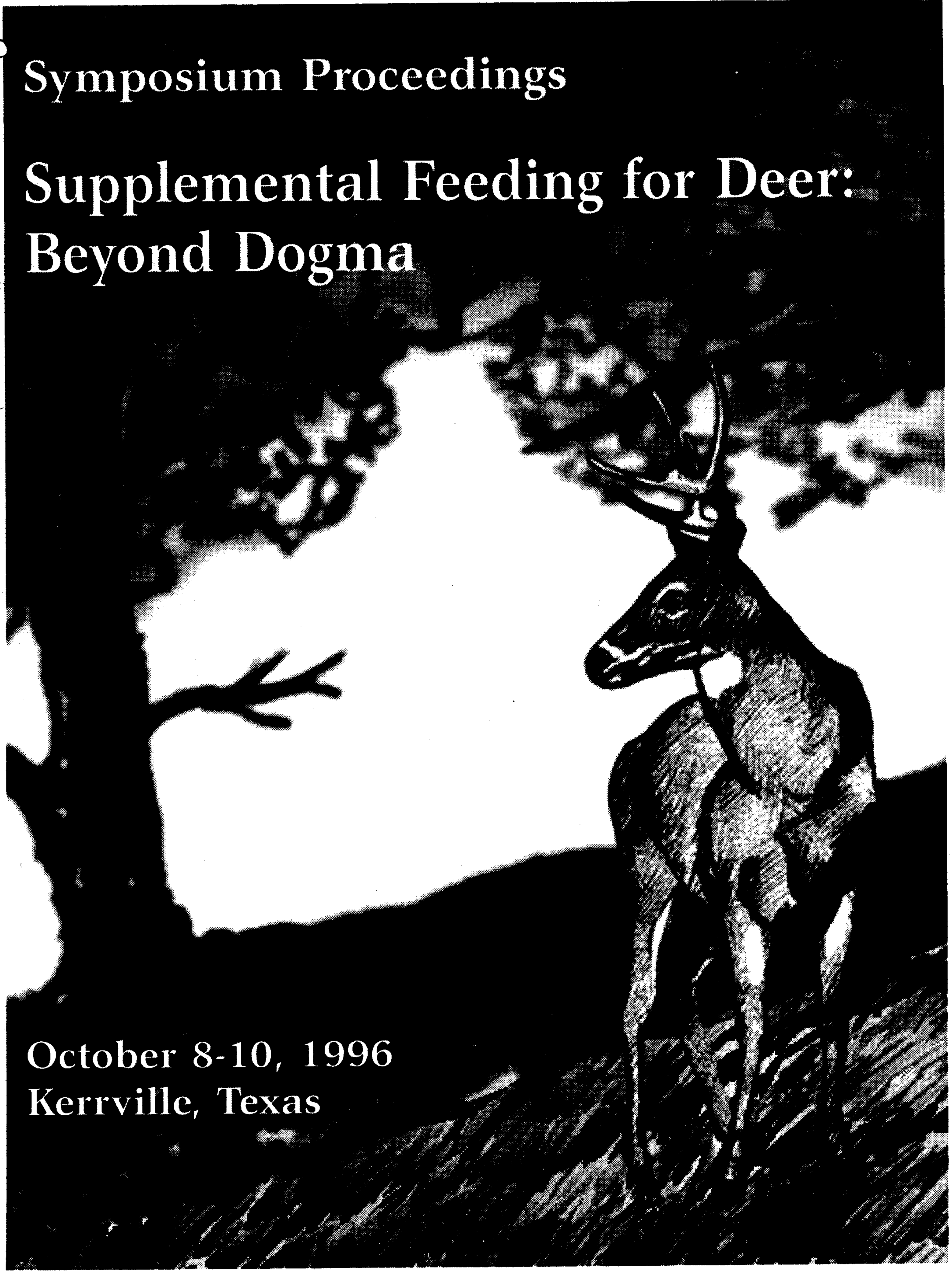
Symposium Proceedings

Supplemental Feeding for Deer: Beyond Dogma



October 8-10, 1996
Kerrville, Texas

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Supplemental Feeding for Deer:

Beyond Dogma

Proceedings of a Symposium

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Edited by

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Foreword

We live in a world that seeks instant gratification. We clamor for silver bullets and quick fixes. A pentium chip is now standard equipment in our computer because the 486 has become too slow. We fast-forward processes whenever possible. We want feed sacks and food plots to do for deer antlers what Polaroid did to photography, microwaves did to Tappan ranges, and the Internet did to the weekly newspaper.

With the possible exception of spike buck management, I know of no other aspect of deer management that is implemented with such zeal and high hopes as that of supplemental feeding. Over the last 10 years, more and more high-fenced properties have sprouted on the Texas landscape, many (most?) with the sole intent of producing more and bigger bucks. We search for nostrums through feed sacks and food plots. We read about their successes in the hunting magazines and we see the photographs of Boone and Crockett trophies, so it must be the way to go. Or is it?

Back in 1988, I was one of the instructors in a program called Total Ranch Management. Much of the S-day course for ranchers was directed at helping them select the right things to do, not just to do things right. There is a distinction between the two. The former involves an examination of the ranch's goals (strategic and tactical) while screening treatment alternatives from a management menu. The latter involves effectively implementing technology in order to achieve those goals. During my portion on wildlife management, I encouraged students to subject any proposed management schemes to the following "acid" test, listed here in order of descending priority:

(a) is the practice ecologically sound?
(b) is it economically sound?, and
(c) does it contribute to the ranch's goals?

The objectives of this symposium are to (a) assimilate the current knowledge on supplementing wild deer under range conditions and (b) instill the critical thinking skills into practitioners to enable them to decide whether supplementation is the right approach for their particular situation.

Webster defines *"dogma"* as *"a doctrine or belief…often asserted without proof.*" One of my most beneficial collegiate courses involved critically reviewing scientific papers which were often tainted by dogmatic thinking or inadequate experimental protocol. Only by a careful review of the facts involved could one form his own opinion about the "truth" expressed therein.

Many practitioners offer testimonials that their supplemental feeding program is effective. When I ask them how they know, they often shrug their shoulders and sheepishly confess "well, *the deer are eating lots of feed*." Obviously, there's considerable confusion about if, when, where, how and why supplemental feeding can be used as a management tool, hence this symposium.

As a professional biologist, I must profess that my colleagues and I carry our own share of dogma and professional heresies. Most of our formal education has addressed supplemental feeding as ineffective, inefficient and/or unethical. Regardless of which side of the feeding debate you're on, you can justifiably argue your opinion, but "*where's the proof*?" There's still much research work needed to pin down the "*it depends*" of the equation.

Expect to hear several recurring themes during this conference. For example, *"it depends"*, *"your particular situation"*, *"supplemental feeding is not a cure-all for poor habitat management"*, and finally, *"I don't know*!" Such caveats suggest that neither the state of the science nor the art on this subject is exact.

Ben Franklin once reminded us that "every person that I meet is in some way my superior, and if I will listen to him, I can learn from him." Speakers at this symposium bring with them a wealth of practical experience, insight and thought-stimulating questions. Listen to their respective presentations and evaluate them critically. Challenge them with your questions and evaluate their debates among themselves. Finally, apply those technologies that hold promise for your respective deer management situation. And that pass the acid test.

Education is a lifelong process.

-- Dale Rollins

NUTRITION REQUIREMENTS OF WHITE-TAILED DEER

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Abstract: To ensure that a deer herd has an adequate diet, we need to know the nutrient requirements of deer. The nutrients of concern are water, protein, carbohydrates, lipids, minerals, vitamins and energy. Water is the most critical of nutrients. Protein is needed for growth, maintenance, and lactation. Carbohydrates are the major source of energy. However, lipids provide 2 ½ times the amount of energy per gram as do proteins or carbohydrates. Minerals are essential for bone and antler growth, but also for milk production, blood clotting, muscle contraction, and general metabolism. Our knowledge of deer vitamin requirements is sketchy. Energy is probably the most variable of the requirements, because it is so dramatically affected by the environment.

What is nutrition? Is it which kinds of acorns a deer prefers? Is how many pounds of forage a deer eats in a day? Is it whether we should supplement our deer, and with what feed? Actually, nutrition is none of those things and all of those things. Nutrition is the study of how animals turn their food into living body tissue. Nutritionists are really not as much interested in what a deer eats as what nutrients are in that food.The nutrients of concern are water, protein, carbohydrates (starch, sugar, and fiber), lipids (fats and oils), minerals, vitamins, and of course, energy. In order to ensure that our deer herd has an adequate diet, we need to know the nutrient requirements of deer, how much food is available, and the nutrient content of that food.

Unfortunately, nutrition is not an exact science. Probably no other species of wildlife have been studied as much as the white-tailed deer, and yet we still know very little about their nutrient requirements. We do know their requirements vary depending on (1) whether they are male or female, (2) whether they are fawns, yearlings or adults, (3) whether they are growing, (4) the season of the year, (5) environmental factors such as extreme heat or cold, and (6) their physiological state, such as pregnancy, lactation, or antler growth.

Complicating matters further are the facts that food availability, by species and amount, changes seasonally, the nutrient content of feeds vary by season, and deer vary their intake over the course of a year. Integrating all of these factors can be difficult and frustrating to the nutritionist, but it is also fascinating work. In this paper, I will briefly review the nutrients required by deer and some of the factors affecting those requirements.

WATER

Water is the most critical of all nutrients. About 70% to 75% of a deer's body is water. Studies have shown that deer can survive about a month with little or no feed, but animals have been known to die in as little as three days without water. My own work has shown that deer will lose weight and go off feed with even a moderate restriction in water (Lautier et al. 1988).

Deer get water from three sources: (1) free water, such as ponds, streams, and the dew on plants, (2) preformed water, or that contained in plants, and (3) metabolic water produced in the animal's cells as part of metabolism. Deer are believed to need about 3 to 6 quarts of water a day, depending on the outside temperature (Brown 1985). It is possible, but we are not sure, that with lush forage available, deer may not need free water at all.

PROTEIN

Protein makes up the building blocks of animal tissue. These building blocks are called amino acids. Protein is needed for normal maintenance, such as blood, hair, and body cell replacement, growth, reproduction, and lactation. Even antler growth requires protein, since the velvet antler, before it mineralizes, is made almost entirely of a protein called collagen.

The protein requirement of weaned white-tailed deer fawns is believed to be about 13 - 20%, possibly even higher (Ullrey et al. 1967). Adults have fairly low maintenance requirements. Earlier studies (Holter et al. 1979) estimated adult maintenance requirements at 8-12%. More recent work (Asleson et al. 1996) suggests adults can be maintained as a 4% C.P. diet and can meet growth requirements with only a 10% C.P. diet. Deer can get by with very little protein, or food at all, in the winter. Pregnancy increases requirements, but not that much, particularly in the first two trimesters. In fact, the average fawn at birth contains only 525 grams of protein, and that is produced over a 6-month gestation period (Robbins and Moen 1975).

Lactation places the greatest demands on a deer for protein. The milk of white-tailed deer averages 8.2% protein on a wet basis or 36.4% on a dry matter basis (Oftedal 1981). Does lacking in protein during lactation will probably not produce a poorer quality milk, but simply less milk. Does with twins obviously have an even higher requirement, again probably around 18% in the diet.

In bucks, even hardened antlers are about 45% protein. We know that body growth takes precedence over antler growth, so if protein is in short supply, the deer will have smaller antlers. In general, we believe a diet of 13 - 16% protein is optimum for antler development.

CARBOHYDRATES

Actually, no animal has a specific requirement for carbohydrates. The soluble carbohydrates, starches and sugars, are the major source of energy for nearly all herbivores (plant-eating animals) and omnivorous (plant and meat eaters), such as we humans. Since the deer is a ruminant (a cud-chewer), like a cow or sheep, it can digest fiber, better known as cellulose. Since deer are mostly browsing animals, their diets contain forbs, grasses, some berries, and brush. In short, they eat little starch, but a lot of fiber.

Fiber is useful to deer not only for energy, but for keeping the rumen healthy. Just like dairy cattle, deer need a fibrous diet, and could not exist for long on solely a concentrate ration. This is important when we supplement deer. A deer getting into a pile of corn could go into a toxic acidosis, just like any other ruminant. Supplemental feeds, if used at all, should be food plots, or pelleted, mixed-grain, high fiber rations.

LIPIDS

Lipids are quite simply defined as fats, if they are solid at room temperature, or oils if they are liquid at room temperature. Deer have no specific requirements for lipids, but the fats and oils in their diets do provide an important source of energy. In fact, lipids have 2 1/2 times the amount of energy per gram as do proteins or carbohydrates. Thus the oils in foods like acorns are important as an energy source. Deer milk is 7.7% fat, nearly double that of cow's milk (Oftedal 1981).

Deer, of course, gain fat during the summer and fall to prepare for winter. But they do not need fat in the diet to do that. They convert the energy in carbohydrates to saturated adipose fat, then draw on that during hard times. This is a natural phenomenon, and one of the reasons the nutrient requirements and feed intake of deer in the winter is so low. Adipose, or depot fat, is readily available for conversion to energy when needed, and the fat in the muscle, known as marbling, is very low in deer.

MINERALS

You would think we would know a great deal about the mineral requirements of deer. Unfortunately, due to the difficulties of working with wild animals, and the lack of adequate facilities and large numbers of deer required for this work, our knowledge of deer mineral requirements is sketchy.

The total mineral content of a deer's body is only about 5%. The major minerals we are concerned about are calcium and phosphorus. These are obviously needed for bone and antler growth, but also for milk production, blood clotting, muscle contraction, and general metabolism.

Hardened deer antlers are about 22% calcium and 11% phosphorus. The many studies of the mineral requirements for antler growth have yielded conflicting results, partly due to a small number of deer in the studies, and party due to the overriding influence of genetics on antler growth. Early studies (French et al. 1956) indicated that .09% Ca and .27% P were the minimum required for antler growth. A later study showed a diet of .64% Ca and .56% P were necessary for antler growth (McEwen et al. 1957). Bob Cowan and Bill Long of Penn State later found that .20% phosphorus was adequate. Harry Jacobson (1984) at MSU suggested P levels as low as 0.14 - 0.29% were adequate. More recently, Grasman and Hellgren, (1993) found that P requirements of adult deer varied between .12% and .16% seasonally. Duane Ullrey (1988) at Michigan State has found that .45% Ca and .30% P are optimal for fawns.

One of the reasons these mineral

levels seem so low, and may be so variable, is the fact that bucks can store minerals in their skeletons, and transfer them to the antler when needed. In fact, during antler mineralization, male deer undergo an "osteoporosis," or removal of minerals from their bones, similar to that which happens in elderly women. The difference, of course, is that after the antlers harden, the minerals lost from the bones are replaced from the diet.

Unfortunately, we know even less about the deer's possible requirements for other macro or micro minerals. Deer probably require sodium, as they will often use salt licks. We don't know if this is because they are lacking this mineral, or perhaps it just tastes good In some areas of the country, selenium deficiencies, which lead to a condition known as white muscle disease, have been suspected. We really have no information at all on the need for other trace elements.

VITAMINS

Our knowledge of deer vitamin requirements it also pretty sketchy. Vitamins are classified as either fat soluble (A, D, K, and E) or water soluble (C and B complex). Fat soluble vitamins are stored in the body, and can, in some cases, become toxic. Water soluble vitamins are not stored and are needed by most animals on a daily basis. Fortunately for the deer, the microorganisms in the rumen (bacteria and protozoa) produce all the vitamin K and B complex the deer needs. Ruminants also have no need for vitamin C.

Vitamin A is converted from a compound in plants called carotene. Deficiencies of vitamin A have been reported in deer (Youatt et al. 1976). Deficiencies can lead to blindness and poor reproduction. Unfortunately, we really don't know what the vitamin A requirements of deer might be.

There has been some work done on vitamin D. One of my students found that circulating levels of vitamin D in the blood varied with the antler growth cycle in bucks (Van der Eems et al. 1988). That makes sense because vitamin D is needed for calcium absorption and metabolism in all animals. We do not know the requirement for vitamin D in deer, and there has not been report of vitamin D deficiency symptoms in deer.

ENERGY

Oddly enough, energy is not really a nutrient. It is a property of other nutrients. Protein, lipids and carbohydrates have energy, whereas water, vitamins and minerals do not. Energy is usually expressed in terms of calories (c), or kilocalories (Kcal). Some cattlemen may be familiar with the TDN system (Total Digestible Nutrients), where energy is expressed as a percent of the diet or pounds per day.

Energy is probably the most variable of the requirements, because it is so dramatically affected by the environment. Basal metabolism is defined as the amount of energy needed to maintain body temperature in a normal environment, allowing for respiration and a small amount of activity. Actual energy requirements are generally about twice maintenance. There are, of course, additional energy requirements for growth, reproduction, pregnancy, lactation, and antler growth. Just as important, there are additional requirements for daily activity such as walking, browsing, avoiding predators, or running from hunters or snowmobiles. Deer need substantially more energy to maintain their body temperature in cold weather, especially if they are forced to move during that time to seek food or avoid danger.

It has been estimated that the maintenance energy required by a 120 pound doe in winter is about 3,192 Kcal/day of digestible energy (Ullrey et al. 1970). Standing increases the energy costs over lying down by about 9%. Locomotion increases energy depending on the speed, surface (such as snow depth and crust), and vertical climb. The overall, actual energy requirement may be as much as twice the maintenance requirement.

ENERGY-FEED INTAKE RELATIONSHIPS

An interesting thing about energy requirements is that they are not directly related to body weight. That is, as the deer gets larger, of course it needs more energy, but it actually needs less per unit body weight. This is also reflected in the white-tail's feed intake patterns. The larger the deer, the less it eats per unit body weight. More importantly, energy requirements and feed intake vary seasonally.

Both bucks and does eat the most in late summer and early fall. This may be the most critical time for deer. Bucks are growing their antlers and laying down fat for the winter rut, does are lactating or weaning their fawns, and fawns are shifting from a milk diet to solid food.

Once winter begins and the breeding season starts, both bucks and does reduce their feed intake. Their minds are on the rut, and even though it and winter temperatures require more energy, they have prepared by storing fat earlier in the year. Deer can easily lose 15% to 20% of their body weight in winter, and recover with the spring greenup.

SUPPLEMENTAL FEEDS AND FOODPLOTS

The critical nutritional times for deer are really spring and late summer-early fall. Deer seldom need supplemental feed in the winter. Our work has shown that deer reduce their intake in winter even if feed is readily available (Weaton and Brown 1983). There is also a mild suppression of feed intakes in the summer, probably due to decreased activity due to the heat. Yes, in some northern states, during prolonged severe winters, there are die offs, but this is fairly rare. Deer have developed an evolutionary ability to get by on reduced feed in the winter. If supplemental food or food plots are used to bring in deer for hunting, then small amounts in relatively small areas are appropriate. However, if you plan to actually supplement the nutrition of the deer, then plots or feeds should be available during the spring and fall, when the deer need them most.

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THE RANGE X SUPPLEMENT INTERACTION

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Abstract: Deer performance is determined by its changing nutrient requirements, by its physical environment and by the quantity and quality of the rangeland nutrient supply. Deer are concentrate selectors which spend much of their time searching for and feeding on forbs and actively growing parts of some woody plants. Stocking rate is the most important grazing management decision of a ranching enterprise. Strong relationships exist between stocking rate and wildlife and livestock production. The use of mixed species for grazing rangelands can increase animal performance and production, and more evenly distribute grazing across the entire forage resource. But, it also offers the potential for competition between species for forage. Livestock grazing systems are considered important for improving white-tailed deer habitat. Supplemental feeding should be a short term "adding to" the nutrition already supplied by range vegetation to meet deer management goals.

Deer performance, in terms of survival and reproduction, is determined not only by its changing nutrient requirements but by its physical environment and by the quantity and quality of the rangeland nutrient supply. Because of these factors, which vary over time, white-tailed deer in the Edwards Plateau region of Texas exist in a highly dynamic situation. Most of the variability is caused by erratic weather. Droughts are common and sometimes of sufficient duration to result in deer die-offs. Most soils are shallow, low in fertility, and lack sufficient water storage capacity when large precipitation events do occur. All of these factors, when combined with livestock grazing and other range management practices, result in fluctuations in forage quality and quantity (i.e., nutritional value). These fluctuations in nutritional value affect nutrient intake, and thus, affect deer survival and reproduction. The purpose of this discussion is to present a general overview of how and why deer use the range resource and in turn, how the management of the range resource affects deer. By gaining a better understanding of these processes, the interaction between feeding a supplement and the nutrients provided by the range can be better understood.

RANGE UTILIZATION

To understand how deer utilize rangeland, a brief description of their digestive system and foraging behavior is required. An important advantage of the deer's digestive system is that forage is digested by microbes in the rumen before entering the true stomach (abomasum). Because of this, they can convert apparently indigestible carbohydrates and chemically trapped proteins into nutritious and useful products. Even though all ruminants share this unique ability to digest forage, deer are not the same as domestic livestock. Different species of ruminants exhibit unique grazing behaviors that often result in large differences in diet composition and nutritional value (Huston 1987).

Hofmann (1989) in a review based

on detailed comparative morphological studies of all portions of the digestive system of 65 ruminant species from four continents, classified ruminants into a system of three overlapping morphophysiological feeding types: concentrate selectors, grass and roughage eaters, and intermediate feeders. Concentrate selectors are typically small-bodied ruminants with relatively small rumens having a large absorptive surface area. This characteristic allows the assimilation of products from rapidly fermented cell contents; rumination is less important. Intermediate feeders can utilize a wide range of forages. Their rumens are less papillated than concentrate selectors and are capable of processing more fiber in their diet. Roughage eaters are large-bodied animals with relatively large fermentation chambers where dietary fiber may be retained for long periods to allow more complete microbial degradation. Under this classification scheme white-tailed deer would be grouped as concentrate selectors, cattle as grass and roughage eaters, and goats and sheep as intermediate feeders.

Because of the animal's morphological and physiological adaptations (i.e., size, shape and digestive and metabolic characteristics), animals search for different types of forage in different ways. Deer are highly mobile and spend much of their time searching for specific forage items. Because deer have relatively small rumens, they must consume plants that are easy to digest and can pass rapidly through the digestive system otherwise they cannot eat enough to meet their energy requirements. Therefore, deer feed primarily on forbs and the actively growing parts of some woody plants. Cattle, on the other hand, are less selective and use a wide variety of relatively common forage species (mostly grasses). Intermediate feeders, such as sheep and goats, have larger rumens and are less selective than deer but are more selective than cattle.

The foraging behavior of ruminants is also influenced by the kind of vegetation. Basically, range vegetation is composed of cell contents and cell walls. Cell contents are highly digestible; however, the plant cell wall, composed of cellulose, hemicellulose, and lignin, is much more difficult for ruminants to digest (Van Soest, 1965). As a plant matures, there is a corresponding increase in the proportion of cell walls; therefore, mature forage can limit the rate of food passage through the digestive tract and prevent or restrict consumption of additional forage (Van Soest, 1965). When animals consume forage high in cell walls, i.e., cellulose, it must be retained in the rumen for a sufficient period of time to digest the cellulose. Grasses are generally higher in cellulose than are forbs and browse. Thus, animals with larger rumens, (i.e., cows), are more adapted for using grasses than are deer, which have relatively small rumens.

Lignin is almost totally indigestible and interferes with cellulose digestion (Van Soest, 1982). Since browse is generally higher in lignin compared to grasses and forbs, it would not be advantageous for a cow with a large rumen to consume a diet relatively high in browse. Conversely, for animals with small rumens that have high turnover rates such as deer (Huston et al. 1986), diets high in lignin could be beneficial. For such animals the lignified cells rapidly pass through the rumen with very little energy being wasted in the process of digesting the cellulose and lignin.

Other components of vegetation that affect its acceptance and digestibility include alkaloids, tannins, and terpenoid oils. Physical properties of plants, such as thorns, hairs, spines, and awns also influence a plant's palatability and accessibility for foraging.

WEATHER-SOIL-PLANT-ANIMAL INTERACTIONS

Weather

The response of plants to herbivory is affected by soil and weather variables. Of these variables, precipitation is the least predictable and exhibits the greatest variance from season to season and year to year. Thus, it is generally the weather variable that is of greatest interest when evaluating forage-animal interactions.

Soil

There are many soil factors that affect plants; however, only a few are of major interest in evaluating forage-animal interactions. Forage production on a soil is primarily a function of the availability of moisture and nutrients for plant growth. The amount of moisture available for plant growth is a function of many factors, which include: the amount of precipitation received, the amount that infiltrates into the soil, soil texture, soil depth, soil organic matter, and the amount of moisture that evaporates or percolates beyond the rooting depth of the plant.

Forage nutrient availability is influenced by the parent material from which the soil was derived, the degree of leaching which has occurred, and the cation exchange capacity. In arid and semiarid environments, nitrogen is generally the primary limiting nutrient. In more humid climates, leaching may have reduced phosphorus and potassium to levels that limit plant growth. Soil organic matter is extremely important in determining the cation exchange capacity of soil and, thus, the size of the nutrient pools. Grazing, through its effect on soil organic matter, may have a very significant impact on the nutrient status of soils.

Forage

In arid and semiarid environments, water is generally the first limiting factor for forage production. Because of reduced moisture availability, plant growth only occurs during brief periods on many rangelands. Since rangelands are grazed yearlong, animals are faced with the prospect of harvesting dormant vegetation most of the time. It is important to understand these relations when evaluating forage-animal interactions.

Vegetation on rangelands is comprised of a great diversity of species with broad genetic variation within most species. This diversity is an asset to both the stability of the plant communities and the animal as it selects its diet. The diversity in plant species adds stability to the nutrient intake of the grazing animals by allowing them to shift their diets from species to species as seasons change and as the degree of utilization increases.

Animal

Grazing and browsing animals exhibit a strong preference for green leaves over stems and dead forage; therefore, animal productivity is largely a function of the amount of green leaves that animals can harvest. Also, the level of forage quality required to meet the nutrient requirements of animals varies considerably among kinds and classes of animals. Forage quality requirements tend to be inversely proportional to the size of the animal; smaller animals having the higher requirements. Nutrient requirements are higher for lactating than for dry animals and for growing than for mature animals. Pregnancy also increases nutrient requirements slightly.

GRAZING MANAGEMENT

Grazing management involves the manipulation of grazing animals to meet specific resource goals. The basic principles for grazing management include : 1) Determining the correct number of animals in relation to the amount of forage produced (stocking rate); 2) Determining the correct kinds and classes of animals (mixed-species grazing); 3) Determining the correct seasons for grazing (seasonal suitability); 4) Obtaining uniform distribution of grazing across both the land area and the plant species (grazing distribution). Application of these principles affects the condition and trend of the rangeland which can have profound effects on deer productivity.

Stocking rate

Stocking rate is the most important grazing management decision of a ranching enterprise (Heitschmidt and Taylor 1991). Historically most ranchers have managed to maximize livestock production on a sustained basis. This has always been a difficult goal to reach because under stocking results in wasted forage and lower total animal production. Over stocking results in damage to the forage resource and lower individual animal production. Furthermore, the optimum stocking rate is not a constant but varies depending upon the current years conditions.

Strong relationships exist between stocking rate and wildlife and livestock production. An understanding of these relationships is essential to meeting the goals of livestock and wildlife production. Stocking rate is a function of three things: 1) the land area, 2) the number of animals, and 3) the time that the animals graze on the land. Given these 3 factors and the demand rate (one animal unit has a demand rate of 12 kg/day; Society for Range Management 1989) for an animal unit equivalent, stocking rate can be determined and accurately expressed.
Merrill et al.(1957a), attempted to determine forage relationships between livestock and white-tailed deer on the Sonora Research Station. He estimated that 5 sheep, 6 goats or 6 white-tailed deer were equivalent to one 489 kg cow and calf. It must be remembered that these values are only estimates and that considerable variation in forage intake is the norm rather than the exception.

The law of diminishing returns

governs the relationship between stocking rate and animal production. Forage may be considered as the basic resource and animals as the inputs. At low stocking rates, the production per animal is not affected by the addition of an additional animal. As the stocking rate is increased, the forage resource remains constant or begins to decline, and a point is reached where animals are competing with each other for forage. The addition of another animal will reduce the production of each individual animal on the pasture, but the total animal production from the pasture will continue to increase. If enough animals are added to the pasture, individual animal production will decline to the point that total production will also decline. If you are stocked at this level, you are probably losing money, reducing the forage resource and destroying white-tailed deer habitat . Unfortunately, a history of excessive grazing and an over-population of deer have resulted in deteriorated range conditions and small, poor quality deer in the Edwards Plateau. "Up to 50% of the deer herd in the Texas Hill Country may die each year from causes associated with malnutrition. This mortality is greatest in young white-tailed deer that require a high nutritional level to support growth functions in their young bodies" (Armstrong 1991). Supplemental feeding can be effective in improving deer survivability; however, it can also maintain excessive numbers of deer.

Murden (1993) examined changes in patterns of diet selection and foraging effort by white-tailed deer and Angora goats in response to the addition of a high-quality supplement. His study, conducted on the Texas Agricultural Experiment Station near Sonora, revealed that supplemented deer and goats reduced total pasture intake but increased their use of the remaining palatable plant species. The author concluded that supplementation may be disruptive to normal foraging behavior and may contribute to the process of overgrazing of the range resources by allowing animals to continue to concentrate in areas where forage resources have been heavily utilized.

Mixed species grazing

Most ranchers have realized that the use of rangelands by two or more species of livestock can increase livestock production by increasing both animal performance and production per unit area. These benefits are the result of different dietary habits of the animals because plants avoided by one kind of animal may be selected by another. The principle that supports mixed grazing is that intraspecific (between individuals of the same species) competition is always greater than interspecific (between different species) competition and that each species of grazing animal, whether domestic or wild, will tend to exploit different portions of a common forage resource. The major biological advantage of using mixed species grazing is that the impact of grazing will be more evenly distributed across the entire forage resource and thus reduce the impact of a single animal species on its preferred forage (Walker 1994).

Even though mixed grazing has advantages, there is the potential for competition for forage resources; this is considered to be a major problem on the Edwards Plateau where cattle, sheep, goats, exotics and white-tailed deer all use the same forage resource (Harmel and Litton 1981).

The need for management guidelines for optimum production of deer and livestock grazing common range in the Edwards Plateau has prompted several studies of the food habits of these herbivores (McMahan 1964, Bryant et al. 1979, Bryant et al. 1981). Unfortunately, conclusions regarding competitive interactions were drawn based only on dietary forage classes found in the diet (Bryant et al. 1979; Bryant et al. 1981). These studies and others, conducted on the Sonora Research Station, were later compiled and re-evaluated for deer and meat goats grazing two sites of differing floral diversity (Bryant et al. 1979; Bryant et al. 1980; Bryant et al. 1981; C.A. Taylor, unpub. data) to determine diet similarity based on plant species shared, relative to availability of those species (Bryant and Taylor 1993).

Both sites were grazed by a herd of mixed-livestock and wild deer during this study. The authors concluded that direct competition between deer and meat goats was light to moderate and probably would have little direct effect on deer performance. Furthermore, the authors reported that management of all livestock and wildlife should be directed at providing the highest diversity possible of all forage classes where deer are a primary consideration.

Murden (1993), in a later study conducted on the Sonora Research Station to detect mechanisms of competition between white-tailed deer and goats, provided little evidence to support the idea that deer and goats are competing for forage resources. Although considerable diet overlap existed between deer and goats in his trials, this overlap did not cause changes in animal foraging behavior or feeding efficiency. He concluded that ranges containing an abundant, diverse mixture of forage species should provide the optimum opportunity for herbivores to express their inherent dietary preferences and would minimize the likelihood for forage competition.

Proper season of grazing

Since most rangelands in the Edwards Plateau are grazed yearlong, how does this principle apply? There are two important considerations relevant to the season of grazing. 1) Forage quality varies across the seasons. In general, concentration of nutrients of a particular plant species are highest early in its growth period and lowest after growth ceases (Huston et al. 1981). On Edwards Plateau ranges, the period of highest forage quality is generally during the spring and the period of lowest forage quality is generally during the winter. Of course this period of low forage quality can occur during any season if precipitation has not been sufficient to initiate plant growth.

Plants function on seasonal cycles and there are critical periods for their growth and reproduction that should be considered when planning deferment and grazing schedules. Seasonal growth cycles for the most important plants (preferred plants) should be considered in determining the times and lengths of deferments for maintenance and/or improvement of range vegetation.

2) Range condition can also interact with season of year to affect forage quality. Bryant et al. (1981), reported that white-tailed deer diets collected from an excellent condition range were greater in crude protein , digestible energy , and phosphorus when compared to diets collected from poor condition range (11.3 vs 8.7% CP; 2146 vs 2117 kcal/kg; and .14 vs .11% phosphorus, respectively). A greater diversity, and abundance of grass, forb, and browse species appeared to provide a higher quality diet from the excellent condition range than the poor condition range.

Proper distribution of grazing

Because animals are selective grazers, grazing distribution problems almost always occur. This is the basic reason for subdivision and implementation of grazing systems on rangelands. Distribution of grazing is a critical component of grazing management if the forage is to be utilized efficiently without site deterioration.

Deferment and rotational grazing should be directed to preventing the development of selective grazing problems and to the correction of existing vegetation problems that have resulted from previous management. Thus, the focus of grazing systems should be the improvement and maintenance of the productivity of the range soils and vegetation.

Grazing systems are considered important for improving white-tailed deer habitat (Merrill et al. 1957b; Bryant et al. 1981; Armstrong 1991). However, little research exists to indicate which types of grazing systems offer the largest advantage to white-tailed deer. Using density as a measure of acceptance by white-tailed deer on an array of grazing systems, Reardon et al. (1978) reported that deer preferred a 7-pasture rotation system over other systems available to them on the Sonora Research Station. Armstrong (1991) listed in order of preference various grazing systems to consider for optimum white-tailed deer management. His first choice was a 12 to 20 paddock grazing system with one herd of livestock. However, results of studies of white-tailed deer responses to various grazing systems on the Welder Wildlife Foundation in south Texas was inconclusive (Drawe 1988).

SUPPLEMENTAL FEEDING

So far, most of this discussion has concentrated on grazing management and very little has been reported about supplemental feeding. There is a good reason for this. While grazing management is not the most important aspect of deer management on rangelands, it is certainly the foundation that managers should build their practices upon. Because of the unique characteristics of rangeland (i.e., climate, soils, topography, animals, etc.), principles of grazing management should be understood first before other aspects of management are applied . Having said that, what are we really doing when we feed a supplement to white-tailed deer and what is considered a supplement? Basically, we should be "adding to" the nutrition already supplied by range vegetation to meet deer management goals. These goals could include providing supplements during periods of nutritional stress to prevent malnutrition , to grow "trophy" deer, or as an attractant to increase harvest efficiency or deer activity in a particular area for viewing. These goals plus others are certainly legitimate but do we really understand what the consequences are. For example, deer hunting in Texas can be a very economical enterprise. If management decides that income can be enhanced if deer numbers are increased through supplemental feeding, then this decision may come down to simple economics. If feed is cheap and net income is driving management decisions then bring on the feed wagons (i.e., more feed equals more deer which results in greater income).

Unfortunately this kind of mentality has not only been used to develop management for deer but also livestock management and it has resulted in serious range deterioration throughout the Edwards Plateau. So, an important question to ask is, "how do we feed supplements to range animals and avoid deterioration of the range ecosystem?". We have to realize that supplemental feeding can be used to "fix" a short-term nutritional deficiency; however, let's first determine how many and what species of animals can be sustained on the rangeland (i.e., apply proper grazing management; Huston 1990).

Each land owner, manager, etc. have their own goals and objectives and perceptions of what is good management. Each ranch has its own characteristics and resources that make it unique. Because of this variability in terms of biological, sociological, and economical factors associated with the range resource, there is no "best management" scenario for the Edwards Plateau. Having said this, I will conclude this discussion with an overview of our deer management philosophy on the Sonora Research Station.

First of all, we hunt deer to make money (i.e., economics is the driving force). In 1994 our gross income from domestic livestock (i.e, wool, mohair, lamb, kid, etc.) was approximately \$6 per ha compared to approximately \$3 per ha from deer hunting revenues. Another way to look at this is that for every kg of livestock product sold we received approximately \$2.20. For every kg of deer harvested (we weight all the deer) we received over \$13. At current market prices deer are more valuable per unit of body weight than domestic livestock. Because of this additional income, deer are important.

We currently day-hunt for 8 days on the Sonora Station (2 hunts). Most of our hunters are from out-of-state and they have only a few days to hunt once they arrive on the property. They come to the Station not expecting to kill trophy deer but to experience a good time and to harvest "quality" deer (they also like to see a lot of deer). Most of our hunters are older and they like to be provided with a lot of convinces (i.e., good food, comfortable place to sleep, friendly guides, well built deer blinds, deer processing facilities, etc.).

