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Title: NUTRITIONAL ASPECTS OF ARTIFICIALLY FEEDING CAPTIVE AND WILD DEER

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Most of the nutritionally related difficulties of winter feeding deer apparently result from either poor acceptibility of artificial rations or digestive disturbances that result from feeding starved animals feeds to which they are not accustomed. Reported in this thesis are studies conducted with both captive and wild deer concerning acceptibility of artificial rations and on the affects of feeding various rations to starving deer.

The relative acceptibility of various physical forms of grains--pelleted, rolled, and whole--and of the common commercial concentrates was determined with captive black-tailed deer. When given a choice between the three forms, the deer markedly preferred the pelleted form in each of three separate trials with corn, barley and oats. The intake of the pelleted form comprised 79.6 percent, 77.9 percent, and 100 percent in the barley, corn and oat trials,

respectively. The rolled form was rejected in the oat trial and comprised 20.4 percent and 22.1 percent of the total intake in the barley and corn trials, respectively. The whole form was rejected in all three trials.

Nine common commercial concentrates were offered ad libitum, cafeteria style in various combinations, to the deer in a series of trials. Consumption rates indicated that corn, wheat and soybean meal were preferred by the deer with barley and oats being selected in limited amounts. Beet pulp, cottonseed meal, linseed meal, and peas were rejected by the deer if given a choice of more preferred feedstuffs, but, if not given a choice then they would consume limited amounts of these.

Two palatability studies were conducted whereby browse plants that were considered to be highly palatable to deer were fed in combination with a cereal grain considered to be of low palatability. The relative intake of the browse-grain mixture was compared to the intake of the grain alone. The browse-grain mixtures were mountain mahogany-oats and blackberry-barley. With one exception, there was uniform rejection of treatments containing browse. The deer were able to detect browse in the feedstuffs at levels of 1 percent browse. Two levels of blackberry leaves (1 and 5 percent) and 3 levels of mahogany (1, 5 and 10 percent) all resulted in marked rejection. One mule deer was used in the mahogany-oat trial and there is some indication that this deer may have preferred the mixture. All of the other data which were taken from black-tailed deer indicate that low levels of dried mountain mahogany and blackberry in oats and barley, respectively, will decrease intake.

The effects of abrupt dietary changes on mule deer and black-tailed deer, following periods of malnutrition were investigated. Four separate trials were conducted. These were, (1) changing five mule deer fawns from a browse diet to alfalfa ad libitum, (2) changing one mule deer from alfalfa to a complete concentrate ration ad libitum, (3) changing one mule deer from alfalfa to a green grass diet ad libitum, and (4) changing 18 black-tailed deer and two mule deer from grass hay to high protein diets. A total of three deer died after these dietary changes, but the ensuing necropsies did not reveal conclusive evidence that would indicate that any of the deer died as a result of the ration changes. Diarrhea was prevalent in the high protein ad libitum rations.

Mule deer were observed while using feeding stations in Eastern Oregon during a severe winter. Rumen contents were taken and body condition was determined by necropsy on 16 deer that died at the feeding site and from 11 live deer that were sacrificed and which had access to the feeders. The results indicated that all deer to die on the feeding site died of starvation. The ingesta from the deer had high acid detergent fiber and cellulose levels, both of which were significantly related to lowered *in vitro* dry matter digestibility of the rumen samples. There was a significant negative correlation between body condition and *in vitro* dry matter digestibility of the rumen contents.

Two herds of mule deer were artificially fed during a severe winter in Eastern Oregon. Two rations were fed to the deer without causing severe digestive upset, although one of the rations, containing 45 percent soybean meal, caused the deer to develop diarrhea for a brief period. Feed cost estimations indicated that it costs $0.07 and $0.11 per deer-day for the two rations fed during this study. It is suggested that creep feeders may offer a method of feeding fawns separate from adults which would make more economical use of the feed. A possible advantage of winter feeding is discussed.

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INTRODUCTION

Artificial feeding of big game animals is a subject about which most people interested in wildlife are quick to voice strong opinions on, yet it is a subject on which very little reliable information is available. Professional wildlife people have a history of being opposed to winter feeding of big game animals, while many non-professionals (but interested people) feel that feeding starving deer prevents much suffering. In the 1930's and 1940's a few publications, which seemed to be based more on emotion and causal observation than on scientific fact, appeared in the literature. These generally expressed the view that emergency winter feeding was impossible because of nutritional reasons and, as a result, many misconceptions evolved and still exist today. On the other hand, many sportsmen and aestheticians believe that winter feeding is the answer to alleviating winter starvation and they continue to apply pressure on game agencies to carry on feeding programs. Only recently have a few wildlife people taken a different view of winter feeding and realized that feeding programs can be a useful management tool in some situations.

In the 1960's the Oregon State Game Commission contracted the Animal Science Department at Oregon State University to research the nutritional aspects of winter feeding. The ultimate objective of the research was to formulate a ration that could be successfully fed to starving deer. The Commission did not want to get involved in feeding programs where they fed deer every year, but they felt that feeding deer in order to prevent massive die-offs would be desirable. This meant that an "emergency" winter ration would have to be formulated. Relatively little information was available on the digestive physiology of starving deer. This, together with the large degree of uncertainty present in the existing knowledge, demanded that some basic research be conducted on the digestive physiology of malnourished deer. There seemed to be two areas that needed to be researched. The first involved the palatability of artificial rations to wild deer and the other was the physiological response of starving deer to artificial feeds. The specific objectives of the research reported herein were (1) to determine which feed preparation (pelleted, rolled or whole) and which of the common concentrates are preferred by deer, (2) to determine if the addition of natural browse into an artificial ration would enhance its palatability, (3) to isolate the mechanism(s) causing deer deaths when refeeding after starvation, and (4) to utilize the information gained in the first three objectives and from the literature to formulate an emergency winter ration and evaluate it on wild deer.

REVIEW OF LITERATURE

The size and reproductive success of many big game herds are determined by the nutritional adequacy of the winter range. Nutrition directly affects such limiting factors as disease, parasitism, breeding, gestation, fawn survival after parturition and starvation. The effects that altering nutrient availability by winter feeding may have on these limiting factors should be reviewed as well as the nutritional aspects of ration formulation. Therefore, this literature review covers a broad scope of nutritionally related subjects, all of which are important considerations in understanding and employing successful feeding programs.

Nutritional Requirements of Deer

Considerable information is available on the nutritional requirements of deer, although much less is known about the nutrition of wild ruminants than is known about domestic species. Dry matter (DM) intake by deer is basically the same as for other ruminants. Brown (1961) stated that captive black-tailed deer (Odocoileus hemionus Columbianus) consumed 2.85 lb of DM/100 lb of body weight. The Sitka black-tailed deer (O. h. Sitkensis) reportedly required 3.33 lb of DM/100 lb of body weight (Palmer 1944). White-tailed deer have been reported to consume between 2.5 and 4 pounds of DM/100 lb of body weight (French et al. 1956 and Lay 1969). Mule deer (Odocoileus hemionus) have been noted to consume between 2.35 and 2.5 lb DM/100 lb of body weight (Nichol 1938 and Smith 1950).

The energy requirements of deer have been documented in several instances. Cowan and workers (1969) reported that a mule deer fawn weighing 70 lb requires about 4000 Kcal of digestible energy per day to grow at a rate of 1.3 percent/day. Work with white-tailed deer (O. virginianus) have shown that a 100 lb deer requires 6300 Kcal of gross energy each day (French et al. 1956). Short (1969) reported that the gross energy requirements of white-tailed yearling bucks was 5000 to 6000 Kcal/day during the spring, summer and fall and 3500 to 4000 Kcal/day during the late fall and winter. Other work with white-tailed deer showed the digestible energy (DE) requirements during the winter months to be 160 Kcal DE/kg $BW^{0.75}$ (Ullrey et al. 1969). The energy requirements for fasting deer was reportedly lower during the winter months than for the summer months with white-tailed deer (Silver et al. 1969). These workers reported the fasting metabolic rate of deer during the summer months to be 52.2 Kcal/kg/day and 33.8 Kcal/kg/day during the winter months. Other work by Silver and workers (1971) stated that deer could adapt physiologically to compensate for seasonal changes in environmental temperature so that energy needs are relatively independent of temperature. Work with black-tailed deer indicated that female fawns consumed 193.3 $Kcal/kg^{0.8}$ of

DE and that buck fawns consumed 118.7 Kcal/kg$^{0.97}$ of DE (Nordan, Cowan and Wood 1970).

The level of dietary protein has been shown to affect productivity, survival and condition of deer (Murphy and Coates 1966). They reported that white-tailed deer required at least 11 percent crude protein. McEwen et al. (1957) reported that fawns fed a ration of 4-5 percent protein were very stunted and barely able to survive. Ullrey et al. (1967) found that white-tailed fawns required 12.7 percent (does) and 20.2 percent (bucks) crude protein for optimum growth. Short (1969) and French et al. (1956) discussed the importance of adequate protein in the diet of white-tailed deer.

Information on mineral requirements of deer is limited. The best available information is that on domestic animals (see Church et al. 1971). Available information on deer indicates that at least 0.45 percent Ca and 0.35 percent P are necessary in the diet for maximum gain, bone-strength and antler growth for growing deer (Church 1972). Other work indicates that deer do not require more than 55 ppm of Zn and 0.3 percent S.

Winter feeding of deer, especially with high protein feeds, could alter the water requirements of deer. Nevada workers showed that sheep could withstand high protein diets when snow was the only source of water (Weeth et al. 1959). Longhurst et al. (1970) reported that deer had a larger body pool of water than did sheep. Work with mule deer indicated that water consumption was 140 gm/kg/$BW^{3/4}$ (Knox *et al*. 1969). Elder (1954) reported that mule deer consumed 7.1 quarts of water per day during the summer in Arizona.

Affects of Nutrition on Antler Growth

The most obvious benefit of winter feeding deer is the prevention of starvation. Often overlooked is the possibility of improved antler quality. Research with captive animals has shown nutrition to be very important in antler growth (French *et al*. 1956; Short 1969 and Cowan and Long 1962). Other work with white-tailed deer has shown that 17 percent protein, 0.64 percent Ca and 0.56 percent P are needed for maximum antler growth (McEwan *et al*. 1957). Studies have shown that body growth takes precedence over antler growth (French *et al*. 1956). This implies that bucks coming out of the winter in very poor condition may not grow large antlers since antler growth is greatest in the spring, at which time the deer's body would channel nutrients to repairing body tissues rather than to antler growth.

Affects of Nutrition on Reproduction

Nutrition has been known for many years to affect the reproductive success of animals. Wiltbank (1968) reported that phosphorus and energy deficiencies are capable of preventing domestic animals from breeding successfully. Verme (1963, 1967 and 1969) have conducted considerable research on the effects of winter nutrition on fawn production. His work has shown that malnourished does produce fawns 46 percent lighter than fawns from properly fed does. In one study nearly one-half of the does on inadequate diets failed to exhibit estrus. A study comparing poor quality and high quality diets showed that yearlings and prime-aged does produced 0.62 and 1.36 fawns/doe, respectively, on the low quality diets and 1.63 and 1.80 fawns/doe on the high quality diets. Verme also presented data indicating that spring, summer and fall nutrition may be very important to fawn production. This was also shown with mule deer where the ovulation rate of does on depeleted summer ranges was 1.31 ova/doe and was 1.95 ova/doe in deer from good summer ranges (Julander et al. 1961). Dietary protein has been shown to affect reproduction in deer. Murphy and Coates (1966) stated that does on protein diets of 7 to 11 percent of their ration lost 25 percent of their fawns. Verme (1965) stated that poor nutrition during the winter months, even with adequate spring nutrition, could result in fawn losses as high as 35 percent. Murphy and Coates also stated that post-parturition fawn survival was reduced when the does were fed diets low in protein. Hines (1970) reported that severe winter weather may affect fawn production in black-tailed deer, especially 2-year-old does. Work with white-tailed deer in Michigan showed that acute food shortages during the winter months did not affect the nutritive value of the does milk nor adversely affect the newborn fawns (Youatt et al. 1965). Nutrition has also been shown to affect breeding. Verme (1965) stated that inadequate nutrition prevents mating of white-tailed deer. Other work has indicated that improper nutrition may lower the breeding ability of bucks (Follmann and Klimstra 1969 and Wood, Cowan and Nordan 1962).

Factors Affecting Rumen Volatile Fatty Acid Levels in Deer

Ruminant animals receive approximately 60 percent of their energy from volatile fatty acids (VFA) (Church 1969). Extended periods of starvation will result in marked declines in rumen bacteria (Church 1969). which results in less VFA production. It would seem that during winter periods the VFA content in the rumen would be an indication of the value of diet. Information on VFA levels in starved deer is lacking, although considerable data are available concerning healthy deer. VFA concentrations in wild mule deer ranged between 93 and 125 mM/l (Nagy et al. 1967). Other work with mule deer showed that the season of the year had a significant effect on the proportions of the various VFA's (Short et al. 1966). Acetic acid was highest in the winter and early spring (68.34 molar percent) and lowest in the late spring and summer (62.59 molar percent). Propionic acid varied inversely, being 20.30 and 21.59 molar percent, respectively, during these seasons. Short et al. (1969) reported that white-tailed deer consuming a diet high in acorns had a lower molar percent (59.2) of acetic acid than did deer consuming a diet high in roughage (73.0). Propionic acid varied inversely, being 21.5 for the acorn diet and 16.3 for the roughage diet. The total VFA concentration did not vary significantly between the diets, being 10.8 and 10.7 meq/100 ml, respectively. Ullrey et al. (1971) showed that white-tailed deer on cedar-aspen diets had total VFA levels much lower than deer on artificial feeds, varying between 12 and 20 μM/ml for the browse and between 38 and 48 μM/ml for the artificial feeds. Short (1971) showed that the total VFA levels in white-tailed deer varied between a high (13.0 meq/100 ml) in July to a low (7.6 meq/100 ml) in February.

