Nutritional Limits of Crested Wheatgrass for Range Livestock Production

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ABSTRACT: Crested wheatgrass has been remarkably successful in fulfilling its purpose of providing productive, nutritious livestock forage during the spring. Livestock production per are has been increased from 5- to 10- fold by establishing crested wheatgrass on degraded Intermountain area ranges. While forage quality is characteristically high during May and June, it declines rapidly as plants enter the flowering and seed stages of growth. By early July, it typically fails to meet nutritional requirements of lactating animals. This rapid decline can be delayed by droughty growing conditions that delay or prevent plants from reaching full maturity. Potential for better realizing the full forage value of crested wheatgrass include winter grazing in some areas and more intensive spring grazing in other areas.

INTRODUCTION

Crested wheatgrass (Agropyron cristatum and A. desertorum) has been planted on public and private rangelands of the western U.S. and Canada for the express purpose of providing productive, palatable, and nutritious forage for the livestock industry. It has been remarkably successful in fulfilling this need. Its main contribution in the Intermountian region has been in helping to alleviate the so-called spring forage "bottleneck" that generally exists on most ranches from late April (when winter hay supplies are normally exhausted) until early July (when abundant summer range forage is available). However, like most good things and ideas, crested wheatgrass is not without limitations. Thus, the purpose of this paper is to briefly review what is known about the productive potential of the species and to specifically discuss some of its limitations. This could lead to changes in management approaches where information is available but is not being applied, and can point to areas of ignorance where research should be directed.

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The underlying hypothesis of this paper is that there are ways to more efficiently utilize established crested wheatgrass stands. These avenues should be pursued completely and all possibilities exhausted, considering that the economic costs and environmental constraints of establishing new seedings (particularly on public lands) are now almost prohibitive.

LIVESTOCK PRODUCTION POTENTIAL

Based on a broad but not exhaustive review of published literature, cattle weight gains of about 2 lbs per head per day can be expected on crested wheatgrass range during May and June (Table 1). In terms of production per unit area of land, this translates to about 45 lbs of beef per acre (Table 1). These data are based largely on yearling animals (typically used for the sake of experimental simplicity), not on the growing, nursing calves that are of primary interest to most Intermountain-area ranchers. Close scrutiny of Table 1 indicates more variation around the mean per-acre value than around the mean per-head value. This probably reflects inherent differences in grazing capacities and stocking rates over the broad geographic range from which these data were compiled (central Oregon, Utah and central Colorado).

When animal production on crested wheatgrass range is compared to that of typical, unimproved native range, the margins are indeed impressive (Table 2). While results in terms of gains per head were mixed, production on a per-area basis was greatly improved in all cases by utilizing crested wheatgrass. The two studies from the Intermountain area (Lesperance et al. 1983 and Frischknecht 1978) showed 5- to 10-fold increases while one study from the Northern Great Plains in Canada (Smoliak and Slen 1974) revealed a smaller but nevertheless significant advantage to crested wheatgrass range (Table 2). The smaller improvement over native range noted by the Canadian researchers might be attributed to the rather unique features of their native shortgrass prairie vegetation. It is generally quite resistant to degradation from overgrazing, while the opposite is true of

Table 1.--Animal production on crested wheatgrass range grazed during spring.

	Stocking rate	Kind/class of animals	Animal production Per head	Per acre	Reference
	(acres/AUM)		(lbs)	(lbs)	
(1)	2.5	Yearlings	2.0	47	Sharp 1970
	2.4	Yearlings	1.9	50	
	2.1	Yearlings	1.8	51	
(2)	Variable (put & take)	Yearlings	1.7	59	Currie & Smith
(3)	2.2	Yearlings	2.6	37	Frischknecht & Harris (1968)
	1.8	Yearlings	2.6	43	
	1.5	Yearlings	2.3	39	
(4)	2.1	Calves	2.1	67	Jefferies et al. 1967
(5)		Calves:			
	---	Early spr.	2.3	--	Cook & Harris 1968
	---	Late spr.	1.6	--	
(6)	---	Yearlings	1.6	--	Wallace et al. 1963
(7)	4	Yearlings	1.5	22	Hedrick et al. 1963
		Average (yearlings only)	2.0	44	

bunchgrass vegetation in the Great Basin. Under a history of overgrazing, shortgrass prairie in southern Saskatchewan would probably maintain a relatively vigorous cover of native grass and a reasonably good grazing capacity for cattle. In contrast, overgrazing in Nevada and Utah where the Lesperance et al. and Frischknecht studies were done has typically led to replacement of native bunchgrasses by shrubs of low palatability e.g. sagebrush (Artemisia spp.), rabbitbrush (Chrysothamnus spp.), broom snakeweed (Xanthocephalum sarothrae). Hence, grazing capacity for cattle has been severely reduced. Conversion of these ranges back to a productive grass stand, i.e. crested wheatgrass, generates a phenomenal improvement in grazing capacity and, in turn, an increase in livestock production on a per-area basis.

