# Nutrient cycling and crop production following cover crop termination

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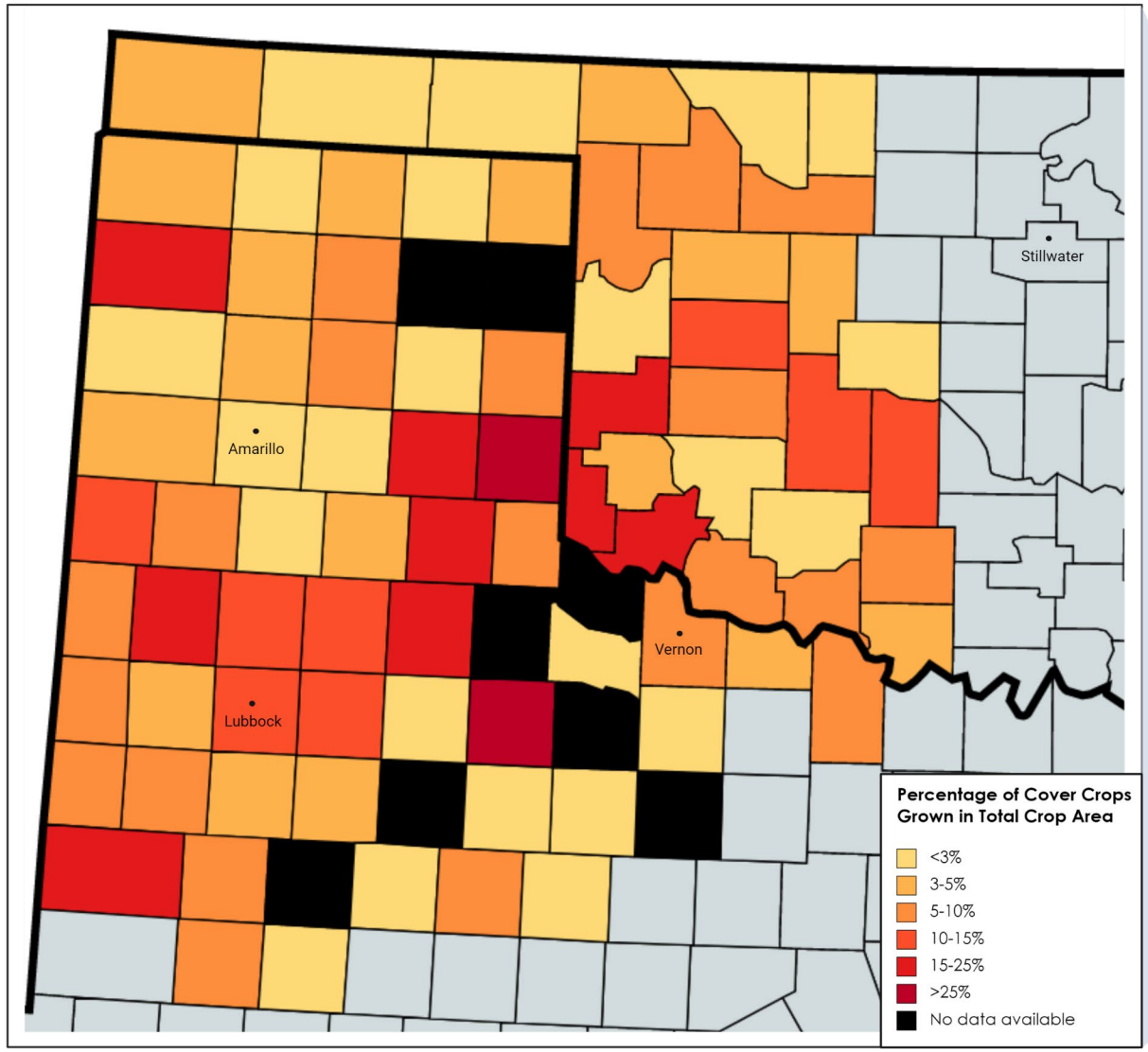
OSU Winter Crops School
Stillwater, OK

TEXAS A&M AGRILIFE RESEARCH

TEXAS A&M AGRILIFE EXTENSION

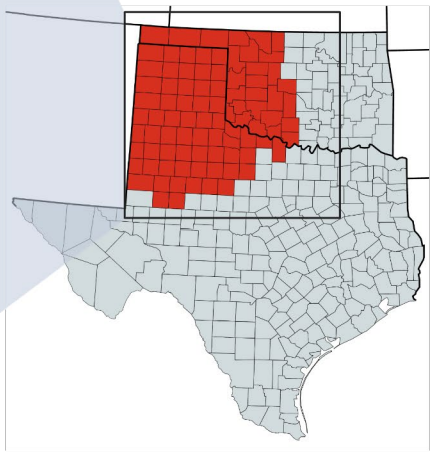
# The Dust Bowl and Beyond


# Cover crop adoption on the Southern High Plains



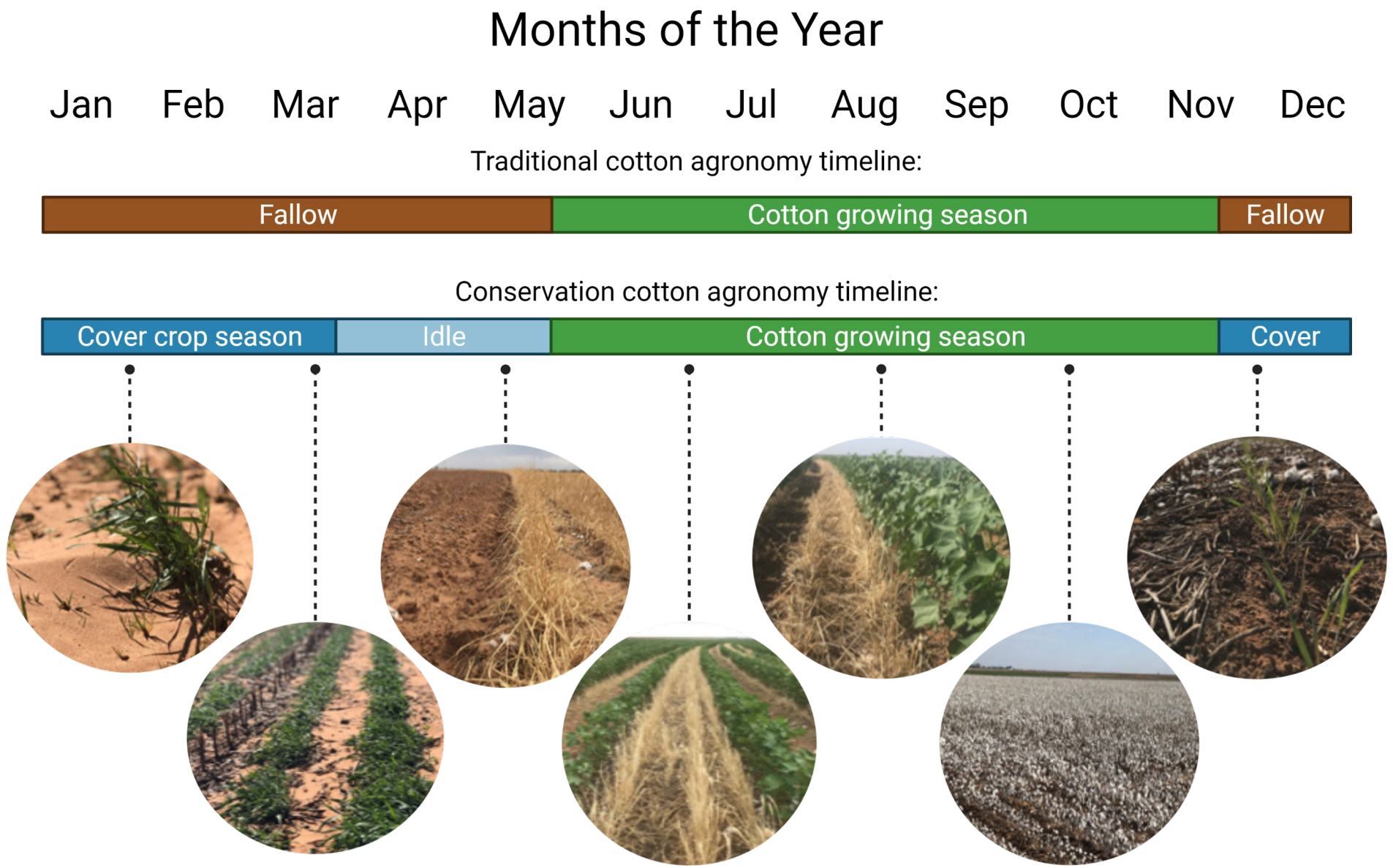

Conservation management:

