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Evaluation of Barley (*Hordeum vulgare* L.) Varieties for Small-Scale Fodder Sprout Production

Abstract

Rising feed costs have increased interest in sustainable, small-scale feed production for household livestock systems. This study provides one of the few controlled evaluations of barley (*Hordeum vulgare* L.) sprout production under household-scale conditions. Six treatments—two barley varieties and a three-way grain mix, each with and without Austrian winter peas—were evaluated for nutritional composition and yield. Crude protein and fiber fractions differed among treatments, whereas dry matter yield and total digestible nutrients were unaffected. Pea inclusion increased crude protein, while the three-way mix elevated fiber. Results demonstrate that barley sprout nutrient profiles can be strategically adjusted without compromising productivity, offering a flexible and sustainable supplemental feed option for small-scale producers.

Introduction

Rising food prices, particularly for protein, have increased interest among both urban and rural residents in producing food at home (See Table 1; Subramaniam et al., 2025). A nationwide survey by the Center for Food Demand Analysis and Sustainability found that 42% of urban and 55% of rural households grow or raise at least some of their own

food (Balagtas and Bryant, 2025). Many of these households plan to expand livestock production, including poultry for meat, large livestock for meat or dairy, small livestock for meat or dairy, and egg production (Balagtas and Bryant, 2025).

Table 1. Growth in US food and meat prices from 2010- 2025.

Food Category	Percentage Change
All Food	57.76%
Meat, Poultry, and Fish	74.77%
Beef & Veal	137.95%
Pork	51.65%
Poultry	55.55%

Small livestock species such as rabbits and chickens offer a practical, sustainable protein source for urban and small-scale producers; however, feed costs remain a major barrier to economical livestock production. Consequently, many producers have explored on-farm or household feed production alternatives. Barley (*Hordeum vulgare* L.) fodder, produced by sprouting barley grain and feeding the shoots, seed, and root mat to livestock, has gained attention as a supplemental feed due to its high nutritional value and minimal space requirements. While research exists on large-scale systems, limited information is available on small-scale barley fodder production suitable for household operations. Producers lack guidance on barley variety selection and the nutritional characteristics of barley fodder produced under these conditions. This study addresses these gaps by evaluating barley varieties for sprout production and assessing their nutritional value for small-scale livestock systems.

In scientific literature, sprouted grain systems are commonly referred to as barley sprouts, whereas many small-scale producers and homesteading communities use the term barley fodder to describe the same practice. In both cases, the term refers to sprouted barley grain harvested with the shoots, seed, and root mat intact and fed fresh to livestock. For consistency with existing research, the term *barley sprouts* is used throughout this manuscript, while acknowledging that *fodder* is commonly used in producer-focused resources to describe the same system.

Methods

To address knowledge gaps in small-scale barley sprout production, six barley sprout treatments were evaluated. Treatments included:

- ‘Rulon’
- ‘Rulon’ and Austrian Winter pea (‘Rulon’ + Pea)
- ‘Stockford’
- ‘Stockford’ and Austrian Winter pea (‘Stockford’ + Pea)
- Three-way (mix of wheat, barley, and oat)
- Three-way and Austrian Winter pea (Three-way + Pea)

For the treatments, two Spring barley varieties (*Hordeum vulgare* L.)—‘Rulon’ (Krause et al., 2024) a 6 row feed grain and ‘Stockford’ (WestBred, 2005) a 2 row forage—and one three-way grain mix (wheat, barley, and oat) named ‘Prosper’, which contains ‘Twin Wheat’ (*Triticum aestivum*; Beardless Soft White; Sunderman, 1972), ‘Morgan’ Spring oat (*Avena sativa* L.; Kibite and Menzies, 2001), and ‘Stockford’ barley, which served as a comparative control. Each of the three grain treatments was evaluated alone and again with the addition of Austrian winter peas (*Pisum sativum* var. *arvense*), resulting in six total treatments. Peas were added because they are frequently recommended in small-scale sprout production guides and online tutorials with little to no research backing but with a desire to increase protein. Germination rates of grain and pea cultivars used in this study are provided in table 2.