In order to meet their expectations of a successful hunt each year we provide a supplement, from September through January, at each deer blind to attract both deer and turkey. This helps to ensure that plenty of wildlife are seen and that ample opportunities exist to harvest animals. We try to harvest from 30 to 40% of our deer population each year. In addition to feeding deer at the hunting blinds we also have a long, narrow pasture that runs through the center of the Station (approximately 60 ha). This pasture is used for prescribed burning experiments. Domestic livestock do not have access to this pasture and parts of it are burned almost every year. We have observed that deer are attracted to the burn areas and that deer density is greater for this area than other pastures on the station. In effect, we are using this area as a deer supplementation area. We think it is especially valuable during extended dry periods. This is also the only area on the Station where supplement is fed year round. Also, part of this pasture is close to the Station headquarters and many of our routes run through the length of it while taking hunters to their deer stands. This provides us with the opportunity to show a lot of wildlife to our hunters while traveling to and from deer blinds since we do not hunt this area. But more importantly, this area can support large numbers of deer without hurting the range resource because of the excellent range condition. We can afford to feed a supplement to attract a large numbers of deer because we have the forage resource to support them .

How do we know we are not hurting the range with high deer densities? We use a software program "The Grazing Manager" developed by scientists from the Department of Rangeland Ecology & Management at Texas A&M University (Kothmann and Hinnant 1993, 1994). This is a tool that can be used to help us be better grazing managers. It is very effective and if used properly, will provide us with the necessary information to prevent over use of the preferred vegetation and increase range productivity.

It is not my intention to either promote or discourage the supplemental feeding of deer. Land managers must decide for themselves if their goals and objectives, plus range resources meet the requirements for consideration of feeding a supplement. Even ranges in excellent condition and under optimal management do not always provide an adequate level of nutrition. Also, it is obvious that more research is needed is this area. However, when properly applied, the feeding of supplements to deer can serve as a tool to meet resource goals and objectives.

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FEEDS AND FEEDING: EVALUATING RATIONS

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Abstract: Evaluating rations in any animal production system is important. The selection of the proper feed should be based on the current or expected nutritional status of the deer, the determined nutrient needs, and the capacity of available feedstuffs to supply such needs safely and economically. The major feed ingredients that are formulated into most animal rations are classified as either roughages, protein feeds, or energy feeds. A ration prepared for deer usually is only a portion of the animal's diet. The selection of the proper feed should be based on the current or expected nutritional status of the deer, the determined nutrient needs, and the capacity of available feedstuffs to supply such needs safely and economically.

Evaluating rations in any animal production system is a challenge worth the effort. Feeds that are improperly used can be harmful and, in some circumstances, can kill the animal that it is intended to benefit. A good feed for one species may be a poor feed for another. A confusing factor in communication is the multiplicity and overlapping meanings of terms. My charge in this paper is to discuss how to evaluate rations. What is a ration? Is ration the same as diet? What is the difference in a supplemental feed and a feed supplement? Obviously, there is not common agreement on the meanings of each of these and other terms. Each time I write an article, reviewers want to change my "rations" to "diets" or vice versa. The following descriptions are offered to assist in the understanding of the discussion.

TERMS DESCRIBING ANIMAL FEEDS AND FEEDING

Diet. --A diet is the total of what an animal consumes during the period considered. It would include the forage (foliage), supplement, mineral lick, etc. A summer diet would differ from a winter diet. Summer and winter diets contain either different plants or the same plants in different proportions. The dietary protein would be the sum of the protein in each dietary ingredient. The diet is both qualitative and quantitative and may be 10% protein or supply ½ lb of protein per day.

Ration. --A ration is a prepared or selected ingredient(s), usually a blended mixture, that is fed in a planned pattern with an anticipated specific result. A ration can be the total diet or only a portion. Usually in the feedlot, a ration is formulated to supply all of the nutrients in the correct proportions and is fed free-choice. In this case, the diet and the ration (a complete feed) are the same (This is where I get in trouble with my reviewers). In another case, animals may be fed a hay free-choice and a limited amount of a mixed ration to complement the hay. The diet is equal to the hay plus the ration. Finally, diets of grazing animals include materials consumed while grazing plus those provided in a separate ration.

Augmentative Feed. --I made this up

for this occasion. As the name implies, this ration is supplied to increase the productivity of animals (growth rate, reproduction, horn growth, etc.) or of land area (animals per acre) by either adding to or substituting for the regular diet. Augmentative feeds are employed when the forage is inadequate either in the overall nutrient content (quality) or in supply (quantity) for the desired effect. An example would be a ration supplied during a particularly dry summer to increase the milk production of does and survival of fawns. A second example would be a ration supplied to provide approximately one-half of the required nutrients so that one deer per 5 acres could be supported on a one deer per 10 acre habitat. In any case, an augmentative feed is fed at a relatively high level (>1% of live weight) and substitutes for forage.

Supplemental Feed. --Some of you will say, “We just talked about that.” No, supplemental feed is different. Supplemental feeding is to increase the value of the rest of the diet (forage in grazing animals) by supplying one or more limiting nutrients and allowing the potential value of the regular diet to be expressed. Generally, supplemental feed doesn’t improve the diet by substituting high quality for low quality. On the contrary, supplemental feed corrects nutrient imbalances causing the animal to consume more of the available forage and use it better. Supplemental feed is fed at a relatively low level (<.5% of live weight) and usually stimulates forage intake.

Micronutrient Supplements. --These feeds contain nutrients that are required in small amounts and often are deficient in range forages. The most common example is a mineral supplement that supplies a mixture of mineral elements that are expected to be deficient in the area. Vitamin packages often are included in these supplements. Some substances that are not classified as nutrients may be formulated into these feeds to enhance health and productivity. These could include antibiotics, probiotics, anthelmintics, ionophores, etc. Micronutrient supplements may be formulated into the supplemental, augmentative, or total feeds or may be provided separately in a salt-based mixture.

FEEDSTUFFS AND MAJOR FEED INGREDIENTS

The major feed ingredients that are formulated into most animal rations are classified as either roughages, protein feeds, or energy feeds. Roughages are high in fiber (20 to 50% crude fiber), mostly cellulose. Protein feeds are high in nitrogen (20 to 90% crude protein). Energy feeds are high in lipids and/or soluble carbohydrates such as starch (60 to 90% TDN). Nonprotein nitrogen sources such as urea can be used to replace a portion of preformed (natural) protein and may be more than 250% crude protein. Similarly, pure lipids such as animal fat and vegetable oil can be used to supply energy and may contain greater than 100% TDN. Generalizations concerning the feeding value of feedstuffs may not apply in all circumstances.

Roughages. --These feedstuffs are very safe for feeding but, when fed alone, range from medium to low in nutritional value. Their feeding values are directly related to protein (CP) content, inversely related to crude fiber (CF) content, and best expressed by total digestible nutrient (TDN) content. Examples include:

High quality
alfalfa hay (CP = 18%; CF = 22%; TDN = 60%)

Medium quality
sorghum hay (CP = 12%; CF = 28%; TDN = 50%)

Low quality
wheat straw (CP = 4%; CF = 42%; TDN = 40%)

The higher quality roughages (e.g., alfalfa hay) can be used effectively as the sole feed for adult animals, especially those that are not lactating. Lower quality roughages fed alone will not meet requirements of animals. The best use of low quality roughages in a mixed ration to ensure safety or when self-fed with a higher quality feed (augmentative or supplemental) provided in addition.

Energy Feeds. --These feeds, usually grains (corn, sorghum, wheat, etc.), are somewhat opposite from roughages. Grains are of very high nutritional value but are dangerous to feed in high amounts. Ruminants are adapted to utilize high-fiber and high quality foliar material. A transition to the use of large amounts of grain (> 50% of the diet) should be made cautiously to prevent lactic acidosis from occurring. Deer seem less aggressive at consuming large amounts of feed over a short period of time compared with domestic animals; thus, grain feeding may be less risky with deer. The best uses of grains are to balance the energy content of a complete feed and as an augmentative feed to increase the nutritional value of the total diet of a grazing animal. Low-level feeding of whole grains (shelled corn) on a regular schedule effectively attracts deer to selected feeding locations. Usually, grains are low in crude fiber (< 5%) and high in TDN (>75%).

Protein Feeds. --Usually these feeds are safe but expensive. Besides having a high crude protein content (>40%), crude fiber is relatively low (< 15%) and the TDN comparatively high (>60%). Most protein concentrates can be fed safely at a high level (1 to 2% of body weight) as an augmentative feed. However a carefully formulated ration including energy feeds and perhaps some roughage products would give equal results at a lower cost. The best uses of a protein feed are to balance the protein content in a mixed ration (total feed or augmentative feed) and as a supplemental feed to provide protein to animals consuming low-protein forages. Nonprotein nitrogen (NPN; urea) should not be fed except at very low levels (< 2% of total diet) or after consultation with a wildlife nutrition specialist.

Vitamins and Minerals. --Except under unusual circumstances, deer in Texas do not suffer from major deficiencies in these nutrients. Although bone and antlers are high in calcium and phosphorus, most research indicates that antler growth is related more to overall nutrition (nutrient balance) than to levels of minerals. However, including vitamin and mineral packages in a mixed ration is good insurance. The micronutrients most likely to be deficient are vitamin A and phosphorus.

FEED LABEL EVALUATIONS

Certain information must appear on the feed label; other information is optional. Required information includes:

- -- name of the manufacturer,
- -- net weight of the product in the package,
- -- minimum crude protein content,
- -- minimum fat content,
- -- maximum crude fiber content,
- -- name and concentration of medication (if medicated).

Optional information includes:

- -- information on other nutrients (.01% cu not just "with Cu"),
- -- range of concentration in some instances,
- -- ingredients,
- -- feeding directions,
- -- efficacy claims.

Example feed labels are included to illustrate the range of information provided in the marketplace. It is suggested that the following "Five Steps in Feed Tag Evaluation" be used in selecting an appropriate feed.

Five Steps in Feed Tag Evaluation

1) Locate the crude fiber content statement:

> 20%, a safe feed that must be consumed in relatively high amounts (> 1% of live weight) to be of much value. Could be a complete feed.

> 10% and < 20%, the appropriate range for a supplemental feed. The actual value depends on the crude protein and mineral (salt) content.

< 1 0%, probably a high-energy, low-protein feed best used as an augmentative feed to be fed at about 1% of live weight.

2) Locate the crude protein content statement:

> 30%, a supplemental feed to be fed at a relatively low level (< .5% of live weight/day.

3) Determine NPN content:

> Usually expressed as the percentage or fraction of the crude protein content. Recommended maximums are no more than one-half of the crude protein in high-energy, low-protein feeds and no more than one-third of the crude protein of high-protein feeds. Liquid feeds should be evaluated separately.

4) Inspect mineral concentrations if included:

>Expect a phosphorus content of about .5% in a high-fiber type feed and 1% in a supplemental type feed. Calcium should be about twice phosphorus or less.

Salt above 2% is probably added as a filler/limiter. Consider salt content when considering price. Look at other minerals for special value.

5) Consider price and value of convenience among products of similar nutrient content.

MANAGEMENT IMPLICATIONS

The decision to purchase feed to be used in deer management should be made after an evaluation of animal performance in comparison with the goals and objectives of the deer manager. The selection of the proper feed should be based on the current or expected nutritional status of the deer, the determined nutrient needs, and the capacity of available feedstuffs to supply such needs safely and economically.

NET WEIGHT 50 POUNDS

DEER PELLET

INGREDIENTS

Grain products, plant protein products, forage products, cane molasses, vitamin A acetate, D-activated plant sterol (source of vitamin D^2), ground limestone deflourinated phosphate, apple flavor, sulfur, iron oxide, manganous oxide, copper sulfate, magnesium oxide, cobalt carbonate, ethylene diamine dihydriodide.

GUARANTEED ANALYSIS

Crude Protein-not less than 18.00%
Crude Fat - not less than 2.00%
Crude Fiber - not more than . 7.00%

FEEDING INSTRUCTIONS

Deer Pellets are designed as a supplement to a deer's natural habitat to be fed at the rate of 1 to 2 pounds per head per day to promote reproduction, horn growth, and increased body weight. It is recommended that Deer Pellets be used in conjunction with a self or timed release feeder near a supply of water.

BEST OF FEED, INC.
Super City, Texas

NET WEIGHT 50 POUNDS

16% **PROTEIN DEER PELLET**

GUARANTEED ANALYSIS

Crude Protein - not less than . 16.00%
Crude Fat - not less than 2.00%
Crude Fiber - not less than. 21.OO%
Calcium (Ca) - not less than . . ..1 .OO%
Calcium (Ca) - not more than 2.00%
Salt (NaC 1) - not less than ...... 1 .00%
Salt (NaC1) - not more than. 2.00%
Phosphorous (P) - not less than .. 1 .00%

Vitamin A - 5,000 USP Units per pound (2,700 mcg/lb)
Vitamin E - 25 USP Units per pound

INGREDIENTS

Forage products, grain products, plant protein products, cane molasses, salt, deflourinated phosphate, Vitamin A Acetate, Vitamin E Supplement, ethylene diamine dihydriodide and cobalt sulfate.

FEEDING DIRECTIONS

Feed free choice during winter season, breeding season and during horn growth period, feed continuously to deer in confmement.

XYZ FEED COMPANY

Happy Home, Texas

NET WEIGHT 50 POUNDS

WILDLIFE - GAME FEEDS

22% DEER PELLET

A pelleted, cantaloupe flavored supplement designed for automatic feeders where amounts fed can be controlled. Contains concentrated levels of essential nutrients and vitamins for optional growth, reproduction and antler development.

GUARANTEED ANALYSIS

Crude Protein - not less than	22.0%
Calcium - not more than ..	2.5%
Calcium - not less than	2.0%
Phosphorus - not less than .	1.5%

Only high quality protein and energy sources are used in our wildlife products - no cheap fillers!

50 Pounds (22.68 kg)

GOAT KID FEED - MEDICATED

For Ruminants Only

Active Drug Ingredient:
- Decoquinate. .... 27.2 g/ton

For prevention of coccidiosis in young goats caused by Elmeria christenseni and E. ninakohyakimovae.

Guaranteed Analysis

Crude Protein (Min)	16.0%
(this includes not more than 1.0% from non-protein and not less than 13.0% from natural sources)	
Crude Fat (Min)	2.0%
Crude Fiber (Max)	26.0%
Calcium (Ca)(Min)	.50%
Calcium (Ca)(Max)	.75%
Phosphorus (P)(Min)	. .75%
Salt (NaC 1)(Min)	.90%
Salt (NaC1)(Max)	1.15%
Copper Cu (Min)	2.90 ppm
Cooper Cu (Max) . .	3.30 ppm
Vitamin A (Min) .	50 IU/LB

Ingredients: Grain products, roughage products 3%, plant protein products, molasses products, salt, calcium carbonate, ammonium chloride, ferrous carbonate, zinc oxide, manganous oxide, zinc sulfate, copper oxide, cobalt carbonate, ethylenediamine dihydriodide.

Feeding directions: Feed kid at a rate of 1.67 lbs. per 100 lbs. of body weight. This supplies 27.2 mg. of decoquinate per 100 lbs. of body weight per day. Feed at least 28 days during periods of exposure or when experience indicates that coccidiosis is likely to be a hazard.

Warning: do not feed to goats producing milk for food.

Manufactured by

Best Goat Feed

Angora, Texas

NON-TRATITIONAL FEDSTUFFS AS SUPPLEMENTS FOR DEER

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Abstract: Numerous feedstuffs have been used successfully to increase the visibility of deer. However, supplementation programs (provision of feeds to correct nutrient deficiencies in the diet) for white-tailed deer (*Odocoileus virginianus*) are not well-defined. Some intensive deer management programs have developed supplements that provide additional protein, energy and minerals for deer. The purpose of this presentation is to discuss feedstuffs with supplement potential that have not traditionally been used in white-tailed deer management programs.

The nutrient requirements of deer have been discussed earlier in this symposium, thus we need not revisit those specifics here. However, the change in nutrient demand over a 12 month period of time is of primary concern in the development of a supplementation program. The greatest nutrient demand for a post-puberal doe is during the last trimester of gestation and first half of lactation. For bucks, the demand for minerals increases during antler formation, and energy requirement may be the greatest during the post-rut period as they attempt to replace exhausted body reserves. When expressed per unit of dietary intake, young growing animals have the greatest protein requirement. In addition, the browse, forb and grass diet available to deer is seldom (if ever) the same from one year to the next. The bottom line - development of an efficient, effective supplementation program for white-tailed deer is a challenge.

NON-TRADITIONAL FEEDSTUFFS WITH POTENTIAL

The nutrient content of several feedstuffs is shown in Table 1. The following discussion will attempt to describe the potential contribution these feedstuffs could make to a white-tailed deer management program.

Alfalfa pellets

Advantages - Alfalfa is a high quality, universally palatable forage. Alfalfa is frequently used as the base for developing a pelleted supplement. Relative to other forage feedstuffs, alfalfa is relatively high in crude protein and an excellent source of vitamin A. If harvested at the proper stage (mid-bloom or earlier), alfalfa grinds and pellets well to produce a "stand alone" supplement for deer. From an economic standpoint, when cereal grains and oilweed meals are in short supply and expensive (i.e., 1996), alfalfa is often a cost-competitive feedstuff. Alfalfa pellets are readily available in any quantity from 50 lb and greater.

Limitations - Alfalfa alone is low in energy relative to the cereal grains and oilseed meals. Hay can be fed but significant wastage will occur and labor and equipment costs rise significantly. Pellets require protection from moisture, reduce handling requirements and are conducive to use in gravity flow bulk feeders.

Cereal Grains

No doubt, whole shelled corn is the most popular "deer feed" in Texas; several million pounds are purchased and fed to deer (and other wildlife) annually. However, the majority of the corn fed would be classified as an attractant rather than a supplement. The difference? Frequency and timing of feeding and the amount fed. With respect to the cereal grains, primary consideration is limited to corn and grain sorghum. Wheat and oats are also included in this group but typically are not cost competitive.

<u>Advantages</u> - On a cost per pound of nutrient basis, cereal grains are almost always the least expensive source of energy. Both are very palatable, handle easily either in bulk or sack, are easily fed and are available in any quantity (40 lb and up).

<u>Limitations</u> - Unlike corn, grain sorghum should be fed in a trough of some kind; feeding on the ground can result in significant wastage by deer. Feeding starchy, energy-dense, readily fermentable feedstuffs to grazing ruminants (cattle, sheep) at levels greater than 0.3% of body weight can result in the depression of forage intake. Cattle and sheep are classified as grazers, whereas deer are considered browsers (Lyons et al. 1996). Forage utilization by grazers is dependent upon residence time in the rumen, the site of microbial digestion. Browsers, like deer, select a higher quality diet which is less dependent on rumen residence time for efficient utilization. Therefore, because of higher diet quality and a lower rumen residence time requirement, the "associative effects" which are cause for concern in domestic livestock supplementation are probably of little significance when supplementing deer.

Whole Cottonseed

Whole cottonseed is Mother Nature's attempt to make the perfect supplement for grazing ruminants. Two types of cotton are produced in Texas, upland and extra long staple (Pima), and the resulting seed is different. Upland seed has lint attached to the seedcoat - Pima seed is lint free. Upland seed is available in the greatest quantity. The two types also differ in their gossypol (natural insecticide found in cotton) content; Pima seed has a higher gossypol content than upland. Despite the media attention over the past few years, gossypol toxicity is <u>not</u> a problem in practical supplementation programs. As a side note, domestic swine are particularly suseptable to gossypol, yet feral swine consuming cottonseed are not adversely affected.

<u>Advantages</u> - A by-product of the cotton industry and long used by livestock producers, the attributes

of cottonseed include: excellent protein source, energy dense and a substantial source of phosphorus. In a ruminant diet, the lint is 100% digestible and the seed coat is an excellent source of fiber. The seedcoat adds another unique feature to cottonseed. Cottonseed has a high oil content (17.5% fat) and the oil is encapsulated by the seedcoat. Oils possess 225% more energy per unit weight than starches (grains) and are more slowly digested than starches in the rumen. Typically, not every seed will be cracked by the ruminant upon consumption. Those seeds not cracked initially will be processed during rumination (cud chewing). The net effect - a sustained-release system of providing energy to the microbial population in the rumen.

<u>Limitations</u> - Availability and handling. Cottonseed is typically purchased from a gin in truckload quantities (20-25 tons). Unlike previously mentioned feedstuffs, small quantities are not available through a retail merchant. In addition, the bulk density of upland seed makes sacking an inefficient process. Cottonseed can be piled on the ground and stored unprotected with relatively little waste. Delivery from storage site to pasture requires the use of a shovel or front-end loader, either of which adds to the labor and equipment requirement. Although very palatable to the experienced ruminant, animals not familiar with cottonseed may initially be slow to consume the feed.

Rice Bran

Rice bran is a by-product of the rice milling industry. Relative to other ruminant feedstuffs, rice bran is second only to cottonseed in fat content and has the highest phosphorus content of "commonly considered" feedstuffs.

<u>Advantages</u> - High energy (fat) and phosphorus content. The high energy content has facilitated its use as a self-limited supplement in the livestock industry. Relative to its nutrient content, rice bran is often a very cost effective feed.

<u>Limitations</u> - Like many of the by-products and as discussed with cottonseed above, limited availability, quantity merchandized and storage/handling can be a problem. For the southwestern and western parts of the state, freight cost from the mill to the ranch may preclude consideration of rice bran. Bran is typically sold in 20-25 ton, truckload quantities; occassionally some is available in 50 or 100 lb sacks. Rice bran has the consistency of bread flour and as a result must be protected from the weather.

Oilseed Meals

The oilseed meals are a by-product of the cottonseed, soybean and peanut oil industries. As a group they are very high in natural protein, moderately high in energy content and a good source of both calcium and phosphorus. (It should be mentioned here that most of the forages across the white-tail habitat of Texas possess a more than sufficient quantity of calcium. With few exceptions, phosphorus is the first-limiting macromineral.)

Advantages - The oilseed meals are traditionally the least expensive source of natural protein (cost per unit nutrient basis) and are very palatable. Livestock producers have mixed the oilseed meals with salt to produce a self-limited supplement for grazing ruminants. Salt content is inversely related to feed intake. Cottonseed meal is readily available in quantities from 50 lb and greater.

Limitations - The oilseed meals must be fed in a trough or feeder of some type. Although they can be self-fed, mixing with salt may be required to limit intake to a reasonable (affordable) level.

Oilseed Hulls

Hulls (seedcoat) of the oilseeds are also a by-product of the oil industries. *The only oilseed hull with supplement qualities is soybean hulls. The information for peanut and cottonseed hulls is included here only for comparison.* Soybean hulls, averaging 12% protein and 77% TDN, appear to have some potential as a maintenance-type feedstuff for deer. If pelleted, these hulls could be handled and fed much like alfalfa pellets. The limitations to soybean hulls are availability and the large quantity in which they are merchandized.

SUMMARY

Supplementation programs for free-ranging white-tailed deer are not well defined. The list of non-traditional feedstuffs discussed herein is certainly not all-inclusive. Nutrient profiles are available for numerous other feedstuffs that might fit in the "non-traditional" category. The challenge for the wildlife manager is to determine supplemental needs and subsequently develop a feeding program that will fill the nutrient voids experienced by the population. *Potential* feedstuffs have been discussed - their efficacy will not be known until they are provided to deer in a controlled experiment. In addition, the actual mechanics of providing feed to deer while excluding domestic livestock and other non-target animals is of paramount importance and will be addressed later in the symposium.

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Table 1. Feedstuffs with potential for deer supplements”.

	% CP[b]	% TDN	% EE	% Ca	% P
Alfalfa pellets	18	61	3.0	1.5	.25
Corn, whole	10	90	4.0	.03	.3
Grain sorghum	13	82	3.0	.04	.34
Cottonseed, whole	24	90	17.5	.17	.62
Rice bran	14	70	15.0	.10	1.73
Cottonseed meal	46	75	3.2	.10	.10
Soybean meal	54	87	1.1	.29	.71
Peanut meal	53	77	2.3	.32	.66
Cottonseed hulls”	4	42	1.7	.15	.09
Soybean hulls	12	77	2.1	.53	.18
Peanut hulls”	8	22	2.0	.26	.07

[a]From: NRC, 1996.

[b]CP = crude protein; TDN = total digestible nutrients; EE= ether extract (fat); Ca = calcium; P = phosphorus.

“Cottonseed hulls and peanut hulls are <u>not</u> potential supplements; data included for comparison only.

STARTING A SUPPLEMENTAL FEEDING PROGRAM

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Abstract: Locate feeding areas in areas of high deer activity and minimal human disturbance. Fence areas to exclude livestock, feral hogs and javelina. Deer will need to be conditioned to accept feeds, feeders and feeding areas. The number of feeding areas required varies according to size of ranch, deer population and deer production goals. Feeders should protect feed from contamination and spoilage, and make feed available free choice to deer. Deer do not like abrupt changes in feed, so make them gradually.

Locate feeding areas, initially, in areas of high deer activity and minimal human activity. Near water or on a game trail are good places to start. Along the edge of a South Texas sendero, which deer naturally use as a travel lane, offers good potential. Feeding areas can, however, be close to roads, if the areas are screened by brush or cover. A simple, effective method is to make a road into the brush, 20 to 30 yards long, perpendicular to a ranch road. Put a "dog leg" in the road, extend the road for 20 to 30 yards and make your feeding area. Figure 1 illustrates this principle. This method allows feeding areas to be conveniently serviced, yet deer are screened from view of vehicle occupants on the ranch road.

If livestock, feral hogs or javelina are present, the feeding area must be fenced. If only cattle are present, they can be effectively fenced out with 3 strands of barbed or smooth wire. If sheep, goats, feral hogs or javelina are on the property, an effective fence can be made using Tee posts and "hog panels" that are about 3 ft high by 16 ft long. Size of the pen is critical. Three panels should be used per side so that the pen is at least 48 ft on each side. If this minimum size is used, it appears that the bottom of the fence does not need to be buried.

STARTING DEER ON FEED

Getting deer to find and jump into the feeding area and then getting them started on feed can be a real challenge. This is the point at which most people get discouraged and quit. If you have trouble with deer finding the feeding area, shred or chop some senderos from the feed pen out into the brush for about a hundred yards. Be sure that one of these senderos goes into the direction of the prevailing wind. Deer usually will approach a feeder into the wind if they can.

I have found that almost without fail the better natural forage and range conditions are, the harder it is to get deer to start eating pellets. The opposite is also true. For example, in 1992 when parts of south Texas had lush forage conditions, it took over 8 months to get deer to begin eating pellets on a ranch near Freer. Conversely, during the extremely dry spring of 1996, most people were able to get deer to eat pellets within 2 weeks to a month.

Regardless of conditions, no matter how smart we at feed companies think we are, we cannot compete with mother nature in supplying foods that deer like to eat.

It is critical that deer first be attracted to the area where the feeding pen is to be located. The quickest way to accomplish this is to use a timed feeder that "slings" out corn twice a day. If that is not possible, then spread corn by hand daily. Once deer are coming to the area on a regular basis, construct a pen around the corn feeder. If feral hogs are a problem, you may have to build the pen first.

Continue operating the feeder until deer are consistently jumping the fence to eat the corn. Place an open trough (any kind: pipe cut-in-half, fiberglass, wooden, garbage can lid, etc. will do) with a little corn in it inside the pen. Once deer are eating corn from the trough, stop the timed feeder and begin to mix a good-quality deer pellet (1/3) with the corn (2/3). Gradually reduce the amount of corn until only deer pellets are being fed.

Sometimes, although not often, deer do not readily come to corn, or they continually sort out the corn and leave the pellets. If that is the case, I have had good success with using a high molasses content "sweet feed" in place of corn to mix with pellets in the trough to get them started on feed. Once deer are consistently eating out of the trough, put the bulk feeder inside the pen close to the trough. Place a small amount of corn or "sweet feed" in the feeder and gradually reduce the amount of feed placed in the trough until deer are eating from the bulk feeder.

After deer are eating pellets and your feeding program is "off and running", if you decide to make a change in feed (i.e., brand, protein or other nutrient level), do it gradually. Deer do not like abrupt changes in feed. If this happens, they generally will reduce their intake for 3 or 4 days and up to a week depending on the magnitude of the change. An easy way to minimize the effect of a change is to allow the bulk feeder to get half empty then fill the feeder with the new feed. That way, as feed is consumed and the feed level in the feeder drops, the two feeds gradually mix together and the change is more gradual.

Although jumping a 3 ft fence is no problem for an adult deer, sometimes even that height is apparently intimidating, particularly if it is a new fence. If you are having difficulty getting the deer to jump into the feeding pen, I have used a couple of approaches to alleviate this problem: (1) Leave one side of the feeding pen open until deer are consistently feeding inside the pen then close the open side. If cattle are present, this is obviously not a good option. (2) Use tall Tee posts to build one or more sides of the pen and raise the bottom of the hog panel 18 to 24 inches above the ground (Figure 2). I much prefer the second option because it appears that deer instinctively prefer to crawl under a fence rather than jump it and it allows fawns early access to the feed.

The first question that everyone always asks when either of these options is suggested is "What about the hogs"? I have had remarkable success using an electric fence with a "hot" wire 8 to 10 inches off the ground 15 ft outside the perimeter of the feed pen (Figure 3). If they still get in, I use 2 "hot" wires, one at 2 inches and the second at 10 inches above the ground. I have used this option to successfully feed deer on a ranch where, cattle, elk, feral hogs and javelina are all present. However, it is critical that the electric fence be kept operational. If it fails, "watch out", since hogs can empty a deer feeder overnight.

Getting mule deer started on feed can be many times more difficult than getting whitetails started. I have been successful in getting mule deer started by "stringing out" pellets or corn for a long way on a ranch road. Observe where the deer are coming to the feed and concentrate the feed there for several days. You can then use a sling feeder if necessary and develop a feeding area at that location.

NUMBER OF FEEDING AREAS

The number of feeding areas that need to be established varies according to ranch size, deer population and deer production goals. On areas greater than 1,500 to 2,000 acres about 2 feeding areas per section should be established. On smaller areas or areas with high deer numbers about 1 feeding area per 100 acres should be established. When feeding mule deer where numbers may not be as great, 1 feeding area per 1,000 acres may be adequate. Another way to look at the situation is to determine your deer population and figure that a bulk feeder will generally take care of 25 to 30 deer. It has been my experience that white-tailed deer will travel about one-half to three-quarters of a mile to a feeder. Therefore, if you want to expose a high percentage of your deer to feed, you need feeders at least at those intervals. I expect that mule deer will travel further to a feeder, but I do not know for sure if that is the case.

It is not necessary to put in all the feeding areas at once. Start in areas where you can have the greatest impact (i.e. where deer numbers and activity are high, where the bucks "hang out" in the spring and summer, etc.). Once you are comfortable with making the feeding program work, then establish new areas as needed.

MANAGING THE FEEDING PROGRAM

Several types of bulk feeders are available for feeding deer, all of which have been used successfully. I personally like the type with an elevated barrel or bin with a pipe coming out the bottom and a small trough at the bottom. Important considerations when buying or building a feeder: (1) Protect feed from the weather as much as possible to reduce contamination and spoilage; (2) Feed should be available free choice to the deer and designed to reduce access to the feed by raccoons and other non-target species. This is a worthy, but probably not achievable, goal.

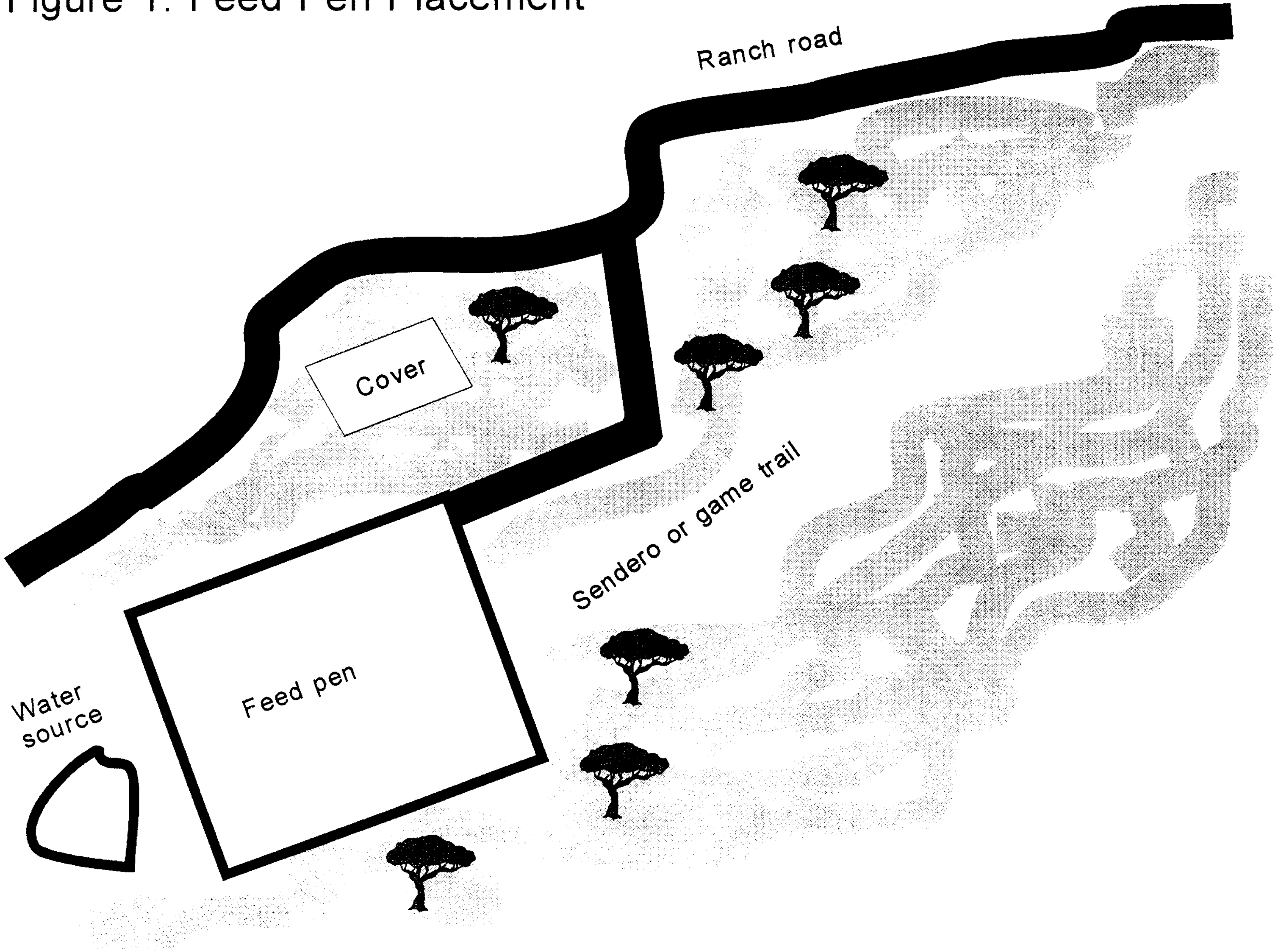
I generally tell producers to just figure that they are going to lose some feed to racoons and other non-target species. To help minimize this problem, many feeder manufacturers are making "timed" bulk feeders that will dispense a certain amount of pellets into a trough at various times of the day or night. Since raccoons feed mostly at night, if the timer is set so no feed is dispensed at night, very little is lost to the raccoons.

A concern I have with this type of feeder is that of not feeding all deer. Dr. Harry Jacobson of Mississippi State recently reported that over 70% of the visits by deer to free-choice feeders were after dark. Considering the value of a good buck in today's market, I personally would prefer to use a trapping and/or another other raccoon reduction program in preference to taking a chance that a good buck comes to the feeder to eat and finds it empty. However, this is a decision that each producer must make after considering feed costs, feed loss, and production goals.

If your goal is to supplementally feed the deer rather than just a "baiting" program, it is very critical that deer, particularly the bucks, feel comfortable about coming to the feeding pen at any time. Therefore, NO HUNTING should be allowed at the feed pen. If baiting is needed around stands, or to harvest does and spikes, place the corn feeders well away from the supplemental feed pens.

Patience and perseverance are an essential part of establishing a successful deer feeding program. Being creatures of instinct and habit, deer have to be taught to come to a feeding pen and eat out of a feeder. Getting deer started eating out of a bulk feeder can take some time so do not get discouraged. Do not expect miracles overnight. A three-year response time is to be expected. Mature bucks often will not come to newly established feeding pens. The real positive response can be expected from the buck fawns that have grown up coming to the feeder with the doe. These animals are the ones that will demonstrate if a supplemental nutrition program really pays off in antler development and body size.

