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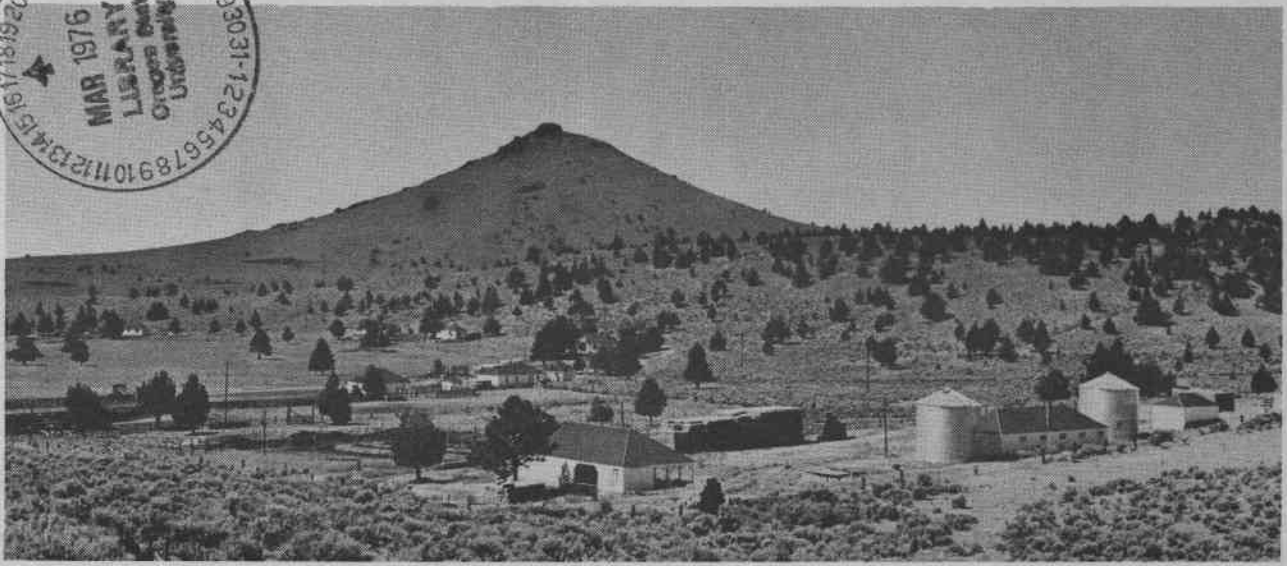
Research in Beef Cattle Nutrition and Management



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AUTHORS: R. J. Raleigh is Superintendent of the Eastern Oregon Agricultural Research Center and Professor of Animal Nutrition, Oregon State University. H. A. Turner is Assistant Professor of Animal Science at the Squaw Butte Station. M. Vavra and R. L. Phillips are Assistant Professors of Animal Science at the Union Station. K. J. Peterson is Professor and R. Stroud is Research Assistant of Veterinary Medicine at Oregon State University. M. M. Wing is Research Assistant at the Union Station.

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Cover picture: Squaw Butte looks down on the summer version of the Squaw Butte Experiment Station.

IMPROVED EFFICIENCY FOR WINTERING COWS BY FEEDING RUMENSIN

H. A. Turner and R. J. Raleigh

The cow-calf industry in the Western United States is very dependent on roughages for maintaining brood cows. A large portion of the roughage is harvested forage fed to cattle during the winter months. Over one million acres of native meadow hay is produced in the West along with sizable acreages of dryland rye hay, cereal straws and alfalfa for maintaining cow herds.

Previous research by the Lilly Research Laboratories has shown that monensin (trade name Rumensin), a biologically active compound produced by *streptomyces cinnamonensis*, has reduced feed intake without a reduction in daily gain of feedlot cattle and increased gains on pasture fed cattle. Rumensin improves feed efficiency by increasing the production of propionic acid, with total volatile fatty acids remaining the same. This apparently is a more efficient energy pathway and increases energy available to the animal for productive purposes.

If similar results with Rumensin can be obtained with cows on a maintenance ration, the net result would be a savings of higher quality roughages. This may provide a means to increase the size of an individual cow herd or at least reduce the total hay requirement. With low quality roughages that do not meet the maintenance requirements, an increased energy value would, in some cases, allow them to be fed alone or at least create a substantial savings in supplemental feed required.

The study reported here was conducted to test the effect of Rumensin on feed efficiency for maintaining cows on meadow hay and to determine if winter feeding of Rumensin has any subsequent effect on reproductive or productive performance.

EXPERIMENTAL PROCEDURE

Forty-eight spring-calving cows were stratified by age and weight of cow to two treatments with three replications. Treatments included a control group receiving no Rumensin and a group on 200 mg of Rumensin per head per day. One pound of barley per head per day was used to assure intake of the Rumensin, the palatability of which is not well documented. Control animals also received a pound of barley.

The individual feeding facilities in the barn and adjacent lots at Section 5 were utilized for this trial. Each lot or replication consisted of eight head. Cows were brought into the barn each morning to receive their supplement on an individual basis. The remainder of the day the cows were turned out in the adjacent lots where they had free access to water, salt, a 50-50 mix of bonemeal and salt and hay free choice. Hay intake was measured by weighing hay in daily with refusals weighed back weekly. Hay was sampled for chemical analysis.

Cows were weighed every 28 days after an overnight shrink from feed and water. Fecal samples were taken prior to the initiation of the trial to check for coccidiosis. Monensin is widely used as an anticoccidial and in order not to confound the experiment it was necessary to insure that the cows used in this trial were free of coccidial agents. Rumen samples were taken to determine total volatile fatty acids and the relative proportions of these.

Calving dates and birth weights were recorded so adjustments could be made for differences in weight change due to pregnancy, if needed. Subsequent conception rate was determined by rectal palpation and calving interval will be recorded when these cows calve again. Interval to first estrus was also obtained.

RESULTS AND DISCUSSION

Gain data and hay intake results over a 98 day period beginning on November 21 and ending on February 27 are presented in Table 1. Initial weights were 1015 and 1022 pounds for controls and Rumensin supplemented cows, respectively, with final weight being 1064 and 1115 pounds. Control cows gained 49 pounds or 0.50 pound per day over the trial period and Rumensin fed cows gained 93 pounds or 0.95 pound per day. Control cows consumed 25.1 pounds of hay per day and Rumensin supplemented cows 24.1 pounds.

These results show that Rumensin did increase feed efficiency substantially. Daily gain was almost doubled by feeding 200 mg of Rumensin and hay intake was slightly less. There was only a six day difference in stage of gestation between the two treatments with control cows being the furthest along. Differences in gain due to pregnancy between treatments were small and accounted for slightly more (0.04 pound per day) of the control cows' gain than those on Rumensin. The actual gain difference between treatments would be slightly greater in favor of Rumensin fed cows if this adjustment were made, however, the effect is quite small.

There were no differences in conception, with all cows in both treatments being found pregnant by rectal palpation after a 60-day breeding season. However, cows on Rumensin were found in first estrus after calving 13 days earlier than control cows. Estrus checks were taken with marker bulls for about 120 days after calving and all cows from the Rumensin treatment were found in heat and averaged 30 days to first estrus, whereas six control cows were not found in heat during this time and those that were averaged 43 days. Calving dates will be recorded this year and the calving interval calculated. This could be very important with a marginal maintenance ration.

Table 1. Gain data and hay intake over the 98 day trial period

Treatment Lot number	Initial weight	Final weight	Hay intake	Average daily gain
	lb	lb	lb	lb
Control				
1	1038	1060	25.1	0.22
3	992	1062	24.9	0.73
5	1016	1070	25.2	0.55
Average	1015	1064	25.1	0.50
Rumensin				
2	1039	1133	24.4	0.97
4	1032	1130	24.4	1.00
6	996	1083	23.3	0.88
Average	1022	1115	24.1	0.95

Table 2 shows the total volatile fatty acids in the rumen fluid and proportions of propiónic, acetic and butyric. Rumensin increased propionate by about 5 1/2% and decreased acetic by about 4% and butyric by 1 1/2%. Increasing propionate at the expense of acetic and butyric improves the efficiency of energy conversion in ruminants. In this study the improved energy utilization gave us increased gains on slightly less feed.

