Enhancing Soil Health and Ecosystem Services through Pasture Cropping

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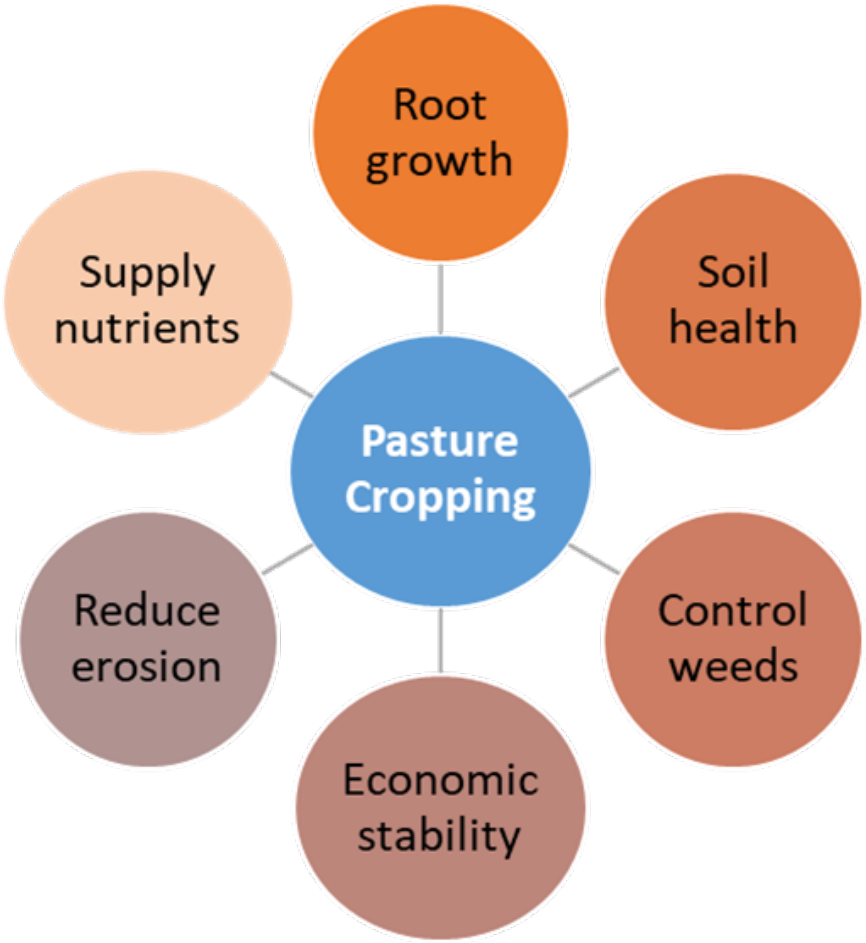
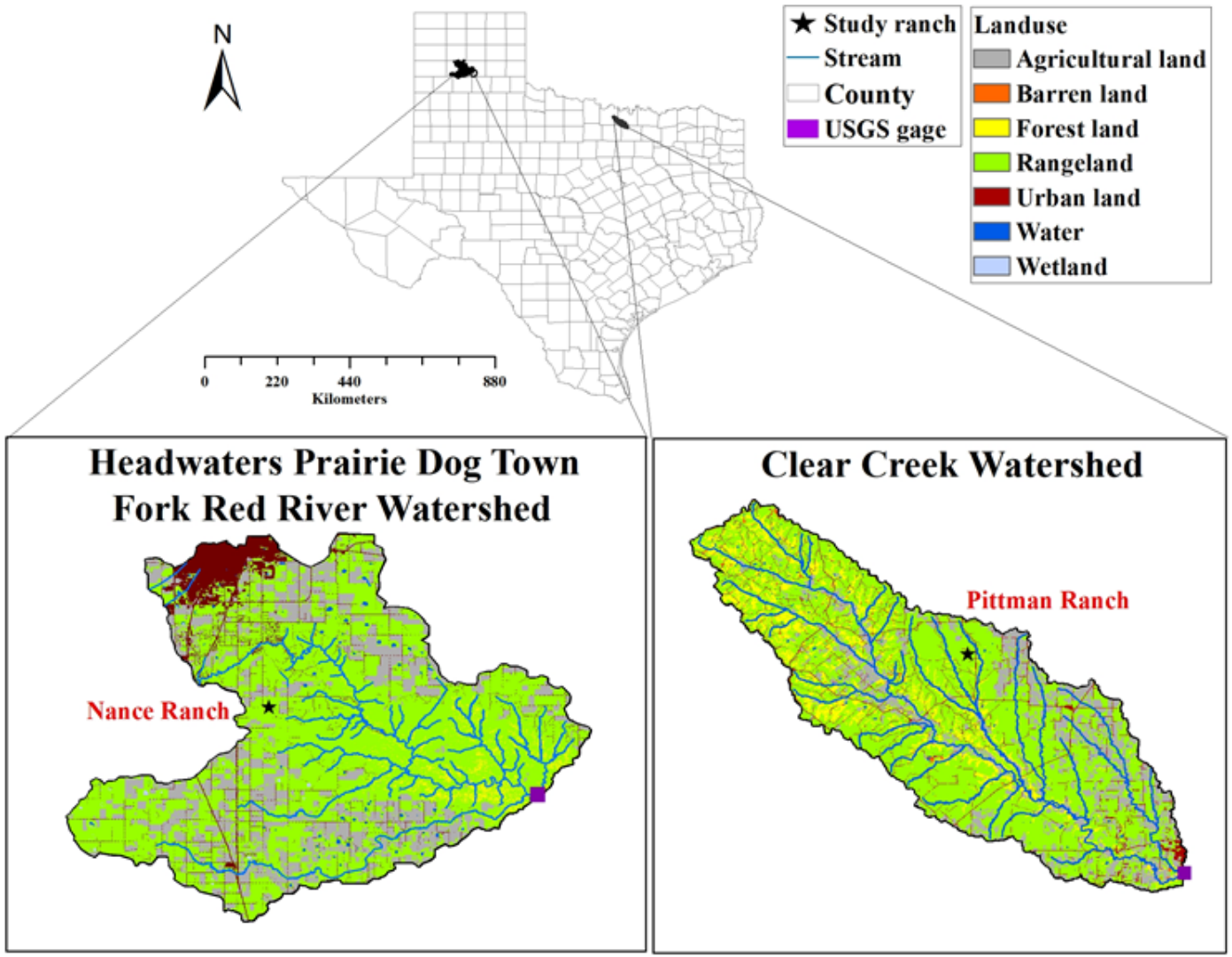
Introduction

- Poor crop and grazing management practices have decreased soil health and contributed to decreased productivity and profitability in much of the Southern Great Plains.
- Regenerative practices such as Pasture cropping, which seamlessly integrates direct seeding of annual crops into dormant perennial grasses, can provide multiple benefits.
- Pasture cropping is a farmer-initiated land management system that has been successfully practiced in Australia and other countries.
- Studies evaluating the performance of pasture cropping in the Southern Great Plains are lacking.



Study Ranches and Watersheds



Nance Ranch

Pittman Ranch

Objective and Ecosystem Services Quantified

Objective: Provide insights into the successes and challenges of establishing pasture cropping at the study ranches.

Ecosystem services/variables measured/quantified:

1. Physical, chemical and biological soil health indicators:
    - Aggregate stability, bulk density, infiltration, soil water/temp.
    - Biological activity, microbial composition.
2. Crop/forage growth/health, biomass, species composition.
3. Ecosystem services:
    - Soil erosion, and sediment/nutrient losses.
    - Soil carbon sequestration.
    - Water holding capacity, downstream flood risk.
    - Climate change mitigation potential.

Experiment Design – Pittman Ranch

Treatments:

Eleven treatment plots of 30 x 30 m replicated 3 times.