Figure 1. Feed Pen Placement



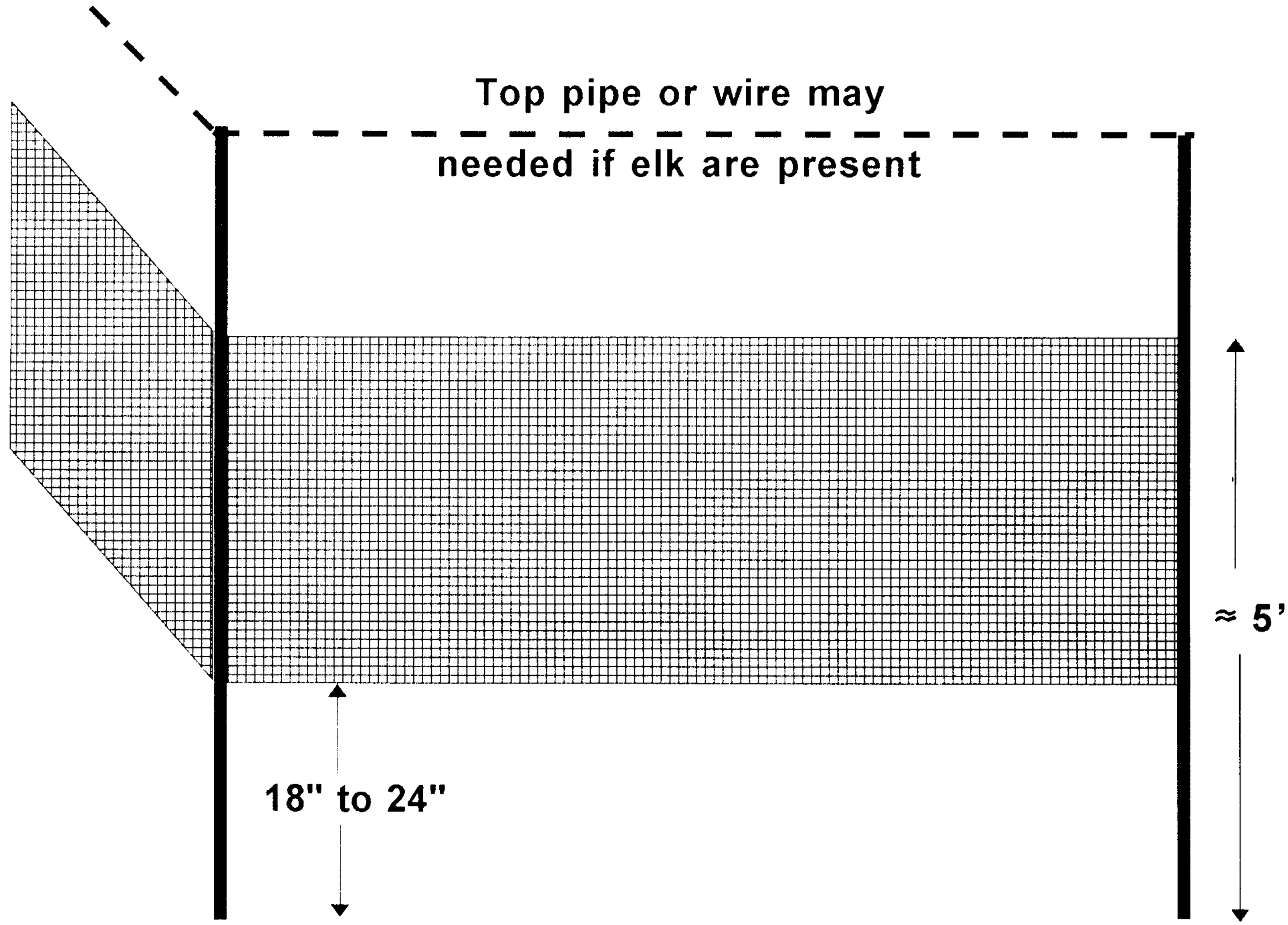


Figure 2. Raised Panel Construction to Allow Deer to Go Under Instead of Jumping

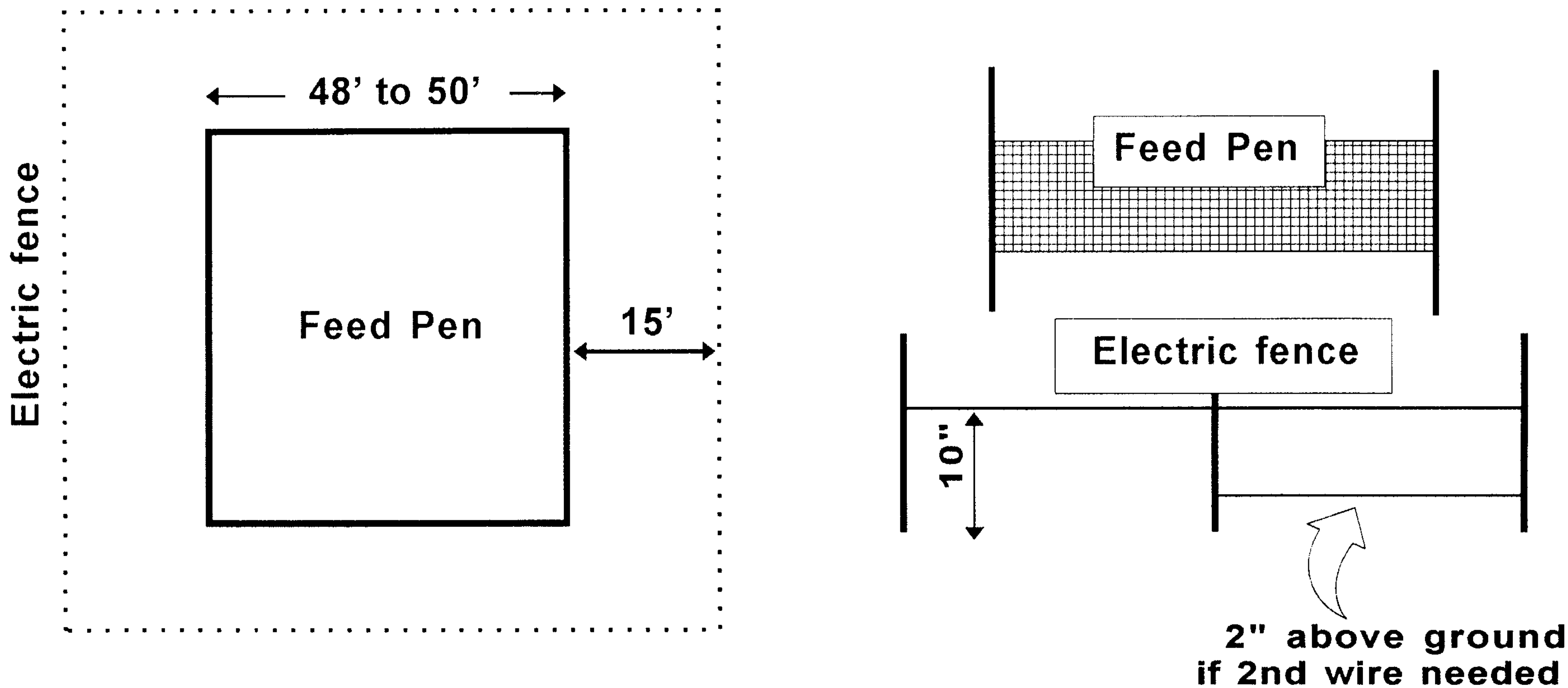


Figure 3. Electric Fence to Keep Hogs out of Feed Pen

GUIDELINES FOR ESTABLISHING DEER FOOD PLOTS

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Abstract: Food plots are planted to provide palatable, digestible and nutritious forage for deer when and where needed. Free-ranging deer are selective feeders. So, food plots must be more palatable than other available foods to be grazed. Plant species for food plots should be selected so that nutritive value of the forage plants will be in sync with the deer's nutritional needs. Likewise, plants selected must be adapt to the region. Appropriate cultural practices are mandatory for success.

The objective of planting food plots is to provide palatable, digestible and nutritious food for whitetails where and when needed. Food plots are usually a supplement to natural forage and browse. The need for supplemental planting is a subjective judgment to some extent, but must be based on habitat food deficiencies and seasonal nutritional needs of the whitetail population in question (Crawford 1984). Food plots are also used to concentrate deer for viewing or harvest. To attract free ranging animals, palatability must be high relative to other foods available.

DEER BEHAVIORAL INFLUENCES

Deer are selective feeders. Their biology--that is behavior, morphology and physiology--sets internal boundaries which guide the diet selection process of each individual. Deer seek out some plants, take portions of others and completely avoid some species. They have highly manipulative lips, soft muzzles and agile tongues. They are able to graze small plants or choose parts of plants, typically the terminal growing portions. This ability to select allows them to maintain a diet higher in nutritional quality than a bulk grazer, like a cow, in the same habitat (Hofmann 1989). However, a concentrate selector such as the whitetail only can select from among those plants with which it has contact. The relationships between an individual animal and its food in time and space are important considerations in making food plots an appropriate part of a deer management program. The "Field of Dreams" idea "plant it and they will come" is not a good guideline.

Deer habitat is composed of a complex arrangement of plant communities which are delineated by the plant species present, their spatial arrangement and their structural configuration. Plant communities might be subdivided into smaller units of relatively more homogeneous plant groupings, patches. Once an animal has oriented itself within a patch it selects its diet among individual plants and plant parts along its grazing path. Deer do not stay in one location and spot graze like a domestic sheep even when the patch is comprised of highly palatable forage..

Diet selection thus has two major components, spatial choice and species choice.

An individual deer has a limited area in which it lives its lifetime, its home range. It will stay at home even under starvation conditions. Food must be within an individual's home range to be used. But, all locations within a home range are not visited equally. Food plots should be located in close proximity to cover for deer to make optimum use of them. Deer feeding rhythm during the vegetation growing season is one of frequently repeated periods of feeding, usually alternating with short rumination periods. Deer prefer to rest/ruminate close to cover. Forage located in large open areas apart from cover may be little used.

The height of food plants is another spatial constraint. Adult whitetails can browse to approximately five feet. So, any foliage grown above that height is unavailable until it falls. One type of food plot comprised of woody species--such as yaupon or honeysuckle--may be manipulated to produce a growth form within reach of the animals (Lay 1966; Stransky, Hale and Halls 1976)1. The use of fire and shredding controls the height and density of plants.

Selection of plant species by free-ranging animals appears to be based on the animal's perception of cost-benefit constraints imposed when different foods are sought and ingested (Stuth, Lyons and Kreuter 1995). This does not imply a conscious analysis by the animal. However, the animal is linked to its nutritional environment by olfactory, visual, and taste cues. These cues influence food selection to meet the animal's physiological needs. The deer's digestive tract and digestive process are adapted to a natural "high quality" diet.

Poorly nourished deer are less selective feeders than well-fed animals. In trying to fill their stomachs they must consume more of the lower quality forage and actively feed for longer intervals of time. However, even under these conditions deer do not consume every kind of plant. For example, they do not take mature grass apparently because they are physiologically inefficient in breaking down cellulose. Crass managed for hay is generally poor feed for whitetails. However, several warm-season grass species provide good forage in early growth stages. Cool-season grasses are palatable longer.

Deer tend to select the most nutritious forage available, even within a single field. However, the relationship between chemical makeup and animal use is not consistent. A site within a food plot may show differential use. This was demonstrate with both wheat and clover (Swift 1948).

PLANT PALATABILITY INFLUENCES

An animal's selection between species of plants has been interpreted as an indicator of palatability. It is not always obvious why some plants or plant parts are more appealing to deer than others. However, palatability of any plant species is relative to all the plants to which an animal has access (Halls 1994).

Palatability of a species is not an absolute, but may be different through the geographic range of a plant species (Harlow 1979). A "miracle forage" at one location may be little used at another.

The stage of growth each individual plant can markedly influence its attractiveness to deer. Hence, palatability changes between and within seasons. Even the separate parts of a plant exhibit different degrees of attraction. For example, growing sorghum may be completely ignored by deer until the grain reaches the milk to soft-dough stage and then have the heads selective eaten. Cow peas may be grazed heavily in the two-leaf stage, ignored as a mature forage plant, but again have the pods taken heavily as they begin to mature.

Palatability of a plant species may be improved with cultural practices such as mowing, clipping, burning, fertilizing, and liming. Preference behavior of deer can also be changed by application of chemicals such as repellents and attractants to food plants. Food flavor familiarity may be the single, most important factor controlling food preference behavior or wild species (Shumake 1978). Mammals show highest acceptance of familiar foods, but they also tend to sample small amounts of any new food item placed in their environment.

No plant species is nutritious, palatable, available and eaten year round. For this reason plants for a food plot should be selected to meet seasonal needs. It is increasingly recognized that food habits, foraging movement patterns, and energy and time expenditures are partial measures of the animal's perception of its requirements relative to its nutritional environment. An individual deer's nutritional needs are determined by its biological cycle of conception, growth in uterus, juvenile growth, maturity, physical and sexual activity. Since white-tailed deer are seasonal breeders, the nutritional needs of all like-age animals are closely in sync with each other and with the seasons. Summer and fall are periods of highest nutritional needs since all animals are growing; does are pregnant, lactating or preparing to breed; and bucks are growing antlers, and preparing for the rut.

The deer's nutritional requirements and behavioral constraints form a framework within which to evaluate the animal's habitat from which it must satisfy its needs. Given the individual's nutritional requirements; what deficiencies are identified in its habitat and in turn what plants can correct the deficiencies? The season of greatest nutritional demands is not necessarily the period of significant habitat deficiencies.

PLANTING FOOD PLOTS

Forage plants used for deer food plots must be high quality (very digestible, low in fiber, high in protein and energy). Although many plants could be used for deer food plots, most are only grazed by deer for a short time due to changes in nutritive value. A plant may be very palatable in a young growth stage and be eaten by deer extensively, but not taken when mature.

In some plants only the new growth is used by deer, therefore, not enough volume of deer food is produced. This makes the plant only fair for deer food plots. Introduced forage plants for food plots are increasing in usage.

Cultivated forage plants are usually divided into grasses and legumes. Legumes (alfalfa, cool season clovers, vetch, warm season clovers, beans and peas) provide a lot of high quality forage for deer. When adapted to the soil type and seasonal rainfall, legumes are a preferred choice for deer. Protein content is from 20 to 30 percent in growing plants. Legumes are low in fiber and high in energy. They are very palatable and selected by deer in preference studies. In addition to excellent forage quality, legumes have the ability to fix atmospheric nitrogen for fertilizer. Hence, properly inoculated legume plants need to be fertilized with phosphorus, potassium and lime (depending on soil test). This makes them easy to establish and more sustainable. Alfalfa is a perennial (comes back from the roots year after year) while most others are annuals. Hay type alfalfa varieties cannot withstand close grazing. They will be grazed out by the deer before established. If alfalfa is considered, plant a grazing type alfalfa. Annuals must be planted each year, or allowed to reseed from seed produced the year before.

Grasses that are used for deer food plots are typically the cool season annual grasses. This includes oats, wheat, rye, and ryegrass. These grasses will provide high quality forage (crude protein of 15 to 20%) from November through March or May (depending on variety planted and management). These are annual grasses and must be planted each year for production.

Summer perennial grasses (coastal bermudagrass, kleingrass, switchgrass) are only utilized by deer in minimal amounts. Deer will utilize some new growth from properly fertilized grass pastures when the crude protein is 12 to 15% and % fiber is low. As the plant grows, it drops in protein content and energy, increases in fiber and becomes unpalatable for deer use. Some research has shown that warm season perennial grasses can be utilized by deer if not allowed to get over 14 days old (shred ½ every week), and fertility remains high. Even at this, deer will prefer other plant species. Even fertilized bermudagrass, for example, will change from 1520% protein when young to 3-5% when fully mature and stemmy.

Some summer annual grasses (millet, sorghum-sudans) have been used by deer, but alfalfa, peas, beans, or alyce clover are a better choice for summer deer plots.

Starting a deer food plot requires more planning than just buying the seed. Plots should be big enough in size that they are not grazed out by the deer before they develop a plant past the seedling growth stage. Many young plants cannot stand close grazing. These plants may need to be planted in a fenced off area, and allowed to get established before deer grazing. Food plots generally should be no less than 1 acre in size and may be 3 to 5 acres or more. Up to 10% of the acreage can be put into food plots (Stribling 1992).

It is better to plant seed of deer food plot plants in a properly prepared seedbed. The closer you can get your plot like a garden before planting the more success you will have with forage production. A proper seedbed is clean, smooth, firm, well plowed, has good soil structure, weed free, moist, and fertile. For this to occur the area should be cleared of trees, brush, and stumps. It is best to mow and do the initial discing of the area 30 to 45 days before planting. However, sometimes the mowing and discing must be done on the same day as planting. The soil should be disced or plowed more than once, if possible. Recommended fertilizer, according to a recent soil test result, should be applied and disced in the seedbed. A rain between discing operations is preferred to sprout weed seed and put moisture in the seedbed. Since most deer food plant seeds are small, a firm seedbed is a must. Otherwise, the need will be placed too deep in the soil for emergence. Dragging or rolling the seedbed before and after broadcast planting is important.

If seeds must be planted in existing sod of plants without plowing or discing, choose a plant species that can give some success at sod seeding and do minimal management to promote plant emergence. Alfalfa, clovers, vetch and ryegrass have been planted into sods with some success. It is important to mow the plot as close to the ground as possible at planting time to remove excess vegetation. This will prevent existing plants from shading out the new seedlings. Broadcast or drill the seed. Drag to make sure the seed makes contact with the soil. Fertilize according to a soil test recommendation. Allow plants to become established prior to grazing, if possible. It is preferable to sod seed just prior to a rainfall (prior to a wet norther, for example).

It has been shown that seed planted on a poor and weedy seed bed results in only 33 percent seed emergence. Therefore, if the seed bed is not well worked, firm and smooth, increase seeding rates.

Seed is distributed on the seedbed and placed at proper depth. Small legume and ryegrass seed should be <u>no deeper</u> than ½ inch. Seeds such as oats, wheat, beans or peas can be planted from 1 to 1.5 inches deep. Planting deeper will result in fewer plants emerging from the seedbed. Seeds are planted by broadcast (with tractor or truck bumper mounted broadcast seeder) or by use of a drill. Rolling or dragging the plot after planting will ensure retaining soil moisture and good soil/seed contact. Both will help ensure a good plant stand. Seed should be purchased from a seed dealer and should have a recent seed viability test showing percent germinating and percent purity.

Fertilize the deer food plots according to a soil test recommendation for the specific plant you are using. Remember that legume seed must be inoculated with nitrogen fixing bacteria prior to planting for nitrogen to be fixed by the plant. Fertilize legumes with other required nutrients. A soil test bag and instructions can be obtained from any County Extension Agent's office.

Following recommended planting information will assure the best chances for successful establishment of deer food plots.

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MANAGING SUPPLEMENTAL DEER FORAGES IN EAST TEXAS

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Abstract: Whether right or wrong, many East Texas landowners, wildlife managers and deer hunters believe that supplemental forages are synonymous with deer management. In fact, "food plots" are often planted when no other management technique is utilized. Nevertheless, the use of supplemental forages can be an important starting point to integrate additional land and deer management strategies that can increase the quality of deer populations as well as hunting experiences. Supplemental forage management strategies are presented in this paper.

The white-tailed deer (*Odocoileus virginianus*) is the most popular big game species in Texas. Our large deer population has generated a tremendous sport hunting demand, which has developed into more than a billion-dollar-a-year industry.

Landowners are becoming more interested in intensive deer management strategies in order to conserve deer populations in the face of decreasing deer habitat. Existing habitat is threatened by the growing human population in East Texas, as well as by land use changes, urbanization, highway and road construction, water development and certain cattle management, timber management and farming methods.

The establishment of supplemental food plots is an important deer management strategy which is becoming widely accepted throughout eastern Texas and much of the southeastern U.S. However, most plantings are not aimed at improving the nutrition of white-tails. This is critical since much of the southeastern deer range (including East Texas) provides substandard nutrition for

desirable deer production. The use of supplemental food plots as an intensive management tool evolved from hunters' efforts to concentrate deer in one area for harvest. It is just as important to use plots to improve the nutrition of whitetails and add critical minerals (particularly calcium and phosphorus) to the diet of a deer herd.

DECRIPTION OF THE REGION

East Texas is composed of two major ecological regions--the northern part of the Post Oak Savannah and the Pineywoods. The Post Oak Savannah lies northeast to southwest between the Blackland Prairie of Central Texas and the Pineywoods in eastern Texas. The upland soils of East Texas are light-colored sandy loams and sands, while bottomlands are typically light-brown to dark-gray sandy loams, clay loams and some clays. Soils throughout East Texas are generally acid (pH below 7.0). Annual rainfall is usually the highest of any region in the state 35 inches on the western edge of the region up to 55 inches along the eastern boundary.

Abundant rainfall is a mixed blessing when managing deer habitat. It quickly leaches nutrients from the soil, which lowers the quality of food supplies. It also results in the rapid succession of vegetation, and causes native food supplies to grow beyond the reach of deer. On the other hand, the amount of rainfall East Texas receives annually is generally sufficient to produce consistent crops of supplemental forages. For these reasons, planting supplemental forage is a sound strategy for managing white-tailed deer in East Texas.

However, even East Texas can be subject to drought conditions in localized areas. The current drought gripping East Texas dates back to early last fall and was responsible for numerous cool-season plot failures. In addition, lack of rainfall throughout 1996 has also resulted in below average performance of warm season forages. These conditions will most assuredly have an adverse affect on deer production, antler development and survival throughout the region.

PLANNING THE FOOD PLOT

Well planned food plots can increase forage availability and at least partially compensate for decreases in suitable deer habitat. However, maximum benefits can be obtained only if forages complement the diet available from native vegetation and if forages are available when native vegetation is lacking or is low in nutritional value. In East Texas these stress periods occur in late summer and late winter.

In addition to timing the availability of supplemental forage properly, landowners also must plant appropriate species in the best available sites, use correct planting techniques and ensure soil fertility.

Site Selection and Preparation

The area selected for planting will depend on the plant species to be established (warm- versus cool-season) and the goals of the landowner/deer manager. The landowner may want to plant both types to supplement the usual lack of nutritious native forage in both late summer and late winter.

Warm-season species are more reliable when planted in bottomland soils that retain moisture during the drier summer months. However, care should be taken to select a site that is not prone to flooding from nearby streams and rivers. Droughty upland soils are not good sites for warm-season species. Warm-season species should be selected for their ability to grow quickly and compete with native weeds.

Cool-season species are not as susceptible to drought or weed competition as warm-season species. One exception may be legumes, which may require delayed planting if rainfall is deficient in the early fall months (September and October). Cool-season species can be planted on either upland or bottomland sites.

Whenever possible, food plots should be planted in existing openings to reduce costs. Examples include fallow fields, pipeline and transmission line rights-of-way, logging roads, firelanes and interior road rights-of-way. Areas adjacent to public roads or areas of public access are poor planting sites since they may encourage poaching.

With either warm- or cool-season supplemental forages, soil samples should be taken to determine lime and fertilizer requirements. Failure to properly amend the soil may result in drastically reduced yield or excessive weed competition. Your county Extension agent can help with soil testing.

If soil testing is not possible, food plots should be: 1) limed every 3 years at the rate of 2 tons per acre; 2) fertilized after germination with 200 pounds per acre of 6-24-24 (cool-season plots) or 0-24-24 (warm-season plots); and 3) top-dressed with 200 pounds per acre of 34-0-0 fertilizer in mid-December (cool-season small grains).

The site should be shredded and disked to prepare a clean seedbed. Agricultural limestone (if needed to correct pH) should be applied prior to disking and worked into the soil. Planting sites should not be shaded by nearby trees, but should be adjacent to adequate escape cover. Since cool-season plantings are often established in hunting areas, particular care should be given to placing these plots near adequate escape cover, travel corridors and other types of habitat frequented by deer.

All legumes should be properly inoculated to increase nitrogen fixation. This will lower fertilizer needs and improve soil quality over time. Planting depth is also critical for successful establishment. Failure to plant species (especially legumes) at the recommended depth may result in poor stands.

Food Plot Size and Shape

The sizes and shapes of supplemental food plots vary tremendously. Most plots are from 0.5 to 3.0 acres in size. However, much larger plots may be necessary for warm-season forages to avoid stand elimination. Deer are more apt to feed along the edges of plots than in the center (especially during the hunting season), several small cool-season plots are often more effective than one large plot.

Larger food plots can be established, especially if the shape is long and narrow instead of square. Long, narrow food plots maximize the edge available and can cut across more home ranges of deer. However, plots must be wide enough to prevent excessive shading from nearby trees.

Properly established food plots are expensive, and this may limit the acreage that can be established. Therefore, it is important to maximize productivity and carefully select planting sites. When only large openings are available for forage establishment, warm-season forages should be established away from adjacent escape cover. This technique allows for the establishment of cool-season forages adjacent to the opening edge which often serves to increase deer use during the hunting season.

Whenever possible, do not establish warm- and cool-season forages on the exact same site. For example, site preparation for planting of cool-season forages already established in warm-season forages will destroy forage that may still be available for deer to use.

A good rule of thumb is to plant 1 to 3 percent of the total habitat in both warm- and cool-season forages. For instance, 1 to 3 acres of food plots should be established for every 100 acres of habitat present. Food plots should be distributed at the rate of at least one plot per 160 acres of habitat.

Species Selection

Every 3-4 years, a "new" deer forage arrives on the scene with much fanfare and promotion. Hunters, landowners and managers continue their quest to find the perfect deer forage like it was the mythical Holy Grail! Despite many marketing claims to the contrary, there is no one forage species that can satisfy all the nutritional requirements of the white-tailed deer throughout the year. With this in mind, warm- and cool-season forage combinations are recommended over the establishment of individual species.

In choosing a species or combination, remember that all deer forages should: 1) increase the nutrition available; 2) be readily accepted; 3) be available at times when native forage is lacking in quality and quantity; and 4) be adapted to both the region (Post Oak Savannah or Pineywoods) and the site (bottomland or upland). In other words, if a forage species does not improve nutrition, if deer won't eat it, if it's not available during periods of stress or if it won't yield sufficient quantities to justify establishment, DON'T PLANT IT! Furthermore, since most plant species are commercially available in several varieties, care should be taken to plant a variety adapted to a particular area.

Warm-season forages supplement the deer diet throughout the important summer and early fall months when doe lactation, fawn growth and antler development occur. In fact, many managers and biologists are convinced that the warm-season component of a supplemental forage program has the most impact on a deer population.

Alyceclover and forage cowpeas has proven to be an excellent combination planting for the warm season, producing 3 to 4 tons of forage per acre in performance trials. "Iron and clay" cowpeas produced higher yields and matured later than other forage cowpea varieties in recent trials in East Texas. Other forage combination recommendations are given in Table 1.

Cool-season forages provide additional nutrition during the hunting season as well as during the critical stress period in January and February prior to spring green-up. Traditionally, hunters and landowners have accepted planted in the Fall in order to concentrate deer for harvest. Unfortunately, inappropriate planting techniques and species selection often lead to poor results.

One of the best methods to ensure a successful cool-season forage program is to establish combinations of compatible species. Cool-season combinations can extend forage availability into early summer, about the time warm-season plots become useable by deer.

Given a choice, white-tailed deer prefer oats over other small grains such as rye and wheat. Unfortunately, commonly available oat varieties are susceptible to winterkill. Therefore, rye is often planted in East Texas and is an excellent cereal grain to include in a cool-season forage combination because of its cold hardiness. Recently, several winter-hardy varieties of oats have become commercially available. However, unless these oat varieties are available, rye should constitute at least two-thirds of the small grain component, with oats and or wheat making up the remainder.

Arrowleaf clover, a legume, is also a valuable component of cool-season forage plots. It provides forage through late spring and early summer. Once established, arrowleaf clover should not have to be replanted. Unfortunately, a virus outbreak over the past few years has decreased the viability of many arrowleaf stands in East Texas, especially in pastures where stands have been established for a number of years.

An annual program of shredding in late summer, followed by light disking or burning of the clover, will result in sufficient seed to develop a stand the following year. Since the arrowleaf clover component of the stand requires slightly different management than the cereal grains, the clover should be planted in a strip adjacent to the small grains.

Ryegrass may be planted with the arrowleaf clover since it will also reseed itself and responds favorably to the same management. Although ryegrass is not preferred by white-tails as much as small grains, it has a reputation of being a reliable forage producer and may be used extensively by deer in the absence of other forages. Cool-season forage combinations of small grains, arrowleaf clover and ryegrass have yielded as much as 4 to 5 tons of forage per acre per year.

Other good cool-season forage species include subterranean clover, sweetclover and Austrian winter peas. Subterranean clover and sweetclover varieties should be selected to produce in the spring and early summer months. Austrian winter peas provide some early growth and may be established alone or in combination with cereal grains (Table 2).

Whenever possible, livestock should be excluded from food plots established for deer. While cattle seldom feed on warm-season plots composed primarily of cowpeas, failure to exclude them from cool-season plots may result in stand failure and certainly will limit the forage available for deer. To exclude livestock from food plots, wires should be spaced to permit deer easy access (i.e., the bottom wire should be 18 inches from the ground).

Table 1. Warm season supplemental forage combinations recommended for East Texas whitetails. *

Species	Region	Site	Seeding rate (lbs/acre) broadcast**	Innocu-lation Req'd	Planting depth (inches)	Comments
Forage cowpeas	Post Oak or Pineywoods	Bottomland	40.0	Yes	1.0	Plant peas, then drag in alyceclover .
Alyceclover	Post Oak or Pineywoods	Bottomland	10.0	Yes	0.5	
Forage cowpeas	Pineywoods only	Bottomland	40.0	Yes	1.0	Plant peas, then drag in alyceclover.
Alyceclover	Pineywoods only	Bottomland	10.0	Yes	0.5	
American jointvetch	Pineywoods only	Bottomland	5.0	Yes	0.5	

* Plant varieties in combination between May 1 and June 15.
** Reduce seeding rate by 20% if a seed drill is used for planting.

CONCLUSIONS

Supplemental forages should not be viewed as "cure-alls" in deer management. Without proper habitat management and population control, food plot establishment is a waste of time and money for the hunter, landowner and deer manager. However, food plots can be an important part of the overall management of deer in East Texas.

Properly established food plots can increase the production capacity of deer habitat by enhancing the nutritional level of white-tails throughout the year. However, selection of adapted varieties and proper planting techniques are critical for success.

Despite numerous advertising campaigns to the contrary, there is no one perfect deer forage! Although landowners and managers should never hesitate to experiment with different forage species and planting techniques, these should always be employed on a limited basis to determine effectiveness prior to large scale establishment. All forages should be measured by their ability to meet four criteria: nutritive value, deer acceptance, availability during stress periods and adaptability to the planting site.

Remember, one test is worth a thousand expert opinions!

Editor's Note: This paper was taken in part from TAEX fact sheet No. L-2457 entitled "Supplemental Forage Management for White-tailed Deer" by Billy J. Higginbotham and J.C. Kroll.

Table 2. Cool season supplemental forage combinations recommended for East Texas white-tails. *

Species	Region	Site	Seeding rate (lbs/acre) broadcast**	Inocu-lation Req'd	Planting depth (inches)	Comments
Rye	Post Oak or Pineywoods	Upland or Bottomland	75.0	No	1.0	Combine and plant oats and rye. Combine and plant rye-grass and clover adjacent to small grains on well-drained soil.
Oats	Post Oak or Pineywoods	Upland or Bottomland	25.0	No	1.0	
Arrowleaf clover	Post Oak or Pineywoods	Upland or Bottomland	10.0	Yes	0.5	
Ryegrass	Post Oak or Pineywoods	Upland or Bottomland	10.0	No	0.5	
Rye	Post Oak or Pineywoods	Upland or Bottomland	60.0	No	1.0	
Oats	Post Oak or Pineywoods	Upland or Bottomland	10.0	No	1.0	Combine and plant rye, oats and wheat. Combine and plant ryegrass and clover adjacent to small grains on well-drained soils.
Wheat	Post Oak or Pineywoods	Upland or Bottomland	20.0	No	1.0	
Arrowleaf clover	Post Oak or Pineywoods	Upland or Bottomland	10.0	Yes	0.5	
Ryegrass	Post Oak or Pineywoods	Upland or Bottomland	10.0	No	0.5	
Sweet-clover	Post Oak or Pineywoods	Bottomland	20.0	Yes	0.5	Plant adjacent to other food plot components.
Subter-ranean clover	Pineywoods	Bottomland	20.0	Yes	0.5	Plant adjacent to other food plot components.
Austrians winter peas	Post Oak or Pineywoods	Upland or Bottomland	60.0	Yes	1.0	Plant adjacent to other food plot compo-nents or in combination with small grains. Reduce seeding rate by 50% if planted in combination with other forages.

* Planting dates for all varieties are 9/15 to 10/15, depending upon available soil moisture.
** Reduce seeding rate by 20% if a seed drill is used for planting.

FOOD PLOT STRATEGIES: SOUTH TEXAS

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Abstract: Food plot strategies for South Texas should emphasize providing forage when natural vegetation is deficient in nutritional quality and quantity. With proper plant species selection, a system of cool- and warm-season food plots will provide supplemental forage virtually all year. Nutritional quality and quantity of native forages is often lowest during late summer. Lablab (*Lablab purpureus*) is adapted to low rainfall and will provide nutritious forage throughout the summer, particularly if skip-row planting is employed. Farming practices that emphasize moisture conservation are critical for maximum success when growing food plots.

South Texas provides a challenging environment for growing food plots for the white-tailed deer (*Odocoileus virginianus*). Rainfall is erratic, temperatures are hot, weeds are prolific, and soils are variable. Average annual rainfall in south Texas ranges from 36 inches in the east to 18 inches in the west. High evaporation results in moisture deficiencies that are particularly severe in the western portions of South Texas. Average annual precipitation deficiency (average annual rainfall minus average potential evaporation) ranges from -12 inches in the east to less than -36 inches in the west. In comparison, average annual precipitation deficiency in the Chihuahuan Desert in far West Texas does not exceed -28 inches. These moisture restrictions make growing food plots difficult and they also hinder the ability of natural vegetation to consistently meet the nutritional needs of deer.

RATIONALE FOR PLANTING FOOD PLOTS TO IMPROVE DEER NUTRITION

Much rangeland in Texas has been overgrazed by livestock and deer or has been degraded by brush control and palatable native forage plants are sparse. Almost half the rangeland in the central Rio Grande Plain and 20% of the rangeland in the western Rio Grande Plain is in poor range condition, which resulted from years of overgrazing by livestock (Texas Soil and Water Conservation Board 1991). Even when proper management is implemented on previously overgrazed rangeland, the time required for vegetation to recover from grazing abuse may be excessive. For example, soils on rangeland overgrazed by cattle may be so compacted that desirable forbs will not reestablish without mechanical manipulations such as roller chopping. Food plots may provide islands of quality forage on rangeland where palatable native forages have been eliminated by overgrazing.

Food plots may also help to ameliorate variation in the nutritional quality and quantity of natural forages that results from seasonal variations in rainfall and temperature. The low and erratic nature of rainfall in South Texas coupled with the seasonal fluctuations in rainfall and temperature result in extreme seasonal and annual variation in the abundance and nutritional quality of deer forages (Meyer et al. 1984, Barnes 1988). Food plots, to effectively ameliorate variations in nutritional quality of natural forages, should supplement native vegetation when it fails to meet the nutritional needs of deer. In other words, having lush food plots when the natural vegetation is lush and having dead food plots when the natural vegetation is dead is not an effective supplementation strategy. The first step in developing an effective food plot strategy is to understand the seasonal dynamics of natural deer forages. An effective supplementation strategy provides an abundance of nutritious supplemental forage during portions of the year when native vegetation does not meet the nutritional demands of deer.

SEASONAL DYNAMICS OF NATURAL DEER FORAGES

Natural deer forages can be divided into the broad categories of grass, forbs, browse, and cacti. In general, forbs are more nutritious for deer than browse or grasses. Deer prefer forbs to browse, and generally consume little grass except when it is young, green, and succulent. When forbs are lacking, browse becomes the mainstay of deer diets and thus also has an important role in deer nutrition (Meyer et al. 1984).

Although winter forbs are abundant if rainfall is adequate, dry winters are all too common in south Texas and often result in a lack of green, nutritious forbs (Varner et al. 1977). Such winters may become periods of nutritional stress, particularly if a hard freeze occurs.

Late winter-early spring rains result in greater production of preferred forbs such as lazy daisy than do summer rains. For example, February rains produce an abundance of annual lazy daisy (*Aphanostephus skirrhobasis*). Unfortunately, February is one of the driest months in south Texas. The infrequency of February rains results in great variation in abundance of annual lazy daisy from one year to the next.

Most south Texas forbs grow best during the cooler parts of the year and their abundance declines by May or June (Barnes et al. 1990). In general, rainfall peaks occur during May-June and September-October. Summers are hot and dry. Summer is a period of high nutrient demand by deer. Fawns are born during the summer, thus does have high nutrient demands to support lactation. The peak period of antler growth in bucks occurs from June 15 to August 15. Good nutrition in the months before and during this period is essential for maximum antler growth. Low rainfall and extreme heat often result in low in digestible energy and protein in deer diets during mid- and late summer (Meyer et al. 1984).

Not only are forbs less abundant in summer, but both forbs and browses decline in nutritional quality during summer, particularly when rainfall is low (Meyer et al. 1984). The energy content of natural deer foods drops below levels required for maintenance during July and August. In addition, protein levels drop below the optimum for body growth. This deficiency of energy and protein results in weight loss or reduced weight gain during the critical May to October period and may result in reduced antler growth and mortality of nutritionally-stressed individuals. Detrimental impacts on deer are accentuated if poor forage conditions are prolonged by drought.

Rains generally occur in late September and October and stimulate growth of some forbs and browse and improve the nutritional quality of deer diets during the fall. As with other times of the year, September and October rains are sometimes lacking, resulting in poor forage conditions.

