PERENNIAL PASTURE IN A GRASSLAND RANGE ECONOMY

by

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INTRODUCTION

Economic Influences of Kansas Rangeland

According to reports of the Kansas State Board of Agriculture almost 40 per cent of the land area of Kansas is still in native range. While there may be some areas in which the local economy is not directly influenced by rangeland, it would be conservative to say that, at least indirectly, range economics has an influence on the economy of the entire state. At the same time there are areas within the state in which the local economy is directly influenced to an appreciable extent by rangeland. In some of these areas range economics exerts a stronger influence in the total economy than in others, and in some areas the economics of grassland ranges completely dominates the economy of the area. Rangeland dominates the economy of such an area because most of the income of most of the people depends upon the production of native grassland range. Furthermore, these areas will continue to be dominated by range until such time as a more productive substitute can be found for the steep, shallow, or rocky soils on which these ranges often occur.

According to the Kansas State Board of Agriculture (1966) there are 20,464,000 acres of native and tame pasture in Kansas. If the value of this land is placed at a conservative $70 per acre then the investment in grazing land in Kansas is more than $1.4 billion. This gives an added perspective to the importance of Kansas grazing lands.

In terms of production, grazing land can also account for an important part of the new wealth that comes to Kansas each year. An estimate of the value of the production of rangeland is difficult to obtain in view of the fact that most of the production is harvested by grazing animals. Many of these animals are fattened with feeds obtained from cropland, and it is difficult to determine the proportion of the value of the animals attributable to grassland at the time they are sold. However, one insight into the value of this production is obtained from the rent per acre that owners of rangeland receive. Rent charged for grassland in the Flint Hills area of Kansas in 1966 averaged $5.60 per acre according to the Kansas Crop and Livestock Reporting Service. Much of the rangeland in the western half of Kansas would not rent this high. Nevertheless, it is quite obvious that the production from native range in Kansas is a business amounting to many millions of dollars each year.

The Condition of Kansas Rangeland

The condition of Kansas rangeland is extremely varied, and this is understandable in view of the large acreage that exists. Some acreages are in an extreme state of depletion while others may be in excellent range condition. The bulk of the range acreage lies somewhere between these two extremes. The purpose here is not to fix a quantitative or qualitative measurement of the condition of Kansas rangeland, but only to recognize that a sizeable percentage of this rangeland is in some state of depletion and could be improved.

That a considerable amount of Kansas rangeland is depleted to some extent is indicated by statements such as the following by Anderson (1953):

> ......some degree of deterioration has occurred even under this system. Pastures grazed the full season without reduction in stocking load, and especially the smaller ones that nearly always are stocked heavily, have suffered moderate to severe depletion.

The terms "range condition" and "range vigor" are not synonymous. The condition of the range is measured as the per cent of the present vegetation that was a part of the original or climax vegetation. The term "vigor" is applied to the range plants that are present, regardless of what species they may be. They may be vigorous, or, because of over-utilization, they may be low in vigor (Weaver and Darland, 1947). In range depletion caused by grazing animals a decrease in vigor always precedes a decrease in the condition of the range (Weaver and Darland, 1947; Weaver 1950; Jameson and Huss, 1959). It is quite possible that a range may be very low in vigor and still exhibit a high range condition. It is also possible that ranges in low condition may be high in vigor.

If it is assumed that the species that were originally found in the range, when they are maintained in a high state of vigor, will provide the most productive range, then it is apparent that "range condition" and "range vigor" are the elements to be improved. By improving the range condition and vigor of depleted rangelands the productivity and carrying capacity of these lands are also increased.

Indication that there is room for an increase in the productivity and carrying capacity again is provided by Anderson (1940).

> The bluestem pastures have steadily decreased in carrying capacity since they were first used extensively for grazing. Old grazing records show that prior to 1900 most of the bluestem pastures could be stocked at the rate of two acres for one mature cow or steer for a grazing season of six months beginning May 1. By 1933, or just before the recent years of drought, the best pastures could carry only one mature animal on four acres, while the average carrying capacity was five acres per animal. At the present time the average grazing capacity is about seven acres per animal.

The Value of Range Improvement

After the question concerning the need for range improvement has been resolved, it seems that another question regarding the impact that such improvement will have on the economy is in order. Is an improved range more productive, and if so, what value can be placed upon this increased production?

Such a dollar value placed on a certain amount of increased production would be very worthwhile information. With the knowledge available at the present time, however, a realistic and valid figure that could be used with some faith as a guideline, cannot be obtained. This statement is supported by Ciriacy-Wantrup and Schultz (1957) who found that in this area of study there is a "need for more suitable but not necessarily more voluminous data." These authors further assert:

> To ascertain the cost of inputs is comparatively easy. To ascertain their effects in physical and monetary terms upon output over a number of intervals is a much more difficult task. This is evinced by the literature on brush clearing and conversion, replete with costs per acre for bulldozing, grubbing, disking, burning, spraying or seeding, but destitute of data on returns.

Caton et al. (1960) also indicated a lack of data on the economics of range improvement.

> Certainly the range livestock industry has wanted for better information but decisions have been made and will continue to be made by "rules of thumb." That these "rules of thumb" have at least been positively directional is reflected in the economic growth of the western livestock industry.
>
> Despite the large task remaining on the "cost side" of the economics of range improvement, the most formidable task facing economists working in this field lies in the evaluation and analysis of benefits. Some very worthwhile work has been done

> but much work remains, especially in analysis of range improvements in the total context of range, livestock, and ranch management and in the evaluation of the so-called "non-market" benefits of range improvement.

These authors (Caton et al., 1960) also stated that "Benefits of range improvement programs are not easily appraised for a number of reasons. Benefits may not take an easily recognizable form." Much of the value of range improvement may be of an intangible nature and cannot be measured. This is not to say that it is impossible to measure some of these things, but time, technique, and expense have so far prevented it. It would be an extremely difficult and expensive process to determine the increased value of an improved range from the standpoint of its being an improved watershed. Notable work on this subject was done by Leithead (1959) in the Big Bend area of Texas where, comparing two watersheds of different range condition, he found the following:

> Runoff is increased in the Davis Mountain-Big Bend area as ranges deteriorate in range condition because the soil absorbs moisture slower. A range site in good condition absorbs moisture five to six times faster than the same range site in poor condition.

Reference is often made in the literature to the increased ability of near-climax ranges as compared to depleted ranges to prevent runoff and erosion and allow more of the precipitation that falls to filter into the soil (Weaver and Zink, 1946; Aldous and Zahnley, 1931). The increased vegetation and the accompanying mulch on top of the soil intercept the energy of the falling raindrops and prevent the soil from puddling and sealing over (Dyksterhuis and Schmutz, 1947). The increased amount of mulch also furnishes food for soil microorganisms that promote soil aggregation which increases infiltration rates

(Weaver and Zink, 1946; Dyksterhuis and Schmutz, 1947). The accompanying mulch of a near-climax range does much to reduce extreme fluctuations in temperature and, in general, make the overall environment of the soil more hospitable for microorganisms. The more moderate soil temperatures also reduce the loss of soil moisture to the air by evaporation (Albertson, 1937; Hopkins, 1954). This reduction of moisture loss by evaporation would more than offset the increased loss of moisture by transpiration from the increased growing vegetation. The increased top growth can also catch and hold precipitation that comes as snow (Albertson, 1937). Schwan (1947) described overgrazed ranges as being droughty and stated, "Drought on the range is not determined by the amount of moisture that falls but by the amount of moisture in the soil." Work done in northeastern Oklahoma (Rhoads et al., 1964) on range grazed continuously for 20 years at four different levels of grazing intensity showed that water-intake rates were inversely proportional to grazing intensity. Leithead (1959) reported that "The loss of moisture by evaporation from the first foot of soil is about three times greater on closely grazed, poor condition range than it is from the same sites in good condition that have been properly grazed" in the Big Bend area of Texas. He further stated that "A greater percentage of the annual precipitation in this section of Texas can be held where it falls by improving the condition of the range."

Such conditions, described above, which are provided by a near-climax range do increase the ability of the range to produce forage. Also, the soil in such condition is a storehouse for water that eventually will make more dependable the flow of small streams and rivers that serve as a water supply for many cities. But, so far it is not possible to place a definite dollar value on an improved range from the standpoint of its being an improved watershed.

Another reason why a precise value for range improvement cannot be determined is that in addition to the complexities of range management there are also various aspects of animal husbandry and economics that become involved in any practical and useful discussion of range improvement.

It should be remembered that some of the factors involved are quite variable and can influence the outcome in any given year. Weather influences greatly the amount of forage a range can produce in a season (Albertson, 1937; Launchbaugh, 1958). Also, livestock prices are subject to considerable fluctuation which can influence the value of range production. In order to cope with such fluctuating things as weather and prices, long time averages must be used. This is the only way that such calculations can have any perennial value. But, it should be remembered that these figures are only averages and that yearly figures will vary from the averages used in this discussion.

