ANNUAL FORAGE PRODUCTION IN DROUGHT

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ABSTRACT

Annual forages are widely grown in the U.S. during periods of drought. Many different crop choices are available in the inland Pacific Northwest, however they vary depending on latitude, elevation and specific climatic events during the season they are grown. For most low elevation valleys in southern Idaho and the Yellowstone and Bighorn valleys in southern Montana, warm-season dryland crops (sudangrass, sorghum-sudangrass hybrids, millet, etc.) are adapted and have high production potentials. In contrast, the annual crop choices for higher elevation, cooler areas in Idaho and most of Montana are limited to cereals and other cool-season crops. The key strategy for all producers who periodically need emergency forages is "drought anticipation" with proper planning and execution of an annual forage program.

Acreage and Production of Annual Dryland Forages

Acreage of dry hay from annual crops now considered as "alternative forages" in most states declined sharply after the introduction of tractors and mechanized field machinery. In Montana, the acreage has maintained at around 200,000 acres (Fig. 1). Due to persistent droughty conditions since the late 1990's, about 309,000 acres of cereal hay were harvested for 477,000 tons of hay annually.

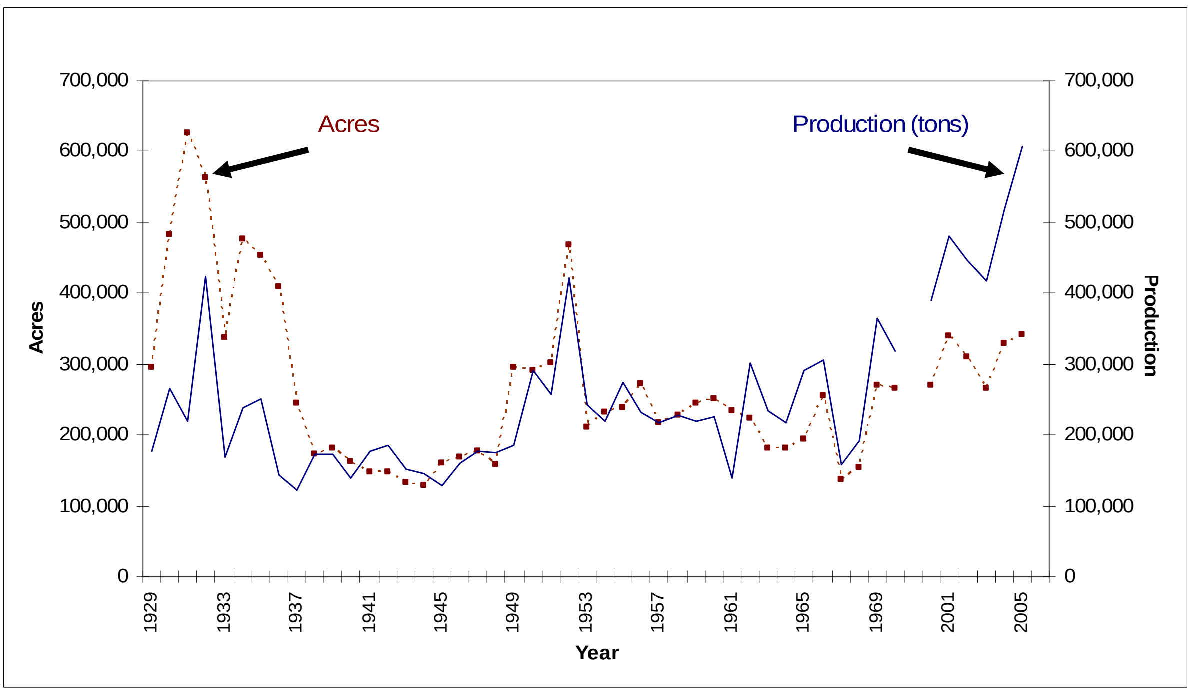

Fig. 1. Acreage and production of small grain hay in Montana, 1929-2005. Records were discontinued from 1970-2000.
Source: http://www.nass.usda.gov/Statistics_by_State/Montana/index.asp and hard copy reports.

