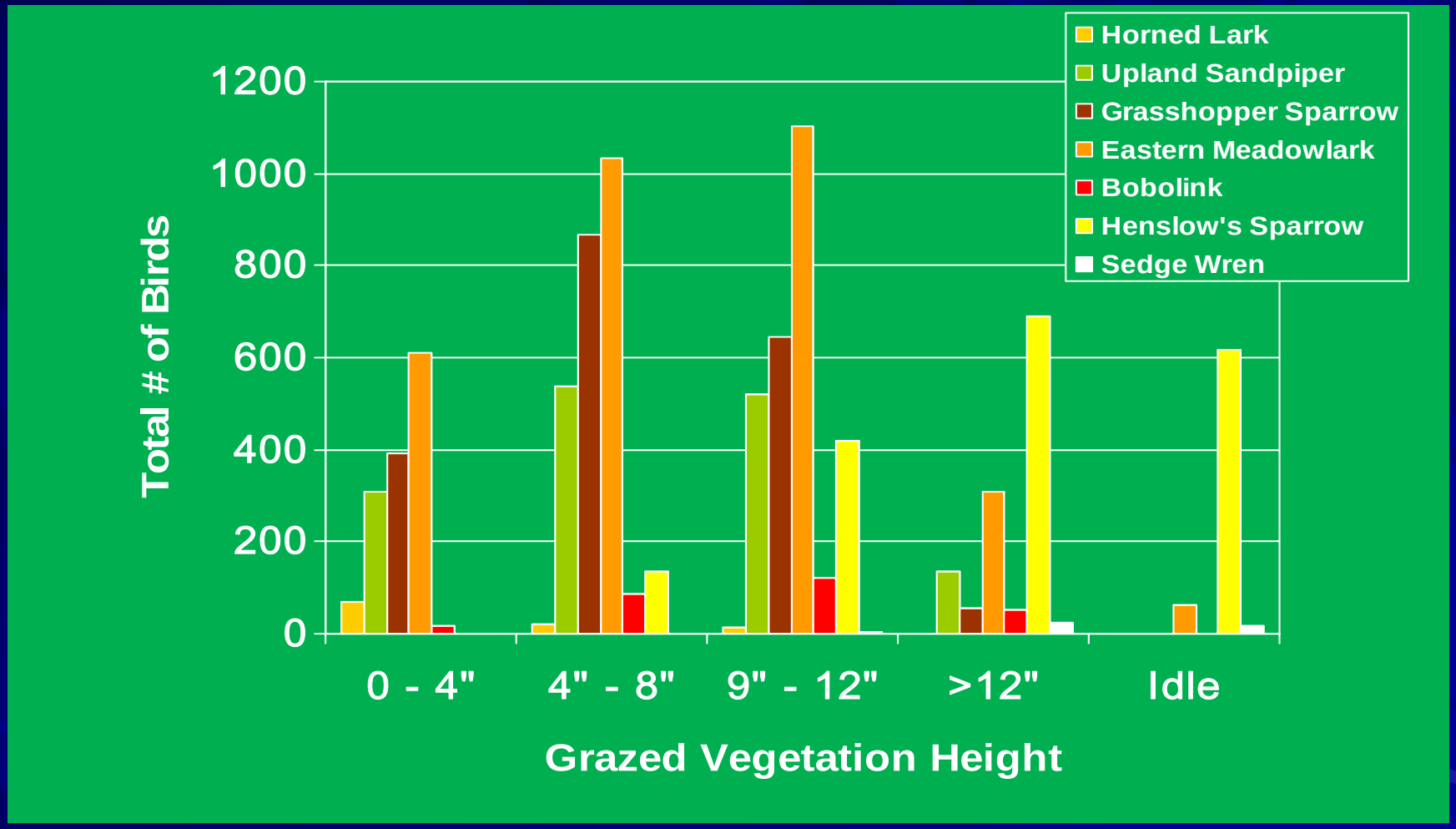
Bird-Friendly Grazing

New paddock with over 20 documented species

Pasture after hard grazing with cover remaining for birds

Images courtesy of Dr. Allen Williams

Bird-Friendly Grazing



Grazing Improves Grassland Bird Habitat

Courtesy of Laura Paine

Improving Fish Habitat

Trout Unlimited: Driftless Area Initiatives

- Trout Unlimited (TU) is partnering with state & federal agencies, conservation groups and farmers to promote managed grazing
- Recreational fishing in the Driftless generates over $1.0 billion annually
- TU is a leader in The Kickapoo Grazing Initiative, promoting grazing to increase SOI and reduce nutrient runoff in streams and rivers
- Improvements in fish populations are so dramatic that WI DNR is removing brown trout from some streams

Grazing Spring Coulee Creek

Grazing in Spring Coulee

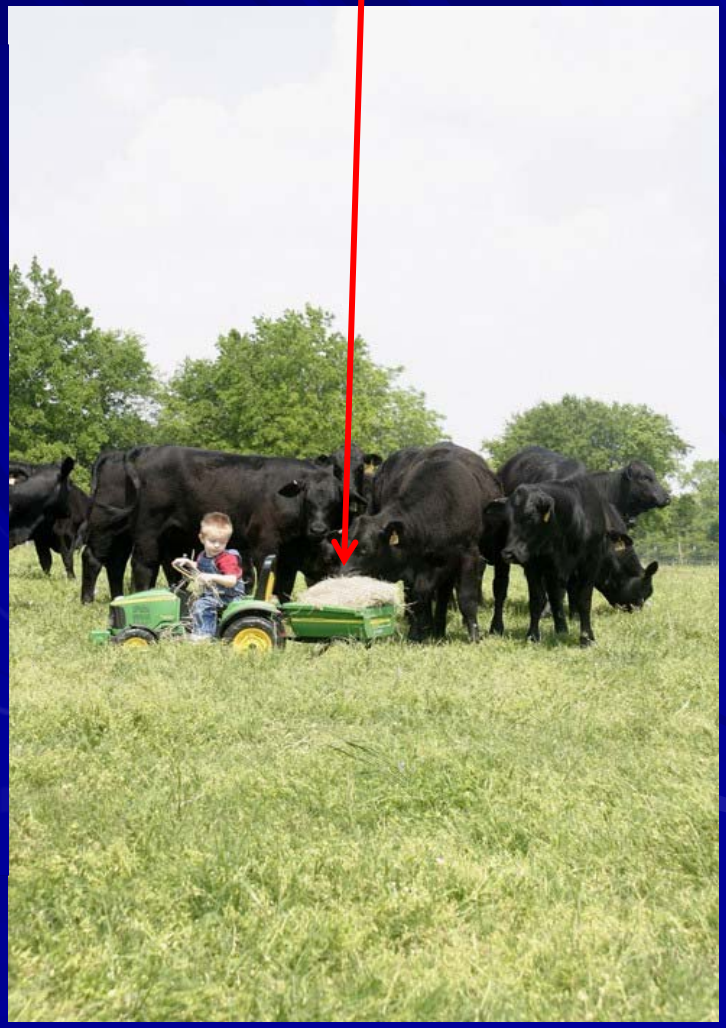
Ungrazed, unrestored stretch

Images Courtesy of Willow Creek Ranch

Important Grazing Tips

- Know DM availability and allow 3.0% - 3.5% DM per head daily.
- Take no more than 30%- 50% available DM in a single grazing.
- Move forward rapidly to not allow too many bites of the same plant.
- Know the brix content.
- Turn into new paddocks in early to mid-afternoon (peak brix or plant sugars).
- Stage of forage maturity critical – Mid-stage to slightly beyond…

More of This and Less of This



Building for Future Generations

Thank you!