In this study these cows were carrying excess flesh at the end of the winter period. This trial is being repeated this year and the results are similar at this point. In future trials we would like to see just how much hay could be saved by limit feeding hay with Rumensin and still get these cows through the winter in good enough condition as to not adversely affect their productive or reproductive performance. Results with Rumensin for brood cows at this point would indicate that the greatest return would be using it for maintaining cows. These cows were continued on Rumensin on through lactation to study long term effects and preliminary results indicate that weaning weights may have been adversely affected. We hope to run trials to see if this is true and if so if milk composition or quantity of milk is being affected. Weaning weights from this years trial will be tabulated to determine if treatments imposed during the winter had any affect on subsequent productive performance. These cows will not be fed Rumensin during lactation.

Table 2. Volatile fatty acid data[1/]

Treatment Lot number	Total mM/L	Molar % Acetate	Molar % Propionate	Molar % Butyrate
Control				
1	72.0	76.3	17.0	6.7
3	65.4	76.8	17.0	6.2
5	67.1	75.6	17.7	6.7
Average	68.2	76.2	17.2	6.5
Rumensin				
2	73.4	70.7	24.4	4.9
4	78.4	72.8	22.2	5.1
6	64.7	73.8	21.3	5.0
Average	72.2	72.4	22.6	5.0

1/ Rumen samples taken from three animals per lot.

This is an exciting new product which has just recently been cleared for feeding cattle in confinement for slaughter. Hopefully Rumensin will eventually be cleared for use as described in this paper.

ANAPLASMOSIS STUDIES CONDUCTED ON THE SQUAW BUTTE RANGE

K. J. Peterson, R. J. Raleigh, R. Stroud, and H. A. Turner

Anaplasmosis is one of the major diseases of beef cattle in the United States. Losses are difficult to estimate but is is believed that the disease costs the cattle industry at least 100 million dollars per year. In addition, state and international regulations prohibiting the introduction of anaplasmosis infected and exposed cattle are increasing. These regulations may seriously limit cattle sales from herds in which anaplasmosis is present. The disease is prevalent in eastern, central, and southern Oregon, but is seldom observed west of the Cascade Mountains, north of Roseburg.

Anaplasmosis is caused by a microscopic blood parasite, *Anaplasma marginale*. Small amounts of blood transferred from a sick or healthy appearing carrier animal to a susceptible animal will transmit the disease. Certain species of blood feeding ticks, flies and mosquitoes transmit the disease by first feeding on infected animals and then on susceptible animals. It is often transmitted during vaccination, dehorning, ear tagging, or by other surgical procedures when contaminated instruments are used. It is a disease of cattle and is of no importance in other livestock. However, the California black-tailed deer (*Odocileus hemionus columbianus*) is susceptible and many in California are carriers of the disease. There remains a question concerning mule deer (*Odocileus hemionus hemionus*) but research conducted recently in eastern Oregon demonstrated no anaplasmosis in 31 mule deer sampled.

Anaplasmosis manifests itself in three forms; peracute, acute, and chronic. The peracute form is characterized by its sudden onset and rapidly fatal course. Usually the animal is found dead. The acute form is characterized by sudden onset, rise in body temperature, difficult or labored breathing, often excitement, and anemia. Icterus, or a yellowing of the membranes may develop later. The infected animal may be ill for several days, may die, or may recover. Recovery may be complete or the disease may develop into the chronic form. In the chronic form, there may be a long convalescent period or the animal may never completely recover. Animals that become infected and develop the disease usually remain carriers for the remainder of their lives.

Losses in calves are rare; they do become infected but seldom become visibly ill. Yearlings often become ill but seldom die while older cattle often develop the acute or peracute forms. Pregnant cows may abort if infected. Adult bulls seem especially susceptible.

RESEARCH CONDUCTED AT SQUAW BUTTE

To increase our knowledge of anaplasmosis as it occurs in eastern and central Oregon as well as in many other Rocky Mountain and Northwest states, a series of studies have been conducted at Squaw Butte. These have been interdisciplinary studies involving the School of Veterinary Medicine, Squaw Butte Experiment Station, and the Department of Entomology of Oregon State University.

The first study was initiated to determine whether the disease was transmitted on the range by ticks, flying blood feeding insects, or both. In the gulf states, horse flies, deer flies, and mosquitoes are the important transmittors of anaplasmosis while in western California a tick is responsible for most transmissions. In this study tick transmission was eliminated by maintaining anaplasmosis free susceptible cattle on tick proof platforms. Two platforms, each capable of holding 10 large calves, were constructed approximately two miles apart on the Squaw Butte high desert range. Twenty anaplasmosis free calves between five and six months of age were hauled from the Willamette Valley on April 29, 1974 and unloaded directly onto the platforms. Ten anaplasmosis free control calves of approximately the same age were maintained on the pasture surrounding each platform. An equal number of infected cows, maintained as a source of infection, were also pastured around the platform. The only water available to the cows and control calves was in tanks immediately adjacent to the platform. This close association between the infected cows and platform calves increased the possibility of insect transmission. The trial was terminated on November 11, 1974. No transmission occurred in the platform calves while 52% of the control calves exposed to ticks became infected.

In 1975 a similar trial was conducted using only one tick-proof platform. On May 5, 1975, eight anaplasmosis free calves were placed on this platform with a known infected steer. The purpose of this procedure was to increase the possibility of insect transmission. Control calves and infected cows were maintained around the platform as in the 1974 trial. The study was terminated on October 8, 1975. None of the platform calves developed the disease, whereas 44% of the controls became infected.

This two year study demonstrates that insects are not important in the transmission of anaplasmosis on the Squaw Butte range. Ticks apparently are the vectors.

The only tick in central and eastern Oregon considered to be the likely transmittor of anaplasmosis is the Rocky Mountain wood tick (*Dermacentor andersoni*). This tick is commonly observed on cattle during the spring and summer months. It is an important vector of human Rocky Mountain spotted fever, Colorado tick fever, and tularemia. It also causes tick paralysis in man cattle, dogs, and other animals. Laboratory studies have demonstrated this tick is capable of transmitting anaplasmosis and that the disease may persist in the male tick for more than six months. However, the method of transmission in nature is not fully understood, nor is the period of time known that the tick remains infective. The life span of this tick is usually two to three years.

Before anaplasmosis control methods can be developed for central and eastern Oregon it is essential to determine whether the infective organism persists in the tick over winter. If it does persist, control will be very difficult. To study this problem, another trial was conducted during the 1975 grazing season at Squaw Butte.

Thirty-five anaplasmosis free holstein steers, seven to eight months old, were trucked from the Willamette Valley on April 22, 1975 and unloaded directly onto a 1,278 acre range pasture.

Thirty anaplasmosis free herefords approximately the same age were placed at the same time in the adjoining pasture. These calves were maintained with the adult herd which is approximately 70% infected. The holstein steers were separated from the controls and infected adults by a double fence inclosing a 20 to 30 foot strip. The pastures were as identical as possible relative to types of forage, other vegetation, species of small animals, and other wildlife and species of insects. Rock Mountain wood ticks were prevalent in both pastures, and both had been grazed by the infected herd during 1974 and many years previously.

The holstein steers were observed daily. Blood samples were collected bi-weekly for hematologic studies and for testing by the anaplasmosis card agglutination test (CT). At this time the steers were also examined for the presence of ticks. The controls were CT tested prior to movement to the pasture, once during the summer, and at trial termination. All animals were removed from the pastures on September 4, 1975 and were trucked to the winter headquarter ranch. Tick activity had ceased prior to this movement. On October 10, the final test was conducted on both holstein steers and the controls. None of the susceptible holstein steers developed the disease while 19 of 30 (63%) of the controls maintained with the adults became infected. Exposure to the Rocky Mountain wood tick should have been similar in both groups. This is a significant finding as it demonstrated that anaplasmosis did not overwinter on this range. Susceptible cattle isolated from infected cattle only by a 20 to 30 foot strip of land did not become infected.