- Cover cropping – 7.5%
- Reduced tillage – 54.4%



Values from 2017 Census of Agriculture

# Cotton agronomy timeline

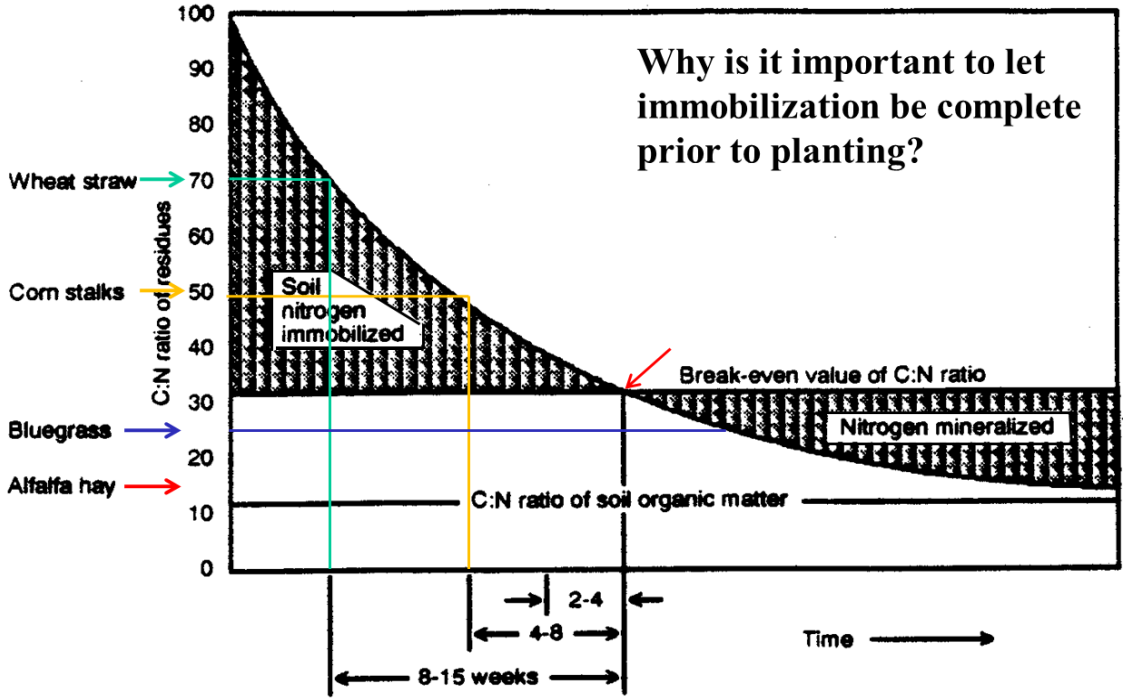


# Mineralization and immobilization

**Organic N ↔ Inorganic N**
**Equilibrium in soils**
(Nitrogen cycling)

***Mineralization*** – conversion of plant-unavailable organic N to plant-available inorganic N ($NH_4^+$); C:N < 30:1

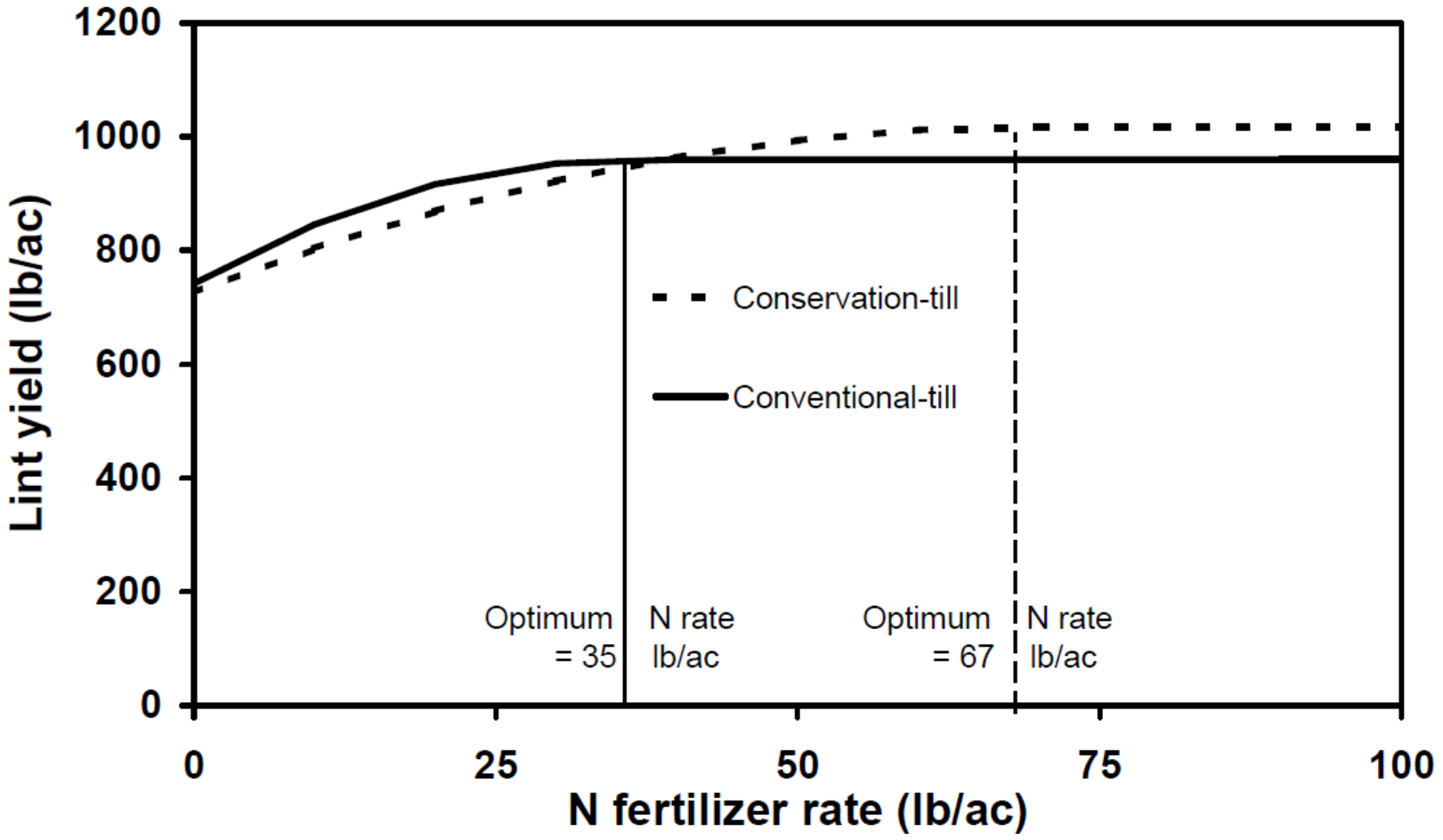
***Immobilization*** – conversion of plant-available inorganic N ($NH_4^+$, $NO_3^-$) to plant-unavailable organic N (**microbial tissues**); C:N > 30:1




***Practical significance??***

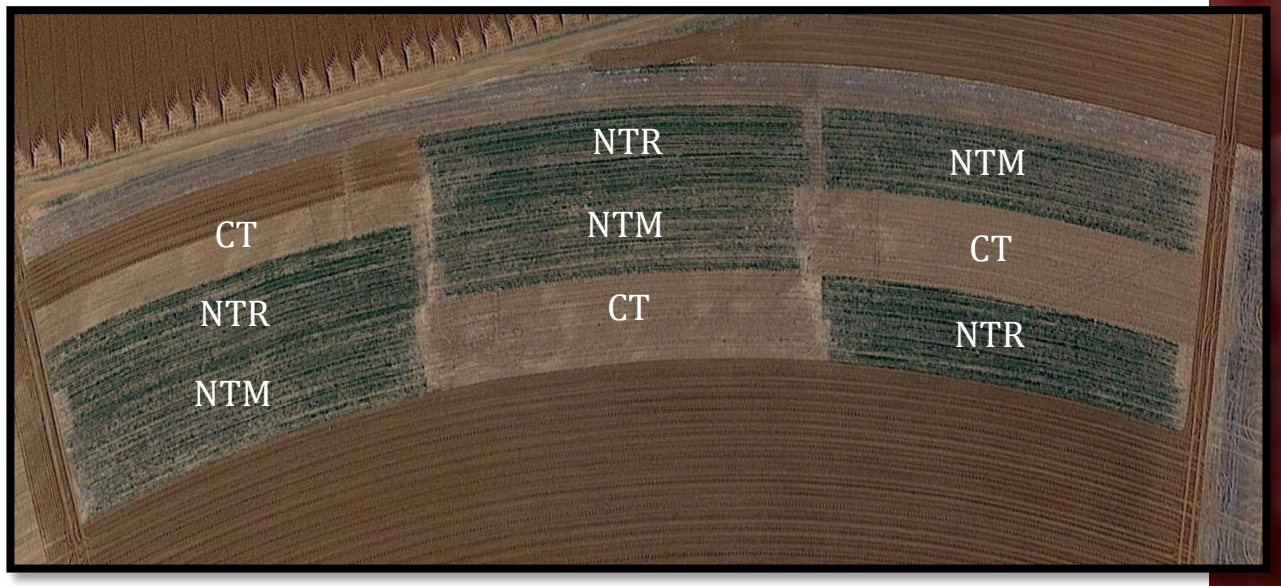
# Mineralization and Immobilization

***AG-CARES, Lamesa, TX***




Source: Nutrient Management of Conservation-Till Cotton in Terminated-Wheat K.F. Bronson, J.W. Keeling, R.K. Boman, J.D. Booker, and H.A. Torbert, April 2004

# Long-term cover crop system




Research plot design at Ag-CARES in Lamesa, TX

## Evaluated systems

Continuous cotton systems – (est. 1998)