While these data are few, they are consistent with conventional wisdom among livestock producers using Intermountain area rangelands. There should be little wonder as to why ranchers are ardent supporters of converting native sagebrush ranges to crested wheatgrass seedings.

FORAGE QUALITY LIMITATIONS

A highly desirable trait of crested wheatgrass is its ability to supply nutritious forage early in the spring, often several weeks before its native counterparts. From the standpoint of efficient livestock production, this is a critical period in the annual management cycle. Cows giving birth in March are at the peak of their lactation period at this time, and nutrient demands are high if the calf is to receive the quantity of milk necessary for rapid growth. Additionally, an elevated plane of nutrition during this period is highly desirable in order to ensure that the female is cycling normally with respect to estrus so that she is physiologically prepared for re-breeding in June or July.

Nutritional values of crested wheatgrass are often exceptionally high during April and May, but decline rapidly thereafter. Figures 1 and 2 illustrate the decline of crude protein content (CP) and in vitro digestibility coefficients (IVD). The latter is considered a good indicator of digestible organic matter (DOM) content of grass forages (Tilley and Terry 1963) and DOM is, in turn, closely related to the digestibile energy content of forages (Rittenhouse et al. 1971).

Crude protein

Crude protein values (Figure 1) are presented from a variety of geographic locations, and dry years are compared to normal years for two locations. First, note the steep and predictable decline from over 20% CP in March and April to less than 5% in September. A similar relationship, using other data, is demonstrated by Mayland (1985), in another paper in this symposium. By early July, CP content of crested wheatgrass has typically fallen below the recommended allowances (National Academy of Science 1976) for both cows and ewes nursing young. This is supported by animal performance data from central Utah (Cook and Harris 1968), showing that lactating cows grazing crested wheatgrass lost weight after June 29. However, young nursing animals, buffered by milk supplied by their dams, continued to gain although at reduced rates. During early May, calves and lambs gained 2.3 and 0.56 lbs

Table 2.--Cattle production on crested wheatgrass as compared to native ranges.

Grazing period	Gain per head Native	Wheatgrass	Prod. per acre Native	Wheatgrass	Reference
	lbs/da.		lbs		
(1) May 12 June 9	1.6	3.3	4	33	Lesperance et al. 1983
June 9 June 30	1.8	2.1	4	21	
(2) Apr-June	1.5	3.0	3.6[a]	36[a]	Frischknecht 1978
(3) May-Oct	2.0[a]	1.8[a]	16	25	Smoliak & Slen 1974

[a]Values calculated from initial data

per head per day, while in late June these rates had declined to 1.6 and 0.39 lbs per head, respectively.

Data points depicted by 4's and 7's (Fig. 1) illustrate how current growing conditions can radically alter the typical seasonal decay pattern of CP levels. These data points are from analyses conducted during years of sub-normal rainfall when crested wheatgrass was forced into drought-induced dormancy before entering the reproductive stage. In effect, the forage was "cured" in its highly-nutritious immature stage and it maintained this high level of CP well into late summer. Sneva (1967) demonstrated a similar effect by artificially "curing" crested wheatgrass by application of the herbicide paraquat. Of course, there is a trade-off of high quality forage for reduced quantities of forage biomass under such circumstances.

Digestibility

Not as many researchers have reported data on digestibility as CP content. However, from the information available, a curve was constructed showing a steep decline over time for in vitro digestion coefficients (Figure 2). A drought-related effect similar to that for CP is apparent here also (compare data points represented by 7's and 8's).

