MANAGEMENT AND SUPPLEMENTATION STRATEGIES FOR STOCKER CATTLE GRAZING WINTER WHEAT PASTURE[1]

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INTRODUCTION

Winter wheat pasture is a very unique and economically important renewable resource in Oklahoma and the southern Great Plains. Income is derived from both grain and the increased value that is added, as weight gain, to growing cattle that are grazed on wheat pasture. The potential for profit from grazing stocker cattle on wheat pasture is exceptionally good because of the high quality of the forage and the very favorable seasonality of prices for stocker and feeder cattle that favor price appreciation of the cattle.

Supplementation of cattle grazing wheat pasture is of interest in order to (a) provide a more balanced nutrient supply and feed additives such as ionophores and bloat preventive compounds, (b) substitute supplement for forage where it is desirable to increase stocking rate in relation to grazing management and(or) marketing decisions, and (c) substitute supplement for forage under conditions of low forage standing crops. It is said that "risk" decreases the value of cattle. Predicting performance of wheat pasture stocker cattle is particularly challenging because of the potentially large variation in weather and forage standing crop. If weight gains of growing cattle cannot be predicted with some degree of accuracy, realistic breakevens, which are prerequisite to sound marketing decisions, cannot be calculated. The ability to predict cattle performance will become more important as the feedlot and stocker segments of the industry compete for supplies of stocker/feeder cattle, and as coordinated beef productions systems come to fruition. Results of some of the supplementation studies that we have conducted over several years at OSU are reported herein.

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FEEDING LOW-QUALITY ROUGHAGES

Low-quality roughages such as wheat straw are often fed free choice to stocker cattle on wheat pasture. The most common reasons cited by producers for feeding low-quality roughages on wheat pasture include the following: (1) to provide a means of slowing rate of passage and thereby increase the utilization of "washy" wheat forage, and (2) to reduce the incidence of bloat. A very important question relative to feeding low-quality roughages to wheat pasture stockers is what effect they may have on wheat forage intake and stocker weight gains. Intakes of 2 to 3 lb of straw dry matter per day, if substituted for wheat forage, decrease calculated weight gains of stockers by as much as .46 lb/day (2.11 **vs** 1.65) as shown in Table 1. These gains were estimated by calculating the effect of substituting wheat straw for wheat forage, taking into account the much lower energy density of wheat straw.

Table 1. Effect of straw consumption on calculated[a] daily weight gains of wheat pasture stockers

Item	All wheat forage	Wheat forage + 2 lb straw	Wheat forage + 3 lb straw
Daily gain, lb	2.11	1.80	1.65
Change from "all wheat forage", lb/day	----	-0.31	-0.46

[a]Calculated for a 440 lb steer with a total dry matter intake (wheat forage alone or wheat forage plus straw) of 3 percent of body weight.

A 3-year study was conducted in which fall-weaned steer calves (378 lb mean initial weight) grazed clean-tilled wheat pasture (November 23 to March 24; plus or minus 3 to 7 days) were fed no supplemental feed or (2) had free-choice access to wheat straw (WS) or sorghum-sudan hay (SS). Results reported by Mader et al. (1983) and Mader and Horn (1986) were as follows:

1. Daily consumption of low-quality roughage was low and ranged from:

Wheat straw:	.15 to .4 lb/head/day
Sorghum-sudan hay:	.35 to .9 lb/head/day

2. Live and carcass weight gains of steers were not affected by offering low-quality roughage.

3. Feeding steers two times the amounts of low quality roughage as listed in number 1 above did not affect intake of wheat forage or digestibility and rate of passage of wheat forage.

4. Bloat was observed only during the last 2 weeks of the period of lush spring growth of wheat forage of the first year. The incidence and severity of bloat

of control, wheat straw and sorghum-sudan fed steers were not different among treatments. Intake of wheat straw and sorghum-sudan hay was only about 5 and 12% of roughage intakes reported in the literature to "effectively control" or aid the prevention of bloat. Therefore, it seems unlikely that low-quality roughage consumed in amounts similar to those of this study will control bloat of stocker cattle on wheat pasture.

We have not, therefore, seen any real positive or negative responses to feeding low-quality roughage to stocker cattle on wheat pasture. It appears to be a practice of little consequence. However, if cattle on wheat pasture do not have a dry place to lie down, availability of low-quality roughages may improve performance by providing bedding and aiding maintenance of body temperature during cold weather.

PROTEIN SUPPLEMENTATION

This section is included to briefly summarize some of the rationale and results of research conducted at Oklahoma State University (OSU) relative to the idea of providing undegradable intake protein to growing cattle on wheat pasture, and not as a through review of this subject. The National Wheat Pasture Symposium was held at OSU in the fall of 1983 to summarize the database relative to production and utilization of wheat pasture by cattle. Beever (1984) presented data that was interpreted to suggest that performance of rapidly growing cattle on wheat pasture may be limited by flow of inadequate amounts of non-ammonia N (NAN) to the small intestine. Johnson et al. (1974) reported CP values of wheat forage of 25 to 31% of DM during January to April with 17 to 33% of the nitrogen (N) being in the form of non-protein nitrogen (NPN). Horn et al. (1977) observed total soluble N and soluble NPN concentrations of wheat forage of 45 to 62 and 25 to 37% of total N, respectively. Beever et al. (1976), in studying different conservation methods for perennial ryegrass, observed a significant negative relationship (r = -.98, P<.001) between the amount of N flowing to the small intestine (grams per 100 g N consumed) and solubility of forage N in .01% pepsin in .1N HCl. Egan (1974), Ulyatt and Egan (1979) and Egan and Ulyatt (1980) reported large losses (i.e., 40 to 45%) of ingested N from the rumen of sheep fed high-protein ryegrass. Studies by Vogel et al. (1989a) showed that N of immature and mature wheat forage exist kinetically as two distinct pools with different rates of in situ ruminal disappearance. Approximately 50 to 75% of total forage N disappeared from a "very rapid disappearance" pool at rates of 16 to 19% per hour. Broderick (1984) also suggested the presence of two "degradation fractions" of N of alfalfa hay. MacRae and Ulyatt (1974) reported that 63% of the variation in live weight gain of sheep grazing ryegrass or white clover pasture was associated with the amount of NAN absorbed from the small intestine, and that there was no relationship between live weight gain and energy absorbed as volatile fatty acids (i.e., a measure of the "energy status" of the animals). These data indicated that the **traditional concept** that performance of growing cattle on wheat pasture is not limited by protein status should be reevaluated.

