Livestock integration provides return on cover crop investment in crop production systems

Katrina Kratzke[1,2], Joshua Wianecki[1,2], Miranda Meehan[1], Kevin Sedivec[2,3], Lindsay Chamberlain Malone[2] and Zachary Carlson[1]

There is potential for grazing to provide a return on cover crop investment through reducing feeding costs without negatively impacting soil health or crop performance and yield, but grazing is heavily dependent on cereal type, planting date, temperature and precipitation. The use of a winter rye cover crop may be considered as a strategy to suppress the establishment of weeds in the spring.

Summary

In the northern Great Plains, cover crops are becoming widely used for their soil health benefits, which can take years and are hard to track. Grazing cover crops has the potential to extend the grazing season and offset the costs of cover crop establishment through short-term returns in an integrated crop-livestock system. The objective of this study was to enhance the profitability of crop production and soil health through livestock integration and cover crop management. This project utilized cover crop management of winter rye, winter triticale and winter wheat and livestock integration through dual-season (fall and spring) grazing, spring grazing, no grazing or no cover crop treatments. Grazing cover crops had no impact on cash crop yield or soil health indicators. Winter rye suppressed weed establishment, and suppression was unaffected by grazing. Grazing of winter cereals provided a return on cover crop investment through lowering livestock feeding and yardage costs.

Introduction

Cover crops have gained popularity as a practice implemented by producers across the United States. In North Dakota alone, cover crop acreage has increased 107% (838,252 acres) between 2017 and 2022 (USDA NASS, 2024). Producers are incorporating cover crops to improve soil health, increase crop yields, reduce soil erosion, manage water and increase forage options for livestock. A recent national survey of farmers found that the greatest barriers to adoption of cover crops were economic return and yield reductions (CTIC 2023). Rye is the most frequently grown cover crop, with the winter cereals wheat and triticale also being common. Winter cereals are typically planted in the fall following a cash crop. They initiate growth in the fall, go through the differentiation process (change in growing point from vegetative to spikelet producing) during vernalization in the winter and regrow in the spring. Winter cereal cover crops enhance soil health by increasing organic matter, enhancing pore development for better water-holding capacity, feeding microbial communities and reducing erosion and nitrate concentrations in runoff. In addition, some winter cereals have been shown to have an allelopathic effect (suppression) on pigeon grass, kochia, pigweeds and marestail (Dhima et al. 2006).

When a winter cereal cover crop is used in conjunction with a corn cash crop, a synergistic system is created, which overcomes many weaknesses of corn in a cropping system. These benefits include reducing wind and water erosion, suppressing early-season glyphosate-resistant weeds and providing stability in saline areas. There is a significant body of research on the benefits of grass cover crops, but the impacts they have on corn production are variable, with many conflicting research results. There is currently no research evaluating the integration of livestock during a corn rotation with winter cereal cover crops in North Dakota.

Despite the ecological benefits of incorporating cover crops into a system, the economic benefits may not be realized if livestock are not incorporated into the system. In recent years, producers have expressed an increased interest in livestock integration due to the

[1]Department of Animal Sciences, NDSU, Fargo, ND.
[2]School of Natural Resource Sciences, NDSU, Fargo, ND.
[3]Central Grasslands Research Extension Center, NDSU, Streeter, ND.

ecological and economic returns, yet only 24% of farmers surveyed reported grazing their cover crops (CTIC 2023).

Due to the short growing season in the northern Great Plains, it can be difficult to establish a cover crop as part of a dual crop system. Dual-purpose cover crop practices often use winter cereals, such as rye or triticale, planted in the fall and then used for spring grazing. Winter rye is commonly selected due to its winter-hardiness, high biomass production and low cost; however, winter triticale and select winter wheat varieties produce higher-quality forage. In other regions, these species are dual harvested (fall and spring) with grazing in addition to a cash crop. Currently, there is no research evaluating the potential to dual-harvest a winter cereal for livestock forage in the northern Great Plains and assessing the economic and ecological benefits of integrated crop-livestock systems.

