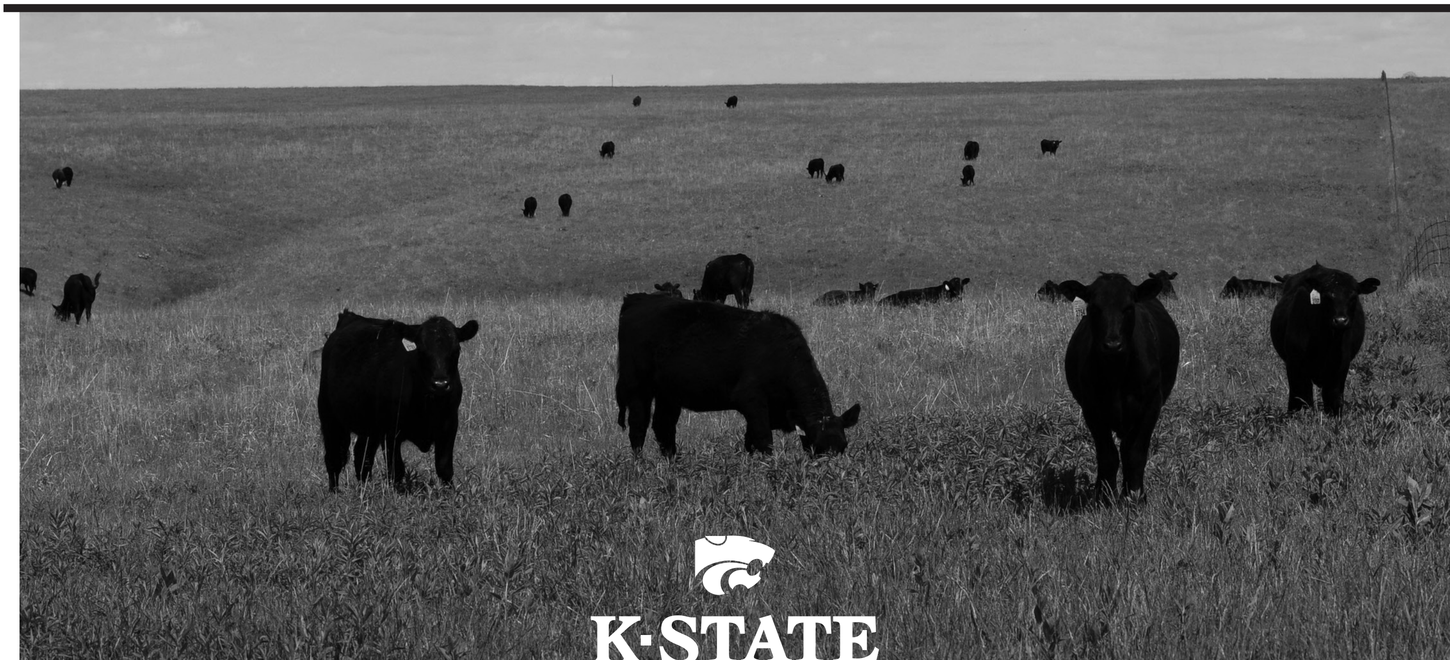
Stocker and Backgrounding Cattle Management and Nutrition



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In the U.S. beef cattle industry, the stocker and backgrounding segment focuses on raising young and lightweight calves by feeding them diverse forages, feedstuffs, and grain-processing industry byproducts. Depending on whether market conditions are favorable, these calves are relocated to a feed yard for subsequent finishing.

Several interacting factors and conditions contribute to a significant and viable Kansas stocker and backgrounding segment. First, the availability of more than 19.2 million acres of rangeland and tame pasture allows producers opportunities to capture competitive costs of live-weight gain. Furthermore, accessibility to winter cereals (such as rye, wheat, and triticale) during the cool seasons of the year and native grass throughout the summer allows producers to purchase and grow stockers aggressively throughout the year. Finally, the proximity of the feeding and meat processing industries to these cattle-growing resources allows for improved industry efficiency and coordination.

Management, health, and nutrition are just three important factors to consider for stocker and backgrounding operators. Without proper consideration of these factors, the growth efficiency of these calves decreases, reducing the operation's profitability. This publication summarizes data concerning the health, management, and nutritional concerns necessary for a successful stocker cattle program.

Pre-Grass or Receiving Management

How calves are managed in the first two to four weeks after arrival is the most critical phase for any stocker or background operator. An operator must have live, healthy cattle to use management tools in the pens or pasture to improve gains and performance. Consult a veterinarian familiar with your operation for processing and treatment program recommendations. This publication provides a basic outline and general recommendations.

Upon arrival, provide immediate access to good-quality long-stem grass hay with access to clean water. The hay will stimulate the rumen to begin functioning properly after being without feed in transit. It is ideal to allow calves to rest for at least 12 hours before processing, ideally during cooler ambient temperatures. One hour of rest per hour on the truck can also be used to calculate rest time.

Working the animals in small drafts will minimize the stress on each one. Ear tag, deworm, and vaccinate all animals with IBR, PI_3, leptospirosis, and blackleg. Castrate and tip the horns at arrival. Highly stressed calves may need with a long-acting antibiotic if necessary.

Brazle (16) evaluated the health and performance outcomes of newly arrived calves started in feedlot pens or grass paddocks. Upon initial arrival, all calves were placed in feedlot pens for three days, and then half of the calves were turned out into grass paddocks. The calves housed in grass paddocks during the ensuing period had less ($P<0.01$) sickness, fewer ($P<0.01$) sick days per animal purchased, and lower ($P<0.01$) drug treatment costs than their counterparts housed in feedlot pens.

Feeding coccidiostats, such as Deccox, are given primarily to alleviate coccidiosis and are frequently fed only the first 28 days after arrival. The improved animal performance occurred when Deccox was fed daily throughout the growing period. A reduction in sickness and increased gain and feed intake was observed when Deccox was fed to newly purchased calves *(11)*[1].

Oklahoma work showed a 26% increase in gains when Deccox was fed for 58 days *(79),* while in another study, cattle fed Deccox gained an average of 0.5 pounds per head per day more than those not fed the coccidiostat *(7).* In these trials, Deccox was fed either hand mixed with the mineral supplement (1.5 pounds of 6% Deccox premix per 50 pounds of mineral) or administered through cottonseed meal pellets at the rate of 50 milligrams per pound in 2 pounds of supplement.

Kansas trials have shown either a slight improvement in gain (3.4%) when Deccox was fed to cattle on wheat pasture *(10)* or a nonsignificant improvement (0.09 pounds per head per day) in average daily gain (ADG) and reduction of sickness on newly purchased steers and bulls grazing native grass pasture *(15).*

The results of feeding antibiotics or coccidiostats are variable and highly dependent on the levels of infections and stress the cattle have been exposed to. This is illustrated in a study in Oklahoma *(6)* that compared

[1] Note: Numbers in parenthesis refer to references, beginning on page 14.

feeding Deccox to 120 head purchased from auction barns and grazed on native grass to 80 head purchased from one ranch and grazed on Bermudagrass pasture. The auction-barn-purchased cattle gained 20% more when fed Deccox, while the cattle purchased from one ranch did not differ in gains when fed Deccox. The differences in the type of pastures should not have affected the results.

Increased gains also occurred when Deccox was fed to newly weaned calves *(103)*. Newly purchased calves stressed by transit, commingling, etc., should be fed Deccox to control coccidiosis and subclinical coccidiosis. Deccox should be fed at approximately 100 milligrams per head per day or 23 milligram per 100 pounds bodyweight per day.

Feeding a coccidiostat is recommended for cattle bought at auctions or that have undergone moderate stress, particularly during the first 28 days. Benefits can be obtained by feeding the cattle the entire length of the stocker program.

Growth Implants

For more than 50 years, growth implants have been a dependable tool for increasing performance and profit for many stocker and backgrounding programs. However, recent label changes by the FDA have forced producers to consider when implants are strategically incorporated.

In July of 2023, the FDA implemented new regulations regarding labeling changes and subsequent re-implantation restrictions within different phases of production. This implication will affect the decision to use growth implants for growing cattle before entry into the feedlot.

Moreover, today many branded beef programs prohibit the use of implants. Therefore, it is incumbent on the stocker producer to fully understand the economic tradeoffs between the proven growth benefits of implants and participating in NHTC programs.

Previous trials have shown substantial improvements in daily gain when implants are used *(14, 22, 23, 24, 38, 64, 67, 71, 72, 74, 75, 100, 105)*. Average increases were 1.45 and 1.65 pounds per head per day for nonimplanted vs. implanted animals using Compudose, Ralgro, and Synovex implants.

Producers wonder how implants affect lifetime performance. Implants have increased average daily gain during the suckling and finishing phases of cattle production, although responses in the suckling phase can be somewhat variable. Laudert et al. *(66)* found that implanting suckling calves did not reduce gains during the growing or finishing phases, but implanting during the growing phase reduced finishing ADG, possibly due to compensatory gain in the finishing phase by the nonimplanted calves.

Subsequent research conducted has shown no effect, or in some cases, a positive effect on ADG by previous implant treatment. Kansas trials found no overall effect of previous implant treatment on ADG *(76)* or that animals implanted during the stocker phase continued to gain faster in the finishing phase *(23, 24, 38)*.

