

Forage Intake and Wastage by Ewes in Pea/Hay Barley Swath Grazing and Bale Feeding Systems

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ABSTRACT

Harvested feed costs, particularly during the winter, are traditionally the highest input associated with a ruminant livestock operation. Although swath grazing has been practiced for over 100 years and literature exists for cattle use of swath grazing, no published results are available on use of swath grazing by sheep. Sixty mature, white-faced ewes were used in a completely randomized design repeated 2 years to evaluate whether feeding method (swath grazed or fed as baled hay in confinement) of intercropped field pea (*Pisum sativum* L.) and spring barley (*Hordeum vulgare* L.) forage affected ewe ADG (average daily gain), forage DMI (dry matter intake), and wastage. The study was conducted at Ft. Ellis Research Station in Bozeman, MT during the summers of 2010 and 2011. Each year, 30 ewes were allocated to 3 confinement pens (10 ewes/pen) and 30 ewes were allocated to 3 grazing plots (10 ewes/plot). Ewes had ad libitum access to forage and water. Individual ewe forage DMI was estimated using chromic oxide (Cr_2O_3) as a marker for estimating fecal output. Measures of fecal output were combined with measures of forage indigestibility to determine DMI for each ewe. Forage wastage was calculated by sampling and weighing initial available forage, and subtracting final available forage and DMI. Forage DMI ($P \geq 0.13$), ewe ADG ($P \geq 0.40$), and forage percent wastage ($P > 0.28$) did not differ for swathed versus baled pea/hay barley forage during either year. These results suggest that a swathed feeding system can function as a viable alternative to a traditional baled feeding system for pea/hay barley forage in commercial sheep operations.

Keywords: Bales; forage intake; range ewes; swath grazing; wastage.

1. INTRODUCTION

Winter feeding costs are some of the highest inputs associated with livestock production [1]. Costs of traditional baled feeding systems include harvesting and baling hay, maintaining machinery, moving, stacking, and feeding bales, and removing wastage and manure [2]. To

reduce winter feed and production costs, feeding strategies can be employed to extend the standard grazing season [3]. Swath grazing is the process of cutting forage and leaving it in windrows or raking it into swaths for livestock to graze at a later date [4]. As more of the burden of harvest is transferred to livestock, swath grazing reduces labor, time, and costs associated with baled forages. The quality of forage tends to be lower in swaths compared to bales because exposure to precipitation and other environmental conditions can degrade its nutritive value [2, 3]. However, swathed forage may still be a viable feeding alternative for livestock operations if lower costs offset nutritive limitations [5].

Although swath grazing is widely used in the Northern U.S. and Canadian Prairie Provinces, present research is limited to cattle and has shown variable results with regard to intake, BW (body weight), and wastage [2, 3, 5]. In this study, we evaluate ewe ADG, forage DMI and wastage for pea/hay barley forage fed in a swathed versus baled feeding system.

2. MATERIAL AND METHODS

2.1 Ewe management and treatments

Activities involving live animals were approved by the Agricultural Animal Care and Use Committee at Montana State University (Protocol #2009-AA04). This experiment was a completely randomized design repeated over 2 years, which evaluated feeding method of intercropped field pea (*Pisum sativum* L.) and spring forage barley (*Hordeum vulgare* L.); as 1) swath grazing pea/barley forage or 2) baled pea/barley hay fed in confinement on forage DMI, and wastage. The same experimental protocol was used as described in Ragen et al [6]. Each year, 60 non-pregnant, non-lactating, mature western white-faced ewes were selected, and an initial shrunk BW was obtained after a 16-h removal from food and water.

Ewes were randomly assigned to either a swath grazing treatment (SWATH, $n = 30$), or a confinement, bale-fed treatment (BALE, $n = 30$). For SWATH, forage was defined as: 1) the swath and 2) standing forage including post-harvest stubble and regrowth. For BALE, forage was defined as baled forage fed in an outdoor pen. There were 3 replications for SWATH (3 plots, 10 ewes/plot) and 3 replications for BALE (3 pens, 10 ewes/pen). Stocking rates of 10 ewes per plot were based on measures of initial available forage determined before harvest [3] and on NRC [7] projected DMI levels for mature non-lactating ewes (75.0 – 81.5 kg) adjusted for ad libitum access to forage. Forage that fell within ten 0.1 m² ring-samples collected at random throughout each plot was clipped to ground level. The mean aggregated 1.0-m² weight of forage was then multiplied by the plot area to estimate total initial forage available per plot. Our stocking protocol assumed 75-80% consumption of initial available forage over the span of 7 d (with no less than 15-20% forage refusal) for SWATH. Ewes in BALE were fed an amount of hay sufficient to ensure no less than 10% daily forage refusal.