Energy Budget

The energy budget of deer, especially during the winter, is one of the most important but least understood aspects of the nutritional physiology of deer. It is known that captive deer voluntarily consume less feed and lose weight during the early winter months (Crawford 1968 and Bandy et al. 1970). This phenomena probably occurs with wild deer, but the magnitude of this reduction in feed consumption has on the energy budget of the deer remains to be determined.

Data concerning metabolism during the winter are generally lacking, especially with mule deer. Failure to maintain homothermy probably results in most of the deaths in winter-killed deer. Church (1967) reported that the level of nutrition is very important in determining the lower critical temperature; also that the amount of adipose fat affects heat losses during cold periods. Nagy *et al.* (1969) presented data showing that deer have less potential for fat storage (5.54 percent of body weight) than do domestic sheep (31.6 percent of body weight), thus making deer relatively more dependent on highly nutritious feeds during winter months. Moen (1968a) reported that white-tailed deer with access to corn, soybeans and sweet clover herbage could retain a positive energy balance in open fields with temperatures below -18°C. Deer without access to such nutritious feed would have to seek cover in order to maintain a positive energy balance. He points out that cover only reduces the heat loss but sufficient food must be available for basal metabolism and activity. Verme (1968) reported that captive white-tailed deer exposed to subzero temperatures and howling winds would lose 16-20 percent of their body weights in spite of *ad libitum* feeding. Other data with white-tailed deer show that the deer will often seek cover instead of food during extreme cold periods (Ozoga and Verme 1970 and Ozoga and Gysel 1972). Moen (1968a) states that cedar cover is much more valuable in conserving heat than open fields or hardwood stands. Other work by Moen (1968b) shows the importance of body size in maintaining a thermal balance. This work demonstrates that smaller deer suffer much more from thermal stresses. For example, a 30 kg deer, on full feed in an open field with a temperature of -30°C cannot maintain a positive thermal balance if the wind is 4 mph. The wind must reach a speed of 11-12 mph before a 70 kg deer enters a negative thermal stance. If these deer had been eating a maintenance level of food, the respective wind speeds necessary for putting the animal in a negative energy balance would be 2 and 6 mph. The importance of winter nutrition and energy reserve levels can possibly be expressed in fawn survival, especially if inadequate spring forage does not allow the doe to recover from a stressful winter. Slee (1971) reported that lambs born from adequately fed ewes had 250 Kcal of energy reserves per kg of body weight while lambs from poorly fed ewes contained about one-half this amount. This may prove to be very important in the survival of fawns if differences of this magnitude exist in deer as well as sheep.

Seasonal Patterns in Feed Consumption and Body Weight

It has been known for several years that captive deer will lose weight during the winter in spite of the amount of feed available. The weight loss is a result of a depressed appetite that occurs during the winter months. McEwen *et al.* (1957) found the daily feed intake of white-tailed deer declined from a high of 6 pounds in October to a low of 3 pounds in March. Black-tailed deer have been reported to experience a bi-phasic pattern in the reduction of food intake (Bandy *et al.* 1970). The first and most drastic reduction in intake occurs during the rut. Bucks may consume little or no feed at all for extended periods. This is followed by a period of restricted, but somewhat greater intake, which lasts into December. Feed intake with captive black-tailed deer is greatest during July, August and September (Crawford 1968). These patterns of intake result in definite periods of weight losses and gains. Captive fawns gain weight at a near linear rate from birth until December, at which time growth is arrested although they do not lose weight (Nordan et al. 1969). Numerous papers have shown that adult deer lose weight during the winter months (McEwen et al 1957; Crawford, 1968; Hoffman and Robinson, 1966; Bandy et al. 1970 and Silver et al. 1969). These papers show that the low point in body weight may occur from December to March with the maximum in body weight occurring in August, September or October. Black-tailed deer have been reported to lose between 7.6 and 35 percent of their body weight during the winter (Crawford 1968 and Brown 1961). Hoffman and Robinson (1966) reported that juvenile white-tailed deer lost 7 to 10 kg in body weight and adults lost 10 to 15 kg during the winter months. Other studies with white-tailed deer have shown that weight losses vary between 11 and 30 percent of body weight (Cowan and Long 1962 and Silver et al. 1969). Smith (1959) reported on the adequacy of some forage plants in sustaining body weight of captive mule deer during the winter. All deer on the study lost weight, varying from 6 percent on a diet of juniper, oak and sagebrush, to 19 percent for a ration of only sagebrush. It seems possible that the adequacy of the various feedstuffs might be confounded with the expected weight losses of deer during the winter.

Value of Artificial Feeds Fed to Deer

Information on the adequacy of various artificial feedstuffs in providing nutrition to wild deer is lacking. Some research has been conducted with captive deer on a few artificial feeds. Dahlberg (1948) reported that unlimited alfalfa (2.73 lb/100 lb of body weight) would sustain white-tailed deer for 90 days with a weight loss of 4.3 percent. A diet of 1.7 lb of alfalfa and 0.9 lb of concentrate maintained deer for 68 days with a weight loss of 2.1 percent. Unlimited alfalfa and 0.5 lb of corn were also successful in preventing large weight losses during the winter months. Diets with large amounts of barley resulted in diarrhea and large weight losses, although a ration of 1.00 lb of barley to 1.27 lb of alfalfa was adequate in preventing weight loss. Colorado workers fed good quality alfalfa, poor quality alfalfa and native hay to mule deer for 21 days. These deer lost 3.2, 6.8 and 7.9 percent of their body weights, respectively (Nagy et al. 1969). Davenport (1939) reported that alfalfa hay and clover hay were adequate in maintaining body weights of white-tailed deer for 90 days when fed alone or in combination with cracked corn or cottonseed meal. Timothy hay was unable to maintain the deer when fed alone. Maynard et al. (1935) reported that white-tailed deer could maintain their body weights on good quality alfalfa. Other work with white-tailed deer showed that the volatile fatty acid content in the rumen fluid provided 105 Kcal/3000 ml from a diet of alfalfa and concentrate. Diets of aspen and white cedar provided 48.1 and 65.6 Kcal/3000 ml., respectively (Short 1963). Ullrey et al. (1971) reported that the addition of urea and/or starch to large toothed aspen (*Populus grandidentata*) or white cedar (*Thuja occidentalis*) diets increased the digestibility of various nutrients in the diets. Work with captive mule deer in Colorado showed that alfalfa hay could maintain body weights (Dietz et al. 1962). The alfalfa used in the trial had a DM digestibility of 51.7 percent. Smith (1956) reported alfalfa digestion coefficients of 76.9, 16.9 and 59.3 for protein, ether extract and cellulose, respectively, from trials with captive mule deer.

Acceptability of Various Feedstuffs

The acceptability of artificial rations is a very important part of feeding programs. Literature referring to artificial feeding of starving deer does not often make reference to acceptability problems. However, personnel of the Oregon State Game Commission have observed black-tailed deer to die in presence of artificial feed as the deer refused the supplemental feed (W. W. Hines 1972, personal communication). There is some evidence in the literature indicating that mule deer, which are not starving, may not readily accept artificial feeds (Doman and Rasmussen 1944). Feeding deer that are not starving may be a problem. Feeding mule deer to divert use from private property and to reduce damage has resulted in variable success (M. Kemp 1972, personal communication). The paucity of information on factors affecting intake of foodstuffs may necessitate more research in this area if "non-starving" deer are to be fed successfully.

Workers in California have shown that olfaction senses are the first used by deer when investigating a strange feed (Longhurst et al. 1968). Should the smell be favorable to the deer, the animal will taste the food. This sequence is followed until the deer learns to recognize the food by sight. It is well known that deer select the most nutritious parts of plants to eat. Recent evidence indicates that domestic ruminants do not always have the ability to select a complete diet (Gordon 1970). Wild ruminants are still given credit for having the ability to select a diet that fulfills their nutritional requirements (Lay 1969), although no research has been designed to specifically study this supposed ability.

In recent years, some information has become available on taste preferences of deer that may aid feeding deer strange foodstuffs. Crawford and Church (1971) stated that black-tailed deer preferred sweet tastes and showed varied responses to sour and salty tastes. Bucks preferred bitter tastes, while does rejected bitter. Rice (1972) stated that black-tailed deer showed preferences for extracts of Douglas fir (Pseudotsuga menziesii), western hemlock (Tsuga heterophylla), cascara (Rhamnus purshiana), and bitterbrush (Purshia tridentata). Banana oil, when used as an attractant on artificial feeds during a feeding study with mule deer, did not improve the acceptability of the ration being fed (Opp 1968).

The acceptability of a ration depends, in part, on the kinds of feedstuffs used and on the physical form of the feed presented to the animals. The literature and correspondence with State Game Departments in the western states indicated that a variety of rations and forms have been offered to deer under field and captive conditions. Very little information is available concerning deer preference for the physical forms of feeds. Doman and Rasmussen (1944) stated that chopped alfalfa was of low palatability to mule deer. Rolled barley was selected in preference over other feedstuffs, one of which was a pelleted ration. Whole oats were not readily consumed. Game personnel have successfully fed wild deer pelleted concentrate rations (Moreland 1970). Cubed feeds, pelleted feeds, and long hay have been offered to deer in Oregon, pelleted feeds have been given to deer in California, and pelleted feeds plus oat bundles have been fed to deer in South Dakota. Pelleted rations are commonly fed to captive deer (Verme 1969 and Wood et al. 1961). Although deer have consumed pelleted feeds without obvious difficulties, it is not known if deer prefer this form, especially if given an opportunity to select among other forms. Many studies with domestic livestock where various physical forms of feed have been compared have shown pelleting to improve the palatability of many feeds. For example, Wright et al. (1963) reported that pelleted roughage was more readily consumed by lambs than was finely ground roughage. Wallace and Hubbert (1959) demonstrated that Hereford steers preferred pelleted meadow hay over coarsely chopped meadow hay, and Gardner and Akers (1955) found that dairy calves consumed more hay per day when pelleted (2.28 lb) than when ground (1.36 lb), chopped (1.13 lb) or long (1.01 lb). However, Pope et al. (1959) stated that rolled grain was more palatable to beef cattle than pelleted grain. Although this information with domestic ruminants indicates that pelleted and rolled feeds might be palatable to wild ruminants, Goatcher et al. (1970) stated that considerable differences exist between species with respect to taste. This could be the case with black-tailed deer versus domestic livestock with respect to the physical form of feed.

Though not conducting preference studies as such, Doman and Rasmussen (1944) indicated that wild mule deer elicited preference of some feedstuffs over others. Their work showed cottonseed cake to be preferred over two complete concentrate rations, which were in turn preferred over dried beet pulp and beet molasses. Linseed meal was the least preferred. They observed that rolled barley was preferred over the following feedstuffs (listed in order of preference): alfalfa hay, apple pomace and sheep pellets. Pea silage was readily consumed by the deer, while whole oats and dried beet pulp were considered not highly palatable.

The ingredients used in deer rations vary and the common concentrates that have been used in formulating some of the deer rations in the Western part of the U. S. A. and Canada are presented in Table 1. Corn, barley, wheat, wheat bran, oats, milo, and beet pulp have been used primarily as energy sources in these rations. Cottonseed meal, linseed meal, and soybean meal are commonly used as protein sources.

Digestive Disturbances of Deer Eating Artificial Feedstuffs

Although much has been said and written about artificial feeding of big game animals, very little is actually known about the digestive physiology of starving deer. It appears that much of the available information is based on emotion and casual observation, often with very little scientific basis. This demands that a certain amount of caution be used in applying much of the literature to other situations.

It is not uncommon to find dead deer at feeding stations and/or from herds being artificially fed, and the reported causes of deaths are varied. Taylor (1956) stated that wild deer die from impacted digestive organs when fed highly nutritious feed. Dasmann (1971) said

Table 1. Concentrate feedstuffs that are commonly used in deer rations in Western U. S. A. and Canada.

Ingredient	Location								
	British Columbia[a]	Colorado[b]	Colorado[b]	Oregon[c,h]	Oregon[d]	Utah[e,h]	Utah[e,h]	Washington[f,h]	Washington[g]
Barley		X		X		X	X	X	X
Beet pulp	X							X	
Bran	X	X	X	X			X	X	
Corn	X	X	X		X	X	X	X	
Cottonseed meal					X	X	X	X	
Linseed meal			X				X		
Milo		X							
Oats			X	X	X	X			X
Soybean meal	X			X	X			X	X
Wheat	X			X	X	X			

[a]Wood _et al_. 1961.

[b]Swope, H. M. 1970, personal communication.

[c]Lightfoot, W. C. 1971, personal communication.

[d]Church, D. C. 1970, unpublished data.

[e]Doman and Rasmussen 1944.

[f]Moreland, R. 1970, personal communication.

[g]Brown 1961.

[h]Indicates rations fed to wild deer.

that starving deer may come to feeders, over eat, and die of bloat. High protein sheep pellets have been reported to kill hungry deer (Anonymous 1964). Spring vegetation which is high in protein has reportedly killed many deer (Bissel and Strong 1955 and Dietz et al. 1962). Carhart (1943 and 1945) made some bold statements when he said that something was lacking in artificial feeds that was essential to deer and that such feeds are incapable of sustaining a deer's life. Mace (1957) reported that starving deer are unable to withstand the stress of abrupt ration changes. Murie (1951) also reported that deer would die on diets on which elk were thriving. Alfalfa hay is commonly cited as being capable of killing deer (Carhart 1943). Longhurst and workers (1968) stated that deer developed severe digestive upset if fed alfalfa exclusively for 10 days.

Recently, information from controlled scientific experiments has appeared in the literature. As a result, some of the factors affecting the digestive physiology of deer are becoming apparent. The fiber content of the diet, especially as it affects the digestibility of the diet, appears to be very important to deer (Crawford 1969). Short (1963) showed that deer cannot digest cellulose and fiber as well as cattle and Short (1966) reported that the cellulose content of the diet may limit the digestible energy of both natural and artificial rations. Other work by Short and Reagor (1970) have shown lignin to lower the digestibility of the cell wall constituents. Work with mule deer in Utah has shown the digestibility of cellulose to be low (Smith *et al.* 1956 and Smith 1957). Nagy *et al.* (1971) have shown that poor quality alfalfa, high in fiber, was capable of killing captive mule deer. *In vitro* studies have shown that the cellulose content of forages greatly affects the microbial digestion (Short 1971 and Torgerson and Pfander 1971). Short (1969) showed that digestibility of woody twigs (leaves included) was 57 to 61 percent and after the leaves drop in the fall the digestibility declined to about 41 percent. Torgerson and Pfander (1971) showed that the cellulose digestion of winter foods was 12 percent, while that of summer foods was 51 percent. The above data indicate that the cellulose and lignin content is very important to the digestive efficiency of deer and may be a factor involved in the death of deer which sometimes die when consuming highly fibrous feeds.

