UNCONVENTIONAL ANNUAL FORAGE YIELD AND QUALITY: EXTENDED GRAZING POTENTIAL

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ABSTRACT

Annual forages can be used for many purposes in cropping and livestock systems. This article focuses on forage yield and quality of unconventional annual forages and their potential for extending the livestock grazing season. Winter cereals offer good yields and good quality forage options for livestock grazing. Sorghum, sorghum sudangrass, and pearl millet provide higher forage yields. However, turnips, peas, rapeseed (canola), and vetch provide higher quality forage. To start using annual forages for summer and fall grazing, this spring consider planting spring cereals, or spring cereal/vetch. To start this summer, consider planting sorghum sudangrass, teff, pearl millet, vetch/teff or pearl millet, or a rapeseed/teff or pearl millet combination in June. Graze these during the summer, or stockpile in the field for fall/early winter grazing. In late summer, consider turnips or rapeseed/winter cereals for a late fall/early winter grazing, plus grazing the following spring, and potentially again on summer cereal re-growth.

INTRODUCTION

Annual forages can be used for many purposes in cropping and livestock systems. They can be used as the primary harvested feed for livestock, as a rotation crop between alfalfa, as a double crop with cereal grains, as a green manure for nutrients or pest prevention, as a cover crop for erosion or weed control, and/or for extending the grazing season for livestock. The forage species choice will depend on the desired outcome. This article is focused on forage yield and quality of unconventional annual forages and their potential for extending the livestock grazing season.

On-farm evaluations and research trials on forages to extend the grazing season in southern Idaho look promising for: 1) spring grazing of winter cereals; 2) summer and/or fall grazing of sorghum sudangrass, pearl millet, teff, cereals, vetch or rapeseed combinations; and 3) fall/early winter grazing of turnips or rapeseed with stockpiled pasture/pearl millet/cereals combinations. Utilizing cereals, annual forages, stockpiled tall fescue, perennial pasture, and Management-intensive Grazing (MiG) allowed a Lincoln County Idaho producer to nearly triple livestock and farm production on the same acreage, compared to previous management. One forage choice will not fit every operation and each producer will have to choose the practice that makes the most economic sense for their operation.

METHODS

Annual forages were grown at the University of Idaho Kimberly Research and Extension Center under sprinkler irrigation. The forages were planted in mid-June and harvested in early to mid-September during 2010-11. The field is located 1 ½ miles north east of Kimberly, Idaho at approximately 3,380 feet in elevation. The soil is a Portneuf silt loam. A randomized complete block design with four replications was utilized. Individual plots (5 x 30 ft) were planted with a press-wheel drill with double disk openers.

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Fertilizer applications were determined based on soil analysis. In 2010 50 lb/acre of nitrogen (N) and 40 lb/acre of phosphorous (P) were applied, no potassium (K) was necessary. In 2011 80 lb/acre of nitrogen was applied (50 lb/acre dry and 30 lb/acre through irrigation) and no P or K were necessary. Since the species were very diverse, weed control was problematic. Weed control was done by small sprayers on individual plots where there were chemicals labeled and on border areas. 2,4-D was applied to the oats and corn, and Basagran was applied to the peas. Otherwise hand weeding was required in most of the smaller biomass production forages. Forage yield was determined by hand clipping 2 frames (2 ft^2) per plot, or the entire plot harvested with a sickle bar mower with scales. Frame yields are reported for 2010. Because of weed pressure reduction in the stand in 2011, poor stand forages (canola, hairy vetch, chickling vetch, peas) are reported from frame harvests. Machine yields are reported for the corn, sorghum, SS, millet, cereals, and teff in 2011. Frame samples for each forage were shredded and a composite sample for each forage across all four reps was analyzed. Forage quality was determined by Near Infrared Reflectance Spectroscopy (NIR) or wet chemistry for outliers to the curves by Rock River Lab in Wisconsin.

Partial results from other research and demonstration trials will be utilized in this article for discussion purposes regarding practical applications of unconventional annual forages for extended grazing. The complete methods and details of the other trials will not be included. Winter cereal forages and annual forages have been evaluated on producer fields in Lincoln County under furrow irrigation for livestock grazing. A two year replicated trial on winter cereals (2007-08, 2009-10) was previously completed at the UI Kimberly R & E Center that can also be utilized to evaluate annual forage potential for extended grazing.

RESULTS

Winter Cereal Crops

Natural precipitation reduces irrigation costs and cattle do most of the work to harvest winter cereals grown for forage. To reduce hay costs, producers can look to increasing grazing days on winter cereals during spring, summer or fall. Consider raising and selling alfalfa on more productive farm ground, while using more marginal ground for winter cereals to feed your own livestock.