GROWING FOOD PLOTS IN SOUTH TEXAS

Successfully and consistently growing food plots in the variable environment of South Texas is not a simple matter. It requires serious planning, proper plant species selection, and application of proper farming practices.

In South Texas, food plots can be grown virtually year round to supplement periods of low quality and quantity of natural forage. Cool-season food plots planted with mixtures of grasses that include oats (*Avena sativa*), triticale (*Triticum aestivum/Secale cereale*) and legumes such as hairy vetch (*Vicia villosa*), alfalfa (*Medicago sativa*), and hubam clover (*Melilotus alba*) are planted in late October or November, depending on the availability of moisture. These plantings provide nutritious forage from November through April or May.

Various cowpea (*Vigna sinsensis*) soybean (*Glycine max*), and sorghum (*Sorghum* spp.) varieties are the most common forages planted in warm-season food plots. Warm season food plots are generally planted during March-May. A major problem with plants commonly used in food plots is lack of persistence through hot, dry south Texas summers (Feather and Fulbright 1995). Much of my research on warm-season food plots for deer has focused on lablab, a legume grown for cattle forage and human consumption throughout subtropical regions of the world. Lablab develops a deep root system and with proper farming practices will persist throughout the summer until frost. Thus, lablab provides forage from early spring until late fall, and supplements deer diets during the July-August period when natural forages are lacking in quantity and quality (Beals et al. 1993). A plant adapted to hot, dry conditions, such as lablab, and intensive farming are essential to produce forage during summer.

Hehman (1995) tested the notion that food plots ameliorate the decline in quality and quantity of natural forages during summer in South Texas. He found that, when forage availability in food plots was high, intensity of use of summer food plots by deer increased as quality and quantity of natural forages declined. Thus, deer relied on food plots to satisfy nutritional needs more heavily when natural forages were lacking than they did when natural forages were abundant. His diet composition data showed that deer that did not feed in the food plots ate primarily browse and cactus (*Opuntia* spp.), while deer that used the food plots replaced browse with high-nutritional quality food plot forages (Fig. 1).

Two-stage strategy for warm-season food plots

Moisture management and conservation are the most critical aspects of any food plot strategy in South Texas. Late winter and early spring is relatively dry in South Texas and rainfall is often inadequate to provide soil moisture for early spring planting. Consequently, warm-season food plots should be plowed under by September to capture fall and winter rainfall in the soil. Stored fall and winter moisture supports crop growth the following spring.

Lablab remains green and nutritious until frost and considerable forage is lost by plowing lablab plots under in the fall. One approach to providing a longer period of lablab forage availability is to plow under only half of a food plot in the fall. This half will be planted in March. The remaining half will be plowed under following frost, and then replanted in May following sufficient rainfall. This system can be repeated annually to provide forage from March to frost.

Skip-row planting

Cotton farmers and other producers commonly use skip-row planting as a moisture conservation strategy. Bonner (1996) tested the use of skip-row planting for growing food plots for white-tailed deer. During 1994 and 1995, he planted lablab in plots with every row planted (solid), 1 row not planted between pairs of planted rows (skip 1), and 2 rows not planted between pairs of planted rows (skip 2). Rows were 36 inches apart.

Averaged across both years, forage standing crop was similar among solid (760 lbs./acre), skip 1 (817 lbs./acre), and skip 2 (727 lbs./acre) planting schemes. Forage availability (the standing crop of grazed plants) was greater in the skip 2 (309 lbs./acre, 1995) in solid (24 lbs./acre, 1995) plantings during late August 1994 and 1995. Skip-row planting schemes had greater plant survival than did solid-rows which resulted in the greater forage availability with skip-rows during late summer (Fig. 2).

Planting in skip-rows did not appear to result in increased deer use compared to solid-rows, except during late August 1995. During August 1995, deer fed in skip-rows rather than in solid plantings because of greater forage availability in skip-row plantings. Deer concentrated foraging efforts at food plot edges throughout most of the study. However, deer shifted their feeding activity toward the interior of the plots as the forage supply at plot edges was depleted.

By utilizing a skip 2 planting scheme in a semi-arid environment, landowners and land managers can increase food plot survival throughout the summer, and thereby increase the availability of nutritious forage to deer during summer stress periods. Additionally, skip 2 plantings decrease seeding costs by 50% without reducing forage yield.

Soils and farming practices

The soils on many South Texas ranches are not good agricultural soils to grow crops. Food plots should not be considered as a management option on ranches that have soils unsuitable to growing crops.

Proper farming practices are essential for maximum yield of food plots. Many people want to plant food plots but are unwilling to purchase or rent the proper equipment and are unwilling to employ proper farming techniques. Simply broadcasting seed and discing it in usually results in sparse, weed-infested plots. Such a strategy may work in east Texas, where rainfall exceeds 40 inches/year, but most of the time it does not work in semiarid south Texas. Under south Texas conditions, appropriate farming practices including weed control and deep tillage are the key to maximizing production of food plots. In most situations, if you are unwilling to invest the time and resources in growing food plots like a farmer grows crops you are better off not attempting to grow food plots at all.

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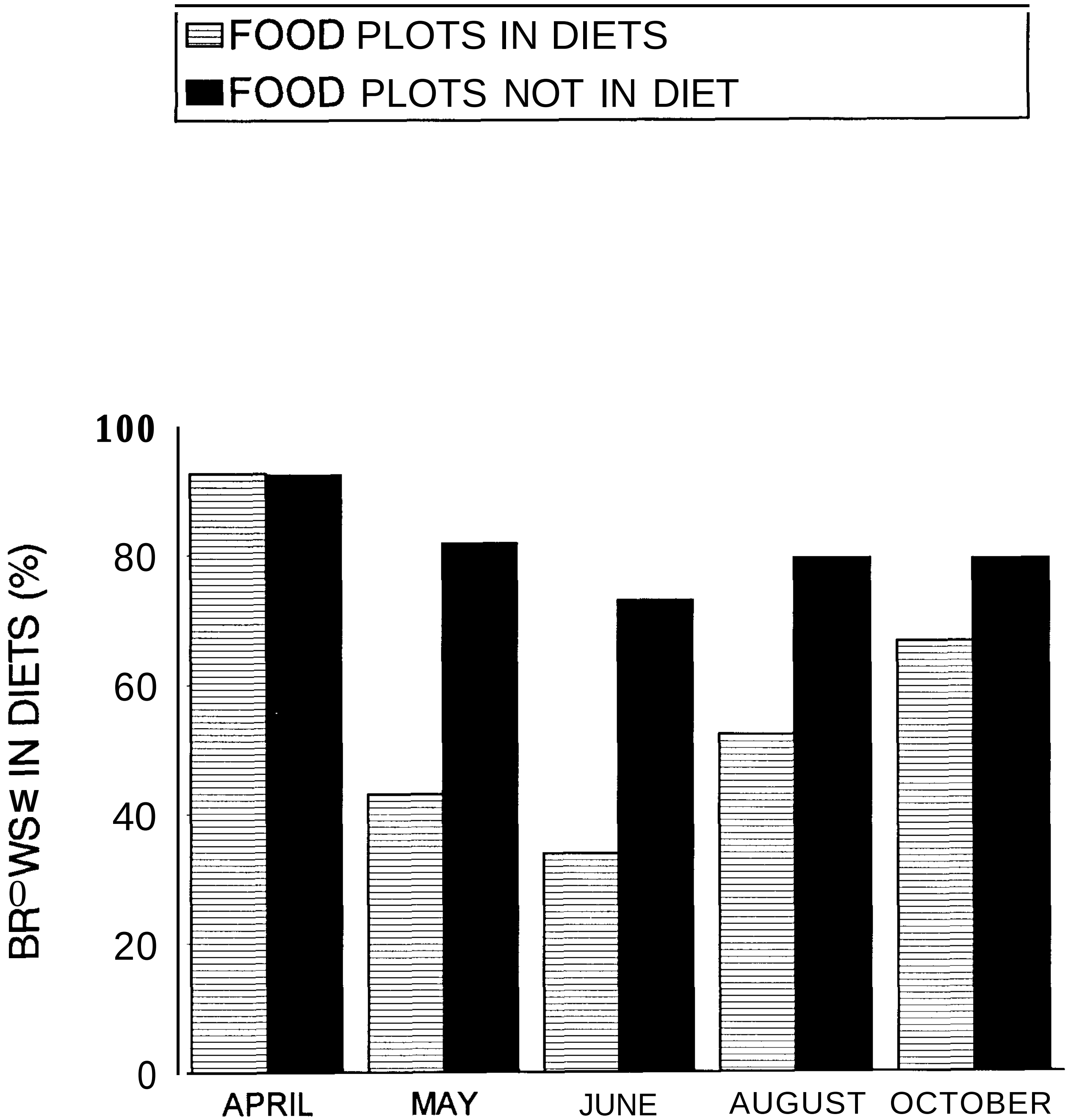

Fig. 1. Percent browse in deer feces averaged across years (± SE, n = 8) collected in 13-ha areas including food plots (n = 4) and 13-ha areas ≥1 km away from food plots (n = 4), May, June, August, and October 1992 and 1993, Starr County, Texas.

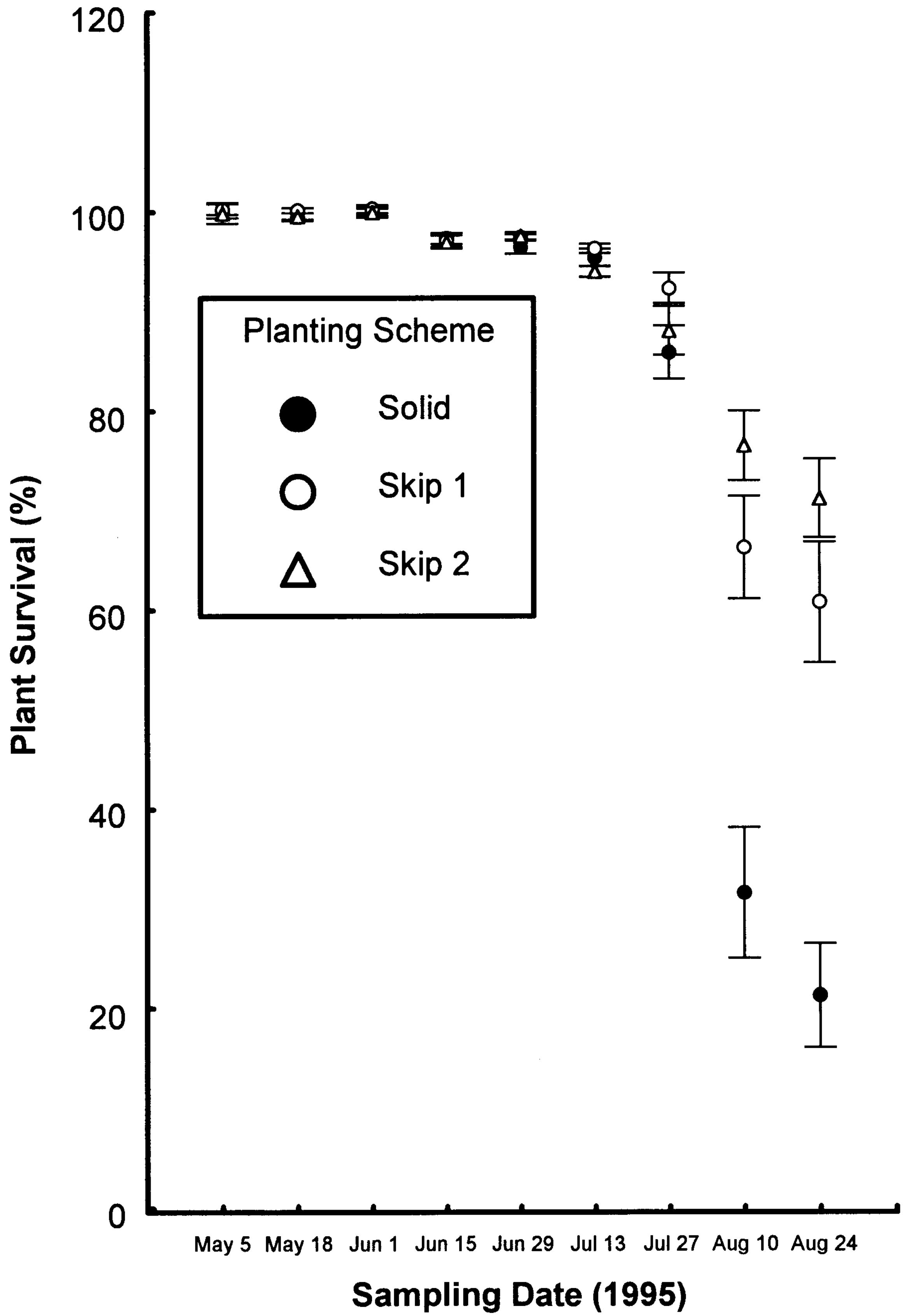

Fig. 2. Mean (± SE) percent lablab plant survival within each of 3 planting schemes over time on El Tecomate ranch in Starr County, Texas (May-August 1995).

SUPPLEMENTAL FOOD PLOTS FOR DEER IN WEST TEXAS

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Abstract: Supplementation is not required to have a healthy, high performing deer herd. However, there are four ways to increase the nutrition of a deer herd over and above what is provided by the existing habitat: a pelleted ration or concentrate can be purchased and fed; land can be farmed each year to produce deer food crops; land can be established to perennial plants to provide permanent deer pasture; and native habitats can be managed to increase the deer food supply. For the individual who desires to push deer performance and/or deer numbers to an artificially high lever, production systems using a combination of these methods can be used. If one is willing and able to provide the financial resources and management intensity required, he can accomplish this goal. However, the cost return may be unsatisfactory.

This paper will consider food plots to include any system used to increase the production of deer food plants. Planting annual and perennial food plots (deer pasture), and manipulating an existing deer habitat to enhance forage production is included. For the purpose of this discussion, West Texas is defined as everything west of the 25-inch average rainfall line excluding South Texas and the Panhandle.

A great deal can be learned from traditional farmers and ranchers about how to grow more or better deer food plants. The same principles that a cotton farmer uses to enhance his yield and that a rancher uses to increase livestock grazing capacity can be used to increase the production of deer forage.

FARMING ANNUAL FOOD PLOTS

Most of West Texas is not suitable for dryland farming. Shallow soil and steep slopes prevent much of the area from being farmable. Lack of adequate rainfall limits everything west of the 18-inch rainfall line from reliable farming. Growing annual crops for deer food is a possibility under conditions of deep soil, relatively flat slope and an average of 18 inches or more of rainfall. In addition one must have farming equipment, farming skills, and the farming mentality to make annual dryland food plots work.

The Farming Mentality

The farming mentality says "I will do everything in my power to overcome obstacles and insure success for this crop." The farming mentality works and labors for success, not merely hopes for success.

If you do not have this vigilant farming attitude and suitable equipment, growing annual crops for deer food in west Texas is not recommended. Plowing and planting with little other management is risky and will result in poor production or total failure. Without the intensive management typically used by traditional farmers, the old food-plot adage is especially true for West Texas; "when you need them most (dry years), you can't grow them; and when you can grow them (wet years) you don't really need them."

Possibly the best way to determine whether annual food plots is feasible for you is to observe how much successful farming is done in the area. If nearby farmers raise decent crops of wheat, grain sorghum or cotton, then fairly reliable forage crops for deer can be raised. However, for you to succeed you will have to think and act like a farmer. The keys to successful dryland farming in the 18- to 25-inch rainfall zones of West Texas are summarized as follows:

Ten Commandments of Dryland Farming

1. Do not attempt to double-crop. Grow warm season crops and cool season crops on different acreage.

2. Keep competing weeds controlled during the fallow period with shallow tillage or herbicides to retain moisture for the next crop.

3. Deep break fields periodically to eliminate plowpans, increase moisture storage and allow greater root development.

4. Plant most warm season forages in 30 to 40 inch rows to allow weed control between rows. Cultivate the "between-rows" as needed to kill weeds especially when the crop is young. Warm season weeds (both grasses and broadleaf) are especially aggressive and can quickly deplete a field of precious moisture. If mechanical weed control is not feasible, pre-plant herbicides should be used.

5. Cool season forages are usually planted with close spaced drills since cool season weeds are much less aggressive and do not generally need to be controlled.

6. Plant forage crops at the proper depth on a clean, firm seedbed. Cloddy seedbeds prevent even seeding depth and do not allow good seed to soil contact.

7. Do not use seeding rate guidelines for East Texas. Lighter seeding rates are always used in dry regions. Refer to Table 1 for West Texas seeding rates.

8. If land slopes enough for runoff to be a problem, either build terraces, or use row disks to reduce water loss from field. Plow on the contour.

9. Fertilize according to a soil test. Proper fertility increases the efficiency of plants to extract moisture from the soil and increases the quality of forage.

10. Periodically grow crops (such as hay grazer) specifically to return organic matter to the soil. Cultivated soils need organic matter to maintain productivity and structure and hold moisture.

Warm Season Annuals

Warm season annuals are planted in April or May and provide forage during summer. Legumes such as cowpeas and lablab are successfully used. Lablab has proven to be the most productive and drought hardy, but is expensive. Other less traditional forages included kochia, okra, cotton, guar and pigweed. Grain sorghum, especially low tannin varieties, are grown for the high energy seed heads.

Cool Season Annuals

Cool season annuals are planted in September or October and provide forage during winter. Small grains such as wheat, oats, and triticale are all successfully used. Legumes including hairy vetch, Austrian winterpea, white and yellow sweetclover and rose clover provide extended season forage into spring. Turnips and Tyfon are also commonly used.

PERMANENT DEER PASTURE

Much can be learned from ranchers regarding the use of permanent, perennial plants for animal forage. Hundreds of thousands of acres of kleingrass, bermudagrass, lovegrass, bluestems and native grasses have been planted in West Texas for cow food. Although commonly referred to as tame pasture, they are really nothing more than food plots for cattle. The principles used by ranchers to grow permanent cow food plots can be used by the deer manager to grow permanent deer food plots. Perennial forbs are used for permanent deer pasture. Many people have misconceptions about forbs, describing them as ephemeral, temporary, weak-rooted plants that provide only short-lived, unreliable deer feed. Although these traits accurately describe many annual forbs, they are totally false claims about the deep-rooted perennial forbs used as deer pasture.

Ideal Deer Forage

If one could custom-make the ideal forage plant for deer, it might have a root system like a mesquite with the quality of alfalfa. This plant would be a deep-rooted perennial, high producing, high quality forb with the hardiness of a native and yet be relatively easy to establish. There are four such forbs, native to West Texas which are commercially available and about as easy to establish as the commonly used range and pasture grasses. With proper management, a mixture of these forbs will provide large amounts of green, nutritious forage 365 days a year, and they do not require the intensive and constant management inputs needed for annual food plots. The four native perennial forbs which are recommended for the 18- to 25-inch rainfall zones of West Texas are described as follows:

Engelmann-daisy is a leafy cool season forage. It begins growth in the early fall, grows well during the winter and spring and goes dormant during the hottest months of summer. Its greatest value is forage production during the critical stress period of January, February and March. It grows equally well on shallow, rocky soil and good deep soil. Its disadvantage is the high cost of seed. However, since it is a long-lived perennial, it is only a one time cost.

Bushsunflower is a warm season forb which is native as far west as the 10 to 12-inch rainfall zones. It is extremely tolerant to drought. It grows best on shallow, rocky soil, but also thrives on good deep soil. It remains leafy and palatable when moderately grazed. It bears no resemblance to a common sunflower.

Maxmillian sunflower is the most productive of the four, capable of producing several tons of forage per acre. Forage quality is high in early growth, but declines in summer unless kept leafy by grazing or mowing. It spreads not only by seed, but also by underground rhizomes similar to Johnson grass. Because in some cases it becomes dominant, a light seeding rate should be used in a mix. Although it will grow in the 18-inch rainfall zone, it is better adapted to the 22- to 25-inch zones.

Illinois bundleflower is the most palatable of the four forbs with very high quality in spring. Being a legume, it has the ability to fix nitrogen into the soil and should be inoculated for best results. It should only be expected to thrive on a good deer soil in the 23- to 25-inch rainfall zones. It will grow in drier regions on shallow soils but with reduced production. Because the seeding rate is high, seed cost per acre is high.

In addition to these natives, alfalfa is often recommended. It is a short-lived perennial which can produce large amounts of quality forage for much of the year. Alfalfa can be seeded in a perennial mix in the rate shown in Table 2, or used by itself in a pure stand. These seeding rates are for a mixture of all five species. If a pure stand is desired, rates should be increased 3 to 5 times.

Planting Permanent Deer Pasture

These forbs should be seeded on a prepared, or at least disturbed seedbed during the winter. The better the seedbed, the better the stand. Seed must be planted very shallow. If a grass drill is used, plant one-half inch deep. If seeds are broadcast, then light dragging will cover the seeds sufficiently. The main requirement for success is patience. Perennial forbs, like perennial grasses are slower to establish than annuals. Do not expect them to explode out of the ground and provide much forage the first year. Priority is given to growing a good deep root system the first year. A suitable stand for the first year would be a plant every 3 to 5 feet. Like planting pasture grasses, failures do sometimes occur and replanting is sometimes necessary, however be patient.

An advantage of these natives is their adaptation to the shallow rocky soils of the region. While annual plots are restricted to good farmland soils, the above-mentioned native perennials can be grown on virtually any soil. They can be seeded following the dozing or grubbing of cedar or mesquite without the expense of intensive seedbed preparation.

GENERAL FOOD PLOT CONSIDERATIONS

A rancher with 200 cows would not expect to get much benefit from 30 acres of kleingrass. It could furnish less than 5% of their nutritional need which would be insignificant. One of the biggest mistakes in supplementing deer with food plots is planting too few acres. When this happens, deer quickly graze down the plants, hampering their establishment or limiting their production. Each deer gets too few bites to receive any real benefit.

How Big and How Many

Rules-of-thumb which have been published for East Texas regarding the size and total acreage of food plots should not automatically be used in West Texas. The proper acreage of food plots must be tied to both the number of deer present and the productivity of the plots. For West Texas a general rule is to plant 0.3 to 0.5 acres per deer. Size of individual plots is not as critical as total acreage. Many small plots are more difficult to farm. They are more expensive to fence, but provide a better distribution of forage. For most situations, 10- to 20-acre plots spaced every 400 to 600 acres will work well as long as the total acreage guidelines are followed. Food plots which are too few and too small may serve well to attract deer but will not provide much nutrition.

Fencing Food Plots

Annual food plots as well as permanent deer pasture should be fenced to control livestock grazing. In addition, a high fence may be needed to control deer access, especially if deer numbers are high and the acreage planted is small or in a dry year. Deer or livestock can prevent the establishment of annuals or perennials by heavy initial use. After establishment, excessive use can reduce plant vigor and productivity and can even kill the stand. Just like livestock forages, these deer forages can be moderately grazed and maintain excellent vigor and regrowth. They can withstand heavy grazing for a season and bounce back rather quickly. Perennial forbs cannot tolerate continuous and prolonged overgrazing.

Food Plot Variety

A well rounded supplemental food plot program should consist of a combination of permanent deer pasture plus both warm and cool season annuals. Equal acreage in each type of food plot will help insure a quality yearlong supplement to a native habitat. Within each type of food plot, forage mixtures are recommended to maximize availability of quality feed. Cool season annual plots planted to 4 to 8 species are suggested. Warm season annual plots should have 2 to 4 species. Permanent deer pasture plots consisting of 3 to 5 species are suggested.

MAKING YOUR ENTIRE RANCH A FOOD PLOT

Although food plots are feasible options for parts of West Texas, the foundation for enhancing deer nutrition in an economically and ecologically sound manner is good habitat management. The existing native deer habitat in much of the region is only producing a fraction of the quality deer food plants which it is capable of. The principles outlined below can increase the deer food supply on most ranches by 100 to 500%. These principles should be implemented before any thought is given to food plots or pelleted feeds. Your entire ranch can be slowly but surely turned into a deer food plot by implementing the *Five R's* of deer habitat management. The principles should be applied in the same order as listed: *Remove, Reduce, Rest, Restrict, Revitalize*

Remove highly competitive livestock and wildlife from the ranch. If white-tailed deer is the number one priority on the ranch, there is no room for goats, sheep or exotic wildlife. The nutritional well-being of deer will be greatly enhanced merely by removing competing animals.

Reduce the number of deer if their performance is inadequate or if the better browse and forbs are being excessively used. The greatest competitor for deer food is another deer. There are definite biological limits of land to support deer. Although supplemental methods can increase this capacity, the conditions of the native habitat should be the first priority. Reduce numbers of cattle if needed. When grass is grazed short or when dormant, cattle will consume large amounts of browse and forbs. Consider this: One cow's diet of 70% grass, 15% forbs and 15% browse is equivalent to as much deer food as two deer. If removal of goats, sheep and exotics is not possible, then a significant reduction in their numbers is desirable.

Rest pastures from grazing. Deer habitats respond best with alternating periods of concentrated cattle grazing followed by rest from grazing. Rest periods should generally be 90 to 180 days. The way to provide these graze-rest periods is with a grazing system where a single herd of cattle is rotated among several pastures. In some cases of deteriorated range, entire ranches need to receive an initial rest of 1 to 3 years to begin the recovery process.

Restrict brush control. If brush control is needed at all, restrict the acreage done in any 1 pasture to a maximum of 50%. Restrict the width across cleared areas to a maximum of 500 feet. Restrict the method of brush control to selective mechanical methods such as dozing, grubbing or hand cutting as appropriate. Selective individual plant treatment with herbicides is also acceptable in some cases.

Revitalize or renovate habitat with aggressive practices. Renovation can consist of a prescribed burn to stimulate basal sprouting of browse plants. It can consist of roller chopping and seeding grasses and forbs where plant cover is poor. Renovation can be the thinning of liveoak by cutting firewood to increase forb and browse growth. It can be the removal of thick cedar to release suppressed forbs and browse. Brush control is often the cornerstone of habitat renovation but it must be combined with the other four principles in order to be effective. Assistance from an experienced biologist is recommended when planning a renovation project.

CONCLUSION

Managing the native habitat using the *Five R's* is the best way to increase deer nutrition. It is cost effective and ecologically sound. However, the high numbers of deer desired by many are not possible using this alone.

When high numbers of quality deer is the management objective, large inputs of management intensity and financial resources will be required. Risk is increased and cost-effectiveness is questionable.

Permanent deer pasture using native perennials can be established on a wide range of soils. Initial seed cost is high, establishment can be slow and overgrazing must be avoided. After establishment, production is very reliable and recurring management is low.

Farming annual food plots is feasible on good deep farmland soil. Intensive farming practices must be applied for success in dry years. Production can be very impressive, but constant management requirements make the cost of production high.

The feeding of pelleted or concentrate rations should never be used to make up for a poor habitat. Deer usually will heavily graze the best native browse and forbs in preference to commercial feeds. When deer numbers are in excess of natural carrying capacity, habitats will suffer no matter how much is fed.

Table 1. Seeding rates and planting depths for annual food plots in West Texas

Plant	Pounds per Acre	Ideal Seeding Depth (Inches)
Cool **Season** Annuals		
Wheat	50	l-2
Oats	50	l-2
Triticale	40	1-2
White Sweetclover	5-10	0.5
Yellow Sweetclover	5-10	0.5
Rose Clover	6-8	0.5
Hairy Vetch	15	1
Austrian Winterpea	25	l-2
Turnips	3	0.5
Tyfon	3	0.5
Warm Season Annuals		
Cowpea	20-30	l-2
Lablab	10-15	2-3
Grain Sorghum	6-12	1
Okra	10	1
Cotton	15	1
Guar	12	1
Kochia	2	0.5
Pigweed	2	0.5

These seeding rates are listed as the full rate for planting a pure stand. Seed mixtures should be reduced accordingly. For example, an equal mixture of 4 species would use 25% of the listed rate.

Table 2. Seeding rates for a deer pasture combination

Plant	Pounds per Acre PLS
Engelmanndaisy	3-4
Bushsunflower	1
Maxmillian sunflower	0.5
Illinois bundleflower	2-4
Alfalfa	l-3

These seeding rates are for a mixture of all live species. If a pure stand is desired, rates should be increased 3 to 5 times.

EVALUATING A DEER FEEDING PROGRAM: BIOLOGICAL AND LOGISTICAL CONCERNS

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Abstract: Most people who supplement deer are unable to document *objectively* the success of their feeding program, either biologically or economically. The effects of feeding are usually confounded with other management efforts (e.g., age at which deer are harvested, livestock stocking rates) and are difficult (probably impossible) to evaluate independently. Harvest records (e.g., Boone & Crockett scores, dressed weights) and estimates of fawn survival are parameters that can be helpful in documenting the effectiveness of a feeding program. Inherent inefficiencies in a feeding program center around feed consumption by non-target species (e.g., raccoons). Recent technologies (e.g., TrailMaster™ camera systems) allow continuous surveillance of feeders and can help monitor non-target feed consumption. Practitioners are encouraged to establish SMART *(Specific, Measurable, Attainable, Related, Trackable)* goals relative to feeding programs.

Today's deer hunters have a fetish with growing bigger bucks, and the quicker the better. Accordingly they seek methods to fast forward the antler production process by improving the deer's nutritional plane, either from a food plot or a feed sack. Over the last 10 years, interest in supplementing deer in Texas has grown at an astronomical pace. Deer corn, buck corn, trophy buck corn, apple-scented buck corn and a similar buffet of pelletized deer rations adorn businesses from convenience stores to WalMarts. If the U.S. Treasury had a $0.05 surcharge on every sack of deer corn fed in Texas, we could probably retire the national debt!

Does feeding deer work? Does it pay? As I visit with deer managers, I'm amazed that so much money is spent in pursuit of a practice that they have little, if any, idea as to whether the practice is effective. When I ask a manager if his feeding program is working, his response is typically a sheepish "well, they (i.e., the deer) sure are eating lots of feed." Some use the "eye test" to conclude "the deer look bigger (or better)." Convinced yet?

Texas biologists often cite a maxim referred to in jest as Wilson's Law: *"if I hadn't believed it, I never would've seen it with my own two eyes."* In my opinion, most feeding operations are evaluated within the constraints of biases imposed by Wilson's Law. Is there a better way to determine objectively if a feeding program is (a) biologically effective and (b) cost-effective? In this paper, I offer some tools that will help shed some light on these questions, and also discuss the confounding factors that make their interpretations tenuous.

SOME PRECAUTIONS ABOUT DATA INTERPRETATION

"There are three kinds of lies: lies, damned lies and statistics." -- B.

Disraeli

Before getting too deep into a discussion about whether supplemental feeding is effective, a basic understanding of statistics, their uses and perhaps more importantly their misuse is warranted. Researchers use various statistics (e.g., averages, standard deviations, correlation coefficients) to help them evaluate the response of some variable (e.g., antler size) in response to some treatment that is imposed (e.g., supplemental feeding). The goal is to be able to look *objectively* at two treatments and say conclusively (i.e., at least 95 percent of the time) whether the treatment response was attributable to the treatment or merely to chance.

Let me illustrate with a simple question, one that you could argue deserves a simple answer. Within the audience at today's symposium, who is the best shot with a .22 rifle? You might lobby that you are, or your neighbor is, but I might argue that I am. How would you design an experiment to objectively (i.e., without bias) determine who's the best shot? So, you suggest we each take a shot at a target 50 feet away, and the closest to the bull's-eye wins? How comfortable would you feel with a sample size of one shot? Okay, you say we'll each shoot 10 shots and see who hits the most bull's-eyes on a target. Will that do it? What if I give you an old single shot .22 with iron sights and a terrible trigger pull, while I help myself to an Anschutz target rifle with front and rear peep sights? Oh, and then I tell you that you have to shoot standing, but I'll shoot from a bench rest. And did I forget to tell you that you'd be shooting at 3 p.m. when the winds blowing 25 mph, but I'll shoot at 8 a.m. with light winds? Hopefully this illustrates how our seemingly simple question can become a nightmare to decipher. Further it illustrates the need for sound experimental procedures and design.

Researches try to minimize the effects of "extraneous" variables, i.e., those they are not interested in, by setting up controlled experiments. In classical animal science research, one might use a set number of steers (e.g., 30 head) of similar breeding to test the effects of protein supplementation on average daily gains. An experimental design might place five steers in six separate pens, three pens (i.e., "replicates") of which would receive the "treatment" while the others would serve as "controls." Experimental diets would be similar except that one group might receive a 12 percent crude protein ration while the other received an 8 percent crude protein ration. To the degree possible, all other variables would be "standardized" (i.e., held constant across all treatments). At the conclusion of this trial, any differences observed in average daily gains should be attributable to the treatment.

But let's get back to feeding deer under free-ranging conditions (which is a far cry from steers in a feedlot). Would you expect the results obtained from feeding Brand X deer pellets to vary from one ranch that had been chronically overgrazed from a ranch that was in excellent range condition? Who knows? Point is, you want to standardize as many potentially influencing variables as possible, leaving only the variable in question (presence of supplemental feed) to be evaluated.

Confounding. When several variables are intertwined to such a degree that the scientist cannot separate the effects of variable A from those attributable to variable Z, they refer to the results as "confounded." Most deer feeding operations are terribly confounded, thus making interpretations cloudy at best. Consider the following common situation.

Bubba Deernut has hunted on the same ranch in Kerr County for 10 years. Finally, he hits the lotto and decides to buy the place. He immediately erects a high fence and plans to "go whole hog" with his deer management, including a supplemental feeding operation. He says his goal is to raise more and bigger bucks. He removes all the sheep and goats and only leaves a few head of cattle to maintain his "Ag.-use exemption." Upon the advice of his biologist, he is to shoot only does and spikes for three years to let the buck herd build up. He purchases 10 supplemental feeders and keeps them filled year-round with Brand X high protein feed and establishes 10 mineral licks with Magic Mineral. He also plants five food plots with "buck" peas and various small grains. In year 3 he begins a prescribed burning operation to control cedar regrowth. Finally, it's the 4th year of management and voila'. His bucks' antlers really are noticeably larger. His average B&C score is 20 points higher than prior to initiating the feeding program. So, his ranch offers unequivocal testimony that supplemental feeding works, right? Hmmmmm ....

A skeptic might correctly argue that some other factor(s) were involved in the antler size increases observed. Allowing the buck cohort to age three years had a major impact, as did decreasing livestock stocking rates, food plots and prescribed burning. What about weather conditions during the 3-year period? Maybe the last two years were unseasonably wet. Fact is, a combination of factors allowed (resulted) in the increased antler size, but asserting that any one factor acted independently is foolish.

Moral of the story: be wary of confounding factors. They're everywhere.

Correlation vs. Cause/Effect. One of the most common traps that we step into is the inability to separate relationships among variables that are "causal" (i.e., a "cause and effect" relationship exists) from those that are simply "correlated." As an example, the following figure represents actual data on bobwhite trends in the southeastern U.S. over a 1 O-year period (Fig. 1).

Study the graph, then answer the following questions.

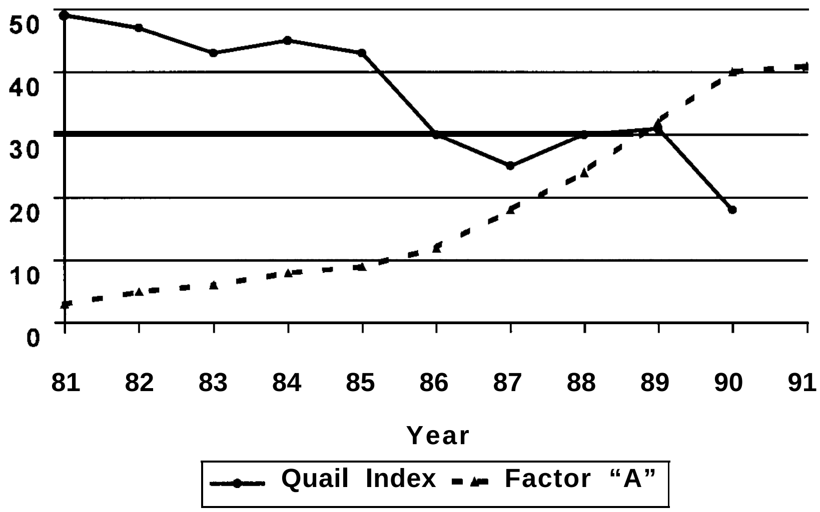
(1) Does an increase in "Factor A" cause the bobwhite population to decline?

(2) Would you recommend controlling "Factor A" if your goal is to increase bobwhite numbers? What if such control would be politically unpopular?

(3) What do you think "Factor A" really represents?

Critical Thinking

Correlation vs. Cause-Effect



(a) raccoon numbers
(b) fire ant numbers
(c) hunting license sales
(d) Quail Unlimited membership

The correct answer is (d) Quail Unlimited membership! This illustrates that two factors may be highly correlated (either positively or negatively), yet have no biological significance.

For example, I can show that the number of churches and the murder rate in a city are highly correlated, so do I deduce that building more churches will cause the murder rate to increase? Of course not. Population size is the independent variable that is driving both the number of churches and the murder rate.