The high essential oil content of some shrub and tree species could seemingly cause digestive problems to deer during winter months. The idea is that, during the winter months, deer could be forced or may voluntarily consume large quantities of plants high in essential oils, such as sagebrush and juniper. Essential oils have been shown to slow rumen fermentation and could conceivably reduce the VFA's available for energy to the deer (Nagy *et al.* 1964; Longhurst *et al.* 1968 and Oh *et al.* 1968). Although sagebrush has reportedly comprised 44 percent of the diet of mule deer during the winter (Humbird, 1970), Church (personal communication 1972) and

Nagy et al. (1964) indicate under most conditions that deer are unlikely to consume enough essential oils to adversely affect their digestive processes.

A common belief is that starving deer when suddenly offered feed will over eat and kill themselves. However, this idea did not originate from scientific research and work with both domestic animals (Church 1971 and Coop 1949) and mule deer (Nagy 1972, personal communication) indicates that starving ruminant animals are very unlikely to over eat.

Feeding Programs

Some observers have stated that winter feeding programs have no place in wildlife management (Carhart 1943). Others have suggested that more has to be learned about the problems associated with winter feeding and that feeding programs could be used as a big game management tool (Nagy 1969 and Hailey et al. 1966). Winter feeding programs have been conducted in many states at one time or another. The efforts made to save deer lives have varied from none in those programs that were conducted only to satisfy the public to programs where a genuine effort was made to save deer lives. The differences in effort put into feeding programs plus logistical and economical difficulties have resulted in tremendous variation in the success of the programs. The reports of unsuccessful attempts to feed big game animals are numerous (Lovaas 1970; Pearson 1969; Doman and Rasmussen 1944). Other people have reported successful feeding programs (Moreland 1969 and Anonymous 1944).

PART I
PREFERENCES STUDIES WITH CAPTIVE DEER

Methods

The research was conducted during the winter and spring of 1970 at Oregon State University. Three female and one male black-tailed deer were used in all trials. These deer were from a group of orphans that were accumulated during the summer of 1969 by the Oregon Game Commission. They were approximately 9 months of age at the beginning of the study and weighed between 60 and 80 lb. Initially, the deer were bottle-raised on water and milk and then gradually placed on a rolled commercial calf starter ration. They remained on the calf starter until January when they were moved to Oregon State University for use in experimental studies. The four deer were kept together in a 12 x 60 foot pen with a concrete floor which allowed access to a barn for protection from the weather. Water and trace mineralized salt were provided *ad libitum* at all times. One month prior to the trials the commercial calf starter ration was replaced by a complete concentrate pelleted ration plus alfalfa hay. The deer were vaccinated for types C and D enterotoxemia.

To ascertain deer preference for various physical forms of feedstuffs (pelleted, rolled, and whole), four self-feeders were placed in the pen. One feeder contained alfalfa pellets throughout the trial which supplemented the grain being fed. The three forms of a grain were placed separately in the other self-feeders. Each form was offered *ad libitum*, allowing free choice between the forms. The amount consumed was measured each day. The forms were rotated in the feeders at periodic intervals in order to remove any bias that might arise from the position in the feeders. Separate trials were conducted with corn, barley, and oats; one week was allotted between trials.

Relative acceptability of barley, beet pulp, corn, cottonseed meal, linseed meal, oats, peas, soybean meal, and wheat was determined. The feeds were offered individually in self-feeders, *ad libitum* cafeteria style, in various combination of two or three at a time until all of the feeds had been presented to the animals at least once. This involved four separate trials, each being five days in length. Alfalfa hay was offered *ad libitum* to the deer in all trials to provide roughage in the diet and also so that one feedstuff would be common to all trials, thus providing a measure of the total relative acceptability of all the feeds offered during any one trial. All feedstuffs were in pelleted form and the intake of each was measured daily. A fifth trial was conducted comprising of only those feedstuffs that had been rejected in the first four trials. This reduced the possibility of overlooking a feedstuff that may have been rejected because of the feeds offered with it in the original trials. All feedstuffs that seemed to be preferred during the first five trials were then offered to the deer. This final trial lasted 14 days.

All feedstuffs were prepared by the feed mill on the Oregon State University campus. The whole grain had only been cleaned. The rolled form was prepared by steam-rolling the grain. All of the pelleted feeds were prepared by grinding, adding three percent bentonite as a binder (except for alfalfa pellets), steaming it and then extruding it through 3/16-inch dies.

Results

The average daily intakes of pelleted, rolled, and whole barley are presented in Table 2. Duncan's new multiple-range test showed significant differences ($P < 0.01$) in the average daily consumption of all three forms of barley. Pelleted barley was markedly preferred over both rolled and whole barley. The average daily intake of pelleted barley was 1.44 lb/deer or 79.6 percent of the total grain intake. Rolled barley was consumed but comprised only 20.4 percent of the total intake of the grain. Average daily intake of rolled barley increased from 0.11 lb/deer during the first week to 0.63 lb/deer during the second week; this increase corresponded to a drop in the consumption of pelleted barley from 1.68 to 1.20 lb/deer. Whole barley was rejected throughout the 2-week trial. The average daily intake of alfalfa remained constant, being 0.44 lb for the first week and 0.49 lb during the second week.

Table 2. Average daily intake (lb/deer) of pelleted, rolled and whole forms of various grains when offered simultaneously to black-tailed deer.

Item	Daily Consumption[1]		
	First Week	Second Week	Mean
Trial I			
Barley			
Pellet	1.68 ± 0.47	1.20 ± 0.32	1.44[a]
Rolled	0.11 ± 0.09	0.63 ± 0.19	0.37[b]
Whole	0.00 ± 0.00	0.00 ± 0.00	0.00[c]
Alfalfa	0.44 ± 0.28	0.49 ± 0.19	0.46[2]
Total	2.23	2.32	2.27
Trial II			
Corn			
Pellet	1.70 ± 0.32	0.98 ± 0.42	1.34[a]
Rolled	0.08 ± 0.08	0.68 ± 0.17	0.38[b]
Whole	0.00 ± 0.00	0.00 ± 0.00	0.00[c]
Alfalfa	0.48 ± 0.17	0.35 ± 0.20	0.41[2]
Total	2.26	2.01	2.13
Trial III			
Oats			
Pellet	1.57 ± 0.30	1.69 ± 0.18	1.63[a]
Rolled	0.00 ± 0.00	0.00 ± 0.00	0.00[b]
Whole	0.00 ± 0.00	0.00 ± 0.00	0.00[b]
Alfalfa	0.40 ± 0.30	0.44 ± 0.16	0.42[2]
Total	1.90	2.13	2.05

1/ Mean ± the standard deviation.

a/, b/, c/ Means within a kind of grain that are followed by different superscript letters differ significantly ($P < 0.01$).

2/ Consumption of alfalfa not compared with the forms of grain.

Results of the corn trial were similar to that of the barley trial (Table 2). Duncan's new multiple-range test showed the intake of the three forms to be significantly different ($P < 0.01$). The average daily intake of the pelleted form was 1.34 lb/deer or 77.9 percent of the total grain consumed. Average daily consumption of the pelleted corn declined from 1.70 lb/deer during the first week to 0.98 lb/deer during the second week. The average daily intake per deer for the rolled form was 0.38 lb for the trial, increasing from 0.08 lb during the first week to 0.68 lb during the second week. The whole form of corn was rejected. The average daily consumption per deer of alfalfa was 0.48 lb during the first week, declining to 0.35 lb for the second week, with the overall being 0.41 lb.

Pelleted oats was the only form of oats eaten by the deer during this trial (Table 2). The average daily consumption per deer was 1.63 lb for the trial, being 1.57 lb during the first week and 1.69 lb during the second week. Both whole and rolled oats were rejected. The average daily intake per deer of alfalfa remained essentially the same, being 0.40 lb for the first week and 0.44 lb for the second week, with an overall average of 0.42 lb.

The results obtained showing the preferences of black-tailed deer for the various concentrates are shown in Table 3. In trial 1 the deer preferred soybean meal significantly ($P < 0.01$) over both beet pulp and linseed meal, the latter two being rejected. Wheat was

Table 3. Intake (lb/day/deer) by black-tailed deer of concentrate feeds when offered in various combinations.

	Daily Consumption[1]					
	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
Alfalfa[2]	.44 ± .20	.20 ± .10	.10 ± .02	.16 ± .10	.93 ± .02	.08 ± .05
Barley	--	--	.20 ± .02[a]	--	--	.26 ± .19[a]
Beet pulp	.00 ± .00[a]	--	--	--	.08 ± .03[a]	--
Corn	--	--	1.60 ± .45[b]	--	--	.71 ± .24[b]
Cottonseed meal	--	.00 ± .00[a]	--	--	.06 ± .05[a]	--
Linseed meal	.00 ± .00[b]	--	--	--	.24 ± .05[a]	--
Oats	--	--	0.32 ± .05[a]	2.62 ± .36[a]	--	.16 ± .25[c]
Peas	--	--	--	.00 ± .00[b]	--	--
Soybean meal	1.90 ± .25[b]	--	--	--	--	.94 ± .15[d]
Wheat	--	1.54 ± .74[b]	--	--	--	.83 ± .29[e]

[1] Mean ± the standard deviation.

[a], [b], [c], [d], [e] Means within a trial that are followed by different superscript letter differ significantly ($P < 0.01$).

[2] Consumption of alfalfa not compared with kinds of concentrates.

significantly preferred over cottonseed meal in trial 2, with the cottonseed meal being refused. In trial 3, barley, corn, and oats were all consumed to some degree but the average daily intake of the corn was significantly higher than that of the barley and oats, which were very similar. In trial 4, oats were significantly preferred over peas by the deer. The results of the first 4 trials showed barley, corn, oats, soybean meal, and wheat to be consumed at least to some degree and cottonseed meal, linseed meal, beet pulp, and peas to be rejected. Trial 5 was then conducted giving the deer no selection other than from those they had previously rejected, except for peas. In this trial, where the deer had no choice, they consumed slight amounts of the three feeds. However the consumption of alfalfa increased markedly from average daily consumptions of 0.44 lb, 0.20 lb, 0.16 lb and 0.10 lb for trials 1, 2, 3, and 4, respectively, to 0.93 lb for trial 5 indicating that these feedstuffs, as a group, were not as palatable as any of the other combinations. In trial 6 all of the feeds that had been eaten in the first 4 trials were offered to the deer, i.e., barley, corn, oats, soybean meal and wheat. Differences in the average daily intake were significant ($P < 0.01$) between all the feeds, but corn, wheat and soybean meal were markedly preferred over both the barley and oats. The average daily consumption of alfalfa was lower, 0.08 lb per deer, than in any of the previous five trials. The rate of alfalfa intake during the six trials was inversely related to the number of cereal grains offered with it.

Discussion

Reports indicate that deer have consumed artificial feeds in a variety of physical forms but environmental conditions and types of feeds differed among these accounts making comparisons between the forms difficult. The data obtained from these trials strongly indicate that pelleted grains are much more palatable to captive black-tailed deer than are rolled and whole grains. This is not surprising since most of the literature indicates that pelleted feeds are very palatable to livestock, especially selective feeders such as goats and sheep. Also, wild mule deer that were trapped and transported to Oregon State University, readily accepted pelleted alfalfa and pelleted concentrates. The initial response to an artificial ration by wild deer would be a critical factor with respect to acceptibility so the increasing preference by the deer for the rolled form during the later stages of the barley and corn trials is not considered to be of great significance. Grains offered in the whole form were rejected in all three trials. Prior to the trials, the deer were exposed to the pelleted and rolled forms and not the whole form. Although previous exposure to the pelleted and rolled forms may have affected the intakes, especially in the first trial, any preference for the whole form should have been elicited in the 6 weeks of trials if such a preference existed. Doman and Rasmussen (1944) indicated that whole oats were not highly palatable to mule deer when the deer were given a choice of other feeds. Also, Arnold (1970), working with grazing sheep, stated that experience will affect intake but the effects are normally small.

Since the pelleted form was readily accepted by the deer, this form was used to determine the relative palatability of the various concentrates. Differences between feedstuffs such as hardness of seed coat, seed size, and other similar factors would not be reflected in the acceptance of these feeds. Of the more common cereal grains or energy sources, the data indicated that corn and wheat are preferred by black-tailed deer over oats and barley, which were in turn preferred over beet pulp and peas. With respect to the type of protein supplement, the deer voluntarily consumed much more soybean meal than either linseed meal or cottonseed meal. Doman and Rasmussen (1944) indicated that cottonseed cake appeared to be more palatable to mule deer than either of two complete rations, each of which contained cereal grains or linseed meal. Their work with wild mule deer was done during winter conditions and it is difficult to determine if this response was a result of palatability or an expression, through selection, of a nutritional need (protein). Goatcher and Church (1969) stated that sheep commonly demonstrated self-selection for dietary components.

These results do not say anything about the palatability of these feedstuffs when two or more are combined as would likely be the case in formulating a ration for wild deer. The results also indicate that deer will consume small amounts of less palatable feedstuffs if forced to do so. These data and those of Doman and Rasmussen (1944) indicate that oats may not be highly palatable to black-tailed and mule deer, but South Dakota has reportedly had success in feeding bound oat bundles to deer (Peterson, personal communication).

