The Professional Animal Scientist 31 (2015):80–87; http://dx.doi.org/10.15232/pas.2014-01335

Case Study: Alternative fodder crops for livestock feed in western Washington

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ABSTRACT

Increased costs of livestock feed and the desire to enhance or expand into feed production have created a need for alternative crops in areas where conventional feed crops such as corn and soybeans are not well adapted. Historically, many crops such as fodder beets, rutabagas, turnips, carrots, and kale were used for livestock feed. This project tested 7 different types and varieties of 5 different alternative feed crops (fodder beets, rutabaga, turnip, kale, chicory) at 2 sites in western Washington for yield quantity and quality for use as livestock feeds. Dry matter yield differed between years ($P < 0.001$) and was generally 2-times greater in 2011 than in 2012. Dry matter yields ranged from 6.3 to 12.9 t/ha and 2.0 to 2.8 t/ha for turnips, 4.8 to 7.7 t/ha and 2.0 to 2.7 t/ha for fodder beets, and 6.8 to 8.3 t/ha and 2.2 t/ha for kale in 2011 and 2012, respectively. In 2012 DM yield was 1.0 to 2.1 t/ha for chicory and averaged 3.9 t/ha for rutabagas. Purple Top turnip produced significantly more total yield when compared with the other crops at both sites in 2011, whereas in 2012 there was no difference between crops. Yield-quality analyses support similar studies of these crops but underscore the limitation of these crops as a stand-alone feed source. Although several alternative feed crops produced equal quantity and quality as commonly grown feeds such as silage corn in this region, impediments to widespread adoption include planting dates suitable for regional climate, affordable access to adequate quantities of seed, mechanization of seeding and harvesting, and postharvest storage management.

Key words: alternative feed, on-farm feed production, livestock production

INTRODUCTION

As the scale of livestock production has increased and intensified over the past century, livestock and feed production have become separate operations in areas most conducive to low-cost production. As these new agricultural systems emerged, farmers began to rely on off-farm feed sources such as corn (*Zea mays*) and soybean (*Glycine max*) while historical vegetable feed crops were abandoned. Today, many feedstock crops flow into energy-production and export markets, thereby decreasing supply and increasing costs for animal feed (Trostle, 2008). Nationally, feed costs increased 55% between 2002 and 2007 (USDA NASS, 2007). In western Washington, feed costs represent 30 to 70% of overall production costs (C. A. Benedict, unpublished data).

Historical importance of vegetable root crops as livestock feed is well documented. For example, fodder beets (*Beta vulgaris*), rutabagas (*Brassica napus*), and turnips (*Brassica rapa* var. *rapa*) were harvested and stored for livestock consumption during winter and fed in a specific pattern (Wrightson, 1889). Forage crops in the brassica family are well suited to soils and environments not suitable for corn or hay production (Herbert and Masoud Hashemi, 2002) and can be used as feed concentrates but can have several limitations in their use as livestock feeds. David (1976) reported that when kale was fed to sheep without iodine supplementation, the sheep developed thyroid enlargement. Price et al. (1990) noted that milk from

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cows fed solely on chicory (*Cichorium intybus*) can have a bitterness or aftertaste caused by high levels of sesquiterpene (a plant defense compound) found in the leaves. Li and Kemp (2005) have stated, however, that new forage varieties of chicory have lower levels of sesquiterpene and would unlikely lead to bitter aftertaste in milk.

Root crop–production practices are well understood for human consumption (OSU, 2004) but not for livestock feed. Previous research has only evaluated a few vegetable feed crops and not in the western United States. Additionally, seed companies have developed new types and varieties of vegetable feed crops (Rumball, 1986; Rumball et al., 2003), but these have not been rigorously tested. To address these needs, the objectives of this project were to (a) evaluate the productivity of vegetable feed crops under western Washington production conditions and (b) evaluate the livestock nutritional value of vegetable feed crops. This project was conducted with low inputs of fertilizer and no irrigation as requested by the livestock producers in the region.

