Irrigated Pastures for Range Livestock

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INTRODUCTION

Improved irrigated pastures can be an important source of forage for the range livestock industry in eastern Oregon and in the intermountain range areas. Although rangeland forage is the primary source of feed for cow-calf operations, improved pasture, when used to advantage, can provide a degree of flexibility to the operation.

Historically, ranchers who depend on native forages to sustain their herds are at the mercy of the weather. In dry years, and particularly in a series of dry years, the rancher may be forced early to remove his herd from the range. He also may be forced to heavy culling and selling. However, if he has sufficient irrigated pasture or supplementary hay available during these short-feed or dry periods, he may maintain his herd at normal numbers.

Irrigated pasture can be an excellent buffer when range forage is limited. Yearlings make good gains on irrigated pasture. Cows and spring-born calves can be held on pasture in the spring to allow the range plants to produce at their maximum. Alternatively, animals may be brought from the range when that source of forage is exhausted. In years when moisture is adequate and the pasture forage is not needed for grazing, pastures can be cut and the forage stored as hay.

Changing herd management from calving in the spring to fall-calving appears to have advantages in certain areas. Proponents of fall-calving report increased calving and weaning percentages and increased weaning weights. Also, fall-born calves are old enough to use forage efficiently and can be weaned onto spring range forage or onto irrigated pastures. Weaned in April, fall-born calves can take advantage of high-quality summer pasture and dry cows can go onto range without the demand of the calf for milk. Cows without calves distribute over the range better, utilize the available forage more uniformly, and consume less forage than those with calves. Additionally, irrigated pastures provide excellent breeding pastures. Also, herd management is controlled, and fall calves are born with fewer disease problems than those born in the spring on spring-flooded meadows.

Realizing the importance of irrigated pastures as a complementary feed source to the range livestock industry, the Squaw Butte Experiment Station initiated a series of experiments to determine alternative uses of improved pastures and their management. The purpose of this report is to present some of the results obtained from these experiments.

GENERAL PROCEDURE

Location and Maintenance

The pastures studied are located at the winter headquarters (Section 5) of the Squaw Butte Agricultural Experiment Station, about 6 miles southeast of Burns, Oregon. Research at the Squaw Butte Station was done cooperatively by the Oregon Agricultural Experiment Station, Oregon State University, and the U.S. Department of Agriculture acting through the Agricultural Research Service (now Science and Education Administration, Agricultural Research).

Soil and Native Plant Characteristics

The soil, generally unclassified but mainly Fluventic and Cumulic Haplaquolls, is composed of variants of the Damon, Stanfield, and Silvies series. It is predominantly silt loam in texture and basic in reaction with pH of 7.5 to 8.5. It was developed from lacustrine sediments related to an old lakebed and alluvium deposits from the Silvies River. In its natural state the site was a wetland meadow subjected to seasonal flooding and a high water table. Production of native plants was vari-

able, depending on depth of flooding and the length of the flooding period. Average production of native meadows is 3/4 to 1 ton/acre (Cooper, 1955). The grazing capacity of native meadows is approximately 1 acre/yearling or 1.67 acres/cow-calf pair for 5 months. This is equivalent to approximately 3 animal unit months (AUM) per acre (Cooper et al., 1957).

Climatic Conditions

The climatic conditions prevailing near Burns, Oregon, are representative of the high desert country in southeastern Oregon. The average annual rainfall is 10 to 12 inches but may be as high as 16 inches or as low as 4.5 inches. Growing-season precipitation averages 2.5 inches. The average annual temperature at Burns is about 46°F, with an average daily maximum in July of 86°F and an average daily minimum in January of 16°F (Johnsgard, 1963). Comparisons of temperature data from the Experiment Station and the Harney Valley (1972-1976) suggest, however, that the growing season is considerably shorter than those recorded at the official National Weather Service. The average frost-free period in the valley is about 83 days, varying from 20 to 116 days (Gomm, 1979).

Pasture Establishment

To establish and maintain introduced species it was necessary to lower the water table and remove the native vegetation. A trench 12 feet wide and 6 to 10 feet deep was dug around a 60-acre tract. A centrifugal pump with the capacity to discharge water at the rate of 25,000 gallons/minute was installed at the lowest point in the trench. A 35-horsepower electric motor set to automatically lift the drainage water approximately 12 feet through a 12-inch pipe maintained the water table at 2.5 to 4 feet during the period the surrounding meadowland was flooded. After the flooding period, the water table level receded about 0.5 inch/day until it stabilized at 12 to 15 feet.

The meadow sod was broken by plowing during the fall of 1967. The seedbed was prepared by disking and harrowing during the spring of 1968 to break up the sod. Barley was then planted. After the barley was harvested, the seedbed was again worked preparatory to planting pasture mixtures.

Phosphorus fertilizer, applied at 40 pounds of P_2O_5/acre, was broadcast and worked into the soil. At time of planting in the spring of 1969, the seedbed was fine and firm and relatively free from live native plants although the soil was high in decaying organic matter.

Planting in 1969 was done with a standard grain drill with rows spaced 7 inches apart. Grass and legume seeds were planted together in a pasture mixture of Fawn tall fescue (*Festuca arundinacea* Schreb.) at 10 pounds/acre with white clover (*Trifolium repens* L.) at 2 pounds/acre or with Vernal alfalfa (*Medicago sativa* L.) at 3 pounds/acre to provide pastures with 50 percent grass and 50 percent legume.

Pastures established in the spring of 1976 were planted with a Brillion[1] cultipacker seeder. Grass and legume seeds were metered from separate boxes into a pasture mixture of Latar orchardgrass (*Dactylis glomerata* L.) at 10 pounds/acre with Promor alfalfa at 4 pounds/acre or with Ladino clover (*Trifolium repens* L. var. Ladino) at 3 pounds/acre.

Pasture Management and Response

The pasture plantings were divided by fences into 16 subpastures, each 2 acres in size. Eight pastures were planted with the tall fescue-alfalfa mixture and eight with tall fescue-white clover. In the fall of 1975, each of the four subpastures was plowed and replanted in 1976 to orchardgrass, four with alfalfa, and four with Ladino clover. The pastures were subdivided to allow for systematic rotational grazing with replication.