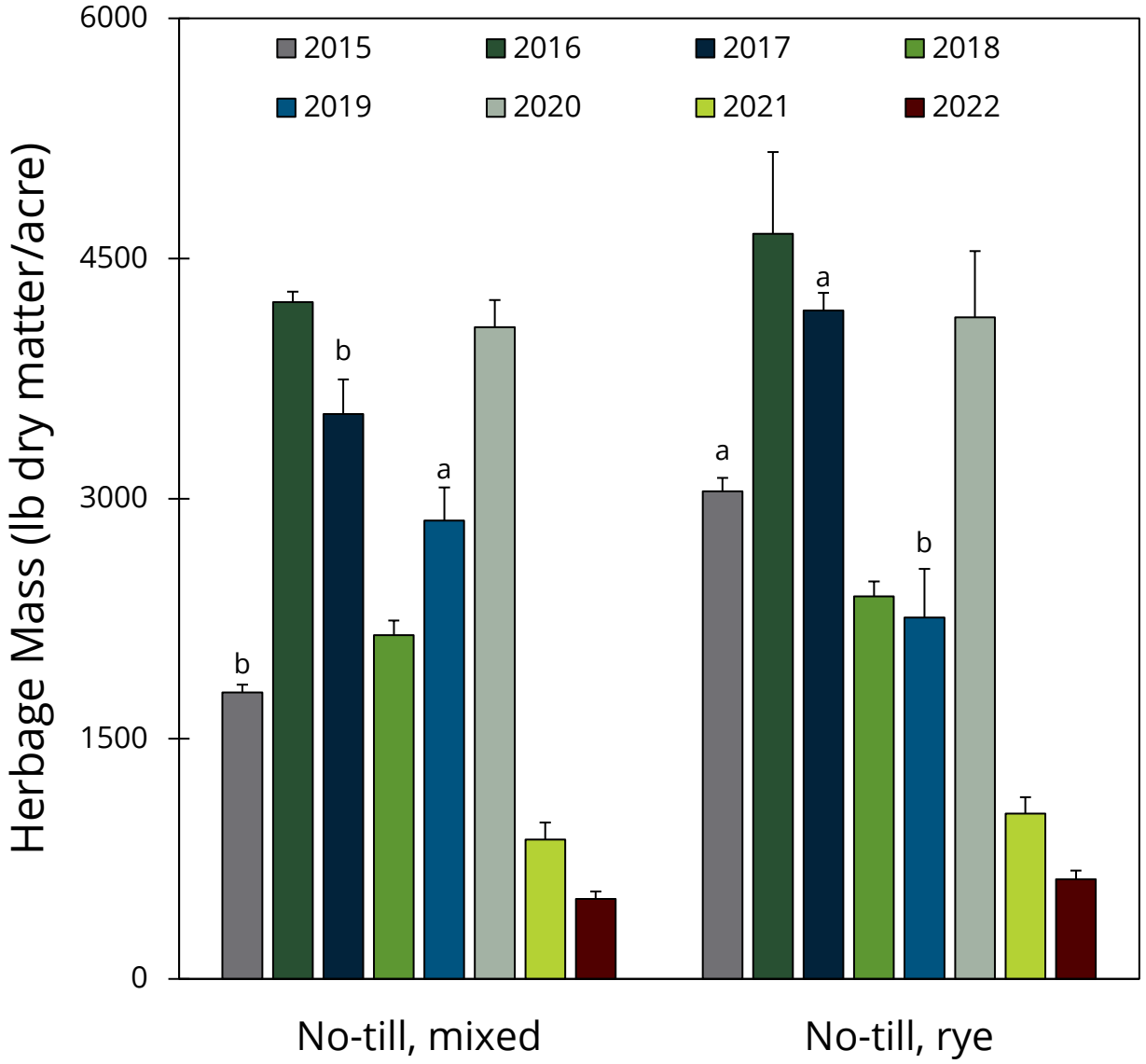
- Conventional tillage, winter fallow (CT)
- No-tillage, Rye cover (R-NT), 40 lb $ac.^{-1}$
- No-tillage, Mixed cover (M-NT), 40 lb $ac^{-1}$
  - Rye (50%)
  - Austrian Winter Pea (33%)
  - Hairy Vetch (10%)
  - Radish (7%)
    - by weight
  - Established in November 2014
  - NRCS recommended mixture

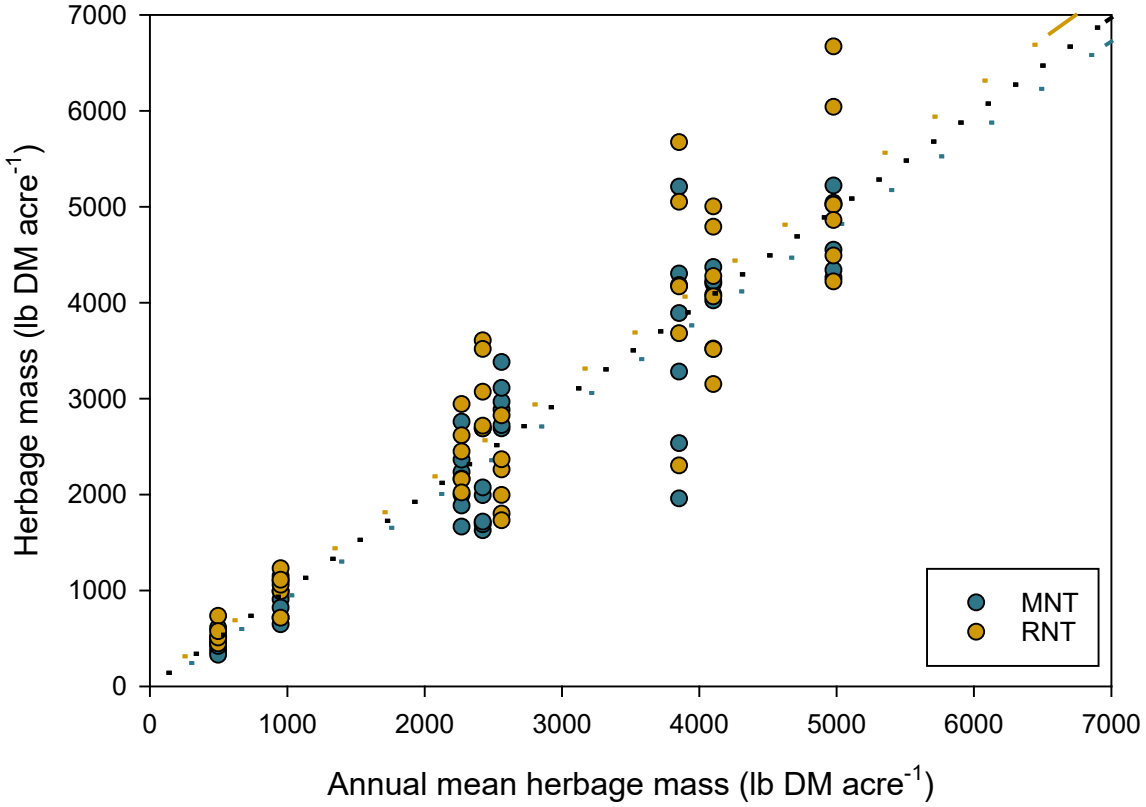
Native Systems (NAT)

- Rangeland - historical record indicates it unplowed at least 80 years

Depths: 0-2.5, 2.5-5, 5-12, 12-30, and 30-40”