Table 2. Seed germination rates of grain and pea cultivars used in sprout treatments

Treatment	Germination Rate¹ (%)
Austrian Winter Pea	99
'Rulon' Barley	97
'Stockford' Barley	98
'Prosper' Three-Way	
- <i>'Twin Wheat'</i>	97
- <i>'Morgan' Oat</i>	95
- <i>'Stockford' Barley</i>	98

¹Germination rates were provided by seed suppliers

Sprouts were produced using 10 × 20-inch plastic trays with drainage holes to simulate household-scale production. Trays were placed on a stainless-steel wire shelving unit (three-tier) to allow drainage and vertical stacking. The experiment followed a randomized complete block design with shelf position serving as the blocking factor to account for potential environmental gradients. Three replicates were used per treatment (18 experimental units total), with one replicate of each treatment randomly assigned to each shelf (top, middle, bottom). Treatment × block interactions were evaluated using SAS PROC MIXED.

All sprouts were raised indoors in Nephi, Utah under controlled conditions, with ambient temperatures maintained between 70 and 75°F and relative humidity ranged from 30 - 40%. No supplemental lighting was provided; sprouts were grown under ambient indoor lighting, including natural light from windows and standard interior lighting. These conditions were selected to reflect typical household environments in Utah and are important when interpreting dry matter results. Regular municipal tap water was used for all soaking and irrigation events.

Before sprouting, the seeds were soaked in large-mouth glass jars. Barley-only and three-way grain treatments used 3.5 cups of seed per tray, creating an even layer that fully covered the tray bottom while allowing adequate space for germination. Seeds were submerged in 5 cups of water and soaked for 24 hours following University of Minnesota Extension guidelines (Heins and Paulson, 2026). All trays and jars used in the study were new, therefore no cleaning or sanitation between uses was required. For pea treatments, 2.5 cups of grain seed were combined with 1.0 cup of Austrian winter peas, yielding a mixture of approximately 71.5% grain and 28.5% peas. Volumetric measurements were intentionally used rather than seed weight to better reflect practices commonly employed by small-scale and household producers, who often rely on volume-based measurements when preparing sprout trays. The target inclusion rate of approximately 25–33% peas was selected to evaluate the impact of protein supplementation while maintaining adequate grain density for uniform sprout development. Given the limited research available on small-scale barley sprout mixtures, this study was designed to establish baseline data using methods that are both practical and easily replicated by producers. Future research should evaluate seed weight-based seeding rates to further refine sprout production recommendations.

After soaking, the seeds were evenly spread into sprouting trays and placed on shelving. Trays were irrigated twice daily for six days, once in the morning (0900–1100 h) and once in the afternoon (1600–1800 h). During irrigation events, trays were moved outdoors for approximately 10–15 minutes to facilitate drainage. Sprouts were briefly exposed to ambient outdoor light during this period. The six-day growth period was selected to allow producers to harvest sprouts within one week, consistent with common small-scale production practices and Extension recommendations, which typically reference a 7-day sprout harvest window (Heinz and Paulson, 2026). Additionally, a 7-day sprout harvest window reduces mold potential and optimizes growth potential.

Following the sixth day, trays were allowed to drain and air-dry for approximately 12 hours prior to harvest. At harvest, each tray was weighed to determine fresh (wet)

barley sprout yield. A subsample was collected from each tray, sealed in plastic bags, and frozen until shipment.

Samples were submitted to Cumberland Valley Analytical Laboratory for nutritional analysis using near-infrared spectroscopy (NIR). Analyses included dry matter, crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (aNDF), and total digestible nutrients (TDN). Dry matter yield was calculated by applying laboratory-determined dry matter percentages to fresh fodder weights.

Data were analyzed using SAS (PROC GLM) to evaluate treatment effects. When treatment effects were significant, means were separated using Tukey's honestly significant difference test at $\alpha = 0.05$.

Results

No treatment \times block (shelf effect) effect was detected ($p > 0.05$). Treatment effects were observed for CP ($p < 0.01$), ADF ($p < 0.01$), and aNDF ($p = 0.01$). In contrast, dry matter yield ($p = 0.13$) and TDN ($p = 0.63$) were not affected by treatment. Post hoc comparisons (Tukey, $\alpha = 0.05$) and LSM means are presented in Table 3.