Fertilization. Except where purposely changed for experimental purposes, all pastures were treated identically. In 1972, urea was applied in mid-June at 120 pounds nitrogen per acre, and phosphorus was applied at 40 pounds P_2O_5/acre in mid-October. In subsequent years, fertilizer-N only was applied as urea, ammonium nitrate, or ammonium sulfate at 60 pounds N/acre in early June and at 60 pounds N/acre again in mid-July. Generally, at the time of application, grass plants were light green in color. Within 10 days after fertilization, their color had darkened, indicating the need for nitrogen although the pasture mix-

[1] Mention of a trademark or proprietary product does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture and does not imply its approval to the exclusion of other suitable products.

tures were relatively high in legumes. Fertilization with nitrogen did not appear to adversely affect the percentage of legume plants. Fertilizer was spread at a time when it would be followed by irrigation.

Irrigation. The pastures were irrigated by sprinkling with well water. Hand-moved lines were used in 1969-1973 and a traveling "big gun" system was used in 1974-1978. The sprinkling systems delivered about 4 inches of water per setting, and the pastures were irrigated five to six times during the growing season. The first irrigation in the spring was about mid-April, depending on soil moisture conditions. Light, frequent irrigations were more effective than heavy irrigations at less frequent intervals, especially for pastures containing white and Ladino clover. When possible, irrigation was done while pastures were in the recovery period of the rotational grazing cycle.

Clipping. Pastures were mowed at intervals to reduce weedy growth and to prevent the formation of bunches of mature and less nutritious grass. The best time to mow the pasture was at the beginning of the recovery period of the rotation cycle as the cattle were moved to another pasture. The most effective method of reducing bunch formations was to cut periodically and remove the forage as hay. The haying method allowed plants in bedding areas to recover, and it removed excess litter buildup in areas where cattle avoided grazing. When excessive litter was left through the winter, field mice populations and activity increased.

Harrowing. Pastures were harrowed early in the spring and again near the end of the grazing season to break up and scatter droppings. This reduced formation of ungrazed bunches and improved efficiency of the manure as a fertilizer.

Controlled grazing. Grazing began in the spring when the growth of the pastures reached a height of 8 inches (about May 5) and continued in planned rotational periods until about September 1. At that time, cattle were removed from the pastures to allow for fall regrowth and buildup of nutrient reserves in the roots, especially in alfalfa plants. After killing frosts stopped plant growth, the remaining forage was grazed to a 3-inch stubble height. Tall fescue required that spring grazing be early enough and heavy enough to remove developing seedstalks. When grazing was too late or too light, plants became mature, set seed heads, and were less palatable than plants more heavily grazed. Because it is a natural characteristic of tall fescue to produce one seed crop per season, removal of the reproductive primordium in the first spring-grazing period caused the plant to produce only leafy growth through the remainder of that season. At no time, however, should the growth be grazed closer than 3 inches. When tall fescue pastures were grazed too closely, they were slow in resuming growth. To control the amount of forage removed and the closeness of grazing, "put-and-take" animals were added to or removed from the pastures as needed.

Animal Management and Response

Livestock. Animals primarily were from the Experiment Station herd. The breeding stock is commercial Hereford with some Charolais mix. In 1975-1977, some of the yearlings were crossbred Hereford and Angus.

Stocking rate. Limiting the time cattle were allowed to graze any one pasture in a rotational system was important to develop uniform grazing with the least amount of waste from trampling and bunch formations. The length of the recovery period before regrazing also proved to be an important consideration especially where tall fescue was the dominant grass. Plants which tend to lose palatability with maturity should be grazed more frequently than highly palatable plants. These pastures were stocked for the season at a per-acre rate of 3 to 3.5 yearlings, two mature cows with their spring-born calves, or 6 early-weaned fall-born calves. This stocking rate is equivalent to about 10 AUM/acre.

Salting. The pasture forage contained copper and molybdenum levels such that copper deficiency symptoms appeared in yearlings grazing the pastures. Except in copper and mineral supplementation studies, copper sulfate calculated to provide 1 pound $CuSO_4$ in 20 pounds salt per head was mixed with the salt. The salt-copper mix and bonemeal were provided for constant access. Yearlings consumed an average of 10 pounds salt mix in 112 days. They used approximately 2 pounds less of the copper-salt mix than they did when copper was not added.

Watering. Fresh water of good quality was provided through the irrigation system. Stock watering tanks were cleaned as needed and filled with water to be constantly accessible.

Insect control. A pour-on type systemic insecticide (Korlan II) was used to control face flies in two years only, 1974 and 1977. Animals were retreated monthly when weighed. Results in 1974 indicated that treated animals gained 0.1 pound/head/day more than the untreated animals.

Parasite and disease control. Because of close confinement and concentrated use of pastures, internal parasites could seriously reduce animal gains. In only one year, 1972, were deworming bolluses administered. Pinkeye was a constant problem, but only a few animals required repeated treatments. Minor eye irritations were treated with pinkeye powders or sprays; serious cases were treated by vaccination in the eyelid.

During the 1970-1977 experiments four animals died while on pasture. One was diagnosed as having an abscessed liver and three with enterotoxemia. Two of these were on a high grain supplement. None of the deaths was attributed to bloat.

Weighing. All animals were weighed approximately 1 month before going onto pasture and allotted to pasture treatments by weight. They were weighed again after overnight shrinking at the beginning of the grazing season. During the grazing season, animals were weighed at 28-day intervals early in the morning without being withheld from feed or water. At the end of the grazing season, final weights were taken after an overnight shrinking period.

EXPERIMENTAL PROCEDURES AND RESULTS

Pasture Mixtures

Pasture plots, 2 acres in size, were planted in 1969. Eight pastures were planted to Fawn tall fescue with white clover and eight were planted to tall fescue with Vernal alfalfa. Initially, good stands of the grass were established, but stands of alfalfa were fair and stands of white clover were fair to poor. However, in succeeding years, the pasture cover filled in as the fescue plants enlarged and the clover apparently seeded itself. By 1973, all bare spaces had filled.