2.2 Study Site and Forages

Research was conducted at the Fort Ellis Experiment Station of Montana State University located 10 km east of Bozeman, MT (elevation 1,520 m). Average annual precipitation was 460 mm, with average annual minimum and maximum temperatures of -0.4°C and 12.9°C, respectively [8]. During the study, August through October of 2010 had an average temperature of 15°C and average precipitation of 50 mm. August through October of 2011 had an average temperature of 14°C and average precipitation of 30 mm.

The study used 12 distinct forage plots (6 for 2010 and 6 for 2011), with each plot measuring 15.2 m × 91.4 m. The pea/hay barley forage was planted mid-May in 2010 and 2011, and allowed to enter the soft dough stage before being harvested in mid-August. Pea forage was

75 planted at a rate of 112.2 kg/ha and barley at 50.4 kg/ha in a zero tillage system using a
 76 John Deere 7320 tractor (John Deere, Moline, IL) and a Great Plains 610 drill (Great Plains
 77 Ag, Salina, KS). A commercial *rhizobium* inoculant was applied to pea seed at a rate of 3.58
 78 ml/kg during seeding.

79 Pea/hay barley forage was harvested using a self-propelled model 8830 Case International
 80 swather (Case IH, Grand Island, NE) equipped with a conditioner. Each year, we randomly
 81 selected 3 plots for the SWATH treatment, and 3 plots for the BALE treatment. For the
 82 SWATH treatment, cut forage in each plot was raked into a single swath measuring 0.6 × 1.0
 83 × 46 m. The swath was allowed to dry and cure without any further handling. For the BALE
 84 treatment, forage harvested in the remaining 3 plots was baled using a model 4590 Hesston
 85 small square baler (AGCO, Duluth, Georgia) as soon as the DM (dry matter) concentration
 86 reached approximately 18% (based on a hay moisture meter; Delmhorst, Ventura, CA).
 87 Bales measured approximately 36 × 46 × 91 cm and were immediately stored on raised,
 88 wooden pallets in a covered, three-sided building on-site.

89 Samples of the swaths (three random 10-cm profile sections of an ungrazed swath per plot
 90 were composited), and bales (core samples of 6 random bales were composited) were
 91 taken. Forage analyses were conducted as described by Ragen et al [6]. Descriptive forage
 92 composition values are presented in Table 1 (taken after curing/baling; August 11, 2010;
 93 August 22, 2011). Within both years, little difference was observed between initial or final
 94 forage quality measures of SWATH and BALE samples (data not shown).

95 **Table 1. Composition of forage consumed by ewes in pea/hay barley swath grazing**
 96 **and confinement (baled forage) feeding systems for 2 years (DM basis)**

Year	Item	Forage type	
		Swath	Baled
2010	CP, %	11.3	10.5
	NDF, %	55.0	50.8
	ADF, %	29.5	28.7
2011	CP, %	7.3	7.1
	NDF, %	50.6	48.7
	ADF, %	27.1	26.6

97 *Where CP= crude protein, NDF= neutral detergent fiber, and ADF= acid detergent fiber*

98 In 2010, forage regrowth occurred in SWATH plots. In 2011, glyphosate was applied before
 99 harvest to all plots to control the growth of Canadian thistle (*Cirsium arvense*). This
 100 application resulted in no post-harvest regrowth available to ewes in the SWATH treatment
 101 of 2011. Because of this, standing forage was omitted and only swathed and baled forage
 102 composition was provided.

103 2.3 Intake

104 Each SWATH plot was divided into 2 sections of 697 m². One section was used for a 7-d
 105 adaption period and the other for a 7-d data collection period. Each 465-m² drylot pen for
 106 BALE ewes contained a combination hay rack/grain trough measuring 3.0 × 0.6 × 1.0 m. All
 107 ewes were permitted ad libitum access to water as well as salt mixed (Sheep Range Mineral,
 108 CHS, Inc., Sioux Falls, SD).

109 Individual ewe forage DMI was estimated using measures of fecal output and indigestibility
 110 as described by Ragen et al., [6] 2015. Dosing and fecal sample collection occurred once
 111 per day at 1000 h to minimize interference with documented grazing rhythms of sheep [9].

