
Sjoerd W. Duiker
GRAZING COVER CROPS TO EXTEND THE GRAZING SEASON
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Penn State Extension

# Benefits of Grazing Cover Crops

**Cover crop value increases**

- Farmer gets immediate economic returns
- Farmer pays more attention cover crops mgmnt
- Cover crops grown bigger

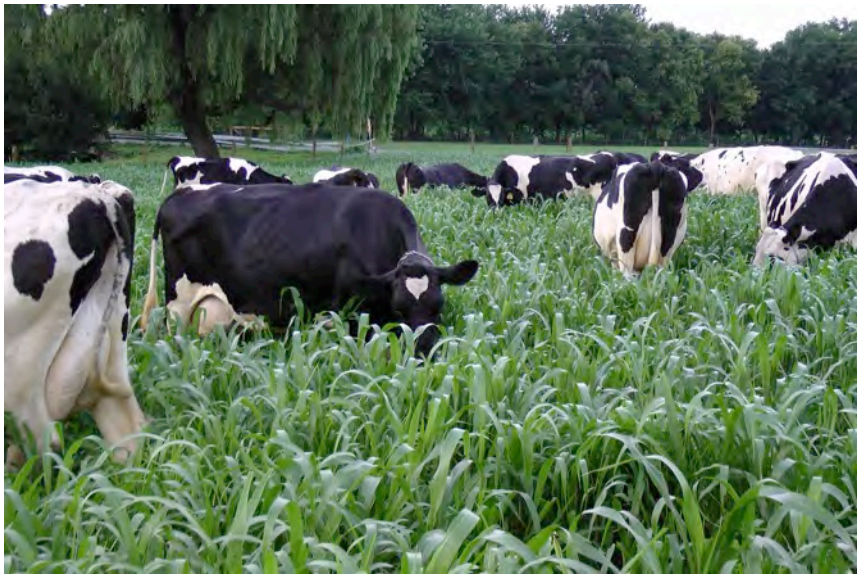
**Soil improvement**

- Manure and urine feed soil and crops
- Trampling organic matter into soil
- Saliva may have beneficial impact

**Reduce costs of livestock feeding**

- Cover crops can meet forage needs in critical periods
- Costs of grazing forage < half of fed forage
- You remove

**We found that using no-tillage, and Management Intensive Grazing greatly improved ability to graze cover crops**



# Nutrient Management Benefits of Grazing vs Haying

Data from Wilson Land & Cattle
130 acre
crop/pasture land

**Nutrient removal in grass hay**
1 T grass hay
45 lbs N
12 lbs $P_2O_5$
50 lbs $K_2O$

Total 130 A @ 3 T/A = 390 T
**17,550 lbs N**
**4,680 lbs $P_2O_5$**
**19,500 lbs $K_2O$**
**1625 lbs S**

**Nutrient removal in animals**
10 cows (@1150 lbs)
2 freezer beef (@ 1000 lbs)
6 steers/bulls (@900 lbs)
10 bred heifers (@900 lbs)
5 calves (@450 lbs)
20 calves (@500 lbs)
60 sheep/goats (@70 lbs)
(2.8% N, 0.72% P, 0.2% K, 0.15% S)

Total 44,350 lbs
**1242 lbs (N 7%)**
**731 lbs $P_2O_5$ (16%)**
**106 lbs $K_2O$ (0.5%**
**67 lbs S (4%)**

# Benefits of No-Till for Grazing Covers

- Reduced cost of establishment of cover crops and main crops
- Ability to establish (cover) crops quickly
- Cover crops produce more above- and below ground biomass
- Lower seeding rate needed for small-seeded crops due to more precise seed placement
- Soil erosion control
- Increased surface soil organic matter
- Better surface soil aggregation
- Continuous macropores in subsoil
- Lower susceptibility to compaction
- Greater infiltration
- Lower water evaporation losses
- More earthworms
- More beneficial microbes

# Management-Intensive Grazing (MIG) is an integral component of the puzzle

- Short duration grazing events (grazing days or hours)
- High stock density (as high as 1,000,000 lbs liveweight/A)
- Long rest periods (20 -80 days)
- Only part of standing biomass is consumed, a lot is left for soil improvement and regrowth
- Rotational grazing yields are 9-68% higher than continuous grazing yields*


* Nelson, C.J. (Ed. ) 2012 Conservation outcomes from pastureland and hayland practices: Assessment, recommendations, and knowledge. Allen Press, Lawrence, Kansas

# Benefits of Management-Intensive Grazing

1. Short grazing period limits compaction
2. Long rest period stimulates strong roots
3. Long rest period allows soil life to heal compaction
4. New pasture regrowth is not grazed prematurely
5. Height of grazing (4-8”) optimal for regrowth
6. About 50% of standing biomass is left to feed soil and act as solar panel for regrowth
7. Manure spread more uniformly
8. Vegetation is grazed more uniformly

