Importance of Irrigated Grasslands in Animal Production

WESLEY KELLER

Research Agronomist, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, Beltsville, Maryland

Irrigation is tremendously important to the agriculture of the western United States; and water, on which it is based, is a primary requirement for the industrial and economic development of the region. Anyone at all familiar with the difficulties encountered in partitioning the waters of the Colorado River realizes this must be so. Garnsey (1950) wrote a book in support of the hypothesis that the Upper Basin States would forever remain a hinterland if they failed to hold fast to their share of the waters of the Colorado River. According to Clyde (1958) irrigation in the 17 western states (96 percent of the national total) uses just over 80 billion gallons of water daily. The nation’s industrial use of water is about the same. The human requirement is 17 billions daily. Industrial use is increasing so rapidly that it is estimated at 215 billion gallons daily by 1975, with irrigation at 110. The nation receives about 4.3 trillion gallons daily as snow and rain. The problem is thus less one of total supply than of distribution. Industry is expanding most rapidly in the West, where it competes for water directly with irrigation, although many industrial processes do not consume the water, but require only its temporary use. Multiple use of water is of great importance in the arid West.

In round numbers there are 30 million acres of irrigated land in the 17 western states, of which nearly half, 14 million acres, produce forage. In addition, 18 million acres of non-irrigated land produce forage (figure 1). Most of the irrigated alfalfa and nearly all the irrigated pastures are in the 11 western states. Haylands in the 11 western and 6 plains states are presented in figure 2. Note the large acreage of wild hay in the plains states. For numbers of cattle and sheep in the 11 western and 6 plains states see figure 3. Note that in terms of animal units (5 sheep = 1 cow) cattle are 10 times as important as sheep.

The extent to which western livestock graze on National Forests is presented in figure 4. Note that 1 of every 9 cows and 2 of every 9 sheep obtain summer feed on the National Forests, the total grazing obtained being about 7 percent of the total need. Approximately 61 million acres of National Forest lands are grazed. The Bureau of Land Management, with 187 million acres under grazing in the western United States, contributes a little more than the Forest Service to cattle grazing.

---

and about twice as much to sheep. The relationship between domestic livestock and big game (chiefly deer) on National Forest lands is illustrated in figure 5.

Alfalfa is clearly the most important harvested forage crop in the 17 western states. There are 13.3 million acres of alfalfa of which 92% are irrigated. With irrigated acreages of 5 million for alfalfa, 4.5 million for pastures, 3.5 million for mountain meadows and approximately a million each for silage and grains cut for hay there can be little doubt about the importance of irrigation to animal production in the western United States.

Alfalfa is particularly adapted to the basic soils of the West. It is a high producer of nutritious forage comparatively high in nitrogen. It responds to water in almost any amount and is easily made into hay. Although it has been subjected to some serious diseases and pests, resistant varieties or effective management practices have been developed as each need arose. Within a given area, methods of establishing, producing and harvesting the crop have become fairly well standardized. It is likely that alfalfa will become increasingly important in the western states. The degree to which alfalfa can be depended upon to produce a crop every year, in the West, is something that ranchers, dealing with generally overstocked ranges with a high dependence on the vicissitudes of nature, can appreciate to the fullest.

In contrast to alfalfa, irrigated pastures have presented an entirely different set of problems. When the West was settled pastures were either available on wet valley-bottom lands or were established on areas not suitable for intensive cultivation. The prevailing system of management was continuous close grazing and flood irrigation, without application of fertilizer. Under this management these pastures, no matter what they contained to begin with, soon reverted to Kentucky bluegrass and white clover, the clover disappearing if irrigation was neglected.

Before improved methods of pasture management could be developed, or much interest shown in them, pressure for pasture products had to be sufficient for pastures to expand onto arable land. Dairy products generated this pressure and along with rotation grazing set the stage for the direct comparison of pastures with other crops.