In applying livestock economics to the problem of range improvement, studies have shown that in certain cases a considerable benefit can be realized by the rancher, independent of range improvement, simply by reducing the stocking rate and allowing the animals that are grazed to make maximum gains. This benefit can be realized before very much actual range improvement is accomplished. In the case of replacement-type steer or heifer operations, the purchase price per hundredweight of this type of cattle placed on pasture in the spring is generally higher than the sale price received for them in the fall (Thomas, 1960). This situation requires that each animal make maximum gains in order to compensate for the loss in value per unit of weight. Launchbaugh (1957) found that although beef gain per acre on heavily grazed range (2 acres per steer) was almost one-third higher than the gains on a lightly grazed range (5 acres per steer), the net profit per acre was much greater on the lightly grazed range than on the heavily grazed range. The primary reason for this was that the 122 pounds gained by the steers on the heavily grazed range was not enough to compensate for the loss in price per pound and the other production costs per steer. However, the 217 pounds gained by the steers on the lightly grazed range was sufficient to absorb the drop in price per pound, pay for the other production costs, and still show a profit.

It should be pointed out, however, that a simple reduction in stocking rate does not necessarily guarantee an increase in cattle gains per head. In Kansas trials (Smith et al., 1963) of different methods of managing bluestem pastures, a 13 year average produced the following results. Understocked range (4.6 acres per steer) yielded 233 pounds of gain per steer, moderately stocked range (3.3 acres per steer) produced 239 pounds of gain per steer, and overstocked range (1.8 acres per steer) produced 218 pounds of gain per steer. This involves only a 21 pound difference between the high-gaining group of steers and the low-gaining group. It should be pointed out that in two of these 13 years, the steers on the overstocked range gained more than the steers on either the moderately stocked range or those on the understocked range. One of those years was 1956, a year of extremely low rainfall.

Also, in 1958 the overstocked range produced exactly the same number of pounds of beef per steer as did the understocked range. The year 1958 was marked by above average rainfall.

The foregoing paragraphs are included to emphasize the point that in dealing with biological phenomena such as the responses of range plants and livestock to varying treatments, what should logically happen does not always take place in the prescribed manner. These paragraphs point up the long term nature of range problems, and they indicate that these problems need to be studied over long periods of time. Ciracy-Wantrup and Schultz (1957) offer the following precaution which is pertinent to this discussion.

> The most obvious requirement for data is 'follow through' in scientific observations to make sure that all significant deferred effects of an experiment are included.............. The investigators themselves may be perfectly aware of the requirement to follow through and be sufficiently patient and cautious. But the ever-present pressure from research administrators to shift funds and personnel to 'new' projects and to announce and publicize the 'solution' of problems is especially detrimental to problems involving conservation.

Individual yearly tests in the Manhattan trials can certainly not be used as conclusive proof of anything. However, the 13 year average of these tests can be said to indicate that the moderate to lower stocking rates result in lower gains per acre, but in higher gains per head. The tests also indicate that higher stocking rates result in lower gains per head, but in higher gains per acre. These higher gains per acre often result in higher gross value of livestock that is misleading to ranchers who do not keep accurate records of all their costs.

In 1962 ranchers were invited by the Soil Conservation Service to meet and discuss relative costs and returns from variously stocked ranges.

Similar meetings were held in Riley, Pottawatomie, Morris, Ottawa, and Barber counties. After much discussion, each group, considering the range of its own area, arrived at a set of figures which compared what they felt was proper use of range to what they considered to be over-use. According to the Soil Conservation Service (1963) "They are the ranchers' own estimates, not those of range technicians, and are based on a general consensus of each group rather than on the estimate of any one person. The case in favor of moderate stocking over heavy stocking is convincing." In every case the gross income from the beef operation was greater from the situation described as over-use than from conditions of proper use. Likewise, in each county the extra livestock costs involved in maintaining the larger number of cattle required under conditions of overstocking were enough to offset the larger gross income and show greater net income for the conditions of proper use.

Up to this point the discussion has concerned only the replacement type beef cattle operations and has not involved breeding herds. Breeding herd operations have their own unique set of complicating economic factors that make it difficult to place a definite value on a given amount of range improvement. The value of the production of range that is harvested by breeding herds is reflected in the calves that the cows produce each year. Aside from the price per pound of the calves, the value of the production of the range can be reduced by a reduction in the percentage of calf crop and by a reduction in the weights of the individual calves at weaning time. The percentage of calf crop and the weaning weights of the calves can be affected by the quantity and quality of the forage that is available to the herd throughout the year. McIllvain and

Shoop (1962), at Woodward, Oklahoma, reported the following results of an eight year study of cows on grass the entire year.

> Cows with access to 12 acres per head weaned calves weighing 404 pounds. Comparable cows on 17 acres of similar range weaned 481 pound calves, and cows on 22 acres weaned calves weighing 512 pounds. Cows on 12 acres averaged an 81 per cent calf crop; those on 17 acres, 92 per cent; and cows on 22 acres, 89 per cent.

From the foregoing discussion it can be seen that it is maximum consistent net returns that are desired and that to achieve this the individual animal gains must be high. In order to keep individual animal gains high there must be an abundance of forage on which the animals graze. To maintain an abundance of forage the vigor of the range plants and the range condition must be high and this necessitates moderate or conservative stocking. Chapline and Cooperrider (1941) made the following statement in favor of "conservative grazing."

> Probably the outstanding requisite of management to meet drought and other adverse influences of climate is conservative grazing. Too often a few good years with increasing forage production encourage the building up of herds. The result is that when drought comes, numbers of livestock may approach a peak. This condition was general in 1934 and far too common in earlier drought years. Even with the Government relief purchases in the summer of 1934, losses on most ranges were great.
>
> Conservative grazing means stocking a range to a point sufficiently below average forage production over the years to provide adequate forage for the livestock in all but severe drought years in order to minimize drought losses, curtail costly supplemental feeding, assure stable livestock production, and maintain the range resource upon which the whole industry is built.

This discussion is included to illustrate the complexity of range management and range economics and the difficulty of placing a dollar value on a given amount of range improvement. However, it should not be unreasonable to expect that on ranges that have been depleted an improvement of vigor and condition should result in increased productivity which should, with proper management, result in increased profits. How this increased productivity is harvested and how the increase in profits is realized will depend upon the manner in which the individual rancher grazes his range. A stocking rate may be calculated to improve the range, such as the rates recommended by the Soil Conservation Service Technicians Guide to Range Site and Condition Classes (1955). When grazed in this manner any increase in the productivity of the range must be utilized by increasing the stocking rate. This is because, in theory, the cattle grazed at such rates will have enough forage to make maximum gains, regardless of the condition of the range, as long as these stocking rates are followed. Then as the condition of the range improves the prescribed stocking rate allows a few more head of livestock to be added to the range. In such a situation, an increase in range productivity will not necessarily increase animal gains per head. The only way to harvest the increased productinn is to graze more animals. Under such stocking rates an increase in productivity of the range will be due partly to a change in condition of the range and an increase in the vigor of the plants. Both of these causes would be aided by increased rainfall.

On the other hand, if the rancher is stocking his range at a rate resulting in over-utilization, it is quite probable that his cattle are not making maximum gains per head. In such a case an increase in range productivity would probably result in increased gains per head without the addition of more cattle. It is doubtful, under such conditions, that any increase in range productivity that does occur would be the result of a change in range condition. Such surges in range productivity under heavy grazing pressure are due to above average rainfall.

THE PROBLEM

Not all of Kansas' range is depleted. Many ranchers have maintained their range in good to excellent condition. However, there are also many ranchers who have allowed their range to become depleted to the extent that they could only be classed as fair or poor in condition. A major initial problem in effecting range improvement is to bring these farmers and ranchers to the realization that their range is in fact depleted and could be made more productive. The depletion of many Kansas ranges has been such a slow process that many ranchers feel that their range has always been in the condition in which they find it now (Weaver and Darland, 1947). They are unable to remember the original condition of the range or, in some areas, the range may have become severely depleted before the present operators gained control of the land. Also, many farmers and ranchers have been more concerned with the performance and condition of their livestock than with the condition of their range. Ciriacy-Wantrup and Schultz (1957) substantiate this assertion and suggest possible consequences in the following statement.

> It is well known that range output in terms of final products can be maintained and even increased for several years at the expense of weakening individual perennials and changing species composition in the vegetation. Eventually such changes will find expression in the output of final products. In practical range management, focusing on the final product favors complacency in matters of conservation. Detection and diagnosis of range deterioration may be delayed until remedial action has become far more expensive than it would have been if started earlier.

The art and science of range management has been among the slower of the various fields of agricultural knowledge to be understood and accepted by farmers and ranchers in Kansas. However, referring again to Ciriacy-Wantrup and Schultz (1957), the problem may not be entirely one of understanding and acceptance but may be due partly to economic conditions.

> Often range depletion is blamed on the ignorance of individual operators concerning actual range conditions and available conservation practices. More effective dissemination of existing knowledge in these two areas is certainly needed, but education is not a cure-all. Slowness in adopting conservation practices is caused more often by the economic and institutional environment in which range managers have to operate than by ignorance. Under such conditions, the best extension work in range conservation can have only meager results.

Regardless of the reasons for range depletion the problem of convincing farmers and ranchers of the need for range improvement is not of major concern here. There is a considerable amount of convincing evidence that would indicate that improved ranges are more profitable, (Chapline and Cooperrider, 1941; Hurtt, 1939; McIlvain and Shoop, 1962; Launchbaugh, 1957; and Soil Conservation Service, 1963).

Of more importance in this report is the problem faced by farmers when they do come to the realization that their ranges are depleted and they want to do something about it. If a farmer or rancher has been grazing his range to the extent that it has become depleted, and he decides that he wants to improve his range, it is going to be necessary for him to relax grazing pressure to the extent that improvement can take place. This relaxation of grazing pressure must be done during the growing season so that plant root reserves may be replenished and seed formation will be accomplished. This means that the number of animal units that the rancher normally handles will have to be reduced or eliminated or the rancher will have to provide supplemental feed for his animals during the growing season. Either of these situations will lead to a reduced income.

