Selection and Management of Irrigated Pasture Mixtures

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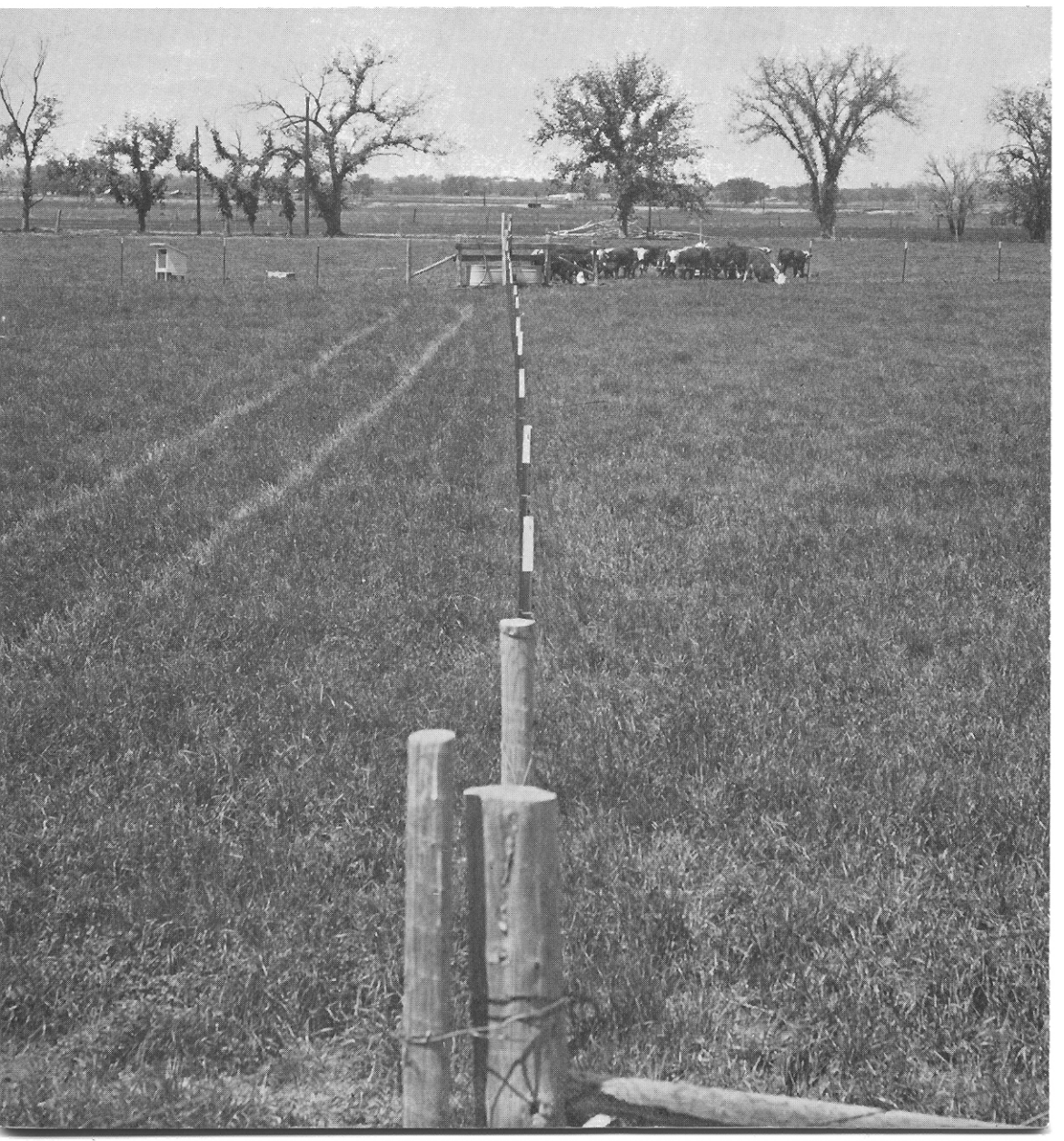

Selection and Management of Irrigated Pasture Mixtures[1]

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In the western United States an estimated 5,000,000 acres of irrigated land are classified as pasture (11). Approximately 10 percent of this land occurs in Montana and provides a major source of forage for livestock (14). Land classified as irrigated pasture generally represents any pasture that is irrigated and grazed. Consequently, the classification includes marginal areas not suited to cropland, as well as productive cropland which has been seeded to high-yielding pasture mixtures.

As the western U.S.A. was settled, the best irrigated land was seeded to cash crops. Those areas not considered suitable for cropping were seeded to pasture. In more recent years research has shown that highly productive pasture mixtures can be profitable enough to justify the occupancy of good as well as poor land. Nearly 800 lb. of beef have been produced at Huntley, Montana (1). Harris et al. (9) produced 1,000 lb. of beef per acre in Utah on a highly productive mixture developed by Bateman and Keller (3). Similar yields of beef per acre were reported by Heinemann and Van Keuren in Washington (10).

Management of irrigated pasture mixtures is more complex than that for most crops, because these mixtures consist of two or more species with different growth requirements. These different species are constantly competing with one another; and both a scientific and artistic approach is needed to maintain a desirable balance of species in a mixture and to provide the growth requirements of each species. The scientific approach consists of a thorough knowledege of the response of each species to light, fertility, moisture and grazing practice. The artistic approach consists of the integration of these factors into successful pasture production for a given area.

This bulletin presents a description of the major species used in irrigated pastures in Montana, factors affecting choice of species in mixtures, and a discussion of management principles.

Grasses For Irrigated Pasture

In Montana four grasses are most commonly used in irrigated pasture grown on well-drained soils. These are Kentucky bluegrass *(Poa pratensis*

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L.), orchardgrass *(Dactylis glomerata L.)*, smooth bromegrass *(Bromus inermis* Leyss.*)*, and tall fescue *(Festuca arundinacea* Schreb.*)*. In addition Reed canarygrass *(Phalaris arundinacea L.)* and meadow foxtail *(Alopecurus pratensis L.)*, are recommended for wet or poorly drained soils and tall wheatgrass *(Agropyron elongatum,* Host, Beauv.*)*, Russian wildrye *(Elymus junceus* Fisch.*)*, and western wheatgrass *(Agropyron smithii* Rydb.*)* on poorly drained and moderately saline soils.