Fiber Fractions

The three-way grain mix without peas had the highest ADF (16.93%) and aNDF (30.67%) concentrations, indicating greater structural fiber content. In contrast two of the treatments amended with peas exhibited the lowest fiber concentrations with 'Rulon + Peas' and 'Stockford' + Peas exhibiting the lowest ADF (10.0 – 11.6%) and aNDF (20.27-22.9%) concentrations. More research is needed to parse out what effect the addition of peas to barley sprouts could have on increasing or decreasing fiber.

Crude Protein

Data found that CP concentrations were significantly greater ($p < 0.05$) in pea-amended treatments (23.9% average) compared to non-pea-amended treatments (16.6%

average). The highest CP concentration was observed in ‘Rulon’ + Pea treatment (24.9%), followed closely by ‘Stockford’ + Pea and Three-way + Pea (both 23.4%). These values were significantly greater ($p < 0.01$) than those of their corresponding grain-only treatments, which ranged from 15.8 to 17.5% CP.

Dry Matter Yield and Dry Matter Percentage

Dry matter yield ranged from 3.23 to 4.85 kg m⁻² and was not significantly affected by treatment ($P = 0.13$). Pea-supplemented treatments numerically produced greater dry matter than grain-only counterparts, with the highest yield observed in the three-way grain mix with peas (4.85 kg m⁻²) and the lowest in Rulon barley alone (3.23 kg m⁻²). Dry matter concentration ranged from 23.63 to 29.70% and did not differ among treatments ($P = 0.46$). These results suggest that producers can incorporate peas to increase protein without negatively affecting overall sprout yield or dry matter production.

Total Digestible Nutrient

Total digestible nutrient (TDN) concentration ranged from 77.57 to 79.43% and was not affected by treatment ($P = 0.63$). Although fiber and protein composition varied among treatments, estimated energy levels remained consistent, suggesting that producers can adjust sprout nutrient profiles through variety selection or pea inclusion without negatively impacting overall energy value.

Table 3. Nutrient composition and dry matter yield of barley sprout treatments after 7 days of growth.

Treatments ¹	Barley Fodder Sprout Variety Nutritional Analysis					
	Dry Matter Yield ² (kg/m ²)	CP ³	ADF ⁴	aNDF ⁵	TDN ⁶	Dry Matter %
Rulon	3.23	16.33 ^b	11.13 ^a	23.23 ^{ab}	79.43	28.93
Rulon + Peas	3.97	24.87 ^a	10.03 ^a	20.27 ^a	78.50	29.70
Stockford	3.48	17.53 ^b	14.03 ^{ab}	26.93 ^{ab}	79.00	23.63
Stockford + Peas	4.11	23.37 ^a	11.63 ^a	22.9 ^{ab}	78.63	27.87
3-Way	3.66	15.8 ^b	16.93 ^b	30.67 ^b	77.57	24.13
3-Way + Peas	4.85	23.37 ^a	12.30 ^{ab}	23.5 ^{ab}	78.50	27.43
P-Value	P = 0.13	P < 0.01	P < 0.01	P = 0.01	P = 0.63	P = 0.46

¹Treatments included 'Rulon' (grain type), 'Stockford' (forage type), and a Three-way grain mix (Twin wheat, Morgan oat, Stockford barley), with or without Austrian Winter peas (*Pisum sativum* var. *arvense*); *n* = 3 replicates per treatment

²Dry matter yield calculated from fresh tray weight multiplied by laboratory-determined dry matter percentage; to convert to lb ft², divide by 4.882.

³CP = crude protein; ⁴ADF = acid detergent fiber; ⁵aNDF = amylase-treated neutral detergent fiber; ⁶TDN = total digestible nutrients.

Means within a column followed by different letters differ significantly (Tukey, $\alpha = 0.05$).

Discussion

The primary finding of this study is that barley sprout quality differed among treatments, primarily in CP and fiber fractions ($p < 0.05$). CP, ADF, and aNDF were significantly affected by treatment, whereas dry matter yield and total digestible nutrients (TDN) were not. It should be noted that there was no effect found on tray placement on shelves, meaning that barley sprouts grown on the top shelf had no differences compared to barley sprouts placed on the middle or bottom shelves. These findings suggest that vertical shelving can be used without negatively affecting yield or nutrient composition under the conditions of this study.

