Economic Efficiency in Pasture Production and Improvement in Southern Iowa

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RESEARCH BULLETIN 419 **DECEMBER, 1954** **AMES, IOWA**

CONTENTS

SUMMARY

1. One objective of this bulletin is to set forth some fundamental principles which are useful in answering questions of economy in pasture production. A second objective is to provide information on costs and returns for different systems of pasture improvement and to relate these to different situations farmers may be in with respect to limitations of capital. Finally, this study analyzes the attitudes, viewpoints and reasoning of farmers regarding pasture management. The data for this study are based on experiments and farm surveys. Budgeting procedures have been used in determining costs of and returns from pasture. The sample data explain how farmers in southern Iowa use pasture and their attitudes in pasture utilization.

2. Pasture costs were calculated in this study for several different improvement or renovation systems. There were large differences in initial costs between these improvement systems. The most expensive improvement from the standpoint of initial cost for labor, machinery and materials was renovation with birdsfoot trefoil and orchardgrass. Clipping and fertilization of bluegrass required the least initial outlay. These systems differ considerably with respect to their normal life span and the amount of pasturage produced. The birdsfoot trefoil-orchardgrass combination and the lespedeza system may last for 20 years or more if fertilizer is added periodically. The alfalfa-brome-ladino system and the reed canary-ladino system were considered to have a normal life expectancy of about 5 years. The bluegrass nitrogen fertilization should be repeated every year. When all of the costs over a 20-year period are taken into account, the two systems lasting 20 years appear least costly. The average cost per year over the 20-year period, based on 1951 prices, are $3.92 per acre for the birdsfoot trefoil-orchardgrass combination, $7.09 per acre for the alfalfa-bromegrass-ladino mixture, $6.55 per acre for the reed canarygrass-ladino system, $2.94 for the lespedeza, and $9.54 for the clipping and fertilization. When costs are discounted at a 5-percent rate (the market rate, which is applicable for farmers with unlimited capital), the two long-lived systems still give the lowest costs but the differences are considerably smaller. When costs are discounted at a rate of 20 percent (as may be appropriate for many farmers with limited capital), the differences in per-year costs are greatly reduced; the per-year cost for birdsfoot trefoil-orchardgrass is then $2.34, for alfalfa-brome-ladino it is $2.38, and for reed canary-ladino it is $2.49. Lespedeza costs only $1.36 and the nitrogen fertilization of bluegrass amounts to $1.38 per acre; rented bluegrass costs $1.00.

3. When pasture yields are considered, more acres are required to produce 1,000 pounds of beef with bluegrass fertilization or the renting of unimproved pasture than under other systems of improvement. Without discounting costs or returns, income over improvement costs is highest for trefoil, followed by alfalfa-brome and lespedeza. When costs and income are discounted, renting of unimproved bluegrass gives greatest net labor income at a 5-percent discount rate and alfalfa-brome is second high; trefoil and bluegrass fertilization have lowest returns. Under discounting rates of 20 percent, alfalfa-brome gives the highest net return while rented unimproved bluegrass is second high; fertilized bluegrass is fifth and trefoil and lespedeza are third and fourth respectively.

4. Improvement of many pastures in southern Iowa can be accomplished only if the land is cleared of brush and trees. Clearing costs vary from about $25 per acre or less for light brush to several hundred dollars per acre for dense woods with trees 10 inches or more in diameter. In some cases, however, the clearing operations provide merchantable timber which will help to defray the costs of clearing.

5. Pasture yields fluctuate a great deal from year to year. The most common methods by which farmers included in the surveys took these fluctuations into account in handling their livestock was to limit their livestock numbers to what they thought their pastures could handle in the average or poorer years. Thus livestock numbers on most of these farms were limited by the expected pasture yields in the poorest months of the poorest years. For farmers who plan their livestock systems in this way, pasture improvements cannot increase incomes unless it results in a more uniform seasonal distribution of production or reduces the year-to-year variation in production.