Digestibility is an especially important measure of forage quality because it plays a dual role in ruminant nutrition. The digestibility of a forage determines the proportion of nutrients liberated in the gastro-intestinal tract for assimilation by the animal. It also plays a major controlling role in the amount of forage dry matter (hence, energy) an animal can consume per unit of time. As a general rule, when dry matter digestibility of forage declines below about 50%, restrictions in intake rate can be expected due to longer residence time of material in the rumen and a slower rate of passage through the digestive tract. This digestibility level corresponds roughly to forage digestible energy (DE) content of about 2.5 kcal per gram of forage. From data shown in Table 3, crested wheatgrass has declined to this level of DE by the time flowering occurs. Thus, the relatively poor animal performance generally observed once seedheads appear is related both to its reduced level of CP and, perhaps more importantly, to its reduced contribution to the animal's energy needs. Havstad et al. (1983) reported that heifers grazing crested wheatgrass from late June to late August were virtually unaffected by the amount of forage available (from 920 down to 140 kg/ha), because they could consume only about 1.2% of their body weight in forage dry matter due to quality limitations. In contrast, Handl and Rittenhouse (1972) found that cattle were affected during early spring by the quantity of forage on-offer, and daily intake ranged from 1.9 to 2.1% of body weight.

In central Utah, flowering in crested wheatgrass typically occurs from early to mid-June. Thus, the plant may be generally characterized as extremely nutritious and productive during vegetative stages of growth, but marginally adequate to inadequate soon after flowering.

PALATABILITY

Crested wheatgrass is generally a palatable species. However, it typically occurs as monospecific stands or as the dominant species in relatively simple mixed stands with sagebrush, rabbitbrush, and cheatgrass (Bromus tectorum). Thus palatability often does not play the same role in grazing management of crested wheatgrass as it might in more complex mixed stands where several palatable species are usually represented.

On the basis of a single study, there are indications that crested wheatgrass may not be as palatable as generally believed. Gesshe and Walton (1980) reported that cattle showed the lowest relative preference for crested wheatgrass of four species tested. Results of their study are shown in Table 4. After flowering, both crested wheagrass and intermediate wheatgrass (A. intermedium) were distinctly lower in relative preference than either alfalfa (Medicago sativa) or Russian wildrye (Elymus junceus). The latter tends to retain green leaves well after flowering while those of crested wheatgrass soon senesce and become dormant.

POSSIBILITIES FOR IMPROVED MANAGEMENT AND CORRESPONDING RESEARCH NEEDS

Readdressing the original assumption of this paper that better ways of utilizing established seedings are available, one potential is winter grazing. Considering the prevailing high cost of wintering beef cows on either purchased or home-grown hay, the incentive for finding alternative,