# Needs for MIG: A Grazing Plan Including Fencing and Water Supply to all Paddocks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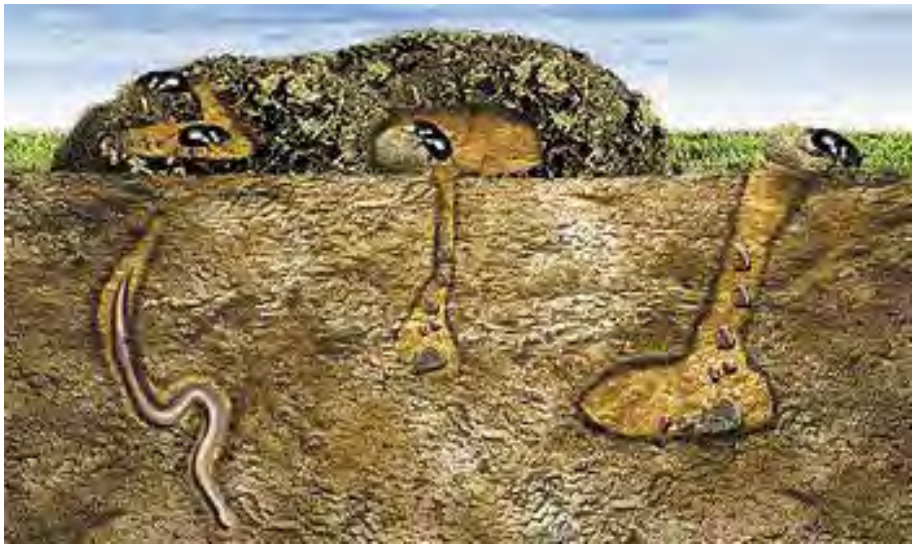
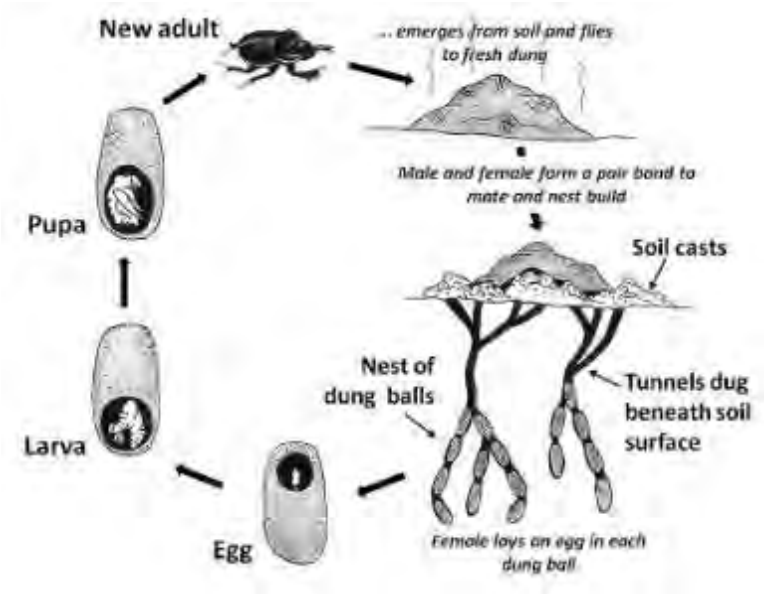
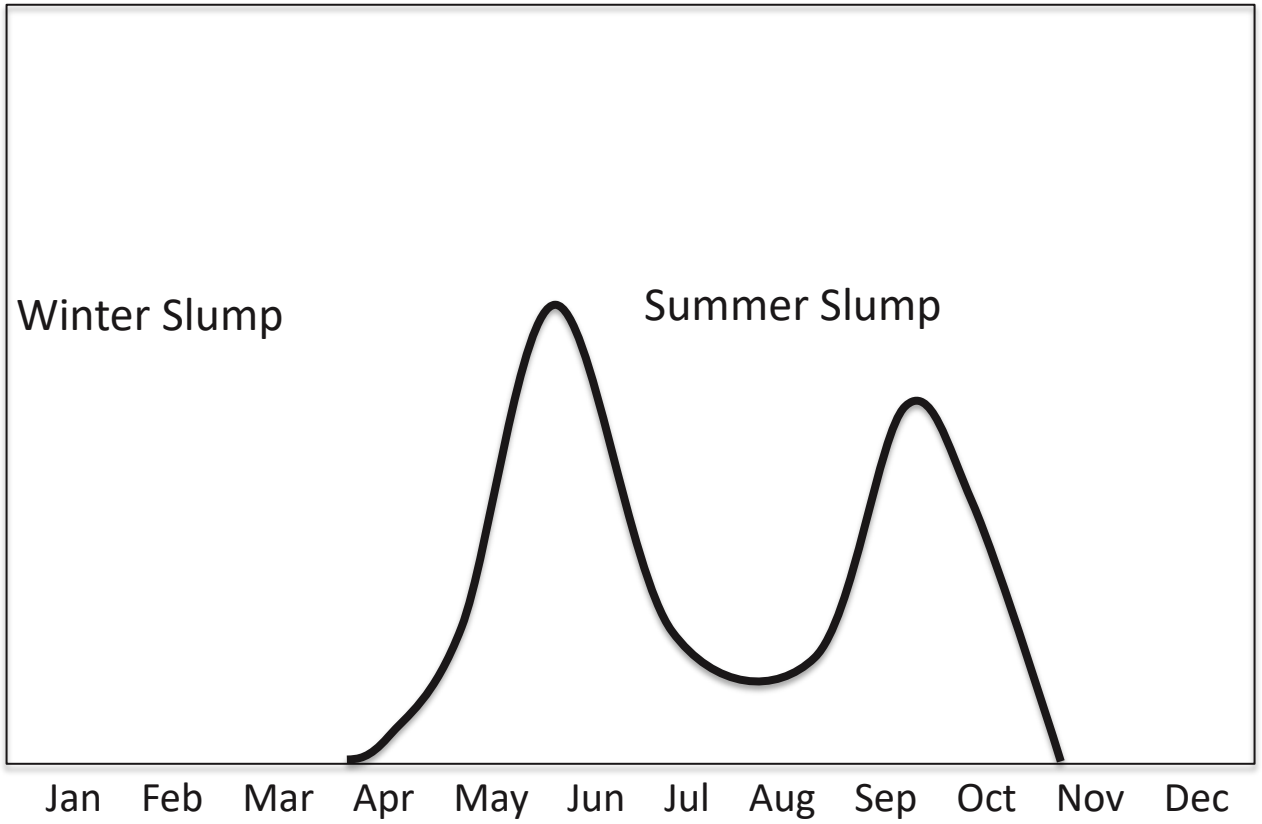
# Manure Piles are Centers of Biological Activity so by Improving Their Distribution Soil Health is Improved