Studies were conducted at OSU over four wheat pasture years to determine the effect of feeding additional escape protein on weight gains of stocker cattle grazing wheat pasture. Details of the studies have been reported by Vogel et al. (1989b) and Smith et al. (1989). Cattle received no supplement (other than free-choice access to a commercial mineral mixture) or were fed daily 2 lb of a corn-based energy supplement or supplements that provided about .25 kg of protein from high-escape protein as cottonseed meal produced by mechanical extraction, meat meal, meat and bone meal or corn gluten meal. The .25 kg of protein from high-escape protein is very similar to the levels used by Anderson et al. (1988) in which supplemental escape protein increased gains of steers grazing smooth brome pastures. The supplements were isocaloric and contained similar amounts of calcium, phosphorus and magnesium. Monensin was included in the supplements to supply 130 to 150 mg/head/day.

Daily gains of the cattle were increased .22 lb ($P<.03$) by the overall effect of supplementation. Provision of additional ruminal escape protein as cottonseed meal, meat meal, meat and bone meal, or corn gluten meal did not increase gains ($P>.30$) as compared with the corn-based energy supplement. Our conclusion has been that even though wheat forage contains large amounts of N that is rapidly degraded in the rumen, intakes of fermentable OM appear to provide energy for sufficient microbial protein synthesis in the rumen for growth of stocker cattle. In a later study reported by Phillips et al. (1995), nitrogen retention of lambs fed freshly harvested wheat forage in metabolism stalls was not improved by supplemental undegradable intake protein from cottonseed meal, feather meal plus corn gluten meal, or blood meal as compared with a corn-based energy supplement.

Interestingly, the Level 1 Model of the 1996 Beef Cattle NRC, with the default microbial efficiency of 13%, predicts a negative metabolizable protein balance of 47 grams/day for a 450-lb growing steer on wheat pasture with an "ME allowed ADG" of 2.11 lb. Clearly, additional data relative to the partitioning of forage protein into degradable and undegradable intake fractions, microbial efficiency, etc. are needed to resolve the fundamental relationships underlying this question.

ENERGY SUPPLEMENTATION

Feeding **moderate amounts** of an energy supplement to growing cattle on wheat pasture is a way of increasing the stability of the enterprise, improving the predictability of cattle performance (i.e., decreasing production risk), and increasing stocking rate and flexibility by having more cattle on hand for grazing during the graze-out period. Because of the seasonality of stocker/feeder cattle prices and the dynamics of breakeven selling prices in stocker cattle budgets, the latter of these can be particularly important to the economics of growing cattle on wheat pasture.

Silage

There are areas of the southern Great Plains where silage is used very successfully to "stretch" available wheat forage and(or) allow initial stocking densities on wheat pasture to be increased. In studies reported by Vogel et al. (1987 and 1989c), use of supplemental silage allowed stocking rate on wheat pasture to be doubled without decreasing weight gains of stocker cattle. Supplemental silage decreased wheat forage intake linearly ($P<.10$). Each pound of added silage DM decreased DM intake of wheat forage by .66 lb. Extent of ruminal digestion of DM and NDF of wheat forage was increased by feeding silage indicating that silage had a positive associative effect on utilization of wheat forage (Vogel et al., 1989c).

High-Starch *versus* High-Fiber By-Product Feed Based Supplements

The response of growing cattle on wheat and(or) other small grain pastures to supplemental grain has been variable. In studies reported by Elder (1967), Lowrey et al. (1976a, b), Utley and McCormick (1975, 1976), and Gulbransen (1976), steer grazing days/ hectare or stocking densities were increased 1.25- to 2-fold and daily gains were increased by .05 to .30 kg by feeding grain at levels of 1 to 1.5% of BW. Supplement conversions (kilograms of supplement/kilogram of increased gain/hectare) ranged from 6.7 to 10.3. To prevent adverse effects of starch on ruminal fermentation, high-fiber byproduct feeds, such as wheat middlings, soybean hulls, and corn gluten feed, offer alternatives in formulating energy supplements with fairly high energy densities. The potential for using these byproduct feeds in supplementing growing cattle on wheat pasture is particularly good because of the rapid rate of ruminal degradation of wheat forage (Zorrilla-Rios et al., 1985) and the relatively low ruminal pH (Andersen and Horn, 1987).

During the three wheat pasture years of 1989/90, 1990/91 and 1991/92, we conducted studies to evaluate **type of energy supplement** (i.e., a corn-based, high-starch versus a high-fiber by-product feed based energy supplement) for growing cattle on wheat pasture. The high-fiber energy supplement contained about 47% soybean hulls and 42% wheat middlings (as-fed basis) and potentially may have less negative effects on forage intake and utilization than the high-starch supplement. The supplements were hand-fed 6 days/week at a level of about .75% of body weight (i.e., 4 lb/day for a 533 lb steer) and stocking rate was increased 22 to 44%. Non-supplemented, control cattle had free-choice access to a high-calcium commercial mineral mixture throughout the study. The objective of this supplementation program with respect to increasing stocking rate was much different from that of Grigsby et al. (1991), Rouquette et al. (1990), and Branine and Galyean (1990), who fed energy supplements at levels of .15 to .20% of BW to cattle grazing rye-ryegrass or wheat pastures without increasing stocking rate. Conversions of a corn-based energy supplement of 1.3 to 3 lb/lb of increased gain/animal were reported by Grigsby et al. (1991). Details of our studies have been reported by Horn et al. (1991), Cravey et al. (1993), and Horn et al. (1995). In general, results were as follows:

Supplementation Response. Over the 3-year period, weight gains during the fall/winter and early spring grazing period (i.e., up to time of jointing of wheat) were increased by energy supplementation (regardless of **type** of energy supplement) by an average of .33 lb/day, and were 2.02, 2.33, and 2.38 lb/day for the control, high-starch, and high-fiber supplemented steers, respectively. The gain response was similar at all stocking densities which increases the scope of application of the results. Mean consumption of the supplements was **.65%** of body weight which was less than the target of .75%.

Type of Energy Supplement. Type of energy supplement (i.e., high-starch **vs** high-fiber) did not affect weight gains of the cattle. In general, one would expect the difference in response by cattle to high-fiber versus high-starch energy supplements to decrease as the amount of supplement fed decreases and as crude protein content of the forage increases. The level of supplement fed in these studies was relatively small and wheat forage contains excess crude protein. Substitution of the supplements (i.e., units change in forage OM intake per unit increase in supplement OM intake) was calculated by regression of forage intake on amounts of supplement consumed. Substitution did not differ ($P > .60$) for the two types of supplements and was -.91 (Cravey, 1993). The mechanism for substitution of the supplements for forage has not been identified, but would not be expected to be the result of a ruminal nitrogen deficiency as has often been the case in grazing studies as discussed by Horn and McCollum (1987).