MATERIALS AND METHODS

Study Sites and Varieties

The study was conducted at 2 sites in 2011 and 2012: Jubilee Farm, Carnation, Washington, 47.607853 N, −121.930336 W, with Nooksack silt loam soil; and the Washington State University Northwestern Washington Research and Extension Center (**NWREC**) at Mount Vernon, Washington, 48.437108 N, −122.387068 W, with Skagit silt loam soil. These sites were approximately 120 km apart, and environmental conditions were measured by the closest Washington State University AgWeatherNet to each site and included air and soil temperature and precipitation.

Crops included turnip Purple Top and Pasja, chicory Oasis (2011 only), kale Maris Kestrel, fodder beet Mammoth Red and Yellow Cylindrical, and rutabaga Major Plus (NWREC only in 2011). Major Plus rutabaga and Purple Top turnip are varieties commonly grown for human consumption, whereas the remaining crop types and varieties have been specifically developed for livestock forage or fodder. Crop types and varieties were selected based on preliminary studies in 2009 and 2010 that included 6 crop types and 4 commercial on-farm sites (data not shown). Preliminary studies were not replicated, and nutritional analyses were not performed; however, overall yield information provided the basis for selecting the varieties included in this study.

Planting and Plot Maintenance

The experimental design at both locations was a randomized complete block with 4 replicates. Targeted and actual seeding rates are shown in Table 1. In 2011 planting was on 22 June at Jubilee Farm with a Planet Jr. vegetable seeder (Cole Planter Co., Albany, GA) and 7 July at NWREC with a Nordsten Lift-O-Matic grain drill (Hillurest, Denmark). At Jubilee Farm, plots were one-bed wide and 76 m long. Beds were 1.5 m center-to-center with 3 rows spaced 51 cm apart. Bed and row spacing followed grower practices at this site, and number and length of beds was limited by the field size (experiment size was 0.21 ha). At NWREC, plots were approximately 2.4 m wide and 122 m long, and total experiment size was 0.62 ha. There were 48 rows per plot, and rows were spaced 5 cm apart. Plot width accommodated 2 passes with the grain drill that was used to test the viability of using this type of equipment for these crops. In 2012 the same crops and varieties were planted with the exception of Oasis chicory and Major Plus rutabaga, which were not available. Crops were planted on 15 July at Jubilee Farm and 29 June at NWREC. Both sites were seeded with a grain drill, and plots were 2.4 m wide and 122 m long (experiment size was 0.44 ha).

At Jubilee Farm, 1.1 t/ha of 4N-2P-1K composted chicken pellets (Perfect Blend LLC, Bellevue, WA) was applied and incorporated during field preparation before planting (May 15, 2011, and June 1, 2012) both years. Plots were cultivated with an S-tine harrow (Agri Supply, Garner, NC) twice in 2011, on 17 July and 8 August, for weed management both in the beds and alleyways. Plots were not cultivated in 2012 because of the close row spacing. At NWREC, 0.5 t/ha of 20N-4.36P-1.66K fertilizer (Wilbur-Ellis, Mt. Vernon, WA) was broadcast and tilled in before seeding both years. No cultivation was used at NWREC in either 2011 or 2012 because of the close row spacing. Crops were not irrigated at either location either year, following common grower practices in the region.

Plant Establishment and Yield

Plant stand was assessed on a row-meter basis and an area basis for both years. A meter stick and a quadrat (1/4 m^2) were randomly placed in the center of each plot, with 3 subsamples per plot, on 27 September at Jubilee Farm and 8 August at NWREC in 2011 and on 15 August at Jubilee Farm and 2 August at NWREC in 2012. In 2011 crops were harvested on 27 September (97 d after planting) at Jubilee Farm and 11 October (96 d after planting) at NWREC. In 2012 dry conditions during August and September and heavy weed pressure at Jubilee Farm caused the study to be terminated before harvest at this site. At NWREC, crops were harvested on 28 September (93 d after planting). Both years, three 1/4 m^2 quadrant subplots were harvested by hand in the center of each plot. Crop types used as either a forage or a fodder crop (fodder beet, turnip, rutabaga) were harvested whole and then separated into roots and tops. For crops that are only used for forage (kale, chicory), only the above-ground portion of the plant was harvested. Samples were immediately washed to remove all soil, weighed, and oven dried at 37°C; dry weight was recorded; and then samples were ground (1.0-mm screen).