Procedures

A research plot at the Central Grasslands Research Extension Center near Streeter, North Dakota, was selected where the grazing treatments have been implemented since fall 2022. The plot was divided into nine pastures and randomly assigned one of three treatments: dual season (fall and spring) grazing (DG), spring grazing (SG) or no grazing (NG). The NG plots were split in half to include no cover crop (NCC) treatments. Winter rye was planted as a cover crop in fall 2022 and 2023.

In the spring of 2024, plots were seeded with corn for silage. Stand counts and growth stage were recorded within each plot. A plot harvester was used to estimate yield. A representative sample of silage was collected from each pasture and submitted to the NDSU Nutrition Lab for nutrient analysis of crude protein (CP), ash, neutral detergent fiber (NDF), acid detergent fiber (ADF), in vitro organic matter digestibility (IVOMD) and in vitro dry matter digestibility (IVDMD). Corn silage was chopped on Oct. 3, and cover crops were planted the next day. Each cover crop management treatment was subdivided into winter rye, winter triticale and winter wheat. Dual-graze plots were not grazed in fall 2024 due to late seeding and limited growth.

In the spring of 2025, prior to and following grazing, forage samples of winter cover crops were collected to determine production, set stocking rates, and evaluate utilization. Samples were submitted to the NDSU Nutrition Lab for nutrient analysis of CP, ash, NDF, ADF, IVOMD and IVDMD. Ground cover was estimated pre- and postgrazing. Dual and spring graze plots were grazed for 0.56 AUMs over eight days. Two-day weights were collected from heifers pre- and postgrazing. Soil samples were taken postgrazing for analysis of total nitrogen (TN), nitrate (NO3), phosphorus (P), potassium (K), soil organic matter (OM), soil inorganic carbon (SIC), soil organic carbon (SOC), aggregate stability and bulk density. Grain corn was planted on May 24, and winter cover crops were terminated three days later. Sprinkler infiltrometers were used to evaluate infiltration rates at two points in each pasture. Soil moisture sensors were installed in every pasture during the middle of June and will be removed at harvest. Population counts and growth staging will be completed in the summer and yield data collected at harvest. At the end of the crop year, system economics will be evaluated using a partial budget.

Results and Discussion

In 2023 of this study, some trends were observed in soybean growth and yield that were likely due to soil moisture dynamics. Kelly et al. (2021) observed similar trends in soil moisture when grazing cover crops in the High Plains region. However, no research has been conducted evaluating soil moisture dynamics as they relate to cover crop management within the northern Great Plains. In 2024, a winter rye cover crop, terminated immediately after planting corn, did not affect crop performance or silage yield. Soil moisture sensors were installed in each plot in 2025 to evaluate treatment effects on soil moisture throughout the growing season.

Fall 2022 cattle grazed DG pastures for 0.6 animal unit months (AUMs). There was insufficient forage produced by winter cereals to support fall grazing in 2023 and 2024 due to late harvest and cover crop planting. Spring 2023, 2024 and 2025 DG and SG pastures were grazed for 3.36 AUMs, 0.98 AUMs and 0.56 AUMs, respectively. Spring grazing in 2025 was short due to complete winter kill of winter triticale and partial winter kill of winter wheat. Animal weights were not different between treatments pre- or postgrazing. On average, animals lost 2.5 lbs per day. This loss of gain can be attributed to the short grazing period, which did not allow animals to acclimate to the change of diet. Livestock in 2023 grazed longer, resulting in a rate of gain of 0.61lbs per day due to the longer grazing period allowing acclimation to the diet.