Supplement Conversion. Mean conversion of the supplements (expressed as lb of as-fed supplement per lb of increased gain per acre) was about **5.0** for both types of supplement, and did not differ (P>.95). This is substantially less than conversions of 9 to 10 that have **traditionally been used** in evaluating the economics of energy supplementation programs for wheat pasture stocker cattle.

Cattle Preference for Supplements. Cattle seemed to like the high-fiber supplement and consume it much more readily than the corn-based high-starch supplement. Generally, the cattle consumed the high-fiber supplement in a matter of 10-30 minutes in the morning; whereas, the corn-based supplement was eaten over at least 2 feeding periods during the day (morning and mid-afternoon). From a feed and bunk management standpoint, this difference in the supplements is extremely important on days of inclimate weather (i.e., rain, snow etc.) and in situations of bird predation where contamination of feed bunks by bird excreta was substantial for the corn-based supplement. In addition, the potential for acidosis is much less for the high-fiber supplement provided that the wheat middlings used in the high-fiber supplement don't contain a lot of fine starch.

Risk Aversion. We addressed the issue of risk aversion and input decisions relative to energy supplementation of stocker cattle under various cattle and supplement price scenarios (Coulibaly et al., 1996), and concluded that, in general, supplementation decreases production risk.

Feedlot Performance. Because wheat pasture cattle are some of the more fleshy cattle that are placed on feed, we were interested in the potential effect of energy supplementation on subsequent feedlot performance and were able to "follow the cattle through the feedlot" in two of the three years. Supplementation did not affect feed intake or feed:gain (P>.30) in one year whereas daily gain was decreased by about 0.20 lb (P<.05). In another year, supplementation did not (P>.80) affect feedlot daily gain.

Economic Analysis (a.k.a.: Will it Pay?)

There are several levels of economic analyses that can be used in evaluating the economics of supplementation programs and other management decisions in stocker cattle programs. Three of them are briefly discussed below.

Comparison to Value of Weight Gain

Steers, 1988 -1997	Price ($/cwt) = 150.11 - .1579x + .00008x^2
Steers, 1992 - 1997	Price ($/cwt) = 132.03 - .1286x + .00007x^2
Heifers, 1988 - 1997	Price ($/cwt) = 120.78 - .1166x + .00007x^2
Heifers, 1992 - 1997	Price ($/cwt) = 104.65 - .0902x + .00006x^2

If one then adjusts the prices for seasonality, value of weight gain for purchasing calves in October and selling feeders in March are shown in Table 2. The value of weight gain for growing steers on wheat pasture from 450 to 650 lb <u>or</u> from 450 to 750 lb ranged from about $54 to $61/cwt. Values for adding 200 lb to 350- or 450-weight heifers are substantially higher.

Table 2. Value of weight gain, $/cwt.

	1988 - 1997 (10 years)		1992 - 1997 (5 years)	
Wt. Range, lb	Steers	Heifers	Steers	Heifers
350 - 550	-----	$73.01	-----	$70.67
450 - 650	$60.61	$66.27	$60.72	$64.38
450 - 750	$54.77	-----	$53.45	-----

If the cost of the additional weight gain from supplementation is less than the value of weight gain, supplementation would be profitable. At a supplement conversion of **5 lb supplement per lb of increased gain per acre** and a feed cost of $140/ton, supplement cost per lb of increased gain would be $0.35. REMEMBER this is valid only if stocking rate is increased since supplement conversion is expressed on an increased gain per acre basis. Also, any additional costs incurred in feeding the supplement (e.g., fuel, labor, etc.) should be included in the evaluation.

Budgeting the Stocker Operation

Microcomputer spreadsheet programs such as the "OSU STOCKER PLANNER" developed by Don Gill are excellent tools for evaluating a myriad of questions, management decisions, etc. in a stocker cattle program. Copies can be downloaded from our web site (http://www.ansi.okstate.edu/). Pasture can be priced on (1) a cost of gain basis or (2) as $/CWT of cattle/month. In addition the pasture cost input can be "finessed" to achieve any pasture cost ($/head) that you want.

Whole-Farm Economic Analysis

As stated earlier, feeding moderate amounts of an energy supplement to growing cattle on wheat pasture has the potential advantage of allowing stocking rate to be increased by about one-third. This allows more cattle to be purchased in the fall on seasonally low markets and to be available to graze-out a greater proportion of wheat in the spring. In a previous report (Horn et al., 1992), whole-farm net returns were estimated for three government farm program alternatives for the 1990/91 wheat pasture year (non-participation, the 5-month option and 0/92) and three cattle price scenarios that reflected stocker/feeder price spreads in real dollars of -$22.00 (low profitability), -$16.00 (moderate profitability) and -$7.00 (high profitability). The energy supplementation program (and increased stocking rate) increased exposure to down-side price risk and resulted in lower whole-farm net returns under the low cattle price scenario. On the other hand, the energy supplementation program captured the benefits of favorable cattle price movements, and increased whole-farm net returns under the moderate and high price scenarios.

THRESHOLD HERBAGE ALLOWANCE FOR INITIATION OF ENERGY SUPPLEMENTATION PROGRAMS

Two studies were conducted (Redmon et al., 1995) to determine the relationship between in vitro organic matter (OM) disappearance in diets of cattle grazing wheat pasture and herbage allowance, the relationship between wheat forage intake (kg OM/100 kg BW) and herbage allowance, and the relationship between estimated daily gain of growing beef cattle grazing wheat pasture and herbage allowance. Paddocks were differentially grazed with growing beef cattle to produce an array of different herbage mass levels, expressed as kg dry matter (DM)/hectare. Each experimental paddock was then continuously stocked with three steers during each 7-day forage intake trial. Estimated daily gain was calculated from forage intake and net energy values calculated from diet organic matter disappearance data. Forage intake, organic matter disappearance, and estimated daily gain were related to daily herbage allowance, expressed as kg DM/100 kg BW/ day, and herbage mass utilizing a quadratic equation with a plateau function. Plateaus for diet OM disappearance, forage intake, and daily gain were achieved at herbage allowance between 20 to 24 kg DM/ 100 kg BW/ day, and decreased markedly at herbage allowances below this range. These data were interpreted as suggesting that a herbage allowance of 20 to 24 kg DM/ 100 kg BW/ day may provide a threshold allowance for initiation of energy supplementation programs for growing cattle on wheat pasture. Similarly, Ellis et al. (1984) reported that DM digestibility by steers grazing annual ryegrass was progressively decreased (P<.01) as herbage allowance was reduced to less than 30 kg/100 kg BW.