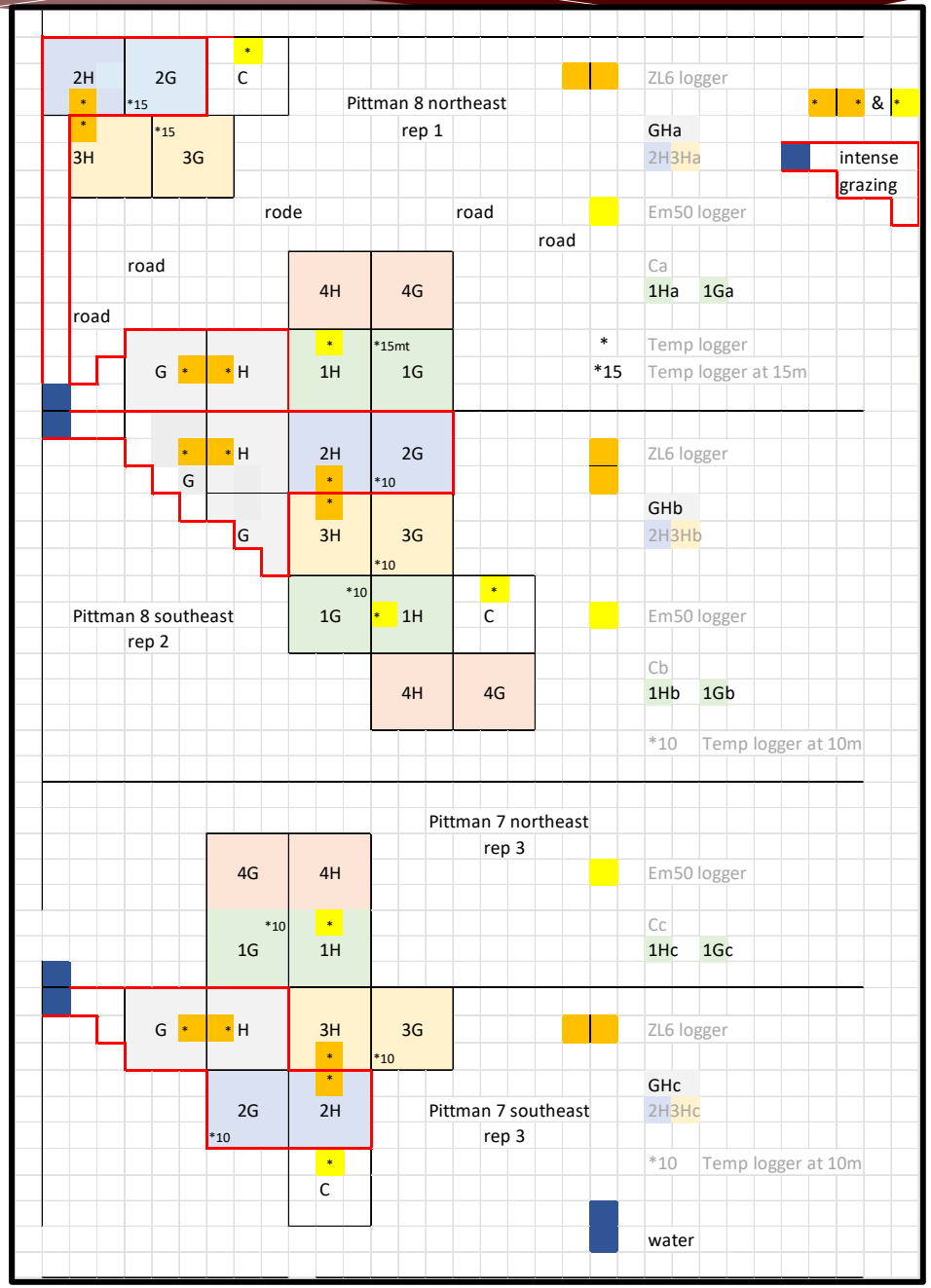
i) control treatment – a tall grass prairie plot without pasture cropping but grazed **(C)**.

ii) winter wheat grown and grazed **(G)** in tall grass prairie plots in all four years.

iii) winter wheat grown and harvested **(H)** in tall grass prairie plots in all four years.

iv to vii) winter wheat grown and grazed in winter-dormant tall grass prairie plots in one of the four years.

viii to xi) winter wheat grown and harvested for grain in tall grass prairie plots in one of the four years.



Study Tasks – Pittman Ranch

- **Plot preparation:** Fencing, soil sensors, weather station.
- **Planting**
  - ***Time***: First week of November
  - ***Wheat Variety*:** TAM 205
  - ***Seeding Depth*:** ½-1”
  - ***Seed Rate*:** 60 lb/ac (~67 kg/ha)
  - ***No-till Drill***
  - ***Row Spacing*:** 7.5”
- **Data collection:** soil sampling, weather data, soil water and temperature data, and vegetation species and biomass.
- **UAV Multispectral Imaging**: Early, mid and late in the season to assess vegetation competition.