In summary, two years of data from the anaplasmosis platform studies on the Squaw Butte high desert range demonstrates (1) that flying blood feeding insects are of no importance in the transmission of anaplasmosis on this range; (2) the Rocky Mountain wood tick appears to be the only important vector; and (3) during the tick exposure period, a high rate of transmission occurs in the susceptible cattle maintained in direct contact with infected cattle. One year's data to study the infective organism's persistance in the tick over winter indicates that (1) the disease did not overwinter on this range, as susceptible anaplasmosis free cattle remained free of infection when direct contact with infected cattle was prevented; (2) rodents and other small animals present on this range are not latent carriers of anaplasmosis; and (3) mule deer inhabiting this range were not important reservoirs of infection.

WEANING MANAGEMENT OF SPRING CALVES ON FORESTED RANGES

M. Vavra, R. L. Phillips and M. M. Wing

As the grazing season progresses from spring to fall, forage quality decreases. Published research by the Forest Service on northern California forested ranges revealed that yearlings made 75% of the summer's weight gain prior to August 1. The grazing period was from June 1 to September 30. Calves left on range with their dams usually do not gain weight in the fall because of a lack of high quality forage to meet the calf's requirement for growth and the cow's requirement for milk production. Maintaining a calf on fall range with no increase in weight or even some loss in weight does not improve income from those calves when sold later in the fall. It is advantageous to find a management tool that can provide for continued growth of calves during the fall months. Weaning the calves early and allowing them to graze hay aftermath is one approach. By September calves are capable of consuming enough forage for adequate growth, providing forage quality is high. Meadows that have been irrigated after hay harvest should provide a high quality forage.

Early weaning of calves has several fringe benefits. Weaning when the weather is warm and dry reduces stress to the calf and therefore less incidence of respiratory diseases common to weaning time. Also, in this type of management the calves will be sold after stress of weaning, and if sold directly off the ranch should bring more for this "preconditioning". Cows without calves will graze rough ground and do a better job of forage utilization in more inaccessible areas. As a result, condition of the cow going into the winter should improve.

PROCEDURE

This study was conducted to evaluate calf performance as influenced by two weaning times. Additionally, both weaning groups were further divided to observe the effect of vaccination for shipping fever - IBR complex at weaning for the prevention of respiratory problems post-weaning. Treatments applied were early weaned and vaccinated, early weaned with no vaccination, late weaned and vaccinated and late weaned with no vaccination. Early weaning was on September 17 and late weaning on October 15. Twenty-five calves were used in each treatment.

After weaning the calves were allowed to graze a barley stubble field for one week. During that time some alfalfa hay was fed with bloat blocks available so that calves could be switched to alfalfa aftermath with minimal problems. The pasture used was an alfalfa-orchardgrass meadow with two cuttings of hay removed and then irrigated. Bloat blocks were available to the calves at all times. Calves were observed daily for bloat and for symptoms of respiratory ailments.

RESULTS AND DISCUSSION

Table 1 presents the results of the study. Calves in all treatments were weighed on August 20 and again on September 17, the early weaning date, to get an indication of pretreatment gains. Calves in all groups gained similarly during the period previous to the early weaning. Calves were again weighed on October 15 when the late weaned groups were weaned. Calves early-weaned gained a pound per day during this period while those left on range with their dams gained less than half a pound. During the final period of the study, all treatment groups gained similarly. Apparently weaning stress was small in all groups as reflected by animal performance during the post weaning period.

Table 1. Calf weights and daily gains during the study period

Treatment	8/20	9/17	10/15	11/18	Total gain
	lb	lb	lb	lb	
Early weaned					
Vaccinated	366	431(2.4)1/	464(1.2)	505(1.3)	74
No vaccination	378	449(2.5)	478(1.0)	512(1.0)	63
Avg. early weaned	372	440(2.5)	471(1.1)	509(1.2)	69
Late weaned					
Vaccinated	374	441(2.4)	451(0.3)	486(1.1)	45
No vaccination	374	436(2.3)	431(0.4)	487(1.2)	51
Avg. late weaned	374	439(2.4)	441(0.4)	487(1.2)	48
Avg. vaccinated	370	436(2.4)	458(0.8)	496(1.2)	60
Avg. no vaccination	376	443(2.4)	445(0.7)	500(1.1)	57

1/ Numbers in parenthesis represent the average daily gain between each weight period.

No calves were diagnosed with respiratory problems during the post-weaning periods during this study. However, the station herd has had problems in other years. Outbreaks of post-weaning respiratory problems are very sporadic and vaccination treatments will be studied for two more years.

Early weaned calves gained 21 pounds more per head than late weaned calves during the fall grazing period (September 17 to November 18). With steer calves selling at $0.35 a pound and heifers at $0.27 returns would be $7.35 and $5.67 more per calf for each respective sex on the early weaning treatment.

Early weaning does mean that cattle must be gathered around September 1-15. On some operations late-season moves are common and no problem would occur. However, on other operations a special gather would have to be made. Other management procedures such as pregnancy testing, treating bad eyes and feet, and culling cows could be handled at this time. If adequate forage is available, cows without calves, to be culled later, would be heavier in the fall at sale time.

THE PERFORMANCE OF INDUCED CRYPTORCHIDS AND STEERS

M. Vavra and R. L. Phillips

Over the past few years much controversy has developed over the livestock growth stimulant Diethylstilbestrol (DES). DES had been banned by the Food and Drug Administration and then reinstated by a court decision. There have been and still are movements in Congress to ban its use as a livestock growth stimulant. This is not consistant with overall goals of increasing efficiency, using less grain and producing leaner carcasses.

Feeding bulls is an immediate alternative as bulls will gain faster and more efficiently than steers. However, bull feeding has several disadvantages. Bulls are difficult to manage, grade lower, and develop undesirable secondary sex characteristics. The relatively new grade of Bullock has only added confusion.

This study was undertaken to evaluate induced cryptorchids as potential slaughter cattle. Cryptorchids are produced by pushing the testicles up into or next to the body cavity and placing a rubber band around the empty sac which then falls off and the testicles remain in or next to the body cavity. Some researchers have coined the term "short scrotum bulls" when describing cyrptorchids. The theory is that by inducing cryptorchidism the ability of the intact animal to gain faster and more efficiently than steers will be retained but the development of undesirable "bullish" characteristics will be stopped or retarded.

EXPERIMENTAL PROCEDURE

Male calves of the 1972, 1973 and 1974 calf crops were used in the experiment. Originally the animals were put in five treatments. However, one treatment contained DES so when it was banned Zeranol was substituted. When DES was again allowed on the market a sixth group was added so both DES and Zeranol could be used. The six treatments were: 1) made cryptorchid at birth; 2) made cryptorchid at 60 days of age; 3) castrated at birth; 4) castrated at 60 days; 5) castrated at birth and DES implants; 6) castrated at birth and Zeranol implants. DES implanted calves received 6 mg at birth, 15 mg at 60 days of age, 15 mg upon entering the feedlot and 15 mg midway through the feeding period. Zeranol implanting followed the same time schedule but the doses were 12, 24, 36 and 36 mg.

Weights were taken periodically and average daily gains recorded. The animals were group-fed by treatment so an estimate of feed efficiency could be made. Carcass data were collected at slaughter.

RESULTS AND DISCUSSION

Performance data are presented in Table 1. While in the feedlot all cattle were fed similarly. Standard feedlot procedures were followed. As time on feed increased the amount of energy in the diet increased and fiber decreased

Table 1. Suckling and feedlot performance

	Cryptorchids		Steers		Implanted Steers 1/	
Item	Birth	60 days	Birth	60 days	DES	Zeranol
Weaning wt., lb.	410	407	403	409	420	403
Suckling ADG, lb.	1.93	1.92	1.83	1.92	1.81	1.92
Wt. into feedlot, lb.	500	488	486	483	494	483
Final wt., lb.	1070	1038	1029	1013	1062	1019
Feedlot ADG, lb.	2.79	2.61	2.25	2.20	2.57	2.39
Feed conversion, lb.	6.6	6.7	7.4	7.5	7.0	7.6
Days on feed	208	210	242	242	221	224

1/ Data somewhat limited because these groups were not represented in all three years.

The effects of cryptorchidism and implanting did not show up in the suckling calf. Little difference among groups in average daily gain was observed.