Although some alfalfa plants undoubtedly were lost, alfalfa continued to be an important component of the cover, and the percentage of alfalfa in the forage remained relatively costant throughout the experiment (Table 1). The percentage of clover in the forage varied considerably through the growing season and by years. White clover plants were scattered early in the study, and clover did not become a significant part of the vegetation until 1973. Seasonally, the percentage of white clover was relatively low in the early spring but became more abundant as the season progressed. In 1973, the percentage increased from about 5 percent in early June to 35 percent in late August (Table 1).

The weedy component changed with time. Annual mustard weeds were prevalent early in the study, but they disappeared in succeeding years as the stands filled in. Perennial weeds became increasingly important. By 1975, dandelions had heavily infested some pastures, sour dock was common, and thistles were scattered.

Table 1. Percent legume component by weight in pasture forage (1972-1977)

Pasture mixture and year	Percent legume composition in forage				
	May 1	June 1	July 1	Aug 1	Sept 1
Tall fescue-alfalfa					
1972	37	20	10	19	13
1973	24	14	26	21	16
1974	29	22	21	17	----
1975	16	16	17	28	----
1977	----	25	16	13	17
Tall fescue-clover					
1972	0	0	5	10	10
1973	0	5	28	30	35
1974	0	15	20	17	----
1975	0	0	17	23	----
1977	----	15	9	10	9
Orchardgrass-alfalfa					
1977	----	27	23	40	57
Orchardgrass-clover					
1977	----	6	7	11	----

The forage quality was good throughout the grazing season (Table 2). The crude protein concentration generally was highest in the early spring, but it remained relatively high throughout the season. The crude protein concentration in alfalfa generally was higher than it was in clover, and the crude protein in either legume was higher than it was in tall fescue. Consequently, pasture forage that contained a higher percentage of legume would be higher in crude protein.

Table 2. Average crude protein concentration in irrigated pasture forage

	Percent crude protein			
	Tall fescue-alfalfa		Tall fescue-clover	
May 1	17.2	20.7	15.0	
May 15	12.8	21.4	12.7	
June 1	10.6	16.4	12.5	14.4
June 15	15.0	19.4	16.7	19.8
July 1	13.2	18.6	12.7	15.4
July 15	13.8	19.8	15.2	17.8
August 1	13.4	19.2	14.8	16.8
August 15	15.0	18.1	12.3	16.2

Pastures planted in 1976 had been plowed the previous fall. Four pastures were seeded to Latar orchardgrass and Promor alfalfa and four to Latar and Ladino clover. Good stands of grass and alfalfa were established initially but clover establishment was fair in some pastures (Table 1). Annual weeds (mustards and lambsquarter) that heavily infested the new pastures in 1976 were mowed. The new pastures were lightly grazed that fall. In the early spring of 1977, it appeared that many orchardgrass plants died during the winter because of smothering and rodent activity under growth left from the previous season. After the old growth was raked and removed from the pastures, the surviving plants recovered. The resulting pastures had good stands of orchardgrass and alfalfa, but clover continued to be only fair in 1977.

Animal Gains

Yearlings. Gains made by yearling cattle from 1970 to 1974 were higher from the fescue-alfalfa pastures than from the fescue-clover pastures (Tables 3, 4, 5, 6, 7). In 1975 and 1976, however, gains were slightly higher from the fescue-clover pastures than from the fescue-alfalfa pastures. These differences may have been caused partly by the percentage of legumes in the pastures.

Table 3. Beef gains from irrigated pastures as affected by mineral supplements, 1972[1]

	Mineral supplements			
	Check[2]	Cu	Cu-Zn	Trace[3]
Fescue-alfalfa				
Animals/acre	3	3	3.5	3.5
Average initial weight (lb)	469	459	436	470
Total gain (lb/acre)	558	664	732	720
Average beef gain (lb)	186	221	209	208
Average daily gain (lb)[4]	1.7a	2.0b	1.9b	1.9b
Fescue-clover				
Animals/acre	3	3	3.5	3.5
Average initial weight (lb)	467	467	444	494
Total gain (lb/acre)	533	603	728	710
Average beef gain (lb)	184	202	208	203
Average daily gain (lb)[4]	1.6a	1.8b	1.9b	1.8b

[1] All pastures were grazed by yearlings for 112 days.
[2] Check treatment received salt and bonemeal free choice.
[3] Trace minerals by percent of mix were Zn 29.6, Fe 9.8, Mn 8.0, Cu 3.0, S 3.0, I 0.18, Co 0.06, and Ca 3 to 5.
[4] ADG values followed by different letters are significantly different at $P<.05$.

Table 4. Animal gains associated with use of irrigated pasture, grazing management, and supplementation (1974)

Class of stock and treatment	Animals per acre	Average initial weight	Total gain	Average beef gain	Average daily gain
	no.	*lb*	*lb/acre*	*lb*	*lb*
Early-weaned fall-calves					
Check	6	289	924	154	1.3
Barley (0.75 lb/head)	6	294	948	158	1.4
Barley (1.5 lb/head)	6	295	1,008	168	1.5
Yearling heifers					
Check	3	627	402	134	1.2
Copper	3	631	537	179	1.6
7-21 day rotation	3	637	438	146	1.3
14-14 day rotation	3	621	471	157	1.4
Fescue-alfalfa	3	626	438	146	1.3
Fescue-clover	3	632	471	157	1.4
Cow-calf pairs					
Cow	2	783	426	213	1.9
Calf	2	86	404	202	1.8

Table 5. Beef gains associated with irrigated pasture management and supplementation, 1975

Class of stock and treatment[1]	Animals per acre	Days on pasture	Initial weight	Total beef gain	Average beef gain	Average daily gain
	no.	*no.*	*lb*	*lb/acre*	*lb*	*lb*
Early-weaned fall-born calves on fescue-alfalfa	6	113	311	780	130	1.1
Yearling heifers						
Fescue-alfalfa (lb N/acre)						
0	3	105	498	513	171	1.6
40–40	3	113	497	552	184	1.6
80	3	113	493	618	206	1.8
120	3	113	492	684	228	2.0
60–60	3	113	495	654	218	1.9
Fescue-clover (lb N/acre)						
0	3	113	509	612	204	1.8
40–40	3	113	498	732	244	2.2
80	3	113	504	675	225	2.0
120	3	113	508	573	191	1.7
60–60	3	113	507	699	233	2.1
Yearling steers						
Fescue-clover						
barley (3.0 lb)	3	113	550	699	233	2.1
barley (1.0 lb)	3	113	558	609	203	1.8
barley (1 lb) + zinc	3	113	588	597	199	1.8
Fescue-alfalfa						
barley (3 lb)	3	113	580	654	218	1.9
barley (1 lb)	3	113	533	630	210	1.9

[1] Split fertilizer applications were applied June 1 and July 15; single applications were applied June 1.