IONOPHORES FOR WHEAT PASTURE STOCKER CATTLE AND DEVELOPMENT OF A SMALL-PACKAGE MONENSIN-CONTAINING ENERGY SUPPLEMENT

Two ionophores, monensin and lasalocid, are available for wheat pasture stocker cattle. Both of them, if delivered in the proper dosage, increase weight gains of growing cattle on wheat pasture by .18 to .24 lb/day over that of the carrier supplement (Horn et al., 1981 and Andersen and Horn, 1987), and improve the economics of supplementation programs. In addition, producer experience and research (Branine and Galyean, 1990) indicate that monensin decreases the incidence and severity of bloat from wheat pasture. Other characteristics of the two ionophores are listed below. The "+" **sign** indicates a more favorable or greater response of one over the other.

	Monensin	Lasalocid
Weight Gain Response	Equal if achieve proper dosage of ionophore	
Bloat protection	+	
Palatability		+
Potential for toxicity	+	
FDA clearance for every-other-day feeding	+	

If the ionophore is included in a mineral mixture with a relatively low target intake (i.e., .25 to 1 lb/head/day) it has to be present at a greater concentration in order to supply the daily dosage of 150 to 200 mg/head than if it is included in a larger amount of some other feed or supplement. Therefore, the palatability advantage of lasalocid favors its use over monensin in mineral mixtures. In a preliminary study that we conducted many years ago (Horn and Phillips, 1985) consumption of a cottonseed meal- and wheat middling-based mineral mix, which contained either monensin or lasalocid, by stocker cattle on wheat pasture was .28 and .53 lb/head/day for the monensin and lasalocid-containing supplements, respectively. The supplements contained 400 mg ionophore/lb and the target daily intake was .50 lb/head.

During the **1991/92** wheat pasture year we measured voluntary intake of three different commercial mineral mixtures by cattle at the Marshall Wheat Pasture Research Unit. Pastures ranged from 18 to 42 acres and small numbers of cattle, as compared with the industry, grazed each pasture. The mineral mixtures were fed in a single weather vane-type mineral feeder in each pasture. No salt or other supplement was fed during the trial. Water from a rural water system was supplied in each pasture by a single water fountain. Intake of the different mineral mixtures is shown in Table 3.

Table 3. Intake of different mineral mixtures (1991/92 wheat pasture year).

Mineral	Wheat Gainer Mineral[a]	Wheat Pasture Pro Mineral B1440[b]	Purina Wheat Pasture Mineral RM[c]
Manufacturer:	Farmland	Farmland	Purina Mills
Ionophore Concentration:	None	720 mg lasalocid/lb	150 mg monensin/lb
Target intake, lb/head/day	0.25	0.25	1.0
Mean (± SD) intake, Lb/hd/day	.30 ± .09	.23 ± .06	.14 ± .04 (Mix 1) .34 ± .11 (Mix 2)
Number of pastures	2	6	1
Head/pasture	12	5 to 7	22 to 26

[a]**Presently named "Wheat Pasture Pro Mineral".** Contained 20% salt, 16% calcium, 4% phosphorus, 5.5% magnesium and 150,000 I.U. Vitamin A per pound. Eleven observations at 6-day intervals per pasture mean.

[b]Contained same mineral and vitamin concentrations as footnote "a" above. Eleven observations at 6-day intervals per pasture mean.

[c]Contained 20% salt, 7% calcium, 6.75 magnesium and 30,000 I.U. Vitamin A per pound. Ten and eight observations at 6- and 5-day intervals for mix 1 and 2, respectively.

Intake of the Wheat Gainer Mineral was excellent and averaged .30 lb/head/day. This level of intake would provide 21 grams of calcium, and is consistent with the type of mineral needed to supply additional amounts of calcium to growing cattle on wheat pasture. Intake of the lasalocid-containing mineral was also good and would have supplied 166 mg of lasalocid. In previous research (Andersen and Horn, 1987), we observed a weight gain response by wheat pasture stockers to 200 mg/day of lasalocid but NOT to 100 mg/day of lasalocid. In general, intake of the monensin-containing mineral mix was low and was consistent with previous experience (Horn and Phillips, 1985) where we compared intake of a monensin- *versus* lasalocid-containing mineral mixture. Intake of the monensin-containing mineral mixture was too low to provide sufficient monensin to increase cattle performance.

During the last few years, several feed manufacturers have marketed a "*new*" monensin-containing mineral mixture for stocker cattle. This mineral mixture is typically an "R1620" formulation and contains 810 mg monensin/lb, about 10 % calcium, and either no magnesium or a much lower concentration of magnesium than the mineral mixture (6.75% Mg) that we used in the 1991/92 study (Table 3). The lower concentration of magnesium may improve intake of the mineral. Recently, Brazle and Laudert (1998) reported that weight gains of yearling steers given free-choice access to a "R1620" mineral mixture while grazing either intensive early stocked or season-long native summer grass tended to be increased by .22 lb/day ($P>.05$) or were increased .16 lb/day ($P<.08$), respectively, as compared with the mineral mixture without monensin. Daily intake of the "R1620" mineral mixture was about 3.4 oz/steer *versus* 5.0 oz/steer for the mineral mixture without monensin. Thus, monensin intake was about 170 mg/steer, and may have been too low for maximum gain improvement of the steers that averaged about 670 to 700 lb during the study. Similar studies need to be conducted to evaluate the efficacy of these mineral mixtures for wheat pasture stocker cattle.

Variation in daily intake of supplements as well as mean overall supplement intake affect the response of grazing cattle to supplementation programs, and should be considered when selecting among the different strategies for getting appropriate additives into grazing cattle. In the study reported by Andrae et al. (1994), improvements in weight gain of cattle grazing wheat pasture and fed a monensin-containing energy supplement decreased as variation in daily supplement intake increased. Also, improvement in weight gains of cattle that consumed greater than 150 mg monensin/head/day was greater than that of cattle that consumed less than 150 mg/head/day of monensin.

Self-Limited Monensin-Containing Energy Supplement

Because of problems associated with delivering a sufficient amount of monensin by mineral mixtures and other considerations as discussed above, one of our initial research objectives within the **Expanded Wheat Pasture Research Program** was to develop a small-package, self-limited monensin-containing energy supplement for wheat pasture stocker cattle. The target level of consumption of this supplement is 2 to 3 lb/head/day and the supplement should:

1. Help balance the energy:crude protein ratio of wheat forage as discussed, from a conceptual standpoint, by Hogan (1982).
2. Provide monensin to:
    - A. Improve the economics of the supplementation program.
    - B. Decrease the incidence of bloat.
3. Provide additional calcium for growth of stocker cattle.
4. Provide a means from a **management standpoint** of getting other feed additives into the cattle when needed [i.e., Bloat Guard (poloxalene) in cases of severe or protracted bloat outbreaks].