Artificially feeding wild deer concentrated feeds has been successfully done in Washington (Mooreland 1970), South Dakota (Peterson personal communication) and in places in Oregon without great difficulty in getting the deer to accept the feeds. If this were the case with all deer, then the palatability of the artificial rations would be of less importance. However, other reports from Oregon have indicated that deer, which had not had any previous exposure to artificial feeds, have starved to death even though feed was placed in the immediate area of the deer (Lightfoot personal communication). Doman and Rasmussen (1944) suggested that possibly wild deer will not consume enough supplemental feed because they are attempting to feed upon native forages. More information is needed on the importance of presenting the most palatable ration possible to wild deer.

PART II
VALUE OF BROWSE IN ARTIFICIAL RATIONS

Methods

Two separate trials were conducted with captive black-tailed deer. Trial 1 was conducted between March 6 and 20 of 1971. Nine deer were used in the study which was designed as a 4 x 4 latin square. The variables in the study were time periods, pens (sex) and treatment. Each time period was three days in length and each of the 4 pens was approximately 1/2 acre in size with pen 1 containing 2 black-tailed does, pen 2 containing 1 black-tailed doe and one mule deer doe, pen 3 containing 3 black-tailed bucks and pen 4 containing 2 black-tailed does. Each pen furnished green forage to the deer. The four treatments consisted of oats containing one of four levels of dried mountain mahogany (Cercocarpus ledifolius), 0%, 1%, 5% and 10%. Two feeders were placed in each pen. An oat-mahogany mixture was placed in one feeder and oats, without mahogany, was placed in the other feeder. Consumption was measured daily in each feeder. All feedstuffs were pelleted and bentonite (10%) and molasses (5%) were added as binders to improve the quality of the pellets.

Trial 2 was conducted between July 18 and August 3, 1971. In this trial dried blackberry leaves (Rubus laciniatus) were added at the 0, 1 and 5 percent levels to a barley diet. Barley was used instead of oats because there may have been a carry over effect between trials 1 and 2 if oats were used in both trials. This was a 3 x 3 latin square in which the other two variables were time periods (2 days) and pens (one containing 3 black-tailed does, one with 4 black-tailed bucks and one with 2 black-tailed does). Two self-feeders were located in each pen. The barley-blackberry mixture was placed in one feeder and barley alone was placed in the other feeder. The feed remained in the feeders for one day and on the second day they were rotated to remove positional bias. Feed consumption was measured daily. At the conclusion of the trial a repeat trial was performed in the exact same manner in order to get a replicate. Ten percent bentonite was added to the pellets. All feedstuffs in both trials were prepared by the Oregon State University feed mill and all feedstuffs were pelleted (3/16 inch pellets).

Analysis of variance was run on results of both trials. The total intake/treatment/pen/period for both the grain-browse mixture and the grain alone was calculated and then the percentage of this intake that contained the grain-browse mixture was figured. The statistical analysis was then run on these percentages.

Results

Results of trial 1 indicated that there was no significant statistical difference within periods (Table 4). Both pen and treatment effects were significant at the $P < .10$ level. The significant effect seen in pens was caused by pen 2. This pen contained a mule deer doe and a black-tailed doe. These two deer consumed more of the oats-mahogany ration (53 percent of intake) than they did of the oat diet. The other 3 pens rejected the oat-mahogany mixture. Pen 3, which was comprised of black-tailed bucks, strongly rejected the oat-mahogany mixture, consuming only 17 percent of their intake in this form. Pens 1 and 4, which were black-tailed does, rejected the mixture also but they did consume 37 and 29 percent respectively of the mixture. There was very little positional bias resulting from feeder position. When the deer were given oats (without mahogany) in both feeders, consumption was near 50 percent in each feeder (46 vs 54), thus indicating little feeder bias. The overall effect of different percentages of browse in the ration was relatively small. Data summed over the pens and periods showed that, when the oat-mahogany pellets contained 1 percent mahogany, consumption was 31 percent of the intake. With 5 percent mahogany, the intake was 39 percent of the total and at 10 percent mahogany, intake was 30 percent. For consumption figures see Appendix Table A-10.

AOV of the data from trial 2 showed that pen (sex) and period did not result in significant variation although treatments caused highly significant variation ($P < .05$), Table 5. The variation in the treatment effect was due to the rejection of all treatments containing blackberry leaves. The deer consumed only 13 and 9 percent of the barley-blackberry mixture, which contained 1 and 5 percent black-berry leaves, respectively, as opposed to 87 and 91 percent for barley alone. See Table A-11 for actual consumption data.

Table 4. Analysis of variance of the data taken from the mountain mahogany trial.

Source	D. F.	SS	MS	F
Period	3	642	214	1.46
Pen	3	1735	578	3.96
Treatment	3	1613	537	3.68
Error	6	878	146	
Total	15	4868		

Table 5. Analysis of variance of the data taken from the blackberry palatability trial.

Source	D. F.	SS	MS	F
Squares	1	99	99	1.00
Period	4	458	114.5	1.15
Pen	4	450	112.5	1.14
Treatment	2	4628	2314.0	23.42*
Error	6	593	98.8	
Total	17	6242		

Discussion

The marked rejection of most of the feedstuffs containing browse was surprising. Originally, the study was designed to use mountain mahogany with mule deer and blackberry with black-tailed deer. However our trapping success for mule deer fell short of anticipated so, rather than dropping the mountain mahogany study, it was tried with black-tailed deer. It should be pointed out that the only pen in trial 1 that did not show a rejection for the oat-mahogany combination contained one mule deer. The possibility remains that mule deer may have preferred mahogany in their diet and the black-tailed deer did not. With this single exception, all groups of deer rejected the oat-mahogany combination. In the barley-blackberry trial the browse combination was rejected in every case by the black-tailed deer. All deer had previously been exposed to live blackberry plants and readily consumed them.

It is evident from these trials that deer are able to detect very small levels of a feedstuff in a ration. In both trials the deer were able to detect both the mahogany and blackberry when present at 1 percent of the diet.

It is difficult to explain why deer reject a foodstuff that they seemed to relish under natural conditions. Many possibilities exist, all of which will not be discussed here, but a few do deserve mention. It is possible that drying may greatly alter smell and taste of the plant. It is also possible that larger levels of browse (greater than 10%) could enhance the acceptibility of a ration. Mixing the two feeds may produce a taste unlike either of the original tastes, which is less palatable than oats or barley. However, of all the possibilities one seems to be more logical. The basis for this is that acceptibility or palatability are relative terms, meaning that what is acceptable or palatable under one situation may not be under another. Barley and oats were not considered highly palatable to captive black-tailed deer when compared to wheat and corn and blackberries and mountain mahogany are known to be very palatable when compared to most native vegetation. It seemed that adding something "palatable" to the "unpalatable" feeds should increase acceptance, which it did not. Since there have not been any comparisons made whereby native forage plants and cereal grains have been compared for relative palatability, it seems most likely to me that oats are more palatable to black-tailed deer than is mahogany or blackberries and adding the browse only detracts from the taste of the grains.

PART III
STARVATION-REFEEDING STUDIES

Methods

It has been our experience that excessive handling of deer, especially wild individuals, can result in death of the deer. Necropsies of these deer often showed enteritis. In this study we were interested only in the effects that abrupt ration changes might have on the survival of malnourished deer and did not want to confuse the results any more than necessary by imposing additional stresses on the animals. For this reason we sacrificed handling and stressing the deer any more than was necessary.

Four separate trials were conducted where one of 4 rations--alfalfa, green grass, concentrate and high protein--feed were fed to deer following a period of malnutrition. The first trial was conducted during January, 1971, when 5 wild mule deer fawns were trapped on their winter range in Southcentral Oregon, and were transported to Corvallis, Oregon. Following a 1 1/2 day complete starvation period, they were fed long or pelleted alfalfa ad libitum for 85 days. Following this trial the effects of ad libitum feeding of green grass and a concentrate ration (see Table A-12) were examined on two of the mule deer used in the alfalfa trial. Each of these deer was restricted to 0.50 lb of alfalfa/day for 3 days. This was then followed by 2 days of complete starvation, at which time one of the deer was fed orchard grass (*Dactylis glomerata*) *ad libitum*. The grass was cut fresh twice each day and given to the deer. Samples of grass were also clipped and the percentage of dry matter of the grass was determined.

Consumption was determined each day and the trial lasted 30 days. A complete concentrate ration (Table 1) was fed *ad libitum* to the second mule deer after she had been subjected to the same starvation regime as the mule deer fed the grass. This trial also lasted 30 days and the intake each day was recorded. In December, 1971, 18 black-tailed deer and 2 mule deer fawns became available for study. These deer were reared as orphans and were semi-tame. At the time of the study they had been eating a commercial calf-starter ration plus a poor quality grass hay. It was our intention to place these deer on a restricted level of the grass hay (.33 lb/deer/day) for 3 weeks which would allow time for adaptation of the rumen microbes to those characteristic of a ruminant on a roughage diet and, which would at the same time, serve as a semi-starvation period. However, after 14 days of this treatment, 4 of the fawns had died of starvation and at this time the remaining deer were divided into 4 groups and fed the following high protein rations for 22 days. Group I was fed soybean meal (SBM) *ad libitum*. Group II was fed a restricted level of SBM, 0.72 lb/deer/day, for 12 days followed by 0.92 lb/deer/day for the remaining 10 days of the trial. Group III received a diet of 1/2 SBM and 1/2 whey *ad libitum*. Group IV was fed a restricted level of the SBM-whey ration, being 0.72 lb/deer/day for the first 12 days of the trial followed by 0.92 lb/deer/day for the remaining 10 days of the trial. All deer were fed 0.20 lb of the grass hay each day to provide roughage in their diets. Consumption was measured each day for each group of deer.

Every deer in all the trials mentioned above were observed closely each day of the trial for signs of digestive disturbance. All deer to die were examined by veterinarians at the Veterinarian Diagnostic Laboratory on the Oregon State University campus.

Results

Seven deer died during the 4 trials, 5 of which succumbed during the high protein trial and the other two during the alfalfa trial. In the high protein trial, four of the deer to die did so during the two week period of malnourishment that preceded the ration change from grass hay to the high protein diet. The necropsies showed that no visible body fat reserves were present and the cause of death in each case was termed starvation. The other deer to die during the high-protein trial was receiving a restricted level of SBM-whey. This deer began scouring on the 6th day after the ration change and died on the 10th day. The necropsy showed that this deer had no stored body fat and had severe pneumonia with lung-worms. Two deer died on the alfalfa ration. The first of these to die did so on the 29th day of the trial and the necropsy showed that lung congestion was the only abnormality found. The second deer to die on the alfalfa trial did so on the 35th day of the trial. This deer had lung congestion and hemorrhagic enteritis of the small intestine.

Abnormal feces appeared during the concentrate and high protein feed trials. The feces of the doe on the concentrate trial was non-pelleted on the 4th day of the trial. The condition was not diarrhea but the feces had a consistancy intermediate between scours and normal. Diarrhea was observed in 3 of the 4 high protein trials. One deer in the ad libitum feeding of SBM had diarrhea on the 18th day of the trial, which persisted until the end of the trial. Deer in both of the SBM-whey trials had diarrhea. In the group receiving the restricted level of SBM-whey, one deer had diarrhea on the 6th day of the trial, which continued for 4 days at which time the deer died (previously discussed). Diarrhea was very prevalent in the SBM-whey ad libitum trial. Three of the four deer receiving this treatment had diarrhea. The first deer to show signs of diarrhea did so on the 4th day of the trial and the other 2 on the 8th and 9th days of the trial. Once these deer began scouring, they continued to do so until the end of the trial. One deer of this group did not scour during the trial.

There were no problems encountered in getting deer in any of the trials to accept the new feedstuffs when the rations were changed.

Even the wild mule deer, after being placed in captivity, readily accepted the alfalfa. The average daily intake in all trials when the deer were fed ad libitum showed that consumption during the first few days following starvation was less than at any other time during the trial (Table 6).

Table 6. The average daily intake (lb/deer) of various rations following abrupt dietary changes.

	Ration					
Days	Concentrate	Green Grass[a]	Limited SBM	Ad libitum SBM	Limited SBM-Whey	Ad libitum SBM-Whey
1-5	1.92	0.77	0.64	0.67	0.72	1.06
6-10	2.24	1.43	0.74	1.04	0.72	1.04
11-15	2.66	1.25	0.80	1.19	0.92	1.72
16-20	2.18	1.42	0.71	1.44	0.92	1.82
21-30	2.59	1.46				

[a] Dry weight.

Discussion

One of the greatest difficulties in conducting and interpreting research of this type is knowing the body condition of the animals at the time of changing rations. Herein probably lies a source of much of the variation in the success of winter feeding programs. We were very cautious in the alfalfa, concentrate and green grass trials and probably did not starve the animals enough.

The animals in the high protein trial were in very poor condition at the time of the ration change. Two deer in this group, one in the SBM ad libitum group and one in the SBM restricted group were very emaciated and appeared near death at the time of the ration change. Both of these deer survived.

The post mortem on the 2 deer that died in the alfalfa trial did not reveal any conclusive information concerning this treatment. Enteritis was seen in one of these deer but enteritis has been a condition observed in many of the deer that have died from reasons other than nutritional. Alfalfa has been successfully fed to deer in many other studies (Dietz et al. 1962 and Smith 1952). Evidence from in vitro studies indicates that deer rumen fluid is capable of digesting alfalfa (Nagy et al. 1967).

Caution should be used in projecting the results of the concentrate and green grass trials into other situations because of the limited number of experimental animals used. The results of these two trials do indicate that deer can survive ration changes of this type, but a mortality rate, if any, remains to be determined. Concentrate rations are very popular diets in institutions that have captive animals. In vitro studies with an alfalfa-corn concentrate showed that white-tailed deer could digest this feedstuff as well as a steer (Short 1963). Other in vivo studies with white-tailed deer have also shown that concentrate rations are digested very well (Forbes et al. 1941). Work with captive black-tailed deer showed that grass did not cause acute digestive problems, although it was incapable of sustaining life for more than 50 days.

The SBM ration contained 45.8 percent protein and the SBM-when ration contained 30 percent protein.[1] We do not recommend feeding either of these rations to starving deer, however, these data do indicate that high levels of protein are not necessarily harmful. The high levels of nitrogen-free-extract (69.6 percent)[1] and ash (9.7 percent)[1] of the whey probably were responsible for the high incidence of diarrhea in the SBM-whey trials, especially the ad libitum trial. Other sources have reported success in feeding high protein diets to deer (Dasmann 1971 and Moreland 1969).

