Grazing Cover Crops in the Eastern US: Performance of Sheep, Goats, and Cattle Grazing *Brassica* Cover Crops

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Abstract. Grazing annual forage crops has attained new interest with the increase in use of cover crops. Grazing annual forages grown as cover crops not only allows livestock producers to extend the grazing season but also gives row crop growers a way to recoup the cost of planting cover crops through grazing leases. Species in the Brassicaceae family (turnip, rape, kale, radish, and hybrids) have wide adaptability across the eastern US, excellent forage yield potential, and extremely high nutritional value. *Brassicas* are sometimes described as "high-moisture concentrates." Their low effective fiber content drives the common recommendation to grow them with annual grasses in grazed mixtures to provide the fiber needed by livestock, species biodiversity also improves cover crop value. In this review, I will summarize performance of sheep, meat goats, and cattle grazing *Brassicas* and *Brassica* mixtures from research across the eastern US, including the impact of *Brassica* yield and forage quality on animal gain, animal health, carcass characteristics, meat and milk quality.

Introduction

Rising interest in cover crops in the U.S. has led to a resurgence in use of brassica crops as forage. Fast-growing *Brassica* species such as turnips (*Brassica rapa*), rape (*B. napa*), collards (*B. campestris*), and the closely related oilseed radish (*Raphanus sativa*) are widely used in cover crop mixtures intended to fill a short fallow period between crops, such as after a wheat harvest where the field will not be planted to another cash crop until the following spring. Grazing cover crops provides a means for producers to recoup seeding cost of the covers as livestock feed or sale of grazing leases. Development of online sites like the Midwest Grazing Exchange (https://www.midwestgrazingexchange.com/) provide means for crop growers and animal producers to find each other and negotiate agreements beneficial to both parties. This mini-review summarizes the author's research with grazing sheep, goats, and cattle on *Brassicas*.

Characteristics of Brassicas as Forage

Brassica cover crops planted in mid-late July in the eastern U.S. can usually provide 2.5 Mg ha^{-1} of dry biomass within eight weeks after planting and continue to accumulate biomass up to 10 Mg ha^{-1} with longer growth periods (Cassida et al., 1995). These species hold yield and quality better than most other forage options under cool and freezing weather and can be grazed well into winter. Turnip tubers can comprise a large proportion of the biomass available in a *Brassica* pasture (Macaluso, 2020) and are readily consumed by sheep and cattle. Tubers are often the last part of the plant to degrade under winter conditions. When grazing is planned and high forage yields are desired, *Brassicas* should be seeded at the greater rates recommended for forage rather than cover crops and receive fertilizer or manure to provide P and K according to soil test and up to 112 kg ha^{-1} of nitrogen.

Brassica forages are often described as high moisture concentrates, with forage moisture content as high as 88 g kg^{-1} (Cassida et al., 1995). Producers are often concerned that the high moisture content will limit animal dry matter intake but this does not appear to be a practical limitation under field conditions. The moisture in *Brassicas* also provide a significant contribution to animals' daily water intake. Non-lactating sheep consuming *Brassicas* may not drink liquid water during cool fall weather (Cassida et al., 1994).

Forage quality is excellent. In pure *Brassica* forage, crude protein (CP) has ranged 123-151 g kg^{-1}, total nonstructural carbohydrates (TNC) 137-370 g kg^{-1}, neutral detergent fiber 208-278 g kg^{-1}, and apparent digestibility of these constituents is high (Cassida et al., 1994, 1995; Guillard et al., 1995). In fact, cell wall content can be too low and potentially limit animal performance by providing inadequate effective fiber. Therefore, it is not recommended to feed diets consisting solely of *Brassicas* (Cassida et al.,

1994). Fiber content on offer is easily increased in cover crop pastures by adding species from other functional groups to the seeding mix and this also helps alleviate the high moisture concern (Macaluso, 2021; Maciel et al., 2022). Because of the concentrate-like nutrient profile, livestock should be transitioned carefully from grass/legume to *Brassica* pastures to allow the rumen microbes time to adjust to the potentially drastic change in diet. This can be done by limit grazing the *Brassica* for increasing periods of time over a week or two or offering hay supplement during that time.