GOALS FOR FEEDING OPERATIONS

"*If you don't know where you're going, then any road will get you there.*"

-- Anonymous

Do you have a set of well thought out, written goals for your deer management operation? If not, I encourage you to take enough time to develop them, following these suggestions. Goals should ascribe to S.M.A.R.T. criteria, that is they should be:

Specific,
Measurable,
Attainable,
Related,
Trackable.

Specific means just that, are the goals well defined within a prescribed time period? *Measurable* means a parameter that can be assessed quantitatively (e.g, B&C scores, dressed weights).

Attainability encourages you to set goals within the constraint of reality. Are the deer management goals *related* to other ranch goals, or contradictory? Finally, make sure that progress toward the goal is *trackable (e.g.,* B&C scores over a 5-year period).

Bubba Deernut's goals were to grow "more and bigger bucks." Do his goals satisfy SMART criteria? Hardly. The following goals might come nearer to being SMART goals.

(a) Increase percent bucks in herd to 40 percent while keeping deer densities at 1 deer per 15 acres by Year 2000;

(b) increase (and maintain) *average* B&C score of mature bucks (4.5 years or older) to 140 by Year 2003;

(c) increase average dressed weights of mature bucks to 140 pounds and of adult lactating does to 80 pounds by Year 2003;

(d) maintain or improve range conditions and browse diversity;

(e) increase net profits from deer hunting enterprise by 200 percent by Year 2005.

Once these strategic goals are defined, tactical goals can be established that should be used to drive your daily management decisions. Goals should be re-evaluated annually (right after deer season is a good time) to see what progress is being made.

HARVEST RECORDS

"He uses statistics like a drunk uses a lamp post, more for support than illumination."

-- Anonymous

Many deer managers have kept harvest records for the last 10 years. There's a shoebox tilled with bloody, sometimes illegible cards that collectively represent many hours of effort. But are the records used to direct management? Every deer harvested should have the following minimum statistics measured: age, dressed weight, physical condition (poor to excellent), antler data (B&C score, beam length, points, circumference) and lactation status for does. Every buck (not just the big ones!) should have a snapshot taken of it in a more or less standardized pose for inclusion into the ranch's annual harvest record book.

The above parameters assume some prerequisites on your part, namely the ability to (a) age deer by examining their molars, (b) measure gross B&C scores and © operate a "point and shoot" camera. None of these requires a Ph.D. Some useful references are *"Determining the Age of a Deer"* and *"Interpreting Deer Harvest Records"* which are available at your local county Extension office.

A computer spreadsheet is handy for assembling, sorting and evaluating harvest record information. Use the spreadsheet to compute the average statistics (e.g., B&C score) for each buck cohort (age class). One measure of a feeding program's effectiveness might be when 3.5 year old bucks are scoring higher than 5.5 year old bucks were before feeding was initiated. Your best statistic will be the average B&C score over a period of years for a specific buck cohort, i.e., how do B&C scores of mature bucks in 1997 compare to those from 1991, 1993, and 1995. Is progress being made towards your strategic goals?

One tangible benefit of protein or mineral supplementation might be stronger antlers, i.e., fewer broken tines. There seem to be some years in some areas where broken antlers (tines and main beams) are excessive. However beware of confounding with this characteristic. Most supplementally fed deer herds are managed at a more balanced buck to doe ratio, which tends to result in more fighting among bucks. Likewise, the heavier body weights involved may also increase antler damage.

FACTORS AFFECTING EFFECTIVENESS OF FEEDING PROGRAMS

Armed now with some appreciation of statistics and critical thinking, what factors determine whether a feeding program is likely to be effective, either biologically or economically speaking? Some to consider include the buck:doe ratio, current harvest strategies, feed ration relative to seasonal nutritional needs, feed intake (seasonally and among various inidividuals/cohorts), feed loss to nontarget species. Most of these will be covered elsewhere during this symposium. I want to focus on how to monitor feed loss to nontarget species.

Deer feeders are a hub of animal activity, both for deer as well as a host of uninvited (i.e., nontarget) guests. While watching the exploits of a covey of quail under a sling feeder or interactions between javelina and deer at twilight may comprise part of your recreational experience, one must ask how much of the feed targeted towards deer actually makes it into a deer? And the best shows undoubtedly occur under the veil of darkness.

Over the last five years, my colleagues and I have been using motion-sensing cameras (TrailMaster™ Model 1500) to monitor species visitation at free-choice deer feeders at several sites across west Texas. These systems use an invisible infrared beam that acts as an "electric eye" between a transmitter and receiver. When the beam is "broken", an event is registered and a photograph is taken. The results have been "illuminating." Depending on the ranch, season of year and type of feeder involved, deer visitations have ranged from 10 to 100 percent of the visitations. Other animals photographed feeding include raccoons, porcupines, opossums, ringtails, javelina, squirrels, rabbits, livestock, wild turkeys, quail, and several species of songbirds.

It is important to note that the TrailMaster camera systems monitor feeder visitation by various species, not feed consumption by various species *per se*. Just because raccoons comprise 30 percent of the visitations doesn't mean raccoons necessarily eat 30 percent of the feed consumed. Intake rates by deer and various nontarget species has not been quantified under field conditions.

Nonetheless, the TrailMaster system is an invaluable index to determine "who's coming for dinner."

Nontarget visitations pose two problems for those trying to feed deer most cost-effectively. First, they no doubt consume a fair proportion of the feed. Second, they may interfere with deer attempting to feed (i.e., aggression). We have photographed several instances where aggressive raccoons appear to have their bluff in on deer and successfully discourage them from feeding (at least while the racoon is present).

As someone interested in feeding deer, the raccoon is your number one nontarget concern. I'd venture to say that any free-choice deer feeder has from three to 13 raccoons visiting it nightly. Our record is 12 raccoons in a single photograph! Using box traps baited with canned cat food, sardines or eggs offers a good way to pare the raccoon population down from a particular area. Be prepared however, as it may seem that you're "digging a hole in the ocean." Cooperators I have worked with have removed over 70 raccoons from their feeders in less than three months! I am curious as to whether an electric fencing system could be designed to decrease nontarget use without interfering with deer use. I believe it could without unduly affecting deer use of the feeder.

Aside from using motion-sensing cameras, there are some indirect measures of feeder use by nontarget species. Tracks and scats often indicate the presence of hogs, javelina, raccoons or porcupines. One way to estimate indirectly the amount of feed being lost to nontarget animals is to fill the deer feeder, then fence the deer out of it so that raccoons can get in but not deer. In this way, one could calculate a daily feed loss to nontarget species.

CONCLUSIONS

Deer are ruminants, and as such, we know they should benefit (biologically speaking) from supplemental protein if (when) their diets are lacking in protein. However, quantifying that response in the wild is open to speculation, largely because of the confounding factors involved. Detailed records may provide insight as to the effectiveness of one's feeding operation over a period of years.

EVALUATING THE ECONOMICS OF SUPPLEMENTAL FEEDING WHITE-TAILED DEER

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Abstract: White-tailed deer (*Odocoileus virginianus*) have been a significant source of income to landowners over time. Opportunities to increase income are still available through skilful marketing. However, realistically for the near term most net returns generated from an intensified deer management program will have to be earned from the supply side. Cost control will be critical. I have used the gross Boone & Crockett score to estimate the supply relation between the state-wide average cost and expected quality of the deer for season and package leases. The results of the estimate are then used to evaluate the financial merits of supplemental feeding deer. Within the stated assumptions, supplemental feeding could be perceived as being economically beneficial.

Persistent low net incomes combined with depression level prices in the cattle business (McGrann 1994, Sharp 1996) are galvanizing landowners in the southern U.S. and northeastern Mexico to the need for enterprise diversity. Frequently this involves assessing the profitability of intensified white-tailed deer (*Odocoileus virginianus*) management. Using Texas as an example, deer have been significant source of income to landowners over time. It was estimated that in 1965 landowners received $13 million. Receipts climbed to $55.7 million in 1977 (Steinbach et al. 1987). They have continued to grow more recently as, hunter expenditures on big game leases (deer and turkey, with deer claiming approximately 85%) reached $200.8 million by 1985 and $313.0 million in 1991 (USFWS National Surveys, 1989 and 1993). Adjusting these values for inflation reveals an annual rate of increase of $9.5 million per year in landowner gross income earned from deer leases in Texas from 1965-1991.

Examining the 3 periods 1965-1977, 1977-1985, and 1985-1991, annual growth in lease receipts was $4.9 million, $14.6 million, and $8.7 million with the rate of growth peaking between 1977-1985. Additional data in the USFWS Surveys show that total hunter expenditures (travel, equipment, licenses, and leases) declined slightly in the period from 1985-1991. This data is interesting from two standpoints. First, hunters are shifting the total money they spend on a hunting trip from transportation and lodging in-route to the lease, suggesting a hunter priority towards better quality leases. Secondly, the trends in expenditure of hunters parallels the health of the state's oil economy, suggesting the money deer managers will be competing for is tied to the fortunes of the oil industry. A final piece of relevant data is the USFWS Surveys that show the total number of hunters has held approximately constant, while the population at large has increased (Aiken 1994).

Altogether, on the demand side, the data suggest a picture of weakening demand, which may have reached a plateau. Although opportunities are still available on the demand side through skillful marketing, realistically for the near term most net returns generated from an intensified deer management program will have to be earned from the supply side. The implication is that cost control will be critical. Weak demand will not support the expectation that the cost of new deer management programs can be covered by rising benefits.

With attention drawn to the supply side, the question arises as to what is the state-wide cost of improving the quality of a deer herd and what would be the appropriate measure of quality? The idea being if a deer herd manager, by implementing a new program, was confident they could raise the quality of the herd a specified amount, they would be competitive so long as the cost of the added quality was below the state average cost of adding the same amount of quality. I have used the gross Boone & Crockett score to estimate the supply relation between the state-wide average cost and the expected quality of the deer for season and package leases. The results of the estimate are then used to evaluate the financial merits of supplemental feeding deer.

Studies attempting to statistically quantify the relation between deer lease prices have been restricted to a hunter's willingness to pay (a demand relation). The studies, nonetheless, are important in determining what hunters value (land managers according to economic theory will supply what hunters find valuable), and the general methods of analysis used are applicable to supply relations. Pope and Stoll (1985) conducted one of the earliest studies of deer lease demand. Using hunter survey data they showed the amount hunters were willing to pay for a season lease varied based on region, presence of a cabin, and other game animals. For example they found hunters were willing to pay \$327.49 a year for a south Texas lease with javelina and quail without a cabin. They also found the size of the lease had no effect on a hunter's valuation. Messonier and Luzar (1990) surveyed hunting club members in Louisiana and found similar regional variances in lease value, hunters were willing to pay \$256.28 for season leases in one district versus \$953.33 in another. Likewise a cabin present on the lease was significant. There was, however, no statistical significance with other game animals present and distance to the lease and lease value. Waddington et al. (1994) analyzing USFWS 1991 national survey data indicated hunters in Texas are willing to pay an average of \$556 per deer, which is a value not directly comparable to the season lease values from the previous studies. Generally, hunters should theoretically be willing to pay more for a lease (Pope and Stoll 1985). Luzar et al. (1992) using their earlier data set explored the price-quality relation further. They did this by considering price and quality variables as variables whose final value was co-determined and then analyzing the data statistically to take so-determination into account using 2-stage least squares regression (Theil 1971).

From the landowners perspective

a supply relation is what a manager is willing to accept as compensation for providing a lease, or more specifically for supplying a hunter the chance to harvest a deer. While no statistical studies have attempted to quantify this relation, several studies provide benchmarks, Steinbach et al. (1987) analyzed 57 possible variables grouped into 7 categories to determine what were the most common types of leases in the Edwards Plateau and south Texas regions. Associated with these leases they developed break-even budgets, which represent what a producer is willing to accept for a lease in the long term. These rates varied from $0.67 per acre for a year-lease with no input in south Texas to $6.32 per acre for an intensive deer management in south Texas to $7.93 per acre for an intensive deer management lease in the Edwards Plateau. Thigpen et al. (1991) reported a value of $2.19 per acre as the state-wide average lease rate.

DATA AND METHODS

In estimating the relation between Boone and Crockett score and lease prices, both season and package lease procedures were the same. Data limitations precluded a large list of explanatory variables, nonetheless, size of lease, availability of lodging, meals, region, and gross score were considered the key variables based simply on what is most often advertised. Although other studies have used availability of other game species and distance from a metropolitan area, these variables were not included. The advertised lease prices and lease characteristics analyzed were from Damuth (1993). Sixty-seven observations were used on package hunt estimations and 22 observations on season leases. The data was aggregated into 4 regions, north Texas (counties near Dallas and Fort Worth), South Texas, Edwards Plateau, and the rest of the State. Data west of the Pecos River was excluded.

Regional Gross Boone & Crockett scores for 1993 trophy deer are reported in Sasser (1994). Whereas the deer scores reported reflect trophy deer, clearly many deer harvested will have lower scores. The trophy sample score was adjusted downwards by 24.9 points to reflect a more general harvest. The adjustment factor is the difference between the South Texas regional trophy average (157.8) and the 9-year average Gross Boone & Crockett score from the annual census of a live buck population on a 56,000 acre ranch located in Dimmit County, south Texas (C. DeYoung, Texas A&M Univ.-Kingsville, Kingsville, Tx., unpublished data).

Luzar et al. (1992) indicated the simultaneous nature of the dependency between lease offer price and lease characteristics (in our case expected Boon & Crockett score). To examine this an a priori model was formed for statistical estimation as two separate equations. The first equation contains factors that biologically explain an expected deer score plus management costs, which would include expense on biological management, such as supplemental feeding. Over the long-term a landowner would seek to recover in the lease price these costs plus a competitive profit. Given the variables obtained from the data, this equation was:

Score = *f*(Lease *Price*, *Region*, *and Lease Acreage*)

where *Region* is a set of four 0-1 binary indicator variables for South Texas, the Hill Country, north Texas, and rest of the State. Notice that management is increasing supplemental feed would increase costs and the lease price they would need to receive to cover costs to suppositionally increase *Score*. Similar reasoning can be used to identify the relation and a priori sign of estimated coefficients associated with the independent variables in the model and the dependent variable (Table 1).

The second equation with *Lease Price* as the dependent variable is specified as those non-biological factors that will affect lease prices plus the dependent variable, *Score*, from the first equation. The second equation was:

Lease Price = *f*(Score, *Cabin*, *Meal*)

where *Cabin* and *Meal* are 0-1 binary variables indicating service availability. The second equation reflects that the lease price offered can depend on additional non-biological amenities. Additionally the equation completes a circle of dependency between the offered lease price and the expected deer score. Statistical estimates were made using the SHAZAM v.7.0 (1993) software and 2-stage least squares regression (Gujarati 1995). The estimation procedure treated *Region* and *Lease Acreage* as exogenous in the first stage and *Lease Price* as the dependent variable in the second stage. The procedure estimates the *Score* equation first and then substitutes the estimated values for *Score* into the *Lease Price* equation in the second stage. Statistics are available only for second stage variables.

RESULTS AND APPLICATION

The a priori models for both season and package lease offer prices have variables that are statistically insignificant (Table 1). Nonetheless, the

Table 1. A priori 2-stage least squares regression results for land owner package and season lease offer prices.

Variable (Apriori sign)	Package Lease Estimates, \$/hunt Coefficient Value (t-ratio)		Season Lease Estimates,\$/season Coefficient Value (t-ratio)	
Intercept (+ or -)	-6984.1	(-1.202)	-12.8	(-2.437)
Score (+)	63.9	(1.041)	0.14	(3.245)
Cabin (+)	4329.6	(1.053)	-0.26	(-0.187)
Meals (+)	1771.4	(0.715)	Not estimated	
R-Square	15.23		34.29	

Table note: absolute t values <1.67 (package) and 1.73 (season) are insignificant at 95 percent level.

Table 2. A posteriori 2-stage least squares regression results for land owner package and season lease offer prices.

Variable (Apriori sign)	Package Lease Estimates, $/hunt Coefficient Value (t-ratio)	Season Lease Estimates, $/seaon Coefficient Value (t-ratio)
Intercept (+ or -)	-11008.00 (-4.200)	-12.740 (-2.402)
Score (+)	109.03 (5.208)	0.1363 (3.274)
R-Square	24.23	32.760

Table note: absolute t-values <2.00 (package) and <2.10 (season) are insignificant at 98.5 percent level.

signs on the estimated coefficients are consistent with prior expectations.

Additional analysis of the data using the individual equations and ordinary least squares indicated that all the regional variables were significant at the 99 percent level. The size of the lease, however, was only weakly significant with the coefficient signs positive. Moreover, ***Lease Size*** had a very small (<0.05) coefficient in both cases, which practically speaking makes the size of the lease unimportant when predicting deer quality of lease prices. The availability of meals as a lease service was likewise not a robust predictor of lease prices. ***Cabin*** was weakly significant on package leases and less significant on season leases. Several nonlinear functional forms were estimated, but a simple linear relation is best supported by the data. Based on the analysis an a posteriori model was selected for predictive purposes which included the original a priori Score quation and only Scores as an independent variable in the second stage equation for ***Lease Price*** (Table 2).

Both these equations are graphed (Figures 1 and 2). Examining what this means in terms of financial feasibility of supplemental feeding, consider 2 cases under package leases and 3 cases under season leases. In all cases use the $1.324 price per acre estimated for supplemental feeding (McBryde 1995). First, consider the increased score required to cover the added cost on a hunting lease when feed affects only score. Assuming an expected score before feeding of 130 per 1,000 acres the owner grossed $3,166. The manager, to be as well off after feeding as before, would need the score to rise from 130 to 142.

Now consider what would happen if feeding increased density and score on a hunting lease. Let the deer be of expected score 130 per 1,000 acres as before, and also let the deer that is added from the increased density remain at 130 after feeding. If the density increases to an expected trophy buck per 800 acres, then the 200 acre residual could be leased at the original score for ***$632.*** Understand, in order to earn these benefits, the lease size has to be

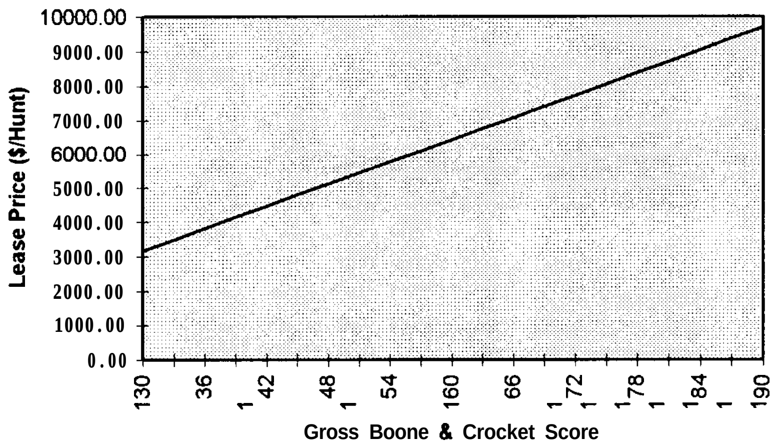

Figure 1. A posteriori model relation between package lease price ($/Hunt) and expected gross Boone & Crockett score.

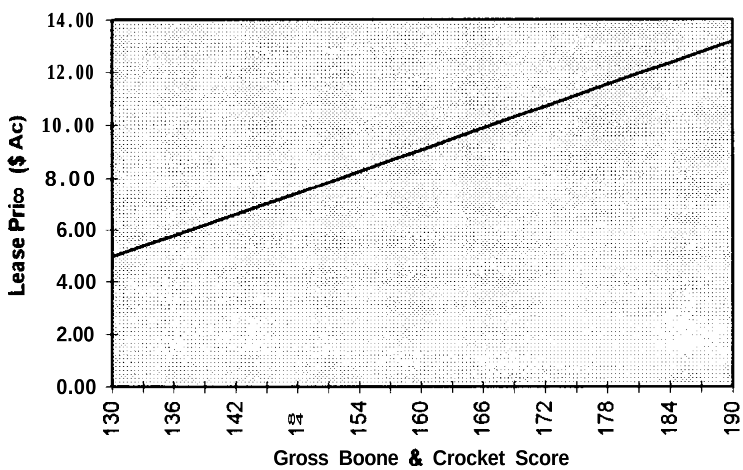

Figure 2. A posteriori model relation between season lease price ($/ac) and expected gross Boone & Crockett score.

sufficiently large to allow an actual increase in total mature bucks, clearly this would be larger than the example. Our example also suggests an underlying economic cause for the interest in landowners creating deer management associations. For example, in this case to effectively capture the possible increased value it would take 4 separate 1,000 acre units managed together. Also, the manager on the 1,000 acre unit, to be as well off after feeding as before, would need to have the score of the buck on the 800 acres increased to 136 to cover the remaining cost and the original lease value.

Comparing the season lease to the hunt lease, keeping our assumption that 1,000 acres is required to produce one buck of expected score 130, the season lease grosses $4,940 versus the $3,166 for the hunt lease. The season lease is higher reflecting that the lessor allows the hunter access for a season rather than just 5-7 days. The first case under season leasing looks at the score needed if only the score was affected by feeding. With an expected score of 130, the season lease in $4.94 per acre. Plus the feeding cost of $1.32 per acre, the new score would need to be 140 to leave the owner as well off as before feeding.

When the deer score stay at 130 on a season lease after feeding and only density is affected, the lease price must increase to $6264, a 26.8 % increase that would needed to be balanced by achieving a buck per 788 acres. Note as the expected score increases on a lease the density increase needed to balance costs decreases. The last case places the added cost of feeding on a relative basis to a land purchase to understand why so many deer lessors provide supplemental feed. Consider the state wide average season lease of about $2 per acre (an expected score of 108). A realistic scenario would be for 1,000 acres to be leased to 3 hunters, grossing $6,000. By adding supplemental feed, gross return would need to cover $7,324. A 22 % increase that could be met if density of bucks increased to 3 per 819 acres. In effect, if this is achieved the landowner acquired an additional 181 acres at $7.31 per acre. A bargain, if the assumptions hold, and likely a reason so many lessors supplemental feed. Even with a large margin of error in the density increase, supplemental feeding could be perceived as being beneficial. Note, in all the cases we looked at, after introducing feeding the changes in score and density kept the manager at the same level of gross income. Based on the lease price estimates, they also stayed competitive with the State average. If an individual can do better, score or density-wise, they stand to make increased revenues.

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A SUPPLEMENTED DEER HERD: DIAMOND K RANCH

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The diamond K Ranch established its deer program in the 1989 spring season when, Mark E. Watson, Jr. of San Antonio purchased 1258 acres of land. In December of 1992 an additional 677 acres were purchased. Another 2625 acres were purchased in December 1994 making the ranch about 4560 acres in size. The entire ranch is under a high fence.

This ranch is very diverse in habitat and terrain. It varies from rolling to rugged and from semi-open to dense. There are more than 1000 acres of coastal and 200 acres of field land. The original 1258 acres has very little of either improvement.

For this discussion I will only refer to this original portion. The program started in the 1989-90 season. We took 49 deer from the ranch. No mature bucks were taken, only does. But, a few inaccuracies were made on spikes. The average doe weighed 52 lbs. Field dressed. In January 1990 the high fence was under construction and a supplemental feed program started.

We put out 4 free choice feeders and deer started on feed in less than 2 weeks. The high fence was completed in September 1990. We proceeded to add feeders until today we have 28 free choice feeders on the ranch (4560 acres). We started with cattle type feeders and had instant problems--nervous consumption, antler damage and death losses. In January 1994 we switched some of the free choice feeders to a tube type free choice feeder that allowed numbers of deer to feed in full view of each other. Antler damage all but disappeared, and death loss has almost completely vanished.

The most noticeable change came in Boone & Crockett Scores due to increased feed consumption and less stress. Our doe weight in the 1995-96 season was at 75 lbs. average with 1 ½ yr Olds averaging 69 lbs. Scores for our bucks have increased steadily until our trophies in 1995-96 averaged 151.5 B&C and averageded 141 lbs. dressed weight. From the beginning scores on our trophies have averaged 146 B&C. Since the 1993 season we have taken 10 bucks better than 150 B&C and 5 of them scored 159 or better. All of this was on 1258 acres--with native deer in 6 years time!

Our supplemental feeding consists of deer pellets, food plots, split peas, alfalfa and reseeding of native plants. All our feeding is free choice 365 days per year. Does supplemental feeding work? When we started, we were told "You can't grow big deer in the hill country." With supplemental feeding, our habitat has continued to improve little by little each year. We now see fluctuations in feed consumption when it rains or when it is dry.

The best testament I can give about our program is the 1995-96 season result--151.5 B&C average on our trophies in our worst year of rainfall, since I started. If a dry year is the ticket to bigger deer, then the 1996-97 season should be scary!

SUPPLEMENTAL FEEDING WHITE-TAILED DEER ON LONG BRANCH RANCH

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The ranch which is located in southwest Llano County was purchased in 1972. It lies in the Central Basin and has typical granitic soils. It is 570 acres in size with rolling topography. Woody vegetation is predominately liveoak, blackjack oak and post oak. Juniper is sparse and the only problem woody plants would be yucca and Texas persimmon.

My livestock grazing program is based on a 5-pasture rotation system, stocked at a rate of 40 cows per 1000 acres. It is a cow/calf operation with no sheep or goats.

The deer population on the ranch is large as is characteristic of the region. Based on more than 20 years of deer counts the average density is 3.0 acres per deer. Variation between years ranges from 1.9 to 4.1 acres per deer.

A deer management program was begun with the purchase of the land. A deer harvest program was initiate to balance deer numbers with the forage produced. Cattle grazing was maintained at a moderate level and was seasonal to favor deer. I decided to increase the intensity of my deer management program by going to an enclosed herd situation. In May 1994 a deer-fence encircling the ranch was completed at a cost of $2.25 per foot.

With the enclosed deer herd my management objectives are now as follows:

(1) Reduce the deer herd to 4 acres per deer.

(2) Maintain a buck to doe ratio of one or more buck per doe.

(3) Produce bucks with 18 to 20-inch wide antlers with good mass.

(4) Provide hunters with an opportunity to see a large number of "good bucks" on each hunt.

I think that providing year-round supplemental feed to the deer will help to accomplish my objectives. Since enclosing the ranch feed has been provided year-round. I want to share some of my observations on that experience.

First, it is more work than I expected--570 acres is large enough for a one-man operation.

Raccoons are the greatest problem relative to feeding deer.

Hogs were eliminated in 4 months after completing the fence. As of this date, they have not returned.

The desired buck to doe ratio was achieved during the first hunting season.

The 1996 buck herd is still young with a maximum estimated age of 4 ½ years.

The fawn crop in 1995 was greater than 100%. A high doe harvest will be required in 1996.

Harvesting does may prove to be the greatest management problem. The logistics make one tired.

The cost of feed in 1996 will be double that of 1995. Deer are eating 40 to 50% more feed. The cost of feed has increased about $100 per ton.

Antler development of yearling bucks is definitely smaller in 1996 when compared to 1995. Many spikes are being observed in 1996 while the number in 1995 was quite low.

While supplemental feeding has not been a cure-all, it is fun and I'm enjoying it.

FOOD PLOTS AT THE FAITH RANCH: THE IMPACT ON ANTLER GROWTH IN OUR FIRST YEAR OF FOOD PLOTS

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Since 1985 the Faith Ranch and a research team led by Dr. Charles DeYoung at Texas A&M--Kingsville has captured 50 bucks at random each year. This random capture of bucks provides a cross section of the buck herd that no hunting sample can deliver. It was through the analysis of the average antler sizes of the mature bucks we captured that I came to realize the extraordinary impact of nutrition on antler size. The average gross Boone & Crockett score of mature bucks can increase by as much as 11% from a poor rainfall year to an exceptional rainfall year. Although 11% may not seem like a lot at first blush, an 11% increase in antler size would--on average--turn a buck that grosses 150 into a 167; or 160 into a 178; or a 170 into a 189. Nutrition (in this case in the form of rainfall) has a big-time impact on antler size.

Not just any rainfall during antler development impacts antler size. In fact, we have found through regression analysis of our data that the key rainfall months for antler development are March and April. May rains, we have found, come too late to deliver the right nutrition to a buck's antlers. March (in particular) and April often pass without much rainfall--at least in Dimmit County. May is our highest rainfall month. But, our data show that those rains come too late to add significantly to antler development.

Armed with these insights, I found myself watching the Weather Channel for hours on end in March and April. But that got old, especially when the rains didn't come. So instead of waiting for Mother Nature to produce another exceptional rainfall year, I decided--after listening to Gary Schwarz for a number of years--to capture the moisture Mother Nature usually provides in the Fall and deliver it to the deer in the form of lablab.

FOOD PLOTS AND DEER UTILIZATION OF LABLAB

In 1995 we prepared and planted 7 food plots on the Faith Ranch. These plots ranged in size from about 10 acres to 25 acres (many of the plots have since been expanded). We planted a mix of lablab and white milo in alternating rows. We produced a fair crop of each, but we believe the production was only a fraction of what we can achieve as our farming practices become more refined and our plots become better worked. Nevertheless, it was clear from observation that the deer were utilizing the lablab heavily; the plants could hardly keep up with the usage. Deer would eat the milo when the shoots were small.

Usage of the lablab was confirmed by fecal samples that we took near the plots. The fecal analysis indicated that lablab usage began in April and grew steadily through August. We also took fecal samples in our Yana Pasture, which did not have any food plots, to make sure that the deer in that pasture did not have lablab in their diet. The fecal analysis confirmed that Lab Lab usage by the deer in Yana Pasture was negligible.

Having just spent a small fortune in root plowing the plots, purchasing farming equipment, and fencing the plots, I wanted to see whether the food plots had the same impact on antlers that Mother Nature did when she gave us early spring rains.

EXPERIMENT

Our random capture of bucks each year provided the perfect vehicle to answer the question of the impact of food plots on antler size. We therefore decided (1) to capture at random 40 bucks within a mile radius from the food plots and (2) to capture at random 40 bucks in our Yana Pasture located several miles away from any food plots. We could then compare the results.

RESULTS

The following table summarizes the results of our brief one year study. As the table indicates, the food plots did indeed have an impact on antler size. Bucks 5 ½ years and older that were captured near the lablab food plots had average scores that were 5.14% higher than the bucks in the non food-plot area. The food-plot bucks 4 ½ years-old and above sported antlers that were an incredible 11.96% larger than the non food-plot bucks.

DISCUSSION

With respect to the 5 ½ year and older bucks, the 5.14% increase in average antler size, while significant (a 160 becomes a 168 and a 170 becomes a 179.), was less than I would expect for the investment. Yet you must understand that (1) this was our first year of food plots, 2) our lablab crop was poor compared to what it will be in the future; (3) our plots were not as big as they are now so the deer were able to overwhelm the plants before they could grow large enough to withstand browsing pressure;

	5 ½ Years Old and Above		4 ½ Years Old	
	# Bucks	Avg. B&C Score	# Bucks	Avg. B&C Score
Food Plot Area	17	136.75	27	136.791
Non Food Plot Area	10	130.056	18	122.177
% Difference in Score		5.14%		11.96%

and (4) this was the deer herd's first exposure to lablab. I believe, though I do not have the data to back it up, that this 5.14% increase will be much greater in the future. Unfortunately, we will not find out this year because the drought destroyed our lablab crop. We will not even do the experiment in 1996.

With respect to the 4 ½ year-old bucks, the nutrition provided by the lablab had the surprising effect of causing younger deer to reach a peak level of antler development early. After some reflection, though, this makes sense. I am sure you have heard of 3 year-old Boone & Crockett bucks in the farm country of the Midwest. I would suspect that those bucks have simply reached their peak antler production earlier as a result of the extraordinary level of nutrition available to those deer. The implication for commercial hunting outfits is significant: if food plots work to accelerate the time of peak antler production, your return on investment (i.e., through the harvest of big antlered bucks) comes much earlier.

CONCLUSIONS

Although the data and my conclusions have not been subjected to scientific scrutiny, I do believe that our food plots had a significant impact on antler size in 1995. And I also believe that this impact will be greater in the future when our improved farming techniques and greater food plot size (with some cooperation from Mother Nature) start to produce huge quantities of lablab for the deer to eat.

So, food plots work, in my opinion. But you must understand, as I am sure other presenters have indicated, that farming food plots is a capital intensive and complicated enterprise. Our capital costs for farm equipment, food plot preparation (root plowing), and fencing now exceed $100,000. The seed costs, equipment maintenance, fuel, and farming labor are annual expenses on top of that number. Furthermore, you will need someone with a good farming background to manage the effort.

I think it is all worth it, but you will have to ask me if I still think so in two years after we gather the data for the 1997 food plots.

A Caveat

The data I present in this paper--neither the antler size data nor the fecal sample data I refer to--have not been analyzed for statistical significance. Nor has Dr. Charles DeYoung or any other wildlife scientist reviewed this paper before its submittal. Furthermore, this is only one year's worth of data; subsequent years could produce different results. We are a long way from definitive truth, but the indications are promising.

A CASE HISTORY OF A SUPPLEMENTALLY FED DEER HERD IN EAST TEXAS

DAVID B. WHITEHOUSE, International Paper, P.O.Box 631310, Nacogdoches, TX 75961

Cherokee Ridge, a 3500-acre tract of land owned by International Paper in Cherokee county was high fenced in 1988. In 1990, the decision was made to improve the available nutrition to the area wildlife through supplemental plantings and feeding.

Small food plots had been established on the property in the past, totaling approximately 30 acres. Heavy equipment was utilized to enlarge existing areas, and create new openings to total the current 75 acres. New food plots are created when timber harvest operations take place, and will continue until approximately 120 acres (3%), of scattered food plots are in cultivation.

Covered trough-feeders and mineral stations have been placed adjacent to many food plots to supply shelled corn or a pelleted ration if needed. Corn was used little on the property, and it took several seasons of feeding before deer would frequent the stations. Deer are still not utilizing feeders to the extent expected. Several types of pelleted rations have been fed, including deer ration, dairy cattle feed, and alfalfa pellets, with little consumption. Corn is the only food picked up by the deer on the area out of the feeders. Consumption drops drastically in the spring and early summer.

FOOD PLOTS

Previous plantings consisted of winter wheat or oats, and small plots of clover. A greater variety of seeds have been used to increase forage diversity. Fall plots are planted with a combination of Elbon rye, oats, and Yuchi arrowleaf or S1 clover, depending on soil type. Seeding rates have been 75-100, 25, 8, and 4 pounds per acre, respectively. Summer plots consisted of a combination of iron-and-clay cowpeas, joint vetch, and alyceclover at 40, 5, and 10 pounds per acre. Other plantings attempted were soybeans and lablab, which produced limited results, either due to poor performance or pressure from browsing.

Until 1994, plots were disked twice to prepare a clean seedbed. Planting was either by broadcast seeding, or drilling with a 7-foot grain drill. Clover seed was broadcast after drilling and lightly dragged in to assure seed coverage.

In 1994, a 7-foot Great Plains no-till drill with a small seed box was acquired to facilitate planting. The drill has allowed one-pass planting of all seeds. In addition, site prep time and expense is saved. Mowing is all that is required to ready the plots. No-till drilling has allowed better utilization of planting sites, and results in very little moisture loss from the soil. Summer and fall food plots are planted in the same ground with little disturbance. Vegetation is mowed, with drilling following immediately. New sprouts have little competition, and existing forage has a chance to regrow.

This type of planting has resulted in almost 12 months of forage production. Summer food plots produce well as a result of existing vegetation providing cover for new seedlings, preventing excessive early browsing. On-site soil stabilization is also improved due to reduced site disturbance. All plots are limed and fertilized according to soil testing.

A rising concern is the presence of native plants not eaten by deer that flourish in the no-till environment in many of the food plots . Passion flower competition is high in several of the plots. Choices appear to be disking on a 2-4 year rotation to reduce competition, or to apply select herbicides periodically.

A CASE STUDY OF A SUPPLEMENTED DEER HERD IN WEST TEXAS

KENNETH BARBUTTI, Encino Ranch, San Angelo, TX

First of all I would ask you to understand that these are observations made on my place under my type of program to attain my goals. They may not be the same for you because each ranch is different and everybody's program and goals may not be the same as mine.

My goal is to raise the largest antlered whitetail deer that the native subspecies will allow. Along with this goal, I also wanted to prove that our area has good genetics in the deer herd. To attain this goal, I needed to provide an environment where the deer could reach a mature age and have 100% good nutrition year-round, from the time they were born through maturity. After building an 8-1/2' high fence, all I had to do was not kill any young deer, but the nutrition part has proven more difficult.

First, I tried to improve my native range by selling my sheep and goats and keeping my cow numbers at a level that would not promote browsing. I also use a type of high intensity, low frequency grazing method to help promote quality plants.

Second, I implemented a supplemental feeding program because the range still did not provide enough forage, due to the general lack of rain. The type of feed I chose was a free choice "woods" type feeder. This type feeder worked but it did not allow enough deer to eat at the same time or to stay and gorge themselves. So, we built new feeders and added these to the existing ones. The new feeders were designed to allow the deer to be able to see all other deer while they were eating. Also, they had sufficient trough space to accommodate more deer at the same time. Within weeks, the total feed consumption increased as well as more feed being consumed at the new feeders instead of the old. We started off with 10 total feeders, or a feeder to every 470 acres, and 50 to 60 deer. By adding 10 new feeders and decreasing deer numbers, we saw better results with a feeder per 230 acres and 20 deer.