The popular theory that starving deer will overeat and die if suddenly offered unlimited amounts of feed is refuted by these data as well as data reported from domestic animals (Coop 1949 and Fowle 1970). In general, intake is minimal for 1-3 days when animals are offered feed after a period of starvation.

In summary, these data do indicate that deer can survive abrupt ration changes following periods of malnutrition. However, the low number of experimental animals, especially in the green grass and concentrate trials, behooves one to be cautious when applying these results to other situations.

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[1] Calculations are based on values obtained from "National Academy of Science." 1968. Nutrient requirements of sheep, 4th ed., Pub. 1693, 64 pp.

PART IV
EXAMINATION OF STARVING AND WINTER KILLED DEER

Study Area and Methods

The deer herd which was studied was located along the Powder River in Eastern Oregon. This area is characterized by low rolling hills. The vegetation is comprised of areas of big sagebrush (*Artemisia tridentata*) scattered throughout a bluebunch wheatgrass (*Agropyron spicatum*) vegetative type. Much of the area has been disturbed and the canyon bottoms and flat areas support mainly invading annual grasses (*Bromus tectorum* and *Taeniatherum asperum*).

The deer herds in this area have a history of suffering large die-offs every few years. The deer are particularly susceptible to starvation during the winter months because most of the forage is grass which is of low nutritive value during winter months and which can easily be covered with snow. Local sportsmen often feed the deer when the winters are severe, as in 1971-72. They began feeding in mid-December and approximately 15 lb of alfalfa hay and 15 lb of a complete commercial concentrate ration were fed to each herd of deer. The numbers of deer using these feeding stations were estimated by the sportsmen to vary between 20 to 40 per station.

On February 16 the experimental feeding began with 2 deer herds being fed different rations, both *ad libitum*. One ration was comprised of 45 percent soybean meal, 45 percent alfalfa, and 10 percent molasses. The other ration was comprised of 85 percent alfalfa, 10 percent barley, and 5 percent molasses.

During February and March, 1972, the deer using the feeding sites were closely observed and rumen samples were taken from 27 deer. Samples were taken from deer that died within approximately 200 yards of the feeding sites and from live deer known to have access to the feeding stations. Each deer was sampled by opening the reticulo-rumen, mixing the contents, and taking approximately one pint of rumen contents. The animals were examined for the presence of fat on the kidney and heart and in the femur. The digestive tracts were grossly examined for evidence of digestive problems. The rumen contents were then frozen and stored until they were analyzed. Acid detergent fiber (ADF), cellulose and lignin were determined by the method of Goering and Van Soest (1970). The percent of DM digestibility was determined by a 48 hour in vitro method of Tilley and Terry (1963). Rumen innoculum was from a rumen fistulated Hereford steer adjusted to a cubed alfalfa diet which contained 16 percent protein.

Results

On 6.5 square miles surrounding and including the feeding grounds, 139 dead deer were examined. Of these, 16 were in the immediate area of the feeding stations, all of which died before ad libitum feeding began. The reticulo-rumens and omasums of these deer contained normal amounts of ingesta. Most abomasums contained normal amounts of material although some were nearly devoid of ingesta. None of the organs of the forestomach were enlarged nor was there any evidence of mechanical damage. Visible body fat on the omental tissue, kidneys, heart and in the fumur was lacking in the dead deer. Eleven other deer, known to have access to the feeders, were killed (before and after ad libitum feeding) for examination. Of these, 7 were very emaciated, appeared weak and the necropsies revealed no visible fat on the various internal organs or in the femur. Forestomachs of these deer contained normal amounts of material and there was no evidence of digestive problems. In general, the rumen contents were darker brown in color than normal and lacked the characteristic odor of rumen fluid.

Results of the laboratory analysis of the rumen contents are presented in Table 7. The ADF levels and DM digestibilities were significantly ($P < 0.05$) lower and higher, respectively, for the stronger deer than for the weaker or dead deer. There were no statistical differences between ADF, lignin, cellulose or DM digestibilities between the dead and weak deer The cellulose and lignin levels in the rumen contents from the more vigorous live deer were lower than those from the weaker deer, although not enough to be statistically significant.

Table 7. Analysis of deer rumen contents.

	Condition of deer at time of sampling		
	Dead[1/]	Alive	
		Weak[2/]	Strong[3/]
Number	16	7	4
ADF (%)			
Average	55.21[a/]	52.67[a/]	42.85[b/]
Range	43.32-64.36	45.78-61.64	36.56-52.69
Cellulose (%)			
Average	31.67	31.23	26.09
Range	26.71-39.88	22.07-40.04	19.65-35.39
Lignin (%)			
Average	16.03	10.63	8.88
Range	2.32-27.64	2.45-22.62	6.52-14.44
Digestibility (%)			
Average	17.36[a/]	17.06[a/]	35.54[b/]
Range	13.11-21.74	9.92-27.88	30.58-48.13

[1/] Samples are from deer dying within 200 yards of a feeding station.

[2/] Samples are from deer having access to feeders. These deer were emaciated and without visible body fat.

[3/] Samples are from deer having access to feeders. These deer appeared stronger and had visible body fat.

[a/], [b/] Means within a determination with different subscripts differ significantly ($P < .05$).

Correlation and regression analysis were used to evaluate the effects of ADF, cellulose, and lignin on DM digestibilities (Figures 1, 2, and 3). Increasing levels of ADF and cellulose caused significant ($P < 0.05$) reductions in DM digestibility. The levels of lignin had no significant affect on DM digestibility as a single entity, although it contributes to the ADF level.

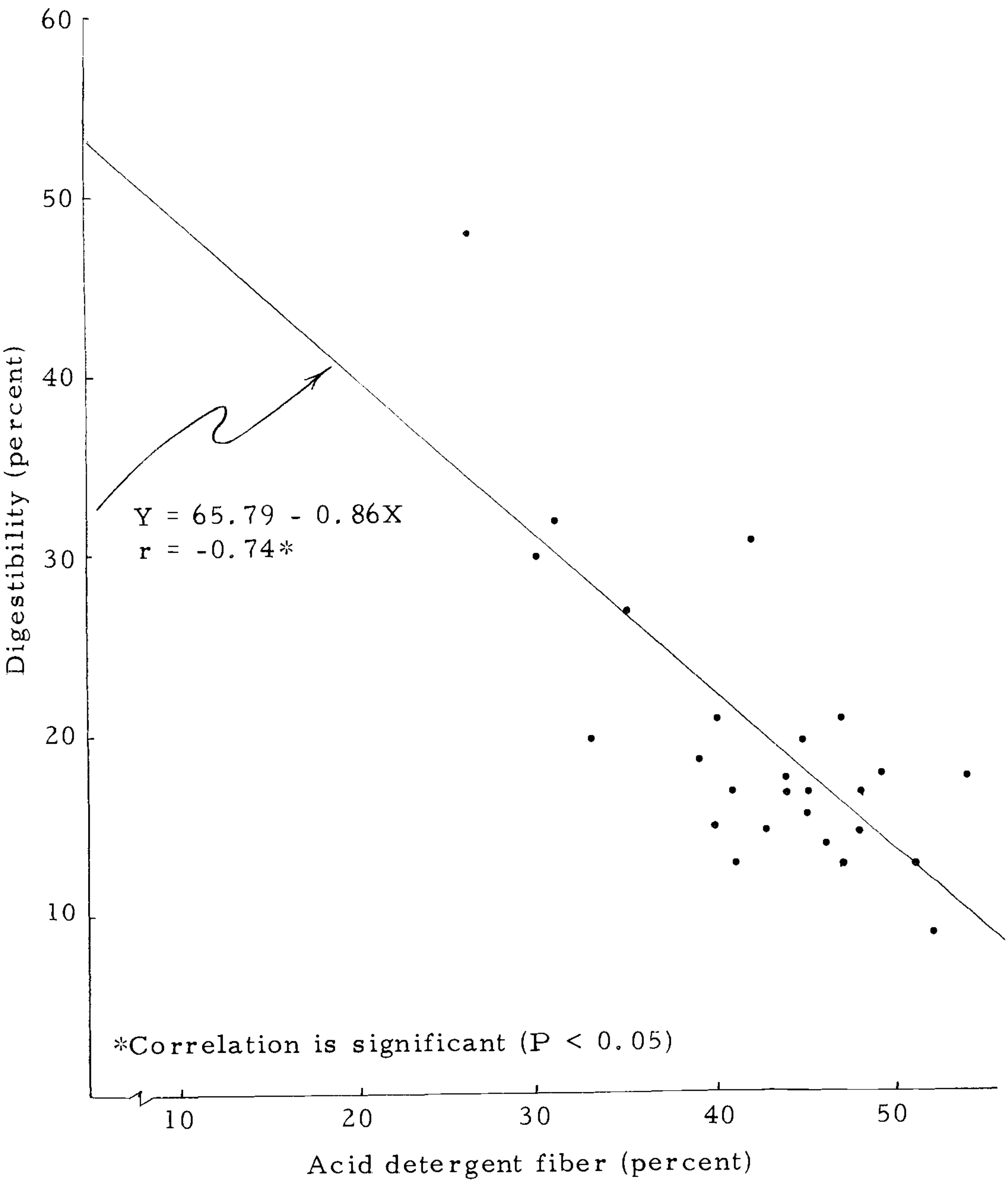

Figure 1. Relationship between the percent dry matter digestibility and percent of ADF in the rumen contents.

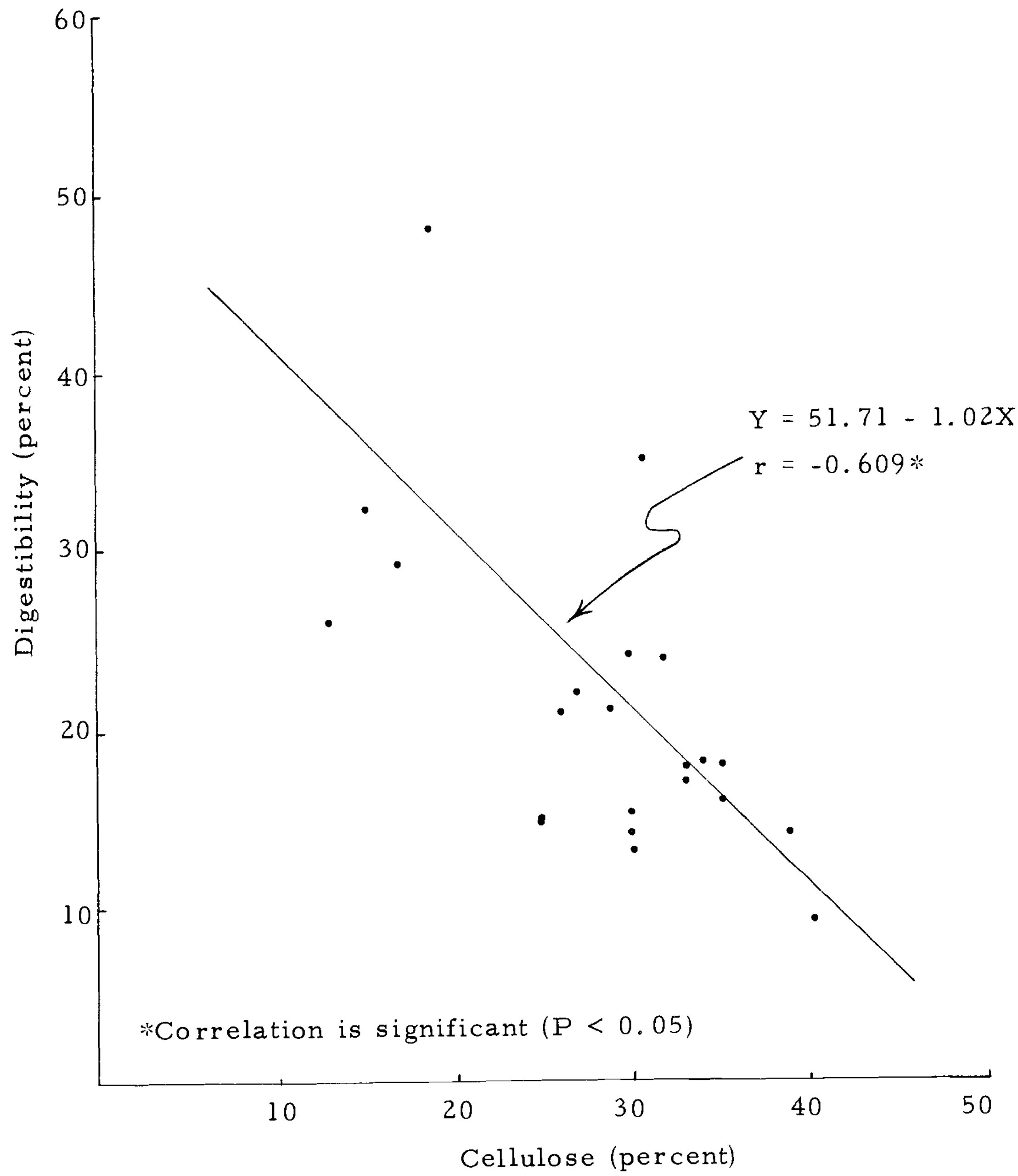

Figure 2. Relationship between the percentage of dry matter digestibility and percent of cellulose in the rumen contents.