Feedlot performance was highest in the two cryptorchid groups, with Cryptorchids gaining at a faster rate than any of the steer groups. Zeranol and DES implanted steers out-gained the non-implanted steers. Steers implanted with DES gained slightly more than those implanted with Zeranol. Both cryptorchid groups were on feed the least number of days (208, 210), while non-implanted steers were on feed the longest (242, 242). Implanted steers were intermediate (221, 224). Late in the feeding period the cryptorchids became more bull-like. Riding and bellowing occurred regularly and the hair on the face began to curl.

Carcass data, Table 2, revealed that the cryptorchids were superior to any of the steer groups in yield grade and ribeye area. Backfat thickness did not show specific trends. However, USDA grades showed definite differences. None of the cryptorchids graded Choice, while several of the steers among all three steer groups graded Choice. The steers implanted with Zeranol have a lower percentage of Choice because they were not fed in 1972 when the Choice/Good ratio was highest of the three study years. Cryptorchids sold in 1973 all graded High Good. However, in 1974, 12 of the 19 cryptorchids sold were designated Bullock and were dark cutters. They graded High Good but because of the dark cutter designation and Bullock grade were dropped 2/3 of a grade. In 1974, 12 of 14 cryptorchids sold were graded Bullock but none were dark cutters. In 1972 testicles were removed at slaughter but during the next two years they were left on the carcasses. Average conformation scores were 17.9, 18.6, 17.4, 17.5, 17.8, and 18.0 (17=Choice, 19=Prime-) for treatment 1 through 6, respectively. Cryptorchids graded very well based on conformation, as good or better than steers. Therefore, the cryptorchids probably were graded Bullock more because of the presence of testicles on the carcass than on a "bullish" conformation.

Table 2. Carcass data

	Cryptorchids		Steers		Implanted Steers 1/	
Item	Birth	60 days	Birth	60 days	DES	Zeranol
Warm carcass wt., lb.	629	617	604	576	617	593
Ribeye area, sq. in.	12.7	12.3	10.8	10.6	11.2	10.7
Backfat, inches	0.34	0.40	0.47	0.32	0.35	0.48
USDA grade 1/	14.4	14.5	15.4	15.3	15.3	14.6
Number choice	0	0	11	11	8	3
Number good	26	26	15	16	10	17
Yield	2.00	1.95	2.72	2.51	2.52	2.67

1/ Based on 14=Good, 15=Good+, 16=Choice-, 17=Choice.

If cryptorchids are to be marketed profitably it may require a change in the procedure of leaving the testicles on the carcass or a change in the Bullock grade. The occurrence of dark cutters may be reduced by improved handling of these animals prior to slaughter. Cryptorchids may net more even with less money per pound, due to the shorter feeding period and increased efficiency of feed.

Data presented indicate that:

1. Cryptorchids gain more rapidly than steers.

2. Implanted steers gain more rpaidly than non-implanted steers.

3. Feed efficiency is better with cryptorchids.

4. At 1000-1100 pounds cryptorchids lack sufficient marbling to grade Choice, however, yield grades and ribeye areas are superior to steers.

5. The occurrence of dark cutters and carcasses grading Bullock pose serious problems.

6. Secondary sex characteristics and "bull-like" behavior occur toward the end of the feeding period with cryptorchids.

Induced cryptorchidism is a tool that can be used to improve average daily gain and efficiency of feedlot cattle. The occurrence of secondary sex characteristics late in the feeding period suggests that cryptorchids should be put in the feedlot at weaning and slaughtered by 18 months of age. For this reason, cryptorchids would definitely not fit a yearling program. The carcass produced can be expected to grade Good but have a yield of 2. The carcass may also be graded as "Bullock" or be a dark cutter, and consequently it will be docked about 2/3 of a grade and worth less. Based on the carcass data presented more information should be gathered before cyrptorchids could be recommended.

PREVIOUS LIVESTOCK FIELD DAY REPORTS
SQUAW BUTTE EXPERIMENT STATION

These reports are available upon request from the Squaw Butte Experiment Station, P. O. Box 833, Burns, Oregon 97720.

THE ESTABLISHMENT AND MANAGEMENT OF ALFALFA IN CENTRAL OREGON

W. M. Murphy and M. J. Johnson[1]

INTRODUCTION

Alfalfa is an extremely important crop in the agricultural economy of Central Oregon. Some of the alfalfa is fed in livestock operations on the farms where it is produced, but most of it is sold as baled hay for use in other parts of the state and region.

Annual yields of 4 to 5 tons of hay per acre have been considered to be very good. However, if proper establishment and management practices are conscientiously applied, much higher yields are possible. Studies conducted at the Central Oregon Experiment Station, Redmond, have clearly shown that yields greater than 8 tons of hay per acre per year are obtainable (Table 1).

Table 1. Yields of alfalfa test varieties grown at the Central Oregon Experiment Station, Redmond, 1970-1974.

Variety	Air-dry hay, tons/acre					
	1970	1971	1972	1973	1974	average
Scout	7.63a-d*	8.16a-c	7.81a-c	5.86a	5.48ab	6.99
Washoe	6.32e	8.04a-d	7.63bc	5.48a	4.84a-c	6.46
Mark II	8.28ab	8.02a-d	8.19ab	5.64a	5.23ab	7.07
Ladak	7.96a-c	8.84a	7.05c	5.06a	5.01a-c	6.78
Vernal	7.88a-d	7.95a-d	8.30ab	5.72a	5.78ab	7.13
Cayuga	7.01cd	7.64b-f	8.22ab	5.71a	5.57ab	6.83
Narragansett	8.00a-c	7.42b-g	7.82a-c	6.00a	5.36ab	6.92
Dawson	7.54a-d	7.01d-g	8.10ab	5.45a	5.22ab	6.66
Saranac	8.50a	7.31c-g	8.42a	6.08a	5.73ab	7.21
Iroquois	8.04ab	8.09a-c	8.36ab	5.92a	5.75ab	7.23
Titan	7.72a-d	7.83a-e	7.89a-c	5.44a	5.96a	6.97
Apex	7.97a-c	8.30a-c	8.09ab	5.48a	5.18ab	7.00
Alfa	8.14ab	8.43ab	8.12ab	4.72a	4.70bc	6.82
Golden Gro	8.05ab	7.42b-g	8.36ab	5.48a	4.96a-c	6.85
NK919	8.30ab	7.00d-g	7.82a-c	5.63a	4.97a-c	6.74
Resistador	7.35b-d	6.49g	8.21ab	5.64a	4.02c	6.34
Promor	7.93a-c	6.83e-g	8.05ab	5.97a	5.19ab	6.79
Haymor	7.44b-d	6.64fg	7.92a-c	5.52a	5.11ab	6.53
Ranger	6.91de	6.77fg	7.62bc	5.71a	5.48ab	6.50

*Values within a year column followed by different letters are significantly different at the 5% level by Duncan's New Multiple Range Test.

[1]Research Agronomist and Superintendent, respectively, Central Oregon Experiment Station, Redmond, Oregon.

ESTABLISHING THE STAND

The successful establishment of a good stand of alfalfa is practically guaranteed if several factors are taken into consideration, and proven procedures are followed.

SOIL CONDITIONS

Soil Testing

The best way to determine soil fertility levels is to use a soil test. Soil tests should be taken not only before planting but throughout the life of the stand to maintain soil fertility at an optimum level for maximum yields. The cost of a soil test is insignificant in comparison to the loss in yield which might occur if nutrients become limiting.

Fertilizers

When alfalfa is harvested, a continuous depletion of mineral nutrients occurs. The approximate amounts of nutrients removed each year by 5 tons of alfalfa hay are shown in Table 2. Unless maintenance fertilizer is applied, it is likely that one or more nutrients will become deficient on soils that are cropped for any length of time.

Table 2. Plant nutrients removed by 5 tons of alfalfa hay.

Element	N	P	K	Ca	Mg	S
Removal, lb/acre	250	25	250	175	30	25

Adapted from Rhykerd, C. L., and C. J. Overdahl (11).

Nitrogen (N) is one of the elements that is utilized in greatest amounts by alfalfa. If the alfalfa is effectively nodulated with N-fixing bacteria (Rhizobia), enough N is fixed from the atmosphere to meet the requirements of the plants.