High feed costs and irrigation shortages negatively impact livestock operator finances. Higher water use and input costs for corn silage and alfalfa necessitate assessment of other forage. In 2008, winter triticale, Willow Creek winter wheat (WCWW) and a beardless winter barley blend were harvested on May 22 and again July 1 for use as silage or hay. WCWW provided a longer interval for grazing, harvesting for hay, or silage, since it did not head out until at least 20 days after triticale.

Relative Feed Value (RFV) has been used historically as an index for pricing and quality assessment of forages. Relative Forage Quality (RFQ) is the newer index that provides a more comprehensive quality evaluation. Barley RFQ was highest in May and July. WCWW and triticale RFQ's were similar. As forages head out, the quality decreases rapidly. The disadvantage with WCWW was in lower yields when compared to triticale. Beardless barley offered quality advantages, but yields were below those of triticale.

Winter cereals planted the previous fall can be utilized for early spring or mid-summer grazing. Winter cereals harvested in May had RFQ's ranging from 157 to 199 and when compared to alfalfa cost and forage quality, winter cereals offered cheaper forage (Figure 1). The re-growth in early July ranged from 109-170 RFQ. In July, the 30-hour digestibility was better for WCWW and beardless barley than triticale. The higher the digestibility, the better cattle can obtain needed nutrition. If the re-growth is captured for forage, the only additional cost is a few irrigations.

Winter cereals planted in August could be grazed in the fall, and again in the spring, as well as mixed with turnips or legumes like hairy vetch to increase the forage quality for fall/winter grazing. For very minimal seed costs and a little irrigation water you can have a winter cereal/turnip combination that could extend the grazing season into December.

If winter cereals don't fit your operation, then substitute **spring cereal crops** like oats, beardless barley, or wheat for extended summer and fall grazing.

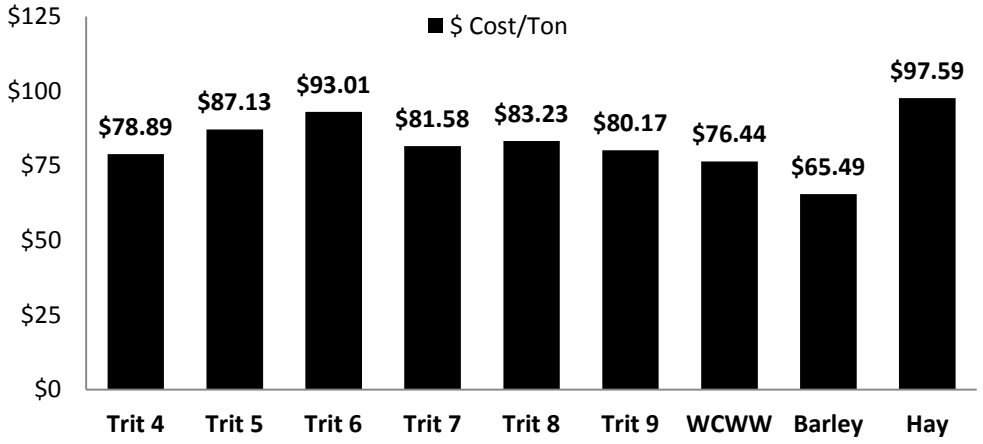

Figure 1. Cost to purchase winter cereal forages compared to alfalfa on May 22, 2008; standardized to 17% crude protein and 143 RFQ (140 RFV). Trit 4-9 = different winter triticale varieties. Feed values will naturally vary as the price of alfalfa hay changes, since that is the base for standardization. Alfalfa Fair Quality prices from 2003-2009 for May ($97.59 100% DM) were averaged and used as the baseline to standardize for value, CP and RFQ.

Warm Season Annuals

Sorghum, sorghum sudangrass (SS), teff and pearl millet show promise for low-cost rotational forage between stands of alfalfa or pasture, as hay, or to stockpile for extending the grazing season. Planted after all danger of frost was past, these warm season forages grew well during hot summer months in southern Idaho. Sorghum sudangrass grew fast and tall and was able to compete well against weeds. The forage yield and quality for 2010-11 are shown in Table 1-3.

