Winter Grazing as a Grazing Management Program for Northern Great Basin Rangelands

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Reasons for grazing native range during winter

The cattle industry in the western U.S. originally existed as continuous, year-round grazing operations with cattle being free to roam, needing minimal management input. The severe winters of 1886-87 and 1889-90 killed thousands of free roaming cattle, and effectively marked the end of the open-range period of the western livestock industry. From this time on, winter feed was made available to livestock. The main costs incurred by livestock operators are those associated with the putting up and feeding of winter hay. These costs include labor, machinery, and fuel. Some of the most productive meadow ground is tied up in the production of hay. A return to winter grazing instead of winter hay feeding could free up these productive pieces of land for other purposes, thereby increasing management flexibility and options. Previous research at the Northern Great Basin Experimental Range (NGBER; formerly Squaw Butte Experiment Station) has shown that winter grazing offers economic advantages when compared to traditional hay feeding systems, primarily by reducing costs associated with putting up hay during summer and feeding hay during winter months. Common management practices in this area involves cattle grazing native range from spring through mid to late fall. At this time, cattle are moved down to native meadows, where they are fed hay through the winter before returning to the range, following spring calving. Winter grazing differs from this program in that cattle are moved off range and allowed to graze native meadow forage in the fall, before returning to rangeland for the winter grazing period.

Grazing cool-season forages during the winter should have little impact on plants' ability to initiate spring growth and produce forage the following year. In this respect, winter grazing should not adversely affect the range forage resource. In fact, this program may actually be beneficial to range condition and productivity. Removing dormant plant material may have little impact on plant productivity, and may improve forage quality. Grazing distribution and overall range utilization may be improved. Since all forage is in a state of dormancy, differences in forage quality are small; animals therefore have less incentive to concentrate use on certain species or areas. Water requirements are lower during winter, enabling animals to graze further from water sources and return to these sources less often. Canadian research has shown that cattle can utilize snow as a source of water. This could improve distribution, since a source of water would be present in many areas of the range. This could also alleviate some of the problems associated with maintaining open sources of water during winter, such as chopping ice, heating water tanks, and preventing water lines from freezing. The class of livestock used on winter grazing programs is also important. Dry, pregnant, mature beef cows have lower nutritional requirements, will graze further from water and return to water less frequently. They will also utilize steep slopes and other less accessible areas of the range more readily than other classes of livestock, including young, growing animals or cows with calves at their sides.

Winter grazing is also compatible with multiple-use management objectives currently employed in the management of public lands. Cattle are utilizing the range resource at a time when other demands for its use are at a minimum. Recreational use of public lands during winter is rare. The potential exists for conflict between livestock and big game if forage is limited and cattle are grazing range that is also traditional big game winter range. This would need to be considered in the planning stages. The impact on riparian areas should be minimal, since similarities of forage quality and other factors enhancing grazing distribution (including use of snow as a water source) will be pulling animals away from the riparian zones. Because of the enormous potential for winter grazing as a management alternative, research was instigated at the NGBER to investigate the efficacy of wintering beef cattle in the Northern Great Basin and possible managerial options to improve animal performance on winter range.

Supplementation of Winter Grazing Beef Cows

Cattle consuming low-quality roughages, such as winter range forage, are often given protein supplements. The addition of protein increases intake and utilization of these forages. Traditional protein supplements, such as soybean and cottonseed meal, are not readily available (and thus are quite expensive) in most areas of the Pacific Northwest. Alfalfa is commonly fed as a supplement in the Northern Great Basin because it is more available and economical to feed than traditional protein meal supplements. A two-year study was initiated in the winter of 1989-90, to further investigate alfalfa as a winter range supplement. In year one (1989-90), 48 mature gestating Hereford x Angus cows were stratified by age and body condition, and randomly allotted within stratification to one of the following treatments: (1) control (no supplement); (2) 3.31 lbs. of alfalfa pellets; (3) 6.61 lbs. of alfalfa pellets; and (4) 9.92 lbs of supplemental pellets. The study was repeated in 1990-91 (year 2), except that 72 cows were used in year 2. For both years, cows were gathered daily at 0900 to 1200 hours and individually fed their supplements. Chemical composition of the alfalfa supplement and grazed range forage is listed in Tables 1 and 2. Individual feeding of the cows began in early November and ended on February 21 (year 1) and January 15 (year 2). The trial was terminated at an earlier date in year 2, due to lack of available forage and concern over the health of the unsupplemented cows. A trace-mineralized salt mix containing vitamin A was provided free choice.

Measurements included cow body weight and body condition score (taken every 28 days), forage and total intake and digestibility, distance traveled, and grazing time. Esophageally fistulated steers were used to obtain estimates of diet quality.

Table 1. Quality of diet selected by esophageal steers in year 1 (1989-90). Northern Great Basin Experimental Range, Oregon.

Item	Sampling Period			
	Dec.	Jan.	Feb.	SE[a]
Organic matter, %	73.9	77.7	77.5	1.15
ADIN[b], %	48.9	50.5	55.3	2.70
	% of organic matter			
Crude protein	6.82	6.26	5.43	.24
ADF	72.2	67.1	70.5	.95
NDF	81.5	79.1	79.0	.84
ADL	6.33	6.14	7.61	.14

[a]Standard error of the mean.
[b]ADIN = acid detergent insoluble nitrogen. Expressed as a % of total N.

Table 2. Quality of diet selected by grazing steers in year 2 (1990-91). Northern Great Basin Experimental Range, Oregon.