6. About 85 percent of the farmers feel that some improvement of their permanent pastures would pay. The most frequent reasons given for not having made such improvements were lack of capital and lack of sufficient livestock to utilize more pasture. Of those who gave lack of capital as their main obstacle, less than one-fifth of them were definitely unable to borrow the funds. Of those who lacked livestock to utilize more forage, a large number did not increase livestock numbers because they felt it too risky. Thus uncertainty looms large in restraining many farmers from the adoption of pasture improvement practices.

7. Many farmers have opportunities for increasing their return by renting additional pasture. On the basis of a survey in 1951 of southern Iowa farms, the average rental rates in that area were $3.60 per acre annually or $2.00 per cow per month for unimproved, open bluegrass pasture.

Economic Efficiency in Pasture Production and Improvement in Southern Iowa*

BY EARL O. HEADY, RUSSELL O. OLSON AND J. M. SCHOLL

Pasture crops provide an important source of income on most Corn Belt farms. On some farms of the Corn Belt, such as in southern Iowa, resources are such that income depends largely or entirely on pastures for livestock production. On these farms, earnings and the level of living of farm families may be raised measurably through better pasture improvement and management. Research in the last few decades has led to discoveries which many persons think can greatly increase returns from pasture crops. New grass and legume species and varieties have appeared which outyield older ones; they are hardier and better adapted to the weather conditions of the area. Techniques of production have been developed which increase yields and reduce risks and costs of pasture production. Farm magazines, newspapers, the extension services of state colleges, and various state and federal agencies have encouraged more widespread adoption of improved pasture practices. Many persons see, in the improved practices, an opportunity for expanding pasture acreage without reducing income.

However, the reaction of farmers to new pasture developments has been disappointing to many persons. Many farmers have made little or no adjustment in their cropping programs to include more pasture or to improve old pastures. Some farmers who have made important changes in their pasture programs have misgivings about the profitability of those changes. The reasons why farmers have not made greater adjustments in terms of pasture acreage and improvement can be explained by many forces. An important one, of course, is lack of knowledge. Many farmers do not have proper knowledge on the increased yields to be obtained from improved pasture management systems; even fewer have information on the costs and returns of improved pasture since education has tended to emphasize mainly the agronomic and physical aspects of pasture and pasture improvement.

Pasture improvement problems involve decisions which are unique to the situation of the individual farm. Following are considerations which determine the most profitable practices for any one farmer and which partially provide the framework for the analysis of this study.

(1) Tenant operation: From one-third to one-half of the farms in the major pasture areas of Iowa are operated by renters. It is seldom profitable for a tenant to invest much in long-term improvement practices since, typically, he moves to another farm or purchases a unit of his own in a few years. For most landlords, investment in permanent pasture may not appear advantageous since they customarily realize cash rent on this area of the farm; also, customary leasing arrangements include few clauses to favor pasture investment.

(2) Capital limitations: Both renters and owner-operators are typically short on capital in the pasture region of Iowa. The question then becomes, with a limited amount of funds to allocate between many alternatives, not whether pasture improvement is profitable but whether it is more profitable than any other investment. Even though pasture investment is profitable, profits for the farm as a whole (the focal interest of the farmer) will be maximized if funds are invested in brood sows, nitrogen fertilizer, machinery or other lines when these return more per dollar than pasture improvement and vice versa. Finally, the greater the shortage of funds, the greater the rate at which long-term improvements will be discounted; premium may be on investments of an annual-turnover basis such as those explained later.

(3) The cost of feed from different alternatives: Where capital and leasing are not limiting factors, the economy of feed obtained either through pasture or pasture improvement depends on whether a unit of feed from this source costs less than a unit of feed from alternative sources. In other words, the rate at which two feed sources compete in producing a given amount of livestock has to be compared to the price ratio or cost ratio of the two feeds. If ½ acre of improved pasture will produce 100 pounds of meat while 700 pounds of hay or 1 acre of unimproved pasture, either rented or on the home farm, will also produce 100 pounds of meat, then the cost of the ½ acre of improved pasture must be less than the cost of 700 pounds of hay if costs are to be minimized and profits are to be maximized; the per-acre cost of improved pasture cannot be more than twice the cost of unimproved or rented pasture (since it substitutes for the latter at the rate of two to

*Project No. 1085, Iowa Agricultural Experiment Station; Agricultural Research Service, United States Department of Agriculture cooperating.

one) if it is to prove the most profitable feed in producing a given gain.