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Winter wheat, spring wheat and barley crops growing during drought conditions are frequently salvaged as emergency forages. However, cereal crops are also purposefully grown for hay production during the rotation of old stands of alfalfa or perennial pastures. For alfalfa, rotation to a small grain is effective for controlling persistent weed problems, reducing pathogen loads of crown and root rot diseases, and allowing sod decomposition. In northern areas and high elevations, annual forage options and the window for decision making are limited. In these environments, winter or early-planted spring forages are the most suitable options for emergency forage planting.

At lower elevations in southern Idaho and basins in southern Montana where corn is grown, the best options for annual forages are the warm-season crops. Dryland corn, sudangrass, sorghum-sudangrass hybrids, millet, teff and a number of other warm season grasses are available. With "normal" summer precipitation levels, these crops have the potential for much higher production than cereal forages. In contrast, in summers with deficit precipitation, the warm-season forages are inferior to early-planted spring cereals, particularly in northern higher-elevation environments. Statistical reporting of warm-season alternative forages is not available for most western states, but the acreage is very limited in Montana. A majority of the acreage where annual forages are grown in Montana are best suited for cereal forage production, which is emphasized in this paper.

Cereal Forages During Drought

Cereal forages have consistently been important to Montana's overall crop and livestock production systems. Across many northern dryland regions, the predominating system of cereal grain production is crop-fallow. Specifically in Montana, there are 10.3 million acres of non-irrigated grain production - 6.3 million acres in wheat or barley and 4 million acres are summer-fallowed annually. Many early winter wheat and spring wheat varieties in the northern Great Plains were bred to be awnless, allowing them to be dual-purpose – they could be hayed or harvested for grain. Hooded cultivars of barley have also been developed, and these had only marginal use as hay, despite the superiority of barley forage compared to other cereals. For all of these cereals, limited plant breeding has occurred other than for head characteristics and biomass production.

The use of cereal forages in Montana increased sharply since 1998 due to widespread and persistent drought. During this period, many acres of drought-stricken winter wheat and spring grains were harvested as emergency forage. However, many growers began planting cereals for hay. 'Haybet' barley, a two-rowed hooded forage variety, is now our second-most planted barley variety behind 'Harrington'. Additionally, several awnless or awnletted winter triticale forage varieties were shipped into the state. A small cereal forage testing effort has been maintained at several of the Montana Agricultural Experiment Station (MAES) centers since the 1990's. Funding has generally limited the program to forage yield testing of adapted cereals at two or three stations annually, and very few forage quality analyses have been completed. However, during persistent drought conditions in 1998 through 2001, we were able to document some important advantages of cereal forages.

A dataset for dryland alfalfa and perennial grass compared to winter or spring cereal forages was compiled from the MAES Central Agricultural Research Center (CARC) near Moccasin, MT (Table 1). This region contains many mixed operations with cattle and dryland pasture, winter wheat, barley and hay production. At the CARC site, soils are Danvers and Judith clay loams with a significant proportion of cobble and small rocks. The site has long-term averages of 110 frost-free days and 15.4 inches of precipitation annually. Perennial forages, winter and spring cereals, pulse and oilseed crops are routinely planted on the station each year, and daily weather records are recorded on AgriMet. For winter and perennial crops, precipitation from September (of the previous year) through May is crucial, whereas April through July precipitation is key for spring crops and alfalfa regrowth.

From 1998 through 2002, persistent drought effects occurred in some crops, despite "normal" annual precipitation in 1999 and 2002. In all years except 2000, all winter or spring cereals (continuous recrop or fallow) had higher forage yields than alfalfa or meadow bromegrass (Table 1). In 2000, a severe hailstorm (common in this region) destroyed all of the cereal, pulse and oilseed crops. Interestingly, both new and older stands of alfalfa or perennial grass did not recover their forage yield potentials after consecutive years of drought.

Table 1. A case study of cereal forages compared to perennial forages during prolonged drought at the Central Montana Agricultural Research Center near Moccasin, 1998-2002.