Implanting suckling calves (1 to 2 months of age) may depress gains in the growing and finishing phases *(82)* while other researchers have found no effect of implanting in the suckling phase on subsequent performance *(106)*. In both studies, finishing gain was not influenced by implanting during the growing phase. Lifetime ADG was increased by implanting and re-implanting throughout the various phases of production.

For a current list of marketed implants and the class they are approved for please visit the FDA website at: *https://www.fda.gov/animal-veterinary/product-safety-information/fda-provides-list-currently-approved-and-currently-marketed-implants-available-beef-cattle-target*

Parasites

Endo and ectoparasites in cattle production can hinder performance and wellbeing of cattle. The threat and severity of infections is highly dependent on environment, season, animal factors (such as genetics or age), and even yearly variation. Controlling and mitigating the effects of parasitism often warrant a multipronged approach. Always consult with a local veterinarian for product selection as parasiticide resistance has been an ongoing threat to the industry.

Dosing products correctly is critical to their effectiveness. When applying products to a group of cattle, be sure to accurately dose by body weight, and not dose by average weight of the lot. When dosing by the average, approximately half of the animals are underdosed, which reduces the efficacy of the product.

Internal Parasites

Common cattle parasites are found naturally in pastures. The most important nematode species in cattle production are *Ostertagia, Haemonchus, Trichostrongylus*, and *Cooperia*. Cattle only become infected when they consume infective L3 larvae as they graze. After eggs hatch in the environment, they molt or change forms twice to become the infective L3 state. Parasite eggs are extremely resilient and can survive in the environment for long periods of time. This includes surviving drought and winter conditions. This ongoing survival is perpetuated by the adult nematodes going dormant inside the animal. This is known as hypobiosis. In Kansas, most nematodes go dormant during the winter months, whereas in the southern United States they go dormant in the hot, dry summer months. This is a survival mechanism of the parasite. Once cattle graze infective L3 larvae, the larvae migrate to either the abomasum or intestinal track of cattle. This is where parasites continue their life cycle into adults. Adult parasites lay eggs that are passed through the digestive track and into the external environment via manure. Worms can complete their life cycle in about three weeks. It is assumed that 90% of the total worm population is on the pasture.

It is important to note that not all cattle are affected by internal parasites in the same manner. In general, calves are much more susceptible than mature cattle, and bulls are often more susceptible than cows. Even within each class of animal, infections are not evenly distributed. It is estimated that within a herd, 20% of cattle harbor 80% of internal parasite infections due to differences in immune status and other genetic factors. Maturity does play a key role in herd infection rates. Cows develop decent immunity to internal parasites by about four years of age. These older animals will still harbor nematodes and shed eggs, but at a vastly decreased rate.

Treatment of internal parasites has numerous benefits to beef cattle production. Improved health, increased weaning weights, and increased fertility are all seen with proper parasite control. There are a multitude of deworming (anthelmintic) products on the market. Most of today's products fall within the benzimidazole and the macrocyclic lactones classes. There are also options when it comes to application including injectable, oral drench, feed additive, and pour-on formulations. Many of the benzimidazoles would be referred to as "white wormers" or drenches, while Macrocyclic Lactones commonly are pour-on or injectable formulations. Some of these products are short acting in the animal, while other formulations have longer acting residual effects. Regardless of product, anthelmintic resistant parasites are an increasing concern in the industry. In some situations, the products are no longer as effective as they once were. Prudent use of these therapies is critical to ensure their continued usefulness.

Discussing deworming programs with your veterinarian is a critically important conversation. Since every beef-cattle operation is different, cookie-cutter parasite control programs that cannot be implemented. Working with your local veterinarian under a veterinary client patient relationship will make sure the program fits the needs of the operation. The decisions on product selection and timing varies depending on history, diagnostics (fecal egg counts), grazing situation, stocking rate, time of year, class of animals, and regionality. For example, cattle entering a feedlot will typically only be dewormed on arrival because they will not be exposed to any more parasites since they are not grazing grass. While stocker calves on permanent pasture will be exposed continuously to parasites while they are grazing, so a different strategy would be implemented. Your veterinarian will be able to give guidance on product purchasing decisions.

There are some critical control points that can limit the effect of internal parasites. One of the most important management pieces is the proper dosing of anthelmintic products. These products are dosed by weight. Underdosing can greatly increase the likelihood of resistant nematodes in the environment. Weigh scales on chutes can help with this. Grazing management is another critical component to parasite control. Nematode larvae typically do not migrate further than 2 inches (5 centimeters) up grass, and 8 inches (20 centimeters) horizontally from the manure pack. Overgrazing grass increases the opportunity for animals to be exposed to nematodes. Lastly, ensuring adequate cattle nutrition, specifically protein, enhances the immune response to internal parasites. While this does not clear parasite infections, it does lessen the influence of nematodes in many situations.

Horn, Stable, and Face Flies

It is estimated that horn flies alone may account for up to a billion dollars of damage and loss to the cattle industry each year. Economic effect can be seen on individual animals with as few as 200 to 300 flies per animal. This can be visualized by horn flies covering the withers and going about halfway down the side. The economic impact hits producers in decreased average daily gain and reduced weaning weight of calves. Each horn fly takes 20 to 30 blood meals each day. They spend most of their lives on the backs of cattle, and only leave the animal to lay eggs on fresh manure patties. Populations typically rise in late May and persist during the summer months.

Stable flies are also blood feeders, and feed on the lower limbs. They deliver a painful bite during feeding. Infested animals are often seen switching their flanks, moving constantly, flicking tails, and even standing in water in attempts to escape the painful bites. It has been estimated that as few as five flies per leg can influence performance in beef cattle. Stable flies spend little time on cattle, and only feed during daytime hours. Different from other flies, stable flies lay their eggs in decaying organic matter (spilled feed, undisturbed manure, and decomposing hay bales).

Face flies feed on the protein-rich secretions from the eyes and nose. Face flies are the primary vector for spreading the bacteria that causes the disease known as pinkeye. Pinkeye in cattle is a major economic concern for producers. Pinkeye accounts for an estimated $150 million in losses per year through decreased production and treatment costs. Although multiple factors play a role in pinkeye, face flies are generally a part of the spread of the disease. As with horn flies, face flies lay eggs on fresh manure patties. One main difference between the behavior of these two pests is the face fly can travel several miles between animals and spends less time on the animals themselves.

Management

It is important to understand that combating these external parasites during the summer takes a multimodal approach. Many products help control these pests. Each product is designed to work in a specific way, against certain targets, for a specified amount of time. Expectations of a product to last from turnout to grass until the first frost, or to eliminate 100% of the pests is unrealistic. Producers should develop an integrated management plan to combat pests.

Stable flies tend to be more of a confinement or barnyard issue but have increased in occurrence in pasture settings. Typically, this is due to winter feeding sites having a buildup of hay residue and manure. This mixture provides an ideal location for stable flies to flourish. Rolling out hay during the winter-feeding months greatly reduces the number of stable fly larvae that survive the winter. Round bale feeders tend to leave a large amount of residue on the ground after winter feeding and can yield up to 1 million more stable flies the next grazing season. Cleaning feeding areas before late spring reduces the habitat for stable fly larvae to develop. Cleaning can include scraping, composting, or even dragging the sites with a harrow.

Cattle Insecticides

There are many animal health products to help specifically control targeted external parasites in grazing cattle. They can include insecticide impregnated ear tags, pour-ons, sprays, oilers or dusters, injectable, and feed-through products. Usually, a combination of these products is used to provide coverage during the summer. As with any animal-health product, it is important to read and follow all label directions. It is important to note that most of these products have a slaughter withdrawal time, so documentation of treatment dates is crucial.

Common classes of insecticides include pyrethroids, organophosphates, and macrocyclic lactones. Continued use of one class of product promotes resistance in the local fly population. Using one chemical class each season and rotating classes on a seasonal basis is critical to maintaining the usefulness of these products. Timing is a critical component of insecticide use. Each of these products have an expected duration of efficacy. Producers often use these products, such as ear tags, early in the spring before turnout, but the products start to lose potency and efficacy in the late summer months when needed the most. Holding off treatment until fly levels on cattle hit the critical point (100 to 200 flies per animal) helps to extend duration into the summer. If additional treatment is indicated later in the season after multiple applications of a product or an ear tag have already been used, alternate the insecticide class when changing control methods late in the season. Work with your local veterinarian who is familiar with your individual management strategies to tailor fit a plan.

Tags

Fly tags are excellent tools. To get the most benefit from them, wait until the middle of May or even June to put them in to ensure the tags still have effect later into the season when they are most needed. Many available tags may have effective duration of 12 to 20 weeks. It is recommended to only tag cattle once per season. It is also important to remove these tags at the end of the season. Leaving the tags in will expose these parasites to a sub-therapeutic level of the active chemical that greatly increases the likelihood of resistance development.

Pour-ons

These ready-to-use formulations are administered to the topline of cattle and dosed by bodyweight. Pour-on products work by direct contact with pests, so complete coverage from the poll to tailhead is important. Common products have label claims against flies, lice, and even ticks. Reapplication of these products may be necessary as expected duration of efficacy is two to four weeks. Use the economic threshold of about 200 flies per animal as an indication for retreatment.

Dust bags/cattle rubs

Many producers use self-applicators such as dusters or rubs in the pasture setting. To increase the effectiveness, fencing off and controlling entry points of commonly used areas can ensure application to the animals of the herd. These areas can be watering or mineral source areas. Read the label instructions carefully, these products may require specific carriers to work properly. Recharging these sites with the proper product mixture in the recommended intervals must be done during the season.

