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Grazing Cropland and Grassland

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June 24th and 27th, 2019
Detroit Lakes and Marshall, MN

Advantages Grazing Cropland

- Livestock manure as primary source of nutrients for crop production cycling nutrients from crops through animals and back to land*
- Biological acceleration, improving soil health at faster rate
  - Add biology
  - Incorporation of organic matter
- Additional source of income
- Increased nutrient cycling (C/N ratio impacts)

Advantages Grazing Cropland

No-Till Farmer

- Increase mycorrhizal fungi abundance
- More rapid building of soil aggregates
- Improved infiltration
- Minimize import of feedstuffs to farm*

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Advantages Grazing Cropland

- Potential increase in diversity of insects to help reduce pest species
- Livestock serve as a sink for agricultural byproducts*

King's Agriseeds

Disadvantages Grazing Cropland

Megapixl.com

- Lack of knowledge/familiarity about:
  - Livestock management/herd health
  - Equipment/infrastructure needed; how to use
- Increased time/level of management to prepare operation, move fence, livestock, water, etc.
- Lack of grazing infrastructure: no fences, fences in poor condition, no water nearby

Disadvantages Grazing Cropland

- Potential hassle working out lease agreement with livestock owner
- Potential risk of livestock not being moved frequently enough causing compaction
- Liability if livestock cause accident on public roads

No-Till Farmer

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Impacts of Grazing Cover Crops on Soil Health

- Pasture Project studied 3 years of cover crop and livestock integration on 8 farms in MN and IA
- Livestock grazed diverse, cover crop mixes (at least two brassicas, two legumes, two grasses)

Hay & Forage Grower

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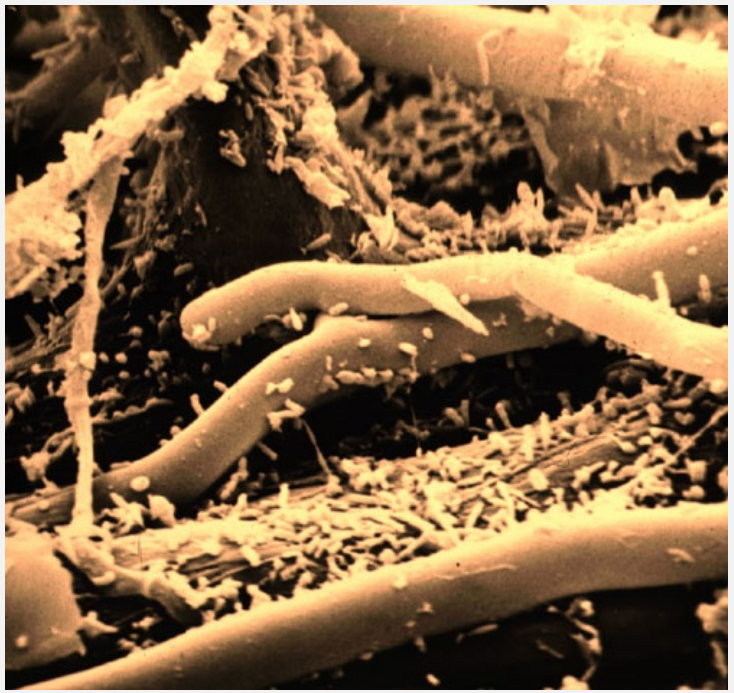
Impacts of Grazing Cover Crops on Soil Health

Compared to control (no covers/no grazing):

- Fertility → slight increases for P, K, Ca, Mg, S, B, Cu, Mn
- Chemistry → no change for pH, OM, CEC
- Carbon → increases for Total Organic Carbon, Inorganic C, Total C
- Biology → increases for TLMB (Total Living Microbial Biomass), TBB (Total Bacteria), G+ bacteria, Actinobacteria, Rhizobial bacteria, G- bacteria, total fungi, AMF, Saprophytic fungi, Protozoa



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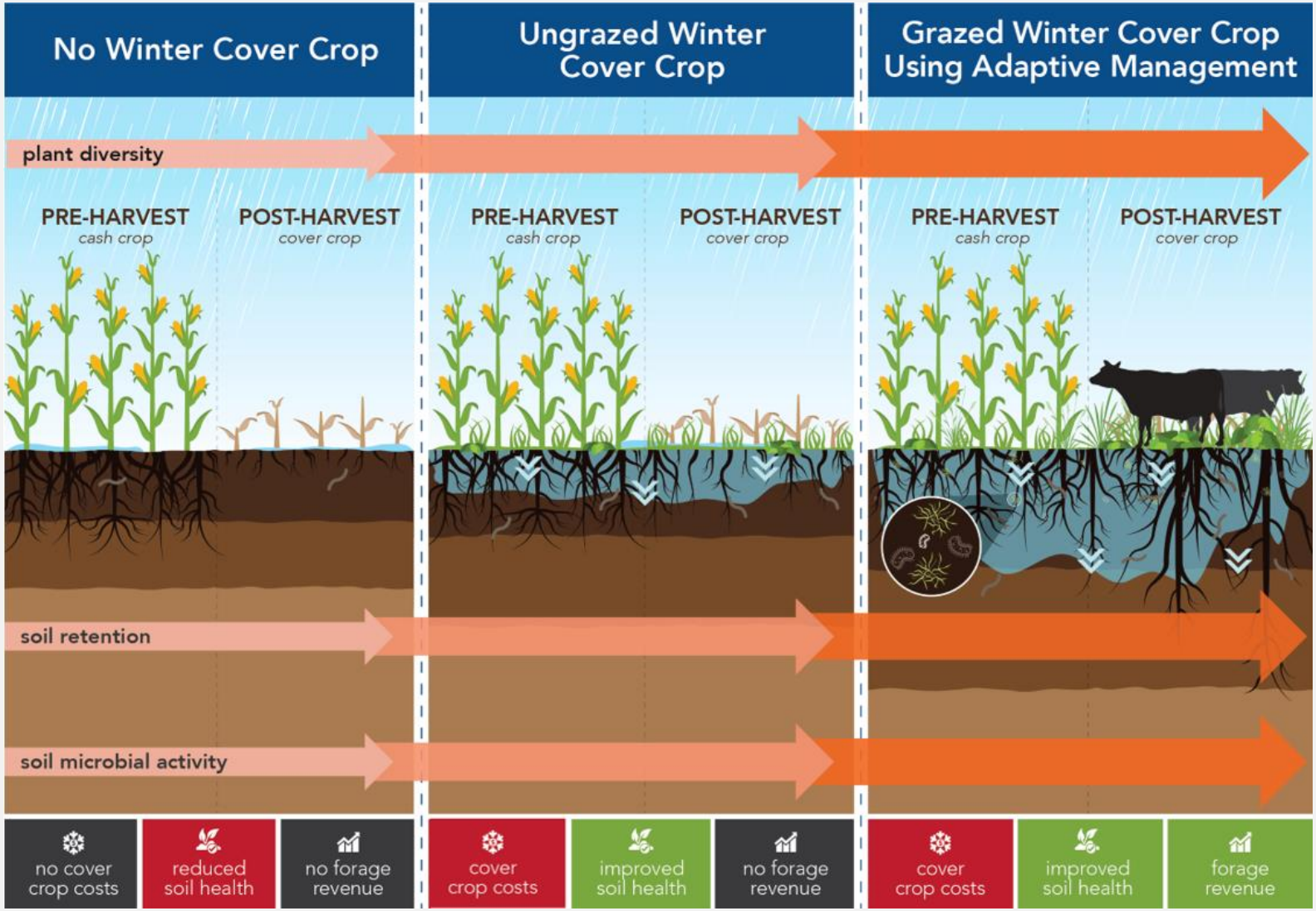
Impacts of Grazing Cover Crops on Soil Health



Source: The Pasture Project

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Impacts of Grazing Cover Crops on Soil Health

- Research in Georgia grazing cereal rye, pearl millet cover crops under conventional tillage and no-till
- Compared to ungrazed control:
  - Bulk density → slight negative effect
  - Aggregate stability → no effect
  - Water infiltration→ reduced when soil water content was high
  - Soil penetration resistance → greater in conventional tillage; no effect in no-till
- **Conclusion: grazing cover crops did not cause substantial physical damage to soil**

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Impacts of Grazing Cropland on Soil Health

- Research in Iowa grazing corn stalks in winter in a corn-soybean rotation
- Compared to ungrazed control:
  - Bulk density → no effect
  - Penetration resistance → greater in top 4 inches for areas grazed when temperatures were above 32 deg.
  - Soybean establishment → no effect
  - Soybean yield → minimal reduction
- **Conclusion: utilizing corn stover as an inexpensive feed source is a viable option; posing minimal reductions to soybean yield**

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Impacts of Grazing Cropland on Soil Health

- 16-year study in Nebraska grazing corn residue in fall or spring
- Compared to ungrazed control:
  - Bulk density → no effect
  - Aggregate stability → no effect
  - Particulate organic matter → no effect
  - Soil organic C → no effect
  - Penetration resistance → negative effect
  - Yield response → no effect on corn or soybean yield
- **Conclusion: long-term corn residue grazing had little to no effect on soil properties and did not affect crop yields**

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Impacts of Grazing Cover Crops on Soil Health

Farm	N (lbs/ac)	P (lbs/ac)	K (lbs/ac)	WEOC* (ppm)	OM (%)	INFL (in/hr)
1	2	156	95	233	1.7	0.5
2	27	244	136	239	1.7	0.7
3	37	217	199	262	1.5	0.45
4	281	1006	1749	1095	6.9	30.0+

Farm 1: Diverse cash grain, tillage, cover crops, no synthetics, no livestock
Farm 2: Minimum tillage, two crops, mod. synthetics, no livestock
Farm 3: Med. diversity, no-till, high synthetics, no livestock
Farm 4: High diversity, no-till, cover crops, 1 herbicide, livestock

*Water Extractable Organic Carbon

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Impacts of Grazing Cover Crops on Permanent Grassland in Rotation

- Greater plant recovery
- Greater forage production
- Maintains and/or improves plant diversity → sufficient time that plants can reseed themselves
- Greater root biomass
- Greater drought tolerance
- Improved plant nutrient density from roots accessing previously unexplored depths of soil profile

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Something to Ruminate About

- What are some advantages for grazing cover crops?
- What are some disadvantages for grazing cover crops? How can they be overcome?

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What are Some Advantages from Grazing Grasslands for Soil Health?