Fiber Fractions

Values for ADF differed among treatments, with 'Rulon' and 'Rulon' + peas exhibiting significantly lower levels than the three-way grain treatment. Although the differences ($p < 0.05$) in ADF initially suggests a potential advantage of grain-type barley, this interpretation is not consistent across treatments, as 'Stockford' + peas—a forage-type barley—also resulted in lower ADF than the three-way treatment. The consistently higher ADF and aNDF ($p < 0.05$) values observed in the three-way treatment are therefore more likely related to the inclusion of additional grain species in the seed mix. The presence of wheat and oat may have contributed to the observed differences in fiber fractions. Salas-Solis et al. (2026) reported similar ADF (10.5) and aNDF (23.7) values with wheat sprouted for six days. In contrast, Rahman et al. (2020) found that oats sprouted for eight days contained higher concentrations of ADF (24.03) and NDF (59.47) than those observed in this barley sprout study. These findings suggest that oat

inclusion may increase fiber fractions; however, additional research is needed to isolate the individual contributions of these species within sprout systems.

Crude Protein

Protein content was substantially increased by the inclusion of Austrian Winter peas in the sprout production system ($p < 0.05$). Treatments containing approximately 28.5% peas achieved CP concentrations of 23–24%, compared to 15–17% in grain-only treatments. While higher protein levels can be beneficial, protein requirements vary by species and production stage. For example, crude protein requirements for growing and lactating rabbits are approximately 16% and 17%, respectively (National Research Council, 1977), suggesting that pea inclusion may not be necessary for all production systems. However, for species or production stages with higher protein requirements, pea-amended barley sprouts provide a practical option to increase protein content. Adjusting the proportion of peas in the seed mix may help producers better match barley sprout protein levels to livestock needs, though additional research is needed to determine optimal inclusion rates.

Energy, Yield, and Dry Matter

The absence of treatment effects ($p > 0.05$) on total digestible nutrients (TDN) and dry matter yield simplifies variety selection for producers, as both energy availability and total output remained consistent across treatments. In addition, the TDN values observed in this study indicate that barley sprouts provide a consistently high level of dietary energy. According to Mullenix and Dillard (2019), low-quality forage typically ranges from 45–52% TDN, mid-quality forage from 52–58% TDN, and high-quality forage is $\geq 58\%$ TDN. In this study, barley sprout TDN values ranged from 77–79%, placing them well above typical forage classifications and more in line with energy levels associated with grain-based feeds (Rivera and Parish, 2023). This consistency allows producers to prioritize protein content, digestibility, seed availability, and cost when selecting barley sprout systems, without concern for reduced energy supply. Consistent dry matter yield among treatments also supports predictable weekly sprout production.

Although dry matter percentage was not affected by treatment, barley sprouts produced in this study contained dry matter concentrations between 23 – 29%. Previous research has reported lower dry matter concentrations in barley sprouts, often ranging from 12.6 to 14.7% (Crump et al., 2025; Zang et al., 2024). However, those studies were conducted in enclosed systems with controlled temperature and humidity, whereas the present study simulated a small-scale, household sprout production environment. Differences in growing conditions may therefore explain the higher dry matter concentrations observed in this study. As a result, a substantial portion of the barley sprouts consisted of water, which may reduce dry matter intake per unit of fresh weight. Lahr et al. (1983) found that as dry matter content of a diet decreased, dry matter intake decreased linearly. Dry matter content should be considered when interpreting nutrient concentrations and estimating feeding rates.

Conclusion

This study provides one of the few controlled evaluations of barley sprout production under household-scale conditions. The study found that barley sprouts grown under small-scale, household conditions can provide consistent yield and energy while allowing producers to adjust protein and fiber through variety selection and pea inclusion. Crude protein (CP), acid detergent fiber (ADF), and neutral detergent fiber (aNDF) differed among treatments ($p < 0.05$), indicating that sprout quality can be matched to livestock nutritional needs without reducing productivity. Adding Austrian Winter peas effectively increased crude protein, whereas grain-only barley sprouts supplied adequate nutrition for livestock with lower protein demands.

These results suggest producers can modify sprout systems to improve nutrient composition while maintaining predictable production. Variety selection and pea inclusion should align with livestock requirements and operation goals. Although sprout production requires daily management, its flexibility and consistent nutrient profile support its use as a practical supplemental feed for small-scale and urban livestock

systems. Future research evaluating additional grains, varying pea inclusion rates, and feeding trials will help clarify animal performance and economic value.

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