Kentucky bluegrass is a low-growing, highly nutritious, sod-forming perennial and is a component of most irrigated pastures as a result of seeding or of natural invasion. It persists well under close or continuous grazing. It does best in the cooler mountain regions of western Montana. It is slower to become established in mixtures and is not as productive as the taller growing orchardgrass, tall fescue and smooth bromegrass. Consequently, these latter species are most frequently recommended.

Orchardgrass is a highly productive, palatable bunchgrass recommended for irrigated pasture in all areas where it will not winterkill. This grass is not as winterhardy as tall fescue and smooth bromegrass, and should not be seeded in areas where winters are too severe to grow winter wheat. Seed of orchardgrass germinates rapidly and produces vigorous seedlings. Orchardgrass is more palatable than tall fescue, and established plants recover quickly following grazing. Orchardgrass matures more rapidly than smooth bromegrass and is less palatable if the rest period between grazings is long enough to permit flowering. It is not as salt tolerant as tall fescue, nor as drought tolerant as smooth bromegrass. Two varieties of orchardgrass, Potomac and Chinook, are recommended for pastures. Chinook is more winterhardy than Potomac.

Tall fescue is a highly productive bunchgrass, similar to orchardgrass in ease of establishment and rapidity of regrowth following grazing. Its chief drawback is lack of palatability. Because of poor palatability this species is not recommended in areas 1 and 2 (Figure 1) where yields have not been shown to be greater than those of orchardgrass and smooth bromegrass. However, it is more productive than these two species on wet or saline soils and can be grown in areas with winters too severe for orchardgrass. Two varieties, Kenmont and Alta, are recommended for Montana.

Smooth bromegrass is a highly productive, perennial sod-forming grass. It is more winterhardy and drought resistant than either tall fescue or orhardgrass. It is adapted to irrigated lands and to dry-land where annual precipitation is 13 inches or more. Seedling vigor and ease of establishment are similar to orchardgrass. Established plants begin growth as early as orchardgrass but are slower to recover following grazing. It is not as productive as orchardgrass in late summer and early fall. Two varieties, Lincoln and Manchar, are recommended in Montana. Lincoln produces an abundance of creeping rhizomes and becomes sod-bound early in the life of the stand. Manchar does not become sod-bound as readily as Lincoln and is more productive in mid and late summer.

Reed canarygrass is a coarse, sod-forming perennial adapted to moist

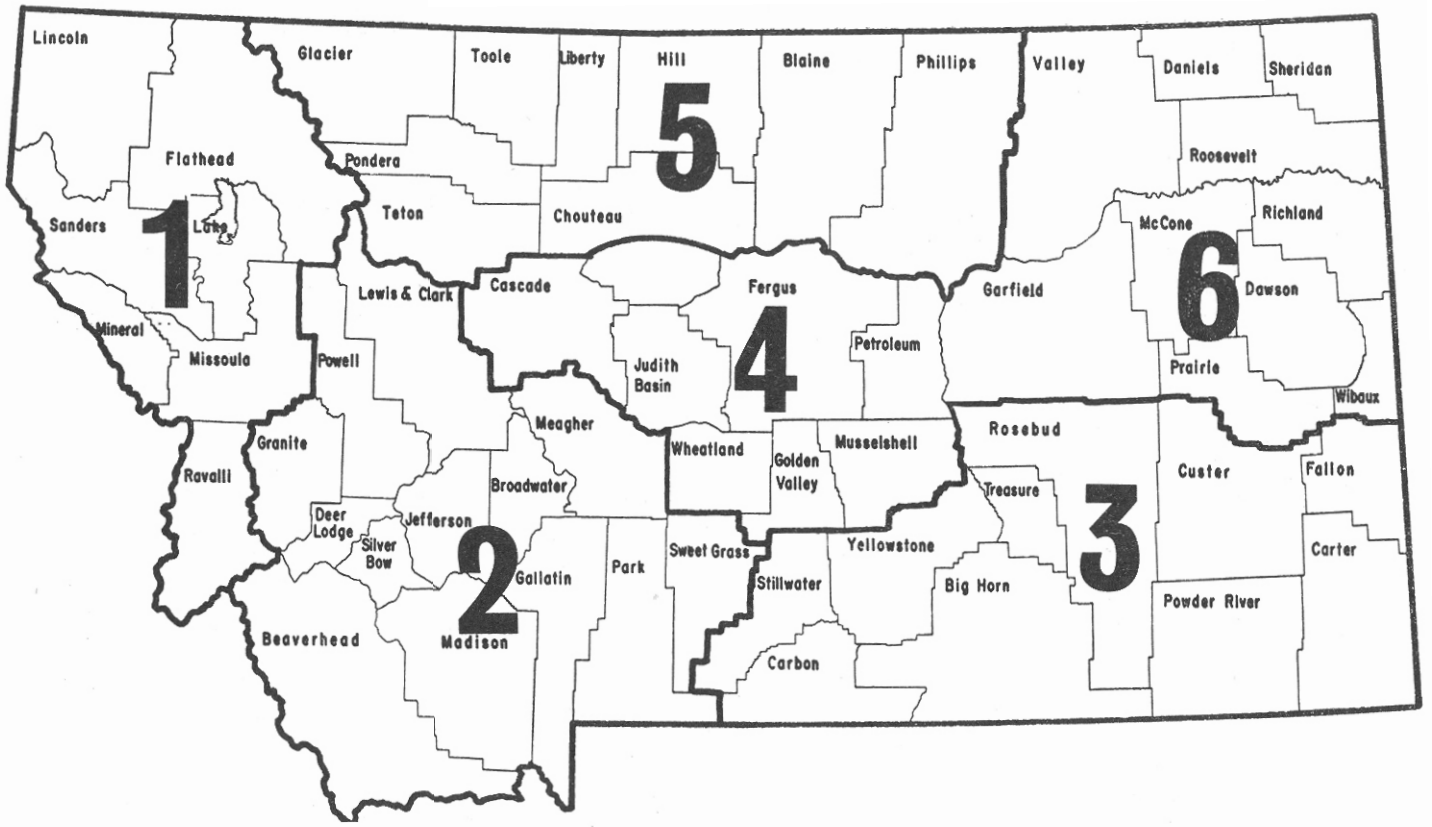

Figure 1. Montana has been divided into six districts to make varietal recommendations more specific. Other area designations within these districts are used, such as irrigated land, dryland, inter-mountain valleys, poorly drained land, saline areas and others.