Sprays

Some products available come as a concentrate to be mixed with water before applying to cattle. These products can be useful for individual animals or groups of animals. Options for administration can range from automatic spray devices in facilities to handheld sprayers for use from all-terrain vehicles in the field. With optimal coverage of the animals, two to four weeks of efficacy can be achieved.

Larvicide or Insect Growth Regulators (IGR)

These products are fed to cattle and are commonly included in certain mineral products. The products pass through the animal and have efficacy in the manure. They work by either destroying developing larvae or disrupting the normal development process of horn, face, and house flies. This process reduces the amount of new fly activity in each area. However, flies do have the ability to travel over distances from neighboring operations. Timing of feeding these products is critical and should be targeted to begin before the beginning of the vector season and end after a killing frost.

Lice

Cattle lice infections can affect the health and performance of cows, stockers, and feedlot cattle during the winter. These months generally range from December through March. The USDA has estimated that livestock producers lose up to $125 million per year due to effects of lice infestations. Not only can they cause direct animal performance losses, but they can also increase wear and tear on facilities and fences. The direct losses to cattle come in forms of decreased average daily gains (documented 0.25 pounds per day reduction in growing calves), skin infections, and potentially blood loss and anemia.

There are two different types of lice that infect cattle. Once type of lice is considered biting lice and feed on the skin and secretions on the outside of the animal. The other type is known as sucking lice. These species are blood feeders and pierce the skin. Both types of lice spend their entire life cycles on the cattle hosts. They do not survive away from cattle well and generally only live a few days. But can live up to 10 days off host in the right environment leading to reinfection in groups of animals. It is important to note that lice are host-species specific. This means that cattle lice cannot affect people, horses, or any other species.

In general, every herd has some level of lice infestation. Lice are carried from season to season by a small percentage of the herd that act as reservoir hosts. Adult lice eggs lay eggs on the hair of infected animals. The overall life cycle for an egg to mature into an adult and lay eggs is roughly 28 days. Most females lay one egg per day.

Clinical signs of lice-infected cattle generally begin with constant rubbing and scratching within the herd. Fences, posts, water troughs, trees, and any other stationary object could be subject to damage from this rubbing. As the infection and irritation continues, large hairless patches become evident on animals.

Diagnosing the issue beyond the clinical signs requires seeing adult lice on the skin. Parting the hair reveals the lice. They are quite small but can still be seen. They are roughly the size of a grain of sand. The economic threshold for treatment is roughly 10 lice per square inch.

There are several options for treating lice in cowherds. One option is the macrocyclic lactone class of endectocides. Examples of products in this class include ivermectin, doramectin, eprinomectin, and moxidectin. These products come in pour-on formulations and injectable formulations. Macrocyclic lactones treat internal intestinal nematodes but also work on external parasites such as lice. It is important to note that the injectable formulations do not work on biting lice since they do not feed on blood. These products are most often used on a herd basis at the end of summer grazing going into winter. Even with herd treatment in the fall, later-season lice infections can still occur. This can be due to fence line contact with other animals or the introduction of new animals.

The other options are topical treatments that are non-systemic. These products are typically pyrethroid products similar to what is commonly used to control horn flies during the summer. These products are effective against the adult lice but do not affect the larvae or eggs. Retreatment is often indicated 14 days after initial treatment. There is a product available that is a pyrethroid in combination with an insect growth regulator that not only works well against the adults, but also works against the eggs and larvae. This product eliminates the need to retreat in 14 days. Since these topical formulations kill lice by contact, it is extremely important to apply them appropriately to cattle. Most formations call for the pour-on to applied with full coverage on the topline of animals, from poll to the trailhead.

When treating cattle, it is also important to treat the entire group. Missing one animal could serve as the reservoir for reinfesting the entire herd. The same thought should be given to new additions to the herd from an outside source. Basic biosecurity such as treating and segregating new additions for 30 days is not only good to reduce risk of lice, but also is a great tool in decreasing introduction of other diseases.

How does the nutritional status or pre-management of the incoming stocker affect performance?

This is a common, but unanswered, question for stocker operators. Many producers keep their calves on a low plane of nutrition, particularly over the winter, by feeding low-quality forage with minimal supplementation. Restricting feed intake through a programmed feeding approach is another alternative.

Can the gain lost during this time be made up during the stocker and finishing phases? The results from two trials on the effect of wintering gain on subsequent pasture and feedlot performance showed compensatory gains during the grazing phase in animals that had gained less over the winter *(72, 124)*. This occurred to a much lesser degree in the study by White et al. *(124)*, which looked at winter gains of -0.51, -0.15, 0.35, and 1.57 pounds per head per day, and this was probably due in part to the overall low grazing and finishing performance and possibly to the negative winter weight status of the animals.

In this case, the winter weight differences were minimized but maintained at the end of the grazing phase. This only affected the length of finishing in the feedlot since no compensatory gains occurred during the finishing phase.

Anglin et al. *(5)* evaluated the restriction of feed intake to minimize backgrounding feed costs in a drylot setting while leveraging compensatory growth during the subsequent grazing season. In this study, calves were restricted to 2.50%, 2.25%, and 2.00% body weight compared to calves provided ad libitum feed. The NEg level of the diet provided for all treatments was 0.53 Mcal per pound (DM basis). As expected, all feed-restricted calves weighed less after 67 days in the dry lot. However, after 90 days of grazing, all restricted calves gained significantly faster than the dry lot, ad-lib-fed calves (Table 1).

In the study by Lewis et al. *(72)*, which looked at gains of 0.62, 0.84, and 1.09 pounds per head per day, most of the lost winter gains were regained during the grazing period. In this instance, the optimal level of the winter gain for stocker performance becomes more of an economic decision, primarily relating to the cost of additional gain and time the cattle will be sold. The cattle that gained 1.09 pounds per head per day during winter gained the most during the finishing phase, but this was due to increased intake rather than compensatory gains with respect to the pasture phase. Increased intake to improve gains is less economically valued than compensatory gains.

In White's *(124)* and Lewis's *(72)* studies, the heaviest animals after wintering remained heaviest after grazing and finishing; however, the weight margins varied. Managing animals' gains concerning the following production phase is an essential economic consideration. Cattle type, particularly frame size, will affect how an animal will compensate; thereby, feeding management may differ.

Seasonal Variation in Cattle Performance

Grasses decrease in quality with increased maturity and seasonal progression through aging and weathering. By the middle of the summer-grazing season, cool-season grasses are dormant and decline tremendously in quality. A fair amount of forage is still available, but the nutritional quality of the mature cool-season grasses is lower. Warm-season grasses are the predominant summer forage, producing 65% to 75% of their yield during mid-summer *(51)*. As grasses mature, leaf production decreases, and stem tissue increases, decreasing forage digestibility and lowering the nutrient content of the plant. Marston and Yauk *(84)* evaluated the nutrient content of native grass samples over five years from southwest Kansas. Crude protein and ADF content levels indicate that grass quality is highest in May and June, steadily declining until October.

Table 2 shows the decline in crude protein and digestibility over the grazing season. Tables 2 and 3 show how this decline in quality affects animal gains.

Animals can be selective when they graze. Cattle selectively graze forage that is lower in fiber and higher in protein. Even on improved pastures containing only one species of grass, beef cows can select forage that is higher in quality than samples obtained by hand clipping *(9)*.

Grass Management

The nutrient content of grass changes from species to species and season to season. Cattle grazing warm-season grasses have different supplemental mineral, protein, and energy needs than cattle grazing cool-season grasses. The most commonly used grazing systems are continuous (season-long) and intensive-early stocked (IES).

TABLE 1. Steer performance of ad libitum and restricted DM intake (% of body weight) during the backgrounding and subsequent grazing period

	Receiving Phase/Receiving period treatment*				
Item	**Ad libitum**	**2.50**	**2.25**	**2.00**	**SEM**
No. head	83	81	81	82	-
Initial wt., kg	420	418	420	420	1.10
Final wt., kg	587[a]	561[b]	557[b]	530[c]	20.48
ADG, lb/d	3.12[a]	2.29[b]	2.13[b]	1.61[c]	0.26
Gain: Feed	0.23[a]	0.20[b]	0.19[b]	0.17[b]	0.06
	Receiving period treatment*/Grazing phase				
Item	**Ad libitum**	**2.50%**	**2.25%**	**2.00%**	**SEM**
Turnout wt., lb	587[a]	561[b]	557[b]	530[c]	20.48
Mid-grazing wt., lb	693	671	671	645	19.8
Final grazing wt., lb	781[a]	770[a]	770[a]	746[b]	21.14
Overall wt. gain, lb	196	207	211	216	8.49
D 1-45 grazing ADG, lb/d	2.33[a]	2.42[ab]	2.51[ab]	2.57[b]	0.22
D 48-90 grazing ADG, lb/d	1.87	2.05	2.05	2.07	0.22
Overall ADG, lb/d	2.09[a]	2.24[b]	2.29[b]	2.31[b]	0.18

Anglin et al. (4)

* Receiving Treatments: steers fed ad libitum; 2.50% body weight: steers fed at 2.50% of body weight; 2.25% body weight: steers fed at 2.25% of body weight; 2.00% body weight: steers fed at 2.00% of body weight.