Details of the individual year studies have been reported by Horn et al. (1990), Horn et al. (1992), and Beck et al. (1993). **Note:** Because of the low targeted level of intake of the supplement, stocking densities were not changed when this supplement was fed. The supplement is designed to "supplement" wheat forage rather than to "substitute" for wheat forage.

Composition of this supplement is shown in Table 4, and the mean (± standard deviation) of supplement and monensin intakes are shown in Table 5. The supplement was fed as a 3/16-inch pellet during the first two years and in the **meal form** during the third and fourth years. While we experienced some over consumption (i.e., **mean overall daily consumption of monensin greater than 200 mg**) of the supplement by one group of cattle during each of the first two years, mean intakes were "close" to the target. In general, the target supplement intake of 2 to 3 lb/head/day was more closely achieved by feeding the supplement in meal form. Feeding the supplement in meal form probably slowed rate of consumption of the supplement and may have increased the taste of salt. Control of intake of the self-limiting supplement was particularly challenging during the 1992/93 wheat pasture year because it was so wet. There were times in which the cattle just didn't seem to want to fight the mud and, therefore, stayed closer to the feeder and source of water.

Table 4. Composition (as-fed basis) of self-limiting monensin-containing energy supplement[a].

Ingredient	%
Ground milo	62.81
Wheat middlings	20.97
Sugarcane molasses	4.79
Calcium carbonate	4.00
Dicalcium phosphate	2.54
Magnesium oxide	.75
Fine mixing salt	4.00[b]
Rumensin 60 Premix	.125[c]

[a]Fed as 3/16-inch pellet during the first two years and in the meal form during the third and fourth years.
[b]Increased to 6%, at the expense of milo, depending on supplement intake.
[c]To provide 75 mg monensin/lb of supplement.

Table 5. Daily consumption of self-limited monensin-containing energy supplement[a].
(Mean ± std. dev.).

Pasture	1	2	n[b]
Trial 1 (1989 - 90)			
Supplement, lb/head	2.63 ± 1.00	4.24 ± 1.02	34
Monensin, mg/head	197 ± 75	318 ± 77	34
Trial 2 (1990 - 91)			
Supplement, lb/head	4.08 ± 1.29	2.41 ± 1.19	33
Monensin, mg/head	306 ± 96	181 ± 89	33
Trial 3 (1991 - 92)			
Supplement, lb/head	2.00 ± .71	2.00 ± .77	34
Monensin, mg/head	150 ± 53	150 ± 58	34
Trial 4 (1992 - 93)			
Supplement, lb/head	2.67 ± 1.28	3.13 ± 1.52	34
Monensin, mg/head	200 ± 95	235 ± 114	34

[a]Supplement was fed as a 3/16-inch pellet during the first two trials and in the **meal form during trials 3 and 4.**
[b]Number of observations. Consumption of supplement was measured twice weekly.

Cattle performance data is shown in Table 6. Weight gains were consistently increased by about .5 lb/day by the supplement. At feed costs of $80, 110 and 140/ton, per-head profits were increased by $15 to $31 (1990 dollars) depending on profit potential that existed during the 10-year period, 1980-89. These increased per-head returns do not include additional profits as a result of decreased death loss due to bloat as a result of feeding the monensin-containing energy supplement. Each one percent decrease in death loss would be worth another $5 to $7/head depending on cost of the cattle and when they died.

Table 6. Effect of self-limited monensin-containing energy supplement on daily gains (lb) of steers.

		Treatment		
Trial No.	Dates (Days)	Control	Monensin/energy Supplement	Supplement Response
1	October 26, 1989 to February 24, 1990 (120 days)	1.76	2.29[a]	+.53
2	November 13, 1990 to March 14, 1991 (120 days)	2.42	2.91[b]	+.49
3	November 17, 1991 to March 6, 1992 (120 days)	2.31	2.76[c]	+.45
4	November 13, 1992 to March 14, 1993 (122 days)	1.65	2.12[a]	+.47

[a]Greater than control ($P < .03$).
[b]Greater than control ($P < .003$).
[c]Greater than control ($P < .15$).

While this supplement was designed to be self-limited, **it has not been approved by the Food and Drug Administration (FDA) for free-choice feeding** and it does **require close management. Monensin in large amounts will kill cattle.** However, if one considers the LD_1 for monensin to be 5.5 mg/kg body weight (Potter et al., 1984) or 1250 mg/head/day for a 500-lb steer, then there is a theoretical safety ratio of 4.17 for 500-lb cattle consuming 300 mg monensin/day. Each year of these studies, cattle had free-choice access to large round bales of grass hay during periods of low wheat forage availability and(or) snow(ice) cover of wheat in an attempt to curb appetite and prevent over consumption of the self-limited supplement. Other management practices that may help achieve the desired level of intake of self-limited supplements by cattle on pasture include placement (location) of feeder(s) with respect to water and other cattle loafing areas, adjustments of the feed hopper door (i.e., How readily does the supplement flow out of the feeder or how difficult is it for the cattle to get at the supplement?), and availability of other sources of salt such as block salt. Proportional adjustments in drug concentration of the supplement can also be made to achieve the desired level of intake.

Modifications of the Formula

We had an additional opportunity to study this supplementation program during the 1995/96 wheat pasture year at the Marshall Wheat Pasture Research Unit. The "original" formula for this supplement contained about 67% ground milo and 21% wheat middlings. The wheat middlings were included primarily to improve pellet quality during the first two years of the study. The objective of the 1995/96 study was to determine if substitution of equal proportions of wheat middlings and soybean hulls **(midds/hulls)** for the ground milo and wheat middlings of the original formula affected intake of the self-limited supplement and cattle growth performance. The monensin concentration of the supplement was also decreased from 75 mg/lb ("original" formula) to **60 mg/lb** in order to provide a greater margin in relation to the FDA approved level of monensin intake.

Mean intake of the milo-based ("original" formula) and the midds/soybean hull-based supplements from December 7, 1995 through March 13, 1996 (98 days) was 2.06 and 2.33 lb/steer/day, respectively. There was no difference between intake of the two supplements. This will give greater flexibility in formulating this supplement depending on the availability and cost of energy feedstuffs. Monensin consumption averaged 124 and 140 mg/steer/day for the milo- and midds/hulls-based supplements, and was lower than the desired level of 180 to 200 mg.

Daily weight gain of steers during the 98-day study averaged 2.12 lb (non-supplemented, control), 2.41 lb (milo-based supplement), and 2.36 lb (midds/hulls-based supplement), and was increased by supplementation but not by type of supplement (i.e., milo- <u>versus</u> midds/hulls-based supplement). The gain response to supplementation was substantially less than that of our previous studies, and probably due to the lower mean intake of supplement and monensin particularly during the early part of the study.