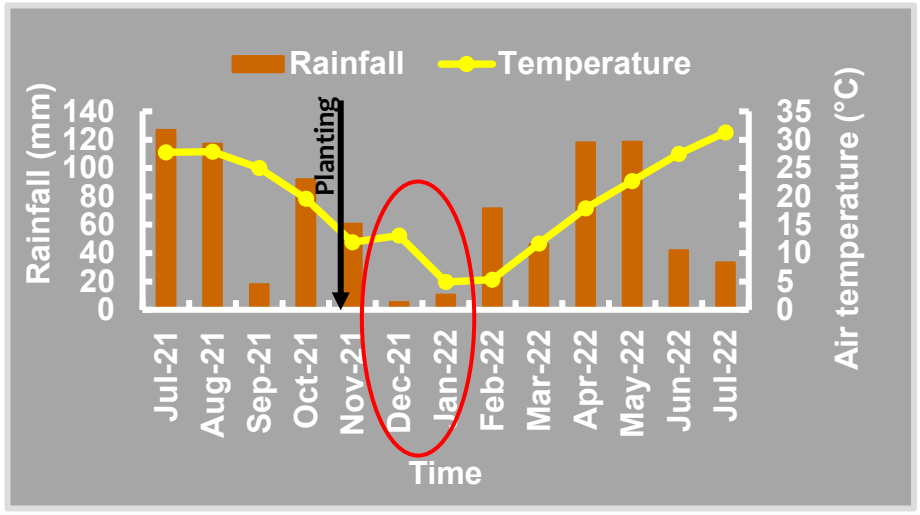
Fencing

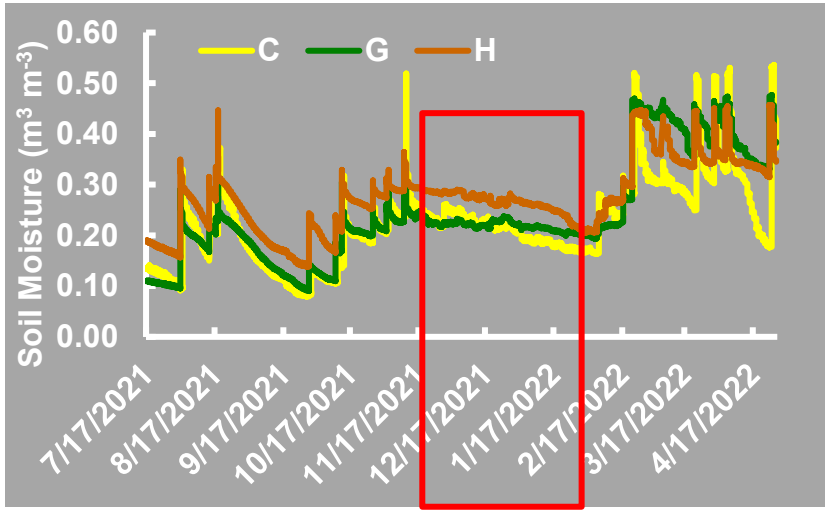
Planting

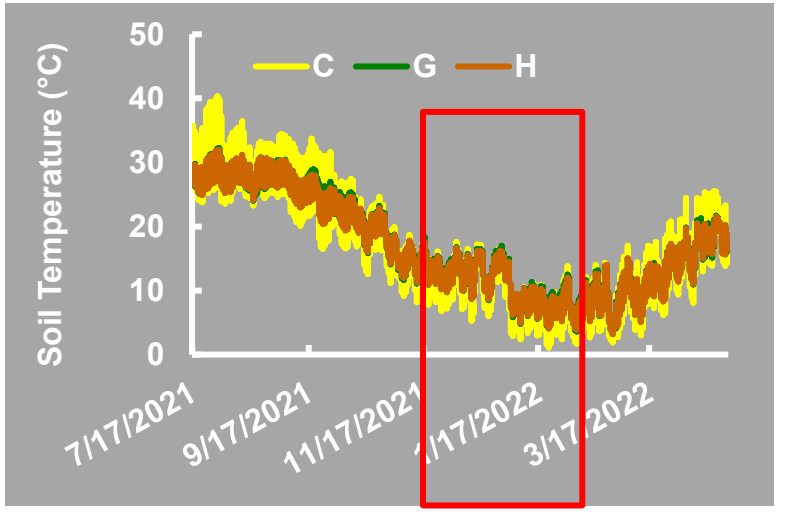
UAV imagery

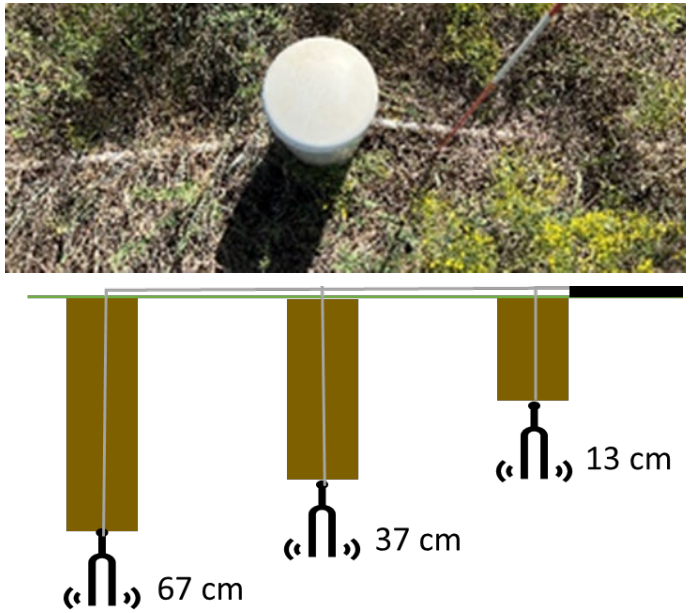
Ground control points

Observations – 2021-22



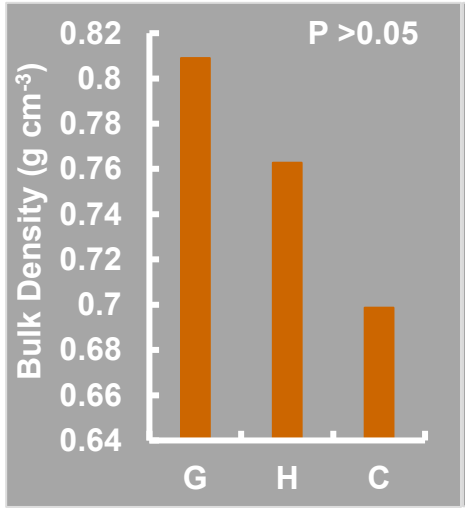


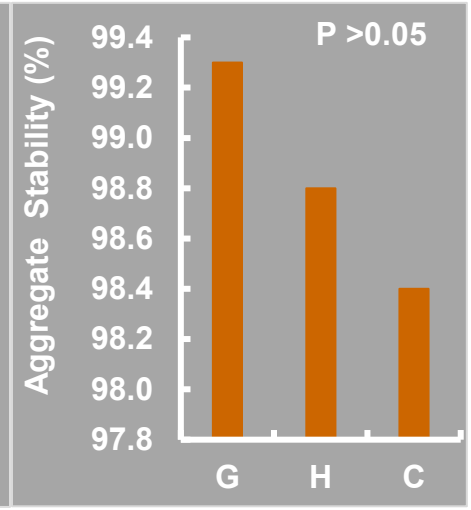


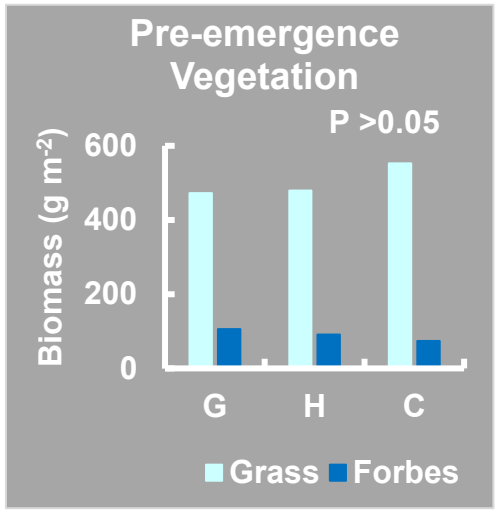


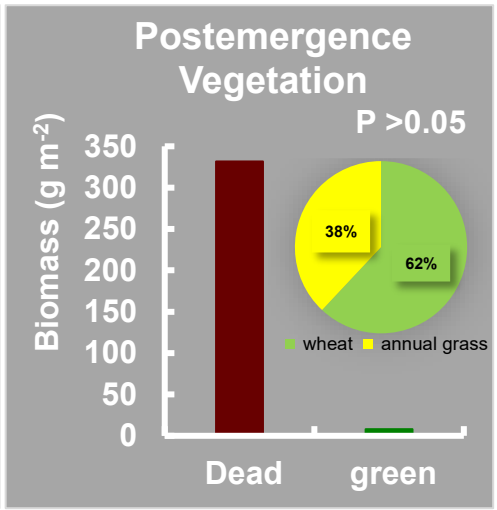
TEXAS A&M AGRILIFE RESEARCH

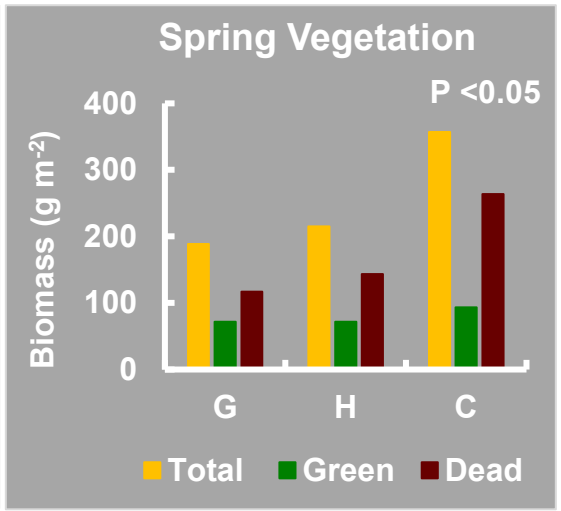
Observations – 2021-22











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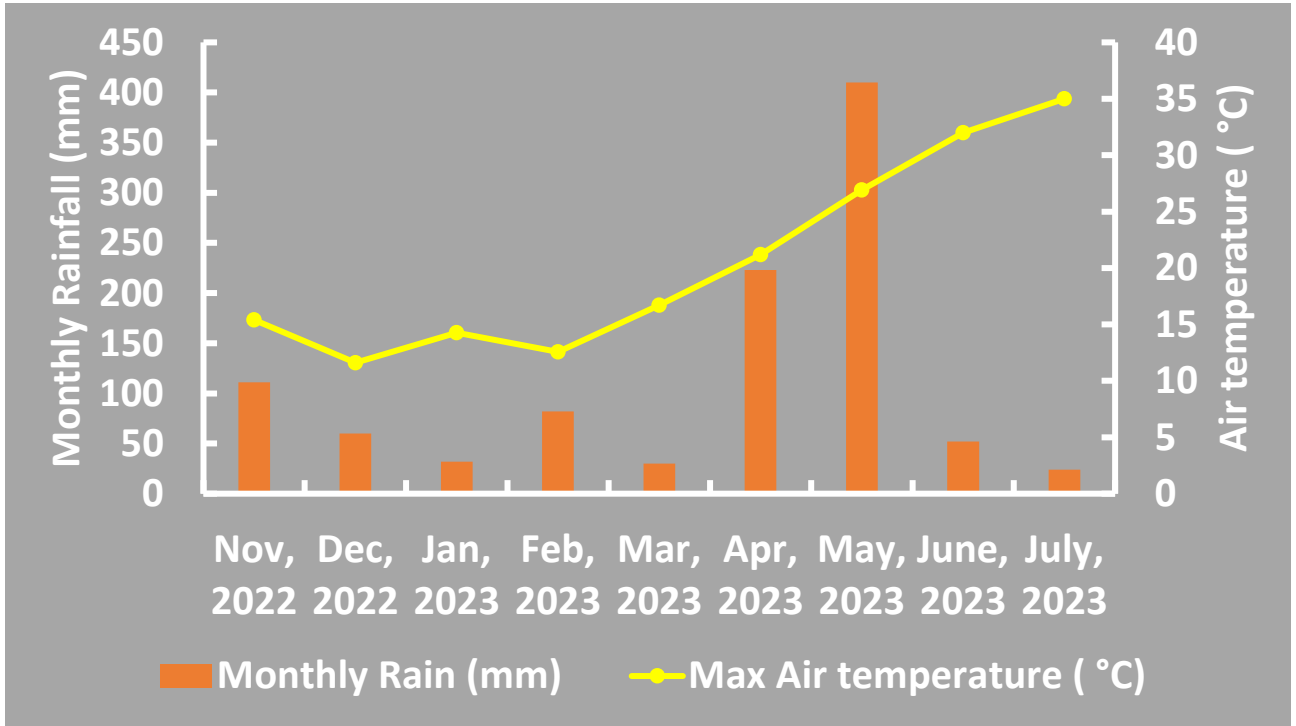
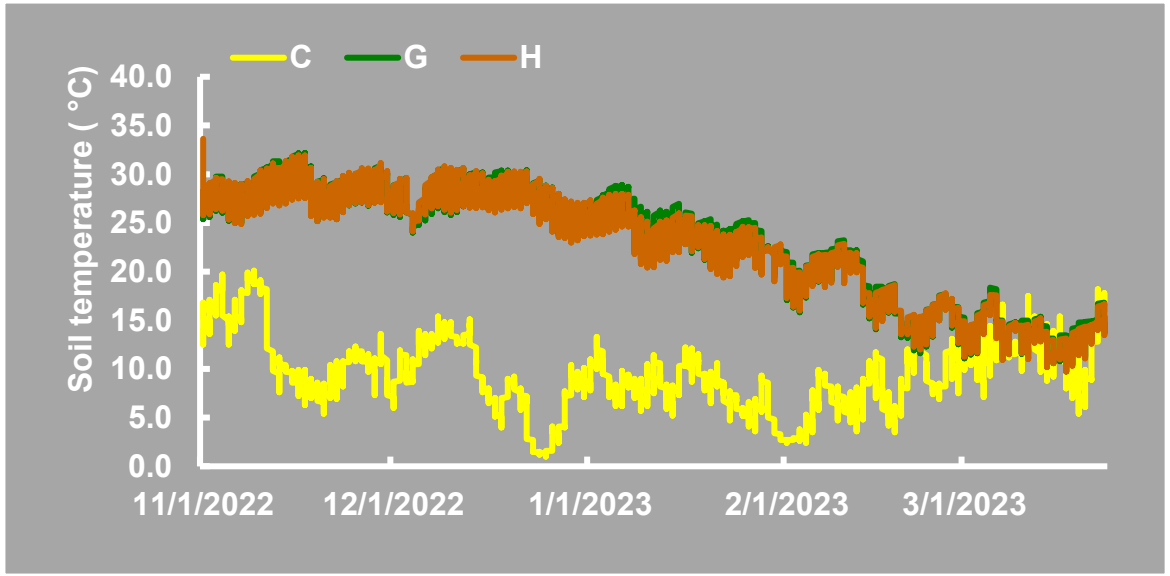
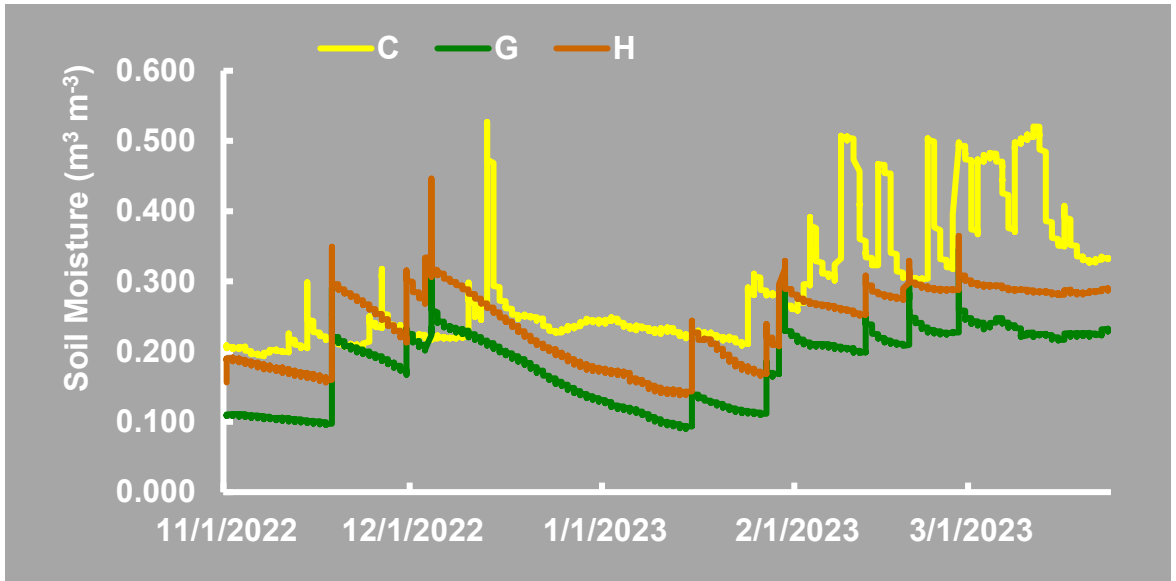
Observations – 2022-23