This led to research. The high productive potential of irrigated pastures, which this research brought to light, has yet to make its impact on the agriculture of the West. Facts now available, however, assure that irrigated pastures will become of much greater importance in the future in animal production in the western states.

Although a few early researchers made notable progress, as have others currently active, it is to the comprehensive and fruitful investigations under the leadership of Bateman at the Utah Station that we are largely indebted for the present promise of irrigated pastures. Carried out over a quarter of a century, these studies were always incorporated into the management of the dairy herd (Bateman et al., 1949) which increased from about 35 milking cows and their young stock to double that number and never lacked for the acid test of practical application on a field scale. Some of these investigations are as follows:

(1) Bateman (1940) reported a study conducted with D. W. Pittman. One application of 600 pounds treble superphosphate

![Figure 3. Cattle and sheep in the 11 western and 6 plains states. In terms of animal units cattle are 10 times as important as sheep. From 1954 census of Agriculture.](image)

![Figure 4. Cattle and sheep grazing on National Forest ranges, the percent of all beef cattle and stock sheep in the western states, and the percent of total grazing requirements of western livestock furnished by National Forest ranges. From 1953 report, Chief of Forest Service.](image)
Table 1. Suggested pasture mixtures and rates of seeding on a good seedbed for 9 conditions common in the Intermountain Region. From the Utah Agr. Exp. Sta., with some modifications.

<table>
<thead>
<tr>
<th>LEGEND</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Best use.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8/8/</td>
<td>Range of adaptation.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Species</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crested wheatgrass</td>
<td>5</td>
<td>8/8/</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intermediate wheatgrass</td>
<td>5</td>
<td>8/8/</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tall wheatgrass</td>
<td>8/8/</td>
<td>5</td>
<td>8/8/</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smooth bromegrass</td>
<td>8</td>
<td>4</td>
<td>4</td>
<td>8/8/</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tall oatgrass</td>
<td>8/8/</td>
<td>4</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orchardgrass</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reed canarygrass</td>
<td>8/8/</td>
<td>8/8/</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alfalfa (wilt-resistant)</td>
<td>3</td>
<td>3</td>
<td>8/8/</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red clover</td>
<td>8/8/</td>
<td>8/8/</td>
<td>8/8/</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ladino clover</td>
<td>8/8/</td>
<td>8/8/</td>
<td>8/8/</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alsike clover</td>
<td>8/8/</td>
<td>8/8/</td>
<td>8/8/</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strawberry clover</td>
<td>8/8/</td>
<td>8/8/</td>
<td>8/8/</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 The slant-marked blocks extend the range of adaptation of each species to areas where they may be valuable under some conditions. For example, Reed canarygrass once established is highly productive throughout the slant-marked zones, but good stands of it are difficult to obtain without abundant water. Likewise, widely adapted sweet clover is not so desirable a pasture plant as alfalfa, but might be used on dryland to safely extend the grazing period without danger of bloat.

2 Tall fescue and all varieties of it (Alta fescue, Kentucky 31 fescue, etc.) though widely adapted, are not recommended because of low palatability.

(43 percent P2O5) resulted in an average increase of 63.8 percent over a 5-year period. Another treatment of 200 pounds treble superphosphate and 10 tons manure gave a 3-year average increase of 34.4 percent. On the basis of these studies the dairy farm pastures were placed under a fertilization program of 10 to 15 tons manure directly from the barn plus 200 pounds treble superphosphate every 3 years. This was later changed to every 2 years (Bateman, 1943) following a response of 95.7 percent the same season from an application in the spring of 6.8 tons manure and 200 pounds treble superphosphate.

(2) During 1942-44 the rate of spring and early-summer growth of pasture was determined by Bateman (1952) for 4 fields grazed in rotation. The results of this study are presented in figure 6. Note the tremendous vigor of pastures early in the season. Grazing must also begin early and be carefully controlled. Otherwise, extra acres must be harvested as hay.