What are the Limiters of Intake?

Salt. During the first year of these studies we sometimes increased the level of salt in the supplement from 4 to 6% when consumption was greater that desired and(or) provided plain block salt for the cattle. These levels of salt were based on initial conversations with some of you, and in subsequent years we have stuck with the 4% level, and have not conducted studies to evaluate the sensitivity of supplement consumption to salt level.

Monensin. Using four wheat pastures equipped with Pinpointer feeders near Stillwater, we (Paisley and Horn 1996a and 1996b) examined the effect of monensin on voluntary consumption of the self-limited supplement. Each 22-acre pasture was grazed by 11 fall-weaned steer calves from one of the OSU beef cow herds. The pastures were about 681 meters long and 125 meters wide and had automatic waterers at the south end of each pasture. The Pinpointer feeders were located within 17 meters of the waterers in each pasture. The steers had free-choice access to the milo-based supplement with 4% salt and either no monensin or 75 mg monensin/lb as-fed. Supplements were fed in meal form, and were sampled each time feed was added to the hopper bin to verify monensin concentrations. Supplement intakes of each group of steers from January 17 to April 12 (84 days) were calculated from feed and weekly weigh-backs because of large discrepancies between the calculated data and Pinpointer data. Thus, no data was obtained relative to frequency of supplement intake and meal size by the individual steers.

Supplement intakes were analyzed as a repeated measures design with week and treatment in the model. Because there were no week by treatment interactions ($P>.15$), the data were pooled across weeks. Mean intakes ($\pm$ std. Dev.) of the supplements were: 4.72 ± 1.52 and 5.35 ± 0.93 lb DM (0 mg monensin); and 1.34 ± 0.35 and 1.54 ± 0.52 lb DM (75 mg monensin/lb), and were decreased by monensin ($P<.001$). Overall weight gains of steers of the two treatments were not different ($P=.24$) even though they consumed much lower amounts of the monensin-containing supplement.

Magnesium Oxide. Similar studies as described above for monensin were conducted by Paisley (1998) with the milo-based supplement containing 4% salt, 75 mg monensin/lb, and four levels of magnesium oxide (BayMag) using the Pinpointer feeders. Levels of magnesium oxide were .25, .75. 1.25, and 1.75 % of the as-fed supplement. Actual magnesium concentrations were .49, .85, 1.17, and 1.56 % as-fed, and the supplements analyzed 80 to 85 mg monensin as-fed. Forty eight spring-born Angus X Hereford crossbred steers were obtained from one of the OSU beef cow herds. Steers were initially weighed November 8 and assigned to one of four pastures. Cattle were fitted with Pinpointer collars on November 13 and allowed to adapt to feeders for 8 days prior to the intake measurements. Final weights were taken December 20, with both initial and final weights recorded after a 14-h shrink.

Because supplement intakes of individual animals were measured, steer weights and daily gains were analyzed as a completely randomized design with animal as the experimental unit. Supplement intakes were analyzed using two models. Model I included treatment, steer(treatment), day, and treatment x day as sources of variation, and was used to analyze all 1344 intake observations (28 days x 48 steer). For Model II, individual supplement intakes were averaged across the 28-day intake period, and the 48 observations were analyzed with treatment as the only independent variable. For both models, pre-planned linear, quadratic, and cubic orthogonal contrasts were used to interpret the effect of increasing levels of magnesium oxide on supplement intake and animal performance.

Table 7. Effect of energy supplementation with increasing levels of magnesium oxide on performance of steers grazing winter wheat.

	Level of magnesium oxide, %					Contrast[a]		
Item	.25	.75	1.25	1.75	SE[b]	L	Q	C
BW Nov. 8, lb	562	556	548	533	15.5	.18	.80	.96
BW Dec. 20, lb	632	637	616	605	16.2	.16	.62	.62
ADG, lb/d	1.71	1.98	1.67	1.74	.132	.74	.45	.11

[a]Observed significance level for linear (L), quadratic (Q), and cubic (C) contrasts.
[b]Standard error of the means

Final weights and daily gains of steers were not affected (P>.11; Table 7) by increasing levels of MgO. Both Models I and II indicated that supplement intake increased linearly (P<.05) with increasing levels of magnesium oxide (Table 8). Differences in intake among the supplements were small, and mean consumption of all supplements was less than the target of 2 to 3 lb/steer/day. Time (minutes/day) that the steers spent in the feeders was influenced in a quadratic manner (P<.01) by level of MgO. Although not significant (P>.05), visits/day appeared to follow the same quadratic trend as eating time. These results indicate that inclusion of MgO at levels up to 1.75% of supplement does not limit intake. Coffey and Brazle (1994) reported that magnesium-mica at levels up to 50% did not limit intake of a ground milo supplement by steers grazing smooth bromegrass supplements.

Table 8. Intake of a self-limited monensin-containing energy supplement with increasing levels of magnesium oxide.

	Level of magnesium oxide, %					Contrast[a]		
Item	.25	.75	1.25	1.75	SE[b]	L	Q	C
			Model I					
Intake, lb-hd^{-1}-d^{-1}	1.31	1.45	1.27	1.93	.055	.01	.07	.07
Min. eating suppl.	15.5	13.5	13.7	20.2	.54	.03	.01	.55
Visits to feeder	2.66	2.53	2.52	3.13	.075	.16	.09	.62
			Model II					
Intake, lb-hd^{-1}-d^{-1}	1.31	1.45	1.27	1.93	.162	.03	.12	.13
Min. eating suppl.	15.5	13.5	13.7	20.2	1.37	.02	.01	.53
Visits to feeder	2.66	2.53	2.52	3.13	.190	.11	.06	.57

[a]Observed significance level for linear (L), quadratic (Q), and cubic (C) contrasts.
[b]Standard error of the means

Hand-Fed Monensin Supplement

While some producers prefer self-limiting supplements that can be fed free-choice, others prefer to hand-feed supplements. **Hand-feeding** obviously allows much better control of supplement intake, and monensin has FDA approval for every other day feeding to stocker cattle. During the 1992/93 wheat pasture year we (Andrae et al., 1994) made slight modifications to the self-limited supplement and hand-fed it every other day at the level of 4 lb/head (or 360 mg monensin) to steers (552 lb mean initial weight) in individual feeding stalls adjacent to wheat pasture. Feedstuff composition of the hand-fed supplement is shown in Table 11. Daily weight gains were increased by **.56** lb/steer, which is similar to that observed in the free-choice studies. We also looked at variation in supplement intake by individual steers and partitioned them into low, moderate, and high variation groups based on the standard deviations of supplement intake. Variation of supplement intakes decreased as mean supplement intakes increased (i.e., the two were inversely related) as shown in Table 9, and mean supplement intakes were significantly different among all three levels of variation. This suggest that cattle with the least variable intakes tended to consume the entire amount of supplement that was offered more often than those in more variable groups. Daily gains also increased as variation in supplement intake decreased. Supplemented steers with monensin intakes greater than 150 mg/day tended to have greater weight gains than those with monensin intakes less than 150 mg/day (Table 10). These data accentuate the importance of not only formulating supplements and managing supplementation programs in order to achieve desired mean intakes by the herd, but to also minimize variability of supplement intake.