- Rainfall received in winters as well as the entire growing season was higher than previous year.
- Soil moisture and temperature were optimum resulting in better wheat stand early in the season.
- Unfortunately, higher competition from natural grasses on subsequent wheat development.







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Observations – 2022-23

4/12/2023 – early season

5/31/2023 – mid-season

7/27/2023 – Late season

Growth rate decreased and vegetation competition increased

UAV Estimation

Silver Bluestem

Broom snakeweed

Ragweed

Snowberry

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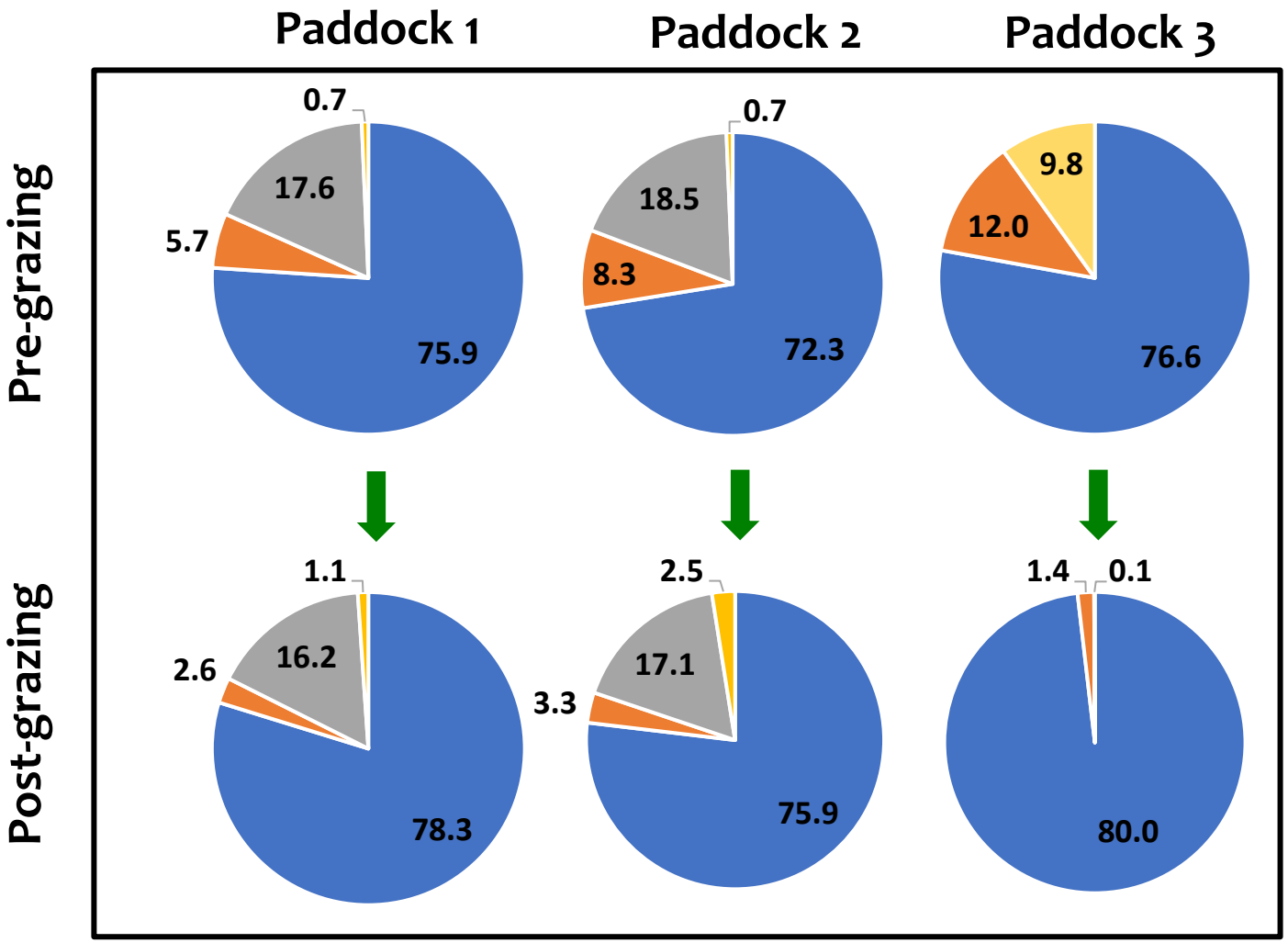
Vegetation composition



Silver bluestem
Snowberry
Ragweed
Broom snakeweed

- As expected, perennial grass (silver bluestem) had highest coverage (72%) across all three paddocks.
- Paddocks 1 and 2 are most infested with Snowberry
- Ragweed had the highest coverage in paddock 3 among undesirable annual grasses.