# Grazing Cover Crops to Complement Cool-Season Perennials




Summer Slump


Winter Slump
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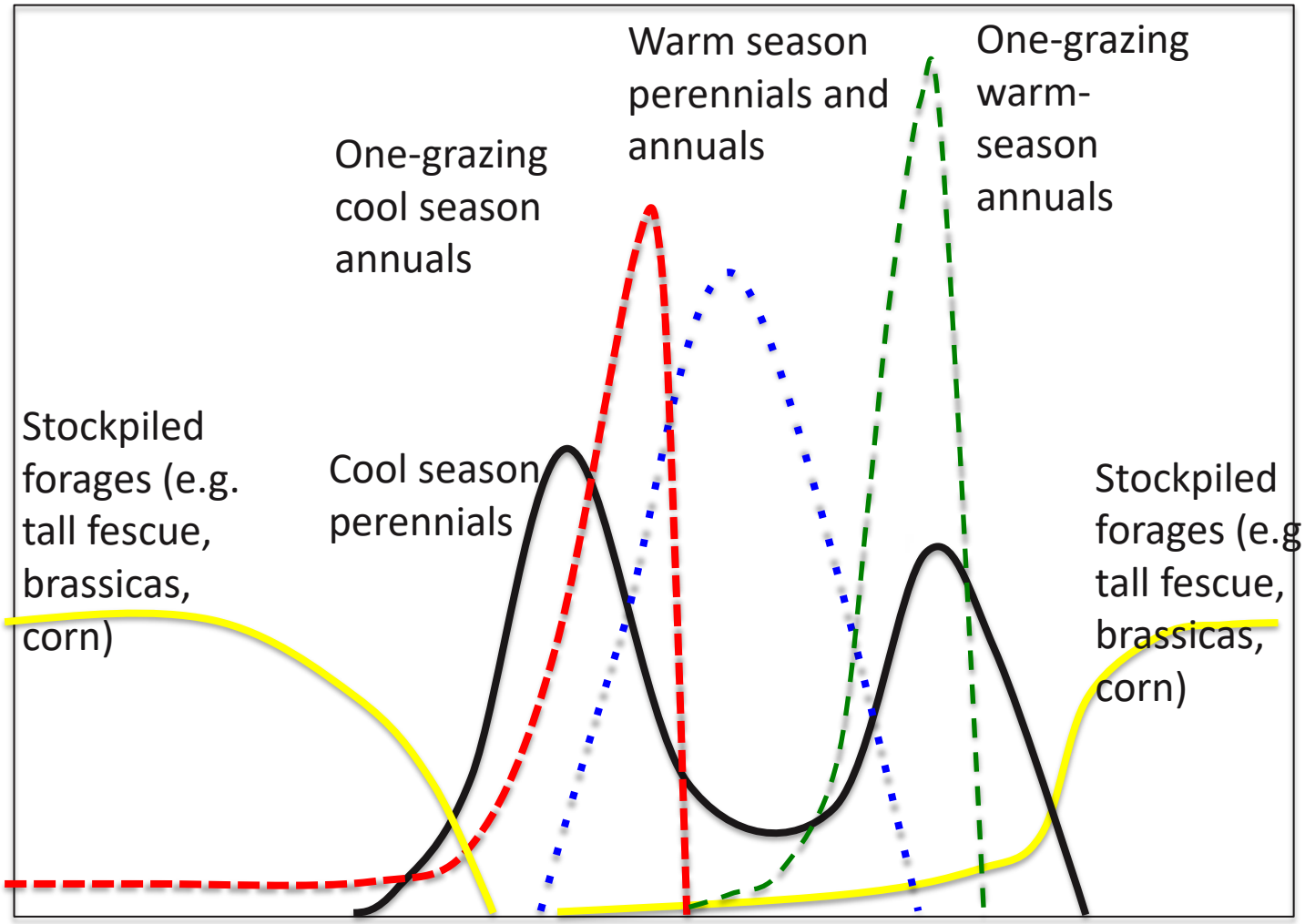
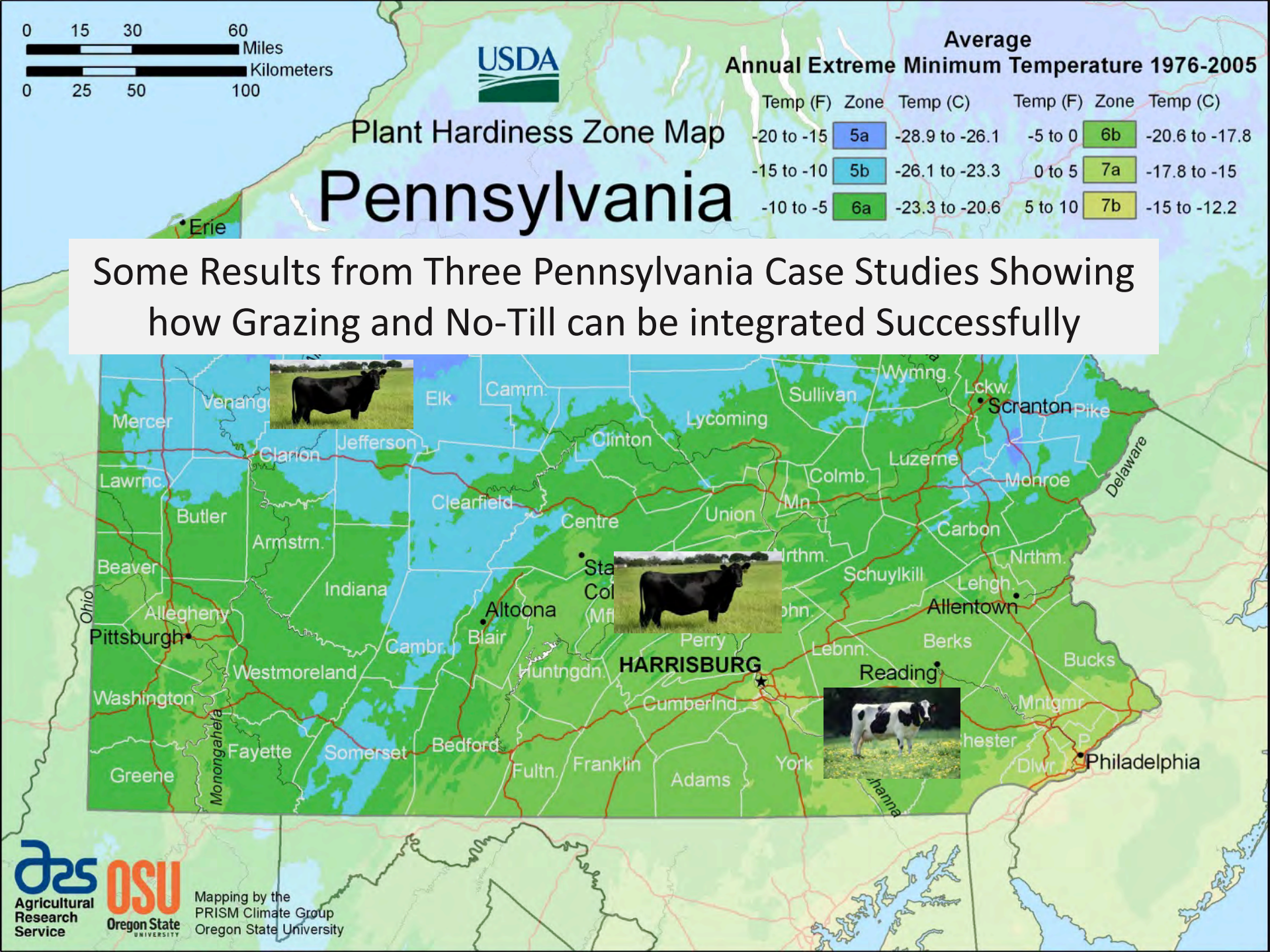
# Maximizing Grazing by Integration with annual and perennial 'cover' crops




0 15 30 60
Miles
Kilometers
0 25 50 100
USDA
Plant Hardiness Zone Map
Pennsylvania
Average
Annual Extreme Minimum Temperature 1976-2005
Temp (F) Zone Temp (C)
-20 to -15 5a -28.9 to -26.1
-15 to -10 5b -26.1 to -23.3
-10 to -5 6a -23.3 to -20.6
Temp (F) Zone Temp (C)
-5 to 0 6b -20.6 to -17.8
0 to 5 7a -17.8 to -15
5 to 10 7b -15 to -12.2
Some Results from Three Pennsylvania Case Studies Showing how Grazing and No-Till can be integrated Successfully
Erie
Mercer
Venango
Elk
Camrn.
Wymng.
Lckw.
Scranton
Pike
Sullivan
Lycoming
Clinton
Jefferson
Clarion
Luzerne
Colmb.
Monroe
Delaware
Lawrnc.
Butler
Clearfield
Centre
Union
Mn.
Carbon
Armstrn.
Nrthm.
Schuylkill
Lehgh.
Beaver
Indiana
Allentown
Ohio
Allegheny
Altoona
Pittsburgh
Blair
Perry
Berks
Cambr.
Lebnn.
Bucks
Westmoreland
HARRISBURG
Reading
Washington
Cumberlnd.
Mntgmr.
Fayette
Somerset
Bedford
Monongahela
Fultn.
Franklin
Adams
York
Philadelphia
Greene
Agricultural Research Service
OSU Oregon State University
Mapping by the PRISM Climate Group Oregon State University

# Farm 1 - Wilsons

Wilson Land & Cattle Co, Tionesta, Forest County, Pennsylvania, started in 2009
1600 feet above sea level, Average annual temperature 47 F, Average precipitation 43”