Table 6. Beef gains associated with irrigated pasture management, 1976[1]

Treatment[2]	Animals per acre	Days on pasture	Initial weight	Total beef gain	Average beef gain	Average daily gain
	no.	*no.*	*lb*	*lb/acre*	*lb*	*lb*
Tall fescue-alfalfa (lb N/acre)						
0	3	70	485	661	221	3.2
40–40	3	83	422	558	186	2.2
80	3	121	467	828	276	2.3
120	3	121	437	735	245	2.0
60–60	3	121	453	944	314	2.6
Tall fescue-clover (lb N/acre)						
0	3	76	443	778	259	2.6
40–40	3	121	476	563	189	1.5
80	3	121	465	780	260	2.1
120	3	121	427	759	253	2.1
60–60	3	121	453	976	325	2.7

[1] Yearling heifers received copper, salt, and bonemeal supplement only.
[2] Single applications of N were applied June 1; split applications were applied June 1 and July 15.

Table 7. Beef gains associated with growing and fattening steers on irrigated pastures

Pasture	Animals per acre	Length of grazing	Initial weight	Total beef gain	Average beef gain	Average daily gain
	no.	*days*	*lb*	*lb/acre*	*lb*	*lb*
May 11-August 4, 1976[1]						
Tall fescue-alfalfa	3.5	85	421	774	221	2.6
Tall fescue-clover	3.25	85	424	744	226	2.7
August 4-Oct. 12, 1976[1]						
Tall fescue-alfalfa	1.8	69	642	434	217	3.1
Tall fescue-clover	1.7	69	650	423	249	3.6
May 17-August 4, 1977[2]						
Tall fescue-alfalfa	3	76	603	318	106	1.4
Orchardgrass-alfalfa	3	76	604	432	144	1.9

[1] Steers received barley supplement at 3 lb/head/day from 5/11 to 7/22; from 7/22 to 8/15, the supplement was increased daily at 0.5 lb increments to a total of 9 lb/head/day on August 15.
[2] Steers received barley supplement at 3 lb/head/day throughout the experiment.

Daily gains made by yearlings on tall fescue-alfalfa without energy supplement for the period 1972-1977 averaged 1.8 pounds. Average daily gains (ADG) generally were highest in May and lowest in August (Table 8).

Weaned calves. Tall fescue-clover pasture was compared with drylot and with native meadow for growing early-weaned fall-born calves (Table 9). Ten calves, weaned in April 1973, were put on a 2-acre pasture in early June, 14 were fed alfalfa hay, and 14 were put on a 20-acre meadow field. Those on pasture and on meadow received a daily supplement of 2 pounds ground barley. Gains made by the calves showed no significant differences among the forage sources. The calves gained 75 to 85 pounds in 67 days, equivalent to 1.1 to 1.3 pounds/head/day.

In 1974, early-weaned fall-born calves grazed tall fescue-clover pastures for 112 days. Pastures were stocked at six animals per acre. Twenty-four calves in each of two lots received supplemental

Table 8. Seasonal average daily gain by livestock classes grazing tall fescue-alfalfa pastures on 14-14 day rotational schedule

Class and year	Average daily gain (pounds) 5/1-6/1	6/1-7/1	7/1-8/1	8/1-9/1
Yearling heifers				
1972	3.2	1.8	1.7	0.7
1973	3.0	2.0	1.9	2.5
1974	1.7	2.5	----	0.9
1975	2.0	2.6	1.2	1.4
1976	3.2	3.1	1.6	----
Average	2.6	2.4	1.6	1.4
Yearling steers (without supplemental energy)				
1975	2.5	1.7	1.7	1.5
1976	1.5	2.5	2.1	----
1977	1.3	1.5	1.5	----
Average	1.7	1.9	1.7	1.5
Early-weaned fall-born calves				
1974	1.5	1.4	1.5	1.7
1975	1.1	1.1	1.3	1.1
1977	1.0	2.6	0.9	0.9
Average	1.2	1.7	1.3	1.2
Spring-born calves				
1974	2.5	1.3	1.8	1.7

Table 9. Gains made by early-weaned fall-born calves, 1973[1]

	Forage source Drylot[2]	Fescue-clover[3] pasture	Native[3] flood meadow
Animal numbers	14	10	14
Average initial weaning weight (lb)	282	262	288
Average final weight, 67 days (lb)	445	447	459
Average daily gain (lb)	1.1	1.3	1.1

[1] Calves were weaned April 18 at 170 days of age.
[2] Fed alfalfa hay.
[3] Supplemented with barley at 2 lb/head/day.

barley at 3/4 or 1 1/2 pounds/head/day (Table 4). A similar group received no supplement. The ADG increased slightly when the calves received the barley supplement.

In 1975, early-weaned fall-born calves were pastured on tall fescue-alfalfa for 113 days without supplement. Their ADG was 1.1 pounds and the total gain was 780 pounds/acre. The low gains were attributed to low palatability of the tall fescue and to lack of ability of the animals to utilize the fescue.

Ten short-yearlings, born in the fall of 1975 and weaned from cows on range August 15, 1976, were placed on tall fescue-clover pasture (Table 10). During the next 56 days, these short-yearlings gained 1.6 pounds/head/day. Their total gain was 356 pounds/acre.