Item	Sampling period			
	Dec.	Jan.	SE[a]	P-value
Organic matter, %	84.2	83.6	.50	.56
ADIN[b], %	53.3	53.1	1.36	.92
	% of organic matter			
Crude protein	4.78	5.42	.18	.03
ADF	67.9	67.6	.97	.85
NDF	80.8	83.1	.80	.03
ADL	6.22	6.90	.19	.04

[a]Standard error of the mean
[b]ADIN = acid detergent insoluble nitrogen. Expressed as a % of total N.

Diet quality declined throughout the winter grazing period, due to reductions in forage availability caused by forage removal, and(or) increases in plant maturity and nutrient leaching. Providing supplemental alfalfa improved cow body weight and body condition status in both years (Figures 1 thru 4). The largest improvements were noticed in cows receiving 3.31 lbs of alfalfa, relative to nonsupplemented control cows. Higher levels of supplementation provided smaller benefits relative to body weight and condition changes. Intake data show that at higher levels of supplementation, alfalfa substituted for forage, reducing the quantity of forage consumed. Forage intake and digestion, in addition to performance, was optimized by providing the first level (3.31 lbs) of alfalfa supplement.

Animal performance for all treatment groups was much lower in year 2 (1990-91) than in year 1 (1989-90). This difference may be due to a number of factors. First, more forage was available in the first winter, since a substantial amount of fall regrowth had occurred prior to the winter grazing period. Therefore, the forage may have been more readily available and of higher nutritional quality in year 1. Intake differences verify this hypothesis. In addition, the winter grazing period of 1989-90 was unseasonably mild, with little or no measurable precipitation. In contrast, 1990-91 was marked by extremely cold temperatures, especially in December. This reduced grazing activity and forage intake, which led to decreases in animal performance.

In summary, this two-year study showed that supplemental feeding of alfalfa is important in maintaining beef cattle weight and body condition, as well as improving forage intake and utilization during the winter grazing period. Supplementing 3.31 lbs of alfalfa pellets appeared to be the most effective supplementation strategy to optimize animal performance and forage utilization. Feeding higher levels of supplemental alfalfa resulted in smaller increases in animal performance and substitution of supplement for forage. In addition, this study clearly demonstrated the influence of the environment on forage quality and availability, as well as beef cattle nutritional physiology, in a winter grazing program.

This first study showed that alfalfa supplementation is beneficial to beef cows on winter range. However, pelleting alfalfa is expensive and could be justified only if animal performance is improved by pelleting the alfalfa hay. Another way of reducing costs associated with providing supplement would be to provide supplemental feed on an alternate-day basis. While this practice has been shown to be as effective as daily feeding, and to offer such economic advantages as reducing labor and travel costs, previous work has focused on protein meals or concentrates, not on alfalfa. Therefore, a winter grazing trial was initiated to compare the following: 1) physical form (pelleted vs. long-stem hay) of alfalfa supplements, and 2) frequency (daily vs. every other day) of alfalfa supplementation on beef cattle winter grazing Northern Great Basin rangelands.

This study was conducted during the winter of 1991-92 on the NGBER. Two, 1,000 acre pastures were used in the 70-day study, which ran from early November to mid-January. Original designs had the study ending in mid-February; however, low amounts of available forage (the result of six consecutive dry years) and snow cover, which reduced forage availability even further, caused the trial to be terminated early. In early October, 60 mature, pregnant Hereford x Angus cows were grouped by age, condition score, and fetal age. They were randomly assigned within groups to one of the four following treatments: (1) 4.4 lbs/day of alfalfa pellets, (2) 4.4 lbs/day alfalfa hay, (3) 8.8 lbs alfalfa pellets every other day (same as 4.4 lbs/day), and (4) 8.8 lbs/every other day of alfalfa hay (same as 4.4 lbs/day). Animals were gathered daily at 0800, sorted into individual pens, and fed their supplement. On days when only two groups received alfalfa supplement, the remaining two groups were returned to graze. Cows were moved to the second pasture on day 28. Cow weights and body condition (1-9 scale) were obtained on days 0, 28, 56, and 70. Two sampling periods (early December [Period 1] and mid-January [Period 2]) were conducted to obtain estimates of forage intake, digestibility, grazing behavior, and diet quality. Diet quality estimates was obtained by using esophageally fistulated steers.

Diet quality was lower in period 2 (Table 3) due to reductions in forage availability caused by the grazing animals' removal of forage, and by excessive snow cover. Neither physical form nor frequency of alfalfa supplementation had any effect on cow body weight, body condition, forage, NDF or total intake and digestibility, grazing time, or distance travelled. However, the effect of period was significant (Tables 4 &5). Cows lost weight over the first 28 days of the study, but showed weight gains at subsequent weigh periods. This change may have been caused by changes in forage quantity. Cows were moved on day 28 from a pasture where forage availability was limited to one with more available forage.

Cows lost more condition the last 14 days of the study than in either of the previous 28 day periods. Reductions in forage availability and rapidly increasing fetal growth may have prompted increased mobilization of tissue reserves to meet the increased demands of the fetus. Cows spent less time grazing in mid-January (period 2); colder temperatures and snow cover may have contributed to reducing grazing time as animals tried to reduce energy expenditures to conserve energy for heat production. Intake and digestibility of grazed forage was lower during this time, as well. Diet quality was reduced in period 2; this lower quality diet could have reduced forage intake. Cows were observed grazing bare sagebrush twigs during period 2. Subsequent cow and calf performance was not affected by supplementation treatment. Results from this study indicate that feeding alfalfa pellets or hay on a daily or alternate day basis has no affect on performance, intake, digestion, or grazing behavior of winter grazing beef cows. Alternate day feeding of alfalfa hay does not negatively impact animal performance and may offer the benefits of reducing labor and feed processing costs. Weather conditions and forage supply can influence winter grazing animals and should be considered when planning winter grazing programs.