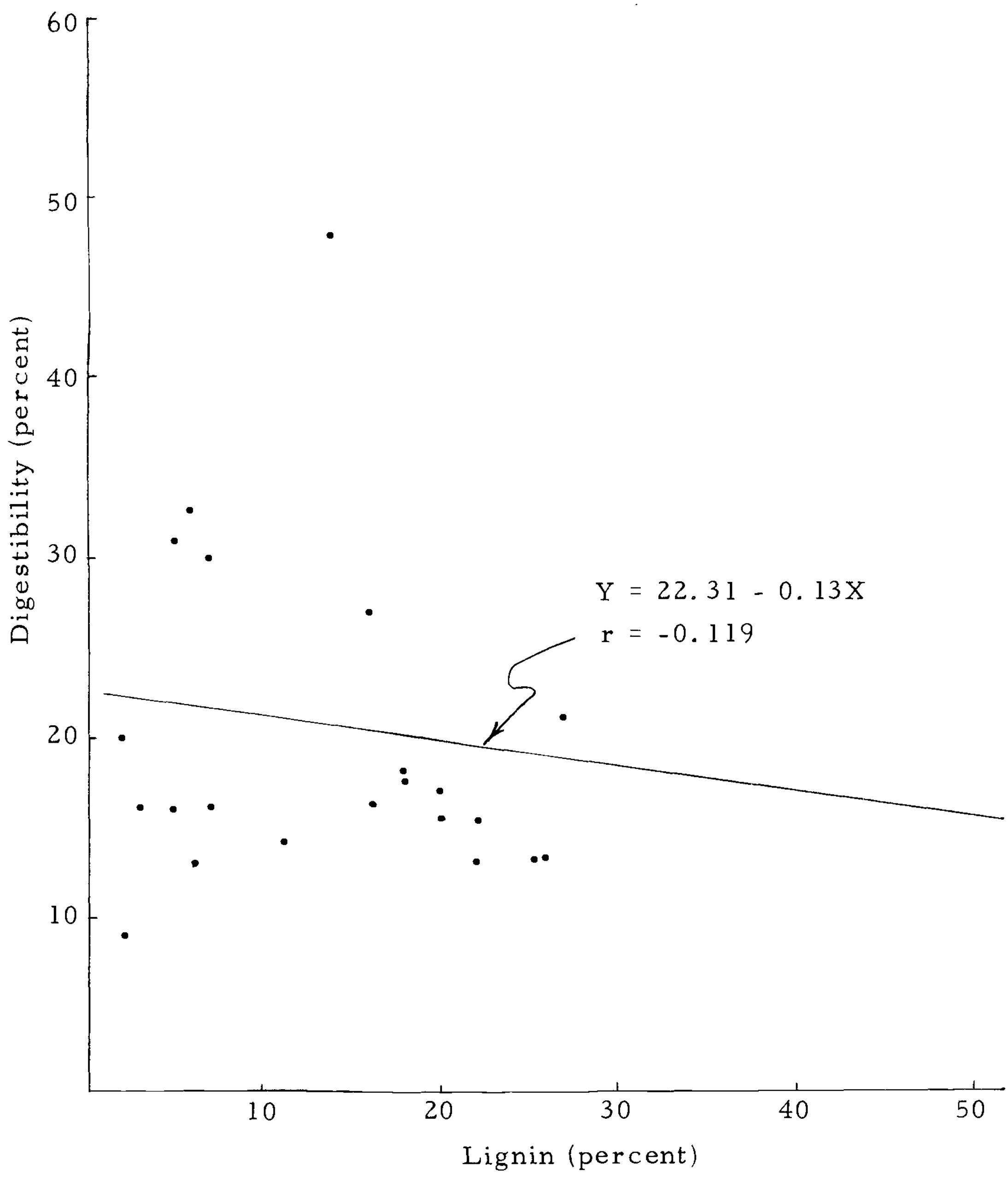

Figure 3. Relationship between the percentage of dry matter digestibility and lignin in the rumen content.

Discussion

Examination of the dead deer and rumen contents indicates that the deer which died around the feeding stations did so as a result of starvation. There was no evidence that the rumens of any of these deer were impacted as reported as occurring at feeding stations by Dasmann (1971) and Taylor (1956). These deer were devoid of body fat and the low *in vitro* DM digestibilities of the rumen contents indicated that the deer were getting very little, if any, nutrition from their diets. It is also known that an adequate source of nitrogen as well as various minerals are required for digestion of cellulytic material. Thus it would seem that the high levels of ADF and cellulose are probably indirect indications of malnutrition.

The *in vitro* DM digestibilities indicate that all deer, even the stronger deer, were consuming diets likely to be inadequate for proper nutrition. It should be pointed out that the *in vitro* examination of the rumen samples cannot be considered equivalent to the *in vivo* digestion of the deer, although the relative differences are probably real. The rumen innoculum used in the *in vitro* system was from a steer whose rumen microflora was adapted to high quality alfalfa hay and not to a highly fibrous, low quality diet. It would seem that the steer innoculum would be less efficient in digesting the deer rumen contents although Nagy *et al*. (1969) stated that steer rumen fluid digested deer rumen contents better than deer rumen fluid. It is known that adaptation of rumen organisms to a particular diet gives more reliable predictions of digestibility. Another possibility which could result in lowered *in vitro* DM digestibilities would be that the more soluble nutrients may have been fermented in the rumen before the samples were taken. This would leave the more insoluble fibrous material in higher concentration in the rumen samples. However, the reduced ability of the rumen to function properly during periods of starvation could make *in vitro* digestibilities an overestimate of *in vivo* digestibilities. A marked reduction in rumen motility with weak deer would be expected, a situation which would lower the digestive efficiency *in vivo* (Church 1969). The poor quality of the diet plus low rumen motility would result in a situation where the microflora would be less efficient.

The lower levels of ADF, cellulose and lignin in the rumen contents of the stronger deer indicate the selection of a more nutritious diet. One explanation for the poorer quality diets of the dead and weak deer is that as the deer are weakened from starvation, the time spent foraging and grazing selectivity probably decrease, resulting in the consumption of a less digestible diet. The deer that were weak were commonly found resting in cover and not moving much during the day. The stronger deer would travel as much as a mile from the feeders to seek forage.

In summary, the deer's ability or inability to cope with the artificial feeds may have nothing to do with deer dying at feeding stations. It is possible to have deer dying on feeding areas because of starvation and in spite of the feeding program.

PART V
FEEDING WILD DEER

Study Area and Methods

Several studies with wild deer were conducted between January 20 and March 26, 1972. The first was a palatability study with soybean meal (SBM) at Silver Lake, Oregon. The SBM was prepared in two forms, either meal (SBM) or pelleted (SBP). Also used in this trial was a bitterbrush (*Purshia tridentata*) water extract which was placed in open vials next to the feed as an odor attractant. Bitterbrush leaves and twigs were also placed in some of the feed in hopes of attracting deer. Eight self-feeders were placed on the Silver Lake winter range in an area where deer were observed. Four feeders were filled with SBM and four with SBP. One feeder of each series of four contained only soybeans. To the remaining three feeders, bitterbrush extract, bitterbrush extract and bitterbrush browse, and bitterbrush browse were added. This arrangement was set up to be analyzed by a factorial method.

After two weeks in the Silver Lake area the feeders were moved to Eastern Oregon where the winter was more severe and where deer were suffering from malnutrition. Two palatability studies were conducted, one near LaGrande and one near Baker. The LaGrande study was designed to compare the relative palatability of SBM, SBP, and

O.S.U. ration (Table A-12). This study was conducted in an area where deer were being fed a ration formulated by the Washington Game Commission (Table A-13). Three feeders were placed at the site and SBM, SBP, and the O.S.U. ration were offered ad libitum. Consumption in each feeder was measured daily. This trial lasted 10 days. The second palatability trial was conducted near Baker, Oregon, in an area where deer were not accustomed to eating artificial feed from feeders. Results from the LaGrande trial indicated that soybeans alone were not as palatable as the O.S.U. ration, so two other rations were added to the trial. One was a pelleted ration comprised of 45 percent SBM, 45 percent alfalfa and 10 percent molasses and the other was a pelleted ration containing 85 percent alfalfa, 10 percent barley, and 5 percent molasses. These three rations were placed in feeders and the time required before the deer began eating the feeds and the consumption of each ration was recorded.

In all the areas previously mentioned the deer were in relatively good condition. However, in the Powder River area above Richland, Oregon, the deer were in poor condition and many were dying of apparent malnutrition. Three feeding stations were established along the Powder River to observe what effects artificial feeding of these three rations would have on starving deer. Three separate sites were selected from one general area on the north side of the river.

The deer were fed from February 16 to March 26 and consumption measured on 34 days of this period. Prior to the beginning of this study, local residents in the area had been feeding deer at each site since mid-December. They were feeding approximately 30 lb daily of alfalfa and a complete commercial concentrate ration at each site.

The number of deer using each site were determined by counting the deer at the feeding sites. The deer remained together as herds while they were in the hills away from the feeders and each herd was located and the deer counted while they were in the hills at least every third day and sometimes more often. The daily movement patterns of the herds using each feeding site was determined by observation and these areas were searched at least every third day for dead deer. Also, during the course of the study, the areas adjacent to those used by the herds under observation were searched for carcasses. This was accomplished by walking each ridge top and creek bottom. Each carcass was sexed and aged (fawn, yearling or adult), one femur broken and the color and consistency of the marrow noted; with those does not badly decayed, the number of fetus were counted.

Results

The feeding trials at Silver Lake were unsuccessful. The feeders were left in the area for two weeks and were not used. Fresh deer tracks observed in the snow around the feeders showed that deer approached close enough to eat if they so desired. Two adult does killed on a nearby highway were necropsied. The location and amounts of stored fat indicated that the deer were in good condition. Both deer had subcutaneous fat plus large amounts of omental, kidney, and femur fat.

The winter of 1971-72 was more severe in north easter Oregon than in the Silver Lake area. Reports indicated that deer in some areas were starving to death and that the Oregon Game Commission and private interests were feeding in the LaGrande-Baker area.

The Oregon Game Commission had been feeding the Washington formulation to a herd of deer near LaGrande for one month. When this ration was replaced in the feeders by the O.S.U. ration, SBM and SBP, the deer showed a preference for the O.S.U. ration over SBP and SBM. The average daily intake (lb) of these three feeds was 30.2, 6.9 and 0.2, respectively (Table 8). Accurate counts of the number of deer using the feeders were not obtained during this period, so the intake per deer could not be calculated. The total amounts consumed however, indicated the relative palatability of the three feeds.

An area near Baker, Oregon was selected to investigate how long it would take deer unaccustomed to eating from feeders to begin using them and to compare the relative palatability of SBM-alfalfa pellets, barley-alfalfa pellets, and the O.S.U. pelleted ration. Deer in this area were not suffering from extended malnutrition at the time of the study as no dead deer were found. The first deer use of the feeders occurred in seven days. Oregon Game Commission personnel from LaGrande stated that they had experienced considerable variation in the time required by different deer herds to begin using offered feeds. Some herds would begin eating artificial feed at once, other herds would have to be coaxed into eating, and other herds refused to eat artificial feeds at all. The Baker study lasted 10 days. As few as four and as many as 16 mule deer were observed using the three feeders. Total consumptions of the O.S.U. ration, alfalfa-SBM pellets and the alfalfa-barley pellets for the 10-day period were 75 lb, 50 lb, and 61 lb, respectively (Table 9).

Table 8. Daily intake (lb) of the OSU-ration soybean meal and soybean meal (pelleted) when offered simultaneously to wild mule deer near LaGrande, Oregon.[a/]

Day	OSU	SBM	SBP
1	26	0	7
2	45	0	3
3	0[b/]	2	15
4	36	1	15
5	10	0	7
6-10	54	0	23
Total	171	3	70

[a/] These deer had been receiving the Washington ration prior to feeding these three rations.

[b/] The OSU-ration was purposely omitted to see what effect this would have on the consumption of the other two rations.

Table 9. Intake of OSU-ration, barley-alfalfa, and SBM-alfalfa rations when offered simultaneously to wild mule deer near Baker, Oregon.

Days	Total Intake (lb)		
	OSU	Barley-alfalfa	SBM-alfalfa
1-4	25	3	7
5-10	52	58	43
Total	75	61	50

Most of the winter was spent working along the Powder River in the Richland, Oregon, area. Three feeding sites were established along the Powder River where a sportsmen's group from Richland had been feeding alfalfa hay and the Washington ration since the middle of December. Records were not kept on the amounts fed by these people, although they estimated that they were feeding approximately 25-30 lb of feed each time at each site. At each of the three sites one of the following 3 rations was fed ad libitum; pelleted SBM-alfalfa, pelleted barley-alfalfa, and the O.S.U. ration. The deer using the OSU ration feeder joined the herd using the alfalfa-SBM feeder, leaving only two feeding stations being used.

The deer were fed ad libitum from February 16 to March 26, 1973. By March 14, most of the deer had stopped using the feeders. Approximately 35 deer (4 fawns) used site 1 (SBM-alfalfa) and 17 deer (2 fawns) used site 2 (barley-alfalfa). The total intake figures at each site are shown in Table 10. The estimated average daily intake (ADI) per deer was highest (2.8 lb) during the first five day period at the SBM-alfalfa site and lowest (0.6 lb) just prior to the time when the deer stopped using the feeders. ADI per deer at site 2 was highest (3.4 lb) during the second five day period and lowest (0.8 lb) during the last 5 day period before the deer stopped using the feeders. There was no evidence of over-eating when the deer were first offered the feeds *ad libitum*. The highest daily intake (3.1 lb) at the SBM-alfalfa site occurred on the 4th day and on the 7th day (4.0 lb) at the barley-alfalfa site.

Table 10. Daily intakes (lb) of the SBM-alfalfa and barley-alfalfa rations when offered *ad libitum* to wild mule deer on the Powder River area, Oregon.[a]

Day	Ration: SBM-alfalfa		Ration: Barley-alfalfa	
1-5	98[b]	(91-108)[c]	54	(46-63)
6-10	83	(69-92)	58	(47-68)
11-15	89	(85-93)	50	(47-55)
16-20	58	(34-74)	38	(30-46)
21-25	22	(0-62)	14	(0-35)
26-39	0		0	

[a] Approximately 35 deer were using the SBM-alfalfa ration and 17 were using the barley-alfalfa ration.

[b] Mean intake for the period.

[c] Range in intake for the period.

During the first 12 days of the study the number of feeders at site 1 was varied between 1 and 3 and between 1 and 2 at site 2. During this period, deer use and activity at the feeding stations appeared to be uniform. ADI for 1, 2, and 3 feeders at site 1 was estimated to be 2.5, 2.7, and 2.5 lb/deer, respectively. At site 2 the ADI was 3.2 lb/deer for either 1 or 2 feeders.