- 220 acre farm – all owned except for 10 acres
- 130 acres cropland and pasture
- 100% no-till

- 102 black angus beef cows
- 160 dorset sheep
- 12 goats

- Farm entirely perimeter fenced
- 30 permanent paddocks
- Electric mobile interior fencing
- Started intensive rotational grazing in 2011
- Moves cows typically 4-6 times a day
- 70+ different plant species for grazing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# Farm 2 - Brubakers

Double B Farms, McAlisterville, Juniata County, PA
650 feet above sea level, Average annual temperature 51F, Average annual precipitation 40”

- Enterprises:
  - farm store
  - broiler production
  - grain production
  - grass-fed limosine
  - embryo sales
- 400 acres – 180 acres owned
  - 90 acres fenced paddocks (22 total) w. perennial pasture
  - 90 acres perimeter fenced
    - 35 acres cropland (corn, soyb., spelt, hay )
    - Graze cover crops and crop residues
    - 55 acres pasture
    - Typically move animals 1 time a day
- 50 breeding cows + calves = approx 90
- 100% no-till since 1996

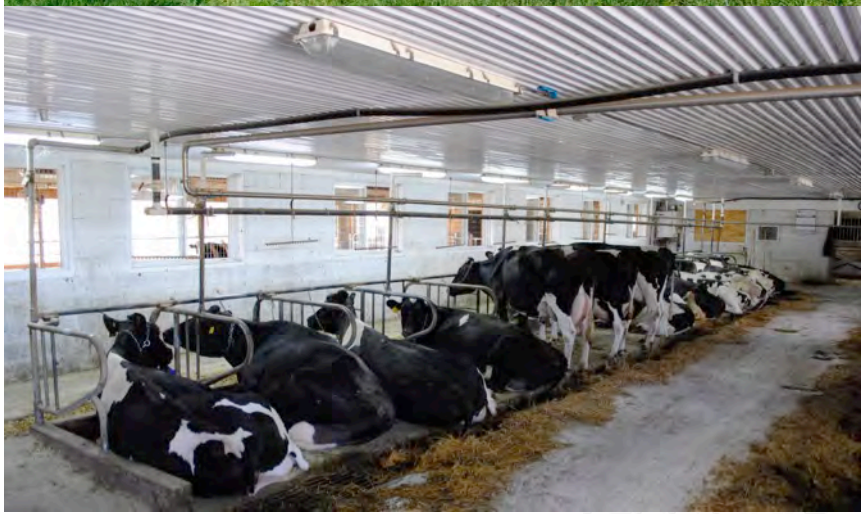
# Farm 3 – Weavers

**Eli Weaver, Leola, Lancaster County, PA**

**400 feet above sea level, Average annual temperature 53 F, Average annual precipitation 43”**

- Enterprises:
  - dairy farm
  - Seed business
  - Nutrition business

- 30 milk cows, 12 replacement stock (calves, heifers, dry cows)
- 45 acres

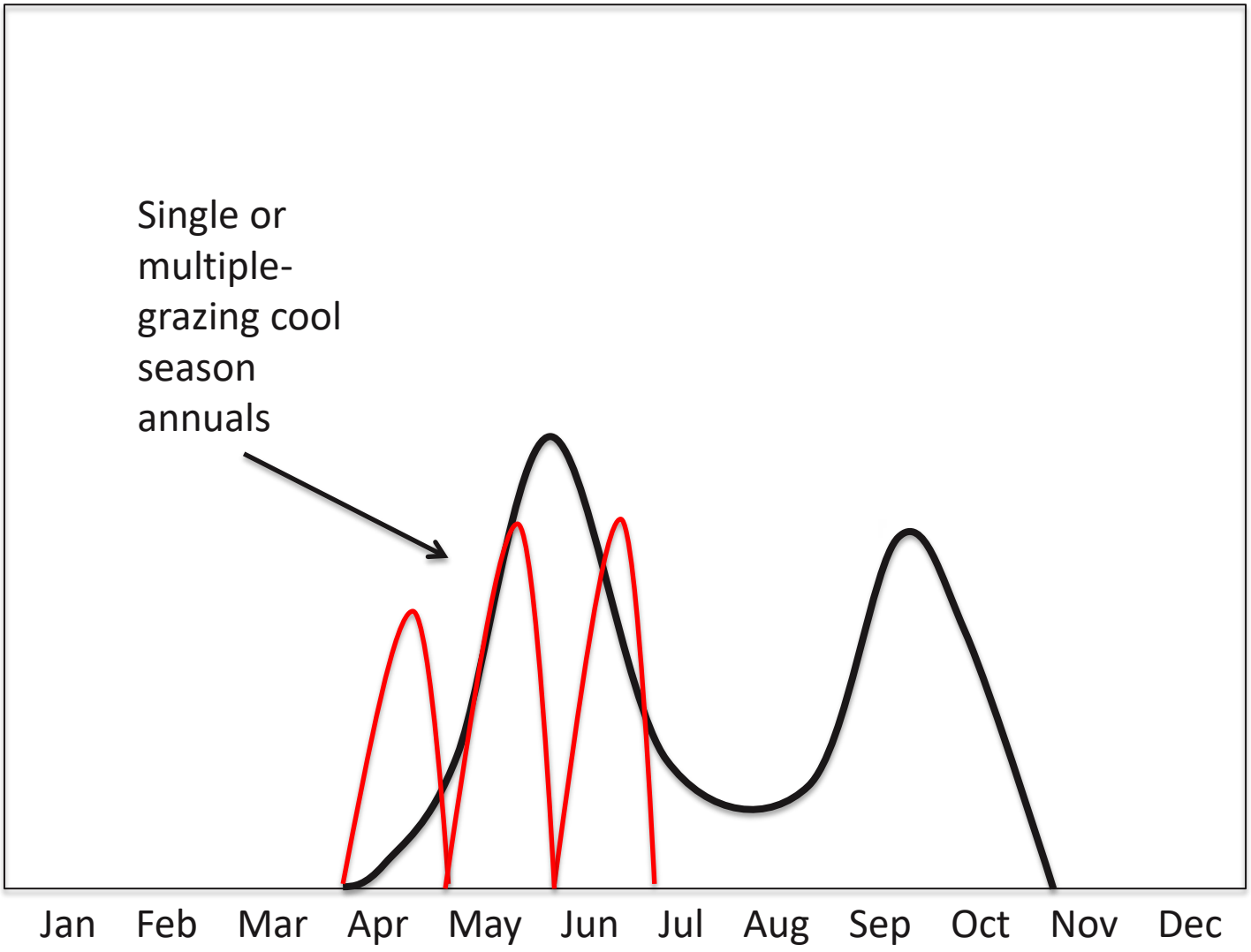
# Overview of Farms - Weaver

- One part of farm is fenced for grazing:
  - 7 acres alfalfa/grass, or orchardgrass/perennial ryegrass/meadowfescue/red+white clover)
  - 3 acres cool and warm season annuals
  - 15 acres can be used for grazing or harvesting

- The other part of the farm is set up for harvesting:
  - 20 acres (two 10 acre blocks that are rotated) – very intensive double and triple cropping for silage. E.g. triticale/annual ryegrass-sorghumsudan-oat/radish/y.sweet+red+white clover.