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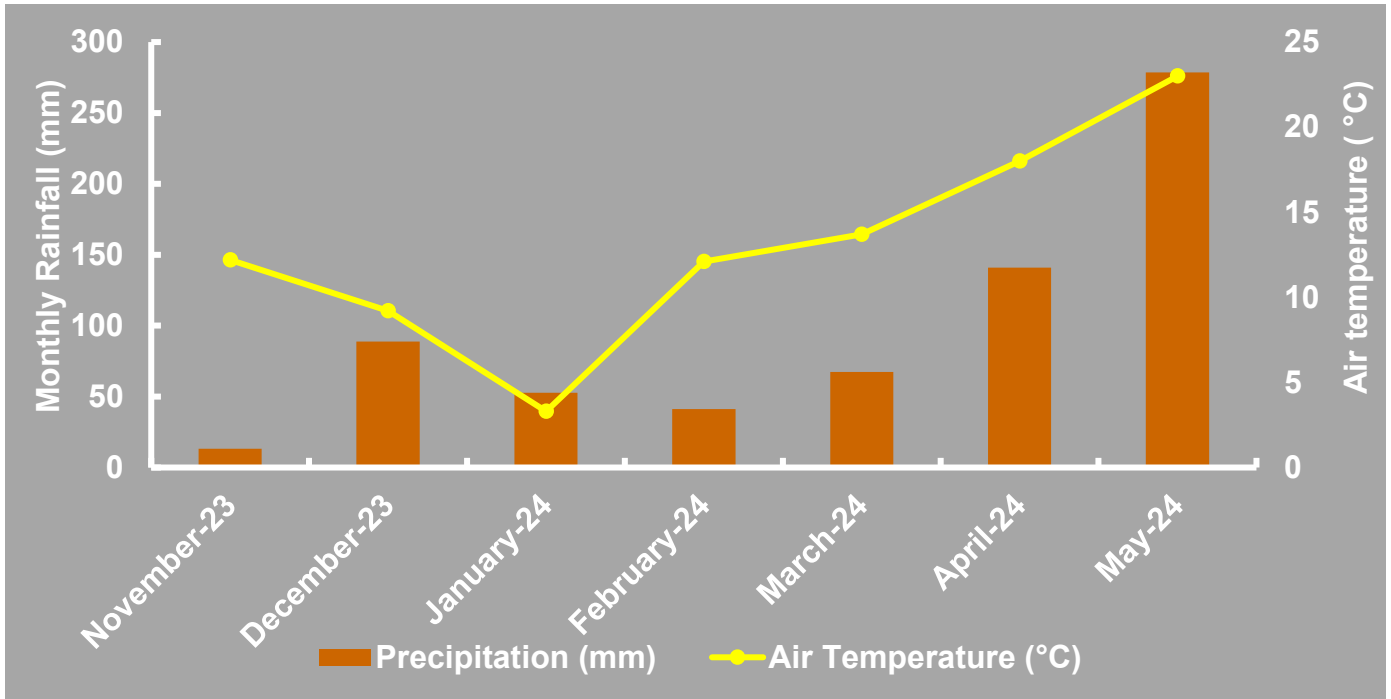
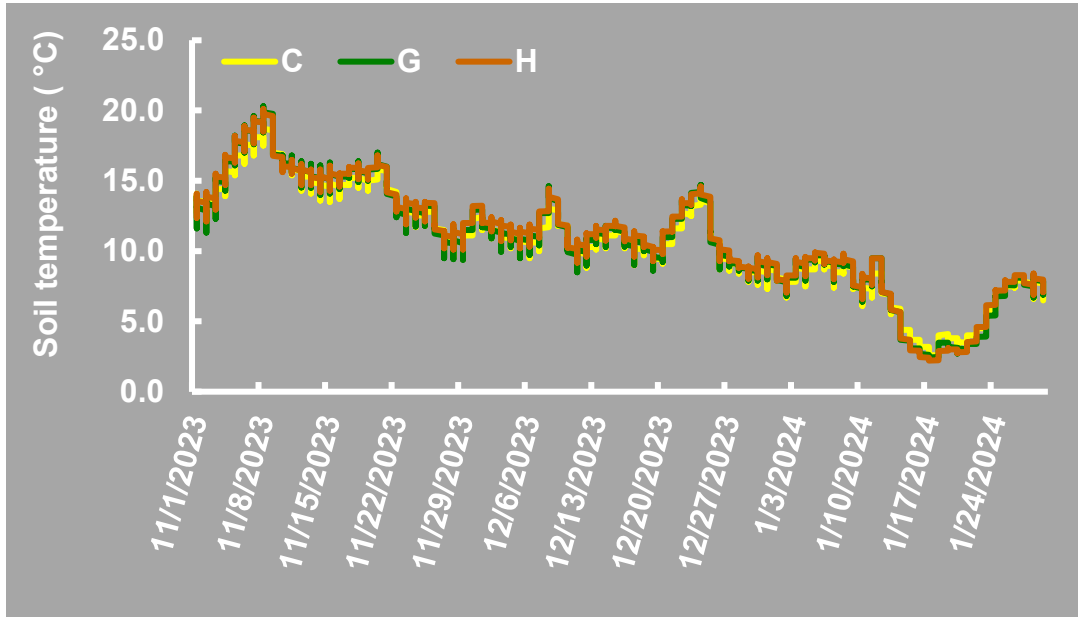
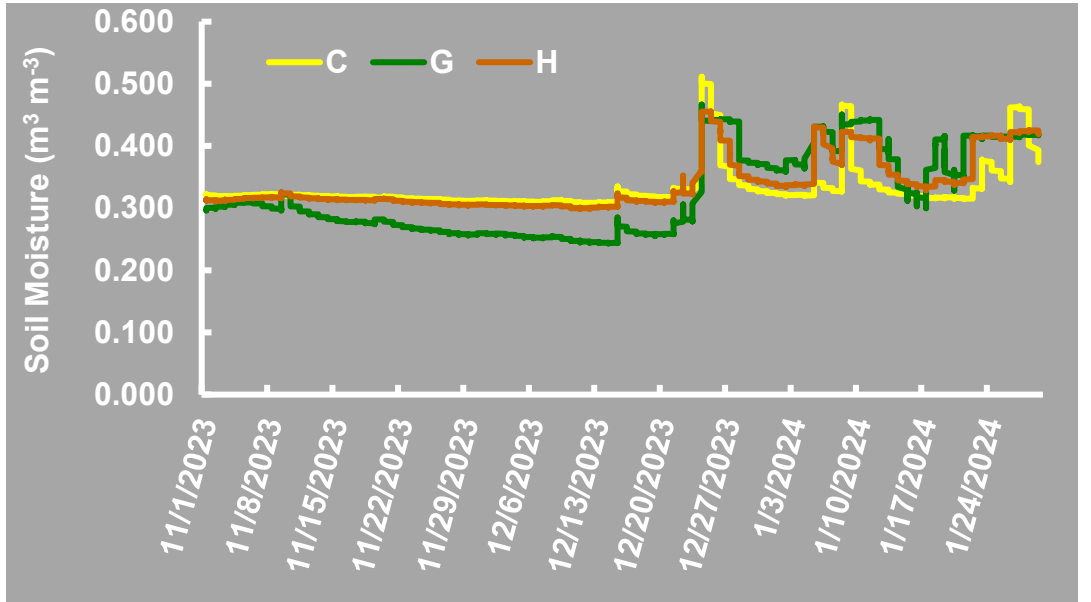
Observations – 2023-24

- Higher rainfall received in winters compared to previous two years.
- Better wheat stand in the early season.
- Again, higher competition from natural grasses was noticed on subsequent wheat development.