# Herbage mass and stability

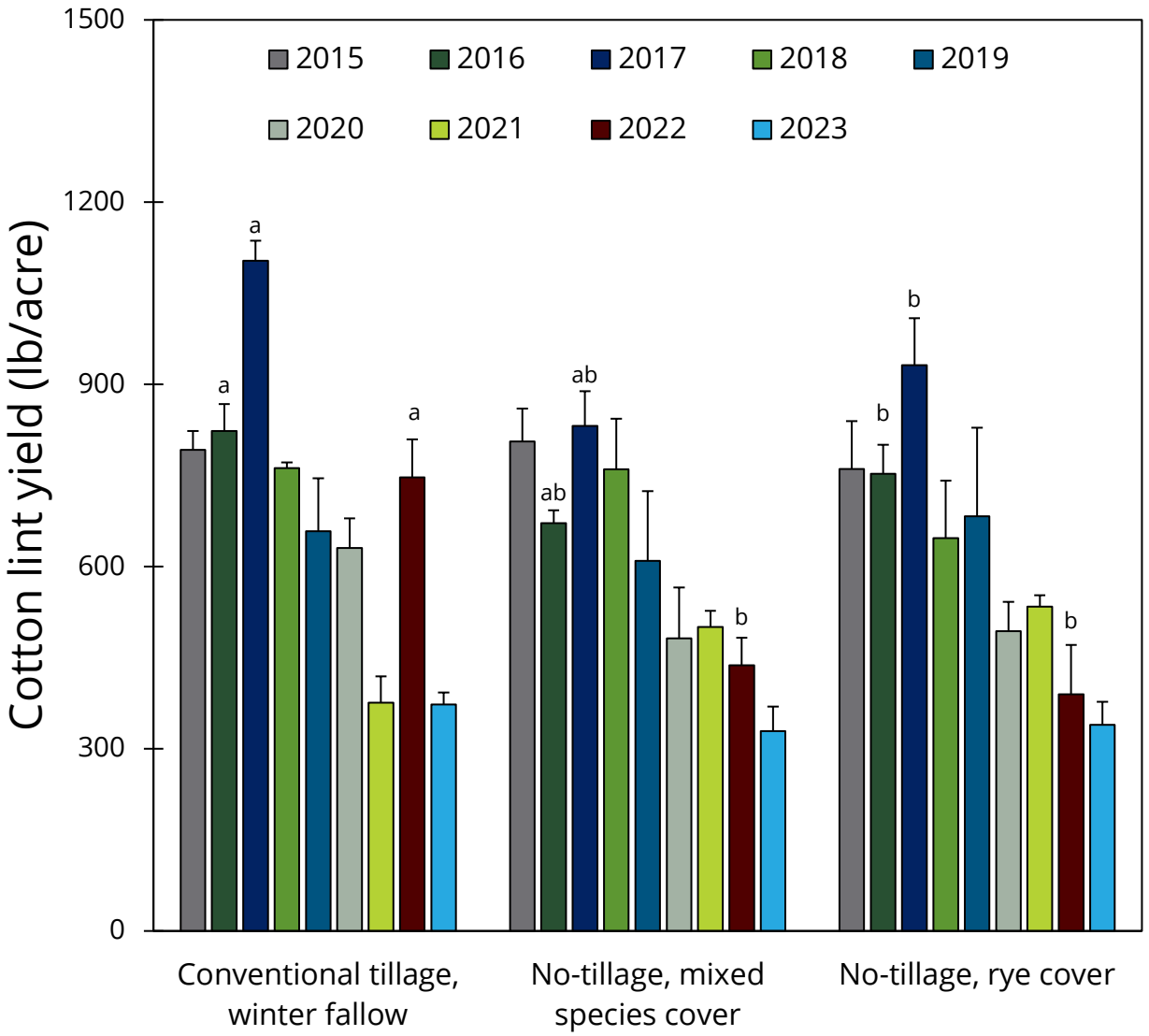


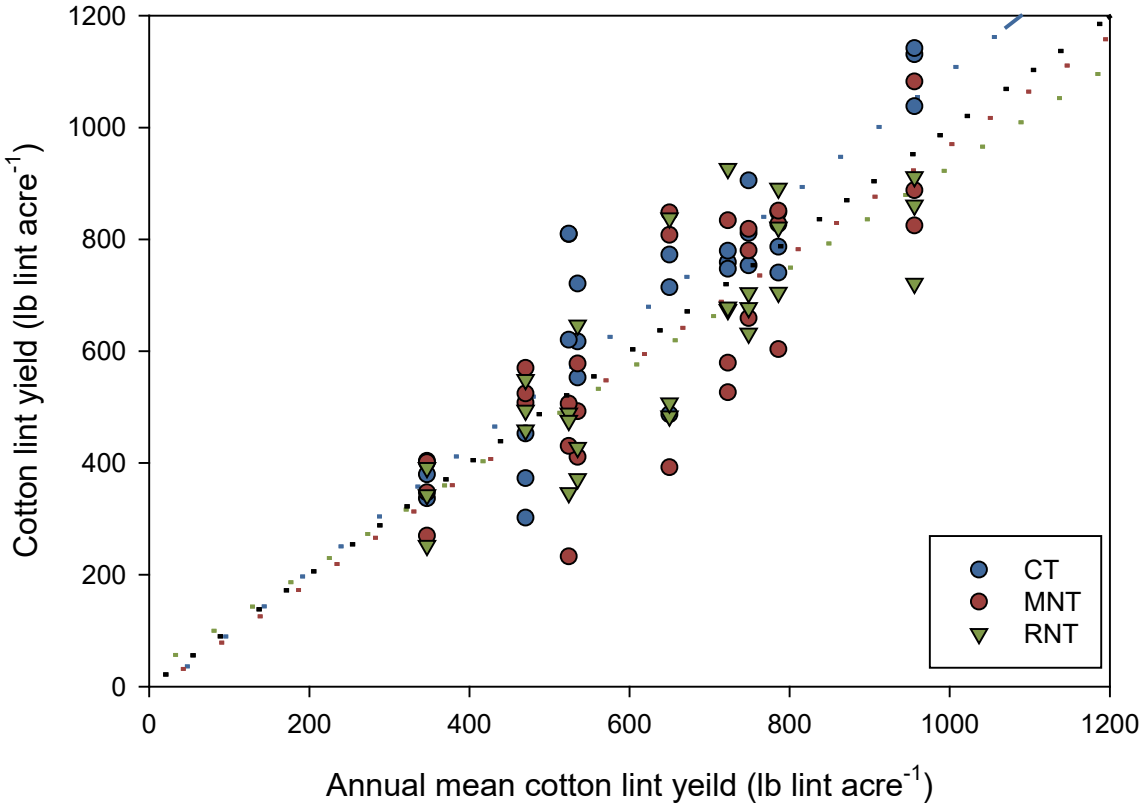




| Treatment | $\widehat{\beta}_1$ | $R^2$ |
|---|---|---|
| MNT | 0.968 | 0.551 |
| RNT | 1.031 | 0.655 |

> 1, more stable; = 1, stable; < 1, less stable

# Yield and stability

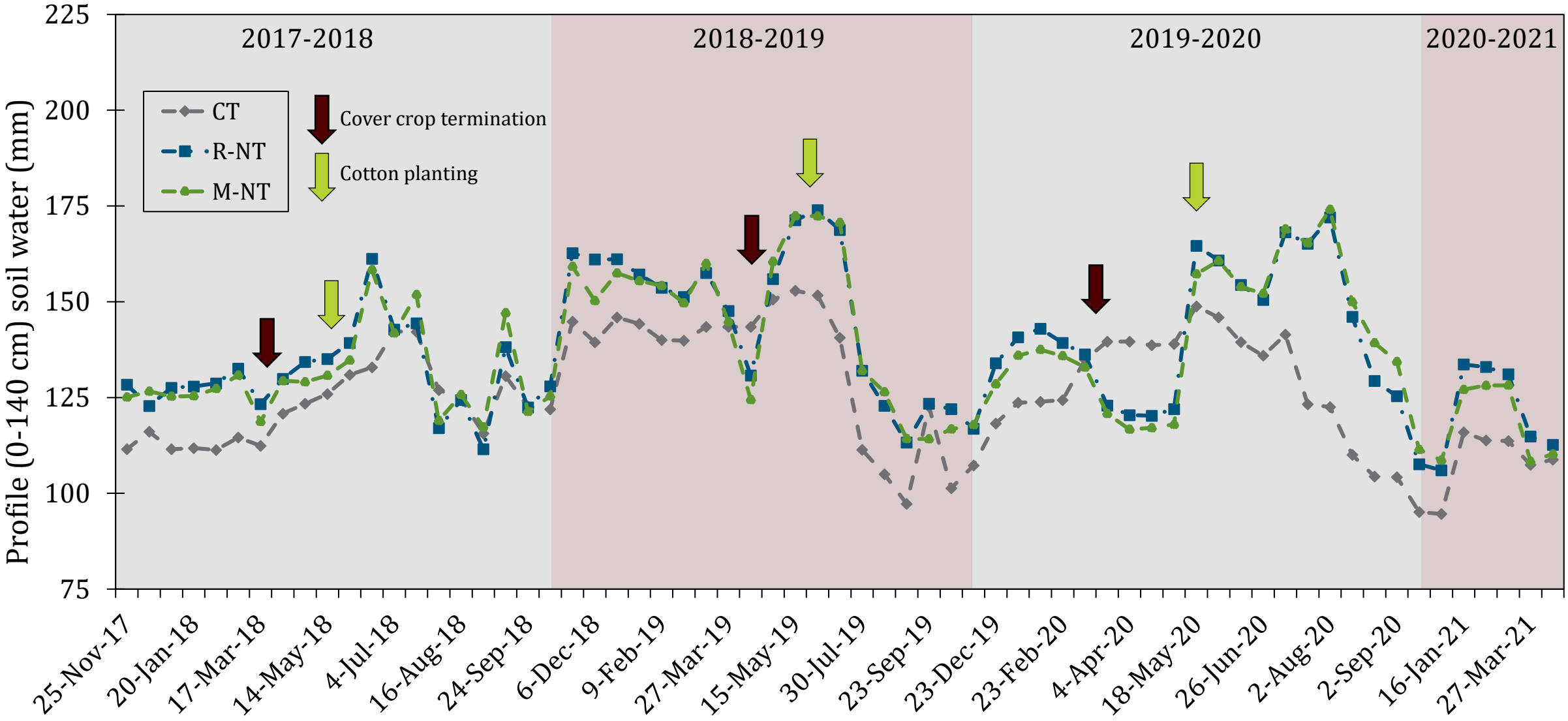



| Treatment | $\hat{\beta}_1$ | $R^2$ |
|---|---|---|
| CT | 1.120 | 0.771 |
| MNT | 0.978 | 0.659 |
| RNT | 0.903 | 0.696 |