Experience in dealing with farmers and ranchers indicates that few of them are willing to reduce the number of animal units that they handle. They are accustomed to selling a certain number of livestock each year and they are reluctant to reduce this volume. In recent years the margin of profit on which farmers and ranchers operate has narrowed to the extent that it has exerted a considerable amount of pressure upon them to increase their volume. They must increase volume to maintain income. This is a major reason for the rancher's unwillingness to reduce animal numbers in order to improve his rangeland. This is not to say that the alternative of reducing animal numbers is not a good one. On the contrary, it may be the most economical way to effect range improvement in the shortest time, on certain ranches, especially on those where income from range through livestock is not a major part of the farm income. Likewise, on farms and ranches on which the livestock enterprise consits of young replacement type cattle the alternative of reducing numbers or, even eliminating them completely during the growing season may be the most practical. In contrast, owners of cowherds do not have nearly so flexible an operation and are much more reluctant to reduce numbers.

The alternative to reducing animal numbers is to, in some way, provide extra feed for the livestock handled during the growing season so that the rangeland on which they normally would graze can be rested. This extra feed can be provided in several ways: The rancher could simply rent more rangeland; he could keep his cattle confined and haul to them feed that he has raised on his own land or that he purchased from another source; or he could provide a supply of tame pasture on which his cattle could graze during the growing season.

The most economical procedure for any given farm or ranch may be quite different from that of a neighboring farm or ranch and may employ one or more of the foregoing alternatives.

The problem, then, is to find the procedure in which the period of range recuperation results in the smallest economic loss to the rancher.

The following discussion will concern itself with the alternative of providing tame pasture for supplemental feed and the place this alternative has in a grassland range economy relative to the other alternatives.

This paper shall be more concerned with perennial tame pasture than with annual tame pasture. A tame pasture may be defined for purposes of this paper as forage species that are grazed and managed in such a way as to prevent natural ecological succession. For further clarification tame pasture grasses may be categorized as follows:

A. Perennial
   1. Native
      a. Cool season (western wheatgrass0
      b. Warm season (switchgrass)

   2. Introduced
      a. Cool season (smooth brome)
      b. Warm season (Caucasian bluestem)

B. Annual
   1. Cool season (cereals such as wheat and rye)
   2. Warm season (sudangrass)

In addition other forage crops such as alfalfa, alone and in mixtures, and sweetclover may be considered tame pasture.

PERENNIAL PASTURE IN A GRASSLAND RANGE ECONOMY

The organization of the individual farm or ranch units must be considered in trying to determine what place perennial pastures might have in providing grazing for cattle during a period in which grazing on native range is being deferred for the purpose of resting and improving the range. The term "organization" is here used to include several things, among them the kind of livestock program involved and its relative importance as a contributor to farm or ranch income when compared to the cropping program. The ratio of rangeland to cropland is also a part of the organization of the unit. The size of the farm or ranch unit may also affect its organization and may influence the practicality of establishing perennial pasture.

Livestock Programs

Some livestock programs are more intensive than others. The more intensive ones usually involve animals that are more efficient converters of grain or forage to edible human food. The physical size of the animals involved and their adaptability to confinement also helps to determine the intensiveness of operations under which they can be produced. Poultry and modern swine programs usually involve very intensive operations. Dairy cattle, in spite of their large size, also lend themselves well to an intensive operation, chiefly because good dairy cows are relatively efficient at converting feed to milk. Young beef cattle are also fairly efficient feed converters, but, relatively speaking, mature beef cows are the least efficient of the classes of livestock mentioned thus far.

The beef cow is kept for an entire year after which she may wean a calf weighing 450 pounds. In the succeeding year this same calf may gain as much as 600 to 800 pounds depending upon how well the calf is fed and whether it is a steer or a heifer. Furthermore, the calf will have made this greater gain on less feed than the cow consumed during the year that she was in the process of producing the 450-pound calf (Morrison, 1956).

A ten-year study at El Reno, Oklahoma (Zimmerman et al., 1959) indicates that the beef cow normally does not respond to intensive treatment with increased and more efficient production. The cows in herds receiving medium and high rates of winter supplement weaned fewer calves, lighter calves, and considerably more expensive calves than those in the herd receiving a low rate of winter supplement. This study tends to emphasize the relative inefficiency of the beef cow. The extra feed given to the two herds on the medium and high rates of winter feeding was wasted when viewed from the standpoint of the rancher. As a contribution to research, however, it has been most valuable.

The Oklahoma study emphasizes the impracticality of using high-quality, expensive feeds for beef cows. They are at their best economic advantage when handled in such a manner as to utilize large amounts of such low quality roughage as dry native grass.

That younger classes of cattle generally demonstrate a higher feed efficiency is widely known to stockmen. Other things being equal, higher feed efficiencies generally mean a wider margin of profit within which to operate. Thus ranchers or farmers with livestock programs involving replacement cattle may be better able to afford the extra expense of establishing permanent pasture than ranchers with cowherds (Thomas, 1963). Similarly, dairymen should be more able to afford this expense as well as the possible loss suffered by removing some land from more productive crops and seeding it to perennial pasture.

Relative Importance of the Livestock Program

Within the farm or ranch unit the relative importance of the livestock program as a contributing factor to the total farm income may have some influence on the economics of perennial pasture. In general, the more important the livestock enterprise the more feasible will be the establishment of an acreage of perennial pasture. Livestock is here intended to mean cattle such as dairy cows, beef cows, or steers and heifers involved in a grazing program. The feasibility of establishing perennial pasture for the purpose of resting rangeland becomes greater where livestock are important to the farm income and much of the livestock production is dependent upon range. On such farms and ranches the practicality of planting perennial pasture may be offset by the shortage of avilable land on which to plant such pasture. This is discussed under the next subheading.

The idea of the relative importance of the livestock enterprise and its influence upon the feasibility of planting perennial pasture may be more clearly conveyed graphically. For example, one may consider a rancher in the Kansas Flint Hills who maintains a herd of 500 beef cows that provide a net income of from $8,000 to $10,000 per year. This rancher also has a flock of turkeys that brings him another $1,000 per year. A ten per cent increase in production from the beef cow enterprise would be much more beneficial than a like increase in the turkey enterprise. Therefore any management decisions regarding the allocation of the basic resources of land, labor, and capital must be made with this in mind, and the beef cow enterprise will obviously be given preference. The same would be true if the $1,000 enterprise involved hogs, or even a field of wheat.

Perennial Pastures in Range Dominated Areas

In an area that is influenced by the presence of large acreages of range the availability of cultivated land may be quite low (Aldous, 1938; Anderson, 1953). In such situations the cropland that is available is almost always devoted to the production of forage that is necessary to feed cattle during the winter months. This would be especially true in areas where ranges may be covered with snow for periods of several days. This would include all of Kansas, although snow cover is more of a problem in northern than in southern Kansas. The average number of days during which the ground is covered with snow varies from about 10 days on the extreme southern border of Kansas to 35 days on the northern border (Flora, 1948). The fewer days of snow cover near the southern border may tend to lessen the need for a supply of winter feed; however, as Thomas (1961) has pointed out,

> While the southern counties have less snow cover, and slightly less severe winter temperatures, the much greater winter precipitation results in more weathering of the winter forage and more days when the cattle suffer from cold winter rains.

In such range-dominated areas perennial pasture would be in competition for a limited acreage of cultivated land. The competition for cultivated land would be greater if the livestock enterprise on the ranch is a cowherd. A cowherd is a much more permanent kind of enterprise than those involving replacement cattle. It is almost imperative that a supply of winter feed be maintained for the cowherd (Chapline and Cooperrider, 1941). In the case of replacement steer or heifer programs the supply of winter feed is not so necessary because the steers or heifers may often be sold off grass before snow cover becomes a problem. This may not always be true, however, and wintering programs involving young cattle are becoming increasingly important in Kansas as Thomas (1961) points out.

> Kansas experimental work indicates that young cattle can also be wintered economically on dry grass plus protein supplement, on either a wintering and grazing; or wintering, grazing, and feeding program. These experiments involved both steer calves and heifer calves. Programs of this type have been an important part of the bluestem cattle business for many years. It appears reasonable to expect that they will play an increasingly important role in the years ahead.

Wintering programs that involve young cattle will nearly always require the supplemental feeding of protein and in many cases silage, alfalfa, and even grain, since they are not so able as mature cows to utilize the poor quality dry grass (Smith, 1953). The protein and also the grain may be purchased off the farm, but the roughage usually is produced on the cultivated acres of the particular farm or ranch in question. In such situations, if perennial pasture is to be used for supplemental grazing while the rangeland is being rested, it must compete with these winter-feed crops for the available cultivated land.

Perennial Pasture in Areas Not Dominated by Native Range

It may be much easier to utilize perennial pasture in a range improvement program in areas where much of the land is cultivated than where range occupies most of the ranch, because there range may be the land in short supply. Indeed, there may be a surplus of cultivated acres, often because of government imposed restrictions on acreages of feed grain and wheat. There may be enough acres to produce silage and alfalfa hay for a livestock program but not enough native range to support that program during the spring and summer. This often results in heavy stocking pressure on the existing range, and as a result these ranges may often be in poorer condition than those in areas where range is dominant.