- High quantity & quality forage for livestock from perennials
- Allows enough leaf area to:
  - Protect soil from raindrop impact
  - ↓ Evaporation
  - ↑ Infiltration
  - Hasten plant recovery
- Post-grazing recovery to maintain plant vigor, desired plant composition
- Controls grazing pressure in time, space

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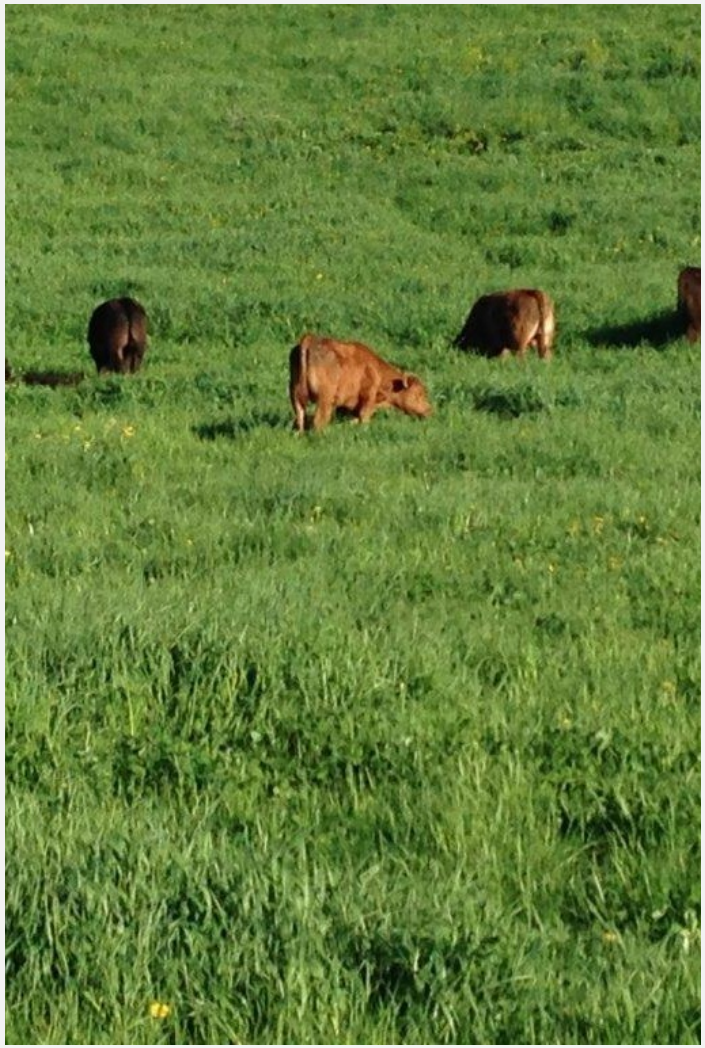
What are Some Advantages from Grazing Grasslands for Soil Health?



- ↓ Need for mechanical harvest
- Greater gain per acre
- Biological acceleration, improving soil health at faster rate
  - Add biology
  - Incorporation of organic matter
- ↑ Nutrient cycling (C:N ratio)
- Ensures livestock eat variety of plants for improved animal health

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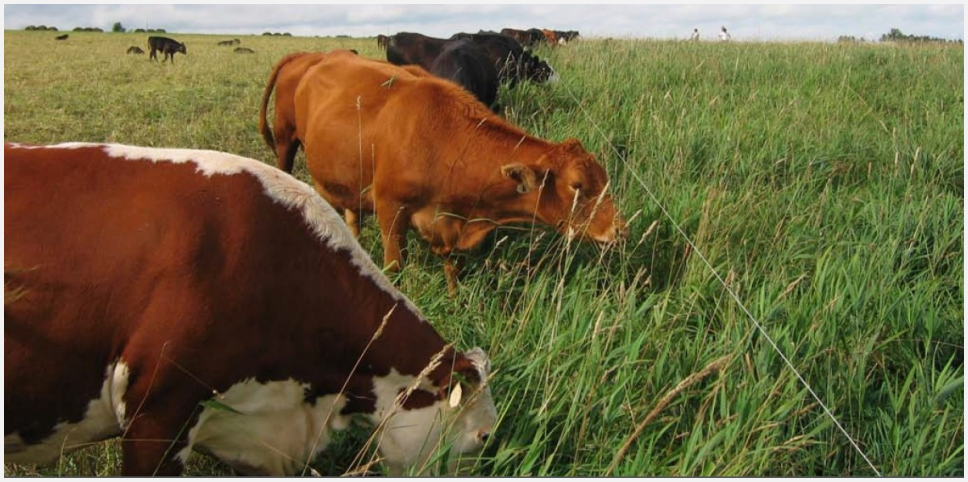
Impacts of Grazing Grasslands for Soil Health

- 9-year ranch-scale study compared heavy continuous, light continuous, multi-paddock, and no grazing on vegetation and soil properties
- Bare ground highest under heavy continuous grazing
- Aggregate stability lowest under heavy continuous grazing
- Dominant grasses
  - Multi-paddock/No grazing: tall grasses
  - Light/Heavy continuous: short grasses



Impacts of Grazing Grasslands for Soil Health

- Soil penetration resistance lowest under multi-paddock grazing, no grazing
- No difference in bulk density, infiltration rate
- Sediment loss highest with heavy continuous grazing
- OM and CEC highest with multi-paddock grazing, no grazing
- Fungal/bacteria ratio highest with multi-paddock grazing indicating higher:
  - Water-holding capacity
  - Nutrient availability/retention

Impacts of Grazing Grasslands for Soil Health

- 3 Mississippi farms
  - All same soil types
- Farm 1: Adaptive High Stock Density grazing management for 5 years
- Farm 2: Continuous grazing; slow rotation for 50+ years
- Farm 3: Continuous grazing; 30+ years; no rotation

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Impacts of Grazing Grasslands for Soil Health

- Three Mississippi farms
- Farm 1: Adaptive High Stock Density grazing management for 5 years
- Farm 2: Continuous grazing; slow rotation for 50+ years
- Farm 3: Continuous grazing; 30+ years; no rotation
- All same soil types

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Impacts of Grazing Grasslands for Soil Health – Total Soil Carbon (kg/m^2)

Soil Depth	AHSD Grazing	Continuous Grazing Slow Rotation	Continuous Grazing No Rotation
0 – 6”	4.67	1.64	1.36
6 – 12”	4.00	1.88	1.37
12 – 18”	2.95	1.03	0.40
18 – 24”	2.04	1.02	0.54
24 – 30”	1.71	0.38	0.40
30 – 36”	1.42	0.41	0.34

AHSD: Adaptive High Stock Density
Source: Allen Williams, 2016

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Impacts of Grazing Grasslands for Soil Health – Soil Organic Matter (kg/m^2)

Soil Depth	AHSD Grazing	Continuous Grazing Slow Rotation	Continuous Grazing No Rotation
0 – 6”	4.26	3.28	2.72
6 – 12”	3.22	3.76	2.74
12 – 18”	3.10	2.06	0.80
18 – 24”	2.98	2.04	1.08
24 – 30”	2.80	0.76	0.80
30 – 36”	1.98	0.82	0.68

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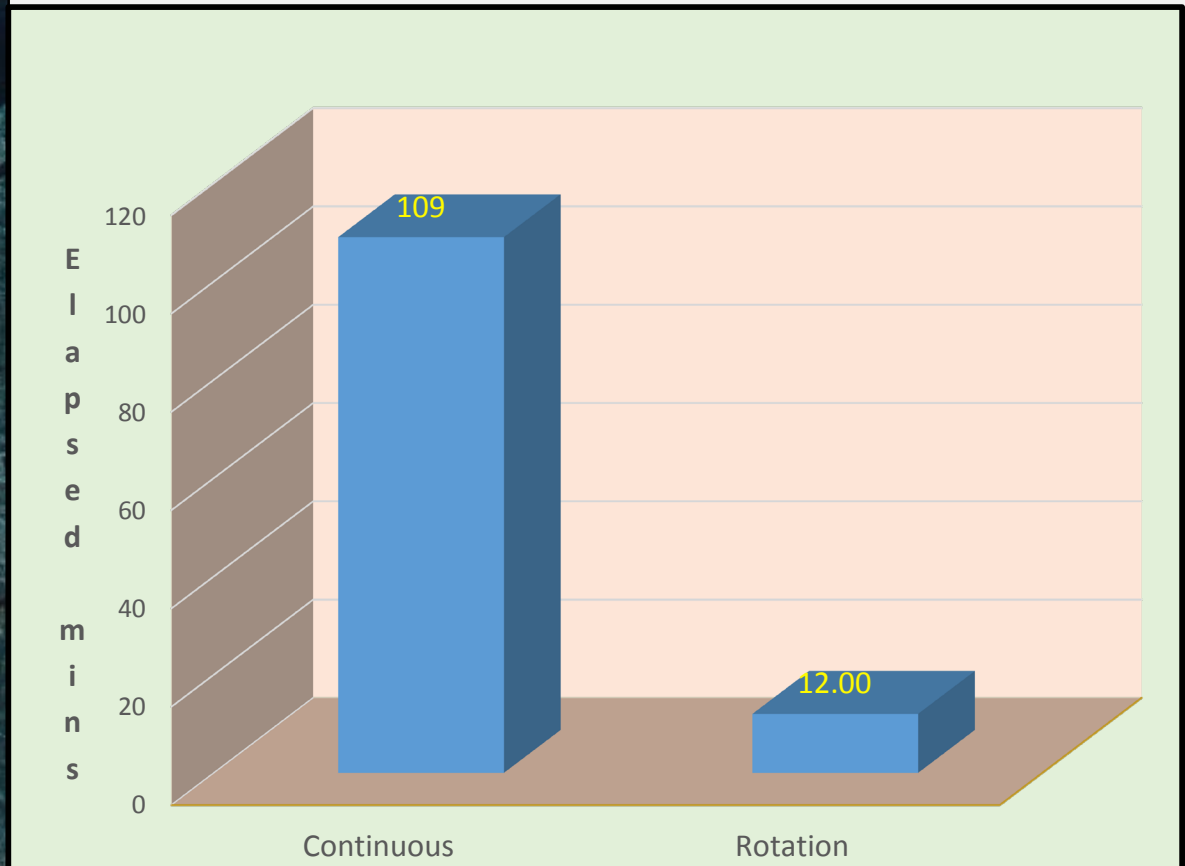
Barnes soil – Eastern South Dakota

Deuel County, SD
Barnes soil

Continuous season-long

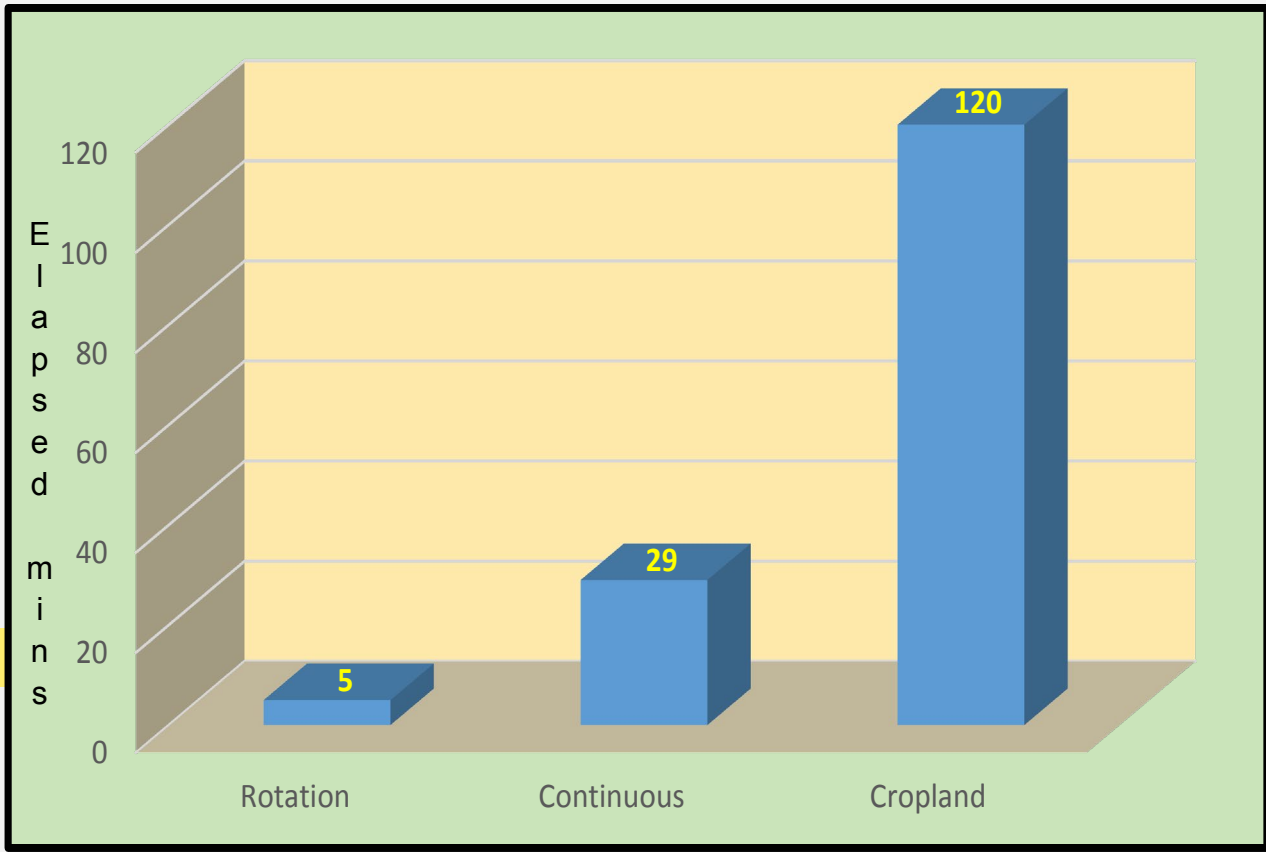
Rotational Grazing

Infiltration Rate



Hyde County
Glenham soil

Infiltration Rate



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Impacts of Grazing Grasslands for Soil Health

% Leaf Removed	% Root Growth Stopped
10	0
20	0
30	0
40	0
50	2 to 4
60	50
70	78
80	100
90	100

When You Overgraze the Shoot You Overgraze the Root!