> 1, more stable; = 1, stable; < 1, less stable

# Soil water over time

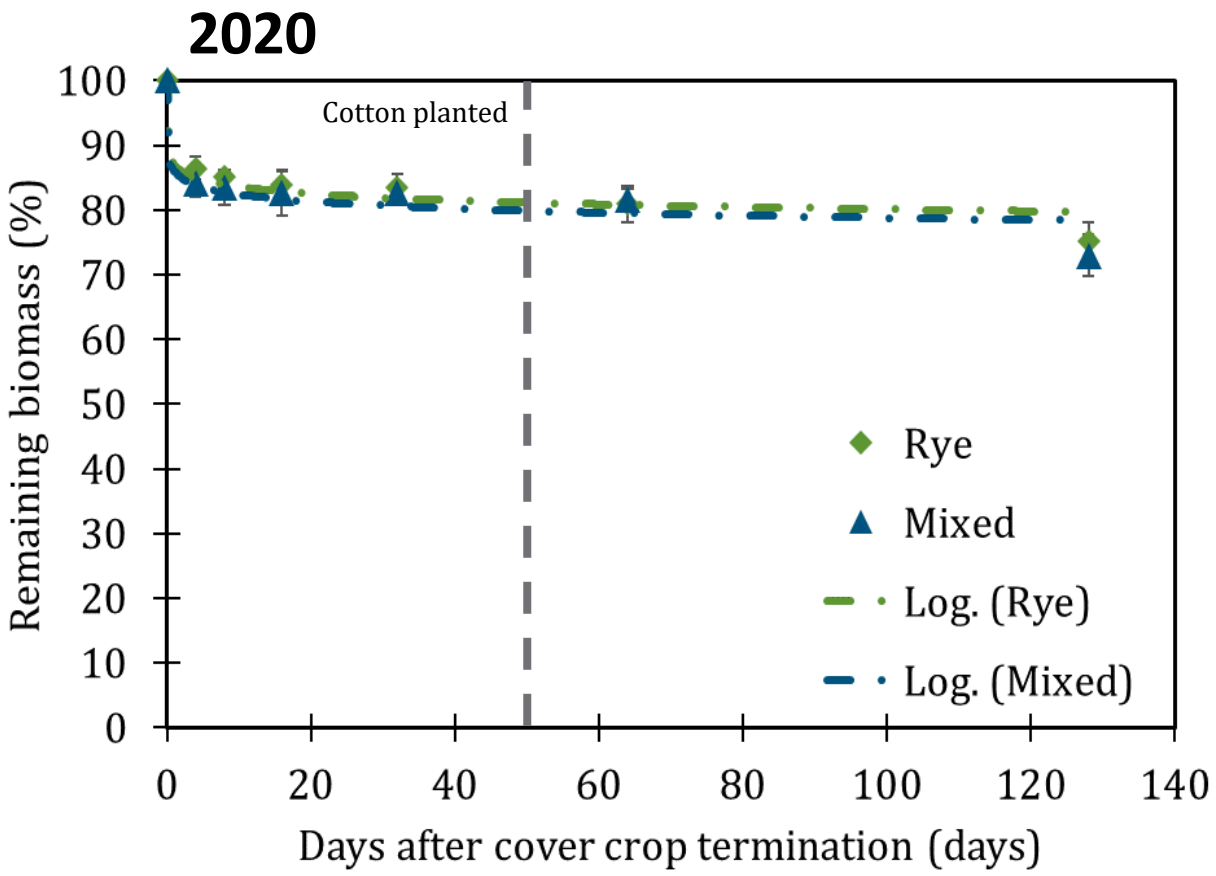


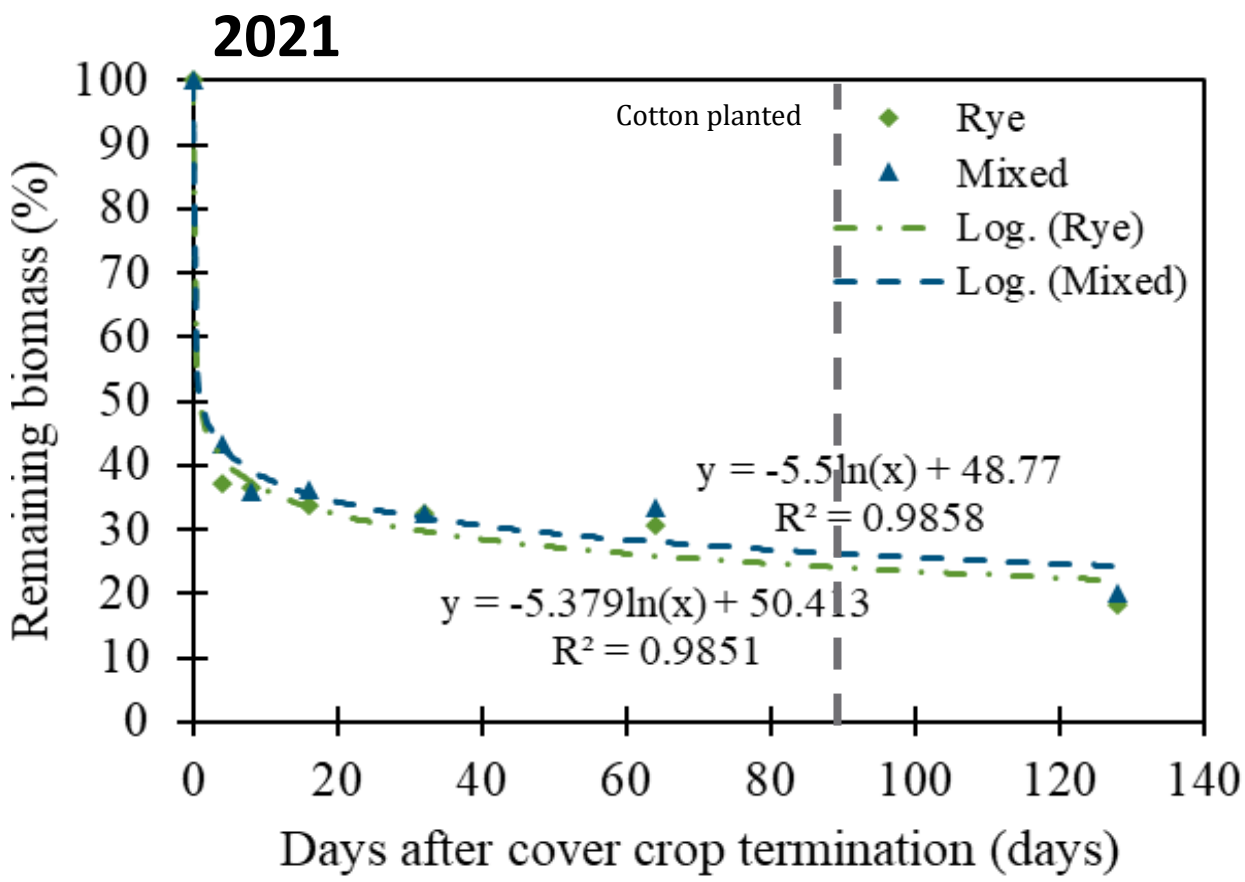
# The field methods

**Biomass decomposition**
75-mesh litterbags retrieved at 0, 4, 8, 16, 32, 64, and 128 days, *Heath, 1964*

**Soil samples**
Collected at 0-15 cm depth from directly beneath the litterbags

# Cover crop biomass decomposition



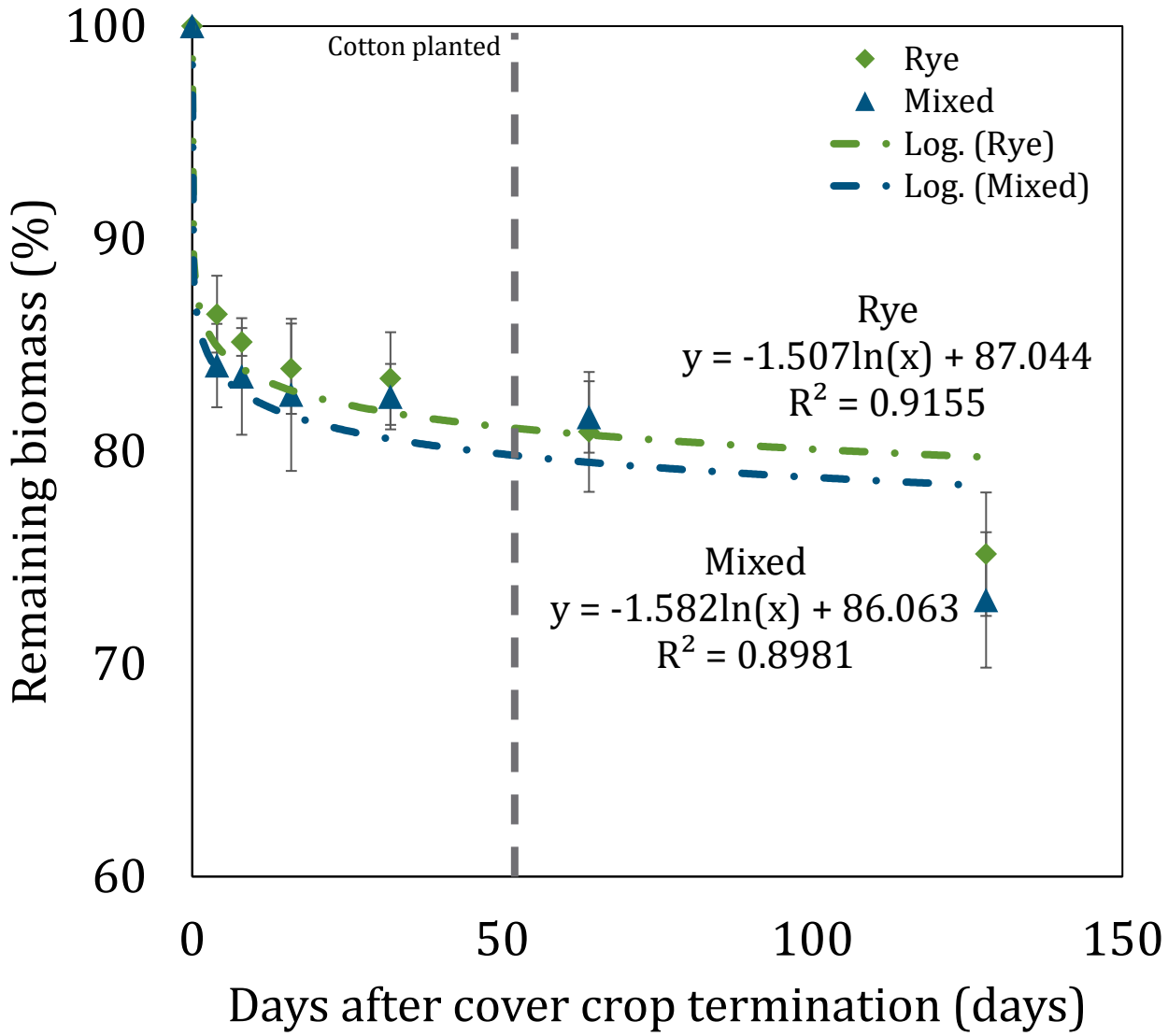
# Biomass decomposition - 2020

| Cover crop | Biomass (lb ac$^{-1}$) | N (%) | Potential N (lb ac$^{-1}$) |
|---|---|---|---|
| Rye | 4,131 | 3.1 | 128.0 |
| Mixed | 4,068 | 3.0 | 122.1 |

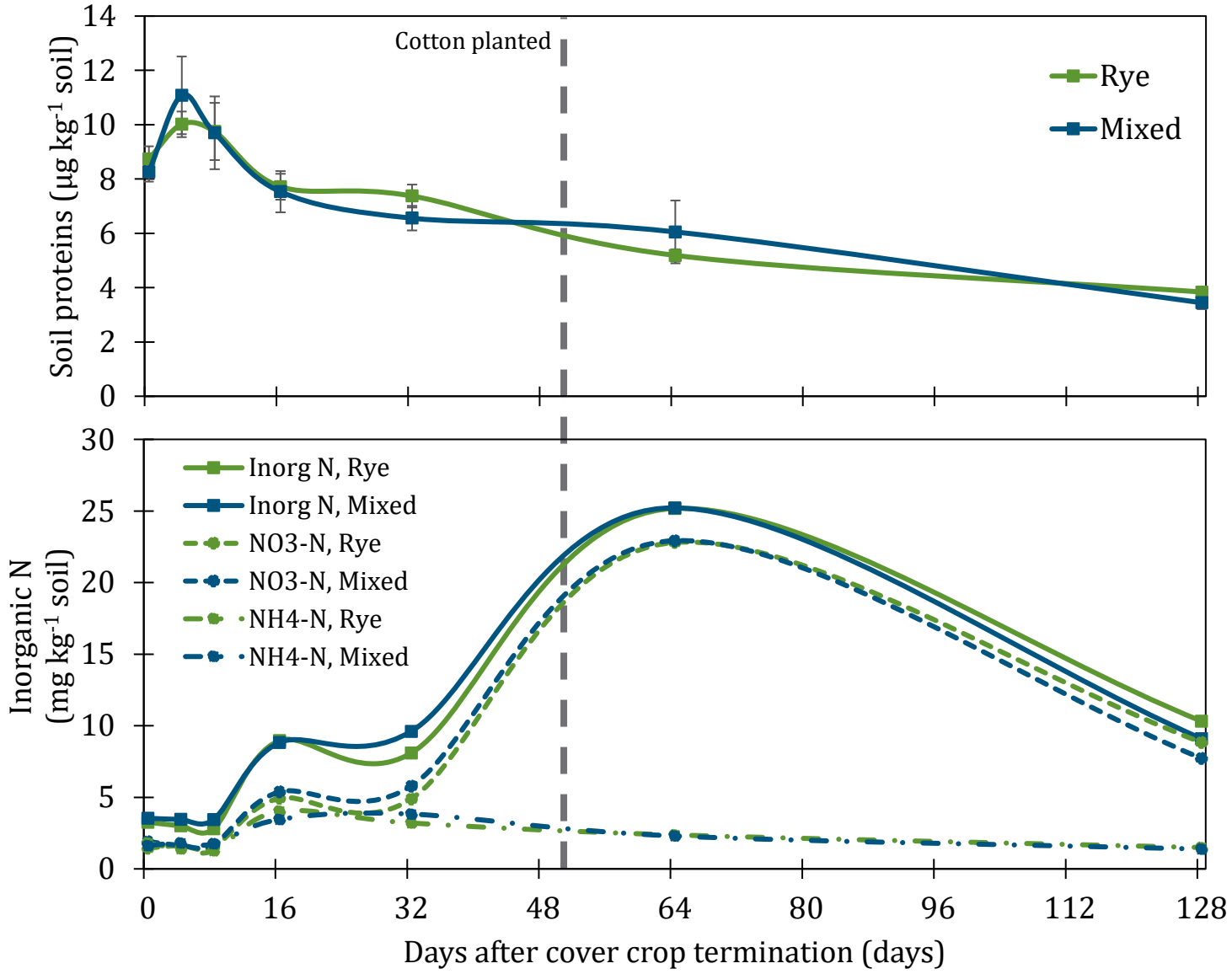
Potentially mineralizable N

| | Mineralized N (lb ac$^{-1}$) | |
|---|---|---|
| % Mineralized | Rye | Mixed |
| 5 | 6 | 6 |
| 10 | 13 | 13 |
| 20 | 26 | 24 |
| 30 | 38 | 37 |
| 40 | 51 | 49 |
| 50 | 64 | 61 |