112 Ewe forage DMI was averaged for each plot or pen, and plot or pen was used as the
113 experimental unit.

114 **2.4 Forage Wastage**

115 Wastage was determined during the 7-d collection period. In both SWATH and BALE
116 treatments, initial and final forage availability was determined to calculate DM wastage as W
117 $= F_i - F_f - I$, where W is wastage, F_i is initial available forage, F_f is final available forage, and
118 I represents intake over the 7-d collection period. Both F_i and F_f included swathed forage,
119 stubble and any regrowth. To estimate initial forage availability of SWATH treatments prior to
120 stocking, 3 random 1-m sections of swath (approximately 6%) were collected. These
121 sections were weighed in a wire sling and then replaced using methods similar to Volesky et
122 al. [3]. The average weights of the 3 samples were multiplied by swath length to estimate
123 total swath weight for each plot. Any post-harvest regrowth and crop residue biomass were
124 included in the analysis of wastage. Standing forage was sampled using the ring-sampling
125 method described previously to estimate standing forage and added to the total estimated
126 swath weight to derive the initial available forage per plot. Final available forage was
127 collected in the same manner and was defined as refused and edible (unsoiled, untrampled)
128 forage. To estimate initial available forage for BALE treatments, all bales were weighed
129 before feeding each day. Final edible forage available for BALE treatments was estimated by
130 weighing refused forage left in each combination hay feeder at the end of the 7-d data
131 collection period.

132 **2.5 Statistical Analysis**

133 This study was a completely randomized design with each SWATH or BALE enclosure as
134 the experimental unit. Data were analyzed within year due to experimental differences
135 between 2010 and 2011 (use of glyphosate in 2011). PROC GLM of SAS (SAS Institute Inc.
136 Cary, NC) was used to evaluate within-year treatment differences in initial BW, ewe ADG,
137 forage DMI, and wastage. Means were separated using the LSD procedure when a
138 significant F value was found ($P \leq 0.10$).

139 **3. RESULTS AND DISCUSSION**

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141 **3.1 Forage DMI and Ewe Performance**

142 Proper nutrients and intake are critical in winter feeding systems for animal performance [10]
143 (Baron et al., 2006). Ewe DMI, measured as kg per day, and percentage of BW, did not differ
144 ($P \geq 0.13$) between SWATH or BALE in 2010 or 2011 (Table 2), averaging 2.2 kg and 3.3%
145 BW in 2010, and 2.2 kg and 3.5% BW in 2011, respectively. Ewe ADG also did not differ (P
146 ≥ 0.40) between treatments in 2010 or 2011 (Table 2). However, our measurement of ADG
147 occurred over a relatively short time period, and may not be indicative of results on a longer
148 term application. Volesky et al. [3] attributed differences in animal performance to availability
149 of high quality regrowth that occurred post-harvest. This could explain the relatively lower
150 ADG we observed by ewes in 2011 when there was no post-harvest regrowth available.

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153 **3.2 Forage Wastage**

154 Wastage can represent a costly aspect of feeding systems in both expense of feed lost as
155 well as labor for removal of soiled feed [5]. Generally, wastage varies depending on storage
156 method, feeder type, feed amount, and whether or not a time-restriction is imposed during

feeding [11, 12]. No difference ($P \geq 0.28$) was seen between SWATH or BALE for wastage expressed as a percent of initial available forage in either 2010 or 2011 (Table 2). Pea/hay barley forage wastage averaged 25.8% in 2010, and 13.8% in 2011.

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Table 2. Dry matter intake, initial BW, ADG, and forage wastage for ewes in pea/hay barley forage swath grazing and confinement (baled forage) feeding systems for 2 years

Year	Item	Feeding system		SEM ³	P-value
		GRAZE ¹	BALE ²		
2010	Initial BW, kg	66.3	64.7	1.25	0.43
	ADG, kg	0.21	0.24	0.027	0.40
	DMI, kg·ewe ⁻¹ ·d ⁻¹	1.8	2.6	0.31	0.15
	DMI, % BW	2.7	3.9	0.49	0.16
	Wastage, % ⁴	31.9	19.7	7.51	0.28
2011	Initial BW, kg	63.1	60.8	1.07	0.19
	ADG, kg	0.10	0.12	0.028	0.66
	DMI, kg·ewe ⁻¹ ·d ⁻¹	2.5	2.0	0.19	0.13
	DMI, % BW	3.9	3.2	0.32	0.20
	Wastage, % ⁴	17.44	10.22	7.51	0.52

¹ Ewes grazed pea/ hay barley swaths and standing forage.