or poorly drained soils in the absence of salts or alkali. It will withstand submergence in water for a considerable period of time, and because of its affinity for wet soils may become a weed on ditchbanks and in drain ditches. If properly managed, this grass is palatable and productive on wet land. On well-drained land it is not as productive as orchardgrass, smooth bromegrass or tall fescue (6).

Meadow foxtail is a long-lived, perennial sod-forming grass adapted to wet lands on which drought and salinity are never a problem. It is well adapted to high elevations. Heads of this species resemble those of timothy, and the name should not be confused with foxtail barley *(Hordeum jubatum L.)*. Meadow foxtail is quite productive when grown on moist sites. This grass is very palatable and relished by livestock.

Tall wheatgrass is a robust bunchgrass tolerant to both drought and salinity. It becomes coarse and stemmy but is readily utilized if grazed prior to the appearance of seed heads. It has given very high yields on saline sub-irrigated soils in several western states, and is recommended for irrigated pastures only on these problem soils.

Western wheatgrass is a sod-forming grass often called bluejoint or bluestem because of its grayish-blue color and is native to Montana. Its ability to grow on heavy soils, together with its tolerance for alkali and drought, make it a desirable grass for some river valleys in northern and eastern Montana.

Russian wildrye is a drought tolerant perennial bunchgrass, normally grown on dryland. Because of its tolerance to salinity, it is also recommended as irrigated pasture on poorly drained, moderately saline soils. It is one of the earliest grasses to start spring growth and withstands heavy utilization. It is not nearly as productive on well-drained irrigated land as orchardgrass, alta fescue or smooth bromegrass (6).

Legumes For Irrigated Pasture

Six legumes, white clover *(Trifolium repens L.)*, red clover *(Trifolium pratense L.)*, birdsfoot trefoil *(Lotus corniculatus L.)*, alfalfa *(Medicago sativa L.)*, alsike clover *(Trifolium hybridum L.)*, and strawberry clover *(Trifolium fragiferum L.)* are recommended for irrigated pasture in Montana. Of these legumes, white and red clover are most commonly used in pasture mixtures.

The term white clover includes both Ladino and common white clover. Ladino is a mammoth-growing, short-lived, creeping, perennial white clover originally introduced from Italy. It is usually twice as productive as common white clover on irrigated land. Ladino has creeping stems which root at the nodes, and individual plants may spread over a large area. Ladino clover is very productive and with good management may live five years or more. For good yields it requires frequent light irrigations. Ladino can withstand close grazing and recovers rapidly. When grown with a rapid regrowth grass such as orchardgrass, Ladino does not protrude above the grass, which reduces the bloat hazard. Growth requirements of common

white clover are similar to those of Ladino. It is much less productive, but is more winterhardy and generally persists in pastures for a longer period of time.

Red clover or medium red clover is a short-lived, non-creeping, perennial clover which may be added to grass-legume mixtures to increase production during the first two years after seeding. Because of its rapid growth the first year of grazing it may present a bloat hazard. The bloat problem is reduced by seeding it with a rapid developing grass such as orchardgrass. Red clover is readily established, and when planted without a companion crop will produce some hay or pasture the year of planting. Recovery following grazing is not as rapid as for Ladino, but is more rapid than for alsike clover. Recommended varieties for Montana are Dollard, Kenland and Lakeland.

Birdsfoot trefoil is a long-lived, taprooted, yellow-flowered legume. An outstanding feature of this legume is that it is not known to cause bloat. It is weakly competitive in the seedling stage and should not be seeded with a companion crop. It should be protected from weed competition by the application of the herbicide 4(2,4-DB) at the rate of 1-2 lb. per acre (12)[1/]. Mowing just above the developing seedlings will also reduce weed competition. Trefoil seed must be innoculated with cultures specific for this legume prior to seeding. Birdsfoot trefoil may be seeded alone or with grass and provides good summer pasture. It is not as demanding in its moisture, fertility and grazing requirements as some pasture legumes. Growth is slower than that of Ladino clover in early spring and following each grazing. Two varieties, Tana and Empire, are recommended for Montana.

Alsike clover is a short-lived, non-creeping perennial which is recommended for pasture only on wet poorly-drained soils. It is well adapted to high elevations. It is recommended for seeding with grasses also adapted to wet land such as Reed canarygrass or meadow foxtail. Alsike clover plants are leafy and provide good forage, but are slow to recover following clipping and do not persist in pastures more than two or three years.

Alfalfa is the main legume grown in Montana for hay production. In pastures it is very productive, but tends to dominate a pasture mixture. Because of this and its rapid regrowth, which is greater than that of the associated grass, it is often a bloat hazard. Alfalfa-grass mixtures cannot be grazed safely except under intense management where a number of animals are restricted to a small area each day. Under these conditions, the bloat hazard, although still present, is reduced.

Strawberry clover is a long-lived, low-growing perennial clover but because of low productivity is recommended for pasture only in alkaline soils or in low, wet, non-saline soils. Its general growth characteristics are similar to those for white clover. Strawberry clover withstands heavy grazing and will survive when submerged under water for relatively long periods of time. It probably will not survive the winter at all locations in Montana.

[1/] Treated plants should not be grazed or fed to livestock within 30 days after application of 4(2,4-DB).