Tall Fescue Rotational

Tall Fescue Continuous

Tall Fescue Continuous

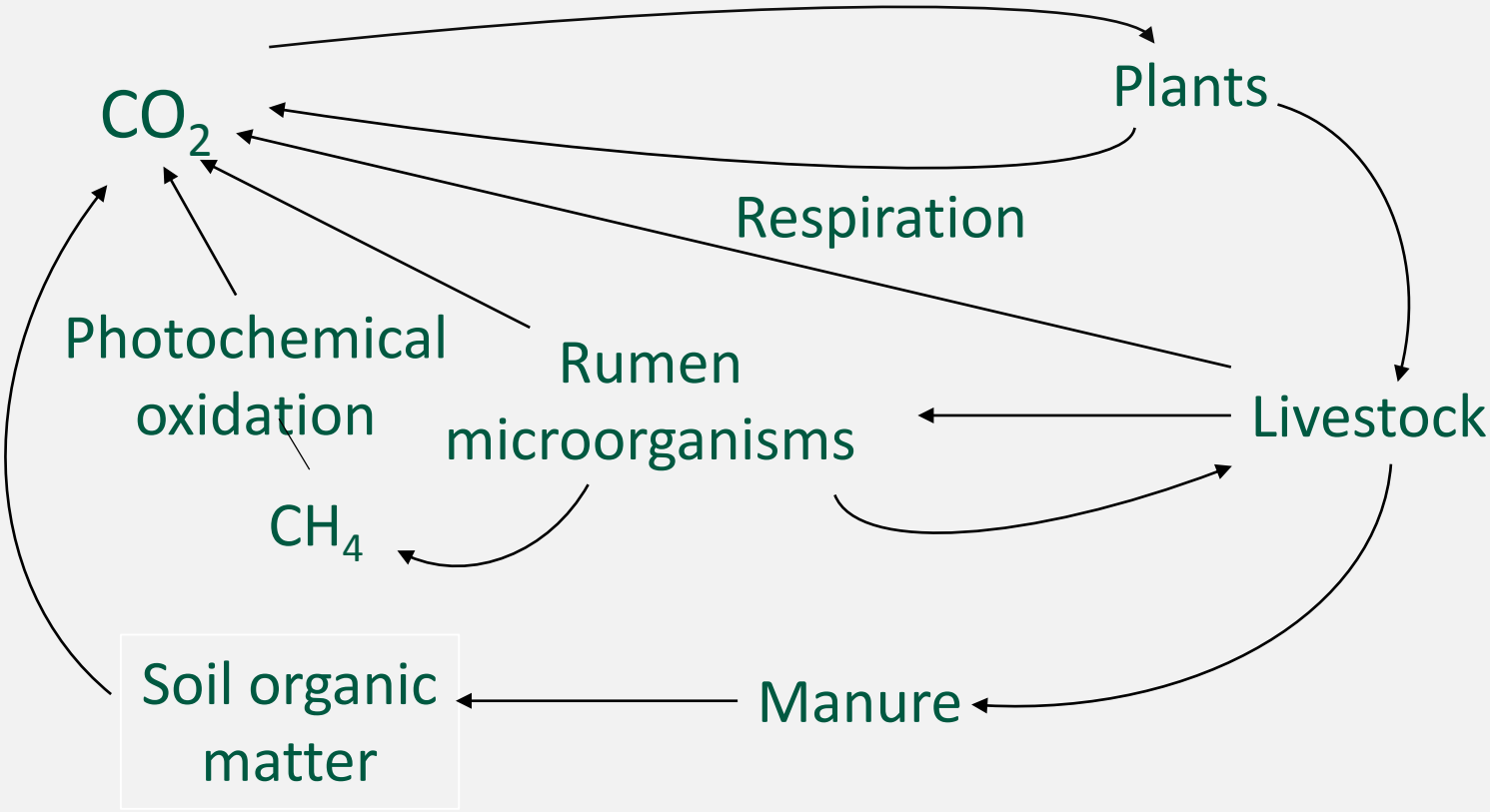
Orchardgrass Rotational

Orchardgrass Rotational

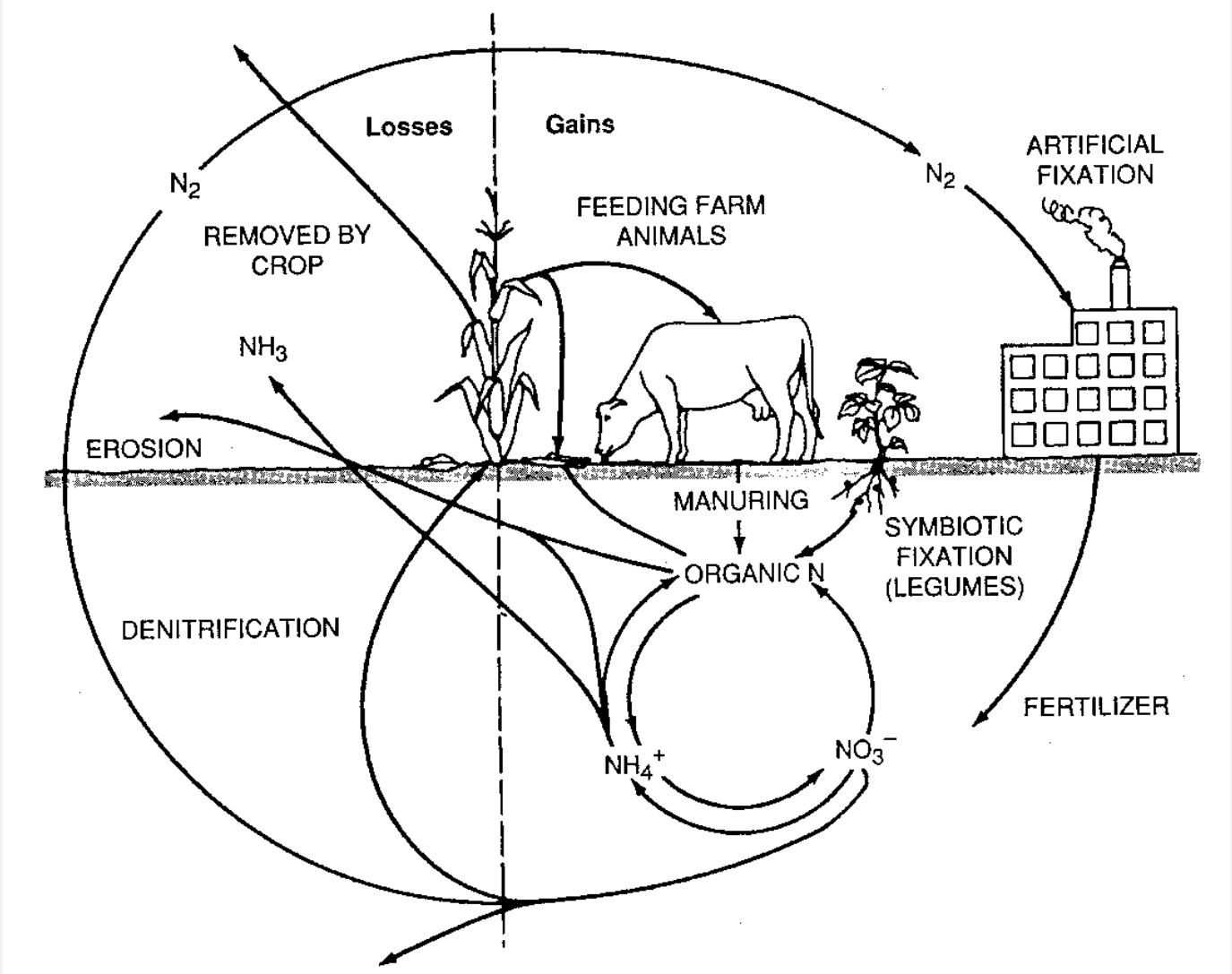
Fescue/Bluegrass Rotational


Well-managed
Species A
Well-managed
Species B
Well-managed
Species B
Recently Grazed
Overgrazed
Species B
Overgrazed
Species A