In Central Oregon, however, it is not unusual for farmers to apply N fertilizer at the time of seeding alfalfa or on established stands. If proper establishment and management practices are neglected, the plants and Rhizobia may be stressed by adverse soil and/or moisture conditions, and N fixation will decrease or stop completely. Under these circumstances, it is necessary to supply part or all of the required N through application of N fertilizer. It is noteworthy that alfalfa yields in excess of 8 tons of hay per acre (Table 1) were produced at the Central Oregon Experiment Station without application of N fertilizer. The practice of routinely applying N fertilizer at the time of seeding alfalfa is not recommended, since this may interfere with normal nodulation of the plants.

Phosphorus (P) is involved in many essential processes in plants. Growth of alfalfa plants is slow on a soil low in P, and yields may be much lower than the potential maximum obtainable if P levels in the soil were adequate. A soil test reading of 15 ppm P (Olsen Bicarbonate Method) (8) is considered to be satisfactory for maximum growth of alfalfa in Central Oregon. In a 1974 soil-test survey of 42 Central Oregon alfalfa fields, only 19 (45.2%) had readings of 15 ppm or greater. Eight ranged from 11 to 14 ppm and 15 ranged from 5 to 10 ppm. This indicates that 54.8% of the alfalfa production in the area might be improved by application of P.

Phosphorus fertilizer can be applied before seeding, during seeding, or broadcast on the established stand. Where soil test levels are below 15 ppm, it is advisable to plow down 40 to 80 pounds of P per acre, depending on the soil test, before seeding. It can be applied most effectively during seeding by banding 1 inch below the seed.

The concentration of potassium (K) is higher in alfalfa than any other mineral element except nitrogen. Potassium is essential for many plant processes and promotes the development of hardiness for over-wintering. If sufficient K is not available in the soil, alfalfa stands rapidly thin out and are invaded by grasses and weeds. A soil test reading of 150 ppm K (1:20 NH_4OAC method) (12) is considered to be adequate for maximum production of alfalfa in Central Oregon. In a 1974 soil-test survey, five (11.9%) out of 42 fields ranged from 76 to 116 ppm K. On such fields, it is necessary to apply 100 to 200 pounds of K per acre at the time of seeding or to top-dress with the same amount of K fertilizer to maintain productivity and persistence of the stand.

It is necessary to apply sulfur (S) on most soils in the area. While only 25 pounds of S are required to produce 5 tons of alfalfa hay, S (as SO_4) is subject to leaching from most Central Oregon Soils.

Consequently, the following annual applications of S per acre should be made: loamy sand soils: 100 pounds; sandy loam soils: 80 pounds; loam soils: 50 pounds. It should be applied in the fall or spring and early summer, preferably in two, 50-50 split applications to minimize loss due to leaching. On most soils it should be applied as gypsum or as contained in ordinary superphosphate so that the soil pH is not lowered, as would occur if elemental S were to be applied.

Liming

Alfalfa and Rhizobia are extremely sensitive to soil pH. A soil pH range of 6.5 to 7.5 is ideal for growth of the plant. It is also the range in which N fixation occurs at the highest rate. Soil acidity should be corrected by applying the rate of lime recommended by a soil test. Since lime is slow to react with the soil, it should be applied at least 6 months before seeding. One of the best methods of applying lime is to broadcast 50% of the amount to be applied on the soil surface before plowing. The remaining 50% is applied after plowing and is disced into the soil. This procedure helps to mix the lime with the soil throughout the major rooting zone of the alfalfa.

In correcting soil acidity for the alfalfa and Rhizobia, liming also increases the decomposition of organic residues by microorganisms, which consequently results in the release of plant nutrients. Liming also increases the availability of P and molybdenum (Mo), and decreases the solubility of iron (Fe), aluminum (Al), and manganese (Mn). In some soils, the high concentration of Al and/or Mn under acid conditions may result in poor growth of alfalfa. Molybdenum is essential in the nitrogen-fixation process and may limit production on some Central Oregon soils under acid conditions (3, 4, 5, 7, 11, 14).

Seedbed Preparation

The seedbed should be moist and firm, with some looseness at the surface for coverage of seed. A firm seedbed maintains soil moisture for seedling roots. Many seedlings die in a loose seedbed with large air spaces because their roots die when they reach the air spaces. Moisture is lost more rapidly from a loose seedbed than from a firm one. It is especially necessary that sandy soils be firm because they lose moisture rapidly if they are loose. Irrigation before seeding assists in firming the seedbed and enhances the effectiveness of inoculation.

INOCULATION

One of the major problems in establishing and maintaining productive alfalfa stands in Central Oregon is the failure to achieve effective nodulation of the plants. If alfalfa is effectively nodulated, yields are increased, quality is improved, protein content is higher, and plant survival is greater. Without nodulation, the plants suffer from N deficiency, yields decrease, and the stand rapidly degenerates. Therefore, it is absolutely essential to inoculate alfalfa seed with a vigorous and effective strain of _Rhizobia_ to nodulate the plants so that N fixation can occur at a high rate.

If a few simple steps of the inoculation procedure are followed, successful nodulation of alfalfa is usually obtained.

1. Use only fresh inoculants specifically for alfalfa that have been stored under refrigeration until the time of planting. If the inoculant has not been stored under refrigeration where it is sold, do not purchase it. Do not use inoculants after the expiration date of the package. Sufficient numbers of viable _Rhizobia_ are present in the package for about 4 months from time of packaging if kept under refrigeration, and for only 3 to 4 weeks without refrigeration. It is best to reinoculate pre-inoculated seed, because the conditions under which the seed was stored usually are not known. Use two or three times the amount of inoculum specified on the package. It is not possible to over-inoculate.

2. In spite of the directions usually found on inoculant containers, dry application of inoculum is not recommended, because only about 20% of the dry inoculum adheres to the seed. Also, survival of the _Rhizobia_ on the seed is less if applied dry. A special slurry method of inoculation should be used to insure maximum survival of the _Rhizobia_ on the seed. Suspend the inoculum in about a quart of 25% sugar solution for each 100 pounds of seed. Just before planting, mix the slurry and seed together thoroughly, before placing in the seeder box. If the seed-slurry mixture is too moist for planting, add small amounts of finely ground limestone to soak up the excess moisture. With this method of inoculation, it is best to recalibrate the seeder to be certain the desired amount of seed is being planted.

3. Inoculate in the shade--never in direct sunlight--because the ultra-violet rays in sunlight kill the Rhizobia.

4. Plant the seed as quickly as possible after inoculation (2, 4).

RATE OF SEEDING

Twelve to 15 pounds of seed per acre are sufficient to obtain a good stand of alfalfa. Use only good seed, having high percentages of purity and germination (4, 14, 17, 20).

METHOD OF SEEDING

Basically, two machines are available for planting alfalfa. Probably the most used is a grain drill with a legume-seeder attachment or corrugated roller for compaction. Optimum coverage of the seed ranges from ¼ to ½ inch on heavy soils and ½ to 1 inch on sandy soils. A cultipacker seeder can give excellent results because seed coverage is nearly optimal and the seedbed is firmed. The cultipacker works well on all soils except if used on a powder or dry sandy seedbed where the soil may roll and result in excessive coverage of the seed. An advantage of the grain drill is that fertilizer can be banded below the seed in the same operation. Also, a grain drill serves to plant other crops (4, 14, 17).

IRRIGATION

Dry soil conditions kill more alfalfa seedlings than any other cause. If the seedbed has been properly prepared and is moist, irrigation after planting for plant emergence is unnecessary. If possible, irrigation after emergence should be withheld until the plants are 3 to 4 inches tall and have three or more true leaves. On some soils it may be necessary to irrigate to soften any crust formation to permit seedling emergence. Frequent irrigations may be necessary on sandy or saline soils to prevent moisture stress of the seedlings (16).

Emerging seedlings are extremely sensitive to soil water conditions. Young seedlings have shallow roots and are severely stressed during warm weather with drying winds. Irrigations should be applied so as to maintain the moisture conditions at slightly less than field capacity. Withholding irrigation in an attempt to force the plants to develop deep roots is not recommended (9, 16).

TIME OF SEEDING

In Central Oregon three climatic factors reduce the chances of obtaining a satisfactory stand of alfalfa:

1. Frost during the period of growth between emergence of the seedlings and the formation of true leaves.
2. High temperatures during July and early August.
3. Frost heaving of small plants during fall and winter.