Table 3. Chemical composition[a] of alfalfa supplements and forage selected by esophageal steers winter grazing northern Great Basin rangelands. 1991-92.

	Alfalfa		Forage		
Item	Pellets	Hay	Early December	Early January	SE[b]
OM	88.50	90.06	72.48[c]	87.29[d]	1.43
ADF	36.41	35.08	77.32[c]	66.70[d]	1.68
NDF	43.85	49.46	83.90[c]	72.61[d]	1.40
IADF	20.06	27.60	24.43[c]	46.92[d]	1.10
CP	18.08	19.86	5.09[c]	5.86[d]	.26
ADIN[e]	20.37	20.53	23.88[c]	50.62[d]	.97
in vitro OMD	67.25	63.62	58.44[c]	34.36[d]	1.13
ADL	8.32	9.10	9.79[c]	20.67[d]	.36

[b]Standard error of the mean.
[c,d]Means with different superscripts differ ($P<.10$).
[e]ADIN = acid detergent insoluble nitrogen. Expressed as a % of total N.

Table 4. Influence of physical form and frequency of alfalfa supplementation on weight gain and condition score of beef cattle winter grazing northern Great Basin rangeland. 1991-92.

	Treatment[a]					Period[b]		
Item	1	2	3	4	SE[c]	1	2	3
Wt. gain, lb.	3.10	-5.11	5.68	7.00	10.76	-81.85	80.77	10.66
Condition change, units	-1.20	-1.49	-1.30	-1.40	.10	-.40[d]	-.32[d]	-.63[e]

[a]Treatments: 1 = 4.4 lbs. alfalfa pellets fed daily; 2 = 4.4 lbs. alfalfa hay fed daily; 3 = 8.8 lbs. alfalfa pellets every other day; 4 = 8.8 lbs. alfalfa hay every other day.
[b]Periods: 1 = day 0 to day 28; 2 = day 29 to day 56; 3 = day 57 to day 70.
[c]Standard error of the mean.
[d,e]Period means with different superscripts differ ($P<.01$).

Table 5. Influence of physical form and frequency of alfalfa supplementation on intake, digestibility and grazing behavior of beef cattle winter grazing northern Great Basin rangelands. 1991-92.

	Treatment[a]					Period[b]		
Item	1	2	3	4	SE[c]	1	2	SE
OM intake, lb.								
NDF	16.36	16.52	16.76	16.78	.52	20.13[d]	13.10[e]	.30
Forage	18.17	18.22	18.63	18.41	.64	21.52[d]	15.20[e]	.36
Total	22.58	22.62	23.04	22.82	.64	25.92[d]	19.60[e]	.36
OM intake, % BW								
NDF	1.59	1.60	1.71	1.68	.18	2.00[d]	1.29[e]	.07
Forage	1.77	1.76	1.90	1.84	.21	2.14[d]	1.50[e]	.08
Total	2.20	2.19	2.34	2.28	.23	2.57[d]	1.93[e]	.08
OM digestibility, %								
NDF	44.74	44.56	44.20	44.14	.60	56.46[d]	32.36[e]	.38
Forage	46.40	46.40	46.43	46.39	.05	58.46[d]	34.34[e]	.02
Total	51.03	50.01	51.04	50.22	.21	59.68[d]	41.47[e]	.14
Grazing time, hr/d	5.96	6.17	5.63	6.00	.30	6.69[d]	5.19[e]	.18
Distance travelled, miles	3.80	3.86	3.89	3.68	.36	3.71	3.91	.22

[a]Treatments: 1 = 4.4 lb. alfalfa pellets daily; 2 = 4.4 lb. alfalfa hay daily; 3 = 8.8 lb. alfalfa hay every other day; 4 = 8.8 lb. alfalfa hay every other day.
[b]Periods: 1 = day 0 to day 28; 2 = day 29 to day 56; 3 = day 57 to day 70.
[c]Standard error of the mean.
[d,e]Period means with different superscripts differ ($P<.01$).

Year-Round Management of Rangelands Used for Winter Grazing

Potentially limiting factors in winter grazing programs include environmental conditions, forage quality, and the quantity of forage available for grazing. While we have no control over the weather, the potential may exist to improve range forage conditions. Traditionally, pastures utilized in winter grazing programs are not grazed during the rest of the year. Grazing these ranges early in spring ("preconditioning") may improve the quality of winter forage by delaying plant development; at the time of dormancy, nutrients would be retained in aboveground forage instead of in the roots. However, this practice may negatively impact forage availability, especially in arid climates; these changes may have a greater impact on forage conditions than changes in diet quality. Therefore, a two-year study was initiated to determine the effects of preconditioning on the quality and quantity of winter forage.

In early to mid-March of 1992, five 100 x 165 ft (30 x 50 m) sites were selected in a 1,000 acre, native range pasture, and excluded from grazing by electric fencing. Cow-calf pairs grazed this range from mid-March to mid-April of both 1992 and 1993, removing 75 AUMs and 125 AUMs of forage, respectively. Plots were sampled in late October to early November, following a hard freeze to ensure plant dormancy. Total forage production was estimated by clipping 20 randomly selected m^2 (3.3 sq. ft.) plots on both the inside (ungrazed), and outside (grazed), of each site. Immediately following clipping, five esophageally fistulated steers grazed the inside, then the outside of each site to obtain estimates of diet quality.