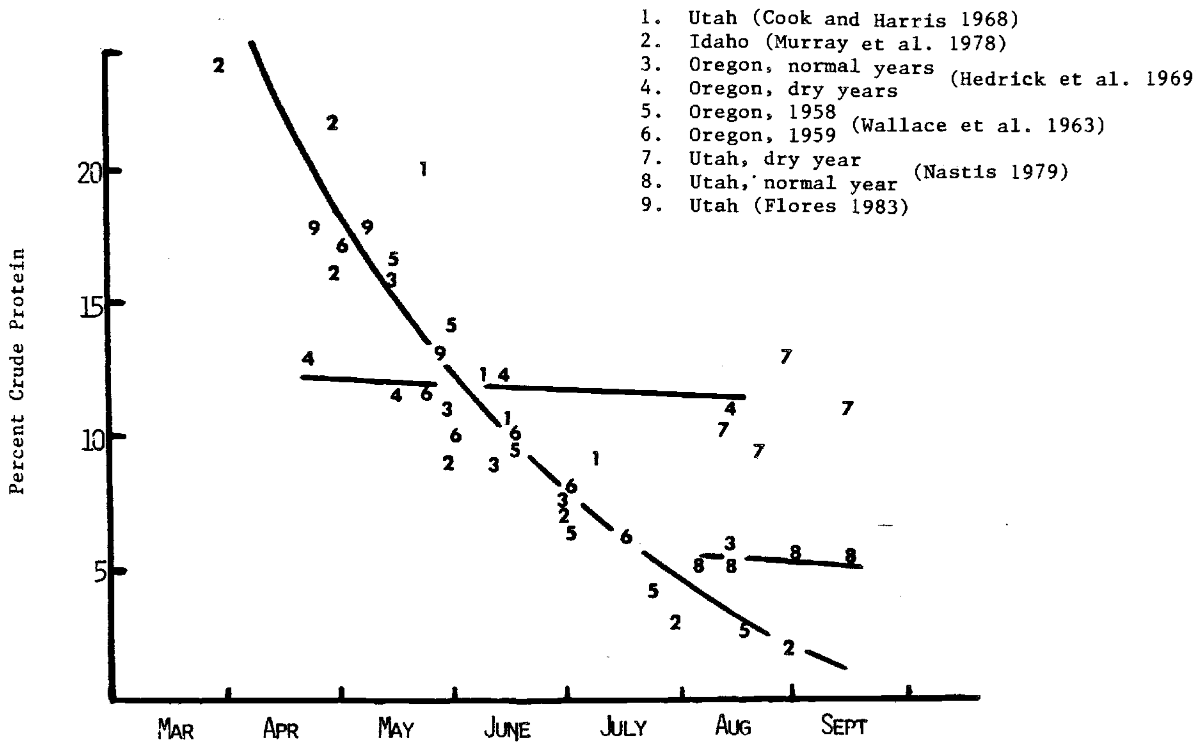

Figure 1.--Seasonal trends in crude protein content of crested wheatgrass, Great Basin area locations.

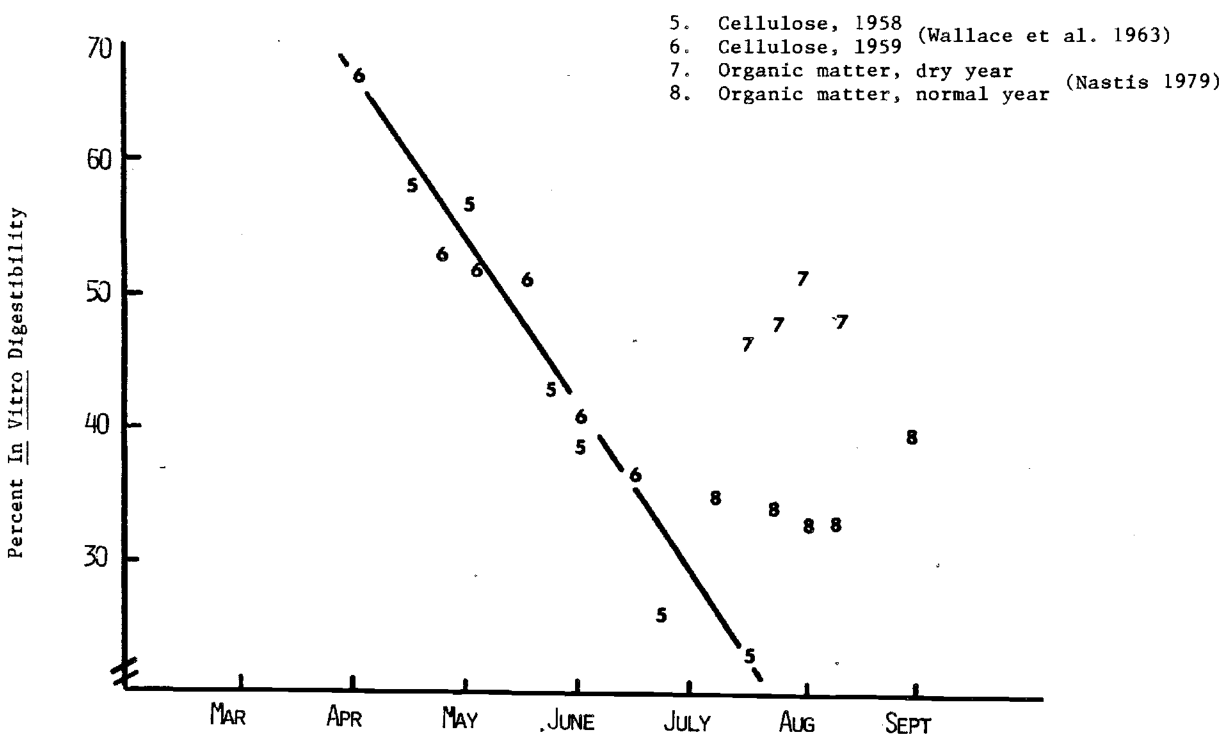

Figure 2.--Seasonal trends in *in vitro* digestibility of crested wheatgrass, Great Basin area locations.

Table 3.--Digestibile energy content of crested wheatgrass at four stages of maturity (Cook and Harris 1968).