The two most opportune times for seeding alfalfa in the area are in the spring and late summer.

Spring seedings made during the first week of June usually are not damaged by frost and become established well enough to survive the high temperatures of July and August. Spring seedings must be made either with a herbicide or a companion crop to control weeds. On light sandy soils, 2 pounds per acre of EPTC (Eptam) herbicide applied according to recommendations provides good control of annual grass and broadleaf weeds in establishment of alfalfa. Use 3 pounds per acre on heavier soils (1). Spring seedings made with a herbicide usually may be harvested in the late summer and will yield 1 to 1.5 tons of hay per acre. Although a companion crop provides some income as grain or hay, it may compete so severely with the alfalfa seedlings for water, nutrients, light, and space that the alfalfa stand would be greatly reduced. For this reason, the use of companion crops to control weeds in spring-seeded alfalfa is not recommended in Central Oregon.

Late summer seedings made before August 15 usually become established well enough to resist heaving by frost in the following fall and winter. Annual weeds usually are not a problem because weather and light conditions at this time discourage their growth. The seeding may be made in the stubble of an oat or barley hay crop, thereby permitting some production to be realized from the field in the alfalfa seeding year.

MANAGING THE STAND

In some respects, management of alfalfa for maximum production and persistence in Central Oregon is even more difficult and more critical than in other northern areas of the United States. Dry, hot summer conditions require careful and correct irrigation practices. Cold winters without continual snow cover and with freezing and thawing conditions make fall management for development for hardiness especially critical. The soils are complex, with wide variation in depth, drainage, texture, water-holding capacity, and fertility, making it very difficult to achieve and maintain correct soil conditions for alfalfa.

If the best available practices are diligently followed, effects from these environmental factors can be minimized. High yields of 6 to 8 tons of alfalfa hay per acre per year from long-lived stands are possible in Central Oregon.

IRRIGATION

One of the major problems in the management of alfalfa in Central Oregon lies in achieving proper irrigation. Much of the alfalfa grown in the area is not irrigated properly. On a given summer day any number of fields or parts of fields can be found in which the alfalfa plants are wilting or near the wilting point. After each cutting, bales of hay are left on fields for excessive lengths of time, during which no irrigation can be applied. This practice not only retards regrowth of the plants, but also kills plants by smothering and lack of sunlight beneath the bales.

Three factors must be taken into consideration in determining when to irrigate alfalfa: water availability, soil water-storage capacity, and crop needs. If water is available to irrigate, crop needs are then most important.

Central Oregon soils generally are shallow and have low water-holding capacities. Moisture conditions in such soils can change rapidly. Consequently, irrigations should be made when available soil moisture is about 50% of field capacity (13).

Two practical methods are available to determine the amount and timing of irrigations required for optimum production of alfalfa. They are based on the use of pan evaporation (ET_p) rates and tensiometers.

If the soil water-storage capacity and effective rooting depth of the plants are known, ET_p rates obtained at the Central Oregon Experiment Station (Figure 1) can be used to predict irrigation needs. Available water-storage capacities for major soils in Central Oregon are shown in Table 3. The effective rooting depth of alfalfa varies with soil depth, but alfalfa obtains most of its moisture from the top 2 feet of soil.

Table 3. Available water-storage capacities of major soils in Central Oregon.

Soil type	Avg. available water-storage capacity	Location, county
	in/ft	
Agency sandy loam	2.2	Crook, Deschutes, Jefferson
Agency loam	2.2	Crook, Deschutes, Jefferson
Deschutes loamy sand	1.5	Crook, Deschutes
Deschutes sandy loam	1.7	Crook, Deschutes
Lamonta loam	1.7	Crook, Deschutes, Jefferson
Madras sandy loam	2.2	Deschutes, Jefferson
Madras loam	2.3	Deschutes, Jefferson
Metolius sandy loam	2.4	Crook, Deschutes, Jefferson
Ochoco sand loam	2.4	Crook
Prineville sandy loam	1.6	Crook
Willowdale loam	2.9	Jefferson, Wasco

Adapted from Simonson, G. H. and M. N. Shearer (13).

As an example, a Deschutes loamy sand can store 1.5 inches of water in each foot of the soil profile. If the soil is 2 feet deep, the maximum it can hold is 3 inches of water. In a shallow, light-textured soil such as this, it is necessary to irrigate when the soil moisture reaches 50% of field capacity, or 1.5 inches of available water. The ET_p rate between July 22 to 31 is about 0.31 inches of water per day. At this rate, evapotranspiration (ET) would remove 50% of the water from the profile in 5 days. Therefore, the maximum interval between irrigation sets would be 5 days--as long as the ET_p rate remained at 0.31 inches per day. With longer intervals between sets, the plants would be under moisture stress after 5 days, and yields would be reduced. Each irrigation set should apply 1.5 inches of water to fill the soil up to its water-storage capacity.

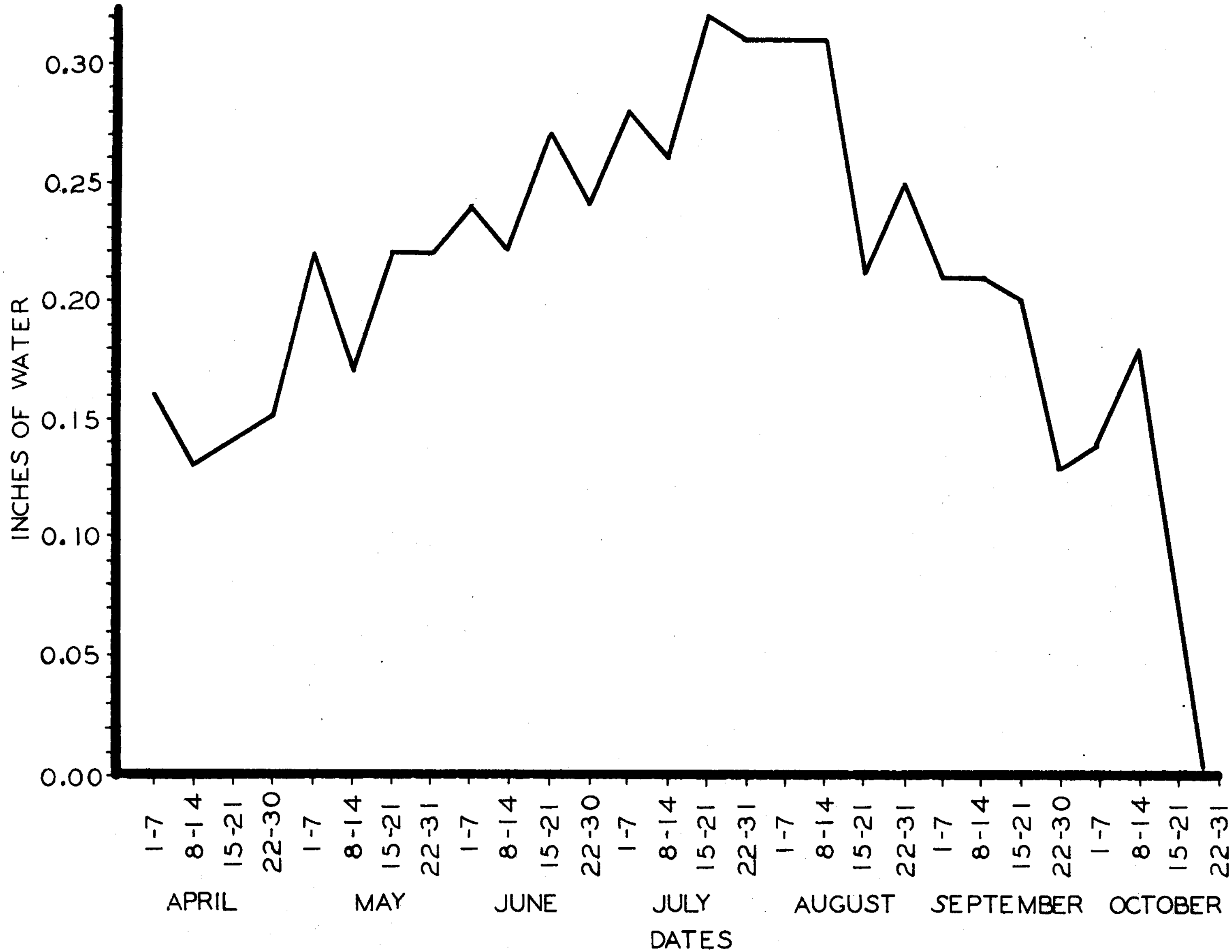

Figure 1. Average (1970-1975) pan evaporation rates at Central Oregon Experiment Station, Redmond.