Growing season precipitation totals for 1991-92, 1992-93, and the 40-year average are shown in Figure 5. The growing season runs from September to August of the following year. Values for effects of treatment and year on forage production and chemical composition are shown on Tables 6, 7, and 8. Spring grazing reduced total forage available in the fall by over 100 lbs/acre. Spring grazing did not affect the quality of the diet selected by grazing animals. Standing forage quality, however, appeared to be enhanced by spring grazing. The increased amount of forage available on ungrazed sites provided animals with a greater opportunity to select a high-quality diet; this cancelled out the improved standing forage quality in the grazed sites. Forage production was higher in 1993 than 1992, but forage quality was much higher in 1992 than 1993. The crop year of 1992-93 was the wettest on record. Favorable growing conditions will increase forage production at the cost of reducing forage quality. Plants have higher concentrations of cell wall and reproductive tissue, which are harder for animals to digest. These increases in plant fiber reduce the availability of proteins and other nutrients. While the amount of forage is increased, the overall quality is reduced in years of abundant moisture.

Preconditioning did not appear to enhance the quality of diets selected by grazing animals. While forage quality of the standing crop appeared to be slightly improved by spring grazing, no spring grazing dramatically increased forage production and offered animals an increased opportunity to selectively graze. Major changes in forage quality and

Table 6. Effect of grazing treatment on forage production and chemical composition[a] of winter forage following deferred or spring grazing on northern Great Basin rangelands. 1992-93.

	Clipped samples				Esophageal samples			
Item	Ungrazed[b]	Grazed	SE[c]	P-value	Ungrazed	Grazed	SE	P-value
Total forage (lb./acre)	238.0	167.4.0	13.45	< .01				
NDF, %	77.17	75.21	.70	.07	78.00	77.94	.33	.90
ADF	56.61	54.63	.84	.12	60.40	59.81	.47	.37
AD[d]	6.35	6.21	.24	.69				
OMD					62.86	62.38	.49	.49
DMD	46.88	48.74	1.16	.28				

[a]Chemical composition expressed on a % OM basis.
[b]Ungrazed = grazing deferred until winter. Grazed = early spring grazing.
[c]Standard error of the mean.
[d]A significant (P<.05) treatment x year interaction was evident for ADL concentrations in esophageal samples.

Table 7. Effect of year on forage production and chemical composition[a] of winter forage following deferred or spring grazing on northern Great Basin rangelands. 1992-93.

	Clipped samples				Esophageal samples			
Item	1992	1993	SE[b]	P-value	1992	1993	SE	P-value
Total forage (lb./acre)	105.0	282.0	13.45	< .01				
NDF	69.21	83.17	.70	< .01	70.45	85.50	.33	< .01
ADF	52.85	58.39	.84	< .01	55.30	64.91	.47	< .01
ADL[c]	5.56	6.99	.24	<.01				
OMD					65.86	59.38	.48	< .01
DMD	50.26	45.37	1.16	.01				

[a]Chemical composition expressed on a percent OM basis.
[b]Standard error of the mean.
[c]A significant (P<.05) treatment x year interaction was evident for ADL concentrations in esophageal samples.

Table 8. Influence of grazing treatment and year on chemical composition[a] of winter forage following deferred or spring grazing on northern Great Basin rangelands[b].

	1992				1993			
Item	Ungrazed	Grazed	SE[c]	P-value	Ungrazed	Grazed	SE	P-value
Clipped samples:								
CP	7.48	9.48	.54	.05	2.08	2.12	.11	.81
Esophageal samples:								
CP	7.64	8.43	.20	< .01	3.23	3.15	.10	.59
ADL	6.03	6.96	.26	.01	7.83	7.70	.21	.68

[a]Chemical composition expressed on a % OM basis.

[b]A significant (P<.05) treatment x year interaction was evident for these variables.

[c]Ungrazed = grazing deferred until winter. Grazed = spring grazing.

quantity between 1992 and 1993 were likely caused by environmental differences, especially precipitation. In arid range environments, regrowth following grazing is not an automatic occurrence. In these environments, our research suggests little, if any, benefits to preconditioning of winter range forage.

Effects of Environment on Winter Grazing Beef Cattle

Cold temperatures can increase the energy requirements of cattle by over 100 percent, as animals increase their heat production in order to maintain a constant body temperature. Other environmental stressors (such as wind, precipitation, and mud) can raise energy requirements even higher. In feedlot or confinement situations, animals will increase their feed intake to try and meet these demands. Digestive activity is also increased, which speeds up the rate of digesta passage, but reduces diet digestibility. Other physiological changes also occur in response to colder weather. Grazing animals often reduce grazing activity and subsequent forage intake during adverse winter weather, apparently attempting to conserve energy for use in heat production by reducing grazing activity, which is very expensive in terms of energy use. These reductions in intake, coupled with the observed decreases in digestibility, result in body weight and condition losses prior to calving. This, in turn, can negatively affect postpartum reproductive performance. However, the exact mechanisms involved in this process are not yet clear. For one thing, animals can adapt to winter conditions, these animals are far better off during cold winter weather than other animals. The mechanisms involved in this adaptation are complicated and not completely understood.

We conducted a study during the winter of 1992-93, to investigate the effects that environmental variables had on grazing beef cattle, nutrition, performance, behavior, and physiology. Estimates of these effects were made on a day-to-day basis. We also hoped to get some insight on how animals respond to various environmental stressors.

The study was initiated on November 11, 1992. Twenty-four mature, pregnant Hereford x Angus cows, and seven bifistulated steers grazed a 1,000 acre, native range pasture, and were supplemented once daily with a corn-cottonseed meal mix (24% CP; 4.4 lb.•day). We began this sampling period on November 23. Cow body weight and condition, forage and total intake and digestion, time spent grazing, distance traveled, thyroid hormone and blood urea N levels, and digesta kinetics were animal responses that were measured. We decided to attempt daily estimations of grazed forage intake, a relatively new and untested procedure. Environmental variables measured at a nearby weather station included temperature, wind speed and direction, humidity, precipitation, snow depth, solar radiation and black body temperature (an estimate of total heat load derived from wind, temperature, and solar energy).