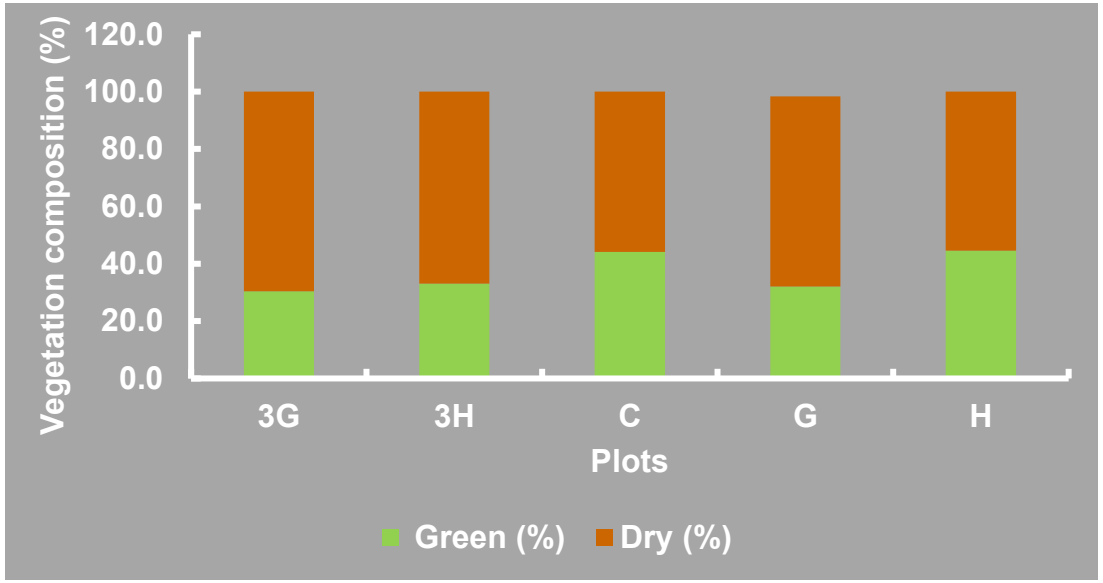


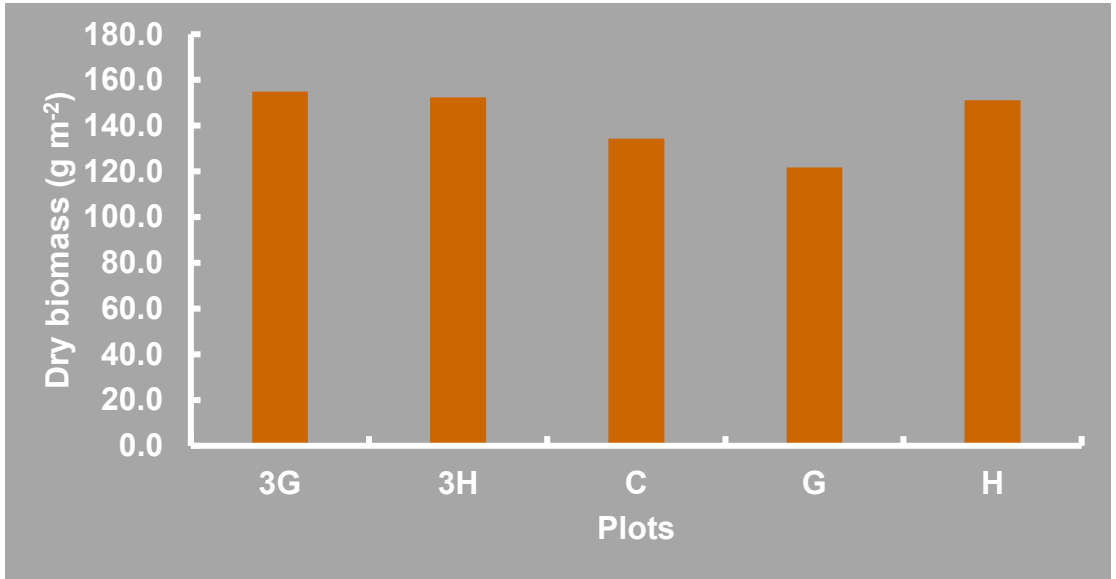
Observations – 2023-24

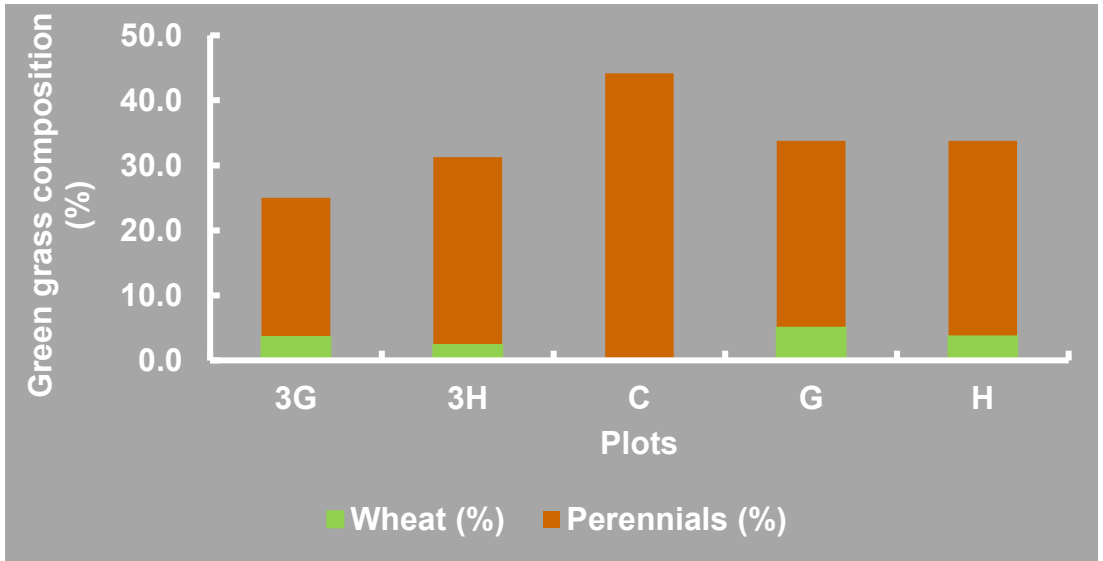
Growth rate decreased and vegetation competition increased

Observations – 2023-24

- Not much difference among treatments/replications for species composition and biomass.
- Dry grass was substantially more than green grass, except in control plots.
- Proportion of perennial green grasses was substantially higher than that of wheat.
- Wheat stand was <10 % of total green biomass.







Summary – Pittman Ranch

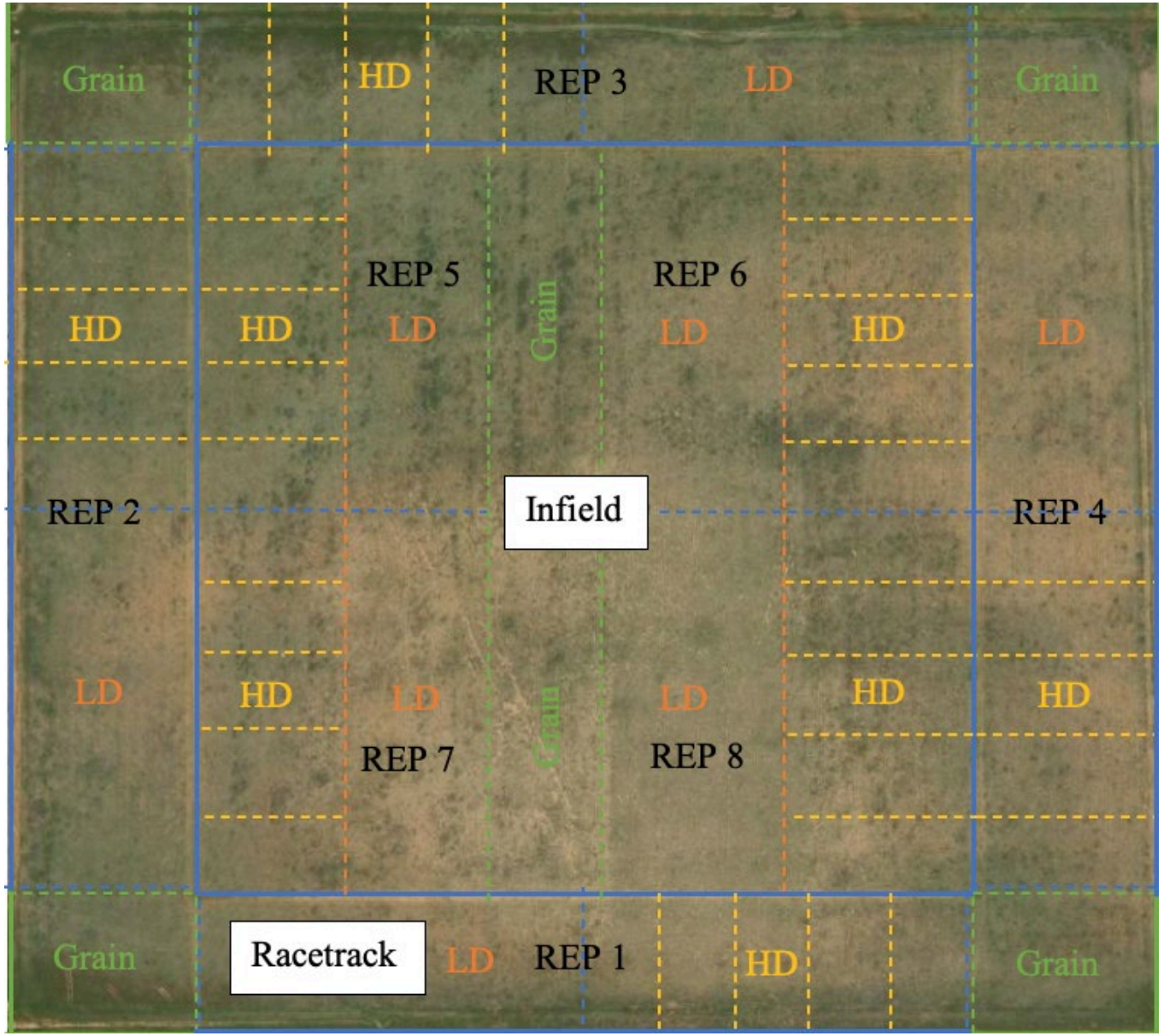
First Year:

- The deficient precipitation in winter and dead biomass challenged wheat growth.

Subsequent Years:

- Higher competition from natural grasses under AMP grazing challenged subsequent wheat development.
- Soil health analysis is underway to further explore vegetation competition.
- This regenerative approach, with its promise of minimal soil disturbance and long-term benefits, appears to be a viable strategy.
- However, the complex interplay of weather patterns and native vegetation significantly limits its effectiveness, highlighting the challenges we faced.

Experiment Design – Nance Ranch



- Eight replicates.
- Each Replicate has
  - 5 High Density Paddocks (1 acre a piece)
  - 1 Low Density Paddock (5 acre)
  - A Grain Section
- Within Each High- or Low-density paddock…
  - Year 1 pasture cropped
  - Year 2 pasture cropped
  - Year 3 pasture cropped
  - Year 4 pasture cropped
  - Never cropped
- Within grain area…
  - Year 1 pasture cropped
  - Year 2 pasture cropped
  - Year 3 pasture cropped
  - Year 4 pasture cropped
  - Continuously Cropped