[a-c] Means within a row lacking common subscript differ ($P < 0.05$).

The native grass intensive-early stocked system involves doubling the number of cattle grazed per acre of rangeland but for a shorter grazing season. In Kansas, this is typically from May 1 to July 15, when forage growth rates are highest and provide the most nutrition. In a traditional five-month continuous-grazing system, 60% to 70% of the total animal gains are achieved during this time. In an intensive-early stocked system, animals are removed at mid-season and moved to other grazing or feed yard. This allows the vegetation time to recover, and research shows that intensive-early stocked does not damage the plant composition in the Manhattan area.

However, a stocking rate greater than 2 times will damage the vegetation at the Fort Hays Experiment Station, and greater than 2.5 times will reduce animal gains. Retained ownership of the cattle should be considered with this type of program. Total gain on pasture is typically reduced per head (by 30% to 40%) because of the shorter grazing period; however, the greater numbers of animals per acre result in substantial increases in gain per acre.

The gain per animal during early-season grazing is usually equal using the intensive-early stocked or continuous system. Grazing distribution is improved, and soil moisture is conserved. Other intensive-early stocked advantages include the ability to market the cattle mid-season, unlike most cattle being marketed at the end of continuous grazing. Also, significant variable production costs, especially interest on investment in stocker cattle, are reduced by about 50% per head by only having the cattle in half of the grazing season.

TABLE 2. Monthly Steer Gains and Nutritive Values of Clipped Kansas Bluestem Pasture Forage—15-Year Average

	May	June	July	Aug.	Sept.
Avg. daily gain, lb	2.28	1.93	1.64	1.23	1.29
Crude protein, %[a]	17.7	11.6	6.0	4.5	4.3
Crude fiber, %[a]	25.9	33.5	32.8	30.8	34.0

[a]Dry matter basis.
Smith (108).

TABLE 3. Daily Gain of Steers Under Continuous Grazing of Nebraska Mixed Prairie Forage—9-Year Average

	May 15 June 15	June 15 July 15	July 15 Aug. 15	Aug. 15 Sept. 15	Sept. 15 Oct. 15
Gain, lb	2.14	2.04	1.76	1.40	0.40

Reece *(98)*.

TABLE 4. Intensive-Early Stocking (IES) at the Fort Hays Experiment Station Effect on Steer ADG and Livestock Production

	ADG (lb/hd/day)				Livestock Production (lb/acre)			
Year	**SLS[a]**	**2 x**	**2.5x**	**3x**	**SLS**	**2x**	**2.5x**	**3x**
1981	1.3	1.9	—	1.7	57	79	—	110
1982	1.3	1.8	—	1.5	57	75	—	99
1983	1.2	1.5	—	1.3	52	61	—	82
1984	1.4	1.5	1.7	1.4	60	64	93	89
1985	1.0	1.3	1.3	1.1	43	54	71	68
1986	1.4	0.9	0.9	0.6	58	38	49	37
1987	1.1	1.4	1.4	1.1	49	62	74	72
1988	1.2	1.2	1.2	0.9	46	40	53	48
Average	**1.2**	**1.4**	**1.3**	**1.2**	**53**	**60**	**68**	**76**

[a]SLS = Season-long stocking. Olson (94).

Steer average daily gains (ADG) and pounds of production per acre for 1981 through 1988 at the Fort Hays Experiment Station are shown in Table 4. Similar data from research conducted in the Manhattan area are shown in Table 5. Both areas were stocked from May 2 to July 15. The Fort Hays stocking rates were 3.5 (season-long), 1.8 (2×), 1.4 (2.5×), and 1.15 (3×) acres per head. For the Manhattan data, stocking rates were 1.75 (2×), 1.50 (2.5×), and 1.25 (3×) acres per steer.

Burning

Intensive-early stocked pasture should always be burned because of the advantage in cattle average daily gain of approximately 0.35 pound per head per day.

As described by Ohlenbusch and Hodges *(93)*, prescribed burning "can be used as a major management tool for native grasslands, especially in the tallgrass areas. It can control many woody plants

TABLE 5. Intensive-Early Stocking (IES) from May 1 to July 15 on Kansas Flint Hills Bluestem Pasture Effect on Steer Gains

	Gains (lb/steer)			Gains (lb/acre)		
Year	**2 x**	**2.5 x**	**3 x**	**2 x**	**2.5 x**	**3 x**
1982	139	128	137	79	85	110
1983	133	122	137	76	81	110
1984	166	166	168	119	123	134
1985	208	184	175	119	123	156
1986	185	190	195	106	127	156
1987	178	182	187	101	121	145
Average	**168**	**162**	**166**	**96**	**108**	**133**

Owensby et al. *(95).*

and herbaceous weeds, improve poor grazing distribution, reduce wildfire hazards, improve wildlife habitat, and increase livestock production in stocker operations. To gain these benefits, fire must be used under specified conditions and with proper timing. Not following appropriate precautions can lead to tragic results. The average recommended dates of burning (based on tallgrass increase) are shown in Figure 1. It should be noted that these dates may be as much as 10 days earlier or later depending on growing conditions."

Burning in western Kansas is limited to controlling brush and weeds and improving grazing distribution. Grazing distribution can be improved by burning areas that are not usually grazed or are undergrazed. Animals are attracted to the burned areas since the grasses are more accessible and palatable. The overgrazed areas generally will not have enough fuel to carry a fire and will be used less and can recover.

The proper burning date is critical regarding the effect on vegetation and cattle performance. Burning to favor desired plants should occur when they are just starting to green up and have 1 to 1½ inches of new growth. The soil profile should be filled with water, and the surface should be wet *(92).*

Prescribed burning increases summer gains of growing cattle by 9% to 12% or more, with most of the gain occurring in the first half of the summer *(8),* as illustrated in Table 5 with data collected in Manhattan, Kansas. Steer gains on burned and unburned bluestem

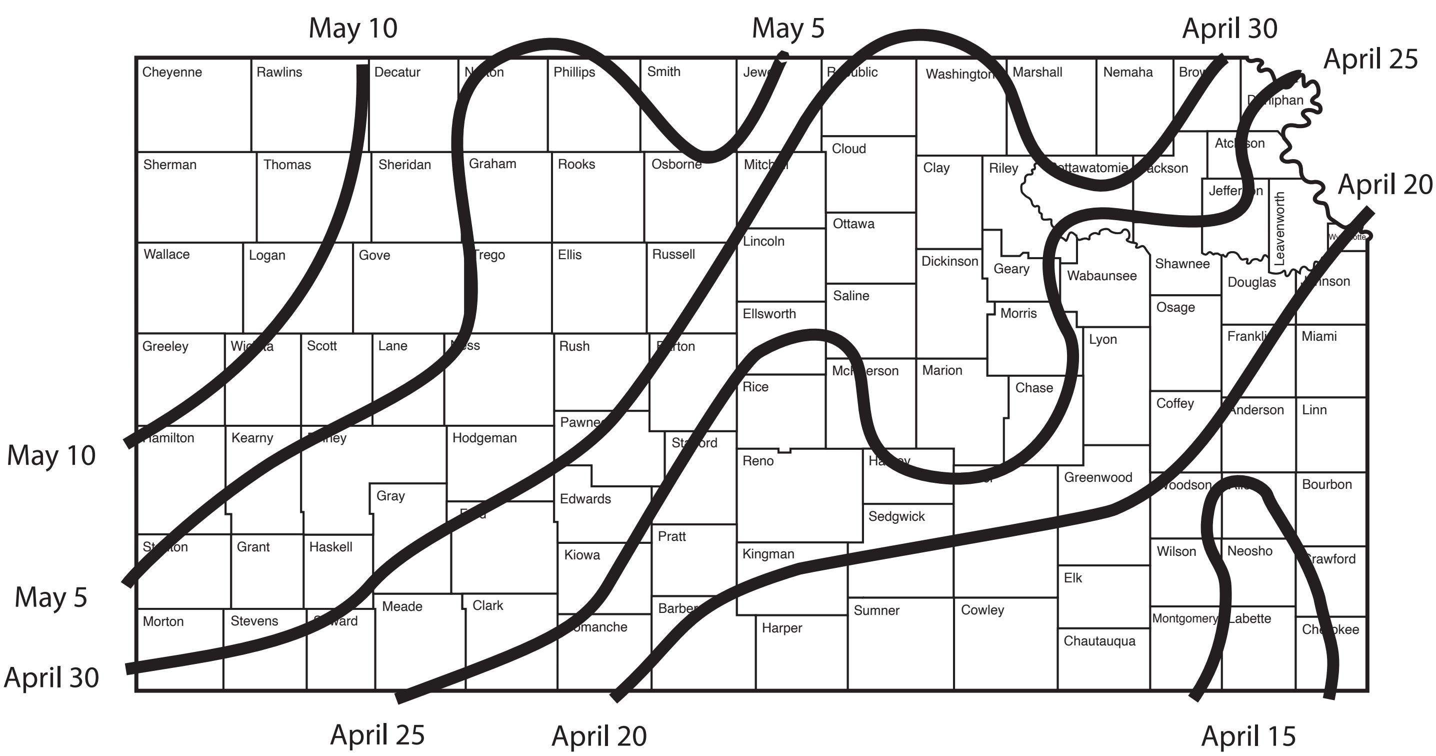

FIGURE 1. Average last date of spring occurrence of 32° Fahrenheit low temperature in Kansas

pastures over five years (1978-1982) were 21% greater each year when cattle grazed burned pastures than unburned pastures *(109)*. The increased performance resulted from the animals consuming a larger quantity of more digestible forage *(103)*.