The grazing period ended on December 9, as 10-12 inches of snow covered all plants except sagebrush. We decided to push on and began feeding a low-quality hay at this time. By trials end, the snow was nearly 3 ft. deep on the range site. The original termination date was March 1, 1993; but by February 22, the road into the study pasture was impassable, so we terminated the study at that time.

While final results and conclusions have not been drawn, preliminary indications are that in this case, winter environment had no real significant impact on animal performance. Only snow depth had consistent affects on any animal responses. However, several interesting pieces of information was obtained from the study. The first involved snow consumption by cattle. Cows on this study did not travel to the lone source of open water in the pasture from early December until trial termination in late February; however, no adverse effects were noted, which agrees with several Canadian studies in this area. Visual observations showed cows consumed snow immediately after eating in the morning; however, no snow was eaten until all feeding had ceased. Cows also dramatically increased their feed intake and subsequent body weight and condition once hay feeding began. After a few days, intakes declined, but the levels remained slightly higher than those seen during grazing. Once hay feeding began, cows tended to congregate in the feeding ground and remained all day, of course heavy snow cover may have influenced this behavior. Our technique for daily estimation of forage intake under grazing situations appeared to work satisfactorily. And finally, we concluded that winter grazing is not a feasible management plan in years with severe winters, or in areas where such winters are common. Conclusions drawn in this study should be extrapolated to actual grazing situations only with great care, as this turned out to be not a grazing study, but more of a winter hay-feeding study.

Conclusions Regarding Winter Grazing

Results from the NGBER indicate that winter grazing can be a viable alternative grazing management program in this area. Feeding low levels of supplemental alfalfa in either pelleted or hay form daily, or on alternate days, can improve animal performance and maximize forge utilization without substituting for it. Forage quality of arid rangelands used for winter grazing may not benefit from spring grazing, as reductions in forage quantity appear to overshadow any potential enhancements in quality. Spring grazing reduces the amount of forage available for winter use; this could be especially detrimental to winter grazing in dry years. When designing and implementing winter grazing programs, the number one consideration should be, what is the chance that adverse winter weather (especially heavy snows) will occur?

Other criteria that should be met or addressed include the proximity of the winter range to the producer's base operation. Producers must be able to get to the range to supplement and check on animals, and to quickly get them out if the situation necessitates. A reliable water source is necessary, since snow will not always be present as an alternative water source. Winter ranges should have areas where animals can seek shelter, such as: a draw or pockets, or maybe some trees. Areas where forage is available in all but the heaviest snows, such as south slopes and wind swept ridges, is also a good idea. Use older, pregnant cows, preferably ones with winter grazing experience, or who are adapted to winter weather. Their requirements are lower and they will do better on the mature forage resource. Winter grazing programs will work in the proper situation or environment if certain considerations have been met.