The Pasture Mixture

Factors determining species to use

Selection of species for a pasture mixture is influenced by several factors. Among these are: (1) site adaptation; (2) intensity of management practices; (3) purpose of the pasture; and (4) productivity desired.

Selection on the basis of adaptation may be limited. For example, for wet lands only two of our recommended grasses may be selected. The choice of which of these to use will depend upon other associated factors. On well-drained land a greater number of species are adapted, a factor which permits greater freedom of choice. Under these conditions choice of species depends largely upon factors 2, 3 and 4 listed above.

Intensity of management practice includes adequacy of irrigation water, grazing system and fertility practice. Plants with shallow root systems like Ladino clover or Kentucky bluegrass require frequent irrigation. Alfalfa or birdsfoot trefoil with deep tap roots do well with less frequent irrigation. Figure 2 illustrates the difference in response of two legumes to irrigation where a water table was present at about four feet. Increased irrigation

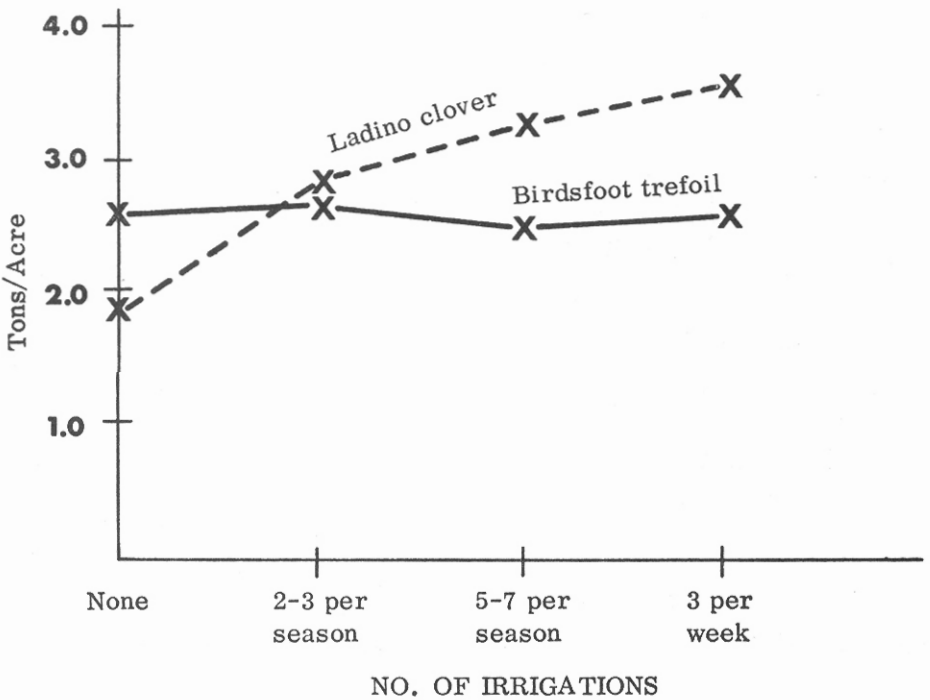

Figure 2. Influence of irrigation level on three-year average yields of Birdsfoot trefoil and Ladino clover (5).

did not affect the yields of the deep-rooted birdsfoot trefoil, but markedly increased the yields and persistence of the shallow-rooted Ladino clover. Thus, birdsfoot trefoil might be selected where irrigation water is limited and the water table is not too deep. Ladino clover, however, should not be seeded unless water is available for frequent irrigation.

The rest period between grazings will affect the species composition and performance of mixtures. A rest period is necessary to allow ample time for the plants to restore food reserves in the roots which are used for initiation of new growth after grazing. Since species may vary in the time required to replenish reserves, length of rest period will favor one species over another. Length of rest period will also affect the light environment and favor a particular species. Long rest periods in early spring will favor tall-growing grass species such as orchardgrass over low-growing legume species such as Ladino clover or birdsfoot trefoil. In contrast, more frequent grazing will favor the shorter growing legumes. These effects are clearly shown (Figure 3) with studies at Bozeman where mixtures were given different rest periods between grazings (8). Both the Huntley mixture (containing common white clover) and birdsfoot trefoil-smooth bromegrass

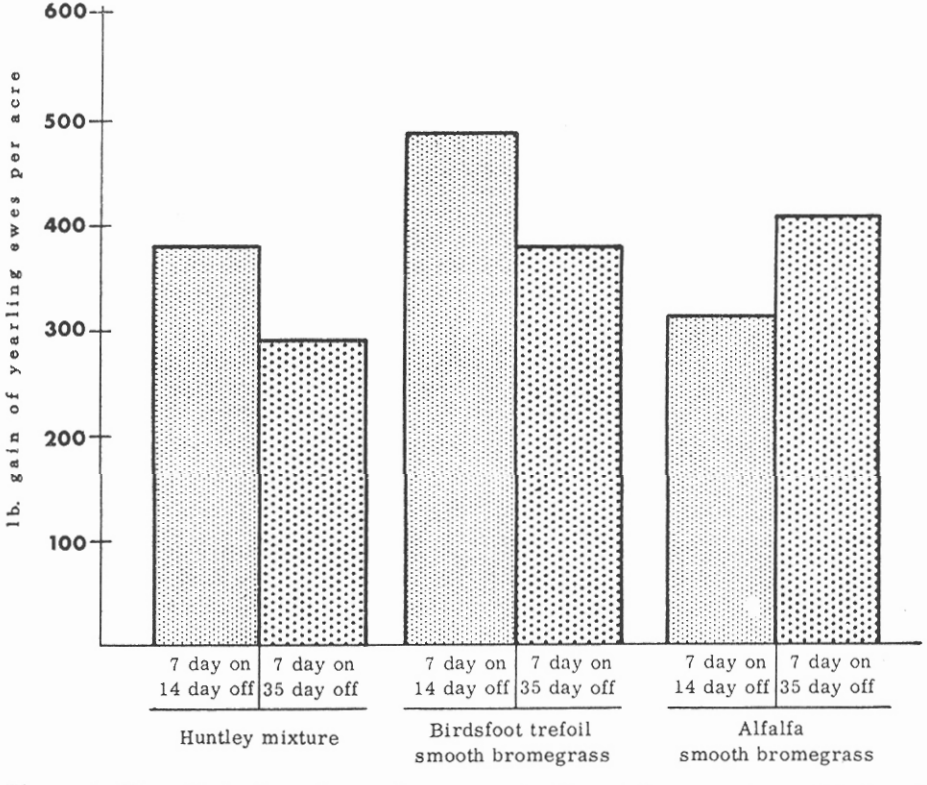

Figure 3. The effect of grazing system on production of three pasture mixtures at Bozeman, Montana (8).