Intensive-early stocking and burning. As shown in Table 2, the highest animal gains occur early in the grazing season on burned (and unburned) pastures, which lends itself to possible intensive-early stocking management. An economic analysis of intensive-early or season-long stocking using burned versus unburned pastures found that intensive-early stocking returns exceeded season-long stocking *(8)*.

Prescribed burning improved the receipts for both programs, but the increase was proportionally greater for intensive-early stocking in terms of average daily gain. The mean estimated returns for unburned pastures with season-long or intensive-early stocking were $5.14 and $6.61 per acre, respectively. The returns for burned pastures with season-long or intensive early stocking were $6.25 and $13.36 per acre, respectively.

Recent research at Kansas State University has evaluated the effect of shifting the timing of prescribed fire application from spring to late summer or early fall as a strategy to control sericea lespedeza and old world bluestem infestation *(42, 49)*. Shifting prescribed-fire timing from spring to summer resulted in similar stocker cattle growth performance and native rangeland plant composition.

TABLE 6. Effect of Burning on Average Monthly Steer Gains (lb/hd/day; 16-year Summary, 1950-1965)

	May	June	July	Aug.	Sept.	Avg.
Unburned	1.83	1.74	1.59	1.24	1.44	1.53[a]
Early-spring burned	2.42	1.90	1.56	1.13	1.23	1.57[ab]
Mid-spring burned	2.50	2.31	1.64	1.28	1.19	1.64[bc]
Late-spring burned	2.36	2.06	1.75	1.28	1.28	1.70[c]

[abc]Two means not bearing a common superscript differ significantly ($P < 0.05$).
Smith *(97)*.

TABLE 7. Effects of Feeding Ionophores On Stocker Cattle Gains

Number of trials	Method	Intake, mg/hd/day	Weight Gain, lb/hd/day	
			-ionophore	+ionophore
Rumensin				
47 trials	hand-fed	144	1.52	1.62
12 trials	self-fed	88	1.37	1.52
Bovatec				
9 trials	hand-fed	193	1.64	1.81
3 trials	self-fed	162	.78	.80

Rumensin studies *(77, 80, 101, 115, 125)*
Bovatec studies *(8, 33, 37, 48, 50. 59, 78, 111)*

Ionophores

Feeding ionophores is a highly recommended practice in stocker cattle production.

Rumensin improves daily gain in grazing cattle, allowing more energy to be produced per unit of feed. Average daily gain increased by 0.11 pound per head per day for animals fed 1 pound or more of Rumensin supplement per head daily *(108)*. When Rumensin was fed to cattle grazing low-quality forage, gains were increased by an average of 0.12 pounds per head per day. Most trials fed Rumensin at 200 milligrams per head per day, with a few using 100 or 150 milligrams per head per day. Brazle (unpublished) showed improved gain when Rumensin was consumed at 115 milligrams per head per day or more, but this increase in gain was cut in half when Rumensin intake was only 75 to 90 milligrams per head per day. Stocker cattle which were self-fed Rumensin supplements, gained similarly to hand-fed cattle when consuming 0.5 pounds or less of supplement and grazing good quality forage.

In self-fed supplements, Rumensin tends to decrease intake. Feeding Rumensin to stocker cattle improves weight gains, primarily through improving feed efficiency. A summary of research on feeding Rumensin to stocker cattle appears in Table 7.

Bovatec produces similar results to Rumensin when included in hand-fed supplements *(Table 7)*, increasing daily gain by an average of 0.17 pound per head per day. Bovatec is more palatable than Rumensin. Therefore, it is the ionophore of choice when limiting intake in a self-feeding system because higher levels can be incorporated. Rumensin reduces the requirement for salt by 30% to 40% when self-feeding large amounts of grain. Therefore, it would be the ionophore of choice when a high percentage of salt is used to limit grain intake. Feeding ionophores is a highly recommended practice in stocker cattle production.

Salt and Mineral Supplementation

Performance improvements may or may not occur by providing a mineral supplement. It is, however, low-cost insurance and worth the cost. After sodium (Na) and chloride (Cl), phosphorous (P) is the most important mineral for grazing cattle since forages, in general, are low in phosphorous. Native range contains approximately 0.1 to 0.2% phosphorous and 0.3 to 0.5% calcium when growing but only about 0.05% P and 0.25 to 0.30 per- cent calcium when dormant.

These levels of calcium (Ca) are adequate but are quite low for phosphorous in the dormant stage and marginal in summer. Therefore, a mineral supplement fed free choice should contain 4% to 8% phosphorous. Protein and grain supplements help provide phosphorous and some trace minerals. Research shows copper and zinc as two trace minerals that may improve performance when included in a supplement.

Mineral forage levels vary depending on species, fertilization, weather conditions, and region. In the past, research in Kansas has not shown benefits from supplying supplemental phosphorous.

Using stockers grazing Flint Hills native grass, Weibert et al. *(123)* evaluated the efficacy of providing salt alone or with injectable trace minerals compared to a complete mineral supplement. After the 90-day trial, there was no growth response to a salt block and injectable trace mineral supplementation compared to a complete mineral.

When supplementing cool-season grasses, particularly ones that may cause grass tetany, such as wheat, rye, fescue, or brome grasses, the mineral mix should contain 6% to 10% magnesium. Ionophores increase the absorption of magnesium, phosphorous, and sodium and may also help prevent tetany problems.

Antibiotics

Antibiotics have been used for improvement in performance of stocker and backgrounding cattle *(18, 36, 86, 14, 122)*. However, as of January 1, 2017, with the implementation of the Veterinary Feed Directive, the use of medically important antibiotics for production purposes (improving weight gain, or feed efficiency) is no longer legal. This regulation was implemented to ensure the judicious use of medically important antibiotics (shared use with human medicine) in food producing animals by putting their use under veterinary supervision to curb and slow the development of antibiotic resistance. Feed-grade antibiotic use is still available to treat and control on-label diseases in growing cattle with written authorization from a licensed veterinarian.

It is important to know that while ionophore use does not fall under Veterinary Feed Directive status, combining an ionophore with a Veterinary Feed Directive medication in feed does. Only FDA-approved use combinations can be legally fed to cattle. Off-labelled use of feed grade medications is illegal. A complete listing of approved feed medications and their blue-bird labels can be found on the FDA website: *https://animaldrugsatfda.fda.gov/adafda/views/#/blueBirdLabels*

When are protein and energy supplements needed?

Supplementation can dramatically affect performance during all seasons of grazing. Balancing dietary protein and energy in supplements is important to ensure a successful response to supplementation. Generally, the most limiting or deficient nutrient should be supplied first. The key is to have a good idea of the forage quality being grazed and to adjust the supplement used accordingly.

All supplements are a source of energy and protein. However, those feedstuffs that are higher in their concentration of crude protein (CP) are classified as protein supplements (i.e., soybean meal, cottonseed meal, corn gluten meal,), and those with lower crude protein concentrations relative to energy would be classified as energy supplements (i.e., corn, sorghum, wheat).

The goal of supplementation is to optimize performance or gains, but the value of the gains must be examined from an economic standpoint. The economics of supplementation should be scrutinized within each operation, as discussed by Brethour *(12)*.

The value of added gain needs to be weighed against how that extra weight affects market price and the costs associated with the labor, equipment, etc., it took to feed the supplement, above the cost of the supplement itself. Because many factors can affect the responses, each producer's supplementation program should be tailored to the individual enterprise. The benefits of supplementation can be numerous:

1. Implants increase gains more in supplemented cattle than those that are not.
2. More uniform gains are often achieved with supplementation.
3. Feeding a supplement provides the carrier to feed an ionophore.
4. Supplemented cattle often perform better in the feedlot because they are already partially adapted to grain and an ionophore.
5. Handfeeding tends to quiet the cattle and make them more manageable, particularly at sale time, causing less weight loss.
6. Supplementation forces a closer observation of the cattle, which can be valuable.

Early summer grazing. Supplementing animals during the early portion of the grazing season, when pastures peak in quality, has yet to be researched extensively. This is likely because forage quality is adequate, and supplementation is unnecessary compared to other times of the year. Animals will, however, respond to energy and protein supplementation during the early summer (May through mid-July). A Kansas State University study *(43)* evaluated the provision of dried distillers grains and solubles (DDGS) with steers in an intensive Flint Hills grazing system (250 pounds live weight per acre for 90 days). The supplemental treatments were fed from June 15 through August 3 in feed bunks in each pasture. The treatments were control (no supplement) and pelleted sorghum distillers grains and solubles supplemented daily at 0.25, 0.50%, and 0.75% of body weight. All cattle provided distillers grains and solubles had a significantly more significant average daily gain than unsupplemented cattle. In general, weight gain increased as levels of distillers grains and solubles increased. However, subsequent performance in the feedlot was lowest for steers fed the highest level of distillers grains and solubles during the grazing period.