The location of all feeders is in the brush, out of sight from the outside fence, near water if possible and somewhat evenly spaced throughout the ranch. But mainly they were placed in areas where deer travel or bed down and away from high traffic ranch roads. Where two or more draws come together are our highest use feeders.

We fenced off all the original feeders in a 50' X 50' square using 39" net wire. To get more deer to eat feed, we fenced off the new feeders in a 150' X 200' rectangle with 5 strands of smooth wire. This allowed access for the fawns to come in with the does so they could get to the feed. It also allows us to put 2 feeders in the same pen if it is a high use feed area.

After we got feed to all the deer, then I decided to try some different feed rations. I tried all kinds of different things, using other companies' rations, adding more minerals, more protein, more fiber and more corn. But deer are very selective eaters and consumption went down by at least 50%. So I settled with the original feed but I mix whole corn in the feeder with the deer feed during winter months when more energy is needed. The other feeds are not bad; it is just that the deer got used to the original feed. Also, most other feeds contain salt and the ration I am using contains no added salt. We also have our feed made up every 2 weeks and fill our feeders to last 2 weeks. This keeps the feed fresh and keeps the deer eating as much as possible.

We have had less than normal rainfall for several years now, so I thought the deer might need something extra. We put out alfalfa hay in the feeder pens. After 2 to 3 weeks, the deer started eating it but it created a problem with the cows getting into the hay and then to the feed, which had not happened until the hay was added.

This year (1996) my feed consumption has increased (Table 1) yet again, even though I have fewer deer (Table 2). Other animals were eating feed, e.g., turkeys and varmints. I decided to go to a ½" pellet. My average feed consumption has dropped 30% even with it being June and July with no rain. Most of the turkeys have left since the feed pellet is too large and they have little native vegetation. Most of the varmints are still visiting the feeders but cannot consume as much of the feed as before. Also we have not had the waste of feed onto the ground with this ½" pellet like we had with the ¼". I have not been feeding this size pellet for enough time to see the long-term effects, but at the onset it seems to be the answer to some of my problems. I do think that the ¼" pellet is good if you don't have the problems with or are not concerned about the extra amount of feed consumed by these non-target animals. Also when the fawns get big enough to come to the feeders, I will mix in some ¼" pellets to get them started on the feed as young as possible.

The supplemental feeding has caused several other problems. Now that the bucks are attaining a much greater body weight, we are seeing more antler breakage. Also we are seeing an increase in twin fawns and yearling does fawning which creates stunted fawns and does.

Feed consumption tends to increase when the fawns get old enough to eat, as the bucks stop rutting, in the winter during cold spells, and anytime the native forage drys out or diminishes from the heat and/or lack of rain. Good amounts of rain tend to decrease the amount of feed consumed (Table 3). But it usually only lasts for a few weeks while the forage is green and succulent. When the forage starts drying out or

Table 1. Pelleted feed consumption (pounds) observed at Encino Ranch, Tom Green County, Tx, 1992-July 1996.

	1992	1993	1994	1995	1996
Jan.	15000	21200	18550	28250	48500
Feb.	11000	22000	23850	14500	36000
Mar.	6000	19500	17250	29000	30000
Apr.	9000	23750	17500	18250	39000
May	14000	16600	26000*	20000	26300**
June	9000	23426	26000	27000	26900
July	18600	16150	28500	25000	33000
Aug.	13000	16925	27000	26000	---
Sept.	17000	21500	22000	19000	---
Oct.	16000	20650	24000	38000	---
Nov.	20000	20750	23000	36000	---
Dec.	19550	14650	28650	32000	---
TOTAL LBS.	168,150	237,101	282,300	313,000	**239,700**

Six Month TOTALS (lbs)	64,000	126,476	129,150	137,000	206,700

TOTAL DEER	495	399	411	396	340 EST.

(Bucks, Does, and Fawns)

AVG/HD/ DAY	**.93** lbs	1.63 lbs.	1.88 lbs.	2.17 lbs.	3.32 lbs.

*Added 10 more feeders **Started 1/2" pellet

Table 2. Total deer counts as estimated from fall helicopter surveys, Encino Ranch, Tom Green County, TX, 1990- 1995.

DATE	10/90	10/91	10/92	9/93	9/94	10/95
BUCKS	202	220	205	185	136	125
DOE	337	344	191	127	159	157
FAWNS	243	232	99	87	116	115
QUAL. INDEX	76%	66%*	67%	80%	82%	87%
SPIKES	21	25	17	6	3	1
TOTAL	782	796	495	399	411	397

*started hunting

Fig. 1. Deer population trends, herd composition and Quality Buck Index (number of bucks with 8 points or more) observed from helicopter surveys, Encino Ranch, Tom Green County, TX, 1990-95.

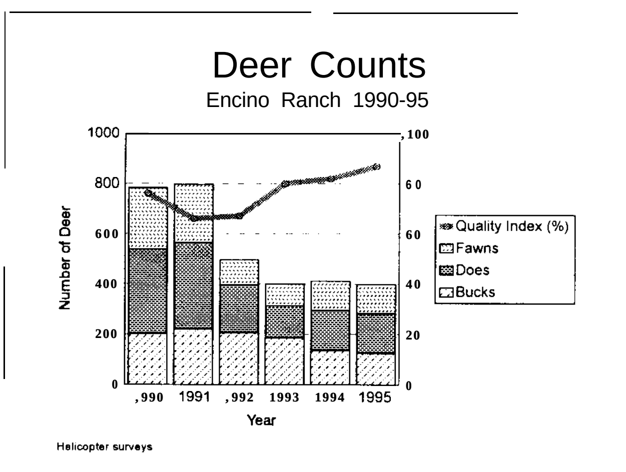

Table 3. Rainfall (inches) measured at Encino Ranch, Tom Green County, TX, 1990-July 1996.

	1990	1991	1992	1993	1994	1995	1996
Jan.	O	2.6	1.8	1.1	0	0	0
Feb.	1.4	.2	4.2	.8	1.2	2.2	0
Mar	3.6	.6	.9	.5	0	.9	0
Apr.	4.4	.4	2.7	1.2	1.5	3.4	3.9
May	2.7	1.1	2.3	2.0	5.0	2.3	2.1
June	0	4.7	4	2.5	0	3.8	1.6
July	6.1	2.8	4.3	.4	0	3.9	1
Aug.	3.1	3.3	1.5	1.6	.8	0	---
Sept.	4.2	7.8	0	1.8	3.4	3.1	---
Oct.	.7	1.7	.4	.6	1.0	.7	---
Nov.	1.8	0	.7	0	1.2	0	---
Dec.	.4	4.3	.5	.6	.5	0	---
TOTAL	28.4	29.5	23.3	13.1	14.6	20.3	8.6

maturing, then feed consumption increases until we get another good rain.

Annual feed consumption rates have increased every year, even with the numbers of deer decreasing. This is due in part to increased number of feeders, lack of rainfall, larger bodied deer needing more feed, more deer coming to feed and higher consumption while at the feeder.

The third thing I did to try and provide quality nutrition year round was plant food plots. I think that food plots are also necessary because feed pellets cannot provide all that natural vegetation can and deer would rather forage than eat out of a feeder. With a food plot, it is more like an all-you-can-eat buffet where the deer can gorge themselves in a more natural environment with lots of space between them and the more dominant deer. Plus the feed is fresher and more suitable to them. Also the cost per pound of feed is less if you get ample rainfall and there is little waste to non-target species.

We needed winter and summer food plots to be provided for the deer. Since everyone in our area planted oats for the winter, we tried that at first. They worked okay but we needed something with higher protein and that would last longer. The next year I planted the Tecomate dual deer mix made up of grains and legumes. These plants matured at different times to give the deer more protein for longer periods of time and with more variety. Then we had to find something for summer, so we tried 'Iron and Clay' cowpeas and lablab. The lablab was far superior to the peas in every aspect - protein, forage production, deer preference and length to maturity.

Once we figured out what to plant, then we had to decide how many food plots were needed. On winter food plots, we planted 1 acre for every 2 deer and have 10 different fields scattered through the ranch. On summer plots, since production is much greater, we plant 1 acre for every 4 deer and have 8 fields. And I would like to put more in because I don't think you can have too many of either.

The 10 winter food plots range in size from 8 to 40 acres. The summer plots range from 7 to 25 acres each. We tried a few smaller fields but they could not handle the grazing pressure from the deer, and they were more susceptible to "droughting out." The bigger the field, the better it seems to do; but it is equally, if not more important, to have them scattered around so all the deer can utilize the forage produced.

At first we looked for the most fertile, deepest soils to pick our location of food plots. This is important to the success of the food plot. Then we tried to scatter them somewhat evenly throughout the ranch, giving access to at least one food plot out of each pasture. We normally have winter and summer plots next to each other so that the deer are comfortable with the area and transition from one to another takes less time.

After we had our locations picked out, then we had to fence them off. On the winter plots, a 3-wire electric fence was the most cost effective and as long as the fence was kept hot, it would keep most of the cattle out. A 39" net wire with a strand of smooth twisted wire on top also works but we had to cut in small openings to allow the fawns access. On fields that were already fenced, we also dropped enough barbed wire to allow easy access.

The summer food plots were more difficult because we had to keep deer and cattle out. We constructed a 7-1/2' electric fence, using 9 wires with a graduated spacing from the bottom up. This kept 95% of the deer out for two years; but this year, with it being so dry, we had to add a 39" net wire to the bottom. So far, this has been working at a lesser cost than a regular deer fence, while allowing us to move the electric wire on top of the net wire down when the food plot is ready to be opened for grazing by the deer.

At first, the deer used the winter plots more readily than the summer and for some reason, we saw an increase in pellet consumption when the winter fields vegetation was good. In the spring of last year, I had to put cattle on these plots because the forage was growing faster than the deer could eat it. On the summer food plots, after the deer figured out that they were open, it did not take long to draw a crowd. Some does even raised their fawns in the plots.

We are currently trying some perennial food plants for the deer. Showy Menendora was planted in the pasture on a shallow, rocky soil and is doing very well but there is no longer a seed source for this plant. Englemanndaisy, Illinois bundleflower, bush and Maximilian sunflower also look promising, but we have not had enough experience with them yet. I do like these plants because once they are established, it improves the native vegetation and you don't have to keep replanting them.

This January we trapped deer and saw a definite increase in antler growth and body size in all the deer, as well as the deer being in better condition. But it was most apparent in the younger aged deer by the 2 and 3 year old does being as big or bigger than 5 and 6 year olds. Fawns were healthier and antler growth on 1-3 year old bucks was better than in years past. Out of the 45 yearling bucks, half were 7 points or better and we only found 6 yearling spikes. We are also seeing an increase in the amount and size of trash points, mainly on the mature deer, but it has started showing up in the 2 and 3 year old bucks. By the end of spring, I was seeing some yearlings that were as tall as their mothers. Our average field dressed weight on mature bucks was 147 pounds with a top weight of 180 pounds. We have also seen an increase of 31% in the quality buck index (8 points or better), which now totals 87% (Fig. 1).

Since adding our food plot program, we have seen the deer really take off. It gave them the little extra push they needed or were not getting before. However, to a lesser extent, some of this was seen on the feed program without the food plots. With the main overall increase seen on the feed program being better browtines and wider spreads.

I believe to attain these results, it took both supplemental feed and food plots. And the timing of the food plots also seems to be important. If Mother Nature cooperates, we are set up to have the winter grains, vetch and peas from October through April to provide a high source of energy and protein for the deer through the cold of winter and as they come out of the rut. The alfalfa and clover should come on in March and last through June to provide high protein, needed for horn growth, weaned yearlings and the fawning does. The lablab can be grazed from June through October to finish out the horn growth, keep the bucks in good shape before the rut, and help the does lactate greater for their fawns.

If all of this works, then my second and third generation deer should have had a mother who received all the nutrition she needed to raise a good fawn. And once old enough, the fawn should have had all the nutrition needed throughout his or her life to grow to their full potential.

PROTEIN PELLET FEED-DELIVERY SYSTEMS FOR WHITE-TAILED DEER

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Abstract: Feed-delivery systems for supplemental feed (protein pellets, 3/16's of an inch in diameter) for white-tailed deer (*Odocoileus virginianus*) were investigated for their economical delivery of feed for free-ranging deer with a minimum of loss to and/or contamination by non-target animals as well as spoilage by the weather. Exclosures were constructed to assist in excluding non-target animals from the feeders. The most effective feeder for protein pellets that we studied was a controlled-time feeder with troughs for the following reasons: 1. Protein pellets should be in a trough for efficient feed consumption and to reduce ground contamination. 2. Since deer can be trained to come to a feeder at a given hour in the morning or late afternoon, one can feed deer when raccoons and turkeys are not normally active. 3. Feed available on the ground is an attractant to cattle, javelinas, and feral pigs, and deer will avoid feral pigs and javelinas to the point of abandoning the feeder. 4. Protein pellets are subject to moisture absorption and lose their palatability; hence, rapid consumption of protein pellets is important at a given feeding time. 5. The high cost of feed necessitates a highly efficient feed delivery system. Our controlled-time feeder was about 95% efficient in delivering feed to deer, whereas free-choice feeders are in the 50% range. However, 95%k efficiency required rather close surveillance of activities at a feeding site. An exclosure constructed of 4-gage stock-panels with 4-inch openings, 30-32 inches in height, and supported by tee posts at 10-foot intervals proved to be resistant to invasions by cattle, feral pigs, and javelinas. We recommend an 80- by 80-foot exclosure as the minimum size.

There has been a proliferation of deer feeders on the market, mostly to distribute shelled corn for hunting purposes. Most of them work very well with shelled corn. However, protein pellets require special protection from moisture and contamination and are less palatable than shelled corn to deer. Consequently, the main objectives of the study were to analyze a number of feed-delivery systems for their economical delivery of protein pellets to white-tailed deer with a minimum of loss to and/or contamination by non-target animals or spoilage by the weather. We also wanted to develop either an avoidance reaction by non-target animals (cattle, feral pigs, and javelinas), or a system of excluding them from the deer feed.

Since there is considerable controversy on the necessity of converting the diet of white-tailed deer from shelled corn to 100% protein pellets, we chose to work with a ration of 75% protein pellets and 25% shelled corn. Helgren (in press) recommended this as a viable goal for supplemental feeding of free-ranging deer. The aflatoxin level of the shelled corn in the 1995-96 season was less than 10 ppb.

The study was conducted on the Matanza Pasture within the King Ranch between November 1, 1994 and March

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31, 1995 and within the same time frame in 1995-96. The vegetation on the pasture was originally designated as Lower Coastal Prairie but is now classified as Improved Rangeland with a heavy invasion of huisache and mesquite. Deer are not hunted on the Matanza pasture, but a deer hunting lease is operated on an adjoining pasture less than ½ mile from 2 feeder sites. The pasture had a high white-tailed deer population throughout the study and an abundance of wild turkeys, raccoons, javelinas, and feral pigs. There was also a normal stocking of Santa Gertrudis cattle.

Our study included observations on 2 different types of exlosures and 4 different types of feeders. However, to keep within the guidelines of this symposium, we shall skip a review of the literature and report mainly on controlled-time feeders, and the conversion from 100% shelled corn to 75% protein pellets and 25% shelled corn. A more detailed report on this study is in preparation at the Kleberg Institute.

EXCLOSURES

Our best exclosure was built from 4-gage stock-panels fence with 4-inch openings, 30 inches high, and 20 feet in length. These panels were produced by cutting in half a 20- by 5-foot high stock panel. The stock-panel exclosure was supported with tee post every 10 feet. The tee post were at least a foot higher than the stock-panel fence, just in case a strand or 2 of barbed wire was needed on top of the panel fence. The stock-panel fences were erected on cliche soil on 1 site and on heavy clay soil on another and tied securely to the tee posts with bailing wire and tee-post clips.

Deer were baited to the area by spreading shelled corn from a bucket on a daily basis. At 1 site the stock-panel fence was erected in 1 day. Within 24 hours the deer had learned to jump the 30-inch high stock-panel exclosure. We had an indications that an occasional feral pig had found his way into the exclosure, probably by climbing the fence. We added a strand of barbed wire about 2 inches above the stock-panel fence after the deer learned to jump the fence and solved the problem. Deer did not seem to have any difficulty in clearing the 32-inch fence.

Although it was not necessary for us to bury any wire either on the cliche or clay soils, it would have been in sandy soil. Brothers used a stock panel 16- by 4-feet with 6-inch openings (A. Brothers, Zachry Ranch, Laredo, Tx., pers. commun.). In sandy soil he buried 18 inches of his wider panels in the ground with a ditch digger and supported the stock panel with tee posts.

We recommend an 80- by 80-foot exclosure as a minimum size. There is a general consensus within the limited literature on deer feeders that the larger the exclosure, the better, and the belief that the larger the exclosure, the less likely cattle, feral pigs, and javelinas will enter (Varner 1994; A. Brothers, Zachry Ranch, Laredo, Tx., pers. Commun.; Pat Reardon, Chaparrosa Ranch, LaPryor, Tx., pers. commun.).

SELECTION OF SITES FOR

SUPPLEMENTAL FEEDING

Select sites where deer but not cattle like to loaf (Varner 1994) and sites relatively free of feral pigs and/or javelinas. All-weather access roads are a must to facilitate servicing the feeder. flat terrain expedites the construction of an exclosure with stock-panel fencing. Avoid establishing a deer feeder across cattle trails.

Deer are sensitive to disturbance, so it is important that a non-hunting area be selected for supplemental feeding, and all disturbance be kept to a minimum. Morrill (1988) stated that roads with frequent pickup traffic within 100 yards had significantly decreased deer usage; consequently, if possible, one should find a site at least 100 yards away from high vehicular traffic.

Explore potential sites by scattering shelled corn either with a controlled-time sling feeder or by hand for approximately a week and check for response by various animals--deer, raccoons, feral pigs, javelinas, turkeys, etc. It is far better to avoid establishing a deer feeder in prime non-target animal habitat than it is to exclude these animals later. Currently, raccoons are almost impossible to avoid, and various control procedures have to be employed.

To say that a feeder and/or an exclosure are raccoon, cattle, or feral pig proof would be a mistake. Chances are that the feeder or exclosure just has not been subjected to the right animal; hence we use the term "resistant."

Our 2 most successful sites were relatively open (85-90%) but had woody vegetation within the exclosures. Woody vegetation within the exclosure is important. It not only provides shade but a feeling of security for deer. On many occasions, we found bucks lying down in the shade within a stock-panel exclosure when we attended the feeder. Also, woody vegetation gives a sub-dominant deer a chance to escape the wrath of a dominant one. The 2 sites were close to good loafing and/or escape cover for deer.

SELECTION OF SUPPLEMENTAL FEED

The most commonly used feed for deer is shelled corn. However, with the advent of year-round feeding for larger antlers and better fawn crops, protein pellets became essential. These 2 feeds have different characteristics; and whereas, a given feeder may be efficient with shelled corn, it may not be with protein pellets.

We investigated shelled corn and protein pellets, mainly 3/16s of an inch in diameter. In the 1994-95 season our Ralston Purina protein deer pellets were 13% protein, not more than 18% crude fiber, and not less than 2.5% crude fat. In the 1995-96 season the Ralston Purina feed was 20% protein, not more than 12.5% crude fiber, and not less than 1.5% crude fat. The switch in protein level was a matter of availability.

Protein deer pellets are prone to deteriorate rapidly when exposed to moisture, becoming unpalatable to deer. Even in limited amounts, moisture will coagulate pellets and initiate mildew. We concur with Warner (1992) on the need to keep dry and fresh feed in deer feeders at all times.

SELECTION OF FEEDERS

The prime considerations in the selection of a deer feeder, besides cost, are efficiency in delivering feed to deer, minimizing the loss of feed to non-target animals, and the amount of time required to inspect and service the feeder as well as its ability to protect protein pellets from the weather.

Free-choice deer feeders can be classified as crib feeders, plate feeders, and tube feeders. Food is available for deer on a 24-hour basis. Whereas, a controlled-time feeder has feed available only at a pre-selected time within a 24-hour period. All free-choice feeders, such as the crib, tube and plate feeders, are subject to large amounts of feed being consumed by numerous non-target animals (Edmondson and Rollins 1994). Whereas, controlled-time feeders can be set to coincide with major periods of deer activity and the quantity of food can be regulated.

Cost is a major consideration in the selection of a deer feeder, but the old adage, "You get what you pay for" also applies to deer feeders. The cost of a deer feeder is minor if it is more efficient in delivering feed to deer. Supplemental feeding is a long-term investment, and over a period of years, the cost of the feed, along with inspection trips, becomes the major expense, not the feeder.

Weather is a major problem. If the feed is exposed to rain, especially protein pellets, one has the problem of replacing the feed as soon as possible, which is both time consuming and costly. Hence, protection of the feed from moisture must be considered in the selection of a feeder. Some feeders have to be cleaned more often than others, not only from wet feed, but from contamination by non-target animals, especially raccoons.

The height of a feeder will also influence deer use. It appeared that the first choice of a feeding site by deer is at ground level. As one raises the height of the feeder to avoid javelinas and feral pigs, deer go through a learning process to feed at greater heights, especially above 24 inches.

All the feeders we tested required frequent inspections to check on feed quantity, feed flow (wet feed), deer use, non-target animal problems, contamination of the feed as well as the ground below the feeder. If there is a feeder that does not require surveillance for high efficiency (90% or better) in delivering protein pellets to deer, we have not tested it.

Controlled-time trough-feeders

Controlled-time feeders for protein pellets are relative new products on the market with far less models than free-choice feeders. We studied two models and settled on the Lamco trough feeder. Although we did not make a detailed study of the efficiency of the time-controlled feeder compared to free-choice crib, tube, and plate feeders, it was obvious by the 1995-96 season that this feeder was by far the most efficient in delivering protein pellets to deer.

To check on deer and non-target animal activity on a 24-hour basis at our 3 feeder sites, we used an "active infrared" sensing unit (Trailmaster 1500). The system consisted of a transmitter, receiver, and a 35mm, weather-proof camera. The transmitter and receiver were fitted to each feeder site so that when an animal attempted to feed at 1 of the feeders an invisible infrared beam was "broken,: and system recorded an "event." The monitor was equipped with a flash 35mm camera supplied with 400 Kodacolor film. The camera had a delay interval of 12 minutes, which prevented more than 1 photo frame from being taken within a 12-minute period. The date, hour, and time were recorded on each negative. Negatives and "events" were studied for animal visitations and 24-hour activity patterns.

The main feeding period for deer at free-choice feeders based on 24-hour camera surveillance was late afternoon. Deer did feed throughout the night hours with free-choice feeders but at a reduced rate. The only period of inactivity at the feeder was between 900 and 1300 hours.

With the controlled-time feeder in the 1995-96 season, we used the average number of times (events) that the infrared beam was "broken" to measure deer activity. The height of the deer activity started about 30 to 60 minutes before the feeders activated in the morning or afternoon and for about 2 hours thereafter.

Deer are largely active in the early morning and late in the afternoon. By feeding only enough feed to be consumed entirely by deer in a 2-hour period in the morning and again before sunset, one tends to avoid nocturnal non-target animals that cannot be excluded by a stock-panel fence. Deer are very easily trained, if hungry, to come to a feeder at a given hour in the early morning and/or the late afternoon. The amount of feed released at each feeder varied from 8-10 to 22-25 pounds per feeding. The amount was adjusted to the demand for feed by the deer.

One may miss deer when there is only 2 feeding periods in 24 hours, such as sub-dominant deer and large bucks that are alleged to feed only at night. The problem with night feeding of deer is that it coincides with the height of activity for feral pigs, javelinas, and raccoons. Although the larger bucks at our feeders were more suspicious and tentative than smaller bucks on approaching and utilizing feeders, camera surveillance of feeders during night hours did not reveal any noticeable difference in the size of the bucks. However, in areas with high hunting pressure, their behavior may be different.

Since our feeder was within a stock-panel fence, we were able to exclude feral pigs, cattle, and javelinas, and we largely avoided raccoons and turkeys by timing the feeder only to release feed about the first 2 hours in the morning and the last 2 hours of daylight in the afternoon. The later time period was also the height of deer activity at free-choice feeders in our study area. As the days grew longer in February and March, we adjusted our feeding times accordingly.

The behavior of deer at a feeding time is a good indication of how hungry the deer are. If they start to congregate in numbers (5 or more) as much as 30 minutes before the feeder is programmed to activate, they probably are hungry. Also, if there is a quantity of feed (3 pounds or more left in the troughs 2 hours after the activation of the feeder, cut back on the amount of feed. However, one should check the behavior of the deer at a feeder for a couple of days. Deer at a feeder can have an "off" 24-hour period caused by harassment by man or beast.

The Lamco time-controlled feeder releases protein pellets into a trough. Deer feeding from a trough spend less time getting the feed than they do if the feed was scattered on the ground. They feed between 5 and 20 minutes with the average time probably being close to 10 minutes. They probably are also more likely to take both protein pellets and corn, whereas on the ground they seemed to seek out the shelled corn.

The metal troughs held the feed and avoided feed contamination from non-target animals. Raccoons served a purpose if only a small amount of feed was left in the troughs by the deer. They cleaned up the remaining feed, which was subjected to dew and less palatable to deer than dry pellets. However, if too much feed was released into the troughs at feeding time, the raccoons would linger in the troughs and defecate on the feed.

Most controlled-time feeders are large in size, and time is required for the deer to adjust to the feeder. Our greatest problem was a height factor. We started with the rim of the troughs about 32 inches above the ground, and the deer would not eat out of the troughs. When we dropped the height of the rim of the troughs to about 18 inches, they readily accepted the feeder.

The popular conception that deer would not feed from a feeder if they could not see what was on the other side was not true. The 4-sided Lamco with a trough on each side and with restricted vision for an individual deer permitted as many as 4 bucks to feed at the same time, depending on the aggressiveness of the individual deer. The deer may take a longer period to adjust to the lack of 360-degree vision, but it was not as noticeable a problem as the height of the rims of the troughs.

The main disadvantage of controlled-time feeders is the cost, $700-$900. When one enters into a supplemental feeding program with protein deer pellets, it is a long-term commitment of at least 3 years. Varner (1989) states that this amount of time is necessary for the animals to become accustomed to using the feeder and to derive any real nutritional benefit from the program. Hence the cost of the feeder is a small part of the investment as compared to the cost of the feed. With this in mind it is important that one gets the greatest possible efficiency in delivering protein pellets to deer instead of non-target animals.

Studies report that deer eat from 25 to 50% of the feed at free-choice feeders with the rest being consumed by non-target animals. Whereas, controlled-time feeders, properly managed, provided better than 95% delivery of feed to deer. The other 5% goes to birds, both game birds and songbirds, and mammals, especially raccoons.

All time-controlled feeders that we have seen are weather proof and have a large feed capacity, more than 500 pounds. Hence, one can control the amount of feed and forecast when feeders will have to be replenished.

Based on our findings we would recommend a time-controlled trough feeder for feeding deer and a mixture of shelled corn and protein pellets within a stock-panel fence exclosure at least 80- by 80-feet in size.

DEER ACCEPTANCE OF PROTEIN PELLETS

The time necessary to convert deer from 100% corn to 25% and 75% deer pellets undoubtedly depends on their hunger and the availability of natural feed. We started with 100% shelled corn on November 1, 1995 and at monthly intervals increased the percentage of protein pellets by 25% until we reached 75% protein pellets and 25% corn on February 1, 1996. If the deer are not given enough time to accept the protein pellets, one may have to clear the feeder of protein pellets and start again with shelled corn.

Warner (1992) stated that deer tend to self-regulate themselves to feed and when there is a good supply of native vegetation, they almost go completely off the supplement. Our observations confirm this conclusion. With more thana 2 inches of rain in March 1995, the natural vegetation was lush and in great abundance and deer use of supplemental food dropped dramatically. DeYoung (1995) stated that Zaiglin (1989) found that the deer quit supplemental feed for about 3 weeks after a rain during the growing season.

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FENCING ALTERNATIVES USEFUL IN SUPPLEMENTAL FEEDING PROGRAMS

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Abstract: Successful establishment of wildlife food plots or supplemental feeding programs is dependent upon some means of reducing depredation by desirable (e.g., deer) and undesirable wildlife. Repellents, scare tactics, and fencing are typically used to reduce damage to crops, but all have been ineffective or too costly for small plot use. Conventional "deer-proof" fences, consisting of two rows of net wire stacked to create an 8-ft tall fence, are effective for protecting wildlife food plots, but cost anywhere from $2.50 - $5.00 per foot depending on plot size. An alternative has been hi-tensile electric fences which are already being used in all types of domestic livestock control. New technology in fencing materials and energizers have made it possible to manage deer and other wildlife on a large or small scale very economically.

FENCE DESIGNS FOR FOOD PLOTS

Traditional 8-ft double-net game fences are essentially maintenance free and extremely effective in controlling deer movement. Variations on this basic "permanent" design, such as folding down the top layer of net wire or installing access gates which can be opened or closed during supplemental feeding periods, offer flexibility for managers to provide/limit access by deer at certain times. These fences are permanently installed and can be used year after year with little maintenance.

Most conventional and electric game proof fences are built to a height of 8 ft because it is generally assumed that deer jump over a woven wire or barbed wire fence to enter a field. However, Wingard (1983) indicated deer preferred to go under or through a fence rather than jumping over. Karlsen (1986) conducted an experiment using 8 different types of electric fencing, 3 different combinations of electric and barbed wire fences and 1 combination of electric and net wire fence. This research indicated that using electric fences in any combination reduced the number of deer entering plots by 50-60%. Plots using only electric fences reduced deer traffic from 14-97% depending on availability of forage outside the test plots. All plots were heavily damaged during unusually dry periods because of reduced grounding capabilities of the soil made the electric fences less effective. All electric fences should incorporate alternating positive and negative wires to increase the effectiveness and reliability of the fence, regardless of the design chosen. Another study by Hyngstrom and Craven (1988) demonstrated that simply flagging electric fences to increase visibility and baiting the fences with strips of tin foil covered with peanut butter increased effectiveness. Using such "conditioning techniques", even a 1- wire electric fence was effective in reducing deer damage to crop lands. Field experience and observations indicate that once deer become familiar with electric fences they generally react in much the same way as other livestock, i.e., total avoidance.

The North Concho Ranch, San Angelo, TX uses 9-strand electric fences with round rod insulators on steel suckerrod posts. This configuration allows the wires to be moved up or down on the posts, thus allowing the fence wires to be opened as a "gate" anywhere along the fence line to allow deer access to the food plot.

FENCE DESIGNS FOR SELF FEEDERS

Fences built around deer feeders are typically designed to exclude livestock but allow other species easy access. Electric fences have been used successfully to exclude raccoons and other varmints from vineyards, chicken houses, and gardens by using 5- or 7-strand fences, approximately 20-24 inches tall. Successive wires are alternating positive and negative thus preventing animals from climbing over the fences. Additional wires may need to be added to prevent livestock access to the feeder. Electric fences around feeders should be no less than 50 ft in diameter allowing deer sufficient room to maneuver after jumping the short fences. Using electric wires around feeder bases to stop varmints from climbing into feeders is risky, because if deer come in contact with the wire they may avoid the feeder entirely. Additional research is needed to determine how portable electric fencing designs can be used to curb feeder use by nontarget animals (e.g., raccoons) without affecting deer use.

CONCLUSION

Regardless of the design or type of fences chosen for food plots or feeders proper installation with high quality materials are essential. In order to avoid the most frequent problems associated with electric fences, pay attention to the following guidelines:

- purchase a high power low impedance New Zealand style energizer;
- pay attention to warranty and lightning warranty programs;
- build braces stronger than you would for conventional fences;
- purchase high quality insulators;
- use self insulating fiberglass post (not steel T-posts!); and
- follow proper grounding specifications.

Success of the fencing project depends on attention to details, such as the contour of the land, watergaps, and strategically-spaced gate openings. Such planning will help eliminate future problems and insure the supplemental feeding program will be successful.

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RECORD KEEPING: FINANCIAL AND BIOLOGICAL

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It is impossible to properly manage a white-tailed deer (*Odocoileus virginianus*) herd without keeping adequate biological and financial records. Biological records give the deer manager a better understanding of deer herd dynamics, while financial records allow the manager to determine the most efficient management practices (e.g., supplemental feeding, prescribed burning) for deer herd improvement. Financial and biological records allow the manager to determine if a supplemental feeding program will be and/or was effective in helping them achieve their deer management objectives.

Most deer managers want to increase overall buck antler quality in their deer herd. Supplemental feeding is one of the many management practices a manager can use to increase buck quality. To focus our discussion, therefore, I will assume that food quality is the only limiting factor on a theoretical deer herd. I will also assume that other possible limiting factors (e.g., food quantity, deer population age structure, shelter, water, genetics) that affect buck quality have already been addressed and are not limiting. Lastly, I will assume supplemental feeding has definitely been shown to improve antler quality in wild deer and that deer are consuming 100% of the feed offered them.

RECORD KEEPING

One purpose of record keeping is to allow a deer manager to determine if a management practice, like supplemental feeding, is effective in improving a deer herd. I t could be that antler quality is not limited by food quality at all, but by age of bucks harvested or competition for a limited food supply. Keeping and analyzing biological (harvest) and financial records will show if food quality is limiting and if supplemental feeding is making a difference in overall buck quality.

Design

A manager must have baseline harvest and financial data from a similar non-supplementally fed deer herd as a standard by which to measure the progress of their supplementally fed deer herd. The collecting of the fed and non-fed deer data can be accomplished through 3 different record-keeping designs: 1) collect harvest and financial data on target deer herd before and during supplemental feeding; 2) collect harvest and financial data from 2 identical deer herds on identical adjacent properties where one is fed and the other is not, and 3) collect harvest and financial data simultaneously from non-fed and fed deer that are in the same deer herd. All three record-keeping designs have problems.

There is not a method currently developed by which to collect fed and non-fed deer data from the same deer herd. There is a collar-key and feed-gate technology used in cattle feeding studies that would be ideal for this kind of application. This method, however, has not been adapted for use on wild white-tailed deer.

Comparing harvest and financial data from fed and non-fed deer herds on identical adjacent properties is fraught with problems because the herd and the habitat in which the two herds occur will not be completely identical. The adjacent property may differ in soil type, plant species composition, plant successional stage composition and habitat management history. The herds will probably differ in buck:doe ratio, fawn recruitment, deer density, and herd management history.

Harvest and financial data from the same deer herd before and during the time they are supplementally fed may be confounded due to a change in rainfall patterns, deer density, plant growth, plant successional stages, and management approaches between time periods.

I mention these biases not to discourage you from collecting data, but to make you aware of different designs and their limitations. Record keeping design 3 would be preferred to the other designs , but it has not been adapted for wild deer. Most managers would then prefer record keeping design 1 over 2, since 1 does not require setting aside adjacent property with deer that will not be supplementally fed. Design 3, therefore, will be used in the following discussion.

Biological Records

Deer herd harvest data should be collected before supplemental feeding begins and annually thereafter in order to monitor the effectiveness of a deer feeding program. Minimum biological data that should be collected includes buck:doe ratio, fawning percentage; deer density, age by sex class, antler quality, body weight, and body condition. Age by sex class, antler quality, body weight, and body condition are particularly important in measuring the effectiveness of a supplemental feeding program. Table 1 is an example of the minimum harvest data that should be collected and summarized for a deer herd before and during the time they are supplementally fed.

Age is one of the most important factors determining buck antler size and body weight. Antler size and body weights vary with deer age. More mature bucks generally weigh more and have larger antlers (up to 6.5 years of age) than younger bucks. Deer aging centers around the fact that deer only have 2 sets of teeth during their life. We can age deer until they are 1.5 years old through tooth replacement. Aging after 1.5 years is based on tooth wear.

There are several methods for measuring deer antler quality. The most notable is the Boone-and-Crockett System. Others are the Burkett and Pope-and-Young Systems. All of these methods require taking various antler measurements that are converted to a standardized point system. These point systems are an index to antler quality. I recommend using the Boone and Crockett system because it is so universally accepted.

Body weights are easily measured using a spring-type scale. Live or dressed weights can be measured as long as you are consistent in measuring one or the other.

Body condition is a subjective measurement based on the amount of fat located across a deer's back, at the tail base, around the kidney, and scattered throughout the body cavity. Poor condition deer have prominent ribs, backbone, and pelvic girdle. Fair condition animals have little or no excess fat, but bones are not showing. Good condition animals have fat across the back, at the tail base, around the kidney and scattered throughout the body cavity. For more information on biological record keeping and interpretation, see the Extension publication entitled *Interpreting Deer Harvest Records* by Dwight Guynn.