Climate	1909-2002 Average	Crop Year				
		1998	1999	2000	2001	2002
Frost-free days (>32°F)	110	125	36	130	101	120
Precipitation		Inches *(% of Long-Term Average)*				
Annual	15.42	13.76 *(89)*	15.63 *(101)*	11.12 *(72)*	10.60 *(69)*	15.73 *(102)*
Sept.-May (winter crops)	8.85	5.21 *(59)*	8.61 *(97)*	6.47 *(73)*	4.02 *(45)*	5.58 *(63)*
Apr.-July (spring crops)	8.62	9.35 *(108)*	6.58 *(76)*	7.33 *(85)*	7.34 *(85)*	7.49 *(87)*
Crops (year seeded)		Forage Yield, DM Tons/Acre				
Alfalfa (1997)		1.20	0.90	0.46	0.37	0.67
Meadow bromegrass (1997)		1.57	0.62	0.36	0.55	1.06
Winter triticale (1997, recrop)		2.88				
Hay barley (1998, recrop)		2.80				
Alfalfa (1998)		0.71	0.85	0.41	0.34	0.94
Winter triticale (1998, fallow)			3.83			
Winter triticale (1998, recrop)			2.99			
Hay barley (1999, recrop)			1.55			
Alfalfa (1999)				0.47	0.74	1.22
Meadow bromegrass (1999)				0.51	0.56	1.12
Winter triticale (1999, fallow)				3.35		
Winter triticale (1999, recrop)				2.23		
Hay barley (2000, recrop)				Hail*		
Alfalfa (2000)				0.48	0.42	0.72
Winter triticale (2000, fallow)					1.89	
Winter triticale (2000, recrop)					1.47	
Hay barley (2001, fallow)					2.56	
Hay barley (2001, recrop)					1.78	
Alfalfa (2001)					0.45	0.84
Meadow bromegrass (2001)					0.20	1.43
Winter triticale (2001, fallow)						3.29
Winter triticale (2001, recrop)						2.25
Hay barley (2002, recrop)						1.84

Source: http://ag.montana.edu/carc/ . Data are from selected replicated forage yield trials in adjacent fields for crops grown under ideal soil fertility and weed control. *Hail on 9 July 2000 precluded harvest of spring crops.

Cereals harvested for grain or forage have higher yields following summerfallow compared to continuous recropping. Generally, winter cereals have consistently higher forage production potential than spring cereals due to better water used patterns. One exception occurred in 2001 (45% of normal September through April precipitation) where spring hay barley forage yields exceeded those of winter triticale. Very little published or historical record would have indicated the superiority of annual cereal forages over alfalfa and perennial grass during persistent drought. No thorough economic comparisons were made (seed, planting, fertilizer costs, etc), however hay prices spiked by 11 to 46% during this period. Since 2000, cereal forage acreage continues to increase, and these crops are being incorporated as "rotation crops" into traditional crop-fallow rotations. Growing cereal forage during crop alfalfa rotation is also increasing.

Growing Cereal Forages

A major advantage for cereal forage production is that no special equipment is needed. Few recent agronomic studies have been conducted with the crops, but growers have been successful adapting their practices for grain production. Seed should be planted as early as possible to capitalize on moisture conditions, and seed treatments are recommended. No thorough fertilizer recommendations have been made, but pre-plant incorporated levels used for grain production are suggested: 60-70% nitrogen, phosphorus, potassium, sulfur, boron, etc. as indicated from a recent soil test. In Montana, very few herbicides are applied to cereal forages other than pre-plant burndown. For irrigated production, we recommend seeding at 50 to 70% higher planting rates than grain, however on dryland the yield advantage is inconsistent. For most cereals, 1 to 1.3 bushel per acre provides an adequate forage stand under dryland conditions. Early planting ensures a competitive crop, and allows for timely harvest prior to most weed seed production. Seeding can be accomplished with conventional drills or airseeders. Many producers have used spring cereal-pea mixes for annual hay, however the inconsistent results during drought, cost and inconvenience often preclude this option. If in-crop herbicides are applied, be sure to follow re-entry and harvest intervals which vary among products. Very few pests impact cereal forages during growth, but in some years aphids, cereal leaf beetle, head smut and ergot are prevalent.