Twenty-five 6-month-old calves, weaned in late April 1977, were put on orchardgrass-clover pastures. Another lot of 24 calves grazed tall fescue-clover pastures. On August 1, two more lots of calves of similar age (but weaned late from cows on range) were mixed with the early-weaned calves in their respective pastures. The early- and late-weaned calves grazed common pasture for an additional 64 days. The ADG of the early-weaned calves from May to August was 1.9 and 1.6 pounds from the orchardgrass-clover and tall fescue-clover pastures (Table 10). During the fall grazing period, the early-weaned calves gained 1.9 and 1.3 pounds daily on the orchardgrass-alfalfa and fescue-alfalfa pastures. The ADG of calves late-weaned from range onto pasture was 1.1 pounds and 0.7 pounds from the orchardgrass-alfalfa and fescue-alfalfa pastures. During the first 30 days, the late-weaned calves on orchardgrass gained less than 0.2 pounds/head/day. Their ADG in the next

Table 10. Gains made by weaned calves on irrigated pasture, 1976-1977

Management treatment and pasture mix	Animals per acre	Initial weight	Total beef gain	Average beef gain	Average daily gain
	no.	*lb*	*lb/acre*	*lb*	*lb*
Grazing period Aug. 17 to Oct. 12, 1976[1]					
Calves on tall fescue-clover	4	479	356	89	1.6
Grazing period May 17 to Aug. 1, 1977					
Calves weaned late April					
Orchardgrass-clover	6	337	882	147	1.9
Tall fescue-clover	6.25	324	744	119	1.6
Grazing period Aug. 1 to Oct. 4, 1977					
Calves weaned late April					
Orchardgrass-alfalfa	5	470	605	121	1.9
Tall fescue-alfalfa	4.75	425	408	86	1.3
Calves weaned late July[1]					
Orchardgrass-alfalfa	5	501	340	68	1.1
Tall fescue-alfalfa	4.75	499	223	47	0.7

[1] Short-yearlings weaned from range directly to pasture.

34 days was 1.8 pounds. The late-weaned calves on tall fescue lost 0.4 pounds/head/day during the first 30 days but gained 1.7 pounds/head/day in the next 34 days. Results of this study indicate that young growing stock gained more efficiently on orchardgrass pasture than on tall fescue pasture. However, after a suitable adjustment period, the fall-weaned short-yearling made reasonable gains from the tall fescue pasture.

Cow-calf pairs. Sixteen cow-calf pairs of spring-born calves grazed tall fescue-legume pastures in 1974 (Table 4). They were stocked at approximately two pairs per acre. Late in the season, these animals were used to clean up pastures and remove excess mature growth. In 112 days, the average gain per cow and per calf was 213 and 202 pounds.

Grazing Systems

Yearling cattle were moved from pasture to pasture as needed to utilize the forage in 1970 and 1971. Grazing began June 9, 1970, when the tall fescue was headed and the alfalfa was in a late bud stage. Twenty-four yearlings grazed a tall fescue-alfalfa pasture and 14 grazed a tall fescue-clover pasture. The animals wasted much of the forage by trampling and by avoiding the mature grass. On June 16, all the other pastures were cut for hay. Through the remainder of the season, four fescue-alfalfa pastures were grazed and four were cut for hay, and all eight of the fescue-clover pastures were grazed.

In 1971, grazing began May 14 and continued through September 2. Six fescue-clover pastures were grazed in rotation and two were cut for hay. Only one fescue-alfalfa pasture was grazed and seven were cut for hay.

In 1972, four pastures each of the grass-legume mixtures were subdivided into 1/2-acre plots to facilitate mineral supplement treatments. The pastures were grazed in a 14-day rotation with 7 days grazing and 7 days recovery. Grazing commenced May 8 and continued for 112 days. The remaining pastures (four grass-clover and four grass-alfalfa) were cut for hay. Herbage utilized by grazing cattle (computed from differences in weight of forage sampled at the beginning and end of a period) indicated that the yearlings grazed 6,090 pounds/acre from grass-alfalfa pastures and 5,852 pounds/acre from grass-clover pastures. This averaged 20.3 and 19.5 pounds/head/day oven-dry forage from the grass-alfalfa and grass-clover pastures. These values are similar to the values expected where a 600-pound animal gaining 2 pounds/day requires 18 pounds dry matter.

In addition to the forage grazed during the trial period and that cut for hay, the pastures sustained considerable fall grazing. About 20 percent of the total forage produced was grazed after September 1 when animals cleaned up the fields.

The pastures failed to recover sufficiently in the 7-day rest period to sustain grazing throughout the season. It was repeatedly necessary to remove the animals to holding pastures to avoid excessively close grazing, especially of the alfalfa.

In 1973, two rotational grazing systems were compared: (1) 7 days of grazing followed by 21 days of recovery; and (2) 14 days of grazing followed by 14 days of recovery (Table 11). The 7-21 day system required four pastures, and the 14-14 day system required two pastures. Yearlings grazing the 14-14 day system gained 0.4 pounds/head/day more than those on the 7-21 day rotation. The difference between grazing systems became more pronounced late in the season (data not shown). Undoubtedly, the forage being grazed from the 7-21 day system was more mature after the 21-day recovery period than it was after the 14-day recovery period. Pastures from the 14-14 day schedule also were more uniformly grazed, and the yearlings probably utilized more forage of higher quality. During subsequent years, the 14-14 day grazing system was used as the standard.

Hay Production

Pasture forage was harvested as hay in 1970-1973 (Table 12). In 1976, hay was harvested only from newly established orchardgrass pastures; in 1977, one cutting only was harvested from each pasture mix. The single cutting in 1977 was made primarily to reduce bunch formation and to remove mature and old growth.

In general, tall fescue-alfalfa forage yielded more than the tall fescue-clover pastures and more than alfalfa alone in an adjacent field. Although single cuttings of orchardgrass-legume pastures produced slightly more than single cuttings of fescue-legume in 1977, the difference was not significant because the orchardgrass pastures were new and the fescue pastures had been in production for 8 years. The significance, however, is that

Table 11. Summary of beef gains from irrigated fescue-alfalfa pastures as affected by grazing schedule and mineral supplement, 1973

	Mineral supplement			
	Check[1]	Cu in salt	Cu injected	Cu in salt and Cu injected
7 days grazing—21 days recovery				
Animals/acre	3.25	3.25	3.25	3.25
Average initial weight (lb)	476	390	474	478
Total gain (lb/acre)	570	652	614	700
Average gain (lb)	175	200	189	215
Average daily gain (lb)[2]	1.6a	1.8ab	1.8ab	2.0b
14 days grazing—14 days recovery				
Animals/acre	3.25	3.25	3.25	3.25
Average initial weight (lb)	475	473	482	435
Total gain (lb/acre)	670	850	916	814
Average gain (lb)	206	261	281	250
Average daily gain (lb)[2]	1.9ab	2.4c	2.5c	2.2c

[1] Check treatment received salt and bonemeal free choice.
[2] ADG values followed by different letters are different significantly at $P < .05$.