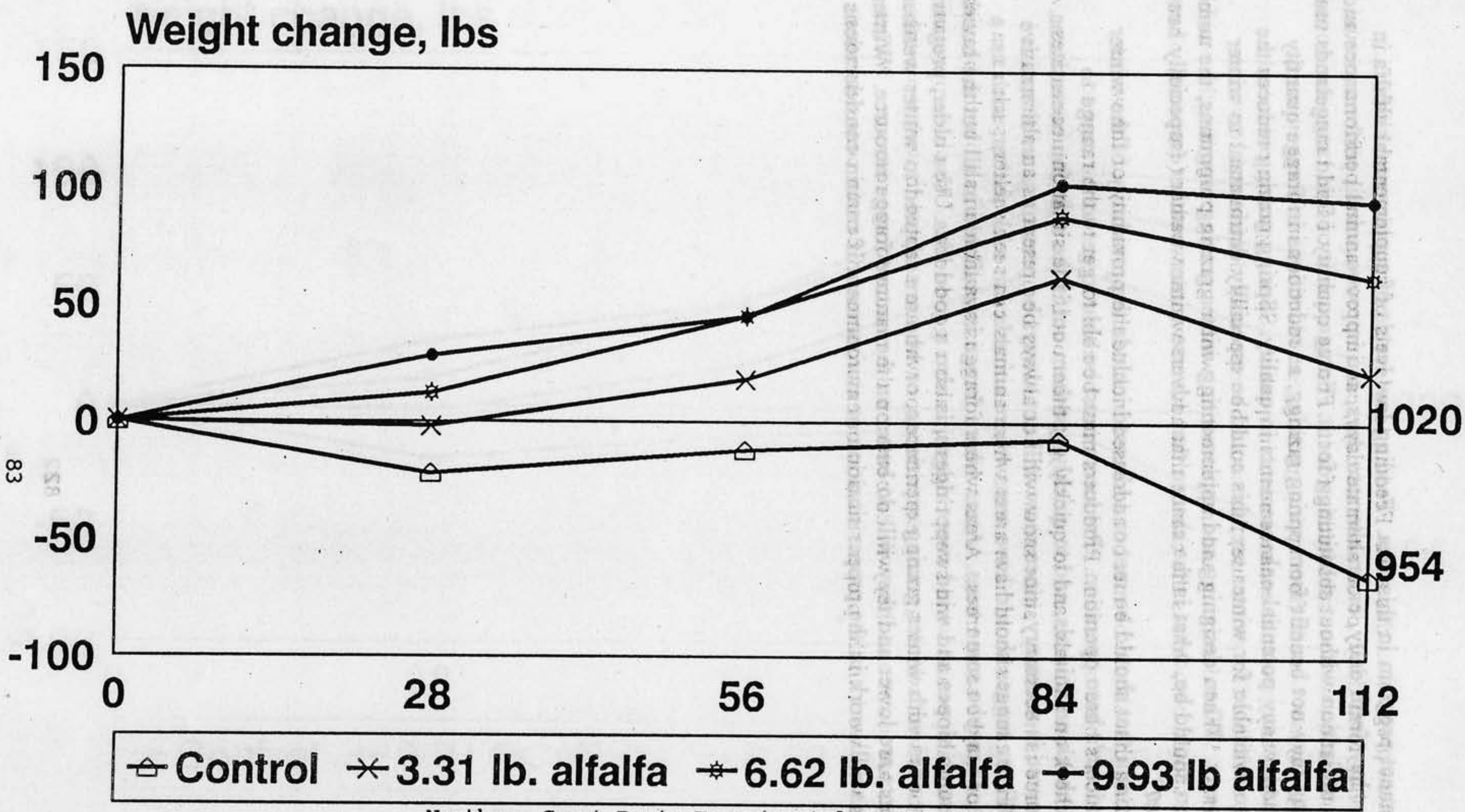


Figure 1. Effects of alfalfa supplementation on cow body weight changes in year 1 (1989-90).

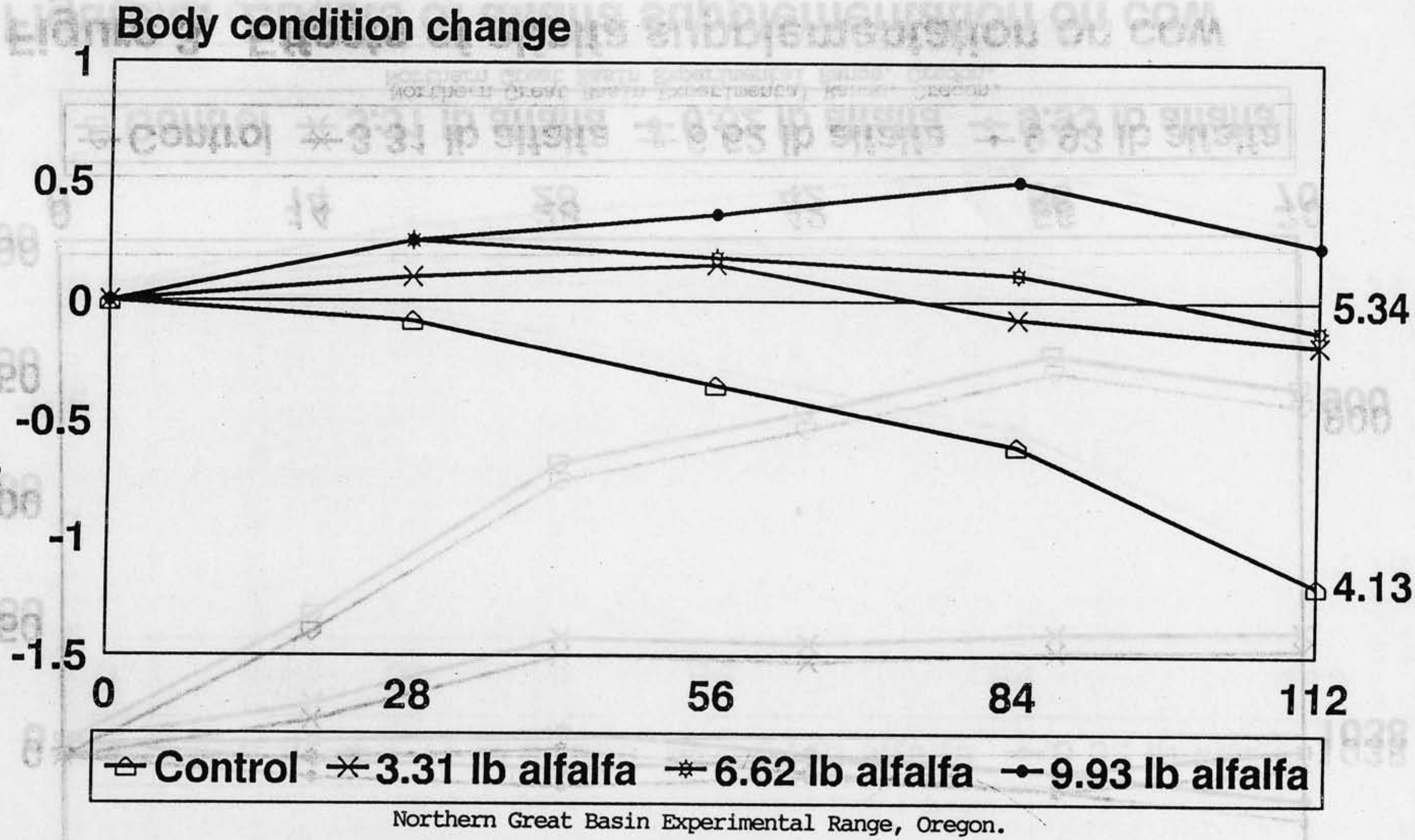


Figure 2. Effects of alfalfa supplementation on cow body condition change in year 1 (1989-90).