Cereal Forage Harvest and Quality

Cereal forages should be harvested at the water to milk stage of grain development which achieves optimum forage yield and quality. For livestock producers harvesting cereal hay, the rule of thumb analogy is to bale a “nice grass hay rather than straw and grain”. Silage is an excellent option for preservation and higher forage utilization, however this is a limited practice on most dryland ranches. As demonstrated in Table 1, dryland yields range from 1.4 to 3.8 tons of dry forage per acre, depending on the cropping system, year and crop. Within a cereal species, very few cultivars are significantly higher-yielding than other cultivars; the major differences are among species, years and cropping systems. Winter cereals typically yield more than spring cereals, and reach the ideal harvest stage 10 to 21 days ahead of spring-planted cereals at the same location.

Forage quality of cereal hay has been evaluated in a number of trials, however a majority of the data were obtained under irrigated or high rainfall conditions. Most of the adapted varieties of forage, feed and malt barley, oat, spelt, emmer, triticale, winter wheat and winter triticale available have been evaluated for forage performance. Under irrigated conditions, barley harvested at the water to milk stage has 11.2 to 13.4% crude protein, and over 60% total digestible nutrients (Table 2). From these and other trials (data not shown), harvest prior to the soft dough stage is critical to maintain the crude protein levels. Yield and energy levels do not decline, however protein levels can drop 1 point per 2 to 3 days. Hay barley with these quality characteristics is an excellent roughage source for overwintering beef cattle. For silage, any high-yielding malt or feed variety would provide good quality. The fiber components of these hays are misleading, and our nutritionists are evaluating direct measurements of intake and digestibility. For example, the standard equation of 120/%NDF to estimate animal intake (as % of liveweight) underestimate actual intake of steers fed coarsely chopped barley, triticale or winter wheat hay by 35 to 52%.

A major drawback for cereal forages is the potential for accumulating toxic levels of nitrate. In Montana, we have noted high nitrate levels in cereals, corn, millet, most warm-season crops, fall alfalfa regrowth, pigweed, lambsquarters, kochia, wild oat, and other crops and weeds. For many plants grown under stressful conditions such as drought or frost, nitrate can be present at levels that can cause abortions and death in cattle and sheep. In Montana, a high forage nitrate level was a widespread problem during the drought of 1998-2001. Thousands of samples were analyzed for nitrate during this period. From lab records and Extension agent involvement we estimated that about

40% of the Montana cereal hay (worth $12 million annually) harvested had nitrate levels too high to feed to pregnant beef cattle (Cash et al. 2005).

Nitrate (NO_3) concentrations above 0.5% or 5000 ppm (or 0.11 = 1130 ppm nitrate-N [NO_3-N]) should not be fed to pregnant ruminants, and should be limited to half or less of the ration for other livestock (Cash et al. 2002). These nitrate tolerances that we have adopted for prepartum beef cattle in Montana are fairly conservative compared to other recommendations. These are based on the known feeding practices of the majority of cattle producers to extend fall and winter grazing on fairly low-quality dry grasses until heavy snowpack, followed by feeding hay. High and uncontrolled hay intake of high-nitrate hay by pregnant beef cows during the winter is a significant risk.

Significant differences in nitrate concentrations among cereal species and cultivars have been detected. Under irrigated conditions, six-row forage barley had significantly higher forage NO_3-N than the other varieties tested (Table 2). Based on recommended nitrate tolerances, only Haybet had a level that would have been considered as safe for this period.

Table 2. Forage yield, quality and nitrate levels of irrigated forage barley tested under irrigation near Bozeman, MT. Values are averages at the water to late milk grain stage (all harvested on the same day) for 2000-2002. Forage analyses were by wet-lab procedures.

Cultivar:	Baronesse	Lewis	Valier	Haybet	Hays	Bestford	Westford
Type:	Two-row feed	Two-row feed	Two-row feed	Two-row forage	Two-row forage	Six-row forage	Six-row forage
Plant Height (in.)	32.3d	33.0d	32.1d	34.4c	33.1d	40.9a	38.1b
Forage Yield (air dry tons/acre)	3.26abc	3.42a	3.28ab	3.36a	3.33ab	3.27abc	3.07bc
Forage % Crude Protein	12.0bc	11.2c	12.5ab	12.0bc	12.6ab	13.4a	12.9ab
Forage % Acid Detergent Fiber	31.4bc	32.2bc	31.7bc	30.5b	33.3cd	34.1de	35.4e
Forage % Neutral Detergent Fiber	58.9c	56.3a	57.0b	57.0b	60.5c	62.8d	64.4d
Forage % NO_3-N	0.162ab	0.120a	0.163ab	0.108a	0.173ab	0.281c	0.282c