In order to relax this grazing pressure and effect some improvement in vigor and condition of the range it seems that seeding perennial pasture might have an important place. From the 1959 United States Census for agriculture it was possible to calculate a percentage of the acreage in range for each county in Kansas (Fig. 1). This percentage was found by dividing the acres listed under "other pasture" by the acres listed under "approximate land area" for each county. The classification "other pasture" refers to all land other than woodland and cropland that was used only for pasture or grazing in 1959. This classification should include primarily native range and very little

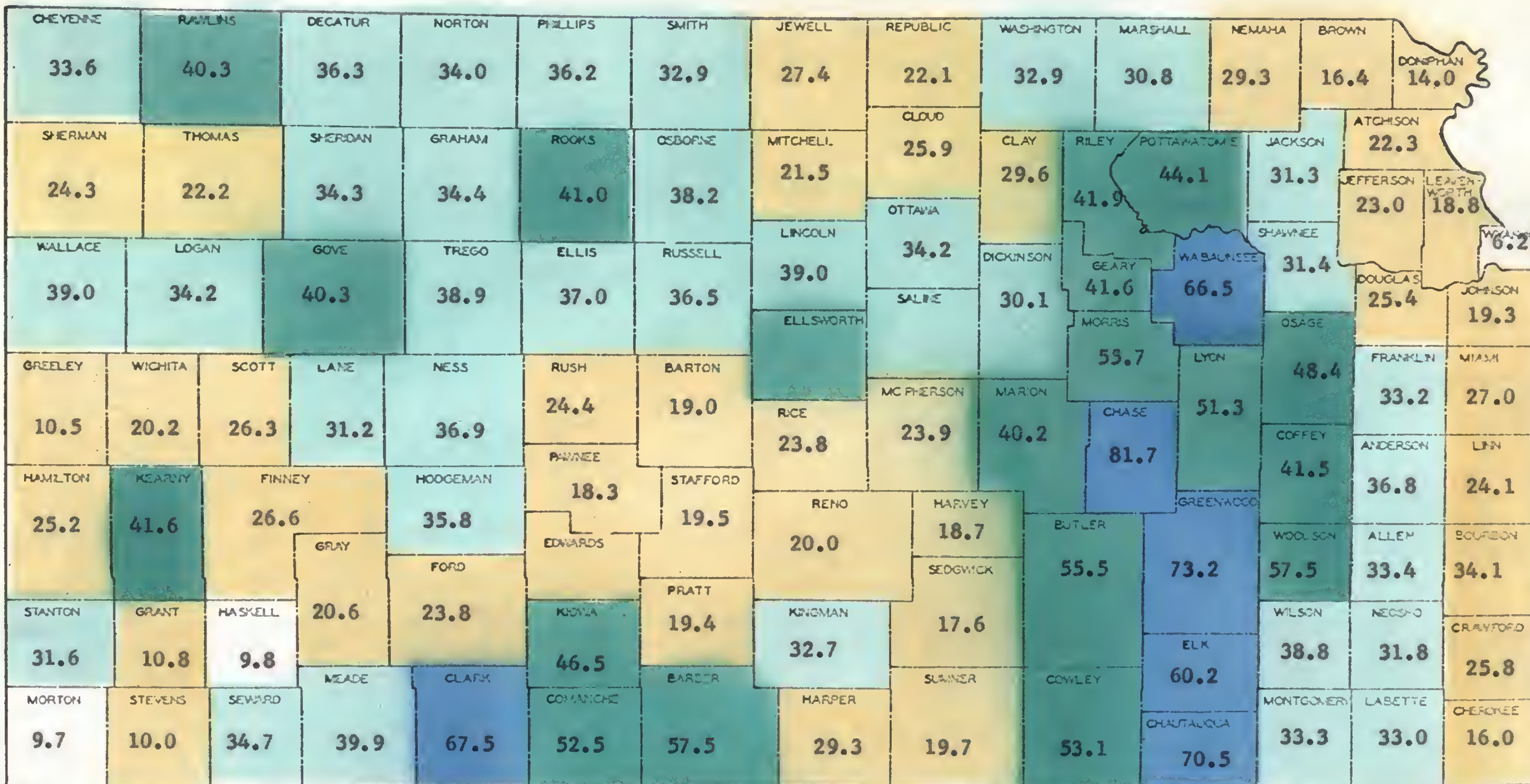

Fig. 1. Percentage of range in Kansas by counties. Figures calculated from information contained in the 1959 United States Census for Agriculture. Average for the state-34.1%.

White------------ 9.9% and below
Yellow-----------10.0% to 29.9%
Light Green ---------30% to 39.9%
Dark Green-----------40% to 59.9%
Blue---------------60% and above

tame pasture. Tame pasture should be included in "cropland used only for pasture" or "improved pasture," two other categories also used in the 1959 census. An obvious discrepancy occurs in the 9.7 per cent reported for Morton county. The Cimarron National Grassland involves more acreage than is indicated for Morton county. These federal grasslands apparently were not included in this census. Aside from Morton county the percentages at least provide an indication of where in Kansas the areas dominated by range are located as well as those areas where range is less extensive. The largest number of counties (42) fall in the 10 to 29.9 per cent category. There are also 35 counties that fall in the 30 to 39.9 per cent category and this is even more significant in view of the fact that this category involves a range of only 10 percentage points. The state average of 34.1 per cent lies in this category also, and is the reason this particular category was limited to 10 percentage points.

The implication that is intended in the use and discussion of this map is that there is much of Kansas in which range does not dominate but in which, nevertheless, it plays an important economic role and may occupy as much as a third or more of the land area. As has been stated above, the availability of cultivated land may be such that the use of perennial pasture for supplemental grazing is quite possible in these areas which occupy more than half of the state.

Perennial Pasture on Marginal Land

Regardless of the size of the farm or its organization the transfer of marginal cropland to perennial pasture may be quite practical. Many acres that are marginal cropland may be quite productive of perennial pasture.

The Kansas State Soil Conservation Committee (1962) in its report to the governor estimated that 2,016,249 acres of land needed to be planted to pasture and that 4,348,418 acres were in need of range seeding. In further discussing range and pasture seeding the committee stated:

> Grass is an important crop in Kansas. Reseeding cultivated land to native and tame grasses for hay and grazing uses is a common conservation practice throughout the state. In the more humid parts of eastern Kansas, native grasses and improved tame grass species and legumes are planted and used for hay and grazing. In the drier parts of western Kansas, a great deal of emphasis has been placed on seeding abandoned and highly erodible soils to mixtures of the native grasses. Once established and properly managed, grass is one of the most effective crops for control of both wind and water erosion and to protect watersheds.

In this context there are at least two situations in which farmers may find the conversion of cropland to perennial pasture desirable. The first and more obvious situation involves those farmers whose cropland acres have been restricted by government programs. The second involves those farmers that may be trying to farm too much land with a limited amount of machinery or labor or both. In both of these situations the conversion of the more marginal cropland acres to perennial pasture may lower costs of labor and machinery, increase the productivity of the marginal land, and provide an opportunity for a range-improvement program.

FITTING PERENNIAL PASTURES TO THE CROPPING PROGRAM

There are various methods of increasing range vigor or improving range condition, some more effective than others. Several of these are "intra-range" management practices designed primarily to distribute grazing more evenly over the range. These include: cross fencing and rotation grazing, managing salt and water locations, and burning. A certain amount of range improvement can be effected by distributing grazing more evenly, thus allowing abused areas to improve while under-used areas are more properly utilized. These methods are applicable to ranges in relatively high range condition, and obviously are not important if the range as a whole is over-utilized. They are used primarily to utilize properly and uniformly the forage produced rather than to effect an improvement in condition. The emphasis in employing these practices is often on maintainence with the object of maximizing beef production while maintaining a high range condition and vigor.

Deferred grazing practices may also be used in addition to the "intra-range" practices discussed above. Deferred grazing allows the range to "rest" and may be more suitable on ranges where a substantial improvement is desired. Grazing may be deferred from the start of the growing season for any length of time until the desired result is achieved. This may require deferment for part of the growing season or resting for the entire season or a combination of these two for several growing seasons.

A factor in favor of resting for an entire growing season is that the Kansas Agricultural Stabilization and Conservation Service Committee (1966) in their state Agricultural Conservation Program (ACP) makes available a cost-sharing payment to ranchers who agree to defer grazing on their range for an entire growing season from May 1 to October 1. Although this practice is available to all counties, some counties may not include it in their local programs. However, it may be made available upon request. The payment varies from $1.25 per acre in the eastern part of Kansas to $1.00 in a group of counties in central Kansas to $0.75 in the counties in the western half of Kansas. In order for a range to qualify for this ACP practice and be eligible to receive this cost-sharing payment its range condition must be between 25 per cent and 75 per cent of climax. If the range condition is above 75 per cent it is considered excellent and it is felt that resting an entire season is not necessary. If the range condition is below 25 per cent it is in poor condition and it is felt that there would not be enough of the decreaser plants left to provide seed and that an improvement in condition could not be achieved. Vigor, however, could be increased, and it may be of value to a rancher to rest a range in poor condition in order to increase the vigor of that range.

Another feature of resting for the entire season is that after September 1, 97 per cent of the season's growth has been accomplished (Aldous, 1933) and the dry tops may be grazed during the fall and winter without detriment to the grass so long as enough top growth is left to provide mulch.