Table 9. Effects of variation in supplement intake on performance.

	Low[a] Variation	Moderate[b] Variation	High[c] Variation
Number of steers	8	11	6
Supplement intake, lb/day	1.82[d]	1.57[e]	1.16[f]
Daily Gain, lb	3.06[d]	2.83[de]	2.56[e]

[a]Supplement intake standard deviation < .9 lb/feeding.
[b]Supplement intake standard deviation .9 to 1.25 lb/feeding.
[c]Supplement intake standard deviation > 1.25 lb/feeding.
[d,e,f]Rows with uncommon superscripts differ (P<.05).

Table 10. Effects of monensin intake levels on performance.

	Low[a] Monensin Intake	High[c] Monensin Intake
Number of steers	14	11
Monensin intake, mg/day	123[c]	161[d]
Daily Gain, lb	2.75[c]	2.95[d]

[a]Monensin intake < 150 mg/hd/day.
[b]Monensin intake > 150 mg/hd/day.
[c,d]Rows with uncommon superscripts differ (P<.07).

An additional study regarding this supplementation strategy was conducted during the 1997/98 wheat pasture year by Paisley et al. (1998). The hand-fed supplement (also shown in Table 11) was similar to that used before except that Smectite was used as a pellet binder and Rumensin 80 Premix was used at a concentration of 0.125% of the as-fed supplement to provide 100 mg monensin/lb of supplement. One-hundred and ten (110) steers and eight wheat pastures were used, and the steers had (1) free-choice access to a high-calcium mineral supplement without an ionophore or (2) were hand-fed 4 lb of the monensin-containing energy supplement every other day. Results are shown in Table 12. Daily consumption of the supplements averaged 0.30 and 1.83 lb/steer for the mineral and monensin-containing energy supplements, respectively. Daily gains of cattle fed the energy supplement were increased by **0.39** lb as compared with cattle fed the mineral supplement. Supplement conversion, expressed as lb of supplement per lb of increased gain, was 4.69.

Table 11. Feedstuff composition (% as-fed) of **hand-fed** monensin-containing energy supplements.

Ingredient	1992/93[a]	1997/98[b,c]
Ground milo	66.65	62.15
Wheat middlings	21.00	21.00
Sugarcane molasses	4.80	5.00
Limestone	4.00	4.30
Dicalcium phosphate, 21% P	2.55	2.55
Magnesium Mica (Smectite)		4.00
Fine Mixing Salt[d]	.50	.50
Magnesium oxide	.35	.22
Rumensin 60 Premix	.15[e]	
Rumensin 80 Premix		.125[f]
Vitamin and Trace-Mineral Premix		.10
Vitamin A-30		.05

[a]Andrae et al., 1994.
[b]Paisley et al., 1998.
[c]Appreciation is expressed to Farmland Industries, Inc. for providing this supplement as an 11/64-inch pellet.
[d]Fine mixing salt (99.5% NaCl).
[e]To provide 90 mg monensin/lb of supplement.
[f]To provide 100 mg monensin/lb of supplement.

Averaged over the two years, this supplementation program has increased weight gain of wheat pasture stocker steers by **0.48** lb/day.

Further Studies On Bloat

In a study reported by Paisley and Horn (1998), twelve rumen cannulated steers that grazed the same wheat pasture near Stillwater were randomly allotted to three experimental groups. Gelatin capsules containing nothing, monensin, or lasalocid were placed directly into the rumen of each steer each day. Dosage of the ionophores was 300 mg/day because the steers weighed 1164 ± 67 lb. After a preliminary period of 16 days, the steers were assigned a bloat score each morning from March 15 through March 28 (14 days). While the wheat was in a rapid growth stage during this time, it was fairly immature. Hard freezes on the mornings of March 14, 15 and 16 increased the incidence of bloat and slowed the rate of wheat growth. Bloat scores were as follows:

0 = Normal, no visible signs of bloat.

1 = Slight distention of left side of animal.

2 = Marked distention of left side of animal. Rumen distended upward toward top of back. Animal has asymmetrical (egg-shape) look when walking away from observer.

3 = Severe distention. Distension is above top of back and visible from right side of animal.

Steer days of bloat (i.e., the number of days that steers had a bloat score of 1, 2 or 3) and the mean bloat score for each group of steers is shown in Table 13. Monensin decreased ($P<.05$) both the incidence and severity of bloat and was more efficacious for prevention of bloat than lasalocid. This study supports the earlier suggestions, as referenced in the first paragraph of this paper, relative to the use of monensin for prevention of bloat of wheat pasture stocker cattle.

Table 12. Forage availability, supplement intake, and performance of steers grazing winter wheat and receiving either the alternate day energy supplement or mineral[a].

Item	Mineral-supplemented[b]	Monensin/energy supplement[c]	SE
Pastures	4	4	
Forage Mass			
Dec. 5, lb DM/acre	2681	2565	334.5
Jan. 20, lb DM/acre	2378	2351	196.6
Feb. 20, lb DM/acre	2059	1989	201.1
Supplement intake			
Supp. Intake, lb/day	.30	1.83	--
Monensin, mg/day[d]	0	183	--
Calcium, g/day[e]	21.9	18.7	2.73
Phosphorous, g/day[e]	5.5	7.5	.67
Magnesium, g/day[e]	7.5[j]	5.6[i]	.95
Cattle performance			
No. of steers	52	53	
Initial wt, lb[f]	512	515	11.9
Final wt, lb	802[j]	848[i]	2.8
Daily gains, lb[g]	2.53[j]	2.92[i]	.029
Supp. conversion[h]	--	4.69	--

[a]Least squares means for treatment.

[b]Steers had free-choice access to Wheat Pasture Pro Mineral™ (Farmland Industries, Inc.).

[c]Steers were fed 4 lb/steer every other day.

[d]Based on supplement monensin concentration of 100 mg/lb.

[e]Calculated from supplement and mineral analysis.

[f]Weights included initial steers as well as steers added December 5, 1997.

[g]Calculated based on 127 and 113 grazing days, respectively, for Marshall and Stillwater locations.

[h]Supplement conversion, lb of supplement/lb of added weight gain.

[i,j]Means within a row with uncommon superscripts differ ($P<.05$).