Source: http://www.animalrangeextension.montana.edu/articles/forage/Annual/forage_yield.htm

Nitrate concentrations are typically high in crops or weeds during early vegetative growth, and usually diminish under normal maturation conditions. Under irrigated conditions, we have found that oat consistently has higher nitrate levels than other cereal forages (Fig. 2). Nitrate concentrations in cereals following a terminated alfalfa stand are risky, and many growers using oat have noted a significant nitrate problem. For these reasons, the MAES is recommending that oat not be used as a forage unless it is ensiled.

Several backgrounding trials have been conducted at Montana State University since 2000. In these trials, 600-pound steers are fed an *ad libidum* diet consisting of 25 pounds of chopped cereal hay, 4 to 8 pounds of rolled barley, and 1 pound of a concentrate containing minerals and Rumensin. Feed consumption, intake, digestibility, and liveweight gains are measured. By varying the forage source, we have documented average daily gains (ADG) ranging from 2.5 to 3.2 pounds per day over 60 days (unpublished data). Based on this animal performance, we are confident that cereal forages can provide a reliable maintenance diet for overwintering pregnant beef cattle.

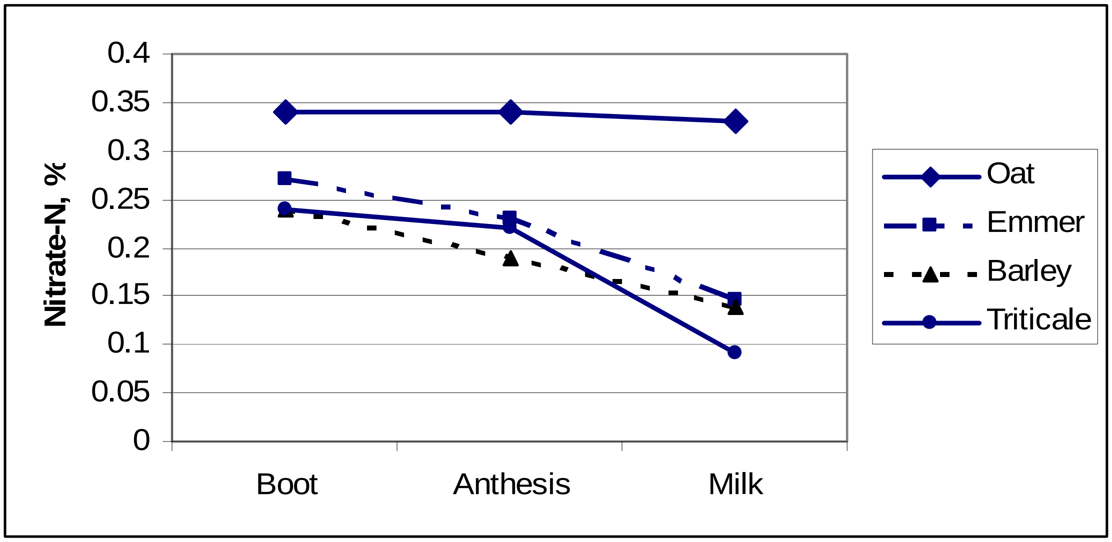

Fig. 2. Nitrate concentrations of spring cereal forages grown near Bozeman, MT under irrigation in 2002. Source: http://animalrangeextension.montana.edu/articles/forage/Annual/nitrate.htm

SUMMARY

Cereal forages play a key role for producers with integrated crop-livestock operations. Many annual crops can be harvested as emergency forage. During consecutive years of drought, we have documented that cereal forage yields were 72 to 533% higher than yields of existing alfalfa stands. Cereals are widely adapted and amenable for routine production during alfalfa crop rotation or used as a "rotation crop" in a grain production system. Winter cereals have a higher production capability than spring cereals, however producers would have to anticipate a forage deficit or drought in the preceding fall. In preliminary trials winter cereals tend to have slightly lower animal performance, and lower nitrate hazard than hay barley. Ongoing agronomic, feeding and grazing trials are underway to determine extended uses of cereal forages in Montana.

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