Resting for an entire season may have a place on some farms and ranches where the range is, or could be, sufficiently subdivided so as to allow a portion of the range to be rested each year while perennial pasture is used in place of the range that is being rested. A rancher may rest all of his range for the entire season also, but this may require a larger seeding of perennial pasture than would be practical and larger than most ranchers would be willing to make. The rancher must keep in mind, however, that the grass produced on the native range will have some value as winter pasture which will tend to lessen the amount of winter feed necessary.

One advantage of resting for an entire season that has not been mentioned is that it is the quickest method of rejuvenating range and improving its condition. In spite of this and the other advantages discussed it may not be possible for a rancher to rest his range for the entire season. It may not fit well into his ranch organization. His range may not be divided well so that he can exclude cattle from parts that need rest. Ir may be more practical for him to defer grazing for only part of the season.

In general the root reserves of Kansas native range plants reach their low point during the middle part of June (Aldous, 1930). If they are grazed heavily prior to and at this time the plants may be seriously weakened. This is one reason it is advantageous to defer grazing from the beginning of the growing season until after June 15 when the plants normally have sufficient top growth and are producing enough photosynthate that they can be grazed and still make a storage of food in their roots. Linked with this is the fact that the bulk of the season's rainfall normally comes in May and June, and this allows the plants to make enough top growth so that root reserves can be accomplished. If a rancher were to graze during the early part of the season with the intention of resting the range during July and August and these two months were to be hot and dry, which is normal, the plants could not continue to grow and there would be little storage of root reserves. Therefore, it is recommended that if the range is rested for only part of the season it should be rested during the first part.

In order to improve condition the percentage of desirable climax plants must increase. This increase may take place vegetatively or from seed production. Only certain plants such as big bluestem, switchgrass, and western wheatgrass, among others, are rhizomatous and can increase vegetatively to an appreciable extent. Others, notably little bluestem and blue grama, can increase only by the production of seed. However, in badly depleted ranges even the rhizomatous plants will be too far apart to improve condition by vegetative increase only. The more badly depleted the range the farther apart will be the important decreaser plants such as big bluestem and the more necessary it will be for seed production to take place so that new plants can be established. Anderson (1953) stated, "Succession following severe depletion is slowed to the extent that dominant forage species have been eliminated." In areas where bunch grasses such as little bluestem make up an important part of the climax vegetation it is also important that seed production be accomplished since these plants increase in size only at a slow rate by tillering (Cornelius and Atkins, 1946).

In order to effect seed production it may be necessary to rest a range for more than one entire growing season. This would be especially true of range where both vigor and condition are low, in which case it may require the first season to increase the plants' vigor sufficiently so that they could accomplish satisfactory seed production the second season.

Whether a rancher chooses to defer grazing on his range for part of the growing season or rest it for the entire season may in part determine the kind or type of grass he will use to provide supplemental perennial pasture. If he will rest the range for only part of the growing season he may need only a cool season pasture that produces the major part of its forage during May and June. If he rests his range for the entire growing season he may also need some additional warm season perennial pasture that produces most of its forage from mid-June through July and August.

A consideration should be made of the length of time that will be necessary to achieve the desired range improvement. In general the poorer the condition of the range the longer it will take to recover. Also if the range can be rested for only part of the growing season instead of the entire season it will require a greater number of years to improve the range the desired amount. Rainfall will have a certain influence on the rate of recovery. A range improvement program carried out during a period of greater-than-average rainfall will proceed more rapidly than a program carried out during drought years.

A consideration of the length of time necessary to achieve the improvement will be useful in making the basic decision of whether or not to use perennial pasture as the supplemental feed during the improvement period. The establishment of perennial pasture can be a difficult process and in general will require a considerably longer period of time than the establishment of temporary pasture.

If it is obvious that the improvement program of a given acreage of range will require only two or three years it may be more economical to provide temporary pastures as the supplemental feed. If the improvement program involves extensive areas of range and will require several years to accomplish, the repeated costs of re-establishing temporary pasture may vary easily outweigh the difficulty and loss of time in the establishment of perennial pasture.

The ease with which a perennial pasture may be established and the length of time necessary for establishment will depend upon several factors including the kind of grass the rancher chooses to use as a perennial pasture. In turn the kind of grass he chooses may depend, in part, upon the climate of the area. A rancher in the eastern third of Kansas who chooses to plant smooth brome for a cool season perennial pasture can usually establish the pasture and make use of it in a shorter period of time than a rancher in the western third of Kansas who also wants a cool season pasture, but because of climatic conditions cannot use smooth brome and must rely on western wheatgrass. Western wheatgrass seedlings tend to become established more slowly than smooth brome (Bieberly et al., 1962; Launchbaugh, 1958).

Some Desirable Characteristics of a Perennial Pasture Grass

A suitable grass to be used for perennial pasture should have certain characteristics which the rancher must weigh in the light of his economic, climatic, and edaphic situation as well as his purpose for planting perennial pasture. The following is a brief discussion of some of these characteristics.

High productivity potential is of prime importance in a perennial pasture grass. The ability to respond to heavy fertilization with increased production is highly desirable. The more productive the perennial pasture can be the fewer acres of cultivated land are needed for diversion to perennial pasture. This is more essential in situations where cropland is needed for production of winter feed. On such farms it is important that the grass used for perennial pasture respond to fertilization and other agronomic practices so that production is considerably greater than that from native range and more economical than that from temporary pasture. In fact, in any farm or ranch situation if the grass chosen for perennial pasture cannot be made more productive than native range in the particular area and on the particular kind of land in question, then it may be more profitable and more conserving of soil and water to seed a native grass mixture and attempt to reestablish an area of native range. Or, if such is available, it may be more profitable simply to rent additional native range to be used as supplemental pasture.

High productivity, although important, is not the only characteristic involved in selecting a grass for perennial pasture. Drought resistance, carrying capacity or grazing tolerance, and palatability are also important.

Drought tolerance becomes more important as one moves from east to west across the state. Rainfall decreases from an average of more than 40 inches annually in the southeast corner of Kansas to an average of 16 inches in the western extremities of the state, or an average decrease from east to west of "about one inch for each 17 miles from the Missouri border to the Colorado line" (Bark, 1963). Evaporation from a free water surface increases in the same direction across the state as rainfall decreases. A six-year average reported by Flora (1948) showed evaporation of 45.6 inches and 49.6 inches at Lawrence and Manhattan, respectively, as compared to 54.8 inches and 60.4 inches at Garden City and Tribune for the six-month period April through September. These higher evaporation rates in western Kansas make the rain that does fall less effective. Chapline and Cooperrider (1941) discussing "Climate and Grazing" stated:

> No one climatic factor acts alone. Relative humidity, evaporation, and wind all have important relationships to range-plant growth, but primarily as they influence the effectiveness of available precipitation. With high relative humidity, evaporation and transpiration are relatively low; with low humidity, evaporation is high, and so is transpiration if moisture is available.
>
> Wind velocity, air temperature, and relative humidity are all active elements of climate directly influencing evaporation rates and amounts. Accompanying low rainfall in drought years are usually higher temperatures, lower relative humidity, greater evaporation, and occasionally higher wind velocities. All of these tend to accentuate the difficulties of plant production during drought periods.

A combination of these factors makes the conditions in western Kansas more rigorous than many grass species can endure. Consequently, species such as smooth brome, tall fescue, intermediate wheatgrass, and switchgrass may not be so productive or so permanent as desired unless measures such as irrigation and planting in lowlands are taken either to modify the existing conditions or to utilize the sites where the moisture relations are the best. Oklahoma work reported by Harlan (1954) indicated that smooth brome stands were "greatly reduced by a combination of drouth and low fertility on the slopes and areas of shallow soils, but in swales and bottoms where soil and moisture conditions were better, performance was good." Franks (1954), in work done at Hays, Kansas, found that "generally the amount of forage produced was greatest from species which occupied the mesic areas and lowest from those of more xeric ones." He noted that on the upland habitat big bluestem yielded "slightly more than 3,500 pounds per acre" while "on the lowland habitat, big bluestem produced about 6,013 pounds."

This would indicate that if the supplemental pasture program on western Kansas ranches involves a combination of perennial pasture and temporary pasture the perennial pasture should be planted on the sites where moisture relations are better or where irrigation is possible.

Drought can be severe enough in western Kansas to kill even the more drought-resistant native grasses such as buffalograss and blue grama (Savage and Jacobson, 1935; Albertson, 1937) and drought of less severity is required to kill many of the introduced species.

The grass used for perennial pasture should be able to withstand comparatively close grazing or, at least, be able to recover from periods of heavy utilization. It must be remembered that a tame perennial grass will also require a storage of root reserves each year in order to perpetuate the stand. Sufficient top growth must be maintained to allow this annual storage of reserves to take place or the perennial pasture will lose vigor and die out (Ahlgren, 1953; Chessmore and Harland, 1955; Wilsie et al., 1945). However, it is assumed that the perennial pasture will be planted on cultivated land and that the grass used is one that can be more easily established than native grass mixtures. In such cases the stand of perennial pasture would be more easily replaced than native range. During periods of drought, when normal stocking rates might result in overutilization, it should be the seeded perennial pasture that is overutilized, thereby protecting the native range.