The sorghums, SS and pearl millet had good yields in the research trials at Kimberly. In comparison to silage corn, SS, sorghum and pearl millet required minimal N and irrigation for large biomass production. All of these forages yielded higher than the vetch, rapeseed, turnips and peas, however their forage quality was less (Table 2-3). In 2011 the pearl millet, SS and sorghum ranged from 0.31 – 0.35 mcal/lb net energy for gain livestock, and had RFQ's from 114-131 (Table 3). Care must be exercised in monitoring the prussic acid and nitrate content of the sorghum or SS when grazing during the summer, especially if it is stressed, i.e. lack of irrigation. After SS is ensiled, or is frosted in the fall and left in the field, the prussic acid concern for livestock disappears.

Pearl millet can be used for summer, fall or winter grazing. The forage quality is the highest in the vegetative stage before it heads out. The average yield for both years combined at Kimberly was 8.7 tons/acre on a 100% dry matter (DM) basis (Table 1), but the RFQ fluctuated from 131 in 2011 to 79 in 2010. Harvest was done in early to mid-September both years, but the plants were more mature in 2010,

hence the forage quality decline. Similar results were observed on a Lincoln County farm where the pearl millet RFQ declined from 175 to 91 in a month, in the same field. Careful attention to repeat grazing when forage quality is high will result in the greatest benefit for livestock weight gain. For this farmer the pearl millet required less fertilizer and water compared to silage corn. It was planted in mid-June after winter triticale and only received small amounts of liquid nitrogen applied through the pivot. The field was planted back to triticale in the fall.

Table 1. Unconventional annual forage yield (100% DM tons/acre) at Kimberly, Idaho in September (planted mid-June). DM = dry matter. Different letters within a column denote statistical difference at p = 0.05 level.

Forage Species	2010		2011		2010-11 Combined	
Special Effort SS WMR			15.7	a		
Grazing corn			11.5	b		
Greentreat Plus sorghum	9.7	a	11.2	b	10.4	a
Cadan SS			10.1	bc		
Bundle King BMR sorghum	11.2	a	8.5	cd	9.9	ab
Pearl millet	9.6	a	7.5	de	8.7	b
Sweeter N Honey sorghum	11.4	a	7.2	def	9.3	ab
Nutri-Plus SS			7.2	def		
Athena winter canola			7.0	defg		
Arvika peas			6.6	defgh		
Oats	5.1	b	6.5	defgh	5.8	c
German foxtail millet			6.2	efghi		
Bonar rapeseed	3.7	bcd	5.3	fghi	4.5	cd
Montech peas			5.1	fghij		
Chickling vetch	4.3	bc	4.9	ghij	4.6	cd
Horse candy teff	3.9	bcd	4.8	hij	4.3	cd
Purple top turnips	2.7	cd	4.6	hij	3.6	de
Tiffany teff	5.1	b	4.3	ij	4.8	cd
Apin turnips	2.8	cd	4.2	ij	3.5	de
Hairy vetch	2.1	d	3.0	j	2.6	e

SS = sorghum sudangrass, BMR = brown mid-rib, WMR = white mid-rib

On another farm, pearl millet was left in the field until December for extended grazing. The pearl millet was strip grazed to reduce trampling by livestock. Pearl millet was chosen because of its limited nitrate and prussic acid poisoning concerns for livestock. The forage stood 5-6 feet tall and stayed upright in the snow. A large biomass of forage (up to 6.7 tons/acre on a 100% DM basis) was produced during a short growing season (June to September). Protein supplements were fed along with pearl millet because the available protein was 4.5%, which was below expectations. Pearl millet RFQ was 135-145 in October and decreased to an RFQ of 58-83 in December. Even with supplement costs, grazing pearl millet was less expensive than feeding hay.

At Kimberly teff had RFQ's ranging from 74-101 (Table 2-3). In farm trials, teff RFQ ranged from 78 to 120. Feed quality decreases with maturity, so harvest timing is important. Repeat harvests are necessary for higher forage quality. Teff provides a viable option for grazing during July and August when cool season grass has slowed due to hot weather. Grazing teff during this time can allow perennial pastures to rest and re-grow.

Table 2. Forage quality at Kimberly, Idaho September 12, 2010 (no statistical analysis can be completed; composite samples for reps).