(3) Bateman has rather consistently obtained yields of 60-80 bushels of barley per acre seeded as a companion crop to alfalfa or pasture. His philosophy is that if a companion crop is not sown there will be one of weeds. (Stapledon 1949) has shown that the ryegrasses are much more competitive against other grasses than is a cereal cover crop.) Success with a companion crop, on irrigated land, requires fertile soil, a firm, clean seedbed, early-spring seeding, and meeting the moisture needs of the small-seeded crop. Barley is recommended at 50 pounds per acre (Bateman, 1956, 1958).

(4) Production per acre from pasture has been reported as pounds of total digestible nutrients, pounds of milk (4 percent fat-corrected), pounds of butter-fat, or combinations of these with gain or loss in body weight of the grazing animals. Such production records led to a search for more productive mixtures (Bateman and Keller, 1956). Some relationships are presented in figures 7 and 8.

The recommended mixture has consistently yielded 5000 pounds...
or more of total digestible nutrients per acre, and when grazed by dairy cows with a 400-pound butterfat average has consistently yielded above 8000 pounds of 4 percent fat-corrected milk, or 320 pounds of butterfat. In 1953 20 acres averaged 9007 pounds and 332 pounds of butterfat. In 1958, Bateman and associates compared grazing with green chop fed in dry lot. Milk production per acre was identical, but labor and machinery requirements of green chop made it the more costly practice. Current literature contains reports that under grazing as much as 30 percent of the feed is wasted. In this connection it is interesting that the Utah study reports 46 pounds dry-weight forage per acre refused under grazing and 114 pounds when fed in dry lot. This is an illustration of the efficiency of utilization possible when irrigated pastures are properly managed.

In a recent study (Bateman, 1958; Bateman, et al., 1958) Bateman and associates compared grazing with green chop fed in dry lot. Milk production per acre was identical, but labor and machinery requirements of green chop made it the more costly practice. Current literature contains reports that under grazing as much as 30 percent of the feed is wasted. In this connection it is interesting that the Utah study reports 46 pounds dry-weight forage per acre refused under grazing and 114 pounds when fed in dry lot. This is an illustration of the efficiency of utilization possible when irrigated pastures are properly managed.

In 1948 LeRoy Bunnell and a former high school student, Mack Hansen, produced 952 pounds of beef per acre on an 8-acre pasture seeded to the new Utah mixture. After accounting for 2.3 tons of barley and 3.2 tons of alfalfa hay fed, they obtained a return of $213 per acre from the pasture (McVickar, 1951).

Heinemann and Van Keuren (1955, 1958a, 1958b) and Van Keuren and Heinemann (1956, 1958) have consistently approached and sometimes exceeded 1,000 pounds of beef or mutton per acre, from irrigated pastures seeded to simple mixtures.

True and Hoveland (1955) have written: "It is possible to produce 1,000 pounds beef gain or milk equivalent per acre on well-managed irrigated pastures in south Texas. Irrigated pastures offer good profits in milk or beef production and the best known method of soil improvement."

According to Staten et al. (1951) well-managed irrigated pastures should carry 30 cows and their calves from April 1 to November 15. They report the experience of farmers that a well-grown and well-managed pasture can be expected to produce 1,000 to 1,500 pounds or even more of beef per acre. They estimate that it costs $42 to establish an acre of pasture and $72 a year to maintain it.

In a preliminary report Jensen and Madsen (1957) give production of beef from Kentucky bluegrass pastures in Nevada for 1957. Pastures given 50 pounds N per acre in March and 55 pounds in July yielded 693 pounds of beef per acre as compared with 498 pounds when no fertilizer was applied. Under each treatment grazing was rotated at 2-week intervals between 2 pastures. In 1958 the fertilized pastures received 36 pounds of N in March, June, and
August (Jensen and Madsen, 1958). Two years of nitrogen fertilization reduced the clover content of the pasture to 5 percent. The unfertilized pastures which contained 41 percent clover actually out yielded those receiving 108 pounds N by 10 percent. Considering the extent of old bluegrass pastures in the western United States, these data are of considerable significance.