High palatability is a desirable characteristic of a perennial pasture grass. Palatability is a relative thing and at times almost nebulous. Grasses that at times seem to be unpalatable may at other times and in other situations be relished by livestock. Cattle on a high concentrate ration crave roughage and will even consume amounts of coarse wheat straw which they would not eat under other circumstances. The term "grazing preference" is often used in this connection. The relative palatability or grazing preference of one plant over another becomes more important when mixtures of grasses or legume and grass mixtures are used (Rather and Harrison, 1944). When component plants of the mixture have the same growing seasons they should be as nearly equal as possible in grazing preference to avoid the over-use of one and the under-use of the other and the eventual domination by the under-used species. Savage et al. (1948), discussing grass mixtures reported that "Some highly palatable species cannot withstand exceedingly heavy grazing pressure. This difficulty is avoided when such grasses are sown in pure stands or as heavy components of a mixture."

Palatability can also influence animal gains. Some grasses are so unpalatable that cattle apparently consume as little of them as possible even when they have no other choice. Savage et al. (1948) reported that although weeping lovegrass had a high carrying capacity, cattle grazing it gained 68 pounds per head less than cattle on native range, 109 pounds less than those on sand lovegrass, and 91 pounds less than those on a reseeded mixture. The decreased gains were attributed to decreased consumption of this fibrous grass. Work currently in progress at Hays, Kansas, and yet unpublished, indicates a similar response for cattle grazing pure stands of Caucasian bluestem. Part of this response may be nutritional, but analysis of these grasses indicates that they compare with native grasses nutritionally (Savage et al., 1948). However, it is difficult to separate nutritional qualities from palatability. They often seem to be related and each tends to vary directly with the other in most grasses.

Varieties of Grasses Most Suitable for Perennial Pasture

A discussion of the forage plants suitable for perennial pasture in Kansas can be found in a number of publications. Various native and introduced pasture grasses and legumes were listed by Aldous and Zahnley (1931), Aldous (1935), and Anderson (1941). These lists usually included a brief description of agronomic characteristics and recommendations for establishment and maintainence. A few grasses suitable for southwest Kansas were listed by Allred and Nixon (1955). The list includes recommendations for establishment and maintenance. It also includes several grasses not suitable for Kansas.

More recently, Bieberly _et al_. (1957, 1962) listed the more prominent grasses planted and grown in Kansas. Also included in the publications are a few grasses that showed "some promise as pasture and hay grasses" under certain conditions. The following cool season grasses are given a brief agronomic dexcription by these authors: smooth brome, intermediate wheatgrass, western wheatgrass, tall wheatgrass, reed canarygrass, and tall fescue. The following grasses are listed as minor cool season grasses "used for special purposes" and described briefly: crested wheatgrass, timothy, orchardgrass, redtop, and Kentucky bluegrass.

In a separate publication Bieberly _et al_. (1957) listed and described the following warm season grasses: buffalograss, bluegrama, sideoats grama, switchgrass, indiangrass, and lovegrass, big bluestem, little bluestem, sand bluestem, Caucasian bluestem, and Turkestan bluestem.

Of the cool and warm season grasses listed above all except tall wheatgrass and Caucasian bluestem are listed in Hitchcock's 1951 manual.

Several of these grasses, among others, are described by Hoover _et al_., in the 1948 U.S.D.A. Yearbook of Agriculture.

Irrigation of Perennial Pastures

In the literature reference has occasionally been made, as in this paper, to the use of perennial pasture under irrigation. Savage _et al_. (1948) summarized work done in Colorado by Robertson and others on the feasibility of irrigating pasture.

> An irrigated pasture is profitable if it yields returns equal to those from an alfalfa hay crop on similar land, according to D. W. Robertson and his associates at the Colorado Agricultural Experiment Station. A heavy carrying capacity for 5 or 6 months of the year makes an improved pasture highly useful in maintaining a dairy or breeding herd. If these goals cannot be attained, the pasture should be replaced by higher-yielding forage crops.

The economic principles of considering the alternative uses of land, labor, and capital apply to the question of irrigating pastures as well as to other farm operations. A farmer or rancher who installs an irrigation system invests a large amount of capital. He does so with the hope that it will pay interest and dividends. In order for the enterprise to be profitable the production from the land must pay for the attendant increased annual costs such as labor, repairs, and depreciation. For these reasons it is important that the crops selected for irrigation either have a high productivity potential and respond to the increased moisture and fertilization with comparatively larger yields or have a high market value. Truck crops, often grown under irrigation, are examples of the latter. McCoy *et al*. (1966) give an indication of the rapid increase of irrigation in western Kansas and some of the accompanying changes in the following statement.

> Irrigated acreage more than doubled between 1955 and 1964, from about 440,000 acres in 31 counties of western Kansas to nearly one million acres. With increased irrigation, corn, forage sorghum, alfalfa, sugar beets, and specialty crops also have become important. Irrigation minimizes the weather risk of inadequate moisture. It greatly increases the investment per acre, but raises and stabilizes crop production. In addition to intensifying the production of established crops, it also provides opportunities for new crops. Irrigation often changes old established patterns.

When compared with such high-producing crops as forage sorghum and corn and such high-value crops as vegetables, perennial pasture may not be profitable on some farms or ranches. On others it may be a valuable addition to a livestock program especially when used to rest and relieve grazing pressure on native range. Much will depend upon the organization of the farm as discussed in another section of this paper. There are certain aspects that favor perennial grass as an irrigated crop. An obvious advantage is that less labor is required for irrigated grass when used as pasture than for other forage crops that must be processed and stored such as alfalfa and sorghum. Another decided advantage is the reduced labor and machinery expense involved in establishment of a perennial grass as compared to the annual labor and expense of establishing stands of sorghum or corn.

RELATIVE PROFITABILITY OF PERENNIAL PASTURE

Perennial pasture was compared with several alternative crops by setting up cost budgets and calculating a net return for each. The use of budgets for comparing costs and profits of alternative crops is not new. Some notable work involving budgeting techniques was recently done in Oklahoma (Connor et al., 1966; Martin, 1966; Schneeberger et al., 1966). There are some variations in the details of this procedure as used by different economists. The procedure used by McCoy et al. (1966) was followed in this study because: it compared the crops on a "per acre" basis; it did not include labor as a cost, but assumed the profits were returns to labor and management; and, it was more easily adapted to crops of interest in this study. Some advantages and limitations cited by McCoy are:

> The information presented can be used and applied to many other situations to suit individual objectives. Operators who experience production costs or yields different from those shown easily may substitute their own costs and yields and calculate returns for their individual situations and proposed crops.
>
> It avoids the necessity of actually trying, by experimentation, the different enterprise combinations. All "other things" are assumed to be equal except those explicitly considered in the budget.
>
> Limitations of this technique are readily apparent. Prices received, costs, and yields vary from farm to farm and over time. Also, projections into the future are, at best, hazardous. The number of crop and livestock combinations that can be considered is limited by the time of manually handling calculations.

Eight different crops, wheat, grain sorghum, corn, alfalfa, sorghum for silage, barley, perennial grass, and sudangrass, were compared at three yield levels (high, medium, and low) for eastern (Table 1), central (Table 2), and western Kansas (Table 3).

Prices and Yields

Prices and yields for all crops except the perennial grasses and sudangrass were obtained from the Kansas State Board of Agriculture Report "Farm Facts 1964-1965." The figures reported were for 1964. Eastern, central, and western Kansas are each comprised of three crop reporting districts. Average yields reported in these districts were averaged to arrive at the yields used in the three sections of Kansas considered in this paper. Yields of pasture crops were estimates based on experimental data and experience of agronomists working with crop production. Prices received per unit for the three sections of Kansas were obtained by dividing the total reported production in bushels,

TABLE 1. COMPARATIVE PRICE, GROSS RETURNS, PRODUCTION COSTS, AND NET RETURNS PER ACRE EASTERN KANSAS

Crop	Price Received Per Unit	Yield Level - Influenced Primarily By Management											
		Low				Medium				High			
		Yield	Gross Returns $	Production Costs $	Net Returns $	Yield	Gross Returns $	Production Costs $	Net Returns $	Yield	Gross Returns $	Production Costs $	Net Returns $
Wheat	$1.43/BU	21	30.00	31.10	- 1.10	31.0	44.30	34.90	9.40	41.0	58.60	42.30	16.30
Grain Sorghum	1.04/BU	20	20.80	33.50	-12.70	40.0	41.60	37.70	3.90	60.0	62.40	46.70	15.70
Corn	1.19/BU	21.5	25.60	35.80	-10.20	41.5	49.40	42.60	6.80	61.5	73.20	51.60	21.60
Alfalfa	22.20/T	1.5	33.30	25.50	7.80	2.5	55.50	33.30	22.20	3.5	77.70	40.80	36.90
Sorghum for Silage	6.70/T	6.7	44.90	36.40	8.50	9.7	65.00	47.40	17.60	12.7	85.10	56.90	28.20
Barley	.88/BU	20.0	17.60	30.30	-12.70	30.0	26.40	34.10	- 7.70	40.0	35.20	40.10	- 4.90
Smooth Brome	4.60/AUM	2	9.20	17.80	- 8.60	4	18.40	26.70	- 8.30	6	27.60	32.20	- 4.60
Sudan-Grass & Sudan-Grass Sorghum Hybrids	4.60/AUM	2	9.20	30.80	-21.60	4	18.40	38.00	-19.60	6	27.60	43.50	-15.90