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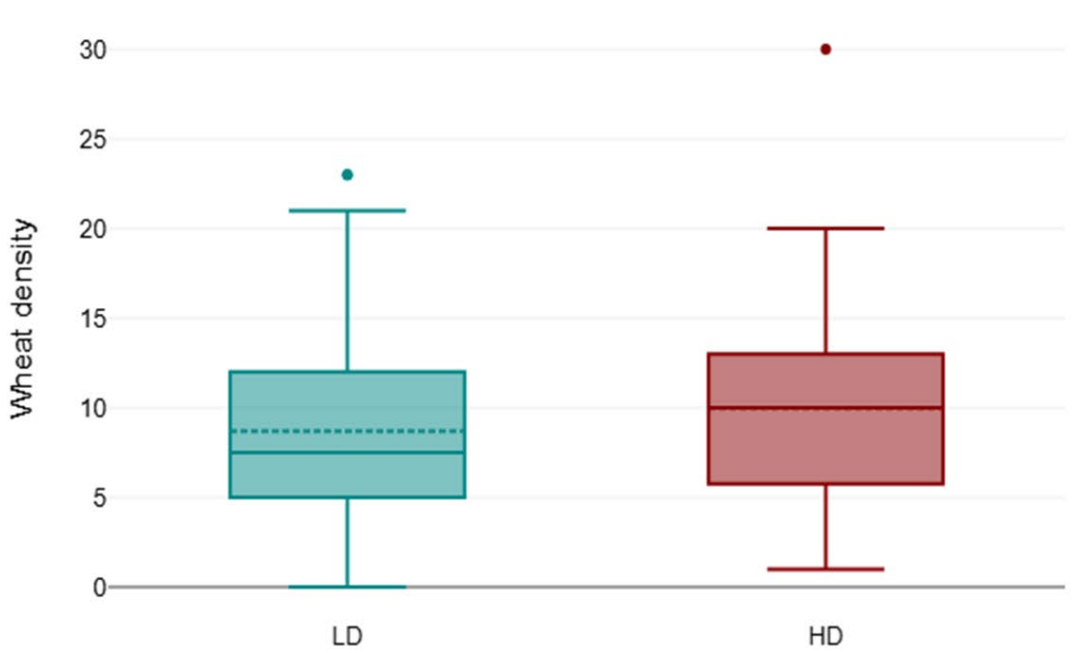
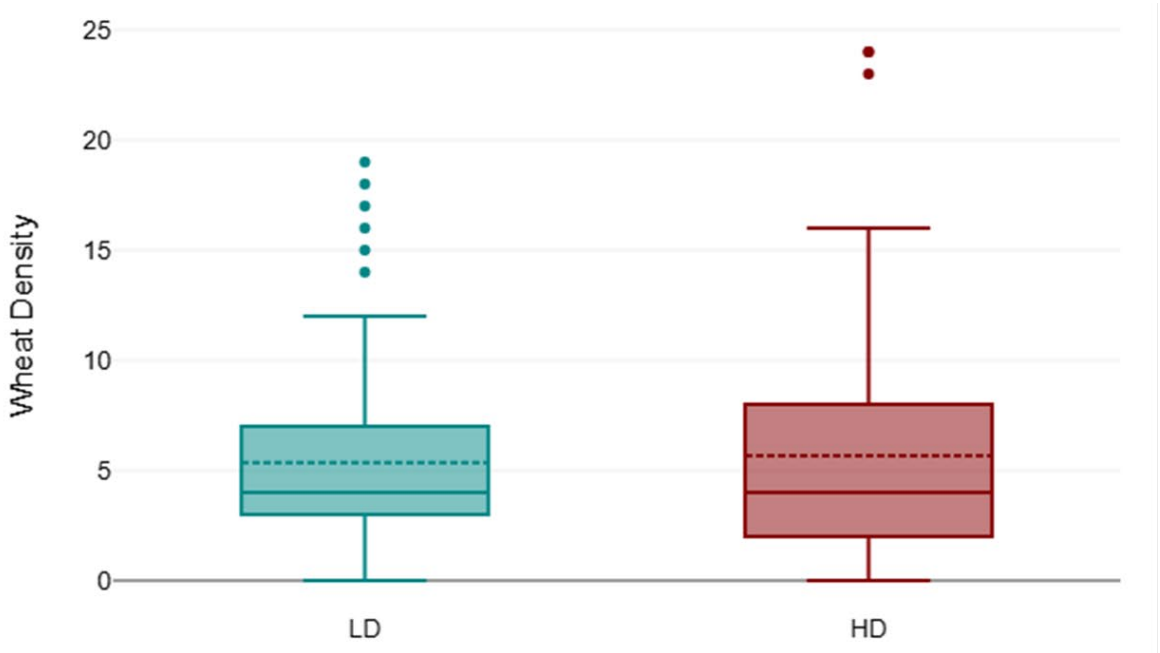
Observations – Nance Ranch

In year 1 (2022), no wheat established. In year 2 (2023), a full stand of wheat established, but heavy utilization by wildlife resulted in no harvestable wheat from the plots. In year 3 (2024), a stand established in 4 of the 8 replicates.

2023



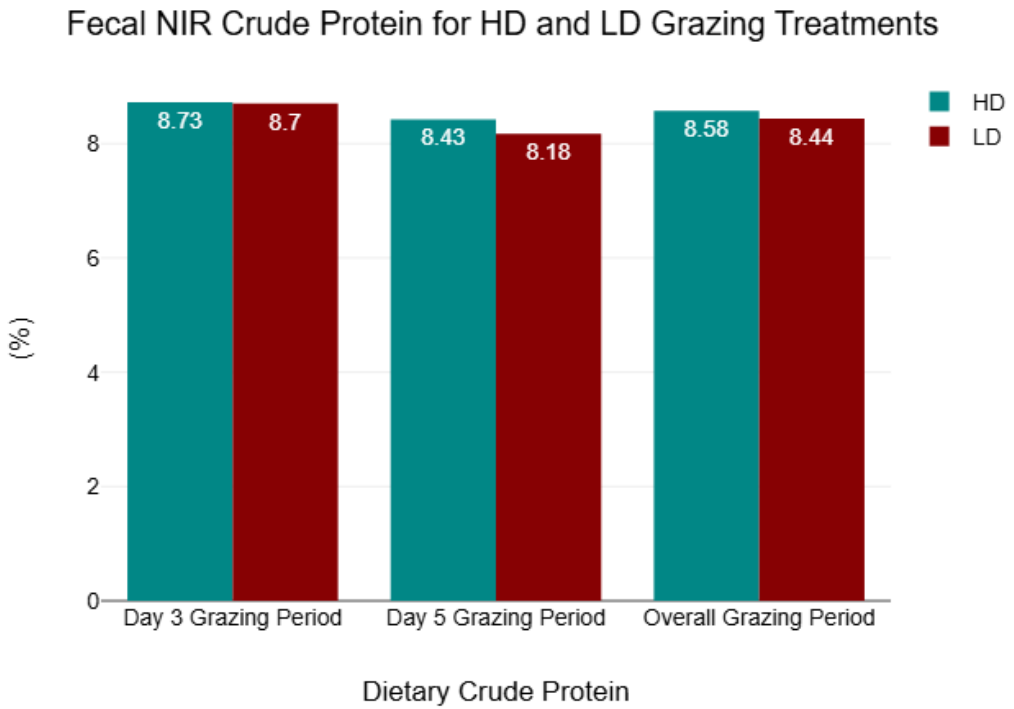
2024

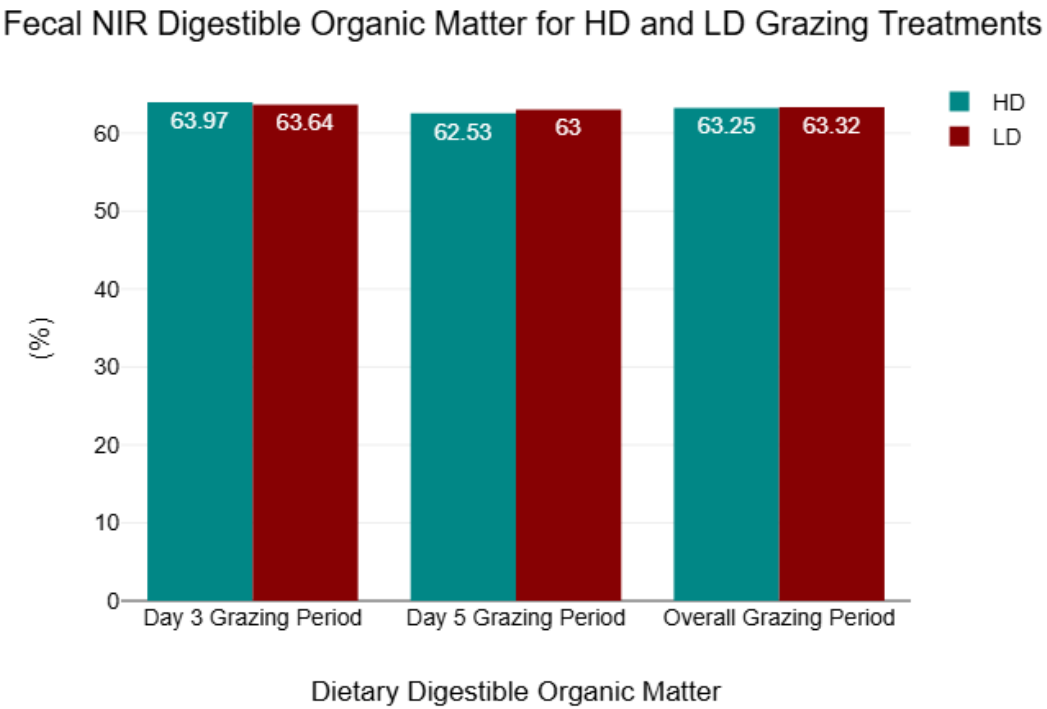


No significant difference between grazing treatments ($p > 0.05$)