During the past season Animal Husbandry and Dairy at Utah State cooperated in grazing yearling Hereford steers on a new 22-acre pasture seeded after leveling and draining the land. The pasture produced 1,078 pounds of beef per acre. No supplements were fed (Dew, 1958).

Research on the improvement of mountain meadows in the West probably began with the studies of Stewart and Clark (1944) in Wyoming and Pittman in Utah (Pittman and Nielsen, 1950) and is now in progress particularly in Oregon, Colorado, and Wyoming. In these studies the effects of high levels of nitrogen (Willhite and Rouse, 1956), new species combinations (Lewis, 1955), and management practices (Cooper, 1957) to improve the quality of forage as well as the yield are making significant progress. Mountain meadows offer great potential for increased productivity, particularly where some degree of water control can be obtained.

Water is so important to the western United States that it is a paradox almost beyond belief that it is so extravagantly and inefficiently used. Lauritzen (1955) estimates that “about ¼ of all water diverted for irrigation is lost in conveying it to the land . . . another ¾ percolates too deeply or runs off during the process of application to the land.” Stansberry (1955), discussing irrigation of alfalfa, states that if 70 percent of the water is used by the plant, efficiency is good, but “in many places not more than half the water delivered to the farm is utilized by the alfalfa plant.”

According to Dominy (1958) the U. S. Geological Survey estimated that 21 million acre-feet of water are lost each year by evaporation from fresh water lakes, reservoirs and streams in the 17 western states and that a much greater annual loss is in water consumed by undesirable vegetation around reservoirs, along natural water channels, canals and ditches. Among the plants involved are phreatophytes, which Dominy reports have encroached on 17 million acres of land and use an estimated 25 million acre-feet of water per year. Experiments now in progress indicate that on water bodies with low surface movement evaporation can be greatly reduced by applying a film of Hexadecanol.

Much progress is being made through canal and ditch lining in reducing losses by percolation (Lauritzen et al., 1952; Lauritzen and Peterson, 1953; and Lauritzen, 1955). Great strides have been made in determining how to control undesirable vegetation economically (Timmons...
and Klingman, 1958) and we have for some time had the knowledge necessary to irrigate properly, so as to avoid excessive run-off or percolation beyond the roots of crop plants, if we but apply it.

Inefficiency as irrigation water appears to be used by farmers whose entire enterprise depends on it, the use of water by ranchers is apparently even less efficient. Saunderson (1950) wrote this: “Generally the tendency has been for the stock ranch to economize on labor rather than water, with the result that the water is not used efficiently by the standards of intensive crop agriculture.” He then pointed out that the labor requirement to produce a ton of harvested hay is lower for irrigated land, largely because of the low yields of the latter.

Even though it may appear that all available water resources of the West are being used, by the prevention of waste alone irrigation could be greatly extended.

Ranchers seeking a better balance in their feed supply, or greater stability for the future, should thoroughly investigate the possibility of developing irrigated alfalfa or improved irrigated pasture on their private lands. It is a reasonable estimate that ranchers not able to do this may strengthen their position by acquiring lands suitable for this purpose.

LITERATURE CITED


Timplins, F. L. AND D. L. Klingman. 1958. Control of aquatic and
Vigor of Idaho Fescue in Relation to Different Grazing Intensities

FLOYD W. POND

Range Conservationist, Rocky Mountain Forest and Range Experiment Station, Forest Service, U. S. Department of Agriculture

The English word, vigor, is from the Latin "vigere," which, according to Webster's dictionary, means "to be lively or strong." The vigor of an individual plant or group of plants, then, may be expressed by some measurement that is indicative of plant health and robustness. Many parts of plants are considered to be indicative of plant vigor although leaf height, culm height, basal area and numbers of leaves and flower stalks are most often used. Relationships between grazing intensity and vigor of Idaho fescue (Festuca idahoensis Elmer), as expressed in terms of leaf height, basal area, and herbage weight, are discussed in this paper.