TABLE 2. COMPARATIVE PRICE, YIELD, GROSS RETURNS, PRODUCTION COSTS, AND NET RETURNS PER ACRE CENTRAL KANSAS

Crop	Price Received Per Unit	Yield Level - Influenced Primarily By Management											
		Low				Medium				High			
		Yield	Gross Returns $	Production Costs $	Net Returns $	Yield	Gross Returns $	Production Costs $	Net Returns $	Yield	Gross Returns $	Production Costs $	Net Returns $
Wheat	$1.40/BU	16.0	22.40	24.60	- 2.20	24.0	33.60	29.10	4.50	32.0	44.80	37.70	7.10
Grain Sorghum	1.04/BU	14.5	15.10	25.80	-10.70	29.5	30.70	30.50	.20	44.5	46.30	35.50	10.80
Corn	1.23/BU	19.5	24.00	28.80	- 4.80	34.5	42.40	36.10	6.30	49.5	60.90	42.60	18.30
Alfalfa	24.50/T	1.5	36.80	22.50	14.30	2.0	49.00	28.10	20.90	2.5	61.30	32.70	28.60
Sorghum for Silage	6.80/T	4.8	32.60	29.30	3.30	6.8	46.20	38.50	7.70	8.8	59.80	45.20	14.60
Barley	.84/BU	15.5	13.00	24.60	-11.60	23.5	19.70	29.10	-9.40	31.5	26.50	37.70	-11.20
Switch-Grass	5.00/AUM	1	5.00	15.10	-10.10	2.5	12.50	19.40	-6.90	4	20.00	22.70	- 2.70
Sudan Grass & Sudan Sorghum Hybrids	5.00/AUM	2	10.00	18.60	- 8.60	3	15.00	25.10	-10.10	4	20.00	29.60	- 9.60

TABLE 3. COMPARATIVE PRICE, YIELD, GROSS RETURNS, PRODUCTION COSTS, AND NET RETURNS PER ACRE

WESTERN KANSAS

Crop	Price Received Per Unit	Yield Level - Influenced Primarily By Management											
		Low				Medium				High			
		Yield	Gross Returns $	Production Costs $	Net Returns $	Yield	Gross Returns $	Production Costs $	Net Returns $	Yield	Gross Returns $	Production Costs $	Net Returns $
Wheat	$1.38 BU	11.5	15.90	23.80	- 7.90	17.5	24.20	25.60	- 1.40	23.5	32.40	28.90	3.20
Grain Sorghum	1.06 BU	17.5	18.60	23.50	- 4.90	27.5	29.20	26.20	3.00	37.5	39.80	31.00	8.80
Corn	1.17 BU	75.0	87.70	60.80	26.90	100.0	117.00	76.10	40.90	125.0	146.10	97.00	49.10
Alfalfa	26.00 T	4.0	104.00	73.50	30.50	5.0	130.00	83.00	47.00	6.0	156.00	92.50	63.50
Sorghum for Silage	7.30 T	6.2	45.30	25.80	19.50	7.2	52.60	29.00	23.60	8.2	59.90	35.00	24.90
Barley	.84 BU	10.0	8.40	23.40	-15.00	16.0	13.50	25.60	-12.10	22.0	18.50	29.40	-10.90
Western Wheat Grass	4.50 AUM	.7	3.20	10.40	- 7.20	1.4	6.30	11.40	- 5.10	2.0	9.00	12.40	- 3.40
Sudan-Grass and Sudan-Sorghum Hybrids	4.50 AUM	1.0	4.50	14.80	-10.30	2.0	9.00	15.80	- 6.80	3.0	13.50	20.10	- 6.60

pounds, or tons into the "farm value" reported in each district and again averaging the three prices for a sectional average.

The price of an animal unit month (AUM) of grazing produced by the perennial grasses and sudangrass is based on the lease prices of native range in the respective sections. The price for eastern Kansas was reported by the Kansas Crop and Livestock Reporting Service in their annual Kansas Bluestem (Flint Hills) Pasture Report for 1964. The prices for central and western Kansas are estimates of county agents, Dr. John Launchbaugh at Ft. Hays Branch Experiment Station, and a farm and ranch appraiser for an insurance company whose territory includes western Kansas. It was assumed that one acre of good to excellent native range in eastern Kansas would provide one AUM of grazing, in central Kansas .8 AUM, and in western Kansas .66 AUM. These figures agree with the Soil Conservation Service (1955) technical guides for stocking rates. The annual rental price per acre of native range was set at $4.60 for eastern, $4.00 for central, and $3.00 for western Kansas. By dividing these prices by the AUM factors listed above a value for an AUM in each section was obtained. Multiplication of price per unit times yield per acre gave gross returns.

Production Costs

The costs of production for wheat, grain sorghum, and corn were based on budgets prepared by Smith and Thomas (1963) for eastern Kansas. Costs of the other crops were estimated by building similar budgets based partly on costs used by these authors and partly on rates for custom farm operations reported by the Kansas Crop and Livestock Reporting Service (1965).

Costs were compiled for each of the crops considered based on eastern Kansas conditions. To obtain costs of production for these crops in central Kansas the costs developed for eastern Kansas were multiplied by 82 per cent and by 69 per cent to obtain costs for western Kansas. These percentages were obtained by averaging rates for certain custom farm operations for eastern, central, and western Kansas as reported by the Kansas Crop and Livestock Reporting Service (1965). Two harvesting operations, two land tilling operations, and two land turning operations were averaged. These averages were then converted to percentages with eastern Kansas being one hundred per cent since this section always showed the highest costs. The 82 per cent factor was applied to all costs in the medium yield level of eastern Kansas to arrive at the crop production costs for central Kansas. The 69 per cent factor was applied to crop costs of forage sorghum and sudangrass in western Kansas. Summer fallow and irrigation enter the picture to complicate calculations in western Kansas. Wheat, barley, and grain sorghum cost budgets were compiled separately taking summer fallow and its attendant costs into consideration.

It is obvious that the yields reported for corn and alfalfa in western Kansas are strongly influenced by irrigation. Corn yields for western Kansas averaged 70.5 bu. per acre and alfalfa averaged 2.6 tons per acre. These yields are too high for dry-land conditions in western Kansas and too low for realistic production under irrigation. They apparently reflect both conditions and are not a suitable average for either condition considered alone. Therefore, a departure from the standard procedure used in the rest of this study was made and yields were estimated to more nearly reflect those usually attained under irrigation. The costs of production were compiled separately based on estimates of Kansas Extension Service irrigation engineers. These costs included increased land values, fertilizer applications, and herbicide and insecticide use over those estimated for dry-land conditions.

Costs of establishing the perennial grasses were compiled and then amortized over a period of seven years for smooth brome and ten years for switchgrass and western wheatgrass. A 150 pound application of phosphate and 30 pounds of nitrogen were assumed for the establishment of smooth brome, and an annual application of 100 pounds of nitrogen was included in the annual costs.

An application of 30 pounds of nitrogen both at time of establishment and annually was assumed for switchgrass in central Kansas. No fertilizer was assumed for western wheatgrass. Nitrogen was valued at 11 cents per pound and phosphate at 8.5 cents per pound.

Yield Levels

The yields, gross returns, production costs, and net returns were all compiled for the medium yield level in all three sections of the state. Since the reported yields are averages for large sections of the state they were used for the medium yield level, and it was assumed that inferior managers would not attain these yields and superior managers would surpass them. Adjustments were made in both yields and production costs, downward to arrive at figures for the low yield level and upward for the high yield level.

McCoy et al. (1966) assumed that there were no "differences in such inputs as inherent land fertility, seeding rate, and quantity and kind of fertilizer applied." They assumed that differences in yield levels reflected differences in levels of management. They included as characteristics of management, timeliness of operations and skills in adjusting machinery and equipment and in performing farming operations. The budgeting procedure used in this paper is at variance with the approach taken by these authors in that it was assumed that the decision to apply or not to apply fertilizer in varying quantities is an integral part of management. This allowed for wider variations between high, medium, and low yield levels than these authors were able to use.

As yield levels were reduced in this study it was also assumed that amounts of fertilizer used would be less. This reduced production costs materially. In some cases it was assumed that no fertilizer would be used under low yield conditions and an additional dollar per acre was deducted from the costs to account for the costs of application. Under high yield conditions additional increments of fertilizer were budgeted. Even in western Kansas small applications of fertilizer were assumed for certain crops under high yield level conditions.

The variations in yield due to management were generally considered to be less in central than in eastern Kansas and less in western than in central Kansas. This is accounted for by the fact that in the drier western parts of the state management would tend to have less influence on yields. Rainfall tends to cause the greater fluctuations in yields.

Discussion

An objective analysis of the study and procedures must include those factors that limit their reliability or usefulness. A basic limiting factor is that many of the data are based upon estimates rather than measured quantities. But, while there is a need for scientifically gathered data, even such data would be limited in their application because of such extremely variable factors as managerial ability, weather, soils, and prices.

This particular study has been generalized for a geographic area but restricted to a rather specific interval of time. It seems that a study more specific in its geographic scope but more general with regard to time may have more perennial application. With regard to the profitability of individual crops, the prices reported for 1964 make certain crops appear more profitable than they may be over an average of several years. Alfalfa is an example of this. A long-time average price for alfalfa of $16 to $20 per ton would lower the relative profitability of alfalfa considerably. In this study alfalfa is the most profitable of the crops considered. Conversely, wheat is considered at $1.38 to $1.40 per bushel, a price somewhat lower than the average over the past several years under government supports. Consequently wheat does not appear as profitable as other crops and may be underestimated.

Also, the price of an AUM of grazing is based upon the 1964 price of $4.60 per acre for eastern Kansas range. In 1966 this price was

$5.60 per acre, up nearly 22 per cent over 1964. The returns from these pasture crops may also be underestimated.