Forage Species	[1]CP%	[2]ADF %	[3]aNDF%	[4]48 hr Trad. dNDF%.	[5]RFQ	[6]NE Gain Mcal/Lb
Apin Turnips	14.5	25.6	32.9	73.0	223	0.44
Bonar Rapeseed	16.5	25.8	33.2	70.0	215	0.44
Hairy Vetch	19.0	30.7	40.9	55.2	141	0.35
Chickling Vetch	17.2	31.5	41.8	51.2	128	0.33
Tiffany Teff	6.6	42.2	63.4	66.0	101	0.26
Horse Candy Teff	7.7	43.8	65.1	65.6	96	0.23
Green Treat Sorghum	6.2	40.5	71.0	68.3	93	0.21
Sweeter N Honey Sorghum	5.4	34.7	72.4	65.3	86	0.19
Bundle King BMR Sorghum	4.7	34.9	72.7	65.3	85	0.19
Pearl Millet	5.3	39.2	72.9	62.8	79	0.16
Oats	8.9	38.4	67.8	47.3	54	0.05

[1]CP = Crude Protein: AOAC Official Method (CP= Nitrogen X 6.25). Other N conversions are more appropriate for specific protein sources.

[2]ADF = Acid Detergent Fiber: Residue remaining after boiling a forage sample in acid detergent solution. ADF contains cellulose, lignin and silica, but not hemicellulose. AOAC Official method.

[3]aNDF = Amylase-treated Neutral Detergent Fiber: Residue left after boiling sample in neutral detergent solution with amylase. The NDF in forges represents the indigestible and slowly digestible components in plant cell walls (cellulose, hemicellulose, lignin, and ash). AOAC Official Method using both amylase and sodium sulfite.

dNDF = Digestible Neutral Detergent Fiber expressed as %DM: The portion of the neutral detergent fiber digested by animals at a specified level of feed intake, expressed as a percent of the dry matter:

[4]dNDF = NDF X NDF Digestibility: The dNDF of feeds may be determined by in vivo feeding trials or estimated by lignin analysis, in vitro or in situ digestibility, or by near infrared reflectance analysis. Indicate the time (hours) of digestion, e.g. dNDF, 48h.

[5]RFQ = Relative Forage Quality: An index for ranking all forages based on intake of TDN calculated by estimating digestible portions of protein, fatty acids, fiber (NDF), and non fibrous carbohydrate.

Formulas:

RFQ = dIntake potential*dTDN/1.23

Where:

dTDN = TDN (defined below) with NDFD.

dIntake potential for legumes =(120/NDF) + (NDFD-45) *0.374*1350/100

dIntake potential for grasses = $-2.318 + 0.442*CP - 0.0100*CP^2 - 0.0638*TDN + 0.000922*TDN^2 + 0.180*ADF - 0.00196*ADF^2 - 0.00529*CP*ADF$

Digestible fiber should be based on a 48-hr in vitro estimate. The higher the RFQ, the better the quality. It is used to compare varieties, match hay/silage inventories to animals, and to market hay.

[6]2001 Net Energy Gain (NEg in Mcal/Lb): An estimate of the energy value of a feed used for body weight gain above that required for maintenance. 2001 refers to the energy prediction equations in the 2001 Nutrient Requirements of Dairy Cattle, published by the National Research Council

Table 3. Unconventional annual forage quality at Kimberly, Idaho September 6, 2011.

Annual Forage Species	CP%	ADF%	aNDF%	dNDF%	RFQ	Lb Milk/Ton	NE gain Mcal/Lb
Purple top turnips	24.9	20.1	21.4	86.4	372	4013	0.54
Apin turnips	26.0	21.9	23.7	90.7	352	4054	0.53
Montech peas	17.5	23.1	31.5	78.3	262	4276	0.54
Hairy vetch	23.4	28.7	37.0	71.1	211	3537	0.44
Athena winter canola	22.1	25.4	34.7	62.0	201	3339	0.39
Grazing corn	8.3	31.0	51.7	89.3	197	4289	0.51
Arvika peas	16.6	27.8	38.1	68.1	189	3902	0.45
Oats	11.1	28.3	43.1	73.9	189	4277	0.51
Bonar rapeseed	20.5	22.7	32.7	55.5	182	3434	0.37
Chickling vetch	16.8	33.4	43.2	58.3	152	3223	0.35
Pearl millet	9.1	40.2	60.5	75.6	131	3643	0.35
Nutri-Plus SS	8.8	40.5	60.0	74.7	127	3511	0.32
Bundle King BMR Sorghum	8.9	41.4	63.7	76.1	125	3553	0.33
Greentreat Plus Sorghum	7.9	41.4	65.0	75.8	122	3504	0.31
Special Effort SS WMR	7.5	40.9	63.3	71.7	119	3586	0.32
Sweeter N Honey Sorghum	8.4	43.3	64.8	72.7	115	3490	0.30
Cadan SS	7.0	42.7	64.2	70.8	114	3569	0.31
Horse candy teff	8.6	43.8	65.2	65.0	94	3187	0.23
German foxtail millet	7.5	45.0	69.2	63.3	82	2965	0.15
Tiffany Teff	8.2	44.2	70.7	60.0	74	1458	0.14

Table 4. Perennial forage legume quality to compare with annual legumes from Kimberly, Idaho September 22, 2010. These were planted in 2009 and overwintered.