Up to 4 pounds of grain sorghum per head per day can be supplemented with minimal effects on forage use and subsequent feedlot gain or efficiency *(117, 32)*. Whether corn, wheat, or grain sorghum is used does not appear to affect these results *(118)*. When intensive-early stocked steers grazing native tallgrass prairie were supplemented with either 0, 2, or 4 pounds per head per day of grain sorghum, respective gains were 2.5, 2.7, and 2.9 pounds per day *(31)*. At Fort Hays (1981-1985), feeding 4 pounds of grain sorghum (with 200 milligrams Rumensin) per head per day to steers grazing shortgrass prairie increased daily gains by 0.56 pounds per head per day with an efficiency of 7 pounds supplement per pound of gain. At Manhattan (1981-1984), feeding 1.4 pounds grain sorghum (with 156 mg Rumensin) per head per day to steers grazing tallgrass prairie increased daily gains by 0.35 pounds per head per day with an efficiency of 4 pounds supplement per pound of gain.

Feeding energy-based supplements when protein is the more limiting nutrient can lead to an imbalance of protein levels and less efficient use of the total diet. A Oklahoma trial compared feeding calves 1 pound per day of a 38% crude protein supplement or 3 pounds per day of a 15.5% crude protein supplement for the first 28 days, increasing to 3 pounds per day of a 25% crude protein supplement for the final 28 days, to calves receiving no supplement *(88)*.

Both supplemented groups gained more (1.60 pounds per head per day) than the unsupplemented groups (1.23 pounds per head per day); however, the efficiency of supplement conversion was quite different, being 2.3 pounds supplement per pound of gain for the 38% crude protein supplement versus 9.2 pounds supplement per pound gain for the higher energy supplement. These results suggest that supplemental protein is helpful during the early summer in tallgrass prairie.

In all trials reviewed, an ionophore was included in the supplements. The importance of this and its effect on gains should be realized. In addition, while increasing amounts of supplements will increase gains, the efficiency of gain will frequently decrease. The optimal level of supplementation ensures an optimal cost-to-benefit ratio.

Supplementation should *enhance* forage use, and often when the amount of supplement is too high, it starts replacing or can often depress forage utilization.

Late-summer through winter grazing. Forage quality decreases substantially after mid-July, particularly in protein content. Intake and digestibility also decrease as quality decreases. If protein is limited, it restricts the ability of the rumen microbes to break down the diet, causing poor diet use.

Growing cattle, mainly young, lightweight cattle, often need more protein throughout the grazing period than the native range can provide. Animal gains must be adequate to economically justify grazing this part of the season, particularly for stocker operators.

This may justify supplementation under some conditions. An increase in hay intake and diet digestibility was found with increasing soybean meal supplementation to cattle grazing medium-quality prairie hay (harvested in July) *(Table 8).*

Kansas State University examined the effect of feeding 3.5 pounds per head per day of three different soybean meal (SBM)/grain sorghum protein supplements (13%, 26%, and 39% crude protein) to 700-pound steers grazing dormant tallgrass range.

The 26% protein supplement increased forage intake by 51% and 32% greater than the 13% and 39% protein supplements, respectively *(39).*

Oklahoma research compared feeding 0.8 or 1.5 pounds per head per day of a protein supplement or supplying the same amount of protein as the 0.8 pound supplement in 3.0 pounds of a corn-based supplement *(Table 9).* All supplements increased forage intake, digestibility, and average daily gain. More response was achieved from the protein supplements compared to the energy supplement, with the energy supplement converted much less efficiently to gain, costing 2 to 3 times as much as the protein supplements per pound of added gain.

TABLE 8. Effect of Soybean Meal Supplementation on Prairie Hay Intakea and Digestibility

	Soybean meal per day, lb				
Item	**0**	**0.3**	**0.6**	**0.9**	**1.5**
Hay intake, lb	10.4	11.2	13.1	13.6	15.0
Hay intake, % of BW[b]	1.88	2.03	2.36	2.44	2.68
Total intake, lb (hay + supplement)	11.3	12.4	14.6	15.3	17.3
Dry matter digestibility, %	38.7	41.4	46.9	47.3	50.0

Guthrie et al. (54).
[a]Dry matter basis.
[b]BW = body weight.

TABLE 9. Effect of Protein or Energy Supplements on Forage Utilization

Item	No supplement	0.8 lb/day 34% CP	1.47 lb/day 39% CP	3.1 lb/day 12% CP
Hay intake, lb	9.1	13.1	15.2	12.4
Dry matter digestibility, %	49.6	54.3	58.4	56.0
Avg. daily gain, lb	1.44	1.88	1.97	1.78
lb supplement/ lb added gain	—	1.8	2.8	8.8
cost of added gain, ¢	—	20.8	36.0	60.0

Adapted from Lusby et al. (81) and Guthrie et al. (54).
The protein supplements were based on soybean meal and the energy supplement on corn.

Many types of protein supplements can be used effectively. Corn gluten feed (CGF) has been examined as a possible protein supplement for cattle grazing dormant native range grass *(41, 85, 107).* Corn gluten feed was found to have no adverse effect on forage digestion or intake and effectively increased weight gain in growing cattle consuming dormant native range grass.

Alternatively, distillers grains and solubles can be used to extend late-season grazing to generate economically feasible rates of gain. Kansas State University research *(44)* provided late-season

(September) supplementation at different frequencies per week (every day, every other day, or every third day). All calves were provided the equivalent of 0.33% of body weight (dry basis) of distillers grains and solubles. At the conclusion of the 72-day trial, the average daily gain was not different among the treatment groups.

In another Kansas State University study *(113)*, distillers grains and solubles was provided to heavy yearling stocker cattle grazing native tallgrass pastures during the late summer and fall at the daily rate of 1% of body weight (dry basis). As expected, pasture supplementation significantly improved daily gain.

Researchers at Kansas State University have examined the use of wheat middlings as a protein supplement for steers consuming dormant bluestem-range forage *(112, 114)*. Results showed increased forage intake and dietary dry matter digestibility with 3.5 pounds per head per day wheat middling supplementation. It was also found that crude protein concentrations need to be 20% or higher for wheat middlings-based supplements to optimize the usage of poor-quality forage.

When alfalfa hay and dehydrated alfalfa pellets were fed to provide the same amount of protein as a 25% crude protein soybean meal or grain sorghum supplement (0.6 pound protein per head per day), forage intake and digestibility were increased, compared to unsupplemented steers *(40)*.

Current Kansas State University recommendations for supplementing cattle grazing poor quality range forage: Supplements must be 20% crude protein or higher when using grain-based supplements (i.e., soybean meal or grain sorghum).

When supplementing with fiber-based protein supplements (dehydrated alfalfa, corn gluten feed (CGF), wheat middlings), the percent crude protein is less important than the amount (pounds) of crude protein supplied.

Unlike protein supplements, feeding energy supplements (ground corn) to cows consuming poor-quality hay decreases forage intake and digestibility, especially when fed at high levels (greater than 4 pounds per head per day) *(30)*.

High fiber byproduct feeds such as corn gluten feed and soybean hulls have shown promising results as energy supplements in that they do not decrease forage intake as much as high starch energy feedstuffs. While corn gluten feed has been mainly examined as a protein supplement, when fed to heifers in late summer native range, heifers supplemented with soybean meal with corn gluten feed or corn gluten feed gained more weight than soybean meal -supplemented heifers (1.7, 1.6 vs. 1.4 pounds per day, respectively) *(45)*. Cows fed 6.2 pounds per head per day of a corn/cottonseed meal mixture, or 7.8 pounds per head per day of soybean hulls lost less weight and body conditioning (–132 pounds, –0.6 units change; –101 pounds, –0.3 units change) than cows fed 3.3 pounds per head day of cottonseed meal (–154 pounds, –1.1 units change) *(56)*. Low-quality hay intake in cows supplemented with either 0, 2.2, 4.4, or 6.6 pounds of soybean hulls was maximized with 2.2 pounds of soybean hulls *(83)*. Soybean hulls provide an alternative to cereal grains as a high-energy supplement to cattle consuming low-quality forage.

Feeding urea (or nonprotein nitrogen) usually gains less than natural protein supplements. Cows grazing low-quality native range lost more weight when supplemented with extruded urea-grain or 15% crude protein soybean meal supplement, compared to cows receiving a 30% crude protein soybean meal supplement *(69)*. Lactating cows grazing native range forage lost more weight and consumed less forage when supplemented with urea than cows receiving a natural protein supplement *(46)*.

A two-year Kansas State University study (Pflughoeft et al., *96)* was conducted to measure the effects of nonprotein nitrogen (NPN; i.e., biuret) or nonprotein nitrogen + ruminal modifier (i.e., biuret + lasalocid) inclusion in a commercial mineral mix on the growth performance of yearling beef calves grazing in the Kansas Flint Hills. Total body weight gain, daily gain, and mineral consumption did not differ between treatments over the 90-day grazing period.

Steers fed a natural protein source (cottonseed meal) gained 3.4 pounds per head more than steers supplemented with corn/urea *(87)*. While urea is a cheap source of protein, and using it in a self-feeding program (such as mixed with molasses in lick tanks can be a less expensive route), one must realize that animal gains will be reduced compared to animals receiving natural protein sources.

It is important that if you supplement with an energy-based supplement during the winter, you can depress forage intake and digestibility. Feeding approximately 2 pounds per head per day of a high protein (greater than 35% crude protein) supplement to cattle grazing native range should support 0.3 to 0.5 pounds gain per head per day. Dormant native range grasses are low in protein (2% to 5% crude protein); protein is generally the first limiting nutrient. While protein supplements can be fed three times per week, energy supplements usually depress grazing performance if consumed in large amounts at one time and should be fed daily.