mixtures were favored by the shorter rest period. In contrast, alfalfa-bromegrass yields were favored by the longer rest period. The percentage legume in the Huntley or birdsfoot trefoil mixtures decreased with the longer rest period because of greater competition for light by grass. Alfalfa was benefited by the longer rest period because it needs a longer time to store food reserves following grazing and is less affected by light competition from grass. Alfalfa stands were also greatly reduced under the short rotation system. These data illustrate the importance of the relationship between species and grazing management. The productivity of pasture will often depend upon the manager's skill in applying his knowledge of this relationship.

Fertilizer level will also affect vegetative composition and productivity of the mixture. Nitrogen favors the grass species and heavy rates of N can result in loss of the legume. Phosphorus generally favors the legume. Proper balance of these two fertilizer elements is essential to the maintenance of a legume in a pasture mixture.

Type of livestock and the time of season that pastures are to be grazed should be considered in the selection of species. If high animal gains are desired, palatability of species becomes a very important factor. A palatable species such as orchardgrass will generally produce greater average daily gains than a less palatable species such as tall fescue (4). If the pasture is to be used for animals where carrying capacity is more important than average daily gain, the most productive species can be selected with little regard for palatability. However, one should avoid putting two grass species with great differences in palatability in the same pasture mixture.

Pastures may be planted for season-long use or for specific periods of use. The latter are considered special purpose pastures. The most common are those used for hay production in early season followed by grazing in late season. For these pastures, grasses and legumes with good late season growth should be selected. Orchardgrass and tall fescue are two of the better grasses and Ladino clover and birdsfoot trefoil are good legumes for this purpose.

If yields of individual species of grasses and legumes are known for a location, then yields of pasture mixtures at that location can be reasonably predicted by knowing the percentage of each of the individual species in the stand. Figure 4 illustrates this general relationship in species clipped to simulate grazing at Huntley, Montana (13). Tall fescue was the most productive of the grasses tested. Note that mixtures containing tall fescue were always highest-yielding, and that addition of a lower-yielding species usually resulted in a mixture yield less than that of tall fescue alone.

The relative yield of grasses varies with location. In southwestern Montana yields of orchardgrass, smooth bromegrass and tall fescue have been similar. In western Montana, orchardgrass and tall fescue yield more than smooth bromegrass.

Dominance of individual species varies with such factors as site, location and management. In mixtures containing tall fescue, smooth bromegrass and orchardgrass, smooth bromegrass has become dominant in

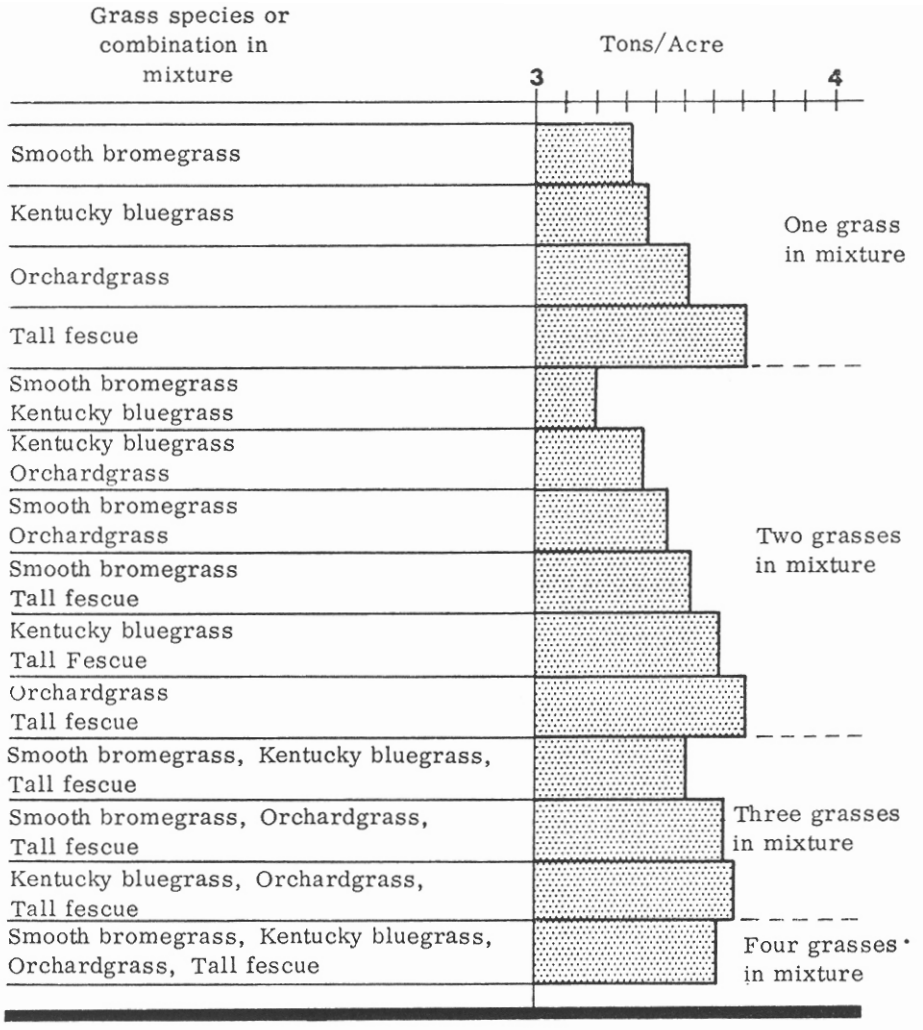

Figure 4. Contribution of grass species alone or in combination to the yield of grass legume mixtures (values are four-year averages of species grown alone, with Ladino clover, with red clover and with Ladino plus red red clover at Huntley, Montana) (13).

many old pastures in north-central Montana; orchardgrass becomes dominant in southwestern Montana, and tall fescue tends to become dominant in the Huntley area. Kentucky bluegrass increases in mixtures under close and/or continuous grazing at all locations.