- The cows are typically grazed at night only and moved once every day, given 1/3$^{rd}$ of an acre at a time

# Meeting Grazing Needs with Cool Season Annuals



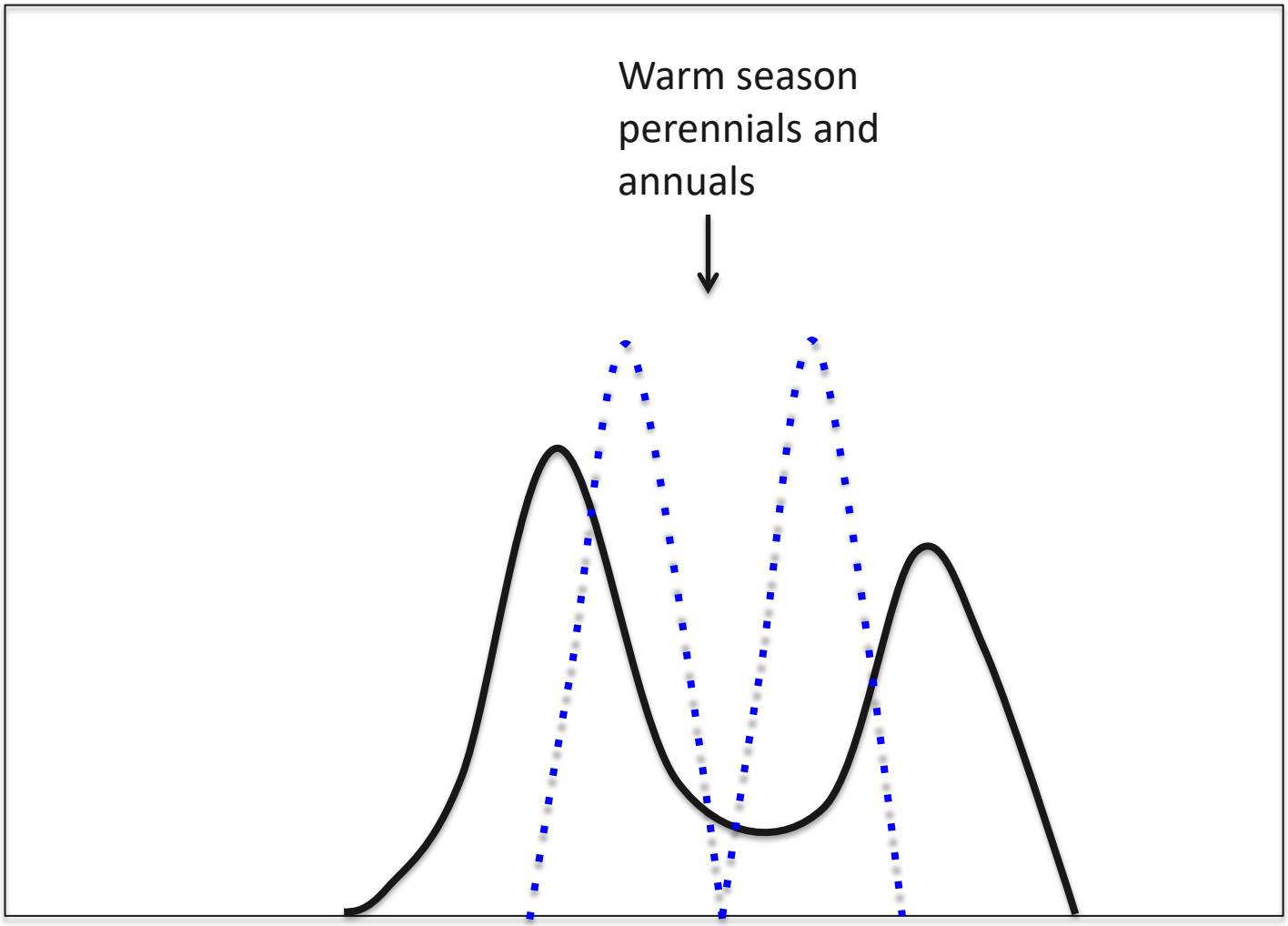
# Grazing No-Till Cool Season Annuals

| | Rye/vetch mix | Rye/vetch/clover mix | Rye/ryegrass vetch/clover mix | Annual ryegrass / triticale mix |
|---|---|---|---|---|
| | Lbs DM/A | | | |
| Date | 7/17/15 | 6/1/16 | 4/21, 6/12/17 | 4/17, 5/4, 5/26/17 |
| Location | Tionesta | Tionesta | Tionesta | Leola |
| Pre- | 3618 | 6051 | Varied | Varied |
| Post- | 2818 | 2398 | 2614** | 3470* |
| Grazed | 800 | 3653 | 2150** | 4216* |
| Grazed (%) | 23% | 60% | 55% | 45% |


* Sum of three grazings
** Sum of two grazings

**Grazed yields ~ 0.4-2.1 T/A**

# Meeting Grazing Needs with Warm Season Annuals Grazed Several Times



# Summer Annuals - Repeat Grazing

| | Japanese millet | | Pearl millet (w.rape) | | Sudangrass | | |
|---|---|---|---|---|---|---|---|
| | Lbs DM/A | | | | | | |
| Date | 7/17/15 | 9/5/15 | 7/23/15 | 8/8/16 | 7/15/16 | 8/4/16 | 8/31/16 |
| Location | Tionesta | | McAlisterville | | Leola | | |
| Pre- | 6786 | 4442 | 3996 | 3657 | 3131 | 3247 | 3872 |
| Post- | 3259 | 2409 | 2944 | 1285 | 2003 | 1582 | 1576 |
| Grazed | 3527 | 2033 | 1053 | 2372 | 1128 | 1867 | 2296 |
| Grazed (%) | 51% | 46% | 26% | 64% | 36% | 57% | 59% |