Table 12. Hay yield of oven-dry forage from irrigated pastures and an adjacent alfalfa field

Species mixture	1970	1971	1972	1973	1974	1975	1976	1977[1]
	tons/acre							
Alfalfa	3.5	3.2	4.1	3.6	4.2	3.4	3.9	4.6
Fescue-alfalfa	6.2	3.6	4.5	3.6	----	----	----	1.4
Fescue-clover	1.6	2.0	2.2	3.3	----	----	----	1.2
Orchardgrass-alfalfa	----	----	----	----	----	----	----	1.4
Orchardgrass-clover	----	----	----	----	----	----	----	1.4

[1] Hay harvests from pastures were single cuttings; alfalfa was from two cuttings.

relatively good yields of hay can be harvested as part of pasture management. During the remainder of the season, pastures can be grazed when the forage will be of high quality.

Mineral Supplementation

It was suspected, because of apparent symptoms, that the pasture forage might be deficient for meeting the copper requirement of yearlings. In 1970, animals gaining an average of 1.1 pounds/head/day showed little advantage from copper supplementation. In 1972, 1973, and 1974, however, animals gained significantly more when supplemented with copper than when receiving salt and bonemeal only. An experiment was conducted in 1972 to determine the comparative effect of supplementing copper, zinc, and trace mineral mixtures. Six yearling heifers were assigned to each of four supplemental treatments and two pasture species mixtures:

Pasture mix	Mineral supplement
Fawn tall fescue-white clover:	Salt and bonemeal
	Copper sulfate-salt and bonemeal
	Zinc oxide-copper sulfate-salt and bonemeal
	Trace mineral supplement-salt and bonemeal
Fawn tall fescue-Vernal alfalfa:	Salt and bonemeal
	Copper sulfate-salt and bonemeal
	Zinc oxide-copper sulfate-salt and bonemeal
	Trace mineral supplement-salt and bonemeal

Mineral supplements mixed with salt and provided free choice were calculated to provide salt intake at 20 grams/head/day, $CuSO_4$ at 1 gram/day (5%), and ZnO_2 at 100 milligrams/day (0.05%). Trace minerals were mixed with salt to provide 1 gram/head/day (5%), and bonemeal was provided free choice. Trace minerals by percent of mix were: Zn 29.6, Fe 9.8, Mn 8.0, Cu 3.0, S 3.0, I 0.18, Co 0.06, and Ca 3 to 5.

The 1972 studies indicated positive response from supplementing the diet with copper and with trace minerals (Table 3). Animals supplemented with copper or trace minerals gained 0.2 to 0.3 pounds/head/day more than those not receiving copper. The addition of zinc gave no additional increase in animal gains.

Sixteen yearling heifers grazing tall fescue-alfalfa pastures in 1973 received copper sulfate in their salt. A like number received no copper. One-half of each group, however, was injected at the beginning of the season with 2 cubic centimeters Cuprin per animal.

Animals receiving copper in 1973 gained 0.2 to 0.5 pounds/head/day more than those that received no copper (Table 11). The method of supplying the copper had no significant effect, and the combined method of Cuprin injection plus $CuSO_4$ in the salt gave similar results to the salt mix and injection methods. Some injected animals, however, developed large lumps at the injection site. Blood samples, taken at each weighing date, were analyzed for plasma-copper and whole-blood zinc by the Department of Agricultural Chemistry, Oregon State University.

In 1974, copper supplementation was studied in conjunction with pasture mixtures and grazing systems. Twelve yearling heifers on each of the two pasture mixtures and two grazing systems received copper in their salt. A similar number received no copper. The yearling heifers that received the copper supplement continued to gain 0.2 to 0.3 pounds/head/day more than those that received only salt.

Zinc oxide was added to barley and fed to 12 steers on pasture in 1975. A like number of steers receiving the same amount of barley gained similarly to those receiving zinc. It was concluded that zinc was not deficient in their diet.

Analyses of blood samples showed no consistent relationship for whole-blood zinc levels with a range of 2.3 to 12.5 parts per million (ppm), except that in 1974, zinc levels generally decreased as the season advanced (Table 13). Analyses for plasma-copper, however, showed a striking decrease in the blood copper of animals that received no copper during the first month they were on pasture. The plasma-copper level continued to decline in the second month but at a slower rate until it leveled at about 0.21 ppm. The plasma-copper level in animals that received copper increased to 0.8 ppm by early June 1973 and remained near that level through the season (Figure 1). In 1974, the blood-copper level also increased with copper supplementation but not to the extent observed in 1973. The normal blood plasma-copper level is about 1.0 ppm.

Table 13. Plasma-copper and whole-blood zinc levels from animals grazing on irrigated pastures

Mineral treatment	Concentration of Cu and Zn					
	4/8	6/3	7/1	7/29	8/12	8/22
	Plasma-copper (ppm)					
Check						
1973	0.75	0.39	0.24	0.26	----	0.21
1974	0.72	0.58	0.56	0.44	0.33	0.24
Copper supplement						
1973	0.77	0.81	0.73	1.00	----	0.88
1974[1]	0.66	0.61	0.71	0.79	0.75	0.74
	Whole-blood zinc (ppm)					
Check						
1973	4.0	5.6	3.2	9.1	----	4.2
1974	5.4	4.2	3.9	3.0	3.2	2.5
Copper supplement						
1973	3.9	5.4	2.8	8.0	----	3.9
1974[1]	5.5	4.0	4.2	3.1	3.3	2.6

[1] Salt was mixed with bonemeal until June 15; after June 15, bonemeal was fed alone free choice.