Disregarding effects on yield, there may be advantage in seeding more than one grass species in the same pasture. Sod-formers will: (1) provide

a thicker turf and reduce damage by animals when the soil is wet; (2) fill in more quickly in new stands; (3) replace plants or species that die out in older stands; (4) fill in quickly on critical sites where stands are difficult to establish and thus reduce invasion by weeds; and (5) reduce danger from erosion.

If the best species for an area are not known, several species may be better than one. Under good management, the most productive species will usually become dominant. Also, one species may not be best adapted to all sites within a given pasture. Other species may be needed for areas that are saline or wet, or which have heavy-textured soils. These areas may be too small to seed or fence separately.

Montana has been divided into six districts to make pasture recommendation more specific (Figure 1). Each district is serviced by a branch experiment station. Data from these stations serve as a basis for recommendations. Districts 1 and 2 represent mountain valleys. District 1 is lower in elevation than District 2 and receives a larger amount of winter precipitation. Districts 3 and 6 are at low elevations in which both cool and warm season grasses are native. District 6 is more characteristic of the Great Plains area with severe winters which result in loss of species with low winterhardiness. District 5 is similar to 6 in severity of winters but is cooler in summer. District 4 is a cool-season, dryland, high elevation area. Pasture mixtures recommended for these districts in Montana are presented in the following tables:

Permanent Pastures — Well Drained Irrigated Land — Complex Mixtures

Species	Seeding Rate[1]/ Districts 1 & 2 lb/A	3 lb/A	4, 5 & 6 lb/A	6 lb/A
Smooth brome	1.7	1.7	1.7	
Tall fescue		1.6	1.6	1.2
Orchardgrass	1.1	1.1	1.1	
Reed canarygrass				.7
Kentucky bluegrass	.7			
White clover			.8	.8
Ladino clover	.8	.8		
Red clover	1.5	1.5	1.5	
Birdsfoot trefoil				3.1
Total	5.8	6.7	6.7	5.8

1/ Based on Pure Live Seed Index of 100.

Permanent Pastures — Well Drained Irrigated Land — Simple Mixtures

Species	All	Seeding Rate[1]/ Districts 1, 2 & 3		4, 5 & 6
Smooth brome	5.1		4.3	
Tall fescue				4.8
Orchardgrass		2.8		
Kentucky bluegrass		1.7		
White clover	.8			.8
Birdsfoot trefoil		3.1	3.1	
Alfalfa	1.7			1.7
Total	7.6	5.9	4.8	7.4	7.3

1/ Based on Pure Live Seed Index of 100.

Short Time Rotation Pastures — Well Drained Irrigated Land

Species	Seeding Rate[1]/ Districts All		1, 2, 3 & 4	5 & 6
Smooth bromegrass	5.1	6.8		
Tall fescue				4.8
Orchardgrass			3.3	
Ladino clover	.8		.8	.8
Red clover	1.5		1.5	1.5
Alfalfa, Ranger		1.7		
Total	7.4	8.5	5.6	7.1

1/ Based on Pure Live Seed Index of 100.

Well Drained Soils — Limited Irrigation Water

Species	All	Seeding Rate[1]/ Districts 1, 2 & 4
Smooth brome	6.8	4.3
Alfalfa, Ranger	1.7	
Birdsfoot trefoil		3.1
Total	8.5	7.4

1/ Based on Pure Live Seed Index of 100.

Wet or Poorly Drained Soils

Species	All	Seeding Rate[1]/ Districts 1, 2, 3 & 4
Reed canarygrass	2.7	
Meadow foxtail		3.2
Alsike clover	1.0	1.0
Ladino clover	.8	.8
Total	4.5	5.0

1/ Based on Pure Live Seed Index of 100.

Poorly Drained and Moderately Saline Soils

Species	All	Seeding Rate[1]/ Districts 3	3, 4 & 6
Tall wheatgrass	9.7		
Russian wildrye		5.7	
Western wheatgrass			6.1
Tall fescue	4.8		.8
Strawberry clover	1.1	1.1	1.1
Total	10.8	5.9	6.8	8.0

1/ Based on Pure Live Seed Index of 100.

Seeding rates are on the basis of a pure live seed index (germination x purity x 100) of 100. Seeding rates for lots with less than 100 pure live seed index should be adjusted upwards. This adjustment is made by dividing the rates given by the pure live seed index and multiplying by 100.

Establishment and management

The first requirement for productive pasture is obtaining a good stand. Thus the seeding operation and management in the first year is very criti-

cal. A firm well-pulverized seedbed is essential for germination. It should be firm enough that tracks left by a man walking across it are no more than ⅛ inch deep. The field should be leveled to insure uniform distribution of irrigation water. Seed of most pasture species should not be planted deeper than ½ inch. Depth bands on the drill will help to maintain the proper seeding depth and are available commercially from several equipment manufacturers.

A sufficient quantity of phosphorus to meet the needs of the pasture for several years should be applied prior to seedbed preparation and should be plowed under. Research has shown that it is more economical to do this than to topdress annually with phosphorus. A highly productive pasture will require about 40 lb. of P_2O_5 per acre annually. These requirements plus a soil test will serve as a guide in determining the amount to be applied.

Nitrogen is usually not needed for successful stand establishment. If applied at seeding time, growth of weeds and companion crops will most likely be stimulated more than the forage species. Competition from either of these in the seeding year may result in reduced stands and will result in decreased yields the first year of production.