Will N mineralization and availability coincide with cotton demands?



# Soil nitrogen dynamics




## Soil proteins = organic N

- Increases in organic N result from decomposition of cover crop residues by soil microbes
- Those microbes will eventually make that N available to plants when they die or through mineralization, but the process is slow in semi-arid cropping regions with limited water

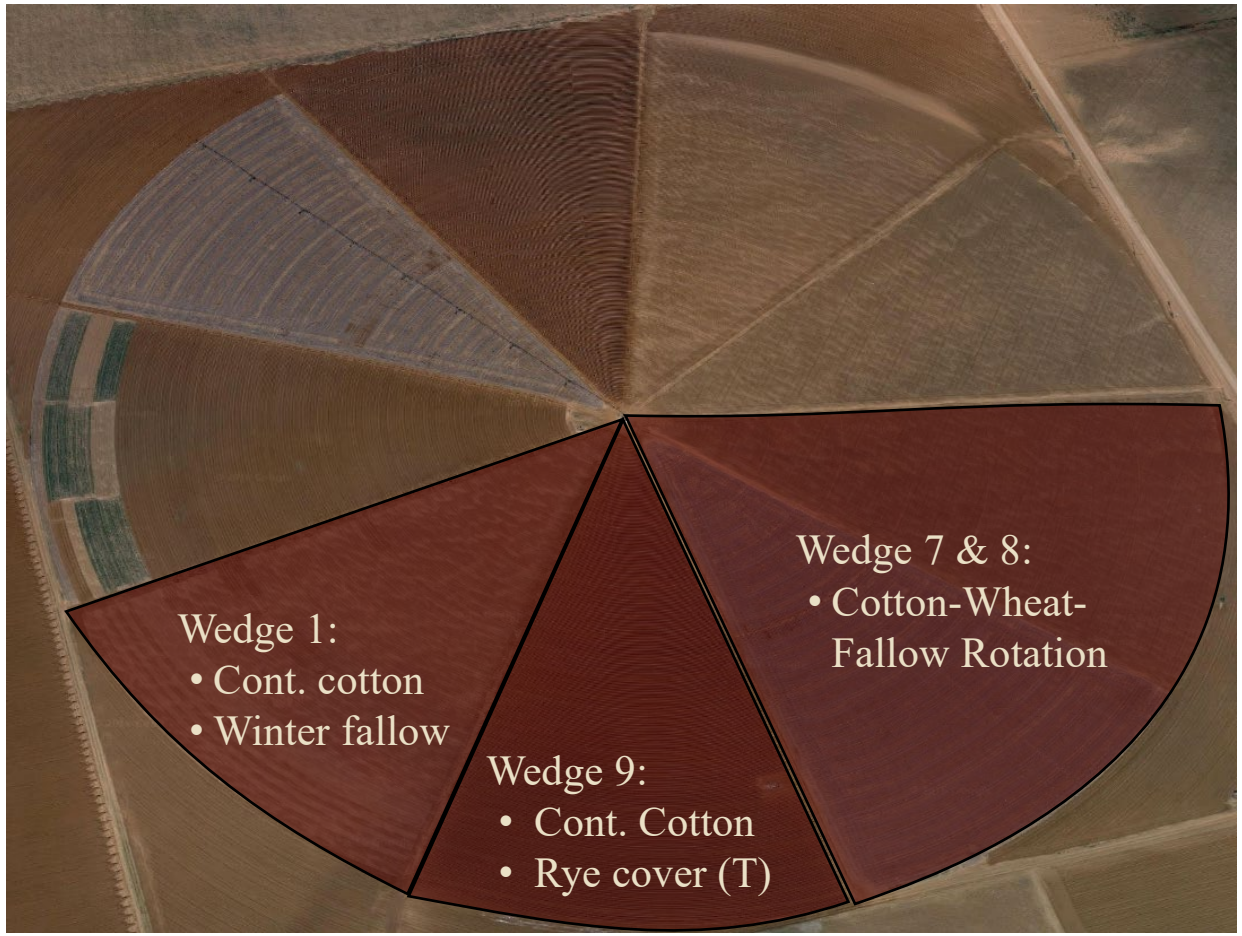
Texas A&M AgriLife Research

# Economics

| Management System | Input Cost* | Lint Revenue 2015 | Lint Revenue 2016 | Lint Revenue 2017 | Gross Margin 2015 | Gross Margin 2016 | Gross Margin 2017 | AVG |
|---|---|---|---|---|---|---|---|---|
| | $/acre | | | | | | | |
| Conv. Tillage | 84 | 412 | 428 | 538 | 328 | 344 | 454 | 375 |
| Rye, NT | 45 | 419 | 349 | 428 | 374 | 304 | 383 | 354 |
| Mixed, NT | 72 | 396 | 391 | 468 | 323 | 319 | 395 | 345 |