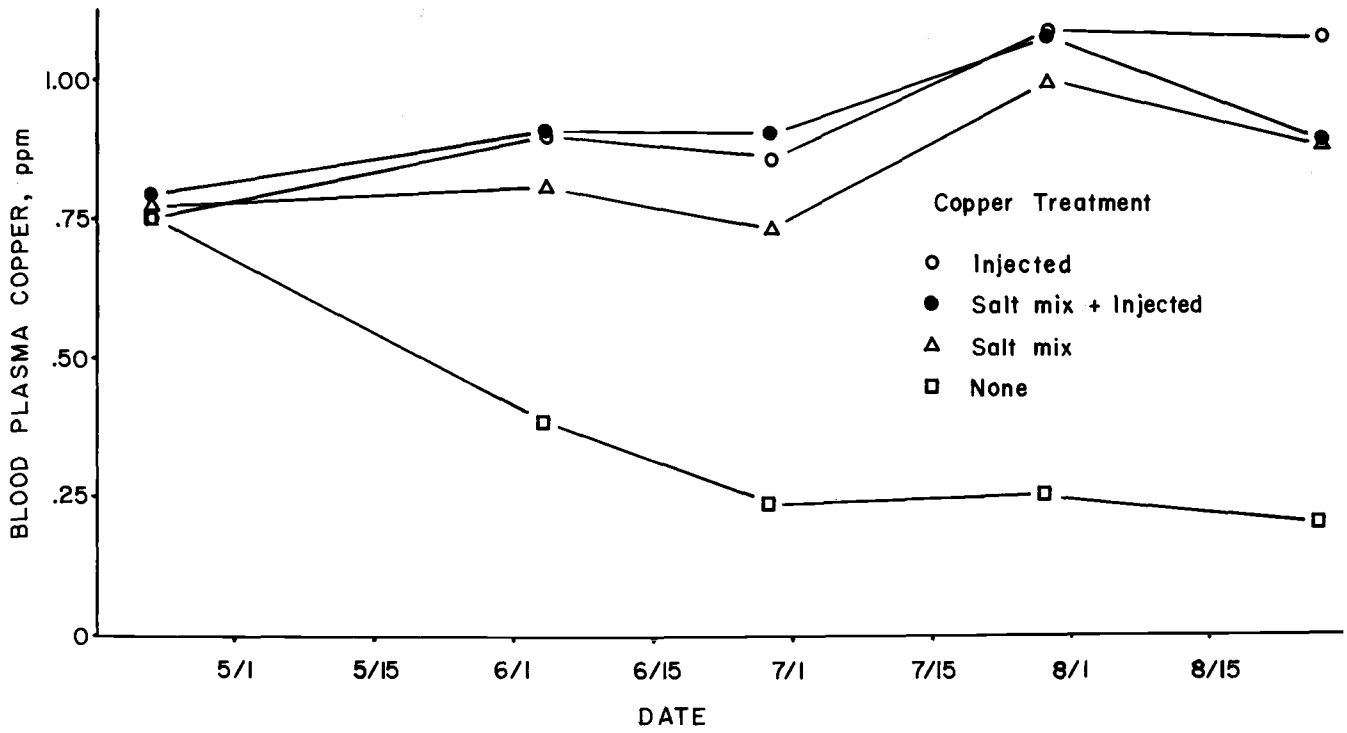

Figure 1. Blood plasma copper level of yearling cattle on tall fescue pasture as affected by method of supplementing copper.

Energy Feed Supplementation

Three groups of 12 yearling steers grazing tall fescue-clover pastures were given different types of energy supplements in 1973. A fourth group received no energy supplement. All groups of steers were supplemented with copper sulfate in their salt, and all were on a 14-14 day rotational grazing schedule. Whole barley was pre-weighed and fed daily to provide 3.0 pounds/head/day. The liquid supplements (Sirlene and vegetable oil) were constantly accessible in open tanks or lick-wheels. Steers without energy supplements gained 1.7 pounds/head/day (Table 14). Steers receiving supplements gained significantly more than those that received no supplement. The steers given Sirlene consumed more supplement than the other groups and also gained more per pound of supplement.

Yearling steers on tall fescue-alfalfa and tall-fescue-clover pastures were supplemented with 1 and 3 pounds of barley/head/day in 1975. Steers on fescue-clover pastures gained 30 pounds more in 113 days with 3 pounds of grain supplement than they did with 1 pound, but steers on fescue-alfalfa gained only 8.8 pounds/head more with the 3-pound level (Table 5).

In 1976, 14 yearling steers on tall fescue-alfalfa pasture and 13 on fescue-clover received barley supplement at 3 pounds/head/day for 85 days. The barley ration was then increased daily by 0.5-pound increments until the steers were receiving 9 pounds/head/day (Table 7). The steers received barley at the higher rate for 69 days. During the first 85 days, the steers' rate of gain (2.6 pounds/head/day) was similar on both pasture mixtures. During the next 69 days, however, they gained more rapidly on the fescue-clover pastures (3.6 pounds/head/day) than they did on the fescue-alfalfa pastures (3.1 pounds/head/day). The increased rate of gain on the fescue-clover pastures may have been caused by the increased amount of clover in the forage as the season advanced. Although the rate of gain was highest for steers on fescue-clover pastures, the total gain was slightly greater for steers on fescue-alfalfa because more animals were stocked on fescue-alfalfa pastures.

Twelve yearling steers grazed each of the two pasture mixtures, tall fescue-alfalfa and orchardgrass-alfalfa, in 1977. They were supplemented with barley at 3 pounds/head/day for 76 days (Table 7). Preliminary results indicated that steers on orchardgrass-alfalfa gained 0.5 pounds more per day than steers on fescue-alfalfa pastures. Their total gain was 432 pounds/acre from orchardgrass-alfalfa and 318 pounds/acre from fescue-alfalfa pastures. The higher rate of gain from the orchardgrass pastures was attributed to the greater palatability of this grass compared to that of tall fescue. The higher gain per acre also was attributed to the higher rate of gain made by steers on orchardgrass and to the higher forage yield made by the newly planted orchardgrass pastures. It is not known if orchardgrass pastures of the same age as the fescue pastures would continue to yield higher total gains, but other studies that compared the effect of these grass species on beef production indicate that the forage yield, forage quality,

Table 14. Beef gains made by steers on fescue-clover pastures as affected by energy supplements, 1973[1]

	Energy supplement[2]			
	Check	Vegetable oil	Sirlene	Barley
Animals/acre	3	3	3	3
Initial weight (lb)	527	549	514	529
Total gain (lb/acre)	578	638	750	615
Average beef gain (lb)	172	190	223	183
Average daily gain (lb)[3]	1.7a	1.9b	2.2c	1.8ab
Average daily intake (lb)	----	2.5	4.9	3.0
Gain/pound of supplement (lb)	----	0.07	0.10	0.04

[1] Animals were on treatment 102 days.