Fighting and competition for feed was common among animals using the feeders. Prior to *ad libitum* feeding many deer would reside at the feeding stations during the day while the other deer, knowing when they would be fed, would come in from the mountains prior to feeding time. During this time the deer could be approached within 50 feet by a human. After *ad libitum* feeding began, all the deer would move into the mountains during the day and none would remain at the feeders. The deer also regained their wariness and would run at the sight of a human. The deer would come to the feeders at dusk and use them during darkness.

A total of 139 carcasses, on the feeding and surrounding areas, were examined for sex and age (Table 11). Most of the deer that died were fawns as shown by the high percentage of fawns among the winter kills and indicated by the low number of fawns/100 adults observed among the live deer using the area. Nineteen does were examined for reproductive information; Table 12. Eleven of the 19 does examined were barren. Fifty percent of the does that possessed some visible body fat (on the heart, kidneys and in the femur) at the time they were killed were barren and 61 percent of the does that were void of body fat were barren.

Table 11. Live deer and dead deer carcasses observed on the study area on the Powder River area, Oregon.

	Live Deer	Dead Deer
Total	129[a]	139
Fawns	15	98 (69 percent)
Adults	114	34 (31 percent)
Buck	---	6
Does	---	28
Yearling	---	7
Fawn: 100 adults	13	

a/ Numbers here refer only to those herds where fawns could be definitely identified from adults.

Table 12. Reproductive information taken from necropsied does on the Powder River study area.

Approximate Age[a]	No. Fetus	Comments
1 yr. -9 mos.	0	Winter kill.
2 yr. -9 mos.	0	Found too weak to escape and killed.
3 yr.	0	Winter kill.
3 yr.	1	Road kill - good condition.
3-4 yr.	2	Winter kill.
3-4 yr.	1	In fair condition - was shot.
4 yr.	0	Winter kill.
4 yr.	2	In fair condition - was shot.
4-5 yr.	1	Winter kill.
5-6 yr.	0	Road kill - good condition.
6 yr.	0	Winter kill.
6-7 yr.	0	Winter kill.
6-7 yr.	0	In fair condition - was shot.
7-8 yr.	0	Winter kill.
7-8 yr.	1	(being resorbed) winter kill.
7-8 yr.	1	Winter kill.
7-8 yr.	0	Found too weak to escape and killed.
10 yr.	2	Winter kill.
10 yr.	0	In fair condition - was shot.
19 Total	10	

a/ Age was estimated on eruption patterns and wear of the teeth. Those deer showing considerable wear were arbitrarily called 10 years of age and all other deer placed between 1 year and 9 months, and 10 years.

Nineteen dead deer were found on the feeding sites at the time *ad libitum* feeding began (Part IV of this thesis). These deer were devoid of body fat and appeared to have died of starvation. After *ad libitum* feeding began no other deer died on the feeding sites nor were any located on the range used by these deer. The deer which appeared weak at the beginning of the *ad libitum* feeding continued to use the feeders and the number of deer using the feeders stayed relatively uniform during the study. All of these factors indicate that the artificial feeds did not result in additional deaths.

Several of the deer using site 1 developed diarrhea on the day following the initiation of *ad libitum* feeding. This condition cleared up within a week, with one exception. One of the fawns using this site scoured for 2 weeks. None of the deer using site 2 developed diarrhea.

Discussion

Palatability or acceptability does not seem to be a major problem with deer that are starving. The difficulty in getting deer to accept artificial feeds at Silver Lake and at some sites near LaGrande (by OSGC personnel) seems to be related to body condition of deer. None of the herds that rejected artificial feed were considered to be in great need of food. The herd near LaGrande that showed preference for the OSU ration over SBP and SBM. This can partially be attributed to the fact that the deer had been eating the Washington ration, which is not very different from the OSU ration. The deer rejected the SBM but later in the year on the Powder River 100 lb of SBM was offered to a group of deer which were being fed a limited amount of Washington ration and long alfalfa. The deer readily consumed the SBM. Thus it would seem that starving deer can be fed most feedstuffs and palatability should not be too great a factor except possibly at the very beginning of the feeding program. Many people are opposed to feeding alfalfa to deer. However, alfalfa is an excellent feed to bait deer into feeding stations. Most mule deer in Oregon seemed to accept alfalfa readily and once "hooked" on alfalfa, other diets could be substituted in its place.

It appears that the ad libitum feeding of starving deer did not produce severe digestive disorders and/or death as had been reported by others (Dasmann 1971; Mace 1959 and Taylor 1956). However, we cannot say that the rations prevented deer from dying since we did not have a control. Apparently the biggest mistake of supplemental feeding in this area was token feeding that occurred prior to ad libitum feeding. Several deer had died on the feeding sites when restricted levels were being fed. With the intense competition between deer for feed, it appears that fawns and weaker deer may have died in spite of feeding since dominant individuals were able to eat all of the feed. If limited amounts are going to be fed, increasing the number of feeders would probably improve the distribution of feed consumption within the herd. However, with *ad libitum* feeding, these data indicated that one feeder is adequate to feed 35 deer. Some reports indicate that starving deer will overeat and die if suddently offered large quantities of feed (Carhart 1945). Consumption figures indicated that the deer did not overeat when *ad libitum* feeding began. Literature concerning domestic animals indicate that intake is minimal for 2-4 days following starvation and over eating is not a problem (Church 1971; Coop 1949 and Fowle 1970).

It appears that both of the rations fed to the deer would be adequate for supplying needed nutrients to the deer. The SBM-alfalfa ration is relatively cheap and no digestive problems were evident. The barley-alfalfa ration contained a high level (85 percent) of alfalfa. There is no reason to believe that the high level of alfalfa should cause any digestive problems. Alfalfa hay has a reputation of causing digestive problems when fed to starving deer, although no scientific research has shown good quality alfalfa to be dangerous. However, Nagy *et al*. (1971) has shown that poor quality alfalfa fed *ad libitum* to captive mule deer caused omasal compaction and abomasal hemorrhaging.

Some of the greatest obstacles of winter feeding programs are the economical problems of feed costs and labor and the logistical problems of supply. Deer, even though concentrated on winter ranges, are still widely scattered and to feed enough deer to have an appreciable effect on a significant number would be a tremendous task, if indeed possible. For example, if the daily intake per deer is 3.0 lb, it costs approximately $0.07 and $0.11 per deer-day to feed the barley-alfalfa and SBM-alfalfa rations, respectively. The deer came to the feeding sites in mid-December and left in mid-March. We estimate that feed costs alone would approach $4.30 and $6.30, respectively, to feed one deer these rations for a 2 month period. If these costs per deer are projected to a large number of deer, the expense for feed alone becomes rather high. One possibility of reducing feed costs would be to use creep feeders, which would allow fawns to eat separate from adults. Fawns are the first to die during periods of malnutrition (69 percent) of all deer to be examined were fawns) and, therefore, would be the age class in greatest need of supplementation. Feeding the fawns separate from adults would greatly reduce the quantity of feed needed if suitable facilities and management methods could be developed.

Winter feeding, should it become economically feasible, has potential as a valuable management tool in areas where winterfeed supplies are inadequate or unavailable. In our study areas, the deer were not dying because the population has grown beyond the ability of the range to support them as this is primarily a grass region where the feed may be covered with snow at times. (This is not to say that mature grass is adequate feed if not covered with snow.) Secondly, fawn survival is very important in states, such as Oregon, where the hunting pressure is heavy and no restrictions are placed on the number of bucks harvested during the season. On the area studied, approximately 12 fawns/100 adults survived the winter. This means that only 6 yearling bucks (assuming 50 percent of the fawns are bucks) would be introduced into the harvestable herd the following fall. Winter feeding offers the possibility of saving a large percentage of the potentially harvestable deer that otherwise may die of starvation.

In summary, it would appear that starving mule deer can be supplemented with artificial rations. Supplementing deer during the winter months has the potential to increase the number of harvestable deer, but economical and ecological considerations may preclude winter feeding. We do feel that artificial feeding has enough merit to be considered as a management alternative, although many factors must be evaluated before such a program can be implemented.

OVERVIEW AND RECOMMENDATIONS FOR WINTER FEEDING DEER

A number of things come to mind as I look back over the subject of winter feeding big game animals. Winter feeding is a complex problem on which very little factual information is known. Among many professional wildlife people, supplemental feeding of game animals on the winter range has no place in big game management and should not be considered as a management alternative. It seems to me that a few early publications, based more on emotion and causal observation than on scientific fact, resulted in perpetuating several "tales" concerning the nutrition of starving deer.

The most disturbing thing about the subject is that many wildlife students are being taught that winter feeding has no place in wildlife management. Winter feeding big game has many disadvantages, but there are some situations where it should be considered as an alternative and, if properly conducted, can aid in the management of wild animals. The pros and cons of winter feeding should be spelled out to students of wildlife management; then they will be better able to make the correct decision when placed in a decision making position.

There are several disadvantages to winter feeding. These include the possibility of upsetting the ecosystem, the costliness, and the tremendous logistical problems; but there is no factual evidence that winter feeding cannot be done from the nutritional standpoint.

This is not to say that nutritional problems do not exist, but rather that if they do, they remain to be determined. Research with domestic ruminants indicate that starved animals can be refed successfully and there is no reason to believe that deer are basically different than domestic animals. Numerous animals have died on feeding grounds in the past, and it seems most logical that these died in spite of the feeding programs rather than because of them.

There are situations where winter feeding can be used to advantage. Game personnel of Washington feed big game animals during the winter months to divert use from private property, thus reducing damage caused by the animals. Elk are fed in the mountains to keep them from coming down into the orchards. Deer are fed in South Dakota during the winter to divert them from private property. Using strategic placement of feed to direct use patterns by game animals offers potential in many different situations. Feeding to prevent die-offs is an entirely different situation than feeding to direct use. Interferring with the forces (winter starvation) that bring the consumers in line with the producers has the potential of disrupting the ecosystem. However, situations can exist where saving lives may not necessarily disturb the balance of nature. These would include situations where hunting is a strong factor and those animals saved during feeding programs could be harvested in the fall, thus not allowing too many animals to enter the winter period to damage the range, yet saving those that might otherwise starve to death on the winter range. Also, on some winter ranges, grass provides most of the feed. During years of heavy snow fall the forage is unavailable and deer may starve to death even though the range is in good vegetative condition. Supplemental feeding on these ranges could save deer lives and not necessarily cause range overuse. The encroachment of man on wildlands has reduced the winter ranges for big game in many regions. Where winter range has been eliminated, it may be desirable to support a herd during the winter months on artificial feeds. Should wild fires destroy winter ranges, supplemental feeding could carry the animals through a short period until the range has regenerated. However, it seems with the present demands for game animals, most feeding programs cannot be justified. If the demands for game animals increase, then management must become more intense, in which case winter feeding practices should enter into more of the decision making.

Studies with the captive and wild deer provided considerable insight into the nutrition of deer. The palatability studies demonstrated that captive black-tailed deer definitely preferred pelleted feeds over rolled and whole preparation, the later being rejected. Corn, wheat, and soybean meal are markedly preferred over oats and barley. Cottonseed meal, linseed meal, pelleted beet pulp, and peas were all rejected. The addition of dried browse into pelleted grains lowered the desirability of the feed for black-tailed deer. The deer can detect levels as low as 1 percent of the ration. Palatability studies with wild mule deer indicated that deer in good physical condition are more difficult to feed than those in very poor condition.

Based on my observations, the most important considerations in formulating an emergency winter ration are supplying the deer the needed nutrients as cheaply as possible. Palatability should not be a serious problem with hungry deer, although Hines (1972, personal communication) stated that black-tailed deer starved to death in the presence of supplemental feed without consuming any feed. Palatability appears to be a real problem when deer are being fed in hopes of luring them away from a specific location. Personnel of the Oregon State Game Commission in LaGrande stated that some deer come quickly to artificial feed and others will not accept the feed at all. In Baker, Oregon, the deer did not come to my feeders until I had scattered alfalfa hay in the immediate vicinity to attract them. Much of the variability observed with deer could result from experiences earlier in the year or from previous years.

An important factor in formulating a ration for a herd of starving deer is realizing that the herd contains individuals of different physical condition. Some deer will be in relatively good condition and some will be near death. Fawns will need nutrients for body growth and does will need to have gestation requirements fulfilled. A successful ration demands that it be formulated to fit the needs of the poorest deer in the herd. This means that the average deer in the herd is receiving more nutrients than it needs but all deer must be fed this ration in order that all malnourished individuals are fed properly.

The crude protein level in the diet should be approximately 20 percent to satisfy the requirements of the fawns. Phosphorus, sulfur and magnesium should be added since these minerals are probably excreted at high rates during periods of starvation. At the time of feeding, little or nothing is known about nutritional background of the deer, nor about the ability of the rumen to function. For these reasons, vitamins A, D, E and the B complex should be included as a precaution. Vitamin supplements are required in small amounts and are relatively cheap. The ration should also contain enough digestible energy so that a deer can consume 160 Kcal/kg $BW^{3/4}$. The following rations fulfill the nutritional needs of deer and are unlikely to cause digestive upset.

RATION 1	Ingredient	lb/ton
	Molasses	190
	Alfalfa	900
	Soybean meal	500
	Corn	400
	Tracemineralized salt	10
	Vitamin A	2,500,000 IU
	Vitamin D	250,000 IU
	Vitamin E premix	25 grams
	Vitamin B complex	250 grams

RATION 2	Ingradient	lb/ton
	Molasses	190
	Alfalfa	900
	Soybean meal	900
	Tracemineralized salt	10
	Vitamin A	2,500,000 IU
	Vitamin D	250,000 IU
	Vitamin E premix	25 grams
	Vitamin B complex	250 grams

These rations should be pelleted to improve acceptibility and to prevent the deer from separating the ingredients. Cost is a very important consideration in ration formulation, and substitutions should be made in order to keep costs minimal as long as the required nutrients are made available. A ration of 85 percent alfalfa, 10 percent barley, and 5 percent molasses would be a cheap ration and would probably satisfy the nutrient requirements of most deer. Since none of these rations have been tested under varying conditions, when a particular ration is fed, the deer using the ration should be observed. Should digestive problems result, make the needed adjustments within the ration or consult a nutritionist for advice. Do not assume that because deer are dying at a site it is because of the feed. Examine the dead deer and determine if the animal died of starvation. Do not be alarmed by diarrhea during the first few days of feeding. This is characteristic of a ruminant being converted from a high roughage diet to a diet more easily digested. Should diarrhea persist or deer die that are showing signs of severe digestive upset the ration should be altered.