Spring 2025 pre- and postgrazing winter rye provided greater cover than triticale in all cover crop treatments (Figure 1). There were no differences in residue cover between treatments or cereal type, pre- and postgrazing. Bare ground was not different pregrazing, but postgrazing NCC pastures were 24.6% bare ground, which was significantly less than triticale with 56.7% bare ground and wheat with 58.3% bare ground, in NG pastures. Postgrazing weed cover was significantly lower in grazed rye at 7.7% than in NCC pastures at 37.1%. Significant weed suppression by winter rye was also seen in spring 2023 and 2024 in the same pastures (Figure 2). Winter cereals may suppress weeds through allelopathic effects (Dhima et al. 2006). The primary weed in the field was kochia, which has become a major problem for many farmers in the northern Great Plains as it is glyphosate-resistant, making it hard to combat. Notably, ground cover was not significantly affected by grazing. Rye provided the greatest cover and the highest weed suppression of the three winter cereals. The superior performance of the rye is likely due to winter kill of winter triticale and winter wheat.

Following three years of cover crop and livestock integration, there have been no changes in soil health indicators. There were no differences between treatments for soil OM, pH, TN, NO3-, P, K, TC, TOC, bulk density or soil aggregates. This is consistent with other research in semiarid regions that have documented no to little change in soil health indicators after three years of cover crop implementation; it was concluded that a longer period of cover cropping is needed to impact soil health in semi-arid environments (Wu et al. 2024).

Production economics for 2023 and 2024 have been estimated by partial budgeting that accounted for the cost of CC establishment and total savings in feed and yardage costs compared to if dry lot management were used (Figure 3). The cost of establishing a CC each year was approximately $43 per acre. Grazing either resulted in a net income or provided a return on CC investment across all years. Integrating livestock is a way to improve profitability when incorporating cover crops into a system (Kelly et al. 2021).

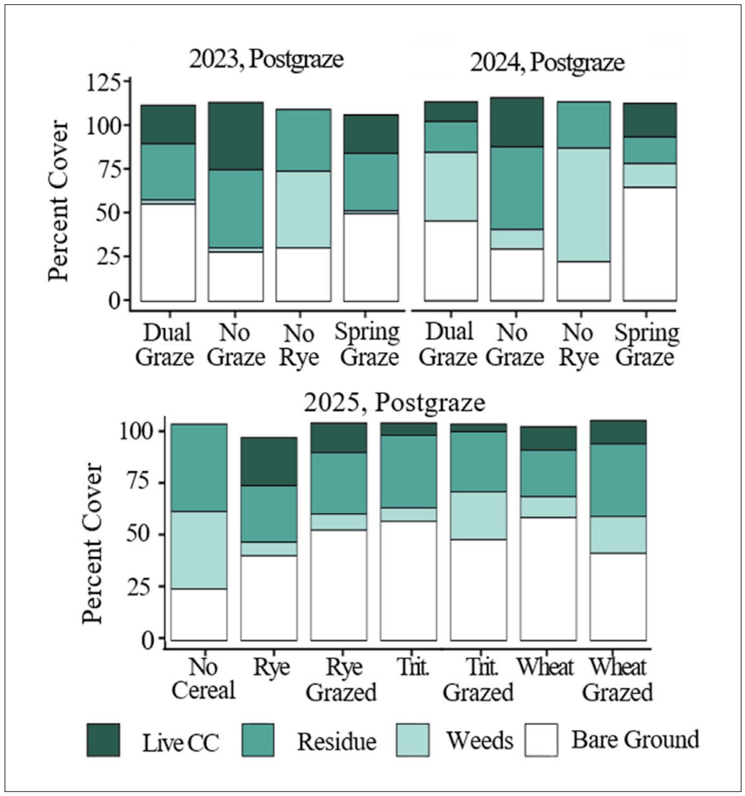

Figure 1. Post-grazing ground cover estimates for spring 2023, 2024, and 2025.

Figure 2. Differences in weed establishment within grazed winter rye (top) and fallow paddock (bottom), spring 2024.