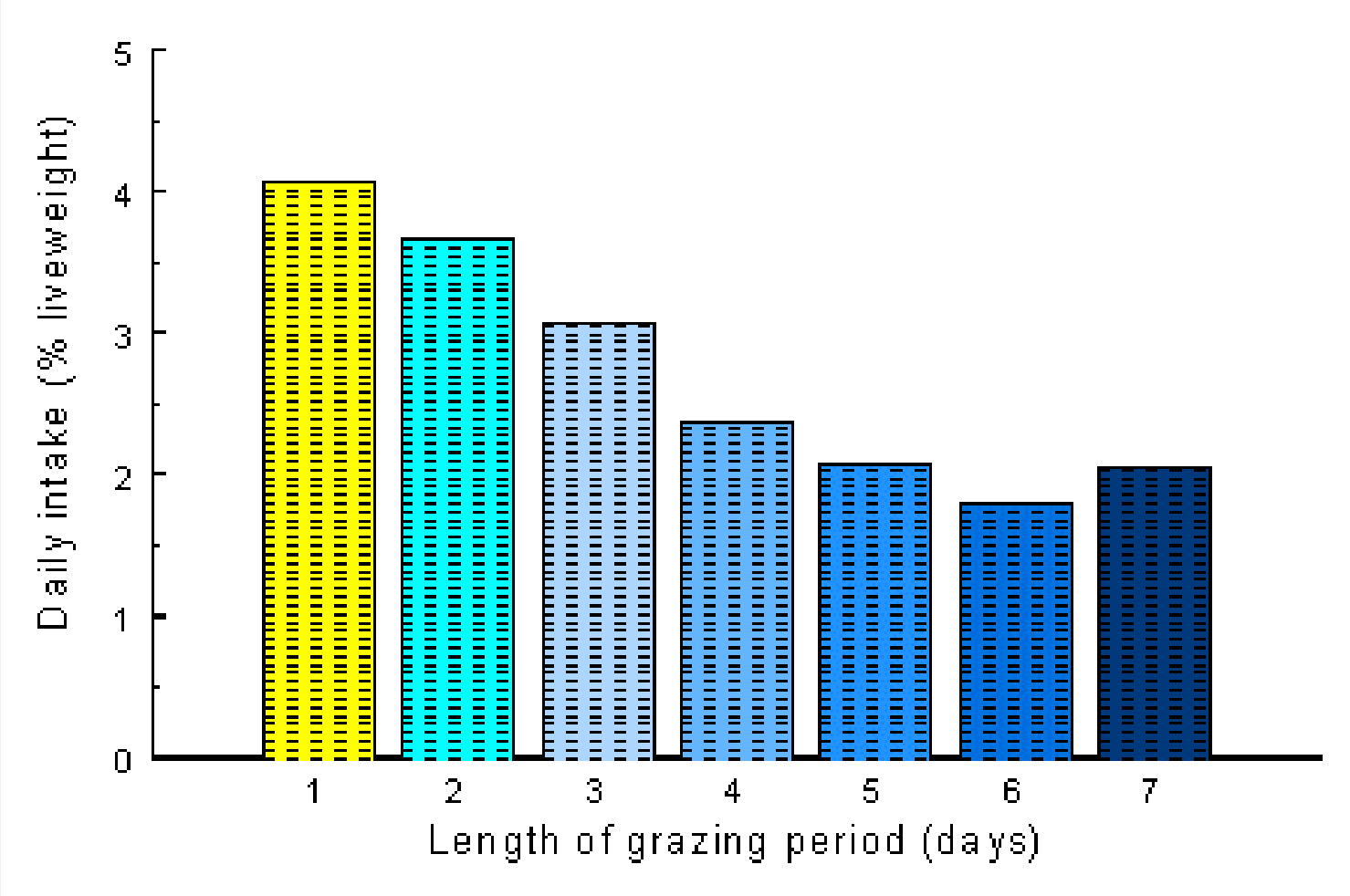
Effect on Carbon Cycle with Livestock



Effect of Grazing on Nitrogen Cycle

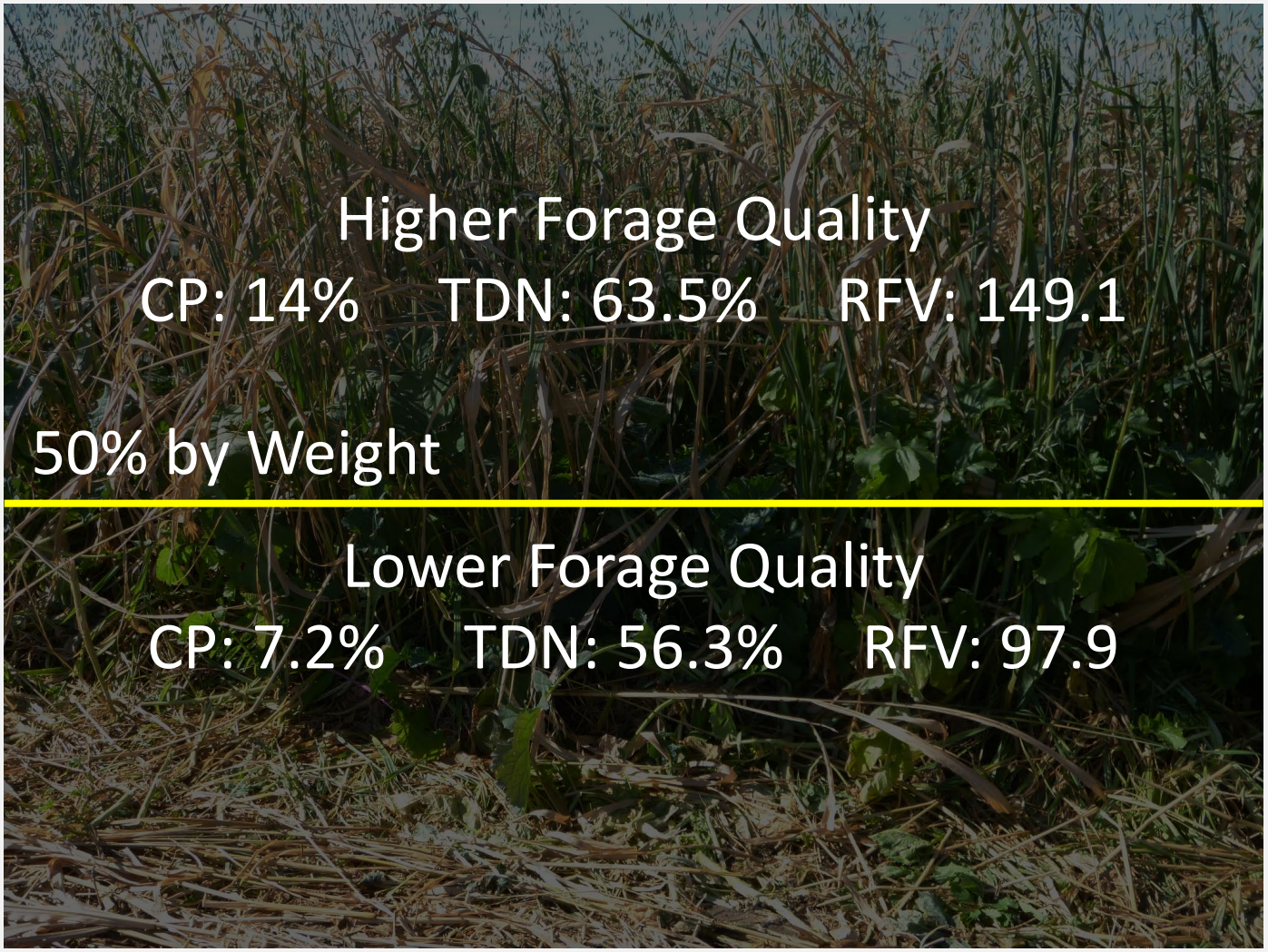


Effect of Graze Period on Animal Performance



Source: University of Missouri Forage Systems Research Center

Forage Quality Declines as Livestock Graze Closer to the Soil



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Knowledge Check

On perennial cool-season grasses, what percentage of leaf area can be removed without significantly affecting root growth?

Answer: 50%

Grazing System Objectives

- Grazing is a tool that can….
  - Improve the resource
  - Degrade the resource
- Grazing System Objective:
  - Provide adequate nutrition
  - Protect and feed soil: feed above/below-ground herd
  - Work within manager's labor; social constraints

- Fast track to soil health → look to nature for common patterns; mimic them as closely as possible

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Natural Disturbances Stimulating Major Ecological Change

- Tornados
- Hurricanes
- Earthquakes
- Volcanos
- Lightning strikes
- Wildfires
- Large herd of herbivores on migration

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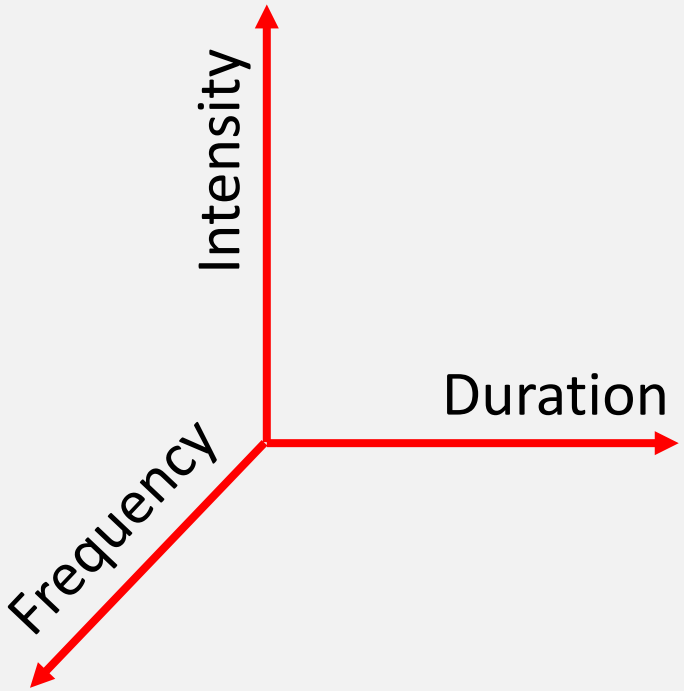
Dimensions of Disturbance

Three dimensions of disturbance:

- Frequency
- Duration
- Intensity

Natural disturbance patterns that stimulate major ecological change are acute, not chronic:

- Low frequency
- Short duration
- High intensity



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Grazing Management Controls . . . .

- When/how often livestock graze a field/paddock → Frequency
- When livestock leave → Duration
- Amount of forage removed → Intensity
- Weight of herd/flock in field/paddock → Intensity
- Field/paddock size → Intensity

} Stock Density

Livestock must be controlled through grazing management to achieve greatest benefits

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Grazing Management for Soil Health

- Provide sufficient quantity and quality of forage
- Ensure animals eat a variety of plants and decrease impacts on desirable plants
- Leave enough leaf area to facilitate interception and infiltration of precipitation; maintain sufficient photosynthetic capacity for rapid plant recovery
- Sufficient post-grazing recovery to maintain plant vigor and desired plant composition
- Control grazing pressure in time and space to facilitate previous four principles

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Adaptive Grazing Management

Mimics natural, acute disturbance patterns under changing environmental conditions; uses feedback from the system to adapt management to fit ecosystem

- Frequency: low → plants grazed few times per year for total plant recovery of desirable plants
- Duration: short → few days to daily to few hours* to prevent re-grazing of desirable plants; facilitate higher stock densities
- Intensity (forage removed): low to moderate → for total soil cover and plant regrowth; facilitate higher stock densities
- Intensity (stock density): moderate to high → for best trampling effect, nutrient distribution, plant diversity, forage quality

*Depending on forage growth rate, resource concerns, time constraints, and objectives

Grazing Systems and Stock Density

Longer

Relative Time to Detect Improvements

Shorter

- **Rotational System:** less than 4,000 lbs/ac
- **Management-intensive Grazing (MiG):** 4,000 – 50,000 lbs/ac
- **High Stock Density (HSD):** 50,000 – 250,000 lbs/ac
- **Ultra-High Stock Density (UHSD):** greater than 250,000 lbs/ac
- **Adaptive Grazing:** 4,000 – 250,000+ lbs/ac

Adaptive Grazing Management

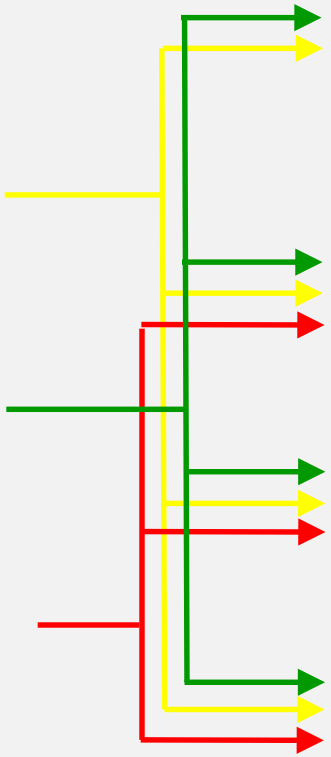
Low frequency

+

Short duration

+

Variable intensity



Soil Health Principles

Minimize (chronic) disturbance

Maximize soil cover

Maximize biodiversity

Maximize living roots

Continuous Grazing

Chronic disturbance resulting in poor soil health

- Frequency: high → same plants grazed every 7 – 9 days
- Duration: long → livestock access plants long enough to severely graze regrowth multiple times
- Intensity (forage removed): moderate to high → all plants grazed down very short or plants grazed very short with ungrazed/unpalatable plants in same field/paddock
- Intensity (stock density): low

Requires little to no management skill


Growth Potential with Sufficient Recovery

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Management Strategies

- Proper utilization
- Adequate recovery
- Change season of use from year to year

- Move to year-round grazing as much as feasible

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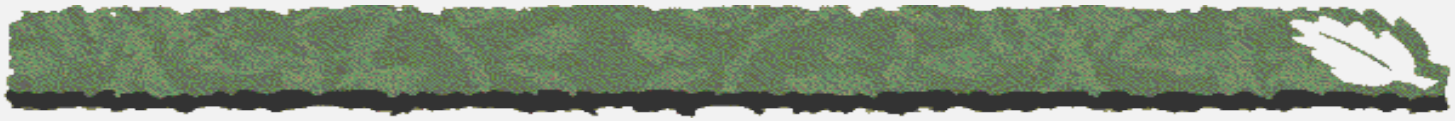
Leaves – The Facts of Growth



- Roots uptake and send water, minerals, and micronutrients to leaves.
- Roots DO NOT transport carbohydrates to the leaves.
- Leaves use carbohydrates to respire.
- 5-10% of new leaf growth is from residual sheath & crown carbohydrate reserves.
- 90-95% of new leaf growth comes from carbohydrates resulting from current photosynthesis.