**Grazed yields ~ 2.8 – 3.2 T/A**


Pearl Millet pre and post grazing

Japanese Millet and Rape/Pearl millet mixture


Sorghum Sudan Grass Pre and Post Grazing
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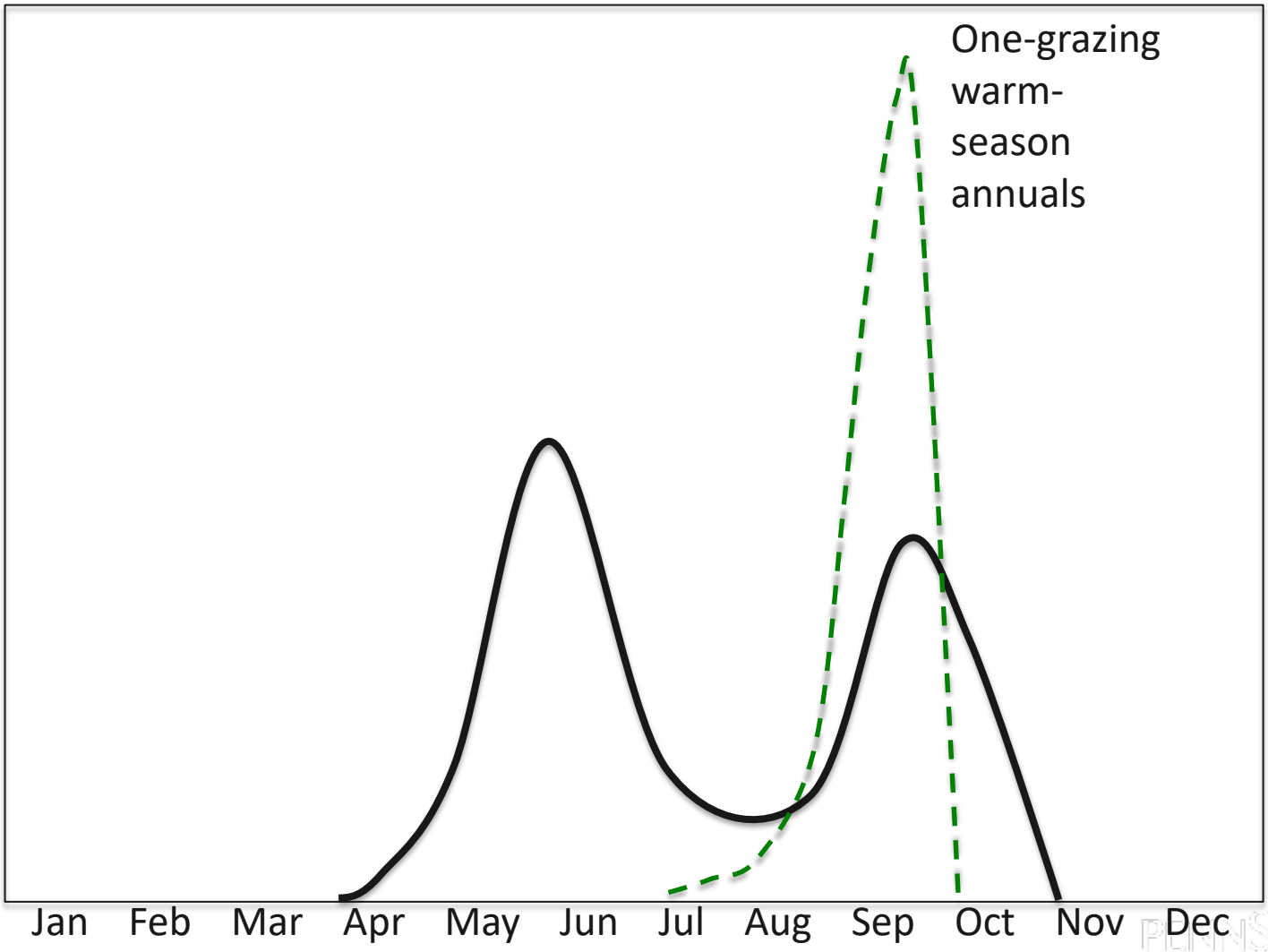
# Meeting Grazing Needs with Summer Annuals Grazed Once



# Summer Annuals - One Grazing

| | Corn/cucurbits/sunflower mix | Millet mix* |
|---|---|---|
| | Lbs DM/A | |
| Date | 8/26/16 | 9/13/17 |
| Location | Tionesta | |
| Pre- | 11,173* | 7238 |
| Post- | 4469** | 2617 |
| Grazed | 6704** | 4621 |
| Grazed (%) | 60%** | 64% |
| * Cucurbits = 26%, Corn/Sunflower = 74%<br>** Not measured | | |

* 2017 summer annual millet mixture was
7 # Japanese millet
5 # Sorghum sudangrass
3 # Forage sorghum
4 # Grain sorghum
2 # Annual ryegrass
.5 # Teff
4 # Sunflower
1 # Mungbean
2 # Cowpea
1 # White clover
1 # Red clover

**Grazed Yield ~ 2.3-3.4 T/A**

# Versatility of mixtures


7 # Japanese millet
5 # Sorghum sudangrass
3 # Forage sorghum
4 # Grain sorghum
2 # Annual ryegrass
.
5 # Teff
4 # Sunflower
1 # Mungbean
2 # Cowpea
1 # White clover
1 # Red clover

Mixture in better drained part of field


Same Mixture in poorly drained part of field

# Annualized yields of different forage rotations

| | # Grazings | Grazed yield (T DM/A) | Soil food and regrowth aboveground (T DM/A) |
|---|---|---|---|
| Winter annual mix | 1 | 1.8 | 1.2 (40%) |
| Summer annual mix | 2-3 | 2.8-3.2 | 2.8-3.2 (50%) |
| Summer annual mix | 1 | 3.4 | 2.2 (40%) |
| **Annual Yield of Winter/Summer Annual Rotation** | **2-4** | **4.8-5.2** | **3.4-4.2 (40-50%)** |
| **Switchgrass/ Big Bluestem/ Indiangrass** | **2** | **4.7** | **1.0-1.1 (32%)** |

# Soil Health Evaluations 2016

**Russ Wilson Soil Health Scores**

| Field ID | F5 | P3C | P3A |
|---|---|---|---|
| DATE | 5/4/16 | 5/4/16 | 5/4/16 |
| | | | |
| Cover crop | Heavily compacted soil with grey/red mottling in surface horizon but bright yellow colored material below . Crimson, alsike, sweet yellow and some white clover | Cover crop mix of hairy vetch, alsike clover, red clover, sweet yellow clover, annual ryegrass | Indigenous perennial warm season mix (13 species) |
| Surface cover | 7 | 8 | 8 |
| Soil Structure | 4 | 5 | 8 |
| Organic matter | 5 | 6 | 6 |
| Soil erosion | 8 | 8 | 8.5 |
| Soil compaction | 4 | 5 | 8 |
| Water infiltration | 2 | 7.5 | 8 |
| Soil diversity | 5 | 7 | 8 |
| Plant and root growth | 5 | 6 | 8 |


Compacted surface
Healed surface
Immediately after grazing
09 .13 .2017
After 2 months of rest
09 .13 .20