Observations – Nance Ranch

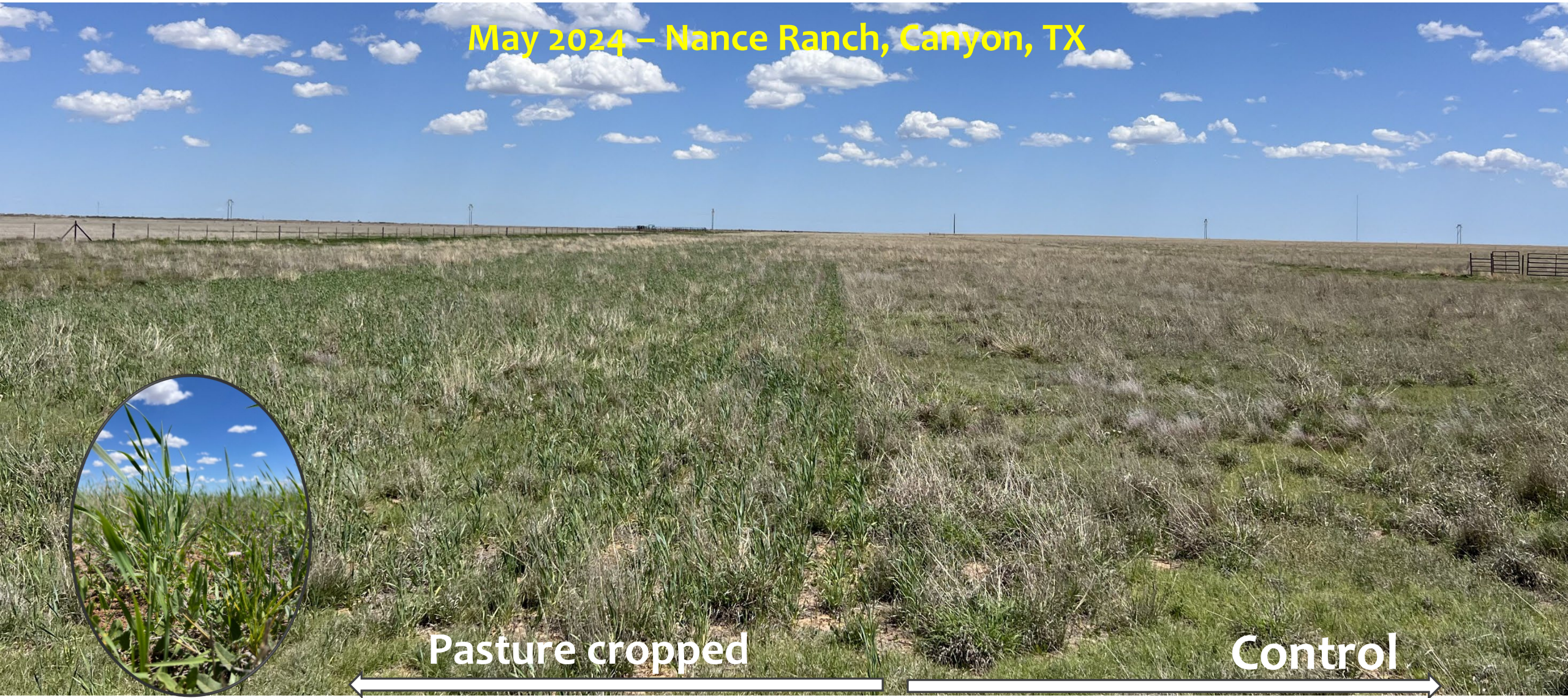
No significant differences in diet quality among treatments containing wheat based on grazing treatment.





No significant difference between Grazing treatments ($p > 0.05$)

Pasture Cropping under normal rainfall and low competition!



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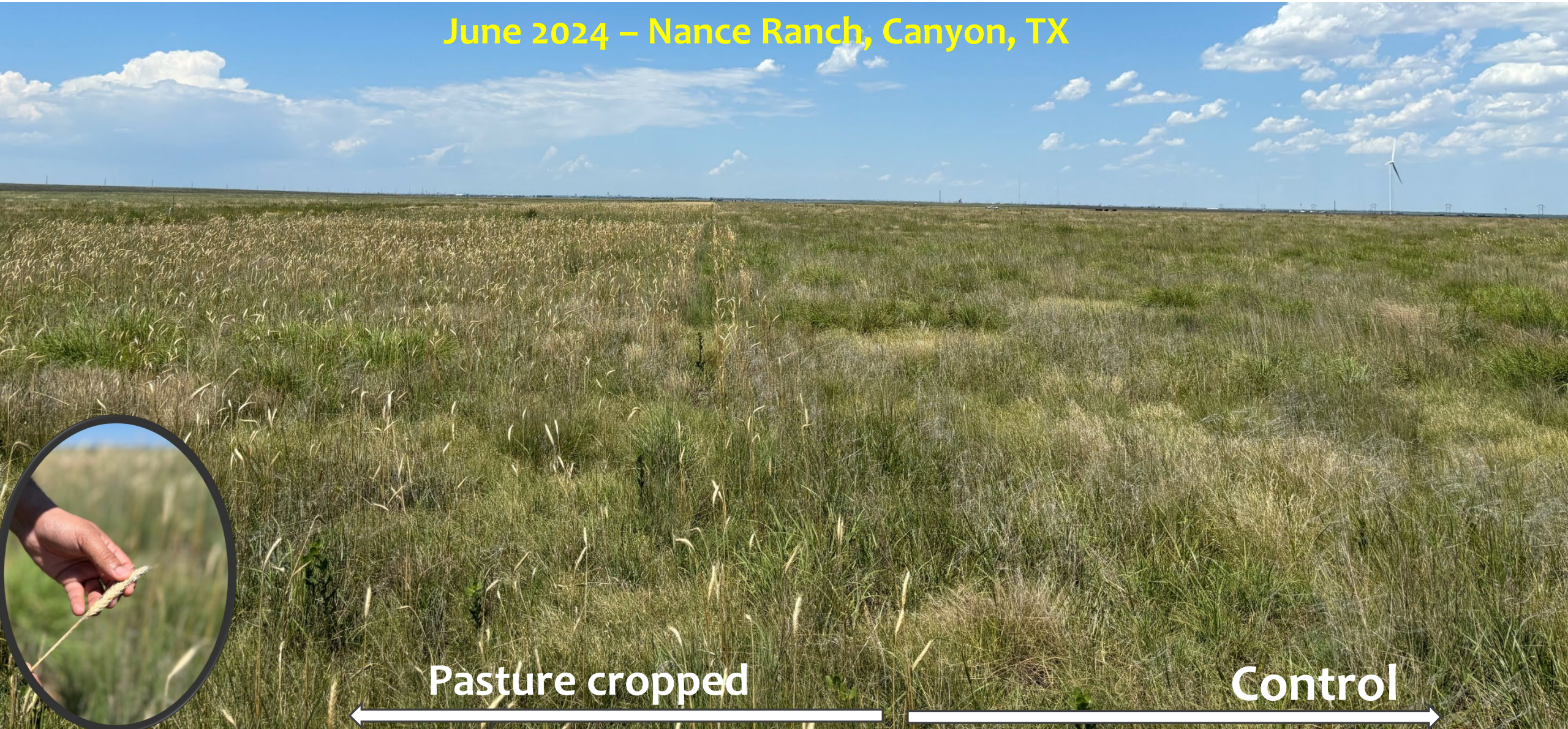
Pasture Cropping under normal rainfall and low competition!



Summary – Nance Ranch

First Year:

- The deficient precipitation in winter challenged wheat growth.

Subsequent Years:

- Successful stands are certainly achievable, but care must be taken to manage competition from perennial grasses through timely grazing and providing adequate residual cover to optimize infiltration of precipitation and decrease evaporative losses.
- In semi-arid environments, grain production is very unpredictable, but increased forage quality through the winter is achievable.
- No differences noted in wheat yield or density, nor in diet quality of cattle, as a result of differences in grazing management, when grazing periods were relatively short at the same stocking intensity.

Economic Goal/Objective

- Carry out a Strategic Livestock Grazing Survey in January 2025:
  - to introduce the concepts of pasture cropping
  - to evaluate adopters' perception of the economic benefits, costs, and challenges of pasture cropping, and their willingness to continue using it in the future.
  - to understand non-adopters' perception of the challenges of pasture cropping, and their willingness to try it in the future.
- The online survey link will be shared with the producer list of Holistic Management International (HMI) and National Center for Appropriate Technology (NCAT).
- We intend to publish a peer-reviewed paper in journals such as *Rangelands using the* collected rancher survey data.

Next Steps

- Pasture cropping experiments continued at both study ranches.
- Assessment of soil health benefits of pasture cropping based on measured data is in progress (including PLFA).
- Soil C mineralization and respiration studies will be conducted at the study ranches.
- Modeling efforts to quantify ranch- and watershed-scale effects of pasture cropping on ecosystem services are in progress.
- Economic analysis will be carried out.

Acknowledgements

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Dixon Water Foundation

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Thank you

AgroHydrology Laboratory
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Deadline for submissions: December 31, 2024 (flexible)

Guest Editors: Srini Ale, Meetpal Kukal, Xiaoyu (Iris) Feng