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Bottom Line

It takes leaves to make leaves!

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Haying

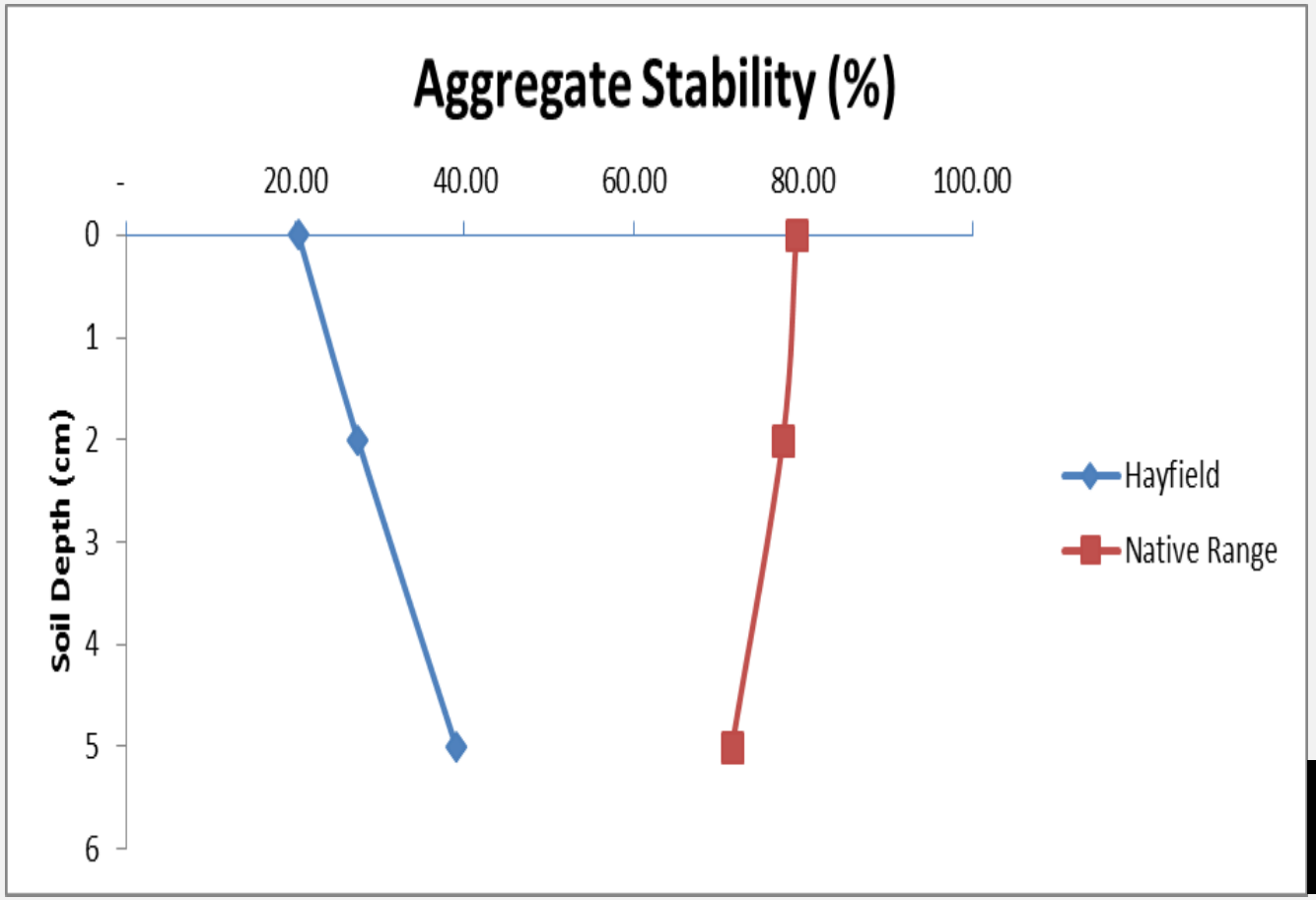
Another disturbance resulting in poor soil health

Midwest Machinery Company

USDA United States Department of Agriculture

Effect of Haying on Aggregate Stability

Mellette County, SD



Rotational Grazing | Hayland

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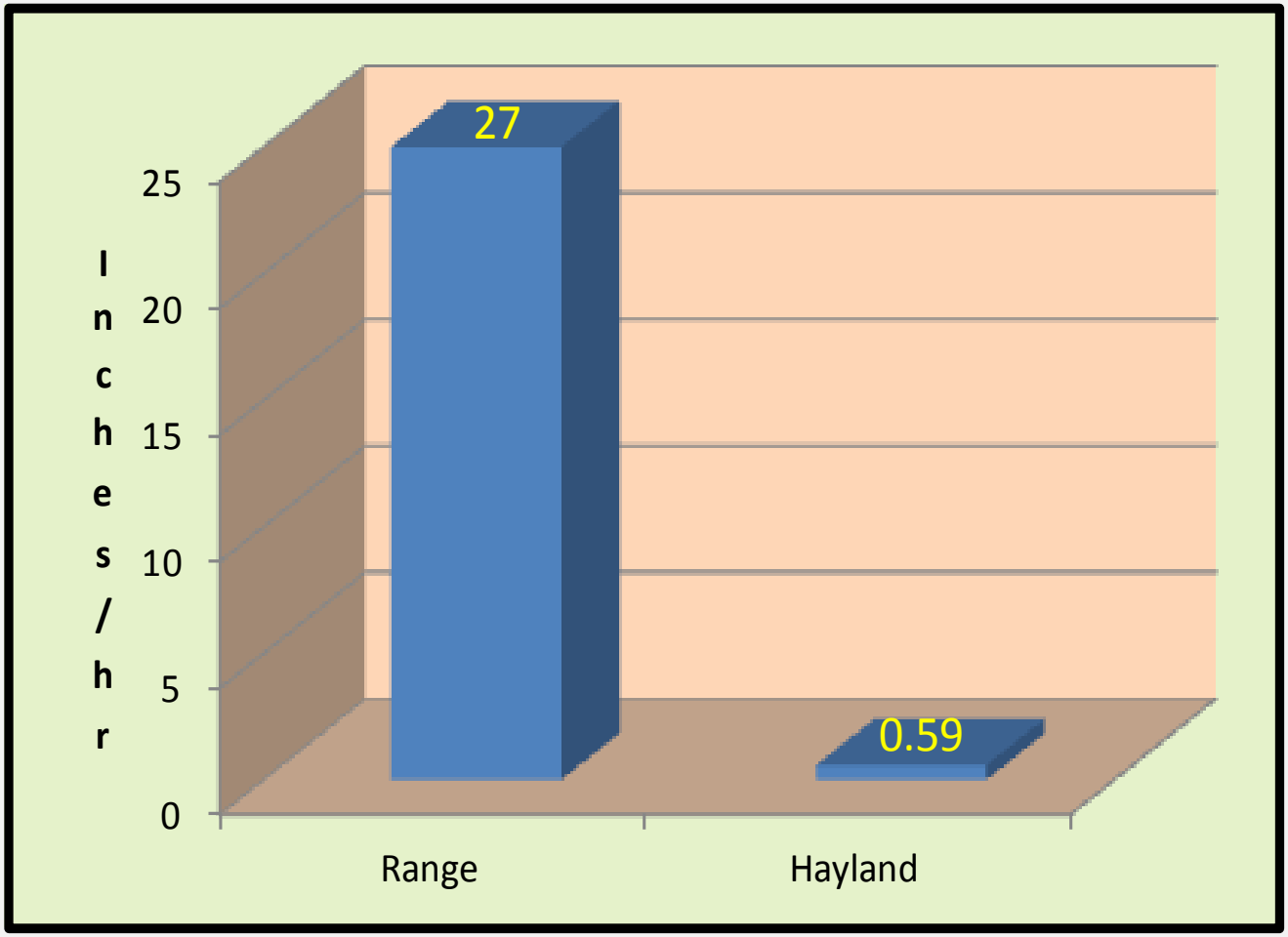
Effect of Continuous Haying on Water Infiltration Rate

Mellette County, SD

Rotational Grazing | Hayland



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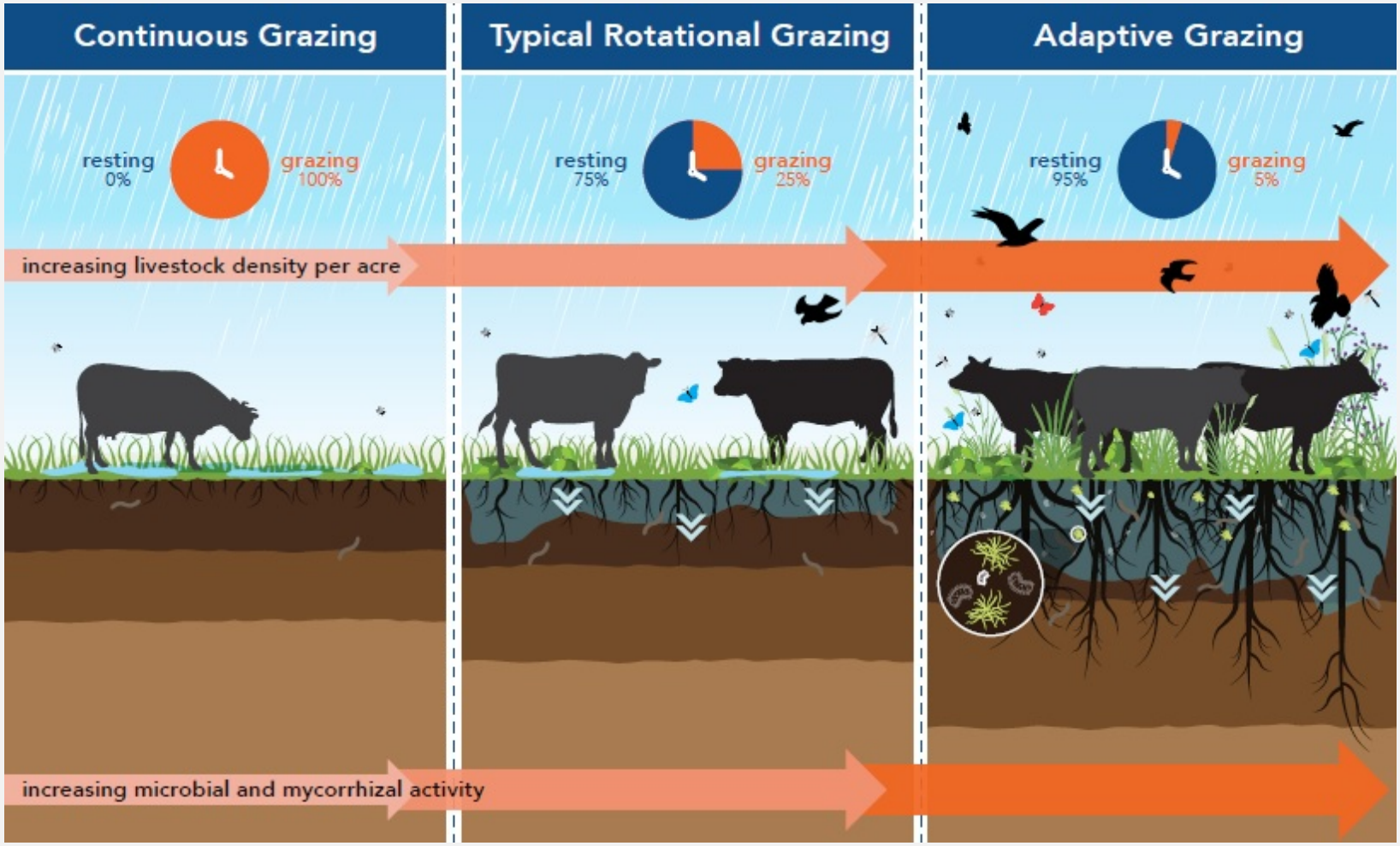
Knowledge Check

What are the three major characteristics of Adaptive Grazing?