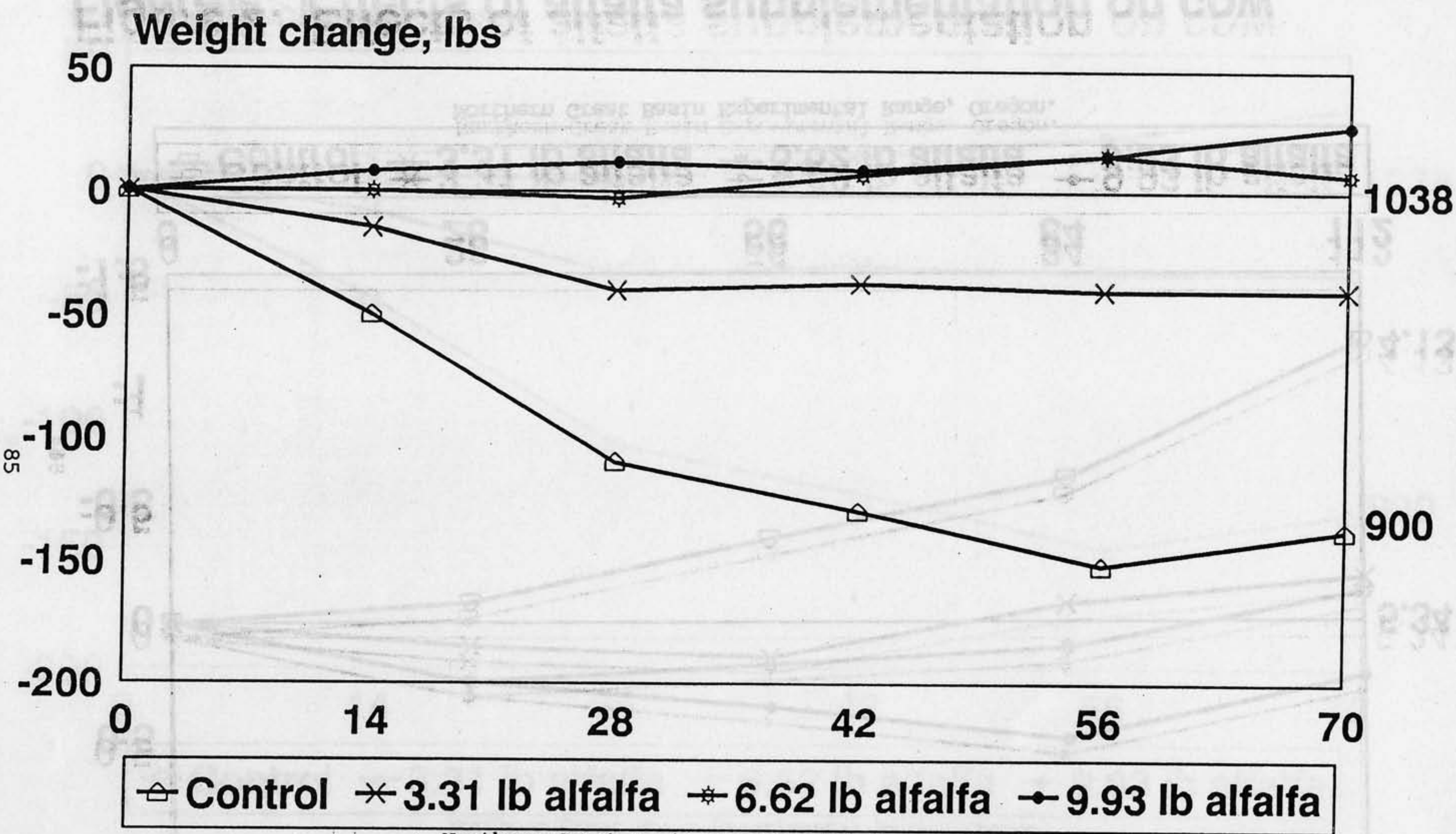
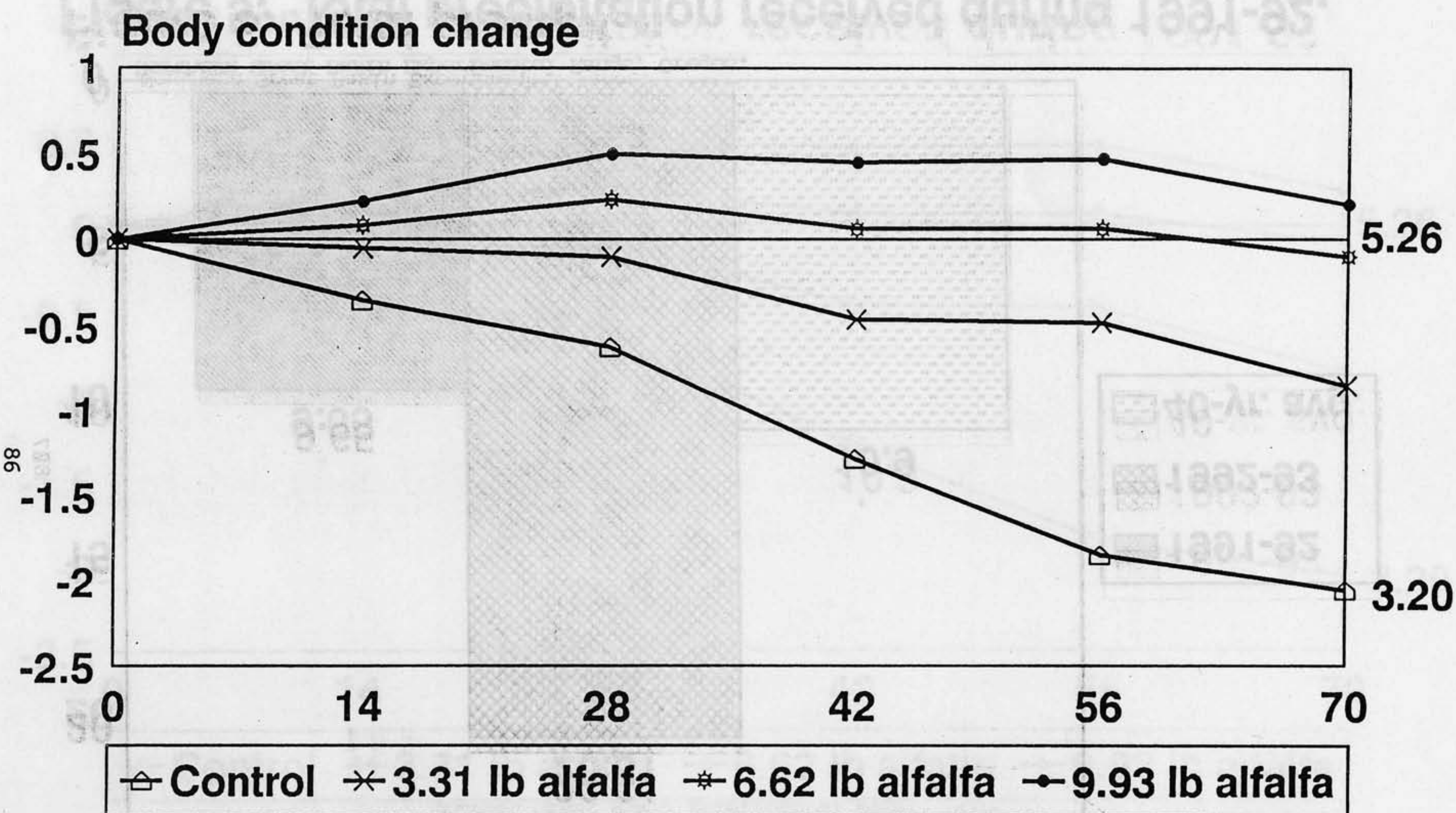