There is definitely more research needed concerning deer feeding during the winter months. Certainly, whenever artificial rations are fed to starving deer, the results should be documented and made available. One of the biggest fallacies with winter feeding has been the lack of coordination between what has been tried and what has been successful. Specific study is needed in the area of nutrition and energy metabolism during the winter months. There is some question as to what a winter range should furnish a deer and in what relative amounts. In other words, how important is cover on the winter range in terms of energy saved as opposed to browse and energy gained? How important is the summer range on deer survival the following winter and how valuable is browse in furnishing nutrients to deer? It is very likely that the importance of browse in supplying nutrients has been over estimated and that the importance of cover has been under estimated. Many of these questions will have to be answered if we are to understand why some herds in some years are more susceptible than at other times.

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APPENDICES

Table A-1. Daily intake (lb) by 4 black-tailed deer of corn offered *ad libitum* cafeteria style in 3 different forms.

Day	Alfalfa	Whole	Rolled	Pelleted
1	3.2	0.0	0.9	7.0
2	1.2	0.3	0.3	7.8
3	1.2	0.0	0.0	7.8
4	1.2	0.0	0.0	5.6
5	2.0	0.0	0.2	4.8
6	2.0	0.0	0.0	8.1
7	2.4	0.0	0.6	6.1
8	1.6	0.0	1.2	5.4
9	1.7	0.0	1.5	6.3
10	1.2	0.0	2.3	3.5
11	1.4	0.0	2.9	5.0
12	0.4	0.0	3.0	2.5
13	0.8	0.0	3.2	4.4
14	2.3	0.0	3.2	1.7
Average	(1.6)	(0.0)	(1.8)	(5.1)

Table A-2. Daily intake (lb) by 4 black-tailed deer of barley offered *ad libitum* cafeteria style in 3 different forms.

Day	Alfalfa	Whole	Rolled	Pelleted
1	3.4	0.0	0.0	2.8
2	3.1	0.0	1.0	8.1
3	2.7	0.0	0.3	7.0
4	1.4	0.0	0.0	11.6
5	1.0	0.0	0.7	5.6
6	0.0	0.0	0.7	7.5
7	0.8	0.0	0.3	6.4
8	0.1	0.0	0.0	3.4
9	1.1	0.0	2.2	7.4
10	2.8	0.0	1.4	4.0
11	2.4	0.0	3.7	4.5
12	1.3	0.0	2.4	4.2
13	1.9	0.0	2.7	4.5
14	2.2	0.0	2.2	4.5
Average	(1.7)	(0.0)	(1.6)	(5.2)

Table A-3. Daily intake (lb) by 4 black-tailed deer of oats offered *ad libitum* cafeteria style in 3 different forms.

Day	Alfalfa	Whole	Rolled	Pelleted
1	0.9	0.0	0.0	4.8
2	0.4	0.0	0.0	6.8
3	1.3	0.0	0.0	6.1
4	3.5	0.0	0.0	6.1
5	0.9	0.0	0.0	7.6
6	2.6	0.0	0.0	6.9
7	2.6	0.0	0.0	6.8
8	1.8	0.0	0.0	6.1
9	2.2	0.0	0.0	7.6
10	1.2	0.0	0.0	6.5
11	0.9	0.0	0.0	7.6
12	1.8	0.0	0.0	6.4
Average	(1.7)	(0.0)	(0.0)	(6.6)

Table A-4. Daily intake (lb) by 4 black-tailed deer of various pelleted concentrate feeds when offered *ad libitum* cafeteria style.

Day	Alfalfa	Barley	Oats	Corn
1	0.4	0.5	0.8	2.5
2	0.0	0.8	1.9	7.3
3	0.3	1.3	0.7	7.9
4	0.2	0.7	1.8	8.0
5	0.6	0.6	0.8	5.8
Average	(0.3)	(0.8)	(1.2)	(6.3)

Table A-5. Daily intake (lb) by 4 black-tailed deer of various pelleted concentrate feeds when offered *ad libitum* cafeteria style.

Day	Alfalfa	Peas	Oats
1	0.0	0.0	2.0
2	0.1	0.0	2.7
3	0.2	0.0	2.9
4	0.3	0.0	2.7
5	0.2	0.0	2.8
Average	(0.2)	(0.0)	(2.1)

Table A-6. Daily intake (lb) by 4 black-tailed deer of various pelleted concentrate feeds when offered *ad libitum* cafeteria style.

Day	Alfalfa	Cottonseed Meal	Wheat
1	0.0	0.0	1.6
2	1.7	0.0	4.6
3	0.7	0.0	7.6
4	1.1	0.0	8.5
5	0.3	0.0	8.2
Average	(0.7)	(0.0)	(6.8)

Table A-7. Daily intake (lb) by 4 black-tailed deer of various pelleted concentrate feeds when offered *ad libitum* cafeteria style.

Day	Alfalfa	Soybean Meal	Linseed Meal	Beet Pulp
1	2.8	8.3	0.1	0.0
2	2.4	7.8	0.0	0.0
3	1.5	6.2	0.0	0.0
4	1.3	8.1	0.0	0.0
5	0.7	8.4	0.0	0.0
Average	(1.8)	(7.8)	(0.0)	(0.0)

Table A-8. Daily intake (lb) by 4 black-tailed deer of various pelleted concentrate feeds when offered *ad libitum* cafeteria style.

Day	Alfalfa	Beet Pulp	Cottonseed Meal	Linseed Meal
1	4.0	0.8	0.3	0.6
2	3.5	0.0	0.0	0.5
3	3.4	0.4	0.2	0.8
4	3.4	0.2	0.3	2.9
Average	(3.6)	(0.4)	(0.2)	(1.2)

Table A-9. Daily intake (lb) by 4 black-tailed deer of various pelleted concentrate feeds when offered *ad libitum* cafeteria style.

Day	Alfalfa	Wheat	Corn	Barley	Soybean Meal	Oats
1	0.2	3.6	3.6	0.5	3.5	0.0
2	0.2	2.9	3.2	0.2	4.0	0.6
3	0.1	2.0	4.0	0.9	4.4	0.5
4	0.1	2.4	2.7	1.5	4.0	0.3
5	0.4	3.0	2.8	2.5	3.5	0.2
6	0.1	3.0	3.0	1.0	3.9	0.1
7	0.5	4.7	2.5	1.1	4.0	0.2
8	0.3	4.1	3.8	0.2	2.9	0.9
9	0.5	3.8	1.7	1.5	4.0	0.2
10	0.3	3.5	1.5	1.1	3.9	0.1
11	0.4	2.8	3.8	1.1	2.1	0.3
12	0.3	4.3	1.5	0.3	4.0	0.3
13	0.7	5.0	2.2	1.0	4.6	0.1
14	0.4	3.3	4.1	0.4	3.5	0.1
Average	(0.3)	(3.3)	(2.8)	(1.1)	(3.7)	(0.3)

Table A-10. Consumption (lb/day) of oats and oats with mountain mahogany by black-tailed deer.

	Pen #1		Pen #2		Pen #3		Pen #4	
Period	2 Does	2 Does	2 Does[a]	2 Does[a]	3 Bucks	3 Bucks	2 Does	2 Does
1	1.1 (0)[b]	1.9 (0)	2.9 (0)	0.9 (1)	3.0 (0)	1.0 (5)	2.5 (0)	1.5 (10)
	1.3	2.5	3.8	0.6	5.1	0.5	4.0	0.9
	1.7	2.0	3.2	2.8	5.5	1.0	4.4	1.1
	4.1	6.4	9.9	4.3	13.6	2.5	10.9	3.5
2	3.5 (0)	1.2 (10)	2.5 (0)	3.1 (0)	4.2 (0)	2.2 (1)	3.4 (0)	2.3 (5)
	2.7	0.7	1.9	2.9	4.7	0.4	3.5	2.6
	5.0	1.0	3.4	4.8	6.0	0.8	5.7	1.7
	11.2	2.9	7.8	10.8	14.9	3.4	12.6	6.6
3	1.4 (0)	3.3 (1)	1.4 (0)	4.4 (5)	5.2 (0)	1.8 (10)	2.4 (0)	3.7 (0)
	1.9	2.6	1.4	4.7	5.3	0.6	2.6	2.1
	3.5	1.6	2.9	2.8	4.5	0.4	2.4	2.9
	6.8	7.5	5.7	11.9	15.0	2.8	7.4	8.7
4	2.3 (0)	2.4 (5)	2.9 (0)	3.4 (10)	2.9 (0)	3.4 (0)	2.9 (0)	2.3 (1)
	3.8	1.9	2.5	4.9	4.1	3.6	4.6	2.1
	2.8	0.9	2.3	2.1	4.0	2.0	4.8	0.4
	8.9	5.2	7.7	10.4	11.0	9.0	12.3	4.8

[a] One mule deer doe and one black-tailed doe.

[b] Indicates the % browse in the diet.

Table A-11. Consumption (lb/day) of barley and barley with blackberry leaves by black-tailed deer.

	Pen #1		Pen #2		Pen #3	
Period	3 Does	3 Does	4 Bucks	4 Bucks	2 Does	2 Does
1	1.65 (1)[a]	5.88 (0)	0.60 (5)	9.40 (0)	2.64 (0)	3.00 (0)
	0.60	6.49	0.38	10.35	1.39	2.08
2	4.00 (0)	2.00 (0)	0.86 (1)	8.37 (0)	0.68 (5)	2.20 (0)
	4.06	3.44	1.45	9.41	2.39	2.11
3	0.25 (5)	7.99 (0)	5.89 (0)	6.99 (0)	0.75 (1)	2.89 (0)
	0.16	7.55	4.13	7.15	1.27	3.04
4	0.70 (1)	8.28 (0)	1.01 (5)	11.53 (0)	2.41 (0)	3.00 (0)
	0.23	7.78	1.38	12.50	3.16	4.61
5	2.62 (0)	4.30 (0)	2.20 (1)	10.91 (0)	0.79 (5)	5.15 (0)
	4.69	2.10	0.57	11.29	0.69	3.50
6	0.14 (5)	6.90 (0)	5.40 (0)	7.85 (0)	1.53 (1)	3.12 (0)
	0.07	7.90	6.21	7.27	0.57	3.76

[a] Indicates the percentage of browse in the diet.

Table A-12. Ration formulated at Oregon State University and referred to as the OSU-ration.

Ingredient	lb/T
Ground oats	300
Ground wheat	180
Ground corn	600
Cottonseed meal	400
Soybean meal	200
Alfalfa meal	100
Molasses	200
Tricaphos	10
Iodized salt[a/]	10
Viatmin A	2,500,000 IU

[a/] One oz. contains 70.9 mg of Zn, 56.7 mg of Mn, 35.4 gm of Fe, 7.09 mg of Cn, 1.42 mg of I, and 1.42 mg of CO.

Table A-13. Ration formulated by the Washington Game Commission.[a/]

Ingredient	lb/T
Alfalfa meal (minimum 15 percent protein)	460
Whole corn (coarse ground)	400
Barley (coarse ground)	220
Wheat bran	280
Beet pulp	270
Molasses	140
Soybean meal or cottonseed meal	170
Calcium carbonate	20
Salt (trace mineralized and iodized)	20
Calcium limestone	20

[a/] The ration is pelleted.

Table A-14. Intake (lb/day) of various high protein rations in deer following 2 weeks of malnutrition.

	Ration			
Day	Restricted SBM[a]	Ad libitum SBM[a]	Ad libitum SBM-Whey[a]	Restricted SBM-Whey[b]
1	2.86	2.45	4.15	2.86
2	2.08	1.86	3.65	2.86
3	2.86	2.77	1.75	2.86
4	2.05	2.43	4.45	2.86
5	2.86	3.96	7.18	3.86
6	2.86	3.34	6.50	2.86
7	2.86	4.96	6.10	2.86
8	2.86	4.15	6.75	2.86
9	2.86	4.19	6.82	2.86
10	2.86	4.24	7.55	2.86
11	2.86	4.38	6.40	2.15[c]
12	3.70	4.21	6.05	2.76
13	2.70	4.48	7.33	2.76
14	3.10	4.98	6.84	2.76
15	3.70	5.68	7.75	2.76
16	3.09	5.92	8.20	2.76
17	3.61	5.30	6.72	2.76
18	3.01	5.60	6.36	2.76
19	2.80	5.66	7.21	2.76
20	3.10	6.09	7.00	2.76
21	2.50	5.95	8.30	2.76

[a] Consumption by 4 black-tailed deer.

[b] Consumption by 2 black-tailed and 2 mule deer.

[c] One mule deer died. Consumption from here on refers to 2 black-tailed and 1 mule deer.

Table A-15. Daily intakes (lb) of the SBM-alfalfa and barley-alfalfa rations when offered *ad libitum* to wild mule deer on the Power River area, Oregon. Approximately 35 deer were using the SBM-alfalfa station and 17 were using the barley-alfalfa station.

Date	SBM-alfalfa	Barley-alfalfa
2/16	93 1[a]	63 1
2/17	95 1	56 1
2/18	95 1	46 1
2/19	108 2	55 2
2/20	91 2	50 2
2/21	69 1	--
2/22	88 2	68 2
2/23	92 3	47 2
2/24	81 3	66 1
2/25	85 1	50 1
2/26	85 3	47 1
2/27	90 3	48 1
2/28-3/4[b]		
3/5	93	55
3/6	66	35
3/7	34	44
3/8	74	37
3/9	65	30
3/10	49	46
3/11	62	35
3/12	50	5
3/13	--	33

[a] Numbers refer to the number of feeders used during the day.

[b] No measurement taken during this period (the deer were fed, however).