Watch the new seeding closely. If a soil crust occurs before emergence, break it up with a light packer to permit seedlings to emerge. After emergence check the pasture frequently for moisture status and weed competition. Irrigate lightly and frequently to keep the seedling root zone moist. Control competition from weeds by clipping just above the tops of young seedlings, or in some instances by spraying with the proper herbicide (12). Grazing should be avoided until late fall of the seeding year. A sequential list of seeding and first year management operations are presented in Table 1.

Once the pasture is established, observe certain routine management practices. These are listed in Table 2. Several of these—fertilizer, irrigation and the grazing system—are of major importance. Fertility is essential to high production. Phosphorus increases legume yields and adds assurance of keeping the legume in the mixture. Nitrogen increases grass yield, but large quantities may increase grass growth to the point that legumes are lost from the stand. Thus a balanced fertilizer program is important. The following shows the average yield increases which were obtained from annual phosphorus applications to grass-legume mixtures over a five year period on a low phosphorus soil at Creston, Montana (13).

Mixture	Average annual increase in tons/A from P_2O_5 applications per acre of 40 lb. T/A	80 lb. T/A
Birdsfoot trefoil-orchardgrass	.26	.35
Ladino clover-orchardgrass	1.02	1.24
Alfalfa-orchardgrass	.83	1.04

At this location little increase was obtained from applying 80 rather than 40 lb. of P_2O_5. The greatest response was obtained from the Ladino clover-grass mixture and the least from the birdsfoot trefoil-grass mixture. Total yields of these two mixtures were similar with phosphorus. Without P the birdsfoot trefoil mixture yielded .63 ton more than the Ladino clover mixture. The data support the contention that fertility requirements of birdsfoot trefoil may be less than for other pasture legumes. Response of these three mixtures to nitrogen was as shown in table below.

The most economical response was obtained from 50 lb. of N per acre. At this rate, with adequate phosphorus, legumes were maintained in the mixture. A fertility rate of 50 N and 80 P_2O_5 per acre resulted in yields of 3.50, 3.77 and 3.84 T/A, respectively, for mixtures containing birdsfoot trefoil, Ladino clover and alfalfa. Yields of these same mixtures unfertilized were 2.33, 1.72 and 2.21 T/A.

Nitrogen fertilizer greatly increases yields from pure grass stands or mixtures in which the legume has been mostly lost from the stand. Over a three year period at Bozeman, average yields of three main pastures species, orchardgrass, tall fescue and smooth bromegrass, were 1.45, 2.02, 2.57, 3.49 and 4.36 T/A, respectively, for nitrogen rates of 0, 50, 100, 200 and 400 lb. per acre (6). At Huntley, Montana, during the period 1961-1963, irrigated pasture, fertilized with 290 lb. of N per acre annually, provided an average of 554 animal days of grazing (500 to 700 lb. steers) and produced 772 lb. of beef per acre. In contrast, during the same period unfertilized pasture provided an average of 322 animal days of grazing and 485 lb. of beef per acre. The net profit from the use of N after deduction of fertilizer and fixed costs (establishment charges, harrowing, clipping, irrigating, land interest, taxes, fencing, etc.) averaged $11.85 per acre more than unfertilized pasture over a three year period. The response that one may obtain from a fertilizer application is dependent upon nutrient status of the soil, available moisture and management practice.

Keep soil moisture in the root zone between wilting and field capacity at all times. Since many pasture species have shallow-root systems it will require frequent irrigation to keep the upper region of the soil moist. The time between irrigations depends on rainfall and soil texture. A soil probe will aid in determining when to irrigate. Over irrigation may be as detrimental as inadequate irrigation. Flooding the soil for long periods of time results in loss of nutrients, poor aeration and invasion by less desirable water "loving" species. The presence of invading species such as timothy (*Phleum pratense*), red top (*Agros-*

Mixture	Average increase in tons/A from N applications per acre of 50 lb. T/A	100 lb. T/A
Birdsfoot trefoil-orchardgrass	.63	.88
Ladino clover-orchardgrass	.66	1.11
Alfalfa-orchardgrass	.71	.86

TABLE 1. SEEDING AND SEEDING YEAR MANAGEMENT CHART

	Time	Operation	Reason for	Results in
(1)	Prior to seeding	Select quality seed of recommended varieties free from weeds.	To help insure good stands of adapted productive species.	Pastures with highly adapted species. Weed control.
	Prior to seeding	Innoculate legume seed with proper bacteria, if needed.	To provide symbiotic bacteria for nitrogen fixation.	Production of nitrogen by legumes for use by grass; increased productivity. Cheap source of nitrogen.
	Prior to seeding	Level field if gravity irrigation is to be used.	To insure uniform distribution of irrigation water.	Increased productivity.
	Prior to seeding	Prepare a firm seedbed.	Bring seed in close contact with moisture and nutrients; prolongs moisture retention for germination. Helps control depth of seeding.	Good uniform stands; rapid emergence.
	Prior to seeding	Provide adequate fertility.	To stimulate development, decrease competition.	Good stands and maximum seedling growth.
(2)	At seeding	Seed at recommended depth.	To allow seed to emerge with energy available.	Uniform emergence and good stands.
(3)	Immediately after seeding	Frequent observation to note soil crusting prior to emergence. If crusting occurs, go over land with light cultipacker.	To break up soil crust to allow emergence.	Better emergence and stands.

Table 1.—Continued

Time	Operation	Reason for	Results in
(4) During establishment	Frequent check of soil moisture. If dry, apply enough water to wet seedling root zone.	To provide adequate water for seedling growth.	Rapid seedling development Increases survival.
	Frequent observation of weed competition. If weed competition strong, mow with guards set high or spray with proper herbicide.	To increase photosynthetic activity of seedlings.	Vigorous seedlings, good stands. Higher yields in first and subsequent production years.
CAUTIONS:			
(5) Do not seed with companion crop in close row spacing, if used, space companion crop in 18-21 inch rows. Use the same drill setting as normal for companion crop but plug ½ or ⅔ of spouts to obtain row spacing.			Less competition to forage seedlings; increases chances for seeding success; increases forage yields.
(6) Avoid grazing until late fall of seeding year.			Better establishment. Less winter injury. More productive stands.
(7) Gear all management operations to meet needs of the forage seeding.			Seeding success.