Grazing cover crops is heavily dependent on cereal type, planting date, temperature and precipitation. There is potential for grazing to provide a return on cover crop investment through reducing feeding costs without negatively impacting soil health or crop performance and yield. As farmers continue to combat kochia, the use of a winter rye cover crop may be considered as a way to suppress the establishment of the weed in the spring. Grazing cover crops can provide a net income or return on CC investment, depending on biomass production.

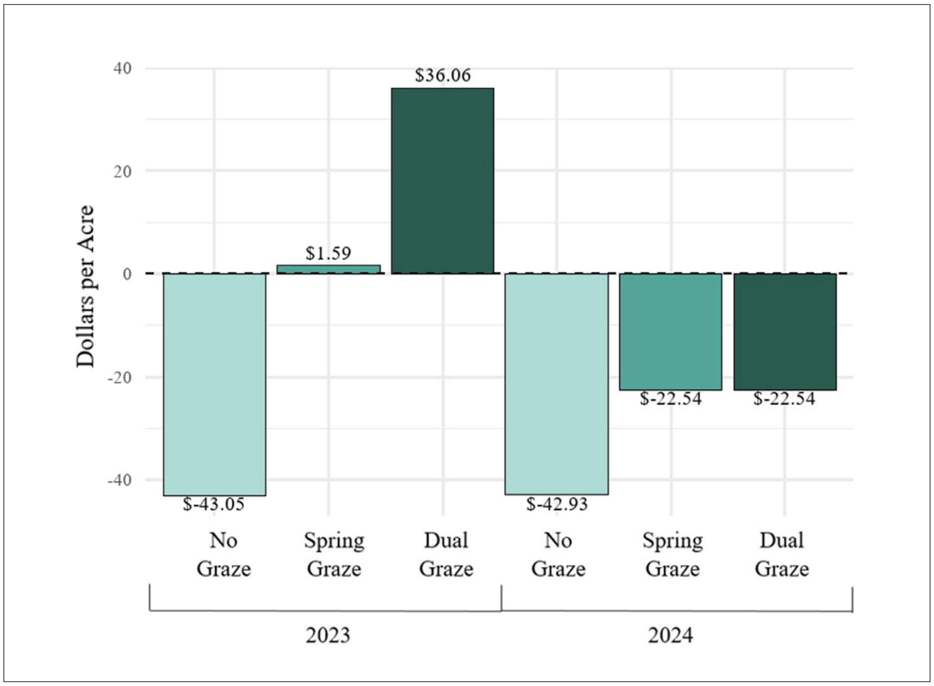

Figure 3. Estimated change to net enterprise income for 2023 and 2024. Changes to income are compared to livestock production utilizing dry lot feeding management without planting cover crops within the cropping operation.

Acknowledgments

Thank you to the North Dakota Soybean Council and North Dakota Corn Council for project funding, and thank you to the staff and technicians at Central Grasslands Research Extension Center for their assistance.

Literature Cited

CTIC. 2023. National Cover Crop Survey Report 2022-2023. Joint publication of the Conservation Technology Information Center, Sustainable Agriculture Research & Education, and the American Seed Trade Association.

Dhima, K. V., I. B. Vasilakoglou, I. G. Eleftherohorinos, & A. S. Lithourgidis. 2006. Allelopathic potential of winter cereals and their cover crop mulch effect on grass weed suppression and corn development. Crop Sci. 46:345-352.

Kelly, C., M. E. Schipanski, A. Tucker, W. Trujillo, J. D. Holman, A. K. Obour, & S. J. Fonte. 2021. Dryland cover crop soil health benefits are maintained with grazing in the US High and Central Plains. Agric. Ecosyst. Environ. 313:107358.

National Agricultural Statistics Service. USDA. 2024.

Wu, Q., Y. Lawley, & K. A. Congreves. 2024. Soil health indicator responses to three years of cover crop and crop rotation in a northern semi-arid region, the Canadian prairies. Agric. Ecosyst. Environ. 359:108755.