1) Low frequency
2) Short duration
3) Variable intensity

Benefits of Adaptive Grazing



Source: Pasture Project

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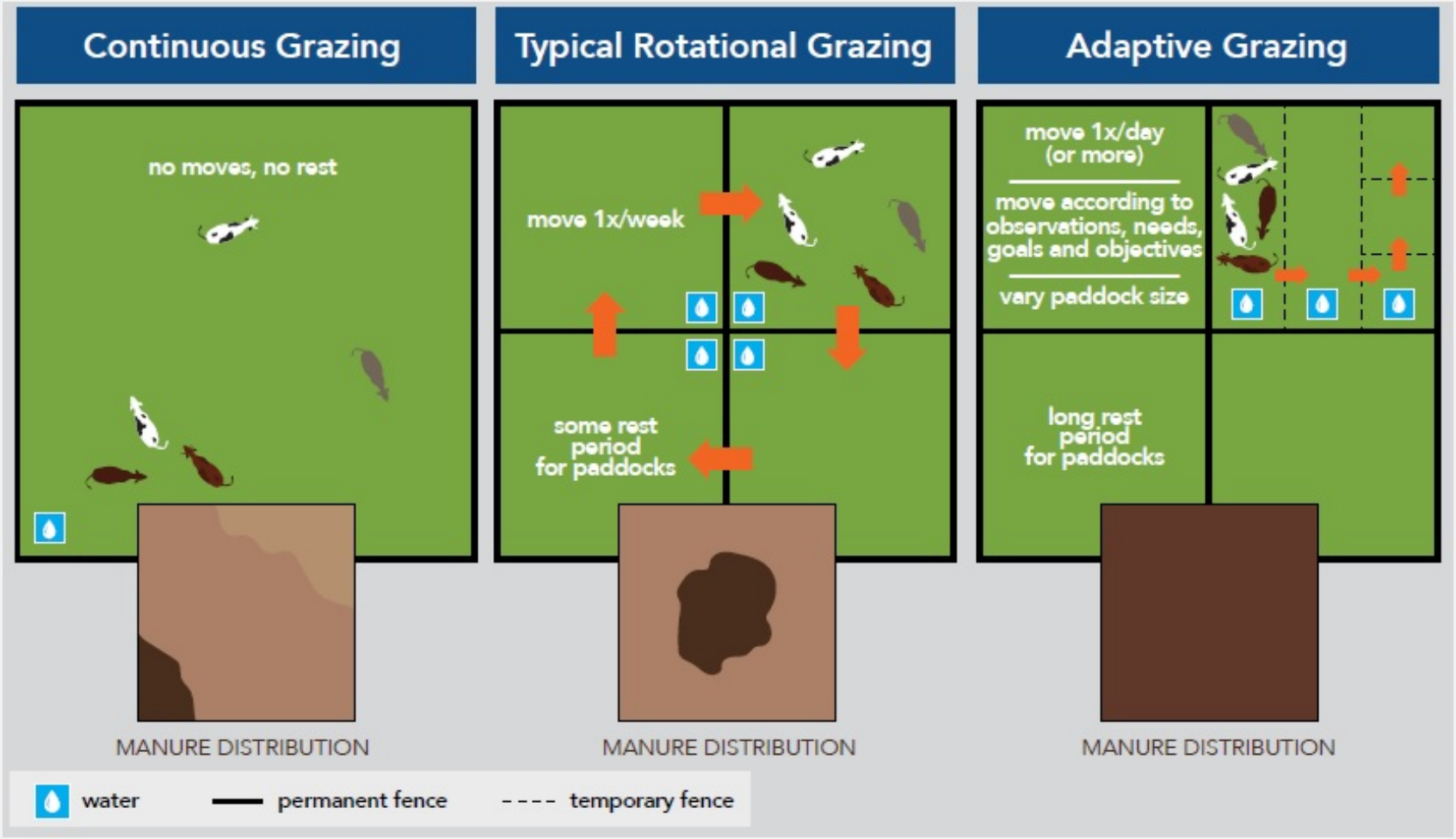
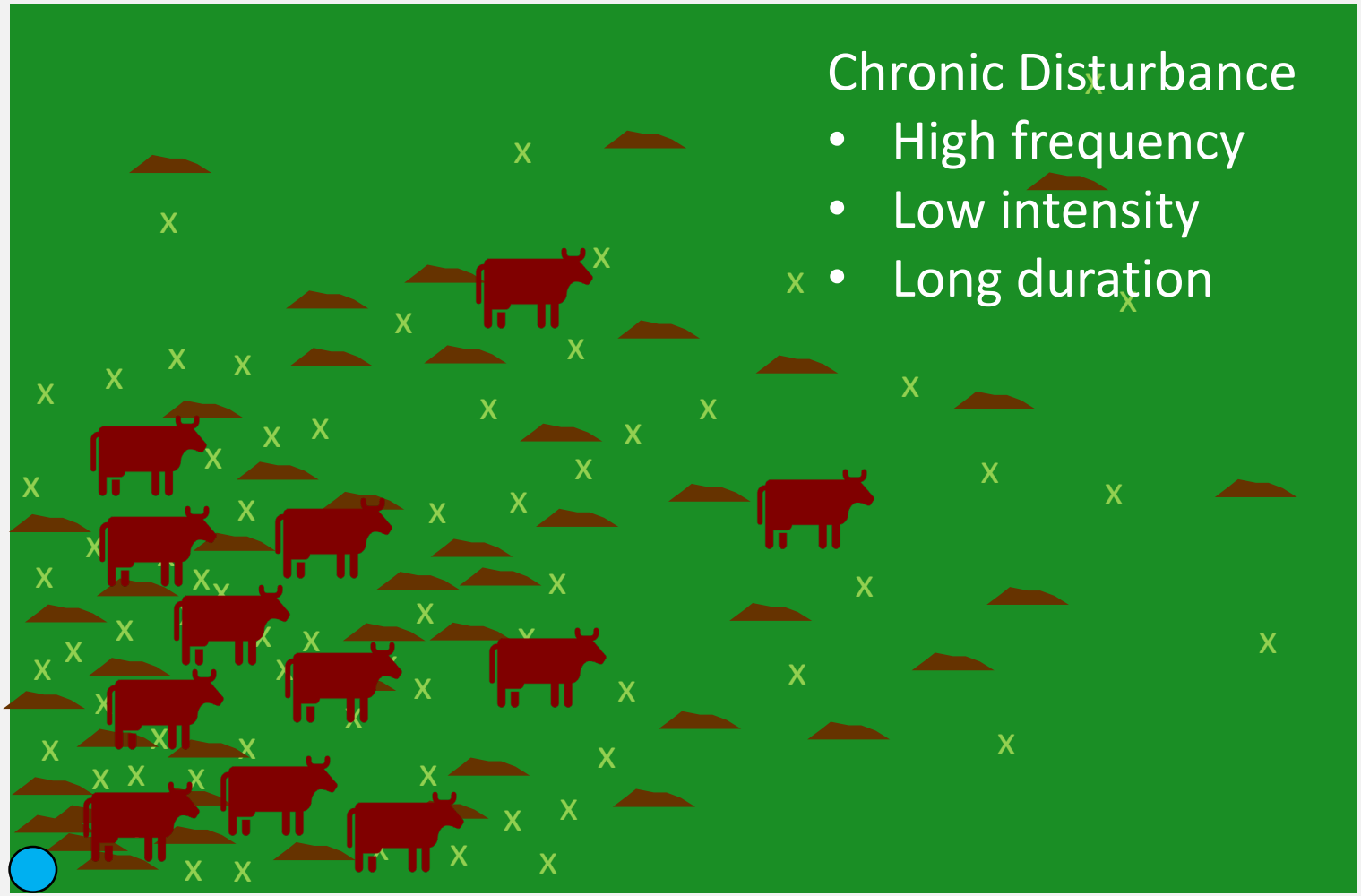
Characteristics of Adaptive Grazing



Source: Pasture Project

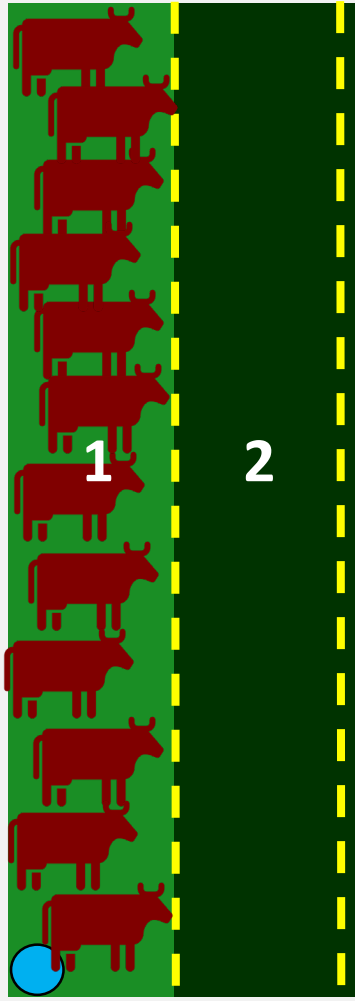
Management Strategies for Grazing Cover Crops