Table 13. Effect of Ionophore on the incidence and severity of bloat[a,b]

Item	Control	Monensin	Lasalocid	SE[c]	Control vs Ionophore[d]	Monensin vs Lasalocid[d]
No. of steers	4	4	4			
No. of steers that bloated[e]	4	2	4			
Total steer days of bloat	40	4	33			
Mean days of bloat/steer	10.0	1.0	8.3	2.25	.083	.049
Mean bloat score/steer	.88	.05	.77	.206	.097	.036

[a]From March 15 to March 28, 14 days.
[b]Bloat scores consist of: 0 = no visible signs of bloat; 1 = slight distention of left side; 2 = marked distension of left side; 3 = left and right sides distended
[c]Standard error of least squares means.
[d]P-value associated with orthogonal contrasts.
[e]Steers given a bloat score greater than zero on one or more days.

ENERGY SUPPLEMENTS TO STRETCH A SHORTAGE OF WHEAT PASTURE

The 1991/92 wheat pasture year was very dry, and many pastures were extremely short of forage at the time of "traditional" turnout. In some of our pastures we had as little as 300 lb of forage dry matter per acre. While this was a problem, it did present us with an opportunity to compare some different types of energy supplements for stretching this severe shortage of wheat pasture. Our objective was to compare **limited amounts (i.e., 1% of mean body weight)** of whole corn, dry-rolled corn or a 50/50 mix of pelleted wheat middlings/soybean hulls. The supplements were hand-fed 6 days/week. Our target gain for the cattle was 2 lb/day. Nine pastures were used in the study and **initial** stocking density was 3.5 acres/steer to provide an initial forage allowance of 1300 lb of forage DM/steer. Because of the very mild winter and continued growth of wheat forage, cattle of three pastures were distributed by treatment through the other six pastures on January 30, 1992 in an attempt to provide equal and lesser amounts of forage to all cattle. Forage availability in each of the pastures on January 21 was about 1500 lb DM/steer and greater than we would have liked for the initial objective of the trial. Forage growth after January 30 was excellent. Because wheat jointed so early, the cattle were removed on February 28. Performance of the steers is shown in Table 14.

Table 14. Energy Supplements for Stretching Wheat Pasture.

	Whole Corn	Dry-rolled Corn	Wheat midds/ soybean hulls
No. Pastures	2	2	2
No. Steers	10[a]	12	12[b]
Initial Weight, lb (12/5/91)	438	438	439
Final Weight, lb (2/28/92)	622	630	625
Daily Gain, lb[c] (84 days)	2.17	2.25	2.19

[a]Increased to 14 on January 30.
[b]Increased to 18 on January 30.
[c]Add-on steers of January 30 were not included in calculation of mean daily gains. Differences among treatments are not significant (P>.62).

Weight gain of all steers was about 2.2 lb/day during the 84-day trial, and was not different (P>.62) among treatments which is in general agreement with our other results where we have not observed a difference in gain between steers supplemented with a high-starch, corn-based supplement *versus* a high-fiber, byproduct feed-based supplement on wheat pasture. Steers consumed the whole corn much more readily than the rolled corn, and usually had slick bunks by mid-afternoon. Two steers fed rolled corn foundered and showed signs of lameness throughout most of the trial. Because of the small numbers of pastures and steers in this trial, this data should be considered only preliminary. However, from a feed and bunk management standpoint, the whole corn was clearly more desirable than the rolled corn.

The 1995/96 wheat pasture year presented us with another opportunity to evaluate a limit feeding program with whole shelled corn for steers on wheat pasture. Three pastures with 10 to 13 steers/pasture were used. Wheat forage standing crops on December 7 (date of turnout), January 17, and March 12 were 511, 376, and 251 lb DM/acre, respectively. Forage allowances on these same dates were 1024, 749, and 725 lb DM/ steer. Steers had free-choice access to a high-calcium mineral mixture (footnote "a", Table 3). While our target level of intake of whole corn was 1% of body weight, the cattle did not achieve this level of intake until about January 17 or day 41. Corn intake was very consistent among pastures, and averaged .75% of body weight from December 7 to March 15 (98 days). Mean weight of the steers at the start of the trial was 540 lb, and they gained 1.86 ± 0.11 (std. dev.) lb/day.

SUMMARY

Supplementation of cattle grazing wheat pasture is of interest in order to (a) provide a more balanced nutrient supply and feed additives such as ionophores and bloat preventive compounds, (b) substitute supplement for forage where it is desirable to increase stocking rate in relation to grazing management and(or) marketing decisions, and (c) substitute supplement for forage under conditions of low forage standing crops. Two different strategies for providing energy supplements to growing cattle on wheat pasture are presented. One strategy was to develop a "small package" (i.e., target intake of 2 to 3 lb/day) self-limited monensin-containing energy supplement to provide a more balanced DOM:CP ratio in the total diet. The supplement very consistently increased daily gain approximately .50 lb, and increased profits by $15 to $31/steer depending on supplement cost and profit potential of the cattle. The milo-based supplement contained (as-fed basis) 4% fine mixing salt, 75 mg monensin/lb, and .75% magnesium oxide. Monensin itself limited intake, but MgO at concentrations up to 1.75% did not limit intake. Substitution of equal proportions of wheat middlings and soybean hulls for the ground milo did not affect consumption of the self-limited supplement. Modification of the formula for every-other-day hand-feeding resulted in similar improvements in weight gain as achieved with the self-limited supplement. An additional study using small numbers of rumen cannulated steers in a completely randomized design compared the effects of monensin or lasalocid *versus* no ionophore on wheat pasture bloat. Monensin decreased ($P<.05$) both the incidence and severity of bloat and was more efficacious for prevention of bloat than lasalocid. A second strategy was to feed two types of energy supplements (i.e., high-starch, corn-based supplement *versus* a high-fiber byproduct feed based supplement) at a level of .75% of body weight. Over the 3-year study, mean daily supplement consumption was .65% of body weight. This energy supplementation program increased daily gain by .33 lb and allowed stocking rate to be increased one-third. Type of supplement did not influence daily gain, supplement conversion, or the substitution ratio of supplement for forage. Supplement conversion was about 5 lb of as-fed supplement per lb of increased

gain per acre, and was substantially less than conversions of 9 to 10 that have traditionally been used in evaluating the economics of energy supplementation programs for wheat pasture stocker cattle. Weight gain of steers placed on wheat pastures with very low initial standing crops (i.e., 300 lb DM/acre) but "stocked" so as to provide initial forage allowances of 1000 to 1300 lb DM/steer, and limit-fed whole shelled corn at a level of .75 to 1.0% of body weight have been about 2.0 lb/day during two separate wheat pasture years.

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