*No-tillage input costs included: seed, drilling, chemical termination, and in-season herbicide application. Conventional tillage input costs included: sand fighting (x2), cultivation (x2), rotary hoe, rodweeding, listing, and Treflan incorporation.

# Cropping systems and N management




Nitrogen study plot design at Ag-CARES in Lamesa, TX

## Treatments

- Cropping systems –
  - Conventional tillage, winter fallow (CC)
  - Continuous cotton with rye cover (CCRC)
  - Cotton-wheat-fallow rotation (CWR)
- Nitrogen applications –
  - Farmer's practice (120 lb N $A^{-1}$, FP)
  - FP + 30 lb N $A^{-1}$ preplant (PPN)
  - FP + 30 lb N $A^{-1}$ 2-3 weeks post emergence (POS)
  - FP + 30 lb N $A^{-1}$ pinhead square + 2 weeks (PIN)

# Cotton production (2018-2020)

*Burke and Lewis et al.*

| Cropping System | Nitrogen fertilization strategies | | | | |
|---|---|---|---|---|---|
| | FP | PPN | PEN | PHSN | |
| | Lint yield (lint acre$^{-1}$) | | | | AVG |
| CC | 723 | 787 (8.9%) | 715 (-1.1%) | 683 (-5.5%) | **727** |
| CCRC | 806 | 938 (16.4%) | 965 (19.6%) | 857 (6.2%) | **891** (23.3%) |
| CWR | 1,134 | 1,032 (-9.0%) | 1,117 (-1.5%) | 1,064 (-6.2%) | **1,087** (50.4%) |
| AVG | **888** | **919** (3.5%) | **932** (5.0%) | **868** (-2.2%) | |

***2018-2020 averages***

**Fertilization strategies:**

- FP = farmers practices (120 lb N A$^{-1}$)
- PPN = FP + 20 lb N A$^{-1}$ at preplant
- PEN = FP + 20 lb N A$^{-1}$ at post emerg. + 2 wks
- PHSN = FP + 20 lb N A$^{-1}$ at pinhead square + 2 wks

**Cropping systems:**

- CC = Continuous cotton, conventional tillage (>25 yrs)
- CCRC = Continuous cotton-Rye cover
- CWR = Cotton-Wheat rotation

# Gross margins (2018-2020)

*Burke and Lewis et al.*

| Cropping System | Nitrogen fertilization strategies | | | | |
|---|---|---|---|---|---|
| | FP | PPN | PEN | PHSN | |
| | Gross Margin($ acre$^{-1}$) | | | | AVG |
| CC | 434 | 489 (12.7%) | 441 (1.6%) | 420 (-3.3%) | **336** |
| CCRC | 489 | 591 (20.7%) | 608 (24.3%) | 536 (9.5%) | **556** (65.5%) |
| CWR | 609 | 575 (-5.6%) | 610 (0.3%) | 587 (-3.6%) | **595** (77.1%) |
| AVG | **511** | **552** (8.0%) | **553** (8.2%) | **514** (0.6%) | |

***2018-2020 averages***

**Fertilization strategies:**

- FP = farmers practices (120 lb N $A^{-1}$)
- PPN = FP + 20 lb N $A^{-1}$ at preplant
- PEN = FP + 20 lb N $A^{-1}$ at post emerg. + 2 wks
- PHSN = FP + 20 lb N $A^{-1}$ at pinhead square + 2 wks

**Cropping systems:**

- CC = Continuous cotton, conventional tillage (>25 yrs)
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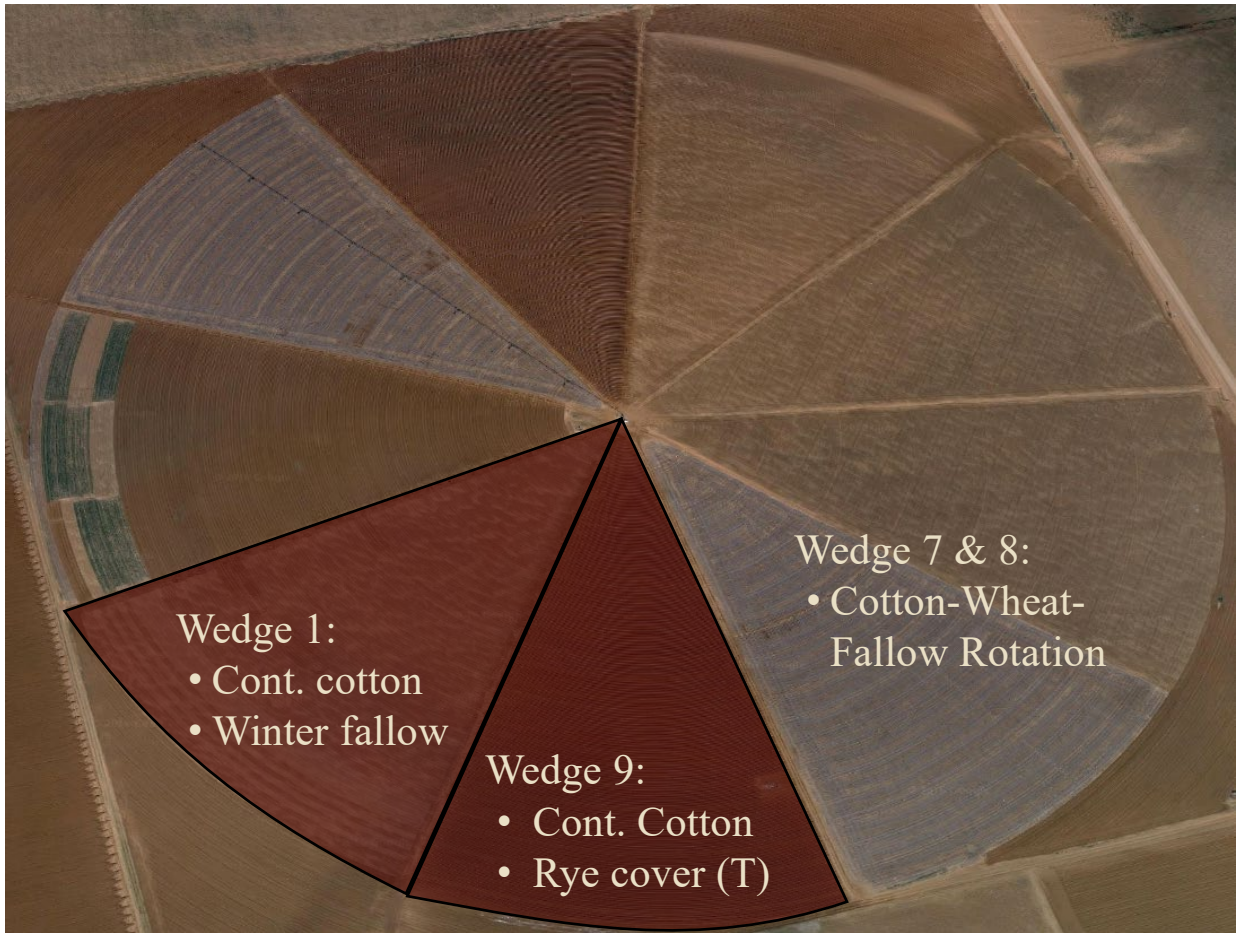
# Nitrogen management (2022-2024)

*Lewis et al.*

**Nitrogen Application (UAN-32)**

| Practice | Pre | June | July |
|---|---|---|---|
| | (lb N/A) | | |
| Common | 30 | 30 | 30 |
| Early | 30 | 50 | 10 |
| Late | 30 | 10 | 50 |