Will supplementing on pasture affect feedlot gains?

The effect of feeding 4 pounds of ground corn to steers grazing irrigated pastures of orchardgrass, smooth bromegrass, and alfalfa mixtures *(Table 10)* decreased the time required to finish steers in the feedlot *(62)*. Feeding 4 pounds grain sorghum with 200 milligrams Rumensin per head per day to steers grazing summer grass increased gain on pasture. Pasture, feedlot, and total pounds gain per steer were 117 vs. 156 pounds, 396 vs. 413 pounds, and 513 vs 569 pounds, respectively, for non-supplemented versus supplemented animals. Feed conversion of the supplement on pasture was 7.4 pounds per pound added gain. The supplemented steers retained the added weight gained during grazing and gained slightly faster in the feedlot *(26)*.

In the Kansas State University study discussed above *(113)*, distillers grains and solubles was provided to heavy yearling stocker cattle grazing native tallgrass pastures during the late summer and fall at the daily rate of 1% of body weight (dry basis). In the feedlot, the control cattle had greater (P<0.01) average daily gain and similar dry matter intake than supplemented cattle. For this reason, the feed efficiency of control cattle during the finishing period was greater (P=0.02) than cattle supplemented with distillers grains and solubles. Stocker operators can supplement DDGS while grazing late-season native tall grass pastures to increase weight gain and improve carcass red meat yield without affecting quality or yield grade.

Are supplements needed when grazing winter wheat?

Winter wheat pasture generally contains 20% to 30% crude protein, which is more than adequate for cattle. However, feeding 1.75 pounds per head per day of protein supplements that are not digested very well in the rumen and by-pass partially to the small intestine (e.g., blood meal, brewers grain, etc.) has increased daily gains by approximately 0.25 pounds per head per day or 11.8% over animals not receiving supplement *(4, 61, 120)*. Feeding cottonseed meal, which is intermediate in ruminal protein digestibility, showed similar gains *(61, 120)*. The increased gains achieved when supplementing protein to cattle grazing wheat pasture are due to increased forage intake *(2, 3, 119)*. When moderate to high levels (1% to 1.5% of body weight) of grain were supplemented to cattle grazing small grain pastures, gains ranged from 0.11 to 0.65 pounds per day with a supplement conversion of 6.7

TABLE 10. Effect of Pasture Supplementation (Ground Corn) on Pasture Gain and Feedlot Performance

Pasture Supplement lb/day	119 d Pasture Gain, lb/d	Subsequent Feedlot Performance				
		Initial Wt., lb	Final Wt., lb	Days on Feed	Daily Gain, lb	Feed/Gain, lb
0	1.43	675	1,174	144	3.49	5.9
1	1.45	686	1,168	137	3.52	6.0
2	1.50	673	1,129	130	3.51	6.0
3	1.65	715	1,174	123	3.73	5.5
4	1.94	735	1,160	116	3.65	5.6
5	1.87	711	1,100	109	3.57	6.1
6	1.87	724	1,100	102	3.69	5.9

Lake et al. (63)

to 10.3 pounds of supplement per pound of increased gain per acre *(57)*.

Supplementation with either a corn-based or high-fiber energy supplement allowed stocking density to increase from 2 to 1.5 acres/steer. Daily gain was increased by supplementation (2.14 pounds per head per day vs. 2.26 pounds per head per day for unsupplemented vs. supplemented steers). Also, fiber-based supplemented steers gained more than corn-based supplemented steers (2.19 pounds per head per day vs 2.30 pounds per head per day for corn-based vs fiber-based) *(60)*.

How can I use salt to limit supplement intake and allow self-feeding?

Rich et al. *(98)* at Oklahoma State University wrote an excellent publication on limiting feed intake with salt, the highlights of which will be presented here.

In using salt to control supplement intake, formulate the supplement using a daily voluntary salt intake at 0.1 pound salt per 100 pounds body weight. Use coarse, plain white salt, *not* trace expensive mineralized salt that could cause mineral imbalances when consumed at high levels. If trace mineralized salt is included in the supplement, it should be consumed at < 0.02% of the animal's body weight (i.e., 0.1 pounds for a 500-pound animal).

The other supplement ingredients should be similar in particle size as the salt, so animals cannot sort out the salt. Adequate forage must be available, so the cattle are not forced to eat the supplement to survive.

TABLE 11. Effect of Water Source on Performance Traits

Water Source	No. of pens	ADG, lb	Avg daily feed, lb	Feed/ gain	Water, gal/d
N–N	16	2.34[c]	15.1[c]	6.59[b]	7.74
N–S	16	2.14[b]	14.4[bc]	6.94[c]	7.82
S–N	16	2.09[b]	13.7[b]	6.75[bc]	7.87
S–S	16	2.12[b]	13.8[b]	6.86[c]	8.27
SE		.04	.15	.08	.21

Adapted from Ray *(97)*
[a]N = 1,300 ppm dissolved salts. S = 6.000 ppm dissolved salts. Combinations of N and S refer to water source during consecutive 56-d periods.
[bc]Means within column with different superscripts differ (P < 0.05).

If the animals have never eaten concentrates before, a week may be needed to hand-feed the supplement without salt as training. Then begin feeding the salt-containing supplement at a high salt level (50:50 or 60:40 salt to meal) to prevent overeating. Then reduce the salt level to obtain the desired level of intake. The salt content may need to be adjusted as the animals become accustomed to the supplement.

A Kansas State University study *(90)* evaluated the use of salt to restrict the consumption of distillers grains and solubles in a self-fed fashion while calves were in an intensive Flint Hills grazing system. The grazing density was increased from 200 (control) to either 225 or 250 pounds of live weight per acre while simultaneously providing salt-limited distillers grains and solubles containing 16 and 10% salt, respectively. Compared to the control treatment, both distillers grains and solubles treatments resulted in significantly greater average daily gain (P<0.001); however, gains were not different between either level of salt inclusion (P = 0.27; 11.2 vs. 7.7 pounds distillers grains and solubles per pound of added gain for 10 and 16% salt inclusion treatments, respectively).

If an ionophore is included in the supplement, this may or may not depress intake. Therefore, less salt may be needed. Research shows that intake can be depressed by feeding Rumensin. The salt content in the Rumensin-containing supplement was 40% lower (12% vs. 19%) than the supplement not containing an ionophore, yet intake of the supplement was still depressed by 11.7%. Also, half as many adjustments in salt levels had to be made in those supplements containing Rumensin *(34, 91)*.

Most important when feeding salt-limited supplements is the availability and quality of water. The rule of thumb is that water consumption will increase by 50% to 75%. The amount of salt in the water will affect how you use salt-limited supplements.

Salt content in water is measured by total dissolved solids (TDS), which include calcium, magnesium, salt, sulfates, and bicarbonates. If total dissolved solids level is high, the salt content in the supplement must be reduced. If the total dissolved solids level is greater than 5,000, caution is advised. In that case, salt-limited supplements are probably not recommended. The supplement might be refused, or the cattle forced into a toxicity situation.

Don’t overlook water!

Water is the most important nutrient required by the animal in the largest amounts. It is also the most abundant and the cheapest to provide. The body can lose and yet still survive 100% of its fat, 50% of its protein, but less than 10% of its water. After one day of water deprivation, the animal becomes uncomfortable and goes off feed; after two days the animal becomes sick, and by three days it will probably die.

The major factors affecting water requirements are age, performance level, environmental conditions, salt and feed intake level, and the nature of the diet. A 600-pound growing animal will consume 5to 6 gallons per head per day during winter, 7 to 8.5 gallons during spring and fall, and increase consumption as much as 13 gallons during the hot summer months *(47)*.

Restricting water intake leads to reduced feed intake. The body will compensate by keeping the feed in the gastrointestinal tract longer and digesting it more completely. The increased digestibility, however, will not fully compensate for the loss of performance from eating less feed. If water has been restricted for some reason and then suddenly made available, overdrinking or water toxicity can be a problem. *Force gradual* access to the water initially when the animals are extremely thirsty.

The mineral content of the water or water quality can also affect water and feed intake as well as animal performance. Water quality, as described in the previous section, is measured by its total dissolved solids (TDS) content. Ray *(95)* studied the effect of normal (N) levels of dissolved salts in water versus high total dissolved solids levels (described as saline water, S) on feed and water consumption and performance *(Table 11)*. Four water treatment combinations were used in two consecutive 56-day periods.

If water high in total dissolved solids is all that is available, water consumption may be slightly increased, while feed consumption will decrease. Consuming excessive amounts of some minerals can lead to imbalances of other minerals, such as copper deficiency resulting from excessive levels of molybdenum or sulfur. If water is moderate in total dissolved solids content and if feed levels become high in minerals and other compounds (such as in years of drought), problems can arise: Nitrate toxicity for example.

Water facilities can be used for the proper distribution of livestock. Cattle should not have to travel long distances for water. Rather than travel long distances to better forage, cattle will graze the areas closest to water. The optimum traveling distance to water is ⅜ to ¾ mile (maximum 1 mile) on rolling terrain and ¾ to 1 mile (maximum 1½ miles) on flat terrain *(104)*.