In general it may appear from this study that the average Kansas farmer (medium yield level) is having difficulty paying expenses and making a living. The low returns in central and western Kansas for such widely planted crops as wheat and grain sorghum tend to substantiate this assumption. The assumption is valid at least in part. It must be remembered that from $5 to $10 per acre of the costs of crop production is interest on land investment. For farmers who own their land or have a substantial equity in it this cost is actually part of their income. The net returns in this study are returns to labor and management. Nevertheless, farmers who want to buy farm land and must borrow large sums of money to do so need better-than-average yields in order to pay for the land, the interest on the borrowed money, and also pay living expenses.

Perennial Grass Compared to Other Crops and Conclusion

Three different perennial pasture grasses were selected because no single grass is well adapted to the entire state and the grass compared in each section is particularly suited to that region. However, switchgrass should be as equally suited to eastern as to central Kansas.

Comparatively, perennial pasture does not appear as profitable as most of the other crops considered in this study. In no instance does the perennial grass compared show a profit. This does not imply that perennial grass cannot compete on poorer kinds of land. On certain marginal lands even though perennial grass does not show a return to labor and management it nevertheless may be the most beneficial way of using the land.

It also must be remembered that in this study perennial pasture is compared with the other crops on a "cash crop" basis. A crop treated as a "cash crop" is sold at the highest value its producer can achieve. Pasture rented for cash may be considered a "cash crop." However, the value received is not the final value. The man who rents the pasture will not pay the price demanded unless there is some hope that he can increase its value by changing it into animal products. For farmers and ranchers who have their own livestock the rental or "cash crop" value of the grass is not its true value. The true value must be measured in terms of animal products. It is expected that the livestock program can increase the value of the grass crop to where it will compare more favorably with that of alternative crops grown on the land.

The specific theme of this paper concerns the relative benefits of perennial pasture as a supplemental feed while native range is being rested and improved. With this purpose in mind the study indicates that perennial pasture would be a better choice than annual pasture such as sudangrass or sudan-sorghum hybrids. Even in western Kansas the relatively low-yielding western wheatgrass is a cheaper form of pasture than the annual pasture. Annual costs of establishment of sudangrass and sudan-sorghum hybrids more than offset the initial costs of western wheatgrass even though interest and taxes for two years of establishment were included for western wheatgrass.

Perennial pasture also appears less costly than barley. While barley is not grown as extensively as other crops, the Kansas State Board of Agriculture (1965) reported 581,000 acres sown to barley in 1964. It would seem that in connection with a well planned range improvement program perennial pasture could profitably replace barley.

It is difficult to compare perennial pasture with sorghum for silage and alfalfa, both of which could be alternative sources of feed for livestock while range is being rested. The increased labor involved in utilizing these two crops has already been mentioned. In addition, it should be stated that if these crops are used for this purpose the increased labor required would come during spring and early summer when other farm activities are already placing heavy demands upon labor resources.

The alternative of leasing additional range is not considered in this study. Much would depend upon the individual circumstances, but there may be several advantages to perennial pasture: It may be nearer home which would allow closer observation of the livestock and lower costs involved in trucking etc.; it would increase the long run productive ability of the farm, especially if the perennial pastures were rotated to other fields after several years of use. This last point would seem to have more application in eastern Kansas where perennial pastures are more easily established.

It was not expected that this study would provide "pat" answers. It was intended to illustrate a method or approach to comparing relative profitability of certain farm or ranch enterprises. Use of the tables must be made only in the total context of an individual farm or ranch situation.

During the time a rancher is resting his range he is losing some of the productivity of the range resource which could be measured in animal unit months of grazing. One method of minimizing this loss may be through providing perennial pasture on which livestock can graze during the resting period. It is hoped that the loss would be temporary inasmuch as the rested range will become more productive. How long it would take for the increased production to pay for the loss cannot be stated. An entire section of this paper was devoted to this point. At any rate, it seems that some loss is almost certain in a range resting program. The loss will occur because the range is not being utilized in its most nutritive stages and because the feed provided during the resting period may be less valuable than an alternative crop that could be grown on the same land at the same time. Any loss, however temporary, may prevent ranchers from entering into a range resting program.

All of this tends to emphasize the importance of protecting the original stand of range grasses and adds weight to the words of caution concerning overgrazing that range managers and conservationists have been issuing for years.

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APPENDIX

SCIENTIFIC NAMES OF PLANTS MENTIONED

1. Western wheatgrass . . . . *Agropyron smithii* Rydb.
2. Switchgrass . . . . *Panicum virgatum* L.
3. Smooth Brome . . . . *Bromus inermis* Leyss.
4. Caucasian Bluestem . . . . *Andropogon intermedius* R. Brown
5. Wheat . . . . *Triticum aestivum* L.
6. Rye . . . . *Secale cereale* L.
7. Sudangrass . . . . *Sorghum vulgare* Var. *sudanense* Hitchc.
8. Alfalfa . . . . *Medicago sativa* L.
9. Sweetclover . . . . *Melilotus officinalis* (L.) Lam.
10. Big Bluestem . . . . *Andropogon gerardi* Vitman
11. Little Bluestem . . . . *Andropogon scoparius* Michx.
12. Blue Grama . . . . *Bouteloua gracilis* (H.B.K.) Lag. x Steud.
13. Tall Fescue . . . . *Festuca arundinacea* Schreb.
14. Intermediate Wheatgrass . . . . *Agropyron intermedium* (Host.) Beauv.
15. Weeping Lovegrass . . . . *Eragrostis curvula* (Schrad.) Nees
16. Sand Lovegrass . . . . *Eragrostis trichodes* (Nutt.) Wood
17. Tall Wheatgrass . . . . *Agropyron elongatum* (Host.) Beauv.
18. Reed Canarygrass . . . . *Phalaris arundinacea* L.
19. Crested Wheatgrass . . . . *Agropyron desertorum* (Fisch.) Schult.
20. Timothy . . . . *Phleum pratense* L.
21. Orchardgrass . . . . *Dactylis glomerata* L.

22. Red Top . . . . *Agrostis alba* L.

23. Kentucky Bluegrass . . . . *Poa pratensis* L.

24. Buffalograss . . . . *Buchloe dactyloides* (Nutt.) Engelm.

25. Sideoats Grama . . . . *Bouteloua curtipendula* (Michx.) Torr.

26. Indiangrass . . . . *Sorghastrum nutans* (L.) Nash

27. Sand Bluestem . . . . *Andropogon hallii* Hack.

28. Turkestan Bluestem . . . . *Andropogon ischaemum* L.

29. Corn . . . . *Zea mays* L.

30. Forage Sorghum . . . . *Sorghum vulgare* Pers.

31. Grain Sorghum . . . . *Sorghum vulgare* Pers.

32. Barley . . . . *Hordeum vulgare* L.

PERENNIAL PASTURE IN A GRASSLAND RANGE ECONOMY

by

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B. S., Kansas State University, 1956

AN ABSTRACT OF A MASTER'S REPORT

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Rangeland is important to the Kansas economy. It involves a land investment in excess of $1.4 billion. The value of its annual production contributes heavily to the state's economy. It occupies about 40 per cent of the land area of the state.

The condition of Kansas rangeland varies from excellent to poor. The majority of the range is in a condition something less than excellent and could be improved.

It is the assertion of conservationists that improved ranges are more productive and therefore more valuable than depleted ranges. Just how much more valuable cannot be determined at this time because of the complexities of the economics of range improvement. Some of the complicating factors are: fluctuating cattle prices, weather cycles that influence range production, and "non-market" benefits of range improvement such as prevention of run-off, and increased stability of stream flow.

The problem of concern involves the fact that in order to improve ranges they must be rested or treated in such a way that grazing pressure on them is relaxed. Resting the range will result in a loss of income to the rancher because he cannot use the range in its most nutritive stage and because he must provide additional feed during the resting period. The problem involves keeping this loss to a minimum. Perennial pasture may be a means of doing this. Presumably the loss will be temporary due to the increased production of the rested range.

Ranchers with the more efficient livestock programs, such as those involving young replacement calves and dairy cows, may be better able to use perennial pasture profitably than those with less efficient programs that involve beef-cow herds.

If the livestock grazing program is important to the ranch income it will be more beneficial to improve the range, and ranchers with such programs may be better able to utilize perennial pasture than those with grazing programs of relatively smaller size and less economic importance.

In areas where range dominates, perennial pasture may be forced to compete with forage crops for acres used to produce winter feed. Perennial pasture may not be so practical in such areas. In much of Kansas, range does not dominate but occupies from a third to one-half of the land on many farms. In these areas there may be an actual surplus of cultivated acres and perennial pasture may be more feasible there than in areas where range dominates. In any area perennial pasture may be the most beneficial way of using lands that are marginal for crop production.

Under irrigation perennial pasture may not be productive enough to pay for the increased costs of irrigation.

On a "cash crop" basis perennial pasture does not show a return to labor and management in any area of the state. It does, however, pay for all of the production costs and provides a return to land investment. Wheat, grain sorghum, corn, alfalfa, and forage sorghum show varying returns to labor and management. The decision to replace these crops with perennial pasture should be based upon other aspects of the ranch economy such as government restrictions on feed grains and wheat, relative importance of the livestock program, and consideration of the increased value of the range after resting. Perennial pasture shows more return to investment than barley or sudangrass pasture and could replace these crops.

In a range resting program some financial loss, presumed to be temporary, seems inevitable. This emphasizes the importance of maintaining the original stand of range grasses, thus avoiding the necessity for major range improvement programs.