[2] Check treatment animals received copper sulfate in their salt. Salt-mineral mix, bonemeal, vegetable oil, and Sirlene were constantly available. Barley was measured and provided daily.

[3] ADG values followed by different letters were different significantly at $P < .05$.

average daily gain, and carrying capacity of orchardgrass pastures were higher than they were from fescue pastures (High et al., 1965; Cooper et al., 1960; Barth et al., 1972; Hobbs et al., 1965).

Pasture Fertilization

Fescue-alfalfa and fescue-clover pastures were subdivided in 1975 and 1976 into 0.5-acre units and fertilized with urea to provide the following treatments: 0 N; 40 pounds N/acre applied June 1 and 40 pounds applied July 15; 80 pounds N/acre applied June 1; 120 pounds N/acre applied June 1; 60 pounds/acre applied June 1 and 60 pounds/acre applied July 15. The 1976 pasture treatments were the same as those in 1975. The pastures were uniformly stocked with yearling heifers at three yearlings/acre. When available forage was utilized to a 3-inch stubble, animals were removed to allow the pastures to recover. All pastures were grazed on a 14-14 day grazing and recovery rotation except as adjusted when animals were removed early from the pastures.

Fescue-alfalfa pastures that were not fertilized failed to produce sufficient forage to carry three yearlings/acre and the animals were removed early. Although an attempt was made to move the animals to new forage before their rate of gain was diminished from lack of feed, they apparently were affected in 1975 when the ADG of yearlings grazing unfertilized pastures was lower than it was from fertilized pastures (Table 5). In 1976, however, the ADG of animals grazing unfertilized forage was relatively high (Table 6). Although the ADG of steers grazing unfertilized forage was good, the decreased number of animal days on pasture reduced the total gains made on those pastures. The rate of gain and total gain of yearlings on pastures that had been fertilized with 120 pounds N/acre in early June were low in 1976 compared to gains made by animals on pastures fertilized with 80 pounds N/acre in June or with split applications of 40-40 and 60-60 pounds N/acre applied in early June and mid-July. The reduced gains from the heavily fertilized pastures were attributed to the stimulation of excessive plant growth that became coarse and less palatable. When the pastures were fertilized with a similar amount of N, but in split applications, growth of the forage was not as rapid, the animals were able to better utilize the forage, and the forage grew at a more uniform rate through the grazing season. The most efficient rates of fertilization generally appeared to be the 60-60 and the 40-40 split applications (Tables 5 and 6). In 1976, however, the 40-40 split application treatment did not produce sufficient forage to meet the need of the grazing yearlings and the animals were removed from the pastures early.

CONCLUSIONS

Although the western livestock industry is based on the availability of rangeland forage, ranch management in eastern Oregon and in the intermountain areas need not be controlled completely by elements that limit the growth of range plants. Results of these studies indicate that improved irrigated pastures can provide a complementary source of livestock forage. The ranch operator, however, should consider carefully the various characteristics of irrigated pasture, first, to determine the class of stock which will use the pasture and, secondly, to manage it to advantage.

Several characteristics to consider are:

1. The stocking rate per unit area is greater on pasture than on range. This is an advantage of pasture during the breeding and calving seasons.

2. Irrigated pastures produce good gains per head and per acre, but a livestock program that converts forage to a rapidly marketable product is likely to be most efficient. Thrifty, fast-growing young animals make the most rapid gain. Therefore, 6-month-old calves produce the most beef per unit area, and yearlings are more efficient producers than older cattle.

3. Development of irrigated pastures on ranches with limited range resources may provide better forage balance. Range forage is notably limited in the intermountain region in early spring. The use of irrigated pasture will permit reserving the range for summer grazing. It also provides an alternate source of forage for fall grazing when the range forage is low in quality or in short

supply. Calves weaned from their mothers in the late summer also can be returned to high-quality pastures when the range forage may be dry and of low palatability and nutrient value.

4. Pastures must be managed according to the plant species. Plants such as tall fescue which lose palatability with maturity require closer grazing in the spring and a shorter recovery period after grazing than do highly preferred species such as orchardgrass. Clipping or grazing at the proper stage for each species, therefore, is essential to maximum regrowth, which in turn is necessary for maximum production.

Alfalfa and clovers require different management. Clover thrives well under frequent light irrigations and can tolerate relatively close grazing. Alfalfa produces better when the water table is low and irrigation is heavier and less frequent than that applied to clover. Alfalfa also does not tolerate as close and frequent grazing as does clover.

Mature animals make more efficient use of coarse forage than young growing animals. Therefore, it is necessary to plant forage species compatible with needs of the grazing animals. Weaned calves, especially, and yearling stock produced better gains from orchardgrass pastures than those obtained from tall fescue. Mature cows, however, gained well on fescue pastures. Because of the abundance of forage produced by tall fescue and because it may be advisable that mature beef cows maintain less finish and gain less on pasture than young animals, tall fescue may be the preferred species for breeding stock.

5. Highest production may be obtained with a legume in the mixture. Bloat, however, is a problem with alfalfa and clover, but pastures usually may be grazed safely if they contain 50 percent or more grass.

6. Forage from irrigated pastures usually will cost more per unit than range forage. The base price of land suitable for irrigation is high and labor requirements and management items are higher per animal unit on pasture than on range.

Properly managed irrigated pastures can be highly productive. The operator who takes advantage of the forage source by having it available when needed can increase the flexibility of his operation. That flexibility can mean the difference between profit and loss in a livestock enterprise.

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