*AG-CARES, Lamesa, TX*

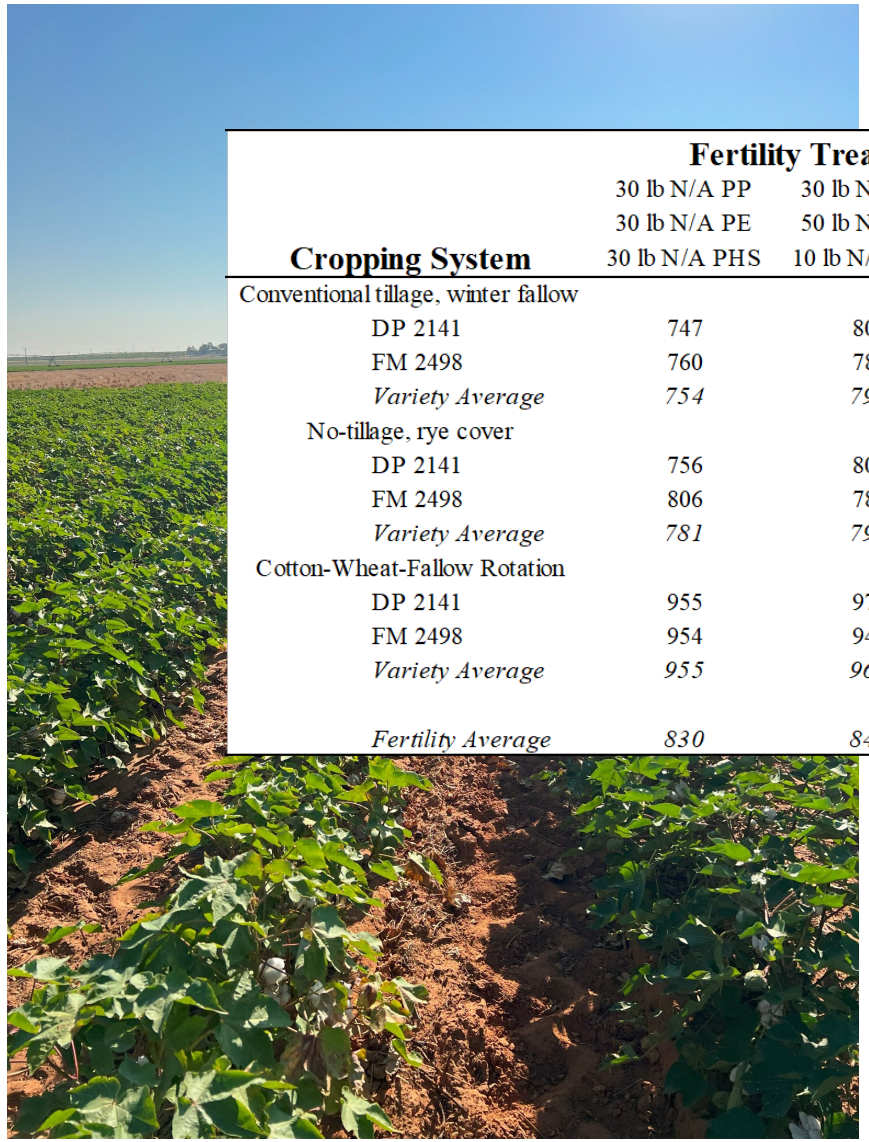



Nitrogen study plot design at Ag-CARES in Lamesa, TX

# Nitrogen management (2022 - 2024)

*Lewis et al.*

***AG-CARES, Lamesa, TX***

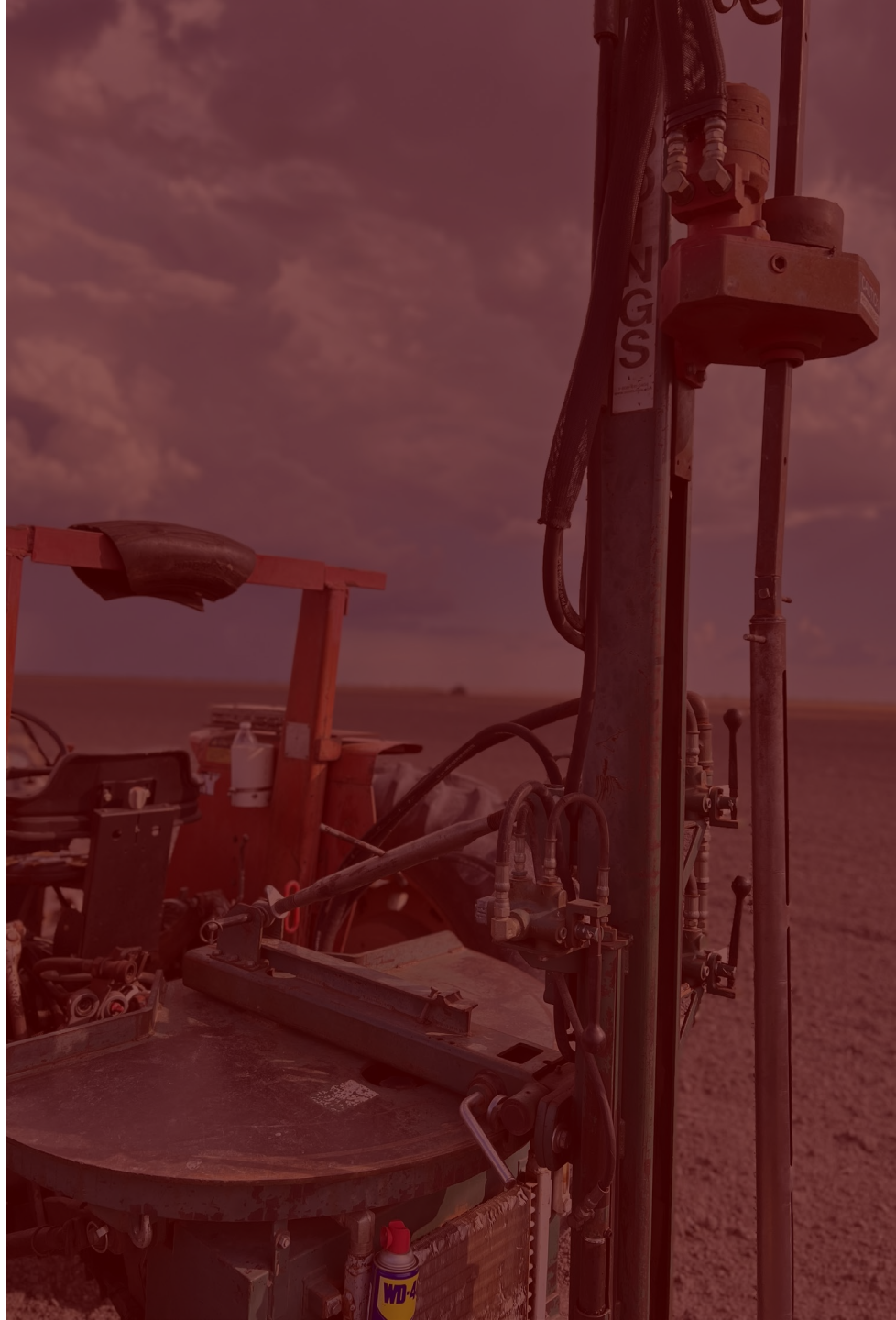


| Cropping System | Fertility Treatment - 2022<br>30 lb N/A PP<br>30 lb N/A PE<br>30 lb N/A PHS | <br>30 lb N/A PP<br>50 lb N/A PE<br>10 lb N/A PHS | <br>30 lb N/A PP<br>10 lb N/A PE<br>50 lb N/A PHS | *Cropping System Average* |
|---|---|---|---|---|
| Conventional tillage, winter fallow | | | | |
| DP 2141 | 747 | 804 | 718 | |
| FM 2498 | 760 | 782 | 812 | *771* |
| *Variety Average* | *754* | *793* | *765* | |
| No-tillage, rye cover | | | | |
| DP 2141 | 756 | 806 | 797 | |
| FM 2498 | 806 | 784 | 782 | *788* |
| *Variety Average* | *781* | *795* | *789* | |
| Cotton-Wheat-Fallow Rotation | | | | |
| DP 2141 | 955 | 977 | 921 | |
| FM 2498 | 954 | 943 | 946 | *949* |
| *Variety Average* | *955* | *960* | *934* | |
| *Fertility Average* | *830* | *849* | *829* | *836* |

| Cropping System | Fertility Treatment - 2023<br>30 lb N/A PP<br>30 lb N/A PE<br>30 lb N/A PHS | <br>30 lb N/A PP<br>50 lb N/A PE<br>10 lb N/A PHS | <br>30 lb N/A PP<br>10 lb N/A PE<br>50 lb N/A PHS | *Cropping System Average* |
|---|---|---|---|---|
| Conventional tillage, winter fallow | | | | |
| DP 2143 | 419 | 427 | 389 | |
| FM 2498 | 421 | 380 | 405 | *407* |
| *Variety Average* | *420* | *404* | *397* | |
| No-tillage, rye cover | | | | |
| DP 2143 | 361 | 406 | 331 | |
| FM 2498 | 391 | 357 | 385 | *372* |
| *Variety Average* | *376* | *382* | *358* | |
| Cotton-Wheat-Fallow Rotation | | | | |
| DP 2143 | 411 | 424 | 398 | |
| FM 2498 | 477 | 494 | 495 | *450* |
| *Variety Average* | *444* | *459* | *447* | |
| *Fertility Average* | *413* | *415* | *401* | *410* |

# Summary

- Cover crop biomass decomposition depends on herbage mass production and environmental conditions.
- Cover crop herbage mass can immobilize soil N early in the growing season.
- Supplemental N fertilization can offset immobilization and increase cotton lint yield.
- Cotton-wheat-fallow rotations may be a better alternative to cover crops in certain regions.



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# THANK YOU

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