Date	Stage	DE
		(kcal·gm^{-1})
5/9	5th leaf	3.5
6/8	early head	2.2
6/16	anthesis	2.2
7/7	hard seed	1.8

cheaper forage is high. Although research information on this question is extremely scarce, limited practical experience as well as preliminary research suggests some possibilities. Rancher J. C. Smith of Snowville, in northwestern Utah, has successfully wintered cows on range supporting a mixture of crested wheatgrass and native bluebunch wheatgrass (A. spicatum) for some 17 years. Hay feeding has been necessary only in three winters when deeper-than-normal snow prevented access to the standing grass foliage. Smith typically weans a 93% calf crop of calves weighing between 450 and 500 lbs per head based on a year-round grazing program (Utah State Extension Service 1982).

In a nearby area, animal weight response was measured during a single winter for a 900-cow herd grazing crested wheatgrass range from mid-November to late January (Malechek and Smith 1976). The range was stocked at the rate of 5 acres per animal unit per month. These cows sustained an average daily weight loss of about 0.3 lbs. per head, or about 2.5% of their initial weight during the 65-day period. Considering that mature cows in good condition can lose up to 20% of their body weight over winter without measurable losses of productivity (Corah 1980), the bodyweight losses observed in this study were small. Also, these losses were under conditions of no supplemental feeding.

Winter grazing on crested wheatgrass presents several questions needing research. Further documentation of cow herd performance (body weight change, calf crop, cow longevity) is needed under a variety of conditions. The influence of supplements, particularly protein, needs clarification particularly under variable weather and snow conditions. Cow behavior and feed requirements in response to different snow conditions needs to be determined so standards can be established for provision of feed during adverse weather conditions. Above all, the economics of winter grazing needs to be better understood.

Another possibility for improved use of seeded crested wheatgrass stands is earlier use in spring. Economic studies show that major returns per dollar invested can be achieved by getting cows on the range earlier in the spring. Traditionally, range managers have been reluctant to push the date of range entry too early for fear of compromising the principle of range readiness. While this principle was developed for native rangeland, it has been extended to seeded range in many situations. Thus, major economic gains may be passing unrealized by this conservative approach to grazing management.

From the standpoint of plant welfare, this concern may not be justified. Sharp's (1970) long-term studies at Point Springs in southern Idaho indicated that early grazing was more detrimental to animal production (presumably because of insufficient forage) than to plant production and plant vigor. However, specific amounts of standing spring forage necessary to meet animal demand were not established in the study and are still largely unknown, although Handl and Rittenhouse (1972) indicated that intake limitations were likely when available forage fell below 176 kg/ha.

Another aspect of Sharp's (1970) study relating to early grazing use was that too light grazing led to production of coarse, stemmy plants ("wolf plants") while heavy continuous grazing in the spring led to plant fragmentation and a reduction in stand density. These findings suggest that some form of rotational grazing at reasonably heavy stocking rates may be desirable for early spring management of crested wheatgrass stands. However, as Sharp (1970) cautioned, neither rigid rotation schemes nor general utilization guidelines are sufficient for gaining the most effective use of the species. Rather, attention should be given to specific characteristics of annual plant growth and environmental limitations in view of animal nutritional requirements and management goals. The particular characteristics and tolerances of crested wheatgrass give the appearance that the species might be well suited to management under the so-called short-duration grazing management schema where great flexibility in livestock management is possible and practical.

Crested wheatgrass is the kind of grass species that seems admirably suited to much greater intensity of grazing management than it has received. However, for this to be realized, a number of questions must first be answered. These include both animal- and plant-related aspects, such as the quantity of standing biomass of early spring forage necessary to meet animal requirements; effects of dead carry-over plant material on animal forage selection and subsequent plant growth; proper timing of grazing to stimulate daughter tiller production; how early grazing and trampling affects soil surface properties and site water budgets; and how various combinations of rest and graze periods affect carrying capacity and long-term site productivity. This list is, by no means, comprehensive but highlights some of the important issues.

Meanwhile, until the new research is done, range managers should accept the challenge of performing better management on crested wheatgrass stands than

Table 4.--Relative preference by cattle for crested wheatgrass and other forage species at three stages of maturity (Gesshe and Walton 1980).

Forage Species	Vegetative	Flowering	Seedset
Crested wheatgrass	0.8	0.2	0
Intermediate wheatgrass	1.2	0.2	0
Russian wildrye	1.2	1.9	1.7
Alfalfa	1.3	1.5	1.3

is currently being done. For a species with such great biological potential and the key economic need it can serve, a stronger attempt to apply state-of-the-art management is certainly warranted. Application of practical guidelines such as those presented by Sharp (1970) can yield major returns next year.

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