² Ewes fed pea/hay barley hay in confinement.

³ n = 3.

⁴ Wastage, % = [(initial forage availability – ending forage availability – total DMI) / beginning forage availability] x 100.

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Prior research on swath grazing has established that wastage is primarily dependent upon stocking rates and grazing management [3]. It has generally been observed that if cattle are allowed unlimited access to swaths, they waste some of the forage by lying on it, urinating and defecating on it, and destroying the continuity of the swaths [5]. Thus, it is widely recommended that an electric fence be used to limit cow access to swaths and a 2-wk grazing window has been proposed [5, 13]. We observed no difference in wastage between feeding systems for either year, despite allowing ewes access to the entire swathed area and the use of stocking rates to ensure 10-20% forage refusals.

Previous research suggests that although forage quality of baled forage may provide an advantage in nutrients when compared to both swath and standing forage, swathed forage can result in adequate calf gains throughout the fall and winter [2, 3]. In our study, observation of nutrient concentrations indicated general weathering effects for both swathed and baled forage.

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183 4. CONCLUSION

Our research expands on previous research for cattle and suggests that swath grazing pea/barley forage may have utility in sheep production. Although our results show that

186 nutrient composition tended to be lower in the swathed pea/barley forage, wastage and
187 animal performance were similar between swathed and bale-fed pea/barley treatments, and
188 suggests that a swathed pea/forage feeding system could function as a viable alternative to
189 a traditional baled feeding system in arid climates.

190 REFERENCES

- 191
- 192 [1] Waldron BL, Larson SR, Peel M, Jensen KB, Mukimov TC, Rabbimov A, Zobell DR,
193 Wang R, Smith RC, Harrison RD, Davenport BW. 'Snowstorm' a new forage kochia cultivar
194 with improved stature, productivity, and nutritional content for enhanced fall and winter
195 grazing. J.Plant Reg. 2013;7:140-150.
- 196 [2] Munson CL, Whittier JC, Schutz DN, Anderson RL. Reducing annual cow cost by grazing
197 windrowed millet. Prof. Anim. Sci. 1999;15:40-45.
- 198 [3] Volesky JD, Adams DC, Clark RT. Windrow grazing and baled-hay feeding strategies for
199 wintering calves. J. Range Manage. 2002;55:23-32.
- 200 [4] Surber G, Fisher T, Cash D, Dixon P, Moore J. "Swath/windrow grazing: An alternative
201 livestock feeding technique." Montguide. MT200106 AG 8/2001. 2001. Accessed 1
202 December 2009. Available:
203 <http://msuextension.org/publications/AgandNaturalResources/MT200106AG.pdf>.
- 204 [5] Karn JF, Tanaka DL, Liebig MA, Ries RE, Kronberg SL, Hanson JD. An integrated
205 approach to crop/livestock systems: Wintering beef cows on swathed crops. Renew. Ag.
206 Food Sys. 2005;20:232-242.
- 207 [6] Ragen DL, Nix EE, Endecott RL, Hatfield PG, Petersen MK, Bowman JGP. Individual
208 mineral supplement intake by ewes swath grazing or confinement fed pea-barley forage.
209 Anim. Feed Sci. Tech. 2015;200:107-111.
- 210 [7] NRC. Nutrient Requirements of Sheep. 6th rev. ed. Natl. Acad. Press, Washington, D.C.
211 2007.
- 212 [8] WRCC. Western Regional Climate Center. 2008. Accessed 2 April 2012. Available:
213 <http://www.wrcc.dri.edu/>.
- 214 [9] Hatfield PG, Donart GB, Ross TT, Galyean ML. J. Range Manage. 1990;43:387-389.
- 215 [10] Baron VS, Dick AC, McCartney D, Basarab JA, Okine EK. Carrying capacity, utilization,
216 and weathering of swathed whole plant barley. Agron. J. 2006;98:714-721.
- 217 [11] Miller AJ, Faulkner DB, Cunningham TC, Dahlquist JM. Restricting time of access to
218 large round bales of hay affects hay waste and cow performance. Prof. Anim. Sci.
219 2007;23:366-372.
- 220 [12] Stockdale CR. Wastage of conserved fodder when feeding livestock. Anim. Prod. Sci.
221 2010;50:400-404.
- 222 [13] Nayigihugu V, Schleicher AD, Koch DW, Held LJ, Flake JW, Hess BW. Beef cattle
223 production, nutritional quality, and economics of windrowed forage vs. baled hay during
224 winter. Agron. J. 2007;99.4:944-951.