Performance of Livestock Grazing *Brassicas*

Grazing livestock achieved acceptable rates of gain while grazing *Brassica* cover crops. Over a three-year trial in Lake City, MI, Angus-influenced beef cattle finished for approximately 10 weeks on *Brassica*-based pastures were lighter at slaughter than cattle finished on perennial grass/legume pasture (500 vs. 518 kg, respectively, $P<0.01$) and had similar carcass adjusted average daily gain (ADG, 100 vs. 114 kg day^{-1}, $P>0.05$), but gained more weight per unit of land (mean 152 vs 100 kg gain ha^{-1}, $P<0.01$) because the perennial grass/legume treatment required twice as much pasture area (Maciel et al., 2022). Across two years of data, Dorset/Polypay-cross lambs slaughtered after 8 weeks grazing *Brassica*-based cover crop mixes grew more slowly than lambs finished for 6 weeks on grain (ADG 300-400 vs 150-250 g d^{-1}, respectively, $P<0.001$) and had lighter hot carcass weights (29.8 vs 27.6 kg, $P<0.01$, Macaluso, 2021). A third year of data remains to be added to this dataset.

Brassica finishing has little negative impact on carcass or meat quality. Beef cattle finished on *Brassicas* had greater dressing percentages than cattle finished on perennial pasture (56.2 vs. 53.3 %, respectively, $P<0.01$) presumably because highly digestible *Brassicas* provided less gut fill. There were no differences among finishing pastures for ribeye area, 12th rib fat thickness, kidney-pelvic-heart fat, marbling score, or yield grade. Across two years of data, lambs finished on brassicas compared to grain had similar loin eye area and dressing percentage (data not shown), but less backfat (0.39 vs 0.51 cm, $P<0.05$) which was reflected in yield grades, and lower carcass quality grades (Choice- vs Choice+) (Macaluso, 2021). Despite treatment differences, all carcass measurements were within acceptable industry standards. Lamb finished on *Brassicas* had greater protein concentration than feedlot-finished lamb ($P<0.05$), but did not differ in fat, moisture, or Warner-Bratzler shear force (Eckhardt et al., 2022).

Brassicas contain relatively high levels of sulfur-containing amino acids and their strong intrinsic flavor leads many producers to question whether the flavor of meat or milk will be tainted when livestock consume these forages. Research indicates this is not common. Milk had no detectable flavor defect 3 hr after dairy cows consumed up to 19 kg of fresh forage of turnip forage (Wiedenhoeft and Barton, 1995). In a sensory panel conducted with beef consumers, overall acceptability of beef from cattle finished on *Brassicas* in Michigan was intermediate between feedlot-finished (more preferred) and grass-finished beef (less preferred) (Martin et al., 2016). Consumers did not report undesirable sensory qualities in loin samples from lambs finished on pure *Brassica* cover crops in Michigan when compared to meat from lambs finished on a mixture of *Brassicas* with grasses and legumes, backgrounded *Brassica* followed by four weeks of feedlot, or feedlot only, and the consumer sensory panel preferred the flavor of the *Brassica*-finished lamb (Eckhardt et al., 2022).

Review of the literature reveals a long list of potential animal health problems associated with grazing *Brassicas* and these may discourage producers from trying the forages. Most of the issues are easily mitigated by management. *Brassica* forages readily accumulate nitrate levels that should be toxic according to standard recommendations but animals are rarely affected, probably because the accompanying high energy content facilitates rapid conversion of toxic nitrite to ammonia by rumen microbes. This was demonstrated in a grazing trial where *Brassica* nitrate levels averaging 2044 mg/kg of NO_3-N caused no detectable nitrate toxicity in pregnant ewes (Cassida et al., 1995). Glucosinolates in *brassicas* can bind iodine in the animal and lead to goiter, but this is easily mitigated by offering an appropriate trace mineral mix containing iodine and we detected no thyroid dysfunction in pregnant ewes grazing *brassicas* (Cassida et al., 1995). While rare, bloat does occur on *Brassica* pasture (Maciel et al., 2022) and appropriate precautions should be taken. Some *Brassicas* contain high levels of the amino acid S-methyl cysteine sulfoxide which may cause hemolytic anemia in grazing livestock, especially goats. Nevertheless, Boer-cross goat kids did not develop acute hemolytic anemia when fed *Brassicas* in a confined feeding study (Cassida, unpublished data).

Conclusions

Brassica cover crops make excellent pasture for grazing cattle, sheep, and goats. High yield potential with excellent forage quality and good cold tolerance in a short growth window makes these covers an excellent fit for a quick-growing fall pasture. Beef and lamb meat finished on *Brassicas* has acceptable meat and sensory quality for typical consumers. Livestock grazing adds value to cover crops and may increase adoption of this valuable method for improving soil.

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