Financial Records

Receipts and costs of a deer lease enterprise should be recorded before supplemental feeding begins and annually thereafter in order to monitor the effectiveness of a deer feeding program. Receipts are the income a manager receives for renting or leasing his land to hunters (Table 2). Receipts maybe reported by the acre, deer, hunt, gun, person, day, season, year, or group. Costs are the expenses a manager incurs in operating his deer lease and maintaining his property, equipment, and improvements (Table 2). The kinds of costs that should be measured are operating and ownership costs. Operating costs include items like feed purchased, fertilizer, labor, seeds and plants purchased, supplies purchased, interest on borrowed operating capital, and automobile gasoline. Ownership costs include insurance, machinery depreciation, improvement depreciation, interest on land investment, and taxes. Operating costs are generally those costs that will no longer be incurred if the enterprise went bankrupt, while ownership costs are those costs that would still be incurred for about 1 year after bankruptcy.

RECORD ANALYSIS

Biological (Table 1) and financial data (Table 2) can be combined to create enterprise budgets (Table 3 and Table 4). Enterprise budgets are a snap-shot of an enterprise's receipts, costs, and profitability at a certain point in time. Enterprise budgets can be used to determine the financial change in an enterprise's status once a certain management practice, like supplemental feeding, is implemented. Table 3 is an enterprise budget for a theoretical year-long deer lease in the South Texas Plains during 1985 before starting a supplemental feeding program. Table 4 is an enterprise budget for the same deer lease the next year after a 16% protein year-round deer feeding program was started. Table 5 is a partial budget that summarizes the financial and biological change between the 2 enterprise budgets.

Using enterprise (Table 3 and 4)

and partial budgets (Table 5) we can analyze the wisdom of implementing a supplemental feeding program. Notice, in this theoretical example, that the deer lease rate increased from $3.22/ac in 1985 to $4.49/ac in 1986 (Table 5). The number of trophy bucks (4) and quality bucks (4) increased and the number of small bucks (8) decreased (Table 5). There was also an increase in operating and ownership costs. Specifically, feed purchased, gasoline used, labor needed, repairs and maintenance conducted, supplies used, operating capital borrowed, and improvements depreciated all rose in 1986 (Table 5).

Average operating cost rose from $123/buck (Table 3) to $1,249/buck (Table 4). Before supplemental feeding the enterprise returned $32,312 above operating costs (Table 3) and $6,301 (Table 4) after supplemental feeding. Neither enterprise was profitable when all costs were considered (Table 3 and 4). This is primarily due to the high cost of maintaining the investment in land and improvements.

We may concluded from this data, given there was no major shift in the economy or a particular part of the hunting consumer sector, that the lease rate increased (assuming inflation is not a factor and the manager actively used the change in antler quality in his marketing) because the number of trophy bucks (4) and quality bucks (4) increased and the number of small bucks (8) decreased from 1985 to 1986 (Table 5). We may also conclude that the increase in better antlered bucks and the decrease in smaller antlered bucks is probably due to supplemental feeding, since we assumed earlier that food quality is the only limiting factor on our theoretical deer herd.

In summary, the effect of supplemental feeding on our theoretical deer herd resulted in 4 more trophy bucks, 4 more quality bucks, and a 8 less small bucks harvested. This improvement cost the deer lease enterprise $28,586 in total profitability (Table 5). The enterprise, however, was already showing a negative balance ($-11,219) in net return above all costs (Table 3) before supplemental feeding was implemented. Returns above operating costs ($6,301) were still positive after supplemental feeding was implemented (Table 4), meaning the enterprise could still operate in the short run without going bankrupt.

These enterprise budgets (Table 3 and 4) and partial budget (Table 5) show how financial and biological data can be used to determine the effectiveness of a management practice like supplemental feeding. Deer managers can make wise decisions about the continuation of a management practice by comparing enterprise budgets from before and after a practice is implemented. Alternatively, managers with an actual pre-feeding enterprise budget and good knowledge of production relationships can develop a good theoretical post-feeding enterprise budget. A manager, by making small variations in the post-feeding enterprise budget (harvest and financial data) and creating a partial budget for each scenario, can then determine a range over which the implementation of supplemental feeding would be wise prior to actually committing the time and incurring cost of implementing the practice. Refer to the book entitled *Farm Management* by Michael D. Boehlje and Vernon R. Eidman for more information about developing and using enterprise and partial budgets in management situations.

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Table 1. Summary of harvest data collected for a theoretical deer herd before (1985) and after (1986) supplemental feeding was implemented on a 11,4 15 ac ranch in south Texas.

Number of Deer	Item	Average Age	Average Boone and Crockett Score	Average Dressed Weight	Most Frequent Body Condition Class
Before Supplemental Feeding					
5	Trophy bucks	5.25	156	146	Fair
10	Quality bucks	4.75	129	143	Fair
21	Small bucks	4.50	113	135	Fair
76	Does	4.25		109	Fair
After Supplemental Feeding					
9	Trophy bucks	5.50	157	149	Good
14	Quality bucks	5.00	131	147	Good
13	Small bucks	4.50	117	139	Good
76	Does	4.50		115	Good

Table 2. Financial data collected and calculated for a theoretical deer herd before (1985) and after (1986) supplemental feeding was implemented on a 11,4 15 ac ranch in south Texas.

Item	Value
Before Supplemental Feeding	
1. Receipts	
Year Round Lease	$36,756
2. Operating Costs	
Fertilizer and Lime	$12
Feed Purchased	$20
Gasoline, Fuel and Oil	$296
Labor	$1,161
Machine Hire	$224
Repairs& Mamtenance	$19
Seeds Purchased	$181
Supplies Purchased	$0
Utilities	$242
Rental of Land	$2,049
Miscellaneous	$61
Oper. Capital Interest	$179
3. Ownership Costs	
Insurance	$274
Machinery Depreciation	$1,354
Improvement Depreciation	$4,523
Interest on Land Investment	$37,132
Taxes	$248
After Supplemental Feeding	
1. Receipts	
Year Round Lease	$51,253
2. Operating Costs	
Fertilizer and Lime	$12
Feed Purchased	$32,000
Gasoline, Fuel and Oil	$2,000
Labor	$5,500
Machine Hire	$224
Repairs& Mamtenance	$525
Seeds Purchased	$181
Supplies Purchased	$346
Utilities	$242
Rental of Land	$2,049
Miscellaneous	$61
Oper Capital Interest	$1,812
3. Ownership Costs	
Insurance	$274
Machinery Depreciation	$2,22 1
Improvement Depreciation	$6,231
Interest on Land Investment	$37,132
Taxes	$248

Table 3. Enterprise budget for a theoretical year-long deer lease in the South Texas Plains during 1985 before starting supplemental feeding program.'

	Item	ac	Price/ acre	Value	Average Value/Buck
1.	**Receipts**				
	Year Round Lease	11,415	$3.22	$36,756	
	5 Trophy Bucks, 10 Quality Bucks, 21 small bucks and 76 does were harvested.				
	Total Receipts			$36,756	$1,021
2.	**Operating Costs**				
	Fertilizer and Lime			$12	
	Feed Purchased			$20	
	Gasoline, Fuel and Oil			$296	
	Labor			$1,161	
	Machine Hire			$224	
	Repairs& Maintenance			$19	
	Seeds Purchased			$181	
	Supplies Purchased			$0	
	Utilities			$242	
	Rental of Land			$2,049	
	Miscellaneous			$61	
	Oper. Capital Interest (1/2 of total x 8.4%)	$4,265	8.4%	$179	
	Total Operating Costs			$4,444	$123
3.	**Returns Above Operating Costs**			$32,312	**$898**
4.	**Ownership Costs**				
	Insurance			$274	
	Machinery Depreciation			$1,354	
	Improvement Depreciation			$4,523	
	Interest on Land Investment			$37,132	
	Taxes			$248	
	Total Ownership Costs			$43,531	
5.	**Total All Costs**			**$47,975**	
6.	**Net Return Above All Costs**			**($11,219)**	

[1] The budget assumes the following: 36 bucks, 76 does, and 0 fawns were harvested; a deer density of 16.3 ac/deer, a fawning rate of 54%; and a buck:doe ratio of 1:4.2; fawning occurs in May, harvest in December; ranch size 11,415 ac; deer foraged on rangeland and oat pasture; hunters purchased hunting leases primarily for deer hunting, one cabin was available to hunters; a real interest rate of 8.4% for calculating interest on operating capital, land investment, and machinery and improvement depreciation.

Table 4. Enterprise budget for a theoretical year-long deer lease in the South Texas Plains during 1986 after supplemental feeding with 16% protein deer pellets year-round.[1]

	Item	ac	Price/ acre	Value	Average Value/Buck
1.	**Receipts**				
	Year Round Lease	11,415	$4 49	$51,253	
	9 Trophy Bucks, 14 Quality Bucks, 13 small bucks and 76 does were harvested				
	Total Receipts			$5 1,253	$1,424
2.	**Operating Costs**				
	Fertilizer and Lime			$12	
	Feed Purchased			$32,000	
	Gasoline, Fuel and Oil			$2,000	
	Labor			$5,500	
	Machine Hire			$224	
	Repairs& Maintenance			$525	
	Seeds Purchased			$181	
	Supplies Purchased			$346	
	Utilities			$242	
	Rental of Land			$2,049	
	Miscellaneous			$61	
	Oper. Capital Interest (1/2 of total x 8.4%)	$43,140	8.4%	$1,812	
	Total Operating Costs			$44,952	$1,249
3.	**Returns Above Operating Costs**			$6,301	$175
4.	**Ownership Costs**				
	Insurance			$274	
	Machinery Depreciation			$2,221	
	Improvement Depreciation			$6,23 1	
	Interest on Land Investment			$37,132	
	Taxes			$248	
	Total Ownership Costs			$46,106	
5.	**Total All Costs**			**$91,058**	
6.	**Net Return Above All Costs**			**($39,805)**	

[1] The budget assumes the following: 36 bucks, 76 does, and 0 fawns were harvested; a deer density of 16.3 ac/deer, a fawning rate of 54%; and a buck:doe ratio of 1:4.2; fawning occurs in May, harvest in December; ranch size 11,415 ac; deer foraged on rangeland and oat pasture; hunters purchased hunting leases primarily for deer hunting; one cabin was available to hunters; a real interest rate of 8.4% for calculating interest on operating capital, land investment, and machinery and improvement depreciation.

Table 4. Enterprise budget for a theoretical year-long deer lease in the South Texas Plains during 1986 after supplemental feeding with 16% protein deer pellets year-round.[1]

	Item	ac	Price/ acre	Value	Average Value/Buck
1.	**Receipts**				
	Year Round Lease	11,415	$4.49	$51,253	
	9 Trophy Bucks, 14 Quality Bucks, 13 small bucks and 76 does were harvested.				
	Total Receipts			$5 1,253	**$1,424**
2.	**Operating Costs**				
	Fertilizer and Lime			$12	
	Feed Purchased			$32,000	
	Gasoline, Fuel and Oil			$2,000	
	Labor			$5,500	
	Machine Hire			$224	
	Repairs& Maintenance			$525	
	Seeds Purchased			$181	
	Supplies Purchased			$346	
	Utilities			$242	
	Rental of Land			$2,049	
	Miscellaneous			$61	
	Oper. Capital Interest (1/2 of total x 8 4%)	$43,140	8.4%	$1,812	
	Total Operating Costs			$44,952	$1,249
3.	**Returns Above Operating Costs**			$6,301	**$175**
4.	**Ownership Costs**				
	Insurance			$274	
	Machinery Depreciation			$2,221	
	Improvement Depreciation			$6,23 1	
	Interest on Land Investment			$37,132	
	Taxes			$248	
	Total Ownership Costs			$46,106	
5.	**Total All Costs**			$91,058	
6.	**Net Return Above All Costs**			($39,805)	

[1] The budget assumes the following: 36 bucks, 76 does, and 0 fawns were harvested; a deer density of 16.3 ac/deer, a fawning rate of 54%; and a buck:doe ratio of 1:4.2; fawning occurs in May, harvest in December; ranch size 11,415 ac; deer foraged on rangeland and oat pasture; hunters purchased hunting leases primarily for deer hunting; one cabin was available to hunters; a real interest rate of 8.4% for calculating interest on operating capital, land investment, and machinery and improvement depreciation.

Table 5. Partial budget showing the change in net enterprise income for a theoretical year-long deer lease in the South Texas Plains during 1985 that has implemented a supplemental feeding program with 16% protein deer pellets fed year-round.

1. Additional Receipts	
Increase in deer lease from $3.22/ac to $4.49/ac with an increase in number of trophy (+4) and quality bucks (+4) harvested and decrease in small bucks (-8) harvested.	$14,497
2. Reduced Costs	$0
3. **Subtotal (1 + 2)**	**$14,497**
4. Reduced Receipts	**$0**
5. Additional Costs	
Purchase of 16% Protein Feed	$3 1,980
Additional gasoline, fuel and oil needed to service feeders	$1,704
Additional labor needed to service feed troughs	$4,339
Repairs and maintenance need to maintain feed troughs	$506
Additional supplies purchased	$346
Interest on operating capital needed to purchase feed.	$1,633
Depreciation on new feeders and equipment	$2,575
6. **Subtotal (4 +5)**	**$43,083**
7. Difference (3-6)	($28,586)

Wildlife-Management-Property Tax Valuation and Supplemental Feeding

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Texas is a private lands state with 97 percent of the land in private ownership. Thus, most wildlife and wildlife habitats occur on private lands. The 74th Texas Legislature acted to define "wildlife management use" as a qualifying agricultural practice to landowners who have an existing open space, agricultural tax valuation. The House Bill 1358 [authored by Representative Clyde Alexander (Athens), co-sponsored in the House by Representative Bob Turner (Voss) and by Senator John Montford (Lubbock) in the Senate] allows landowners to retain an agricultural tax valuation on property currently appraised for agriculture, but provides that the use may be changed to active wildlife management. The bill enhanced HB 1298 passed in 1991 but not widely implemented by county appraisers because of some potential constitutional questions. To clarify the constitutional issues, voters were asked in November 1995 to approve an amendment to the Texas Constitution, **Proposition 11**, that reads, "to allow open-space land used for wildlife management to qualify for tax appraisal in the same manner as open-space agricultural land subject to eligibility limitations provided by the legislature." Texas voters approved the amendment by a 2-1 margin.

The bill and constitutional amendment were supported by a broad coalition from private property rights advocates to environmental groups. This action will neither increase taxes, nor remove any lands from the tax rolls. The change in land use from agriculture to active wildlife management provides more flexibility to land managers while remaining revenue neutral to taxing authorities. Qualified landowners may now manage their properties for both agriculture and wildlife, change their emphasis to meet defined objectives, and enhance wildlife populations and habitats in Texas.

Qualifications and Guidelines

"Guidelines for Qualification of Agricultural Land in Wildlife Management Use" is a publication developed by the Texas Comptroller of Public Accounts that describes the legislation and identifies requirements for qualifying land. The system, guidelines and paperwork are being designed to be easy to implement, review and report by tax appraisers. Only lands having an existing agricultural valuation established under "open-space agricultural appraisal" would qualify. The legislature clearly intended that the existing "AG tax value" roll directly over to the wildlife value, rather than a burdensome reassessment of wildlife production levels. This guarantees no change in tax values and no loss of tax revenue, and a reduced work load on appraisers. Agricultural lands in urban areas will be treated as critically under these guidelines as they currently are for agricultural valuations in these metropolitan centers, and the same strict standards will apply. Lands that are changed to wildlife use may be switched back to agricultural use status if the landowner desires. Lands without an agricultural valuation will have to establish a history of agricultural use (over 5-7 years) before they may be considered for wildlife management use.

Regional Guidelines for "active wildlife management" are being developed by the Texas Parks and Wildlife and the Texas Agricultural Extension Service in association with Comptroller. "Eligible land," in the words of HB 1358, must be managed to propagate a sustaining breeding, migrating, or wintering population of indigenous (native) wild animals for human use in at least 3 of the following 7 ways to qualify:

1. habitat control
2. erosion control
3. predator control
4. providing supplemental supplies of water
5. providing supplemental supplies of food
6. providing shelters
7. making census counts to determine populations

The guidelines are being written to define wildlife management practices that will be as "active" as current agricultural practices for the seven listed wildlife management activities.

Although the legislature has defined broad categories of wildlife management activities, they clearly established intent that practices will be based on regional wildlife population needs and important limiting factors to populations (bird feeders and bird baths will not qualify). For example, drinking water is not a critical limiting factor to most wildlife populations in the eastern part of the state, but wetland habitats are important. Wetland management, restoration or creation would be a qualifying practice under "providing supplemental supplies of water" important to wildlife.

Wildlife and Habitat Management Plan

It is recommended by Texas Parks and Wildlife Department, Texas Agricultural Extension Service and the Comptroller's office that each county appraiser requires a wildlife and habitat management plan to review the context, extent and time dimensional aspects of selected practices, that is what is being planned to meet landowner objectives over seasons and years. The "plan" must address a separate practice in each of a minimum of three of the seven wildlife management categories that must be actively implemented.

Regional wildlife and habitat management plan practices for each of the 10 ecological regions have been developed and are intended to provide the landowner with as much information as required or desired. A comprehensive planning document is available for each ecological region from which landowners can formulate a wildlife management plan applicable to their property and meeting their particular needs. This has been developed to help landowners prepare a Wildlife and Habitat Management Plan that will help them realize their specific goals and objectives. The plan may be as simple or as extensive as the landowner chooses. The contents of the management planning document are not intended to overwhelm the landowner with information, nor should it discourage the landowner from formulating a plan of his or her own, but to provide a reference and check list on most of the subjects of interest.

The wildlife management plan is a planning process that helps landowners identify and document historic and current land use practices. It records the landowner's goals and objectives for the property (also family goals if desired) and aids in charting a course of action regarding the property. It records a set of activities and practices to integrate wildlife and habitat enhancement. This is the landowner's plan, designed by the landowner. Assistance or review of the plan by a wildlife biologist is available from Texas Parks and Wildlife Department, Texas Agricultural Extension Service, USDA Natural Resource Conservation Service, Texas Forest Service, or other qualified wildlife biologist. Efforts to perform activities identified in the plan are completely voluntary on the part of the landowner, except those practices that are necessary to maintain the agricultural appraisal for wildlife management use. A complete plan will likely include elements of all seven listed wildlife management activity categories.

Landowners of smaller properties that cannot by themselves meet "intensity requirements" for wildlife management use may choose to become active members of a wildlife management association ("a wildlife co-op"). They may qualify by actively working under a wildlife cooperative management plan and by participating in key practices outlined in the association's management plan.

To meet the requirements of the wildlife management tax exemption, a landowner must annually implement and complete <u>at least one management practice</u> from at <u>least three of the seven wildlife management activities</u> (i.e., Habitat Control, Erosion Control, Predator Control, Providing Supplemental Supplies of Water, Providing Supplemental Supplies of Food, Providing Shelter, and Making Census Counts to Determine Population). A complete plan will likely include more than three practices. Space is provided throughout the planning document for the land manager to design and designate the management practices that will be implemented.

General Habitat Management Considerations

Fundamental requirements which must be considered when managing wildlife habitats include food, cover, water and the proper distribution of these elements. Wildlife and habitat management planning and practices must be directed at maintaining a productive and healthy ecosystem. The ecosystem consists of the plant and animal communities found in an area along with soil, air, water and sunlight. All management activities should be aimed at conserving and improving the quantity and quality of soils, water and vegetation.

Managing for plant diversity is essential. A diverse habitat site will have a good mixture of various species of grasses, forbs and browse plants. Many of these plants will be at various stages of growth, which adds another element of diversity. A diversity of vegetation increases availability of food and cover for wildlife species. A greater diversity of range plants results in more food being made available during different periods of the year. The volume and diversity of plants protect the soil from erosion. Also, the decomposition of vegetation helps restore needed minerals to the soil to sustain plant life. An abundance of vegetation improves the water cycle by trapping water from rains, thereby preventing excessive runoff which leads to the erosion of soils and flooding of streams.

An ecologically based habitat management program will increase the complexity of the rangeland plant community. A greater diversity of all forms of life, including microorganisms, insects, reptiles, amphibians, birds and mammals will be achieved under a sound management scheme. The long term health of the land is improved and conserved for future generations to utilize as a source of income, recreation and for aesthetic enjoyment.

Well-managed rangelands in excellent range condition are often the most diverse in terms of plant diversity. The climax herbaceous vegetation community of most rangelands may be dominated by a few species of perennial grasses with a low percentage of forbs. While this may be suitable for livestock and for a few species of "grassland" wildlife, many wildlife species are more dependent on the seeds and foliage of forbs (commonly called "weeds") than on the grasses. Communities with a diverse array of "weedy" plant species with tall bunch grasses are more productive than a plant community dominated only by perennial grasses. Periodic disturbances such as fire, soil disturbance, livestock grazing, and mowing can set back plant succession and maintain a diverse plant community, simulating conditions under which plants and animals evolved within ecosystems in Texas. Well-managed native landscapes provide the optimum food conditions for wildlife.

Supplemental Feeding

Providing supplemental supplies of food is one of the activities designated by the legislature to qualify agricultural land for "wildlife management use." In developing applicable practices for providing supplemental food, the committee of biologists divided the activity into two categories of practices: (1) providing supplemental forage by manipulating vegetation of the native habitat to increase quantity, quality and plant diversity, and (2) providing additional forage or food by planting food plots, or by feeding a processed feed.

<u>Grazing Management</u> - Grazing management is the planned manipulation of the numbers of livestock and grazing

intensities to increase food, cover, or improve structure in the habitat of selected species (Refer to *Appendix A-Livestock Recommendations*, in the comprehensive wildlife planning document for information to help prepare a specific grazing plan). A grazing management plan includes the following items: (1) kind and class of livestock grazed, (2) determination and adjustment of stocking rates, (3) implementation of a grazing system that provides planned periodic rest for pastures by controlling grazing intensity and duration, and (4) excluding livestock from sensitive areas to prevent trampling, allow for vegetative recovery, or eliminate competition for food and cover.

Elements to consider might include some of the following: Planned deferments which can be short or long term up to 2 years. Extended rest from grazing (two years or more, if necessary) may be required on some ranges. Seasonal stocker operations may be appropriate to manipulate habitats. Supplemental livestock water may be needed (earthen tanks, troughs, wells, piping) to facilitate deferred-rotation grazing of livestock. Similarly, it is important to design fence construction to facilitate deferred-rotation grazing of livestock. Fencing can also be used to enhance or protect sensitive areas, woodlands, wetlands, riparian areas and spring sites as designated in the plan. Activities should be reviewed annually.

SUMMARY

The wildlife management tax valuation has broad support across the political spectrum, and can provide land managers the flexibility to adjust priorities in management to include wildlife considerations without jeopardizing their current agricultural valuation status. Supplemental feeding is just one of seven activities which landowners can select to meet qualifications for wildlife management use.

For illustration the following procedures which relate specifically to providing food were extracted from regional guidelines for Wildlife Management Activities and Practices. These are to aid a landowner in developing a wildlife management plan.

(1) Select the type of grazing system to be implemented. Also attach an initial grazing schedule as an addendum to the plan.

[ ] 1 Herd / 2 Pasture
[ ] 1 Herd / 3 Pasture
[ ] 1 Herd / 4 Pasture
[ ] 1 Herd / multiple pasture
[ ] multiple herd / multiple pasture
[ ] High intensity/low frequency (HILF)
[ ] Short duration system
[ ] 4 pasture/3 herd rotation
[ ] Other type of grazing system (describe): ____________________

[ ] Planned Deferment (describe; e.g., number of years livestock will be deferred from the property, etc.):

____

(2) Number of acres that will be grazed:

____

(3) Identify the livestock to be stocked, by number of head/by class and type/by number of animal units (refer to *Appendix A* for animal unit equivalents):

Class/Type	Number of Head	Number of Animal Units
[ ] Cattle; cows with or without unweaned calf	____________	______________
[ ] Cattle; weaned calves up 1 year old	____________	______________
[ ] Cattle; stocker steers or heifers, 1-2 years old	____________	______________
[ ] Cattle; bulls	____________	______________
[ ] Sheep	____________	______________
[ ] Goats	____________	______________
[ ] Horses	____________	______________
[ ] Other	____________	______________
Total animal units =		______________

Calculate the stocking rate of all livestock combined (number of acres to be grazed divided by the total animal units = acres per animal unit): __________

acres per animal unit.

(4) Additional cross-fences to be constructed to facilitate a deferred-rotation grazing system. Show the fence location(s) on a map.
[Fence Construction:]
- [ ] Barbed
- [ ] Electric
- [ ] Net
- [ ] Length_________
- [ ] Number of strands_________

(5) Additional water sources to be constructed to facilitate a deferred-rotation grazing system. Briefly describe and show on a map:

---

(6) Specific areas (e.g. spring sites, riparian areas, woodlots, sensitive habitats) will be protected from livestock grazing by fencing or other means. Briefly describe and show on a map:

Prescribed Burning - Prescribed burning is the planned application of fire to enhance habitat and plant diversity, increase food and cover, or improve structure in the habitat of selected species (Refer to Appendix B - Vegetation Management Recommendations, for information to help prepare a specific burning proposal for the plan). Plans should indicate a minimum percent of acreage and general burning cycle **(for example, a minimum of 15 percent of an area should be burned annually in the Cross Timbers and Edwards Plateau, which equates to a 7 year burning cycle where each acre prescribe for burning is burned at least once every 7 years)**. Attach a written burning plan as an addendum to the Wildlife and Habitat Management Plan (burn plans and prescribed burning should only be attempted with aid of professionals). The plan should include a map that shows the areas to be burned and the planned dates (month and year) that each area will be burned during the burning cycle. It should also designate areas to be protected from burning, and should incorporate flexibility during periods/ years when conditions are not favorable.

Planned acreage to be burned__________
Date to be burned_________
Completed acreage burned__________
Date burned__________

Specific areas (e.g.. sensitive sites) to be protected from burning. Briefly describe and show on a map:

Range Enhancement (Range Re-Seeding) - Establish native herbaceous plants (grasses and forbs) that provide food and cover for wildlife or erosion control benefits. Plant species selected and methods for establishment should be applicable to the county (non-native species are generally not recommended, but if required for a specific purpose, non-native species should not exceed approximately 25 percent of the seeding mix). Seeding mixtures providing maximum native plant diversity are recommended. Many herbaceous broadleaf plants (known as forbs - weeds and wildflowers) are beneficial to wildlife for forage and/or seed production. Encourage "weed and wildflower" species by selective application of chemical, biological (e.g.. grazing management) and/or mechanical means on native rangelands, Conservation Reserve Program lands, and improved grass pastures (e.g.. coastal bermuda). Some periodic weed control may be needed in fields converted to native rangeland to assist in the establishment of desirable vegetation. This practice must be a part of an overall habitat management plan and designed to reestablish native habitats within a specified time frame. **For example, may require a range reseeding annually affect a minimum of 10% of the total area designated in the plan, or a minimum of 10 acres annually, whichever is smaller, until the project is completed.** Show the designated areas where Range Enhancement is to be implemented on a map.

Total acres to be seeded__________

Approximate acres to be seeded annually _________

Planned seeding mixture (list names and percentage of total seed mix):

Seeding Method:

[ ] Broadcast
[ ] Drilled
[ ] Native Hay

Fertilized to encourage establishment?

[ ] yes [ ] no

If yes, what kind and application rate__________

Weed control needed for establishment?

[ ] yes [ ] no

<u>Food Plots</u> - The establishment of locally adapted annual (spring and fall) or perennial forages on suitable soils to provide supplemental foods and cover during critical periods of the year. Livestock should be generally excluded from small food plots. **For example, the shape, size, location, and percentage of total land area should be based on requirements for the target species (e.g., 2-5% of area for white-tailed deer) and should meet goals of a comprehensive wildlife plan.**

Managing the habitat for proper nutrition should be the primary management goal. Supplemental feeding and/or planting of food plots are not a substitute for good management. These practices should only be considered as "supplements" to the native habitat, not as "cure-alls" for low quality and/or poorly managed habitats. Consult with the NRCS, TAEX, TPWD, and local seed dealers for food plot mixtures suitable for your area. Plant according to dealer recommendations with proper equipment.}

<u>Proposed Food Plots Project(s)</u> and show on a map as applicable:

Size(s)_________
Fenced:
[ ] yes
[ ] no

Plantings:
[ ] cool season annual crops, i.e. wheat, rye, clovers, etc.
[ ] warm season annual crops, i.e. sorghums, millets, etc.
[ ] annual mix of native plants
[ ] perennial mix of native plants

Irrigated:
[ ] yes
[ ] no

Feeders and Mineral Supplementation - Dispensing supplemental foods from artificial devices to meet the needs of selected wildlife species year-round or during approved critical periods of the year. Attractants for hunting do not apply since this is used for selective harvest to control excessive numbers of deer and/or exotic ungulates under Habitat Control. Protein content of pelletized feed should be analyzed to confirm dealer claims and should be between 16-20% (note that corn is only 6% crude protein and insufficient by itself as a supplemental feed). Aflatoxin levels in grains should be confirmed and not exceed 20 ppb. Mineral supplementation may be supplied by other means than from artificial devices (poured on ground, blocks, etc.) in addition to feeding, but may not by itself meet the requirements of the practice. This practice must be a part of an overall habitat management plan that addresses all animal units and attempts to approach carrying capacity. **For example, a minimum of one free-choice feeder per 160 acres required to qualify.**

Proposed Feeders and Mineral Supplementation Project(s):

Purpose:
[ ] supplementation
[ ] harvesting of wildlife

Targeted wildlife species_________
Feed type_________
Mineral type_________
Feeder type__________ Number of feeders ________
Method of mineral dispensing__________ Number of mineral locations ___
Year round
[ ] yes
[ ] no, if not, when practiced_________

Managing Improved Pasture, Old Fields and Croplands - This practice may include: overseeding or planting cool season and/or warm season legumes and/or small grains in pastures or rangeland in order to provide a supplemental food for wildlife, using plant materials and establishment methods applicable to the county; periodic disturbance of the ground through shallow tillage (discing) that encourages habitat diversity, the production of native grasses and forbs for supplemental foods, or increases bare ground feeding habitat for selected species; no till/minimum till/Minimum Till agricultural practices that leave waste grain and stubble on the soil surface until the next planting season to provide supplemental food or cover for wildlife, controls erosion control, and improves soil tilth. Many broadleaf plants (forbs - weeds and wildflowers) are beneficial to wildlife for forage and/or seed production. Encourage "weed and wildflower" species by selective application of chemical, biological (e.g.. grazing management) and/or mechanical means on native rangelands and improved grass pastures. **For example, a minimum of 5 percent of the designated area must be treated annually to qualify.**

Briefly describe the proposed Managing Improved Pasture, Old Fields and Croplands project(s) and show on a map:____

Transition Management of Improved Grass Monocultures - Annually overseed improved grass pastures with locally adapted legumes (e.g.. clovers, vetches, peas) to increase the plant diversity, provide supplemental wildlife foods, and gradually convert the tame pastures to native vegetation as per wildlife and habitat plan. Legumes should be planted annually until all pastures are established to native vegetation. **For example, a minimum of 25 percent of the designated area must be treated annually to qualify**.

Briefly describe the proposed Transition Management of Improved Grass Monocultures project(s) and show on a map:____

FORAGE USE BY WHITE-TAILED DEER: INFLUENCE OF SUPPLEMENTAL FEEDING

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Abstract: During periods of nutritional stress, landowners and sportsmen often offer supplemental feed to white-tailed deer (*Odocoileus virginianus*) with the goal of helping animals to maintain adequate nutrition. More recently, the goals of supplemental feeding deer have shifted to maintaining higher densities, increasing herd productivity, and/or increasing the number of large-bodied animals with trophy-class antlers. However, supplementation also may destabilize the relationship between deer populations and their food supply. We report results from a study examining the effects of supplementation on diet selection patterns and review ecological mechanisms affecting animal foraging responses to food supply. When a high-quality supplement was provided ad libitum, deer responded by moving more while foraging and by feeding more selectively on native forages. Supplemented deer consumed a greater proportion of plants containing high concentrations of crude protein (CP) and digestible energy (DE). Our results suggest that supplementation may be disruptive to normal behavioral processes affecting the distribution of free-ranging deer on the landscape. These processes may be important in reducing the probability of deer over-utilizing the more palatable, rare forage species.

In temperate environments, periods of nutritional stress for white-tailed deer occur during severe winters or during drought conditions when forage resources are poor in quality or in short supply. During these times, landowners and sportsmen often offer supplemental feed to deer with the goal of helping animals to maintain adequate nutrition (Baker and Hobbs 1985, Holechek et al. 1989). Although expensive, landowners that supplementally feed desire to maintain relatively high deer densities, increase herd productivity (i.e., better fawn crop), and/or to increase the number of "quality (i.e., large-bodied animals with trophy-class antlers) deer". Most landowners recognize that achieving this goal may require a more intensive approach to vegetation management to insure the best possible habitat conditions for deer.

A potential hazard of supplementation is that it may cause a destabilization in the feedback mechanism regulating a deer population and its food supply. In many areas food supply is the habitat factor that ultimately limits deer herd productivity and rate of increase. However, the supplementation of natural forages can strongly influence seasonal distribution patterns and alter animal behavior from what would be expected if deer were dependent only on native forages (Baker and Hobbs 1985). Such alterations can cause other impacts that can have long-lasting negative effects on range vegetation and deer herd productivity. Supplemental feeding may cause animals to concentrate around feeding locations and result in localized overuse of desirable forage species (Murden 1993). Concentrating animals also increases the likelihood of disease transmission (Cook 1984), and increased internal and external parasite loads (Downing 1980, Matschke et al. 1984). In the absence of supplementation, animals would be less likely to concentrate their foraging activities and would be more prone to move to other areas as forage resources were depleted. Thus, understanding mechanisms regulating deer dispersion and productivity is the key to understanding the long-term impacts to deer populations and to forage resources.

In this paper we review ecological mechanisms affecting animal foraging responses to food supply and describe results from a study examining the effects of supplementation on diet selection patterns by white-tailed deer. Our primary objective in this study was to determine if supplementation with a high-quality ration would result in changes to the pattern of use of important forage species.

METHODS

This study was conducted at the Texas Agricultural Experiment Station 45 km southeast of Sonora, Texas (30^0N, 100^0W) during the fall of 1990. Vegetation in this area, a semi-arid oak woodland savanna, is typical of the Edwards Plateau Ecological Region (Hatch et al. 1990). Plant species occurring on the study area have been described by Huston et al. (1981). Rainfall at the station averages 580 mm annually with peaks in May and September.

In our experiments, we randomly assigned 4 hand-reared white-tailed deer to 4 temporary 144-m^2 enclosures constructed of 2. lm-high nylon fencing (Tensar "Polygrid RF", Tensar Corp., Morrow, GA). Enclosures provided control of study conditions and facilitated observation of animal feeding. Hand-reared animals were used to minimize potential biases created by enclosures and human observers. To insure deer were experienced with native forage species, they were raised on-site and had considerable experience with native forages. Prior to trials, deer were housed in separate 0.4 ha enclosures where they were maintained on native vegetation, a pelleted ration, and alfalfa hay.

During phase one of the feeding trial (days 1 - 7), deer were allowed to forage on native vegetation (i.e., no supplemental feeds were provided) while patterns of diet selection and feeding behavior were observed. On day 8, all individuals were moved to 4 adjacent 144-m^2 enclosures and provided ad libitum access to a high-quality pelleted ration (16% CP and 3.82 kcal/g DE), and diet selection patterns observed for an additional 7 days.

Observations totaling 60 min of continuous foraging activity were used to determine feeding patterns and foraging effort of each deer during each trial phase. Diets selected (number of bites by species) were recorded using a portable cassette recorder. Bite sizes (g) were estimated by hand-plucking forage samples representing consumed plants and plant parts (Baker and Hobbs 1982). Diet richness was estimated as the number of plant species in the diet. Movement rates (m/min) of foraging animals were determined by counting steps during 5-

min intervals and multiplying by an average step length (m) determined independently for each animal by measuring the distance traversed during a known number of steps.

Diet selectivity (%) was calculated by measuring the proportion of rare plant species in the diet as described by Hobbs et al. (1983). However, to permit detection of subtle changes in diet selection, we defined rare species as those forages contributing < 5% of the estimated standing crop (kg/ha) in enclosures. For individual deer, diet comparisons were limited to plant species common to pairs of enclosures in both trial phases. To facilitate analysis of changes in use of native vegetation in response to supplementation, the portions of the diets contributed by the pelleted ration were omitted.

Prior to the feeding trials, vegetation in each enclosure was sampled by clipping 10 randomly distributed 0.0625-m^2 plots to determine species composition, relative availability (kg/m^2), and nutritive quality. Standing crop (kg/m^2) was estimated on a species and plant part basis and separated into live and dead categories. Forage samples were oven-dried at 50^0 C for 48 h, weighed, and ground through a Wiley mill with a l-mm screen. Prior to chemical analysis, samples were homogenized using a Cyclotec 1093 mill (Tecator, Hoganas, Sweden) with a l-mm screen to obtain a uniform particle size. Concentrations of CP (% nitrogen X 6.25) in forage samples were determined using micro-Kjeldahl techniques (Horwitz 1980). Gross energy (GE, kcal/g) in forages was determined by bomb calorimetry. In vitro digestible organic matter (IVDOM, %) was determined according to Goering and Van Soest (1970) as modified by Huston et al. (1981) using rumen inocula from a fistulated steer fed alfalfa hay. An index of forage DE content (kcal/g) was calculated as the product of IVDOM and GE.