Several workers have established relationships between plant vigor and grazing use. Short and Woolfolk (1956) found that a definite correlation exists between range condition and leaf heights of bluestem wheatgrass (Agropyron smithii Rydb.) Parker (1954) maintains that changes in grazing intensity are first reflected in plant vigor and later by changes in density, composition, and soil stability. In the meadows of eastern Oregon and eastern Washington, deterioration of rangelands is first shown by a decrease in leaf and culm height, sparsity of leaves and loss of color (Reid, 1946). After eight years at Manitou Experimental Forest, average height growth of Arizona fescue (Festuca arizonica Vasey) was 40 percent less on heavily used range than on moderate- and light-use range (Johnson, 1953).

Area and Methods

The study was carried out on six pastures, each approximately 85 acres, located on grass-forb ranges of the Tongue Ranger District of the Bighorn National Forest. Idaho fescue was the dominant forage producer on all pastures although numerous other species were found. Measurements were restricted to residual soils formed from gigantic parent materials (called granitic soils) and from sedimentary parent materials (called sedimentary soils). Soils formed from shales predominate in the sedimentary areas, although soils formed from limestone and sandstone are also present. The principal soil series were Burgess gravelly loam and Owen Creek silt loam.

Beginning in 1951 the pastures were grazed with steers at 3 different intensities. The dates the cattle were placed on and taken off the pastures varied each year: entering dates ranging from June 19 to July 2 and removing dates ranging from September 9 to 24 depending on when the desired grazing intensities were obtained. Grazing intensities were assigned at random to the pastures. Two pastures were grazed lightly (less than 25 percent of the current annual height growth of Idaho fescue); two were grazed moderately (approximately 50 percent); and two were grazed heavily (approximately 75 percent).

An exclosure, 150 x 150 feet, was located in each pasture. The exclosures in 3 pastures were placed on soils of granitic origin, in one pasture on deep soil formed from shale, and in 2 pastures on thin soils of sandstone and shale origin near granitic outcrops.

In 1955, differences in height growth of Idaho fescue plants were noticeable between the pastures grazed at different intensities. The study was carried out on six pastures, each approximately 85 acres, located on grass-forb ranges of the Tongue Ranger District of the Bighorn National Forest. Idaho fescue was the dominant forage producer on all pastures although numerous other species were found. Measurements were restricted to residual soils formed from gigantic parent materials (called granitic soils) and from sedimentary parent materials (called sedimentary soils). Soils formed from shales predominate in the sedimentary areas, although soils formed from limestone and sandstone are also present. The principal soil series were Burgess gravelly loam and Owen Creek silt loam.

Beginning in 1951 the pastures were grazed with steers at 3 different intensities. The dates the cattle were placed on and taken off the pastures varied each year: entering dates ranging from June 19 to July 2 and removing dates ranging from September 9 to 24 depending on when the desired grazing intensities were obtained. Grazing intensities were assigned at random to the pastures. Two pastures were grazed lightly (less than 25 percent of the current annual height growth of Idaho fescue); two were grazed moderately (approximately 50 percent); and two were grazed heavily (approximately 75 percent).

An exclosure, 150 x 150 feet, was located in each pasture. The exclosures in 3 pastures were placed on soils of granitic origin, in one pasture on deep soil formed from shale, and in 2 pastures on thin soils of sandstone and shale origin near granitic outcrops.

In 1955, differences in height growth of Idaho fescue plants were noticeable between the pastures grazed at different intensities. To measure these differences, one hundred Idaho fescue plants were selected at random on the granitic soils, and one hundred plants were selected on