Soil life is the basis for healing compacted surface
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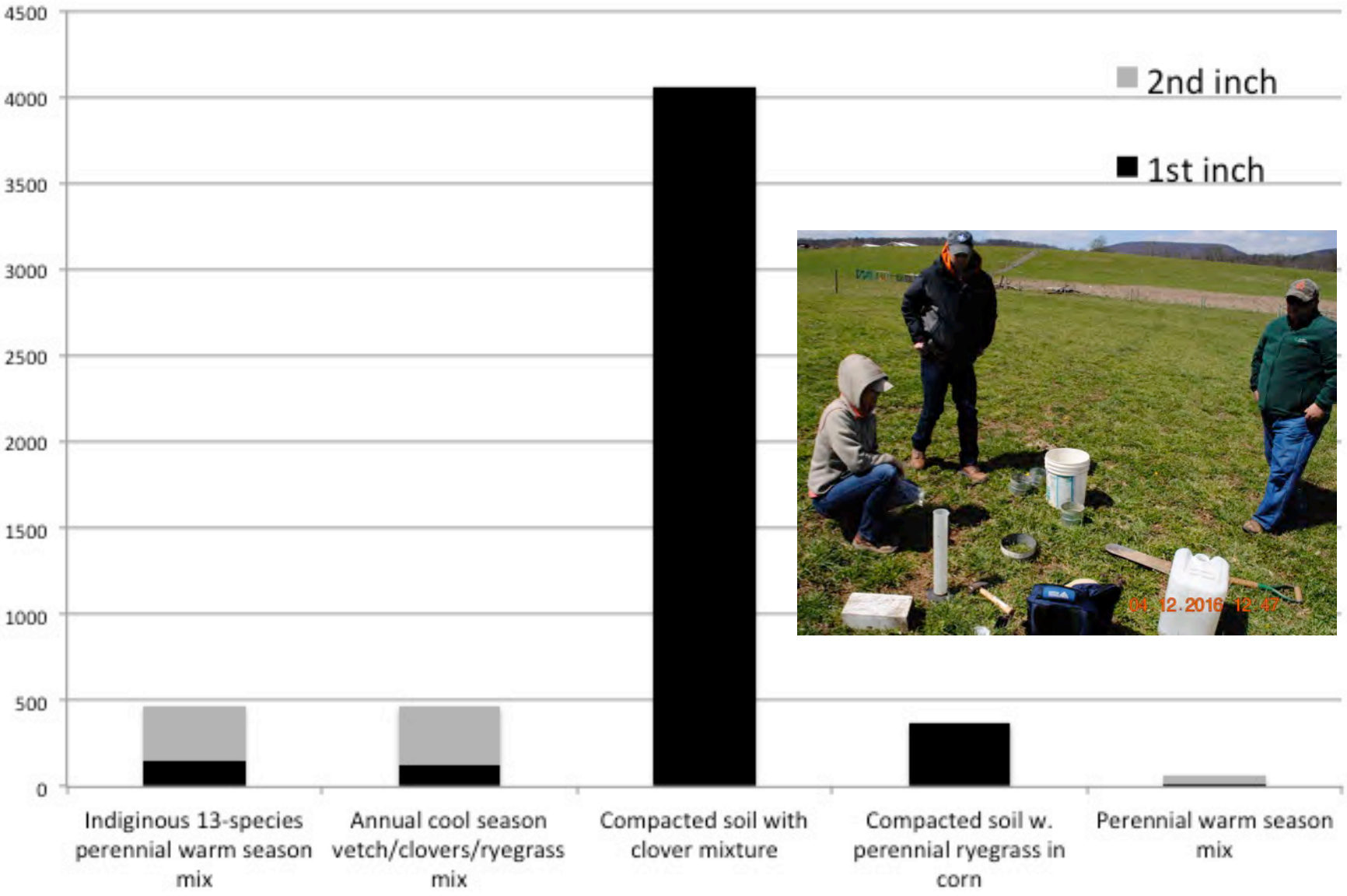
Time (sec) to infiltrate 1 or 2 inches of water (single-ring infiltration test, Spring 2016)

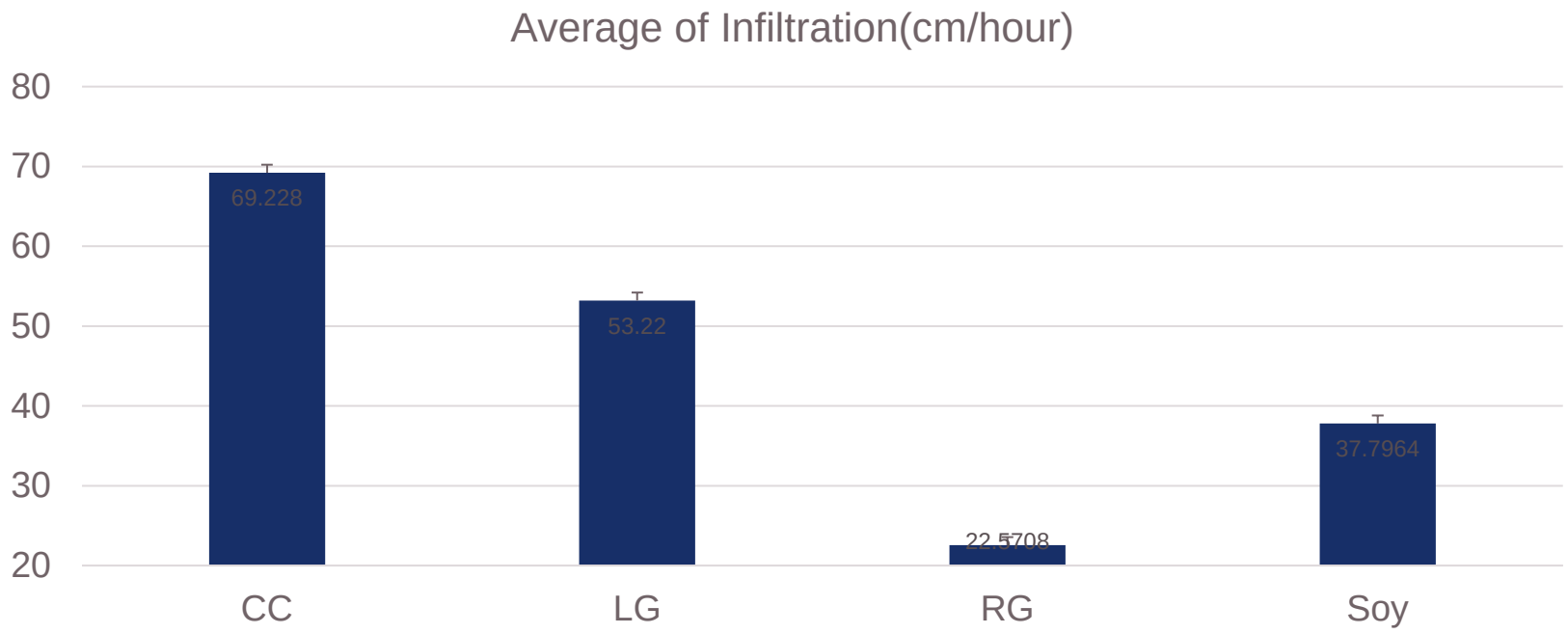


# 2020-2021 project to study grazing of cover crops in more depth

# South-Central PA

- Two scenarios for grazed cover crops
  1. Small grain - double crop soybean vs grazed cover crop mixtures
  2. Corn silage – grazed vs un-grazed cover crop

# Preliminary Results New Cover Crop Grazing Project – After Small-Grain Harvest




CC: Ungrazed Cover crop LG: Cover crop grazed a month ago RG: Recently grazed cover crop Soy: Soybean