Continuous Grazing



Management Strategies for Grazing Cover Crops and Grasslands

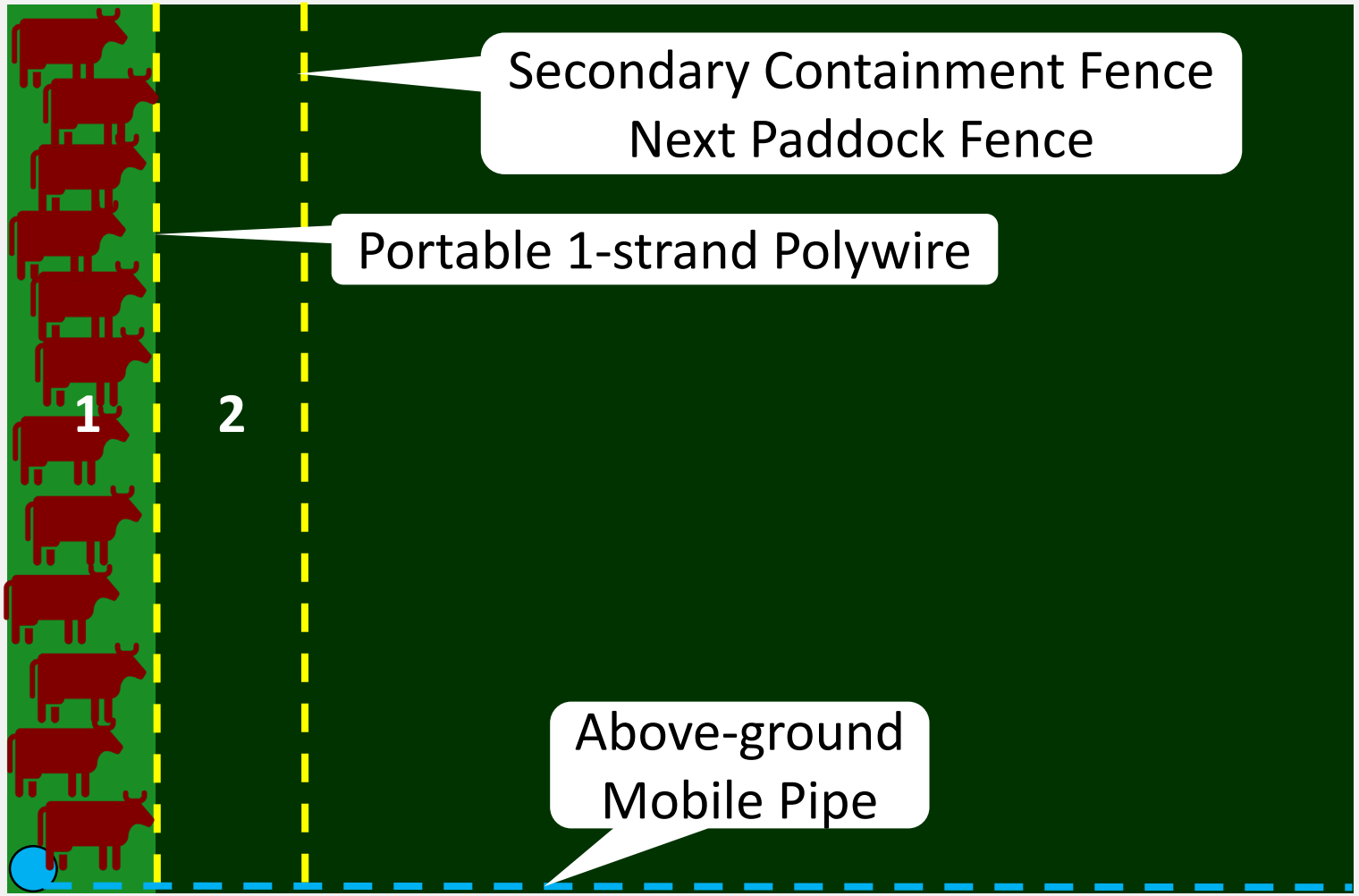
Adaptive Grazing Management



Compared to non-subdivided field:

- More days grazing
- More days for plant recovery
- Greater forage re-growth
- Greater stock density, manure/urine concentration, hoof impact
- Better animal performance

Management Strategies for Grazing Cover Crops and Grasslands



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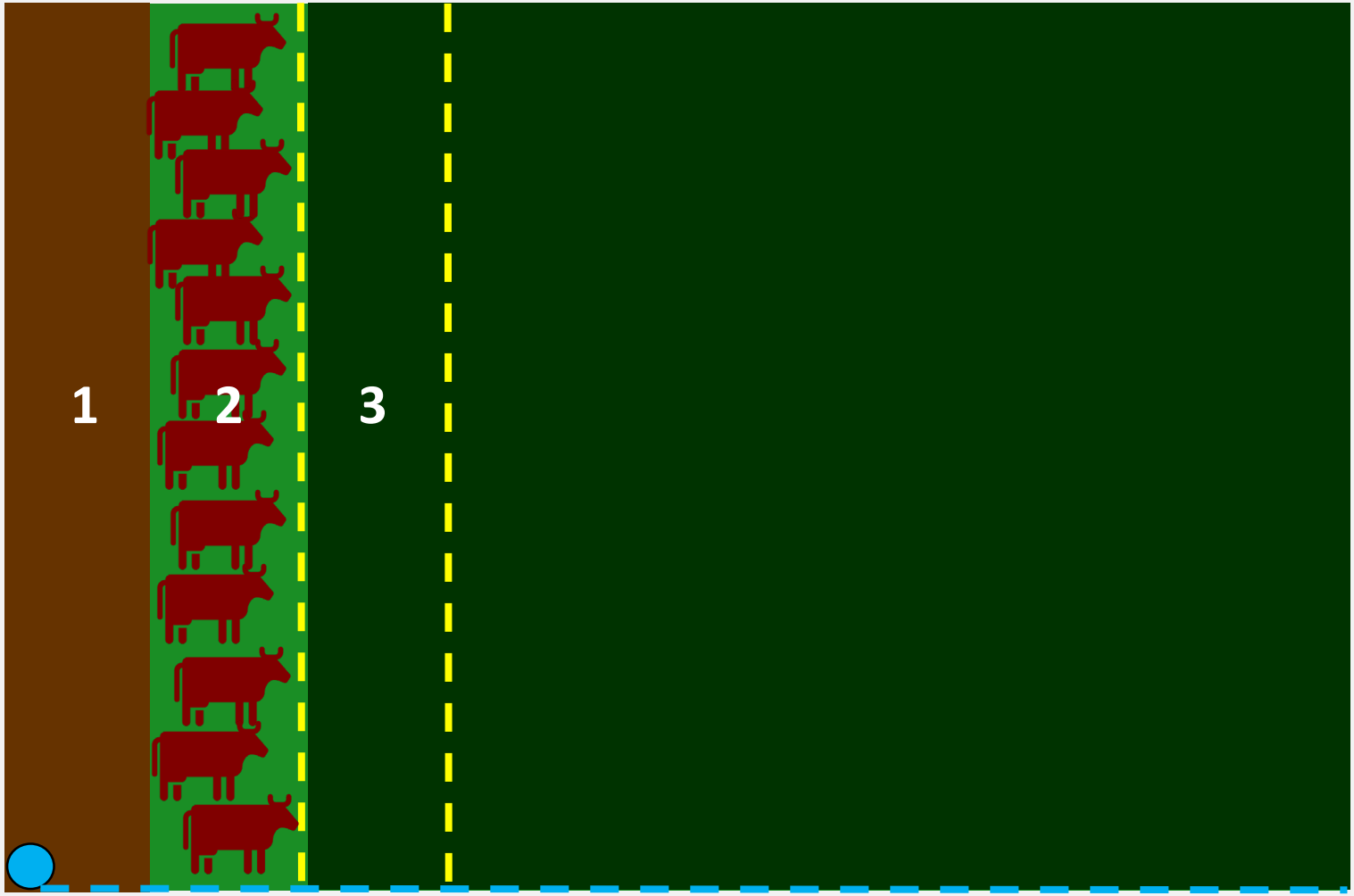

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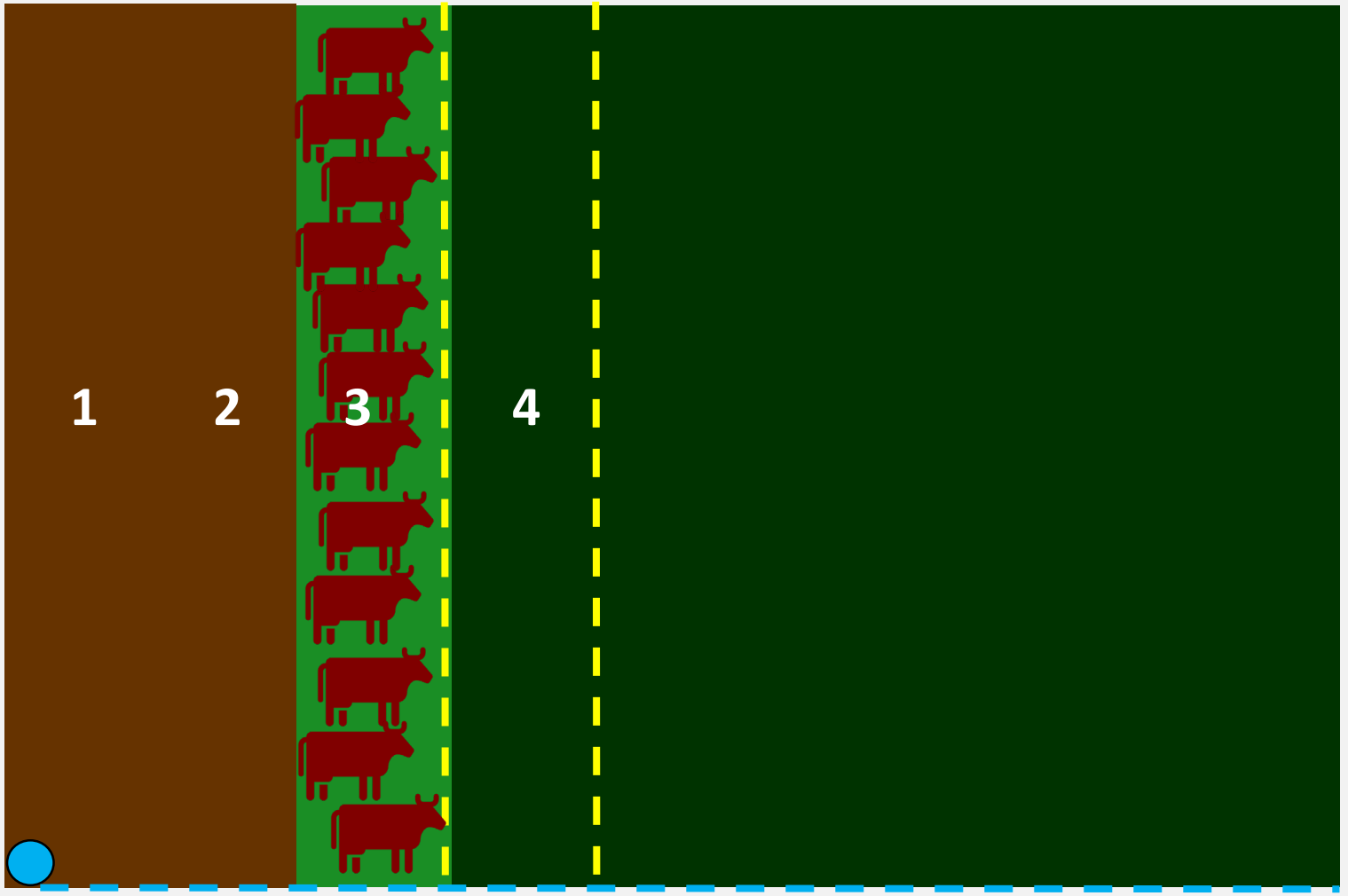