Perennial Forage	CP%	ADF%	aNDF%	48 hr dNDF%	RFQ	NE Gain Mcal/Lb
Double Cut Clover	19.78	24.95	34.97	64.66	218	0.43
Single Cut Clover	17.67	26.58	36.90	65.80	213	0.44
Starfire Clover	17.91	26.65	37.26	64.41	203	0.41
Norcen Birdsfoot Trefoil	23.66	21.92	31.03	54.50	193	0.41
Hairy Vetch	20.51	29.02	35.80	59.58	175	0.39
Vernal Alfalfa	20.97	30.63	41.70	49.33	144	0.29

Forage Combinations

A combination of forage species is a good option for maximizing forage production and quality. Turnips, peas and rapeseed had equal or higher forage quality in comparison to perennial forage legumes (Table 3

and 4). However, some are high enough quality without the fiber that they should not be fed to livestock alone. Consequently, combinations with other higher yielding, lower quality forages could be beneficial.

In a farm trial, the RFQ in August was 183 for pearl millet/turnips, and 155 RFQ for turnips/oats. Turnips planted in August, then strip grazed with stockpiled perennial pasture provided high quality forage well suited for late fall/early winter grazing. The feed quality of turnips alone can be too high for maintenance livestock diets. In September, turnip RFQ in Kimberly was 223 to 372 (Table 2-3). When nitrogen is applied, forage nitrate turnip concentrations should be monitored. Rapeseed (or canola) at Kimberly resulted in an RFQ range of 201-215. So turnips and rapeseed should be mixed with teff, pearl millet or cereals and the nitrate levels monitored.

Legumes (hairy and chickling vetch) resulted in excellent forage quality. In September, at Kimberly, hairy vetch RFQ ranged from 141-211 and chickling vetch had an RFQ of 128-152. Available crude protein was 19-23% for hairy vetch and 17% for chickling vetch. They are both high quality forages that can be mixed with cereals, teff or pearl millet to increase yields, while keeping the forage quality balanced to meet livestock maintenance and weight gain requirements.

Instead of combining the different forage species in the same field, another option is to grow vetch, turnips, or rapeseed adjacent to a field of perennial pasture, cereals or pearl millet, and then setup the electric fencing so the livestock strip graze both fields at once.

CONCLUSIONS

Extended grazing with unconventional annual forages provides an opportunity to produce a larger quantity of adequate quality forage at a lower cost than purchasing alfalfa. Producers may increase overall farm/ranch profitability, while meeting their livestock's nutritional needs with extended grazing. To start using annual forages for summer and fall grazing, this spring consider planting spring cereals, or spring cereal/vetch.

To start this summer, in June consider planting SS, teff, pearl millet, vetch/teff or pearl millet, or a rapeseed/teff or pearl millet combination. Graze these during the summer, or stockpile in the field for fall/early winter grazing. Sorghum, SS, and pearl millet required minimal N and irrigation for large biomass production. All of these forages yielded higher than the vetch, rapeseed, turnips and peas, however their forage quality was less. SS had high yields and competed well against weeds with its rapid growth. Care must be exercised in monitoring the prussic acid and nitrate content of the sorghum or SS when grazing during the summer, especially if it is stressed, i.e. lack of irrigation. After SS is ensiled, or is frosted in the fall and left in the field, the prussic acid concern for livestock disappears. Pearl millet can be used for summer, fall or winter grazing. The forage quality is the highest in the vegetative stage before it heads out. Teff provides a viable option for grazing during July and August when cool season grass has slowed due to hot weather. Grazing teff during this time can allow perennial pastures to rest and re-grow. Teff and pearl millet can both be grazed during the summer with minimal concerns for any nitrate or prussic acid concerns, unlike sorghums and SS. The yields and great forage quality of arvika peas, athena winter canola, montech peas and chickling vetch encourage incorporation of them. Turnips and hairy vetch had lower yields, but their quality was great.

In late summer to early fall, consider turnips or rapeseed/winter cereals for a late fall/early winter grazing, plus grazing the following spring, and potentially again on summer cereal re-growth. For very minimal seed costs and a little irrigation water you can have a winter cereal/turnip combination that could extend the grazing season into December.