Figure 3. Effects of alfalfa supplementation on cow body weight change in year 2 (1990-91).



Norther Great Basin Experimental Range, Oregon.

Figure 4. Effects of alfalfa supplementation on cow body condition in year 2 (1990-91).

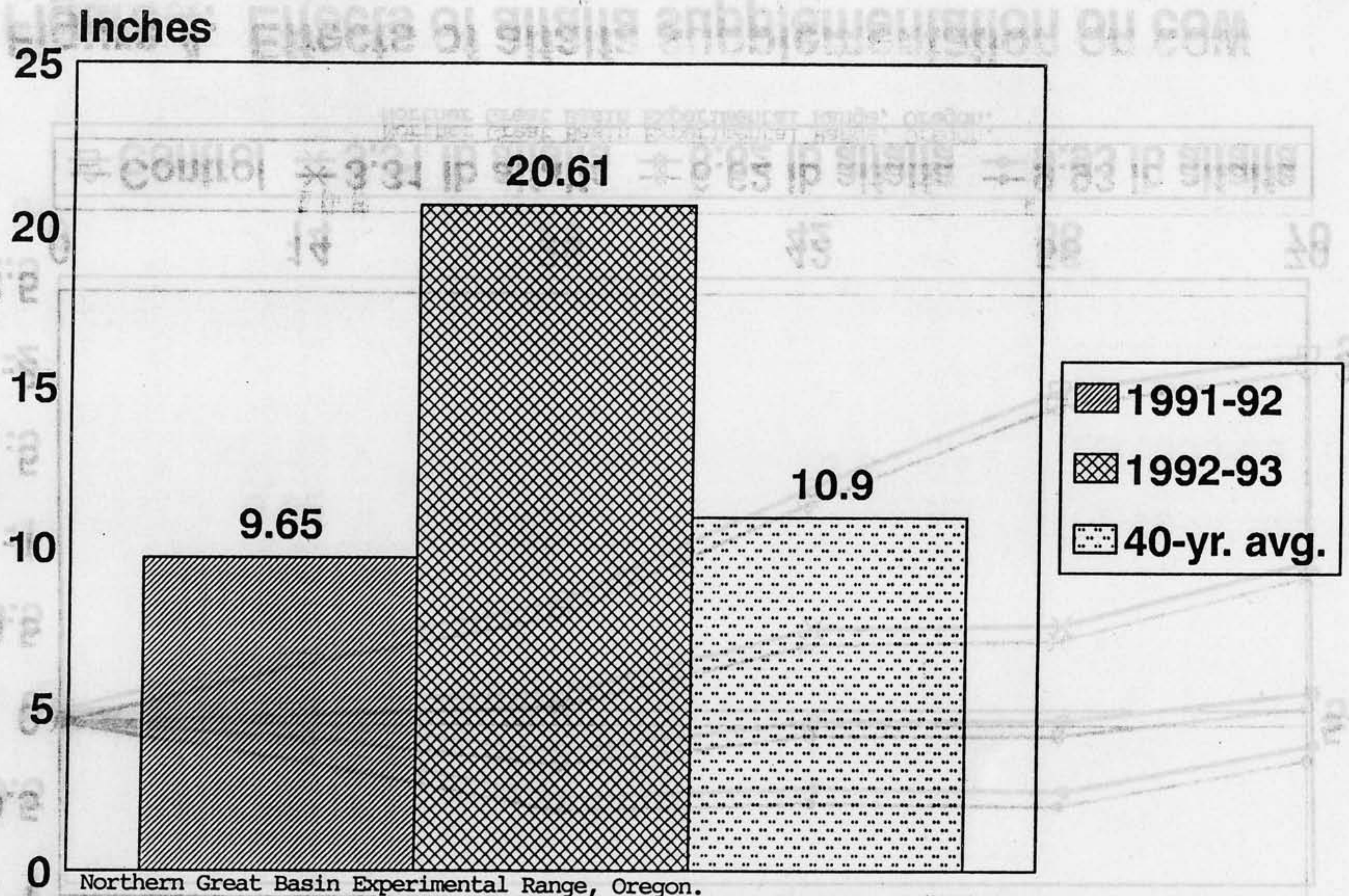


Figure 5. Total precipitation received during 1991-92, 1992-93, and the 40-year average.