TABLE 2. PASTURE MANAGEMENT CHART[1/]

	Time	Operation	Reason for	Results in
(1)	Before spring growth begins	Harrow both ways.	To distribute droppings and applied manure.	More uniform grazing and fertility.
		Apply fertilizer as indicated by soil test, species present and intended use.	Increases soil fertility and helps regulate legume composition.	Earlier and more uniform grazing, increased productivity, maintenance of legume and grass composition.
(2)	When forage is 4 to 6 inches high	Begin rotation grazing.	To graze all forage before hay stage.	Longer grazing season, greater seasonal productivity.
(3)	After first grazing	Begin each subsequent grazing when forage 8-10 inches high or after 3-4 weeks rest period.	Allows plants to store root reserve for new growth.	Faster recovery following grazing and greater seasonal production.
(4)	After each grazing	Harrow and clip if needed.	Distributes droppings. Controls weeds.	More uniform grazing and quality, prevents spot grazing, weed control.
		Irrigate if dry.	Stimulates regrowth, increases yield.	Abundant forage for grazing.
(5)	When ungrazed forages approach hay stage	Mow and make hay.	Prevents forage from becoming too mature.	High quality hay, weed control.
(6)	Fall, winter and early spring	Apply barnyard manure if available.	To save fertility and supply nutrients for plant growth.	Increased yield.

1/ Modified from chart presented by Bateman (2).

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Table 2.—Continued

		Results in
CAUTIONS:		
(7)	When pastures have 60 percent or more of legumes, limit area to be grazed and graze with caution and keep animals under surveillance.	Live animals.
(8)	Do not over irrigate.	Saves water, prevents loss of nutrients through leaching.
(9)	Do not graze when wet.	Less soil compaction and trampling, improved tilth, higher yields.
(10)	Use nitrogen with discretion on pastures containing legumes.	Maintains an optimum amount of legume (40 to 60%).

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tis alba L.), wiregrass *(Juncus balticus* Willd.), and foxtail barley *(Hordeum jubatum L.)* is a good indication of over irrigation. Allow soils to surface-dry before grazing to keep trampling at a minimum. Soils containing little or no clay tolerate grazing during rainy weather better than those with clay.

Grazing management of pasture generally consists of one of three systems: (1) season long grazing; (2) rotational grazing; and (3) strip grazing. The most common and least desirable is season long grazing. In this system animals are grazed throughout the season on one large pasture. There are several disadvantages. (1) Irrigation must take place while animals are on pasture; this results in trampling and compaction of the soil. (2) Animals tend to concentrate on closely grazed areas and ignore more mature unpalatable forage; this results in poorer use of some areas and overuse of others. (3) The system does not provide for a controlled rest period.

In rotation grazing the pasture area is divided into three or four smaller pastures. Animals are rotated from pasture to pasture usually spending 7-10 days on, and 21-30 days off each. This system permits irrigation when animals are not grazing, provides a rest period and results in better utilization. The third system, strip grazing, restricts animals to a small area for a short period of time, usually 1-3 days. Size of grazing area is controlled by moving electric fence ahead of and behind the animals. Size of area for each new grazing area may range from 1-5 acres, depending on number of animals. This system has the same advantages as rotation grazing. In addition, it provides better utilization since choice of forage is restricted. It is also of value in reducing bloat in mixtures with high legume content, since restricted choice forces animals to consume a larger proportion of grass with the legume. Strip grazing does much to preserve the species which were initially seeded. It is similar to mowing the field and selective pressures due to differences in palatability are not allowed. Main disadvantages are cost of labor involved in moving electric fences and the problem of providing stock water.

In all grazing systems, pastures should not be grazed too closely. New growth following grazing originates from growing points. In some species growing points may be several inches above the ground and are removed by close grazing. Two to three inches of stubble left after grazing protects the growing point and provides some leaf area to begin new growth.

Irrigated pasture has the potential to return a substantial margin of profit to the grower, and to compete favorably with other cash crops if the previously discussed management principles are applied. Species selection, irrigation, fertility and livestock management must be considered if this profit potential is to be realized.

Where Does Irrigated Pasture Fit?

An operator needs to consider carefully the various characteristics of irrigated pasture, first, to determine whether it has a useful place in his enterprise and, secondly, to use it to best advantage.

The following are several of the more important characteristics to be considered:

1. More animals can be grazed per unit of area than on range. This is an advantage in dairy operations and in beef programs during breeding season. With sheep, parasites may be more of a problem.

2. Irrigated pasture produces good gains per head and per acre, and stimulates milk production. A livestock program which converts forage to a rapidly marketable product is likely to make best use of it. Dairying, yearling operations and fall calving programs are examples. The purebred herd can use it to advantage also since it is smaller, needs closer supervision and requires more rapid gain and better finish.

3. Development of irrigated pastures on ranches with limited range resources may enable them to achieve a better forage balance. Their use will permit reserving the range for fall and winter, providing a longer grazing season and shorter winter feeding period.

4. Programs must be geared to use forage pretty much *as it is produced,* if maximum production is to be obtained from irrigated pastures. Clipping or grazing at the proper stage is essential to maximum regrowth, which in turn is necessary for maximum production.

5. Highest production is obtained from a mixture of grass and legume. Bloat is a problem with most legumes, but mixtures may usually be grazed safely if they contain 50 percent grass.

6. Labor requirements for irrigating, fencing, moving livestock and other management items are higher *per cow* on irrigated pasture than on range. This may limit volume of enterprise.

7. Forage from irrigated pasture will usually cost more per unit than range forage. In addition, in most of Montana it is easier to provide a long grazing season and short winter feeding period on range, than is feasible from irrigated resources alone.

Irrigated pastures can be highly productive. The operator who can harness them to a profitable livestock enterprise can use them to real advantage.

Montana Agricultural Experiment Station System