From Figure 1 it is clear that intervals between irrigation sets should vary as the ET_p rates change during the growing season. It should be noted that ET_p rates correlate closely with ET rates from complete crop cover. Obviously, ET rates are lower from a developing crop such as in the early spring or after a cutting of alfalfa is made. Consequently, the ET_p values used to schedule irrigations during such periods of growth should be adjusted downward by using an estimated factor of 0.85. For example, the ET_p rate for June 1 to 7 is 0.24 inches per day. Since the alfalfa crop is developing during this period, the actual ET would be less than that from a complete crop cover. The adjusted ET_p rate for this growth period would be 0.85 x 0.24 = 0.20 inches per day. At this rate, the Deschutes loamy sand soil used in the example above, would lose 50% of its available water in 7.5 days (1.5/0.20=7.5). Irrigations during this growth period would be scheduled every 7.5 days and would apply 1.5 inches of water per set.

A tensiometer, which measures soil water suction, can also be used to schedule irrigations. When the instrument registers a suction limit determined for a particular crop, irrigations are made to bring the soil up to its water-storage capacity. The soil water suction at which water should be applied to alfalfa growing on a deep, well-drained, fertile soil is 1.50 bars. More research needs to be conducted in Central Oregon to determine the suction limits for alfalfa growing on the shallow soils of the area (6).

Care should be taken to apply only the amount of water that can be held in a soil. Not only is it inefficient to apply more water than can be stored in a soil, but over-irrigation is harmful to alfalfa growth (Figure 2) and will leach plant nutrients from the soil.

A common practice in the area is to use long sets under sprinkler irrigation of 12 to 24 hours and long intervals of 10 to 12 days between sets. Depending upon the soil, this method can be extremely detrimental to the alfalfa. During and shortly after irrigation, the soil may be at the saturation point. By the time of the next irrigation, available soil moisture may be depleted to the wilting point. Any time the wilting and/or saturation points are reached, there is a reduction in hay yield and quality (10).

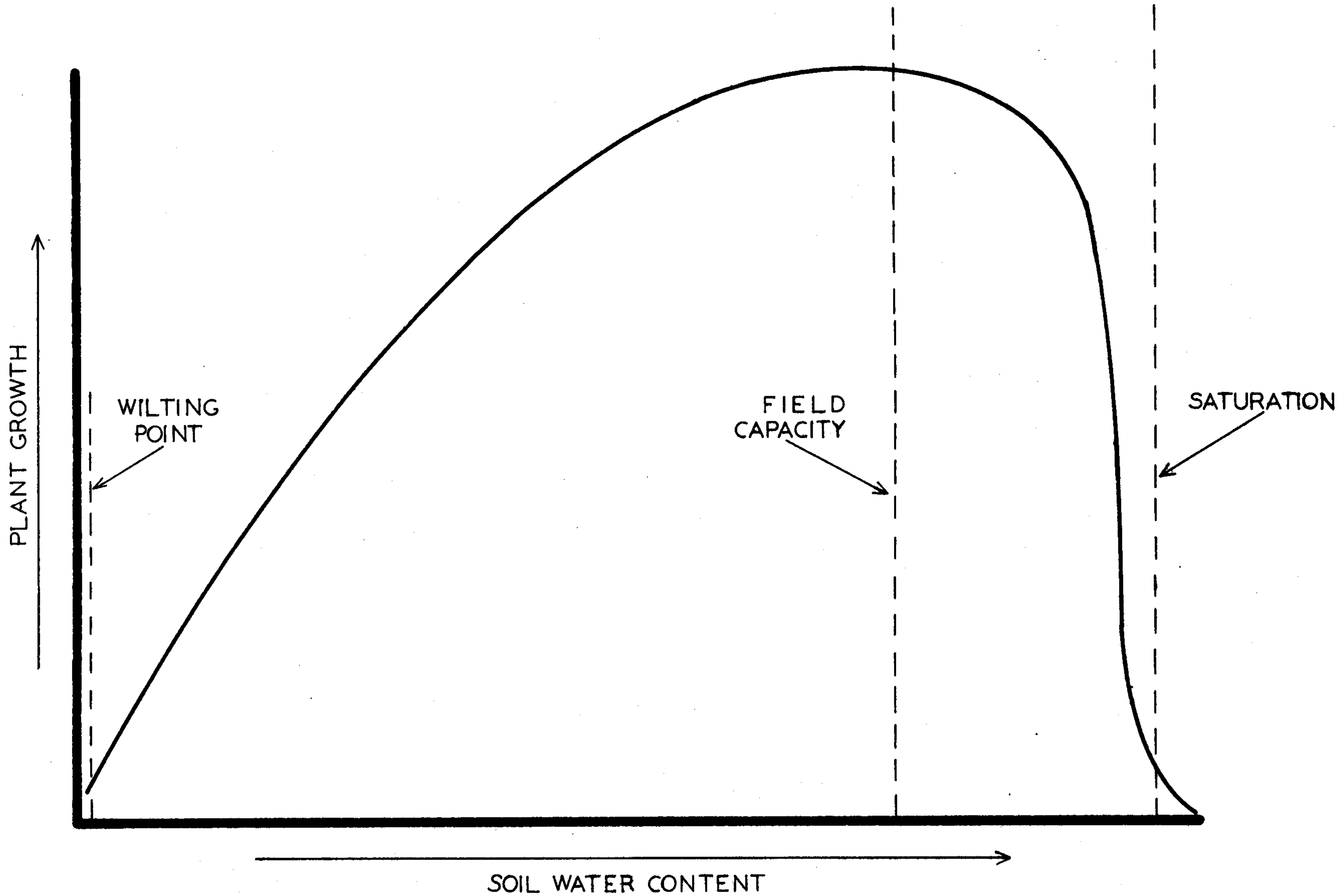

Figure 2. The relation of alfalfa growth and soil water content. Adapted from Peterson, H. B. (10).

Alfalfa fields should be irrigated up to field capacity before winter sets in, so the plants have sufficient moisture to live on over winter.

FERTILIZATION OF THE ESTABLISHED STAND

Soil tests should be taken throughout the life of the stand in order to maintain soil fertility at an optimum level for maximum yields. Top dressing with P, S, and K (if soil tests indicate a need) should be done each year. At the Central Oregon Experiment Station, annual applications of 35 pounds of P and 100 pounds of S per acre have proven to be adequate to maintain productivity and persistence of alfalfa stands. Oregon State University publishes Fertilizer Guides that are periodically revised as information is refined by research. Guides are available at county Extension offices for use by farmers to determine their individual maintenance fertilizer needs.

TIME OF CUTTING

An understanding of the trend of available carbohydrate root reserves in alfalfa is essential for its correct cutting management. The root reserves are utilized by the plant to produce new growth and energy for many of its life processes. Storage and use of the reserves follows a cyclical pattern.

When growth begins in the spring or after the plant has been cut or grazed off, carbohydrate root reserves are used to produce new top growth. The reserves continue to be drawn upon until the plant has produced about 8 inches of top growth (succulent stage). With this amount of top growth, enough carbohydrates are formed by photosynthesis so that the root reserves begin to be replenished. Maximum storage of available carbohydrates in the roots is reached at about full bloom.

When alfalfa is cut at the full-bloom stage, high root reserves have been accumulated and, consequently, regrowth is more rapid. Productivity and persistence of the plants are more easily maintained. Cutting at full-bloom also permits the plants to recover from the effects of stress due to over-wintering, improper irrigation, or disease.

Although delaying cutting until full bloom is best for the plants, the hay that is produced is of lower quality than that produced by cutting at earlier maturity. If very winter hardy, bacterial wilt-resistant varieties are used, it is possible to cut early for better hay quality without reducing the productivity and persistence of the stand. The 10% bloom or first-flower stage is the optimum time to cut alfalfa (Figure 3). Even though root reserves are not at a maximum, they are high enough that the plants are not damaged. The highest yield of nutrients, protein, and minerals is obtained at this stage.