Kolmogorov-Smirnov two-sample tests (Sokal and Rohlf 198 1) were used to test for homogeneity between distributions of CP and DE concentrations contained in native plants in the diets of supplemented and non-supplemented deer. A two-factor analysis of variance (ANOVA) with repeated measures (Sokal and Rohlf 198 1) was used to assess differences in foraging effort and diet selectivity between supplemented and non-supplemented deer.

RESULTS

During the supplementation phase of the experiment, deer continued to utilize native forages (30% of ingested dry matter) despite having free access to the high-quality pelleted ration. Total dry matter intake (native forages + supplement) during 60-min observation periods increased 8%. The average number of plant species in the diet (diet richness) did not differ between supplemented and non-supplemented trial phases (Table 1). However, significant changes occurred in the relative composition of deer diets as a result of supplementation ($P < 0.001$). When a high quality supplement was provided, deer increased their use of rare forages (i.e., prickly ash, scullcap, copperleaf, velvetleaf bundleflower, mat euphorbia, spreading sida) and consumed proportionately less of species common in the environment (Fig. 1). Although average selectivity (i.e. use of rare forages) increased 17% in response to supplementation (Table 1), selectivity did not differ significantly between trial phases (P = 0.96). Average movement rates of foraging deer increased with supplementation, but differences between trial phases were not significant (P = 0.5 l, Table 1). composition, and associated shifts in the nutritional characteristics of diet components, average concentrations of CP and DE in the diet (native forages only) did not change significantly as a result of supplementation (Table 2). However, when the contributions of the pelleted ration are included with those of native forages, average CP and DE concentrations in the diet increased significantly for deer (P < 0.05).

Table 1. Foraging behaviors of supplemented and non-supplemented (control) white-tailed deer in response to a high-quality pelleted ration. (From Murden and Risenhoover 1993).

	Control		Supplemented	
	n	$\bar{X} \pm 1$SE	*n*	$\bar{X} \pm 1$SE
Movement rates (m/min)	4	3.8 ± 1.1	2	5.1 ± 1.8
Diet selectivity (%)[a]	4	75.0 ± 17.0	2	92.0 ± 6.0
Diet richness[b]	4	12.0 ± 2.7	2	11.5 ± 0.5

[a] The proportion of rare plants (<5% of the standing crop) in the diet.
[b] Diet richness is defined as the number of plant species in the diet.

Changes in diet composition during supplementation also produced significant shifts (P < 0.005) in the distributions of nutrients (from native forages only) consumed by deer (Fig. 2, 3). Deer consumed greater amounts of forages containing CP concentrations in the 8-10 and 16-18% ranges, and DE in the 1.5-l .7 and 2.5-3.0 kcal/g ranges (P < 0.005). Despite changes in diet

DISCUSSION

When native forages were supplemented with a high-quality pelleted ration, deer responded by moving more while foraging and by feeding more selectively. Supplemented deer increased their use of high-quality rare forages (i.e., prickly ash, scullcap, copperleaf, velvetleaf bundleflower, mat euphorbia,

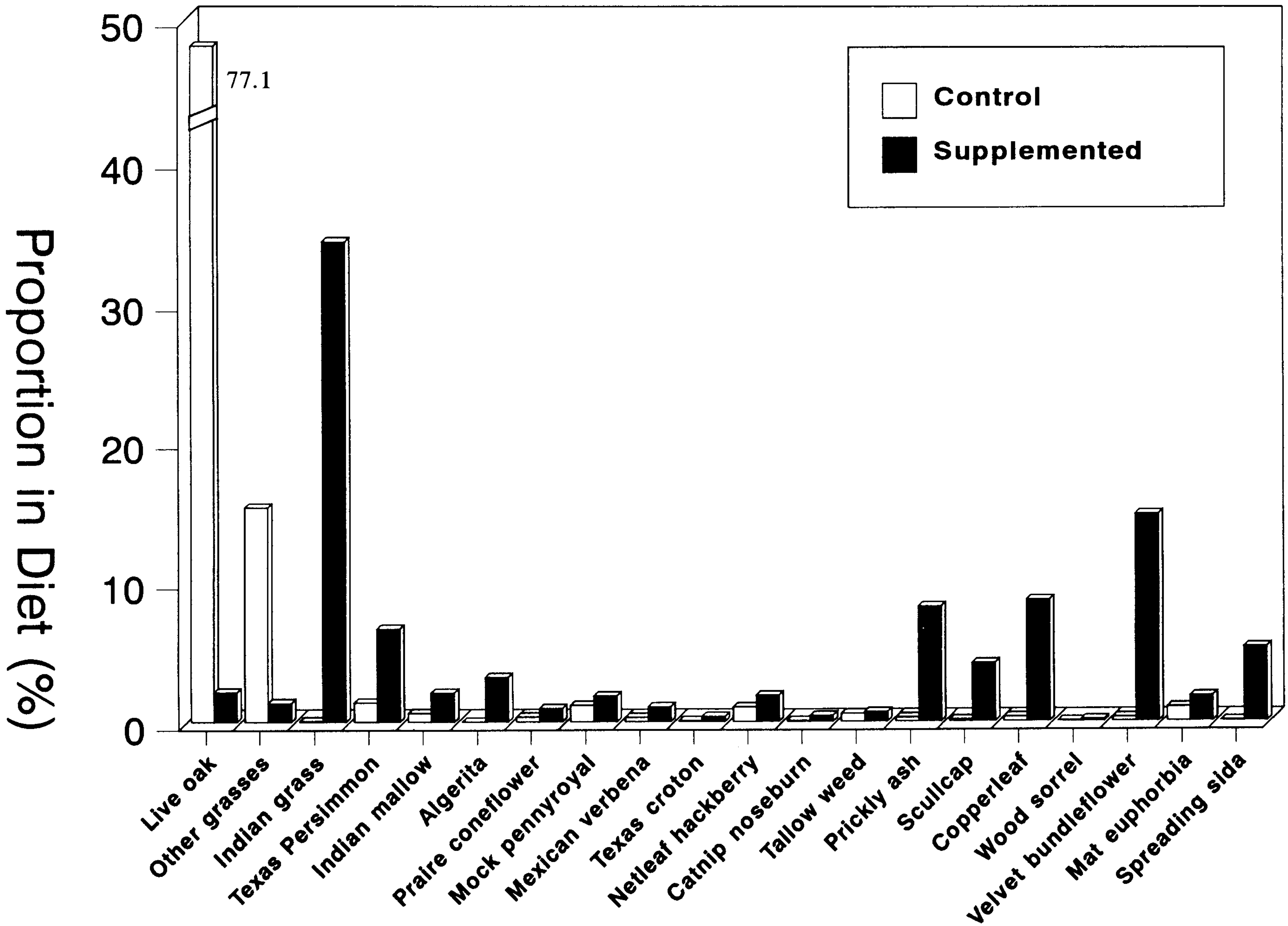


Fig. 1. Shifts in the relative composition of white-tailed deer diets in response to supplementation. Forage species are ranked in descending order according to their availability (kg/ha) in trial enclosures. (From Murden and Risenhoover 1993).

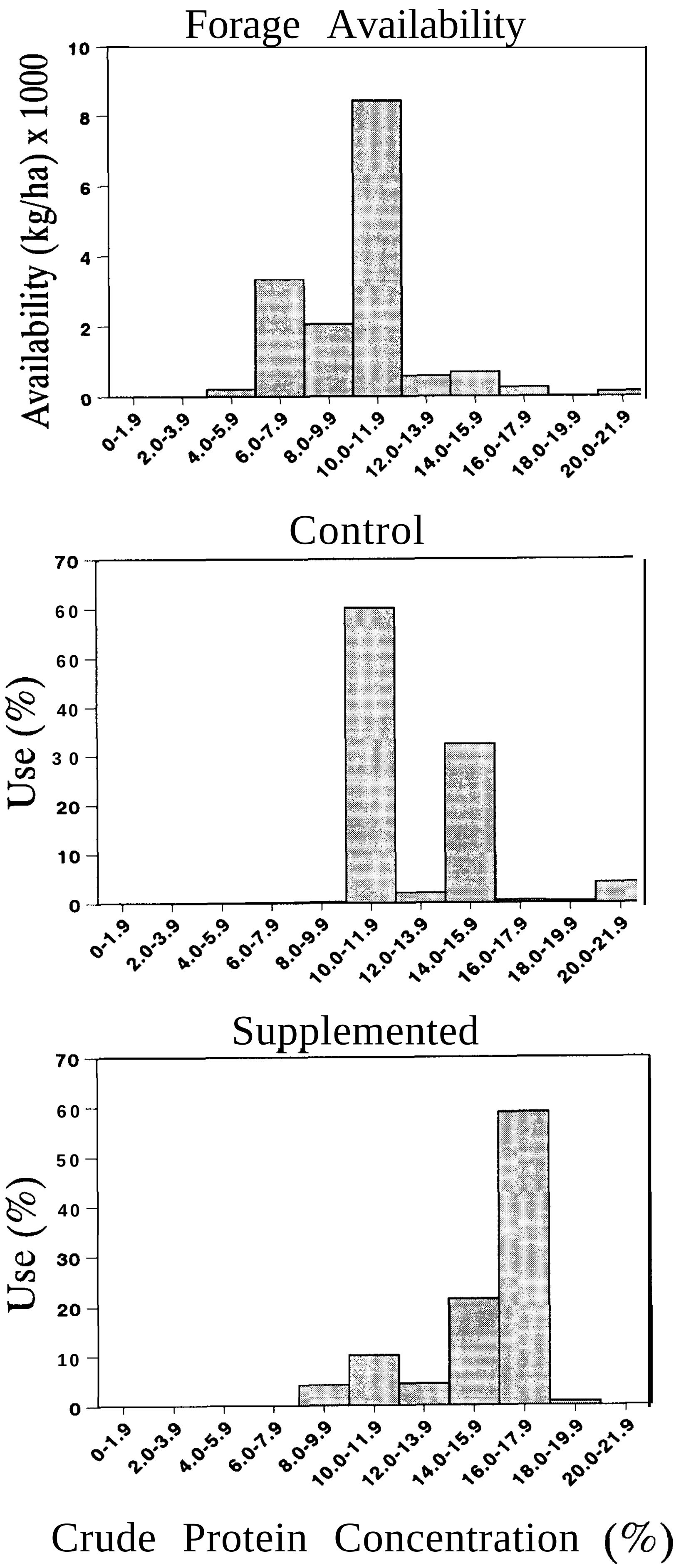


Fig. 2. Distributions of crude protein (%) concentrations in forages available and consumed by supplemented and non-supplemented white-tailed deer. (From Murden and Risenhoover 1993).

spreading sida), and as a result, average diet quality increased.

Deer responded to supplementation by increasing their use of rare, high quality forages. Although the number of forage species in the diet remained relatively unchanged, the overall contributions of rare forages to deer diets increased significantly following supplementation (Fig. 1). Apparently, the availability of the pelleted supplement altered the "constraint assumptions" affecting forage selection (Stephens and Krebs 1986). By consuming pellets, animals obtained a larger portion of their nutritional needs in a shorter period due to the high quality of the pelleted ration (DE and CP) and reductions in the time required for food-searching (the pelleted ration was offered ad libitum at one location in each enclosure). Thus, consumption of the high-quality pelleted ration may have reduced time constraints and their influence on diet selection, and allowed animals to invest more time selecting each gram of forage ingested. If time constraints on search time resulted in animals including less desirable food items in the diet, we anticipated that the relaxation of this constraint would permit animals to forage more efficiently (i.e. increase nutrient capture rates). Conversely, if diet selection was not limited by search time constraints, we predicted diet composition would not be affected by the removal of time constraints. The observed responses of deer to supplementation (i.e. increased mobility, increased selectivity, and dietary shifts) support the hypothesis that time constraints were affecting diet selection and diet quality.

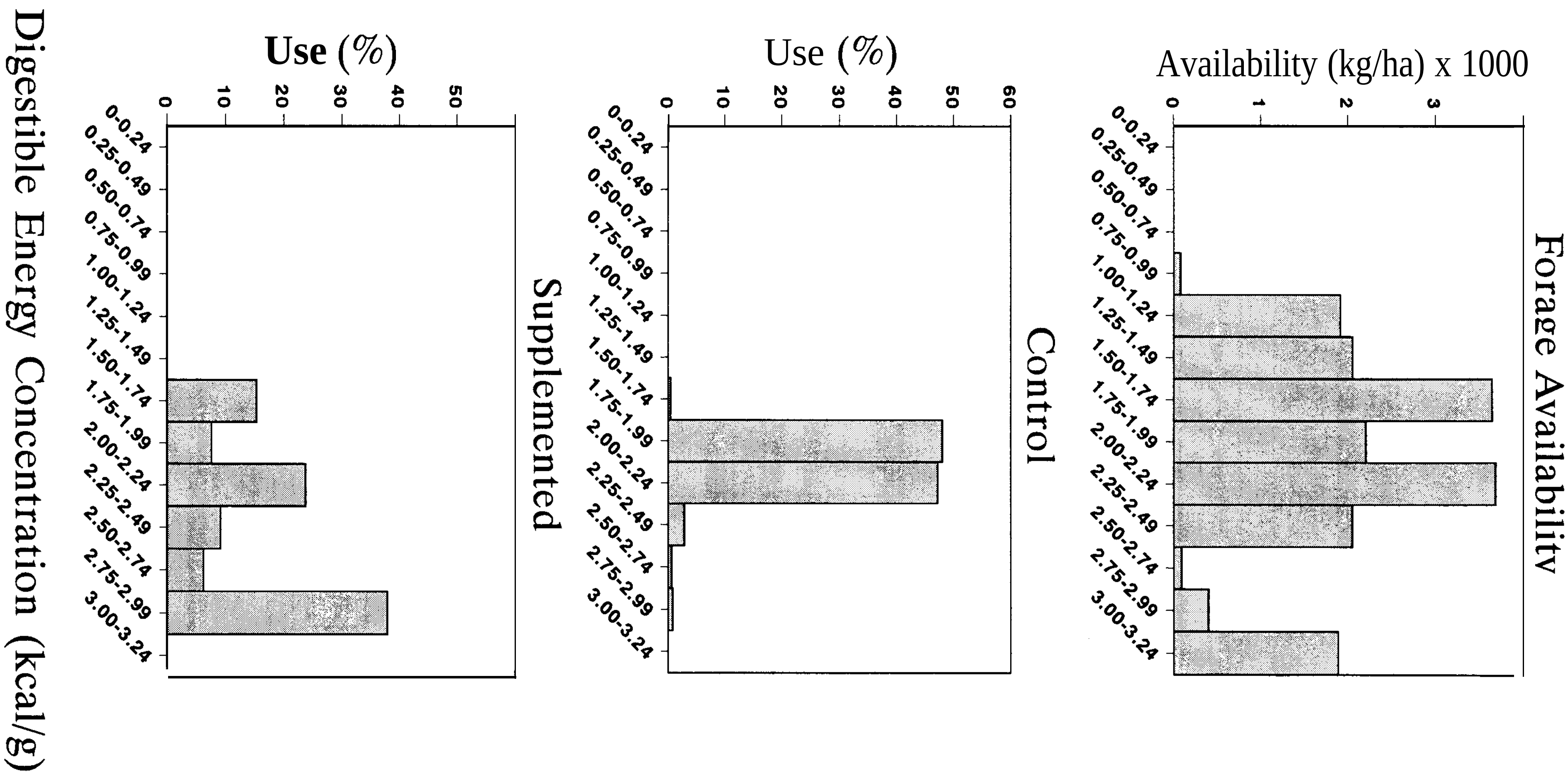
Given the high quality of the pelleted ration, it remains unclear why

Table 2. Diet quality of supplemented and non-supplemented (control) white-tailed deer. Values represent crude protein and digestible energy of natural forages only. (From Murden and Risenhoover 1993).

	Crude Protein (%)				Digestible Energy (kcal/g)			
	Control		Supplemented		Control		Supplemented	
	n	$\bar{X} \pm 1$SE	*n*	$\bar{X} \pm 1$SE	*n*	$\bar{X} \pm 1$SE	*n*	$\bar{X} \pm 1$SE
Available	4	7.9 ± 0.5	2	7.7 ± 0.4	4	1.9 ± 0.2	2	2.1 ± 0.1
Consumed	4	10.6 ± 0.8	2	14.9 ± 0.4	4	2.1 ± 0.1	2	2.1 ± 0.1

[a] Digestible energy was calculated as the product of in vitro digestible organic matter (%) and gross energy (kcal).

Fig. 3. Distributions of digestible energy (kcal/g) concentrations in forages available and consumed by supplemented and non-supplemented white-tailed deer. (From Murden and Risenhoover 1993).



deer continued to utilize native forages. The concentration of DE in the pelleted ration (3.82 kcals/g) far exceeded the highest concentration found in native forages (best species, 3.24 kcals/g). One possible explanation is that during the time period of this study deer forage selection was influenced more by the concentration of CP in plants. If this hypothesis is true, deer should have consumed only native forages containing CP concentrations $\geq$ 16%. The distributions of CP in native forages consumed (Fig. 2) indicated that the diets of deer contained forages with lower concentrations of CP. It is possible that, during the supplementation phase of the experiment, deer use of native forages was not related to forage quality due to the ad libitum availability of the pelleted ration. The nutritional qualities of this ration far exceed those required by white-tailed deer (Verme and Ullrey 1984). This apparent paradox has been reported previously by others examining the influence of supplemental feeding on ungulate diet selection (Verme and Ullrey 1984, Schmitz 1990).

Our results suggest supplementation may be disruptive to normal behavioral processes that reduce overgrazing of rangeland resources by wild and domestic herbivores. Under free-ranging conditions, animals normally disperse from habitats where forage resources have become depleted (Arnold and Dudzinski 1967). Supplementation may disrupt this process by allowing animals to continue to concentrate in areas where resources have been heavily utilized. When supplemented, animals can avoid low-quality forages and selectively consume remaining palatable plant species. The longer the period of supplementation, the greater the likelihood of excessive utilization of preferred plants. Extended grazing pressure may lead to the loss of palatable plant species and eventually to simplification of vegetative communities (Holechek et al. 1989, Briske and Heitschmidt 199 1).

Short- and long-term responses of animal populations to supplemental feeding are largely unknown (Boutin 1990). The supplemental feeding of deer may alter their patterns of dispersion on the landscape and may lead to the development of distinctly different plant communities (reviewed by Crawley 1983). These changes may affect the distribution of other animal species on the landscape, and eventually, impact ecosystem processes such as energy flow and nutrient cycling (Briske and Heitshmidt 1991).

Advocates, supporting the use of supplements, argue that the availability of a high-quality ration reduces animal dependence on native forages during times of nutritional stress (Vallentine 1990). Their basic premise is that animals will prefer to consume the supplement, thereby reducing grazing impacts on native plants. In our study, deer continued to utilize native forages (30% of ingested dry matter) when provided ad libitum access to a high-quality pelleted ration. Thus, our results do not support this hypothesis.

Changes in deer feeding behavior due to supplementation were variable and statistical significance was not detected for all variables. Our inability to reject null hypotheses (i.e. no significant change due to supplementation) was mostly a function of variation in individual behavior. Additional studies using larger sample sizes across a range of habitat quality are needed to delineate animal dietary responses to supplementation. Likewise, more research is needed to determine the effects of supplementation on animal use of forages and dispersion, and its effects on other wildlife species and plant communities.

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AFLATOXINS AND DISEASE CONCERN

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The impact of diseases associated with the use of supplemental feeding programs for deer or any wildlife species is a complicated interaction. This complex relationship of feeding and disease has several components. Both negative and positive aspects of feeding exist. The primary objective of this presentation is to identify and briefly discuss the major aspects of diseases as they relate to supplemental feeding of deer.

There are many ways to classify diseases such as by the causative agent (bacterial, viral, fungal, parasitic, etc.), by the host species (bovine, equine, human, etc.), and by the major target organ system (respiratory, gastrointestinal, etc.). For the topic of disease in relation to supplemental feeding; a disease classification by mode of transmission seems to be the most appropriate.

A brief classification of diseases by mode of transmission would include the following:

(1.) Directly transmitted - from one individual to another through close contact;

(2.) Indirectly transmitted - by inanimate objects, vectors (generally insects, parasites, or prey animals), or airborne.

As one can readily appreciate, anything that brings one individual in close proximity with other individuals, proportionally increases the probability of the transmission of a disease. This is not a novel concept. It has been well established that overcrowded conditions commonly facilitate the transmission of disease causing agents.

A disease agent, suitable host, and their environment are part of a complex interaction. The presence of a susceptible host and disease causing agent alone does not constitute infection or pathology. Before clinical manifestation of a disease can occur, the disease agent must be of sufficient virulence. The disease agent must enter the host. The disease agent must be in sufficient numbers or quantity, and the disease agent must be able to circumvent or overwhelm the numerous host defense mechanisms.

Supplemental feeding brings animals into closer contact, on more frequent intervals and over longer periods of time than commonly occur in more natural situations. This increases the chances of directly transmitted diseases such as brucellosis and tuberculosis. The elk on the federal and state feed grounds in Wyoming are heavily infected with brucellosis. The elk in other parts of Wyoming, Montana, and Idaho that are not associated with winter feed grounds do not have brucellosis.

In the last year, a free-ranging native white-tailed deer herd in a four-county area of Michigan was documented to have tuberculosis. The white-tailed deer on this area of Michigan have been historically baited by applications of apple pulp into concentrations in excess of 60 deer per acre during the winter.

Deer, and/or other animals concentrated around feeders, cause a buildup of feces in the immediate area. Fecal contamination of food placed or spilled on the ground, further facilitates the probability of the transmission of disease. This type of situation is an excellent opportunity for the transmission of parasitic diseases such as abomasal worms. High animal numbers around feeders also aid the transmission of diseases by vectors such as biting insects. Many viral diseases such as bluetongue, rickettsial diseases such as anaplasmosis, and parasitic diseases such as carotid artery worms are transmitted by biting insect vectors. Crowded conditions encourage even indirectly transmitted diseases.

Aflatoxins are a group of very potent toxins produced by fungi of the genus *Aspergillus*. Fungi commonly grow on grains or seeds such as peanuts, corn, and wheat after the grain has become moist and left to mold. However, aflatoxin can occur in corn and peanuts under field conditions due to drought stress of the plants. Numbers of migratory waterfowl die each year due to the ingestion of aflatoxin on moldy grain left in the field after the harvesting process. There has been much discussion about the possibility of losses of deer and other wildlife due to aflatoxicosis and supplemental feeds. By law, the limit of aflatoxin on feed or bait (primarily corn) delivered to wildlife must be less than 100 parts per billion. At this allowed level, there is very little risk of losses of white-tailed deer due to aflatoxin from feeders or broadcast food if the purchased supplemental feed is not subsequently allowed to become moist and moldy. Standing crops of grain such as corn or peanuts which are left in the field for wildlife would pose a much higher risk and most cases should be avoided. Since supplemental feeds are routinely delivered to large numbers of animals, any dangerous contaminant in such feeds has the possibility of also being delivered in large amounts to large numbers of animals.

There are also some positive aspects of supplemental feeding as it relates to disease. If the infrastructure for a supplemental feeding program is in place and the animals are routinely consuming the feed then there is also an opportunity to deliver trace minerals, vitamins, vaccines, "wormers," or other chemotherapeutic agents as needed. Anthrax vaccine is routinely delivered to white-tailed deer and exotics on supplemental feed in the southern Edwards Plateau (Peterson et al. 1993). Corn coated with triclabendezole and albendazole has been used along the Gulf Coast to effectively treat white-tailed deer with liver flukes (Qureshi et al. 1989, 1990). Oral rabies vaccines for raccoons, coyotes, and foxes are commonly delivered on food baits. Other vaccines suitable for oral delivery to wildlife are presently being evaluated.

Orally delivered contraceptives for wildlife are also being developed and evaluated.

The nutritional benefits of supplemental feeding programs may also have considerable positive effects on disease prevention and control. The immunologic system of the host can be compromised by stress such as that associated with malnutrition. Lowered host resistance increases the hosts susceptibility to invasion of disease causing organisms and decreases the ability of the host defenses to limit the spread of the infection. Proper and balanced levels of protein, carbohydrates, and other nutritional requirements available and delivered throughout the year in a feeding program is preferable to the dynamic and unpredictable source of nutrients often seen on the range.

There are a few things that can be done to minimize any disease associated problems with feeding programs. First, provide as many feeding sites as possible. This will decrease concentrations of animals and will decrease the chances for disease transmissions. Move the feeding sites periodically to minimize the buildup of feces surrounding the feeding sites and minimize the chances of exposure to fecal borne diseases. Do not feed on the ground. This will waste feed and dramatically increase the chances of disease. Provide appropriately balanced feed for the species, the geographic area, and the time of year. Remember that by feeding you are artificially increasing the carrying capacity of the area, and any reductions in the level of the supplemental feeding program must then be accompanied by a parallel reduction in animal numbers. Also by supplemental feeding, natural mortality may be decreased. Anything that allows increases in the animal numbers within an area will increase the probability of disease outbreaks, and increase the severity the disease losses, if it occurs.

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CONSIDERING THE ETHICS OF FEEDING WHITE-TAILED DEER

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Is there a need to explore the ethics of supplemental feeding of white-tailed deer in Texas? In some initial investigations into the various aspects of doing a survey of different interests groups in supplemental feeding of deer, we discovered a great deal of anxiety in doing these surveys. Because of these strong perceptions, we believe that there is need to examine these questions concerning supplemental feeding of wildlife, before it becomes an issue that may jeopardize hunting or wildlife management as we understand it to be in Texas.

The concepts of wildlife management that grew from land management principles in forestry and later in range management, did not include many of the animal science principles that are incorporated in wildlife management of the last decade. Some of these principles being incorporated into the concepts of today's wildlife management are genetic selection and breeding, disease treatment and prevention, and feeding and nutritional supplementation. The application of these areas of science to wildlife management is questioned by some of the public and professionals as they tend to blend an "ecological" approach with one of a "physiological" approach. The feeding of wildlife has many levels of application, from limited use as an attractant to confinement and intensive feeding.

Texas landowners' concepts of wildlife management have different value systems directed toward wildlife use and management. The leasing of land for access to wildlife for the purpose of hunting has a tenure in Texas, dating back to the 1920's. Therefore the value of white-tailed deer, to the landowner has caused an acceleration of the "physiological" approach to deer management.

There is strong desire by many landowners and hunters to grow or kill large white-tailed bucks. This desire has increased the value both economically and socially to these two groups. Deer can be feed nutritionally balanced, pelletized diet that will increase their body size by 40% and increase the antler growth by 20%. Landowners have the right to grow the best deer possible on their land, and are supplying a much desired resource for the deer hunting public. There is acceptance of this management by a portion of the hunting public.

Texas has the largest population of white-tailed deer in the United States, and the highest density of deer in certain ecological areas (i.e., Edwards Plateau, more particular the Llano Basin with densities reaching 1 deer per 2 acres). These high densities of white-tailed deer along with high stocking rates of domestic livestock have caused damage to the range resource. High deer densities also exist in other areas of Texas. A common deer management recommendation today is "reduce the deer herd by shooting does to a more reasonable carrying capacity." However, when this management is carried to its biological ideal, deer become very difficult to kill or even see. We have created the image to Texas hunters and the non resident whether from Pennsylvania or Louisiana that you will see a lot of deer when you hunt in Texas. This paradox of high deer densities, but wanting deer hunters to see or kill a lot of deer, can be bad ecologically but possible with supplemental feeding. If desired, landowners can sustain a higher carrying capacity for white-tailed deer by feeding the deer nutritionally adequate rations. At the same time they can reduce the demand on native range plants. This also will allow the producer to get a greater efficiency in production per acre of land. The quality of the "hunt" must be maintained in order for the experience to be one marketable to the expectations of the hunter. These management concepts then increase recreational products produced, increase quality of range conditions, and provide an ethically pleasing quality hunt.

Deer in Texas have their most critical time of food stress in August and September. These low rainfall patterns can and often do extend for months or even years in length of duration. During these periods supplemental feeding can maintain valuable deer stock that may die or produce very poor year classes of animals. Supplemental feeding of deer in these time periods has reduced the variability of deer growth potential, and year to year fluctuations in deer reproduction and survival. The care given by landowners to these deer stocks, is one of concern for their well being and survival. In fact in these cases the landowner has taken on the responsibility of taking care of the state's deer, which is often left to State Game and Fish Agencies as are the elk at Jackson Hole, Wyoming.

High fences to confine white-tailed deer is a rapidly growing phenomenon in Texas. The fences are used to control both deer and people. When fences are used to control people problems (i.e., neighbors harvesting too many bucks or not harvesting enough female deer), the magnitude of responsibility of deer management for the deer herd that is confined is often underestimated. The level of management that is required is significantly more intense. One alternative for management of the confined deer herd is to feed animals. Land owners that use high fences do have a greater degree of ethical responsibility to care for these animals that cannot escape. The use of fences is often necessary because of the use of supplementary feed, but the fences also bring added responsibility for the ethical treatment of the animal.

Feeding of white-tailed deer can reduce the foraging of native food plants. This level of management is a fine balancing act with population control, but can have a positive effect on the environment if used in balance. Therefore landowners incorporating these management techniques are exhibiting a positive land ethic.

White-tailed deer that are on a regular feeding program can be treated with medication, more easily than an unfed herd. The need for use of medicated feeds may prove useful in the case of anthrax, brucellosis, or tuberculosis. In these cases wildlife managers may exercise a higher degree of management for wildlife by having this flexibility than managers dealing with disease in our wild free roaming herds.

Feeding of wildlife for commercialization has been a common practice in Texas. Feeding of white-tailed deer for viewing or hunting is also a common and accepted practice in Texas. This is quite evident by the array of companies that sell deer feeders for almost any application. The question of ethics in hunting of a fed animal needs to be examined in the light of the goals of the landowner and the hunter. First if the hunter finds his gallery of non viewing peers accept this behavior then it would meet the criteria that Aldo Leopold set in ethical values for the hunter. The landowner's ethics in this area are more easily met, since they are trying to achieve the goal of providing a quality animal in a quality hunt. If the hunter is satisfied with the landowner's criteria for feeding, then the landowner is meeting his ethical responsibility. Why do we have this constantly changing societal value system in hunting? The life style of the hunting public has changed and their needs and desires have made hunting different from how hunters hunted in a more rural, less busy, society. Time has become the factor that dictates how long and how often one hunts. Attracting deer with feed to improve hunter success accomplishes the hunter's goal and the manager's goal, in providing recreation and selling the product. Landowners with intensive management programs will have to harvest an adequate number of deer in a restricted time period (set by the state). Feeding to attract deer to hunting sites is very effective in accomplishing the landowners harvest quota. If one questions the hunting ethics, then one must admit the landowner is exhibiting a responsible land ethic.

Inadvertently food is provided to many none target animals when deer are fed. There are many methods to minimize this effect of feeding, but much food is provided to these animals. If quality feed is used for these purposes then the effect on other populations can be beneficial. No detail studies have been done, other than to document the numerous presence of these animals at feeding stations. The wildlife manager that is engaged in feeding wildlife is then having a positive effect on many species of wildlife.

A national survey of all 50 State Game and Fish Agencies was taken to determine the legality of providing feed for white-tailed deer, mule deer, and elk. An individual in each of the 47 agencies that responded provided this information for their state. The following charts provide a summary of that survey.

Number of States (N=47) that expressed support for supplemental feeding by groups.

	Groups	Number of States
Supplemental Feeding	Hunters	38
	General (nonhunting) public	24
	landowners	35
	DNR Commission	16
	No one	6

Number of States (N=47) that expressed support for using supplemental feeding to attract game for hunting by groups.

	Groups	Number of States
Supplemental Feeding to Attract game for hunting	Hunters	25
	General (nonhunting) public	3
	landowners	21
	DNR Commission	9
	No one	16

The percentage of States that have White-tailed deer (N=43), Mule Deer (N=17), or Elk (N=19) that (1) allow feeding, (2) allow hunting over feed *(many exceptions to this law) or (3) allow growing of food for these species.

	Allow Feeding	Allow Hunting	Allow Growing
White-tailed deer (N=43)	**97.6 %**	**55.8 %**	100%
Mule deer (N-17)	**82.3 %**	**64.7 %**	100%
Elk (N=19)	**84.2 %**	**63.2 %**	100%

SUPPLEMENTAL FEEDING: OTHER CONSIDERATIONS

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The first thought that comes into my mind when I hear the phrase "supplemental feeding" is "deer-farming." Given my farming mind set and background, and knowing that supplemental feeding of game usually refers to white-tailed deer, several debatable issues about supplemental feeding emerge.

Supplemental feeding is part of a process that treats a wild game species like a form of domesticated livestock. There are serious legal considerations when, by virtue of investing time and money in supplemental feeding of white-tailed deer, a landowner takes mental possession of all or individual animals. In Texas, all game species are owned by the general public and no game species can be used for personal economic gain (e.g., lease pricing by the animal).

It is highly questionable whether landowners have the right or even the knowledge required to manipulate the natural selection process or population characteristics of a wild game species. As has been the case with livestock, human selection for marketable yet nonadaptive characteristics in white-tailed deer will decrease genetic diversity in the deer population's gene pool. It is doubtful that anyone knows the selective value of Boone and Crockett racks in white-tailed deer herds. On the population level, supplemental feeding has to artificially inflate the white-tailed deer carrying capacity of an area which, without human intervention, would support lower numbers. This leaves the landowner with the problem of determining how many deer and what sexes must be harvested. It would be interesting to know how different landowners come up with their deer harvest goals given the difficulty that trained wildlife biologists have with estimating and determining optimum deer numbers.

The above points need to be considered also in light of why landowners want to provide supplemental feed for white-tailed deer in the first place. Assume that the goal is to produce bigger deer with larger racks. This management objective needs to be explained in terms of the landowner's or the deer herd's need for a force-fed phenocopy of what nature might produce given an array of required but fortuitous natural habitat conditions. There may be a hunter market for big bucks with big antlers, i.e., trophy hunters. Past studies have shown that this market constitutes only 3 to 7% of the licensed hunting public. Lease hunting operations that rely on an expensive supplemental feeding strategy must be profitable with such a small market window. One needs to really force an image of "hunting" considering the scenario that might occur on an area where people come to SHOOT the trophy buck. The horrors of the 1970's CBS depiction of hunting in Texas, "Guns of Autumn," comes to mind.

If supplemental feeding dictates the nature of the hunt, what we are teaching our kids and society in general about hunting is difficult to defend. For example, supplemental feeding precludes the need to understand anything about the life habits of white-tailed deer. For some, hunting whitetails has become a Pavlovian, stimulus/response exercise. For example, of what value is it to teach the future hunting generation anything about tracking, scrapes, rubs, and other whitetail signs when kids know that if deer can be baited into a convenient spot (the stimulus) then all they need to do is pull the trigger (the response). Most youth hunts promulgate this image of hunting.

Any human manipulation of habitat characteristics will have its downside that may defeat the intent of the manipulation. For example, it is well known that supplemental feeding benefits nontarget as well target wildlife. Feral hogs are effective competitors for the expensive feed meant for whitetails. There is some evidence that whitetails will leave an area occupied by feral hogs. The type of disease that can be introduced into the white-tailed deer herd by nontarget species also needs to be considered.

If high fences come into the supplemental feeding equation, then the points made above become even more important to address. Furthermore, the landowner's management responsibilities toward the now caged wildlife increase enormously. Supplemental feeding behind high fences is not an option. It is a necessity. Wild animals have only three choices when faced with some form of environmental resistance: adapt, move, or die. High fences present an abrupt environmental change to species that are free-ranging and accustomed to unlimited access to all resources for survival. It becomes the responsibility of the landowner to provide any resources limited by the construction of a high fence and to carefully monitor total herd conditions. The lack of gene flow between deer herds behind high fences and other herds means that over time all the deer within the fence will be relatives of one another. Genetic diversity in wild game species has been the fail-safe mechanism that sustains each species through times of extreme environmental resistance. High fenced herds will lose this adaptive mechanism.

Again, one has to question the landowner's motives for constructing extremely expensive high fences and providing unlimited body-building feed for whitetails. The return on investments can only come from the one-third of the Texas white-tailed deer hunters who hunt on leased land. Yet, those that do hunt on leased land spend, on average, \$500 for the right of ingress. However, there are a few hunters that will pay tremendous amounts of money to have the opportunity to take a trophy white-tailed buck. Given the anticipated high lease cost to hunt trophy bucks on high fenced areas, there must be some level-of-success guarantees given to the hunter by the landowner. These guarantees effect how trophy hunts are conducted. Trophy bucks may be shot over bait or at locations where they are known to occur during certain times of day, e.g., waiting to be fed. Guides may drive hunters in open jeeps to areas where the guides have memorized the daily movement patterns of specific bucks thus giving the hunter a guaranteed shot at a trophy. How the trophy is taken, e.g., fair-chase or canned-hunt, is a sensitive ethical issue that needs to be debated by the hunting public. Finally, one must question whether the trophy buck taken is a real product of nature or a force-fed copy that should disqualify it from Boone and Crockett competition.

What is the first thought that comes to peoples' minds with the word WILD? For most it is DEER.

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