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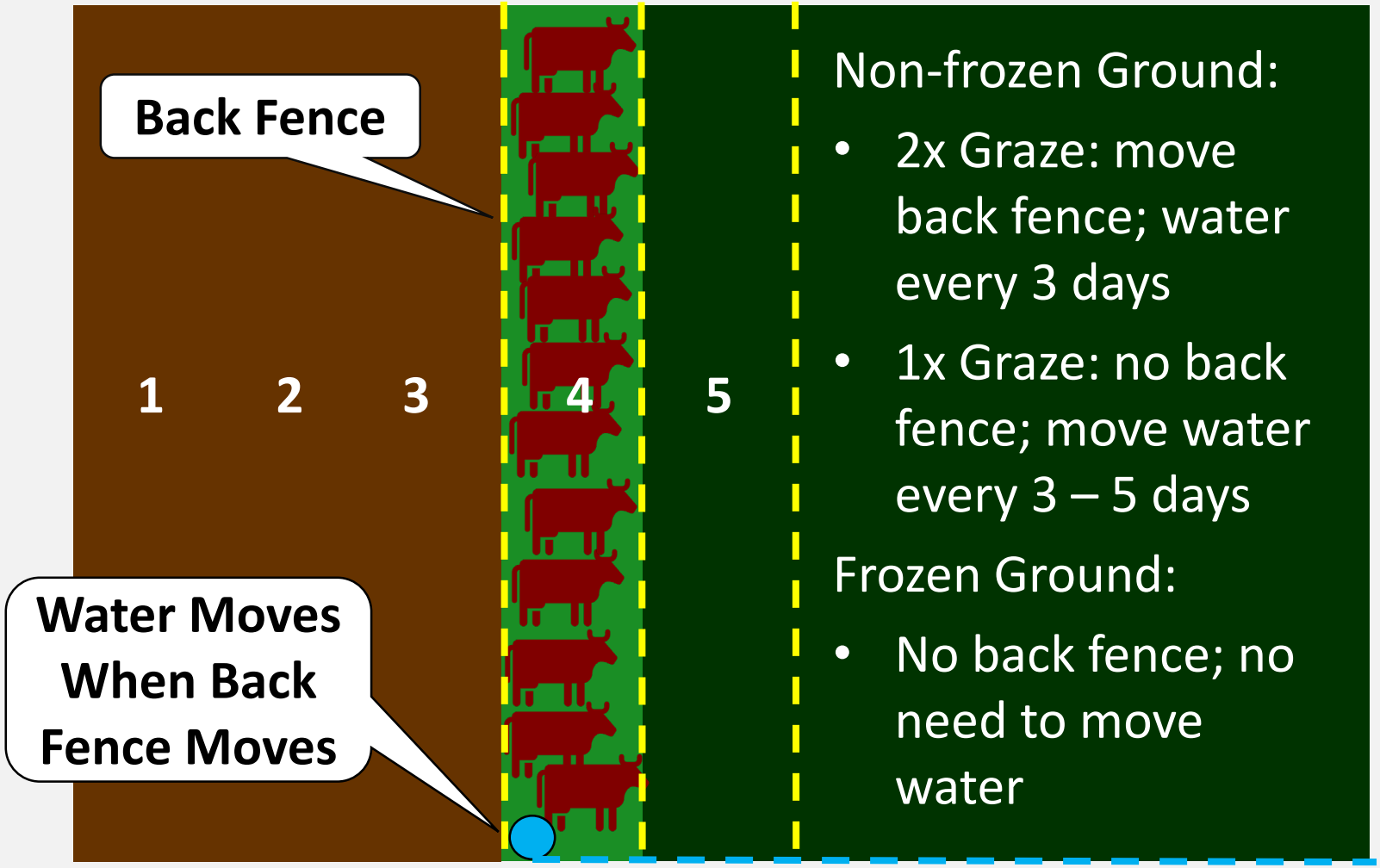
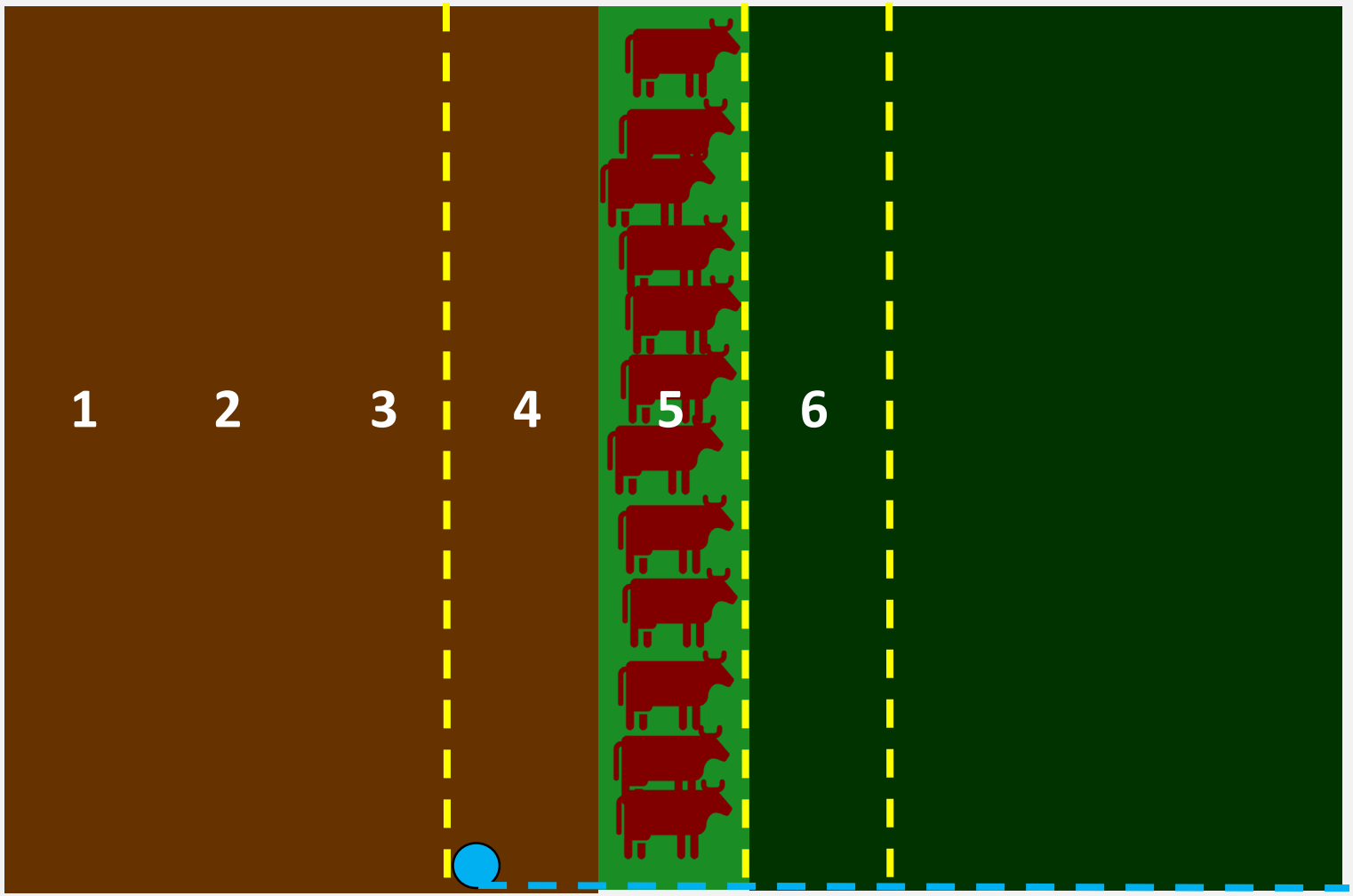


Management Strategies for Grazing Cover Crops and Grasslands



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Other Soil Health Improvement Strategies

Bale Grazing

Saskatchewan Agriculture

Saskatchewan Agriculture

Portable Fencing Equipment

Gallagher

Powerflex Fence

Novel Ways, Ltd.

More to Rumenate On

How does continuous haying affect soil health?

Midwest Machinery Company

- Reduction in aggregate stability
- Reduction in soil carbon

Water: Portable Water Troughs

Rubbermaid

K-Line North America

Judge Jessop

Cover Crop Selection

- Mixtures typically provide considerably higher production and quality versus single species plantings
- Warm-season mixes: typically somewhat lower in protein, but usually higher in production
- Cool-season mixes: typically higher in protein and usually lower in production

Cover Crop Selection

- Usually limit rape to no more than 20% of mix if grazing will occur, and brassicas overall to no more than 70% (potential toxicity issues)
- Mixes with grasses dominant or co-dominant are typically best for cattle

Cisco Farm Seed

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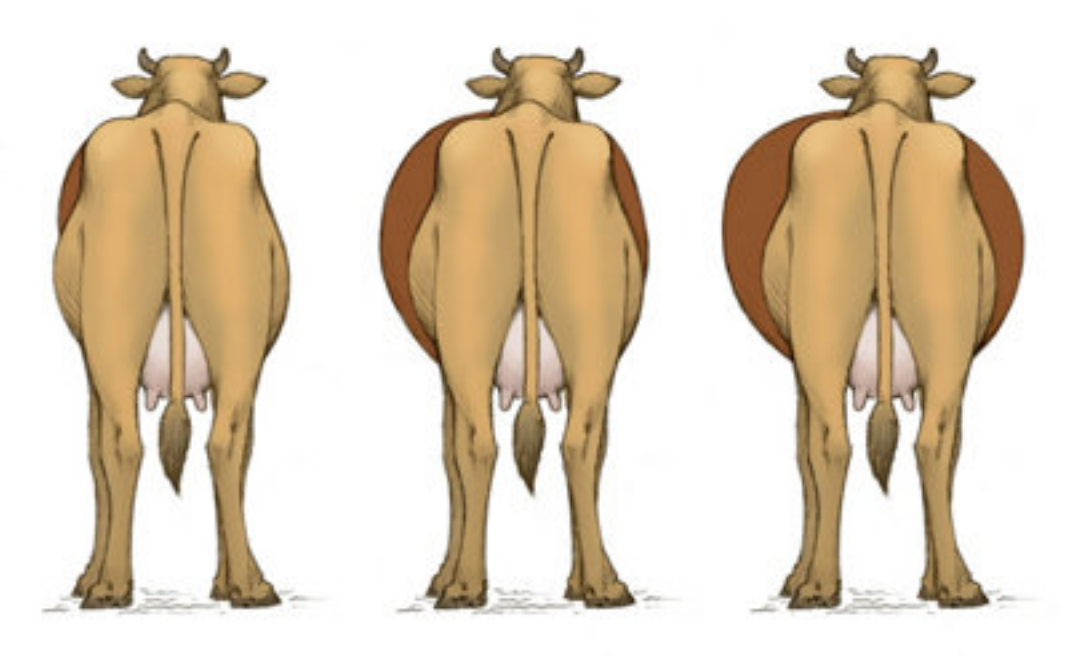
Herbicide Residual Considerations

- Herbicides used on cash crop may prevent crop residues or cover crops from being used as livestock forage
- Most herbicide labels state which cover crop species can be planted given a specified time period between herbicide application on cash crop and cover crop planting
- Several online sources for comparing planting/grazing restrictions of specific herbicides for specific cash crops
- Follow the label

Methods to Avoid Bloat

- Do not introduce hungry animals into a field
- Introduce animals slowly or restrict access over 7 – 10 day period
- Provide dry matter (hay, millet hulls, dry pasture, or crop stalks) when grazing cover crop
- Cover crop species should be at least 25% grasses; no more than 70 – 80% brassicas



Tractor Supply Co.

- Strip graze if possible for best utilization of cover crop; causes animal to utilize entire plant instead of leafy portion of brassica plant first and bulb later
- Use bloat blocks wherever practical

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Knowledge Check

Where is the highest quality forage on a plant?

a) Lower leaves
b) Middle leaves
c) Upper leaves
d) Forage quality is the same throughout

Answer: (c)

Grazing in the 21st century will require…..

- Minimize (chronic) disturbance
- Maximize soil cover
- Maximize biodiversity
- Maximize living roots

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