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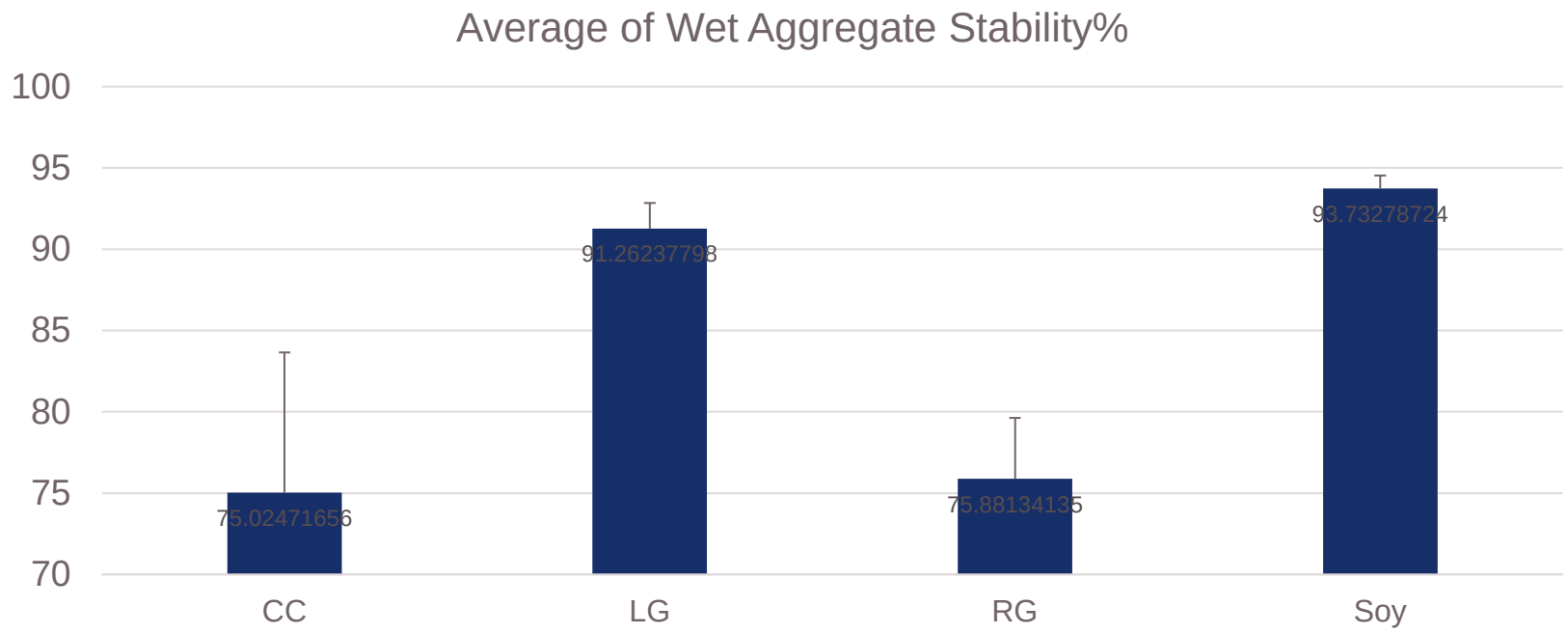

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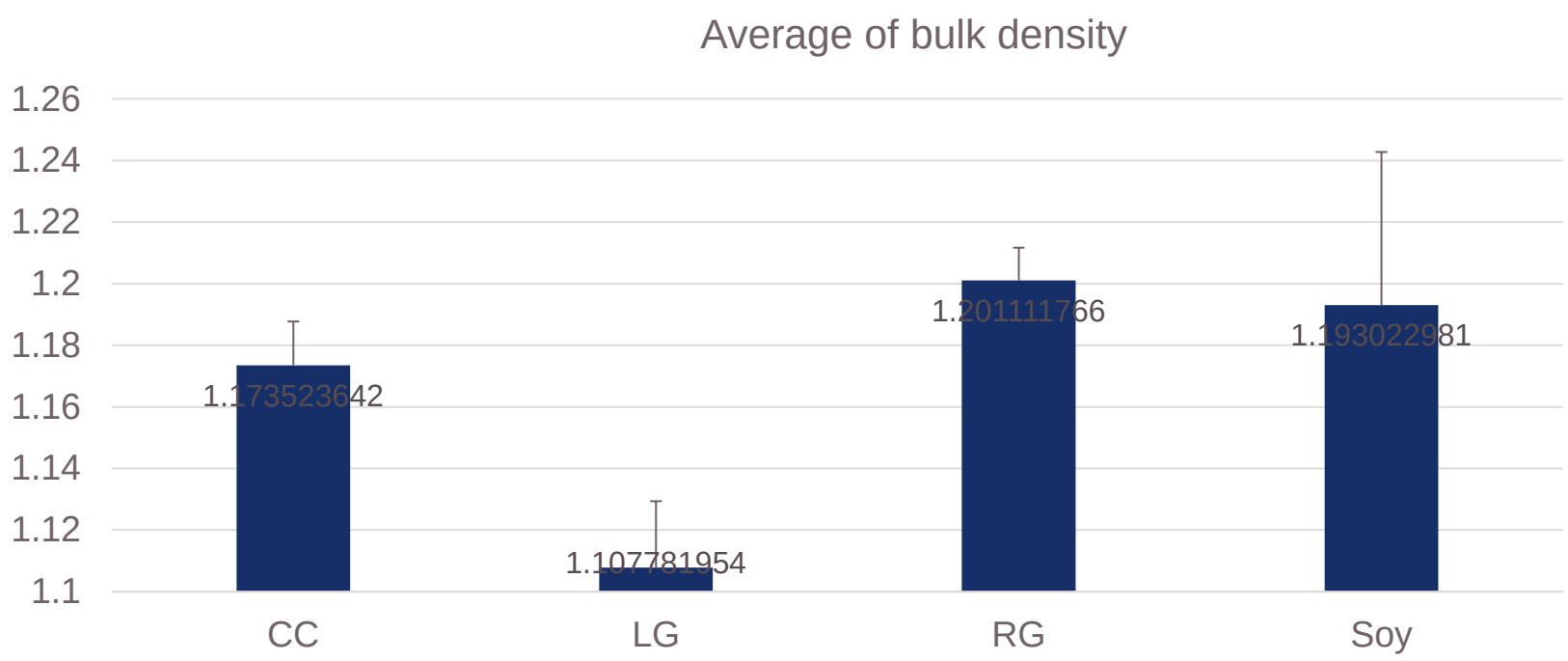

# Conclusion

- Grazing is a cost effective way of feeding ruminant livestock
- No-till winter and summer annuals can be combined with cool and warm season perennials to meet summer and winter grazing needs
- If combined with intensive rotational grazing soil improves
- High production possible (5 T grazed DM/A/yr + 4 T left in field)
- This can help grass-fed beef and milk production increase in the U.S.

# Reading resources

- Extending the grazing season with plant diversity
  https://extension.psu.edu/extending-the-grazing-season-with-plant-diversity
- No-till annuals to beat the summer slump on a dairy farm
  https://extension.psu.edu/no-till-annuals-to-beat-the-summer-slump-on-a-dairy-farm
- Integrating grazing and no-till systems on a grain farm
  https://extension.psu.edu/integrating-grazing-in-no-till-systems-on-a-grain-farm

- You-Tube videos on the same topics
- https://extension.psu.edu/beating-the-summer-slump-on-dairy-farms-with-no-till-annuals
- https://www.youtube.com/watch?v=sqdZ8ydVXcM