Range cattle also have a preference of water source that can affect intake. Cattle prefer water source in this order *(116)*:

1. Tank water from well or spring
2. Tank water from pond
3. Pond
4. Pool in stream
5. Flowing stream
6. How will the following factors affect gain?

How do heifer and steer gains compare? Steers typically gain 0.20 pounds per head per day more than heifers on grass. In a 1999 report that compiled 29 field trials over 10 years (19), the pooled gain differences between steers vs. heifers were 2.3 vs. 1.9 pounds average daily gain, respectively. However, significant changes in cattle size and type have occurred over the past 24 years. In a study where heifer and steer mates were grazed on red clover and fescue pasture, the steers outgained the heifers by 0.15 pound per head per day. However, when stocker cattle are not gaining at their maximum genetic growth level, then differences in gain between classes and types of cattle narrows. In some cases, there may be little difference in pounds of gain per day between steers and heifers if fed to gain l to l.5 pounds per head per day.

Age or weight. Age or weight does not accurately describe cattle type without information on frame size and breed. Previous nutrition and other factors come into play when predicting how just age or weight will affect stocker gains. Brazle and Higgins, 1999 *(19)* reported that yearling steers grazing native grass pastures gained faster (2.68 vs. 2.45 pounds per day, (<0.004) than calves.

Generally, the most desirable weight range for steers grazing native grass pasture for fewer than 100 days is between 500 and 599 pounds *(19).* Conversely, the most desirable starting weight for heifers grazing native grass is between 400 and 499 pounds. With heavier heifers, there is a decline in gain, particularly when starting weights are greater than 700 pounds. Based on the data analysis of Brazle and Higgins (1999), the cattle's weight, age, and condition can significantly affect their performance while grazing native grass.

Generally, in fall-weaned calves ranging from 250 to 550 pounds grazing wheat pasture, the lightweight steers will gain more than the heavier steers *(58).*

In a three-year study where short yearling heifers (ranging from 295 to 650 pounds) grazed burned, double-stocked native grass, the lighter-weight heifers had slightly higher gains *(17).*

You might ask how gains (and profitability) would be affected if the cattle were put directly into the feedlot after weaning versus normal backgrounding and then finishing.

A Nebraska study *(Table 12)* has shown that calves placed directly in the feedlot for 206 days consumed less feed and gained slower but were more efficient in the finishing period compared to calves that were grown on forage (wintered and summer grazed for a total of 280 days) and then placed into the feedlot. From an economic standpoint, the cost of gains was similar, with grain price and wintering costs the primary factors. The cattle grown on forage had the greatest returns regardless of grain price because of the increased total weight produced.

TABLE 12. Performance of Cattle in Two Production Systems – 3 Years Data

Item	System	
	Weaning – Finishing	Weaning – Pasture – Finishing
Weight, lb		
Birth	88	88
Weaning	518	513
After stalks (59 d)		591
After winter (fed husklage for 106 d)		709
After pasture (115 d)	854	
Final	1,169$_a$	1,311$_b$
Daily gain, lb	2.76$_a$	3.75$_b$
Feedlot fee/gain, lb	6.34$_a$	7.29$_b$

Adapted from Lewis et al. *(71).*
[a]Means within rows with different superscripts differ ($P < 0.05$).

Breed type or frame score. Recent research shows considerable variation in lifetime performance due to frame size or breed type. Frame size is reflective of breed type, and since frame categories more accurately describe expected performance, it is the terminology that will be used in this discussion.

When assessing how frame size affects stocker gains, previous management and finishing performance must also be examined to get the whole picture. This information is helpful to the cattle producer, stocker, and feedlot operators but is most meaningful to producers who retain ownership through all phases.

Research at Fort Hays State University shows that nutritional management during the winter/spring growing and intensive-early stocking summer grazing phases is related to frame size and how the animal subsequently performs. When the level of nutrition was controlled during the growing phase (January through April) using small-, medium-, or large-framed steers, subsequent frame type response during summer grazing and feedlot performance was measured *(27, 28).* Feedlot performance of large-frame cattle wintered on a low plane of nutrition (1.2 pounds per head per day) was not affected by pasture gains as much as small-frame cattle. The large-frame cattle continued to show compensatory gains into the feedlot phase, while the small- and medium-frame cattle did not.

Whether or not a supplement (4.4 pounds grain sorghum per head per day) was fed to these animals had different effects on the different frame cattle. Summer supplementation response increased when the large-frame steers had been wintered to gain more, but the opposite occurred for the small- and medium-framed steers, who responded more to supplementation when they had been wintered to gain low or medium levels of gain. Brethour and

Mullen *(28)* made the following conclusions and recommendations from this research:

- Feed small-framed cattle more during the growing period than is customary for traditional, full-season grazing. They will retain most of that additional gain until slaughter. This especially holds true if summer supplementation is not practiced.
- If gains of small-framed cattle are kept low during the growing period, and the cattle are thin when turned out on grass, they probably will respond profitably to pasture supplementation.
- If it is not feasible to provide grain supplementation on pasture, do not increase growing-period gains of medium and large-framed cattle above the amount needed to keep cattle in a growing and thrifty condition. Large-framed cattle can compensate when they are full fed during the finishing phase.
- If summer supplementation is feasible, large-framed cattle can be fed to gain as much as 2 pounds per day during the growing period, and most of that additional gain will be retained until slaughter.
- If cattle are sold on a carcass grade basis at the end of the finishing period, it may be important to consider pasture supplementation to increase the proportion of USDA choice carcasses, especially among large-framed cattle that have been wintered at low nutrition levels.

These recommendations were made from the perspective of retained cattle ownership from birth to slaughter. While the large-frame or heavier-weight cattle will generally remain the heaviest after grazing or finishing in the feedlot, they also require more grass or feed to maintain their weights. This means increased feed costs, which the producer should closely examine in his or her situation. Smaller cattle allow heavier stocking rates and, therefore, possibly a different outcome of pounds produced on a per-acre basis.

Breeds are similar in their ability to use forages. However, some research has suggested that Brahman and Brahman-cross cattle may use forage better than other breeds. A Kansas study showed that Longhorn, Simmental, and Brahman cross cattle gained as well or better than typical British crossbred cattle *(99)*. Even during the winter, in Kansas and as far north as Canada, Brahman cross cattle have performed as well and generally better than the typical breeds used in those areas. A 15-trial summary of different breed types grazing native grass pastures in Kansas is shown in Table 13 (Brazle, unpublished). There was little difference in gain between breeds. For grazing periods of 75 to 120 days, there was little difference in daily gain between breeds.

How much will gains be reduced if calves are bought as bulls and castrated on arrival? A five-trial summary in Table 14 shows the effects on gain of purchasing bull calves and castrating them at arrival. Over 74 days, the calves purchased as bulls gained 22% less or 0.36 pounds less per head per day than calves already castrated.

Heifer Management — Should I spay or feed MGA?

Spaying. Several excellent reviews have been written on spaying heifers *(29, 52, 63, 100)*. Spaying heifers will have a minimal effect on gains. A summary of

TABLE 13. 15–Trail Summary of Effects of Breed Type on Cattle Gains on Grass

Breed	ADG
Hereford	1.70
Angus	1.61
Angus–Hereford	1.65
Dairy cross	1.72
Exotic cross (Charolais and Simmental)	1.77
Brahman cross	1.79
Limousin cross	1.69

Brazle. Unpublished data.
Breed types were visually determined. 2,500 yearling cattle were used.

TABLE 14. Summary of Calves Purchased as Bulls (Then Castrated) or as Steers (Five-Trial Summary)

Item	Steers	Castrated bulls
No. cattle	1,949	1,002
Starting weight	541	537
Daily gain, lb (27 d avg)	2.11	1.37
Daily gain, lb (74 d avg, pasture or silages)	1.63	1.27

Brazle et al. *(12, 20, 21)*

seven grazing trials using 491 heifers showed a 5.5% decrease in gain of nonimplanted spayed heifers compared to nonimplanted intact heifers *(29, 100)*. When implants were used, gains were 2.9% greater for spayed versus intact heifers *(29, 52, 65, 100)*. Implanting is always a necessity, but the data illustrate that it is particularly important in spayed heifers.

The primary advantage of spaying is the guaranteed nonpregnant status of the heifer and marketability as such. Pregnancy in feeder heifers is costly, primarily in the feedlot and when slaughtered. Therefore cow/calf and stocker operators must be conscious of pregnancy problems. Pregnancy and possible abortions can also cause gain reductions for the stocker operator. Work published in the 1980s showed spaying was approximately \$0.68 per hundredweight for a 700-pound animal *(29)* while spayed heifers can bring a premium of \$1 to \$3 per hundredweight. *(63).* Not all feedlots will pay a premium, however, depending on their management program for pregnant heifers *(63)*. Other advantages to spaying other than pregnancy prevention:

1. Increased freedom in interstate shipment – spayed heifers are treated essentially as steers.
2. Brucellosis vaccination is not needed.
3. No pregnancy exams needed at time of sale.
4. Heat suppressing agents such as MGA are not needed.
5. Reduced physical activity associated with heat.

The major factors in deciding to spay is the amount of pregnancy risk within the producer's situation and securing premium prices with the feedlot.

MGA or melengestrol acetate. The efficacy of feeding MGA to grazing heifers was examined. When MGA was fed either in a grain-based supplement or mixed with the mineral supplement, gain was not significantly affected but signs of estrus were suppressed *(13, 35, 73)*.

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C723 April 2024