Cutting according to plant maturity takes into account differences due to varieties, locations, and years. In this sense, it is more satisfactory than cutting according to a calendar date or by time interval. It is also more satisfactory than cutting according to development of new crown shoots. New shoots do not develop regularly at any specific time, and may be brought on by irrigation after severe moisture stress or when top growth lodges and crown buds are exposed to sunlight. Development of new crown shoots should be taken into consideration, however, on all cuts and especially the first one in the spring. In Central Oregon, frosts can occur at any time that would stop the flowering process and eliminate it as an indicator of when to cut. If crown shoots begin to elongate to the point where they would be cut off if cutting were to be delayed further, the stand should be harvested. No matter when a cut is made, the hay should be removed from the field as soon as possible and irrigation should begin.

SPRING MANAGEMENT

Early spring management is very important in maintaining productivity and persistence, especially if the stand has been damaged during the winter. If a winter-damaged stand is cut too early, yields of subsequent harvests will be reduced and the stand will rapidly degenerate. Winter-injured stands of disease-resistant varieties usually recover if the first cut is delayed until full bloom. Subsequent cuts may be made at 10% bloom. If the stand has not been damaged during the winter, all cuts should be made at 10% bloom, unless crown shoots elongate excessively before that time.

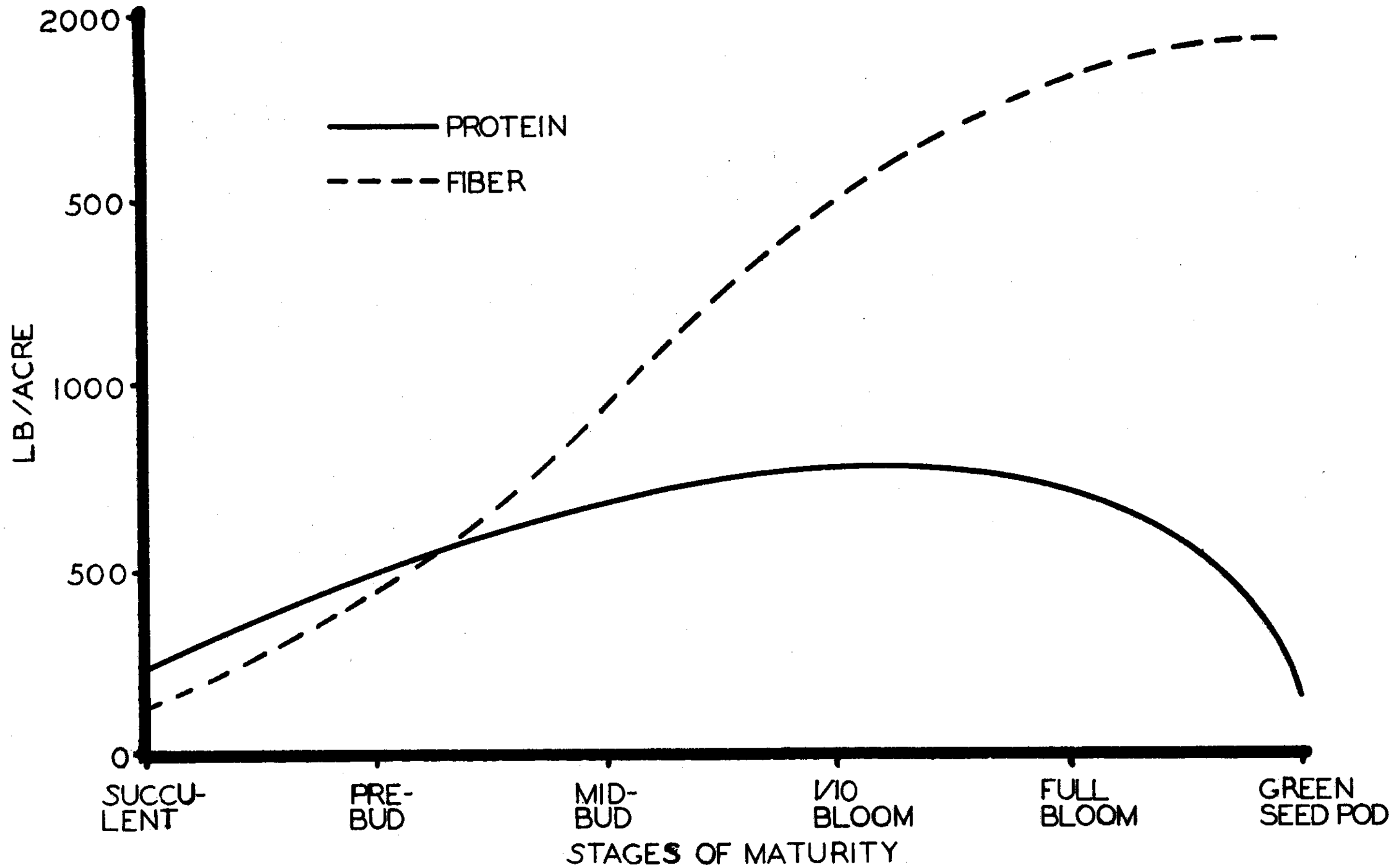

Figure 3. Yields of protein and fiber in alfalfa at different stages of maturity. Adapted from Van Riper, G. E., and Dale Smith (19).

Due to the warm periods followed by low temperatures that occur during the winter in Central Oregon, alfalfa stands usually sustain some winter injury. Injured stands that must be cut at first flower every cutting, to meet quality requirements in saleable hay, probably will need to be reseeded every 5 years.

FALL MANAGEMENT

In Central Oregon, 4 to 6 weeks before the first killing frost is a critical period in the management of alfalfa. Alfalfa should not be cut during this time. Eight to 10 inches of top growth are needed during this entire period to produce sufficient carbohydrates for storage in crowns and roots. The stored reserves are used to develop cold resistance, to live on during the winter dormant period, and to begin regrowth in the spring. About 50% of the stored reserves are used during the winter. If alfalfa goes into winter with a low level of reserves, winter survival is lessened and the number of crown buds and rhizomes that produce regrowth in the spring is reduced.

On the average, the first killing frost occurs in Central Oregon about September 15. Cutting after the first killing frost is not as hazardous as cutting before it. Root reserves are usually at a high level by this time. If a stand is cut in the fall, a tall stubble should be left to catch and hold snow for insulation during the winter. Continual grazing by cattle or sheep during the fall and winter is not advisable (14, 15).

SUMMARY

Yields of alfalfa hay can be increased greatly--possibly doubled--in Central Oregon if proven establishment and management practices are applied. In summary, the practices may be divided into the following major categories, none of which can be neglected if maximum, sustained production of alfalfa is to be obtained:

SOIL CONDITIONS. Soil tests should be taken before planting alfalfa and throughout the life of the stand. Fertilizer and lime recommendations resulting from the tests should be followed.

The seedbed should be moist and firm, with some looseness at the surface for coverage of seeds. Optimum coverage of seed ranges from ¼ to ½ inch on heavy soils and ½ to 1 inch on sandy soils.

INOCULATION. It is absolutely essential to inoculate alfalfa seed with a fresh inoculum specifically for alfalfa. This ensures that the plants will be nodulated with an efficient strain of Rhizobia that will fix N at a high rate.

RATE OF SEEDING. Use 12 to 15 lb/acre of good seed, having high percentages of purity and germination.

TIME OF SEEDING. Plant either during the first week of June with a herbicide, or in late summer before August 15.

IRRIGATION. One of the major problems in the establishment and management of alfalfa in Central Oregon lies in achieving proper irrigation. If irrigations are applied according to crop needs and soil water-storage capacities, the problem may be eliminated. If irrigations are applied according to a convenient time schedule, the problem will continue.

TIME OF CUTTING. Usually alfalfa should be cut at 10% bloom.

SPRING MANAGEMENT. The first harvest of the season should be delayed until full bloom if the stand has been damaged during the preceeding winter.

FALL MANAGEMENT. Alfalfa should not be cut during the 4- to 6-week period before the first killing frost of autumn.

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