(4) Risk and uncertainty: Farmers do not base their actions entirely on those alternatives which give them the greatest average returns over time; many select those lines which appear most stable, where fluctuations are not great and where extended periods of low returns or losses are not likely to occur. As brought out in the survey of 122 farms mentioned later, many southern Iowa farmers look upon major forms of pasture improvement as entailing certain added risks and uncertainties. Some farmers in the survey said they would rather buy 100 acres of unimproved pasture than to improve 50 acres of pasture where the improvement costs were equal to the original cost of the land. Their reasoning was of this nature: Even if the improved pasture produced somewhat more than the greater acreage of unimproved pasture, a drouth in the year of improvement would only cause a temporary set-back of the 100 acres of unimproved bluegrass. It would cause loss of a major portion of the improvement costs for the 50 acres where improvement was tried.

OBJECTIVES OF STUDY

Farmers in planning their pasture program have several important questions to answer: (1) How much of their land should be used for growing pasture crops? (2) Which kinds or combinations should they select from the long lists of annual, biennial and permanent grasses and legumes? (3) How much are they justified in spending for fertilizer, labor, etc., to boost pasture yields? (4) What should be the seasonal pattern of pasture use and the level of intensity of grazing? (5) How can they reduce the risk and uncertainty of income from pasture? One objective of this study is to set forth fundamental principles which may be used as guides in finding the best answers to these questions.

The answers to these questions differ between farms, depending on the nature of the soil and other resources on each farm, the tenure and financial positions of each, the attitude of each farmer toward risk bearing and numerous other considerations. Nevertheless, the same principles can be used in determing the best pasture management plan for each farm. Even when more data are forthcoming from agronomic and other research, the findings will not have universal application to all farm and soil situations. Because of limited research funds and resources, experimental findings ordinarily apply to only a few restricted soil situations. In contrast, the farmer may have three or four soil types on his own farm. Also, if the economics of pasture improvement were worked out for two or three distinct farm situations, they would not apply to all the conditions found on other individual farms. Therefore, certain basic principles are set forth in this bulletin; while the data from a few agronomic experiments or a few economic examples may not apply to all farms or even all fields on a single farm, the principles have universal application regardless of the particular situation. These principles can be used by farmers, but more particularly, by persons who advise farmers to take the few research data available (or as these become available), modify them for different soil conditions and apply the universal principles and logic outlined in this bulletin. The principles are explained and illustrated by some equations which, although they appear complex, can be used by any person who understands arithmetic. The principles illustrated have the advantage of applying to both farms with limited and unlimited capital.

Another objective of this study is to apply these basic principles to determine the gap between what farmers in a particular area are now doing in the way of pasture management and what it would pay them to do. Stated differently, the objective is to indicate the nature and extent of adjustments in pasture management that would be profitable in a given area. The particular area considered in this study is the southern pasture area of Iowa. The results of the study should also have wide applicability in other regions in the Corn Belt where much of the land is suited primarily for pasture crops.

Still another objective of this study is to provide information on costs and returns for different systems of pasture improvement. An attempt is made to incorporate considerations of limited capital and time into the cost calculations in the manner necessary for farmers with limited funds. Costs are calculated for various forms of improvements without land preparation and by partial renovation with different combinations of grasses and legumes. Costs of land clearing also are indicated. Physical returns are estimated for a few systems. Finally, this study includes a preliminary analysis of how farmers use pasture and their attitudes, reasoning and viewpoints in using it as they do.

SOURCE OF DATA AND METHOD OF ANALYSIS

The data used in this study were drawn from several sources. Much of the data pertaining to the pasture practices now being used by farmers in the area, reasons for failure to adopt improved practices and farmers' opinions regarding various phases of pasture management were obtained by interviewing the operators of 122 farms included in a random sample of farms selected from 10 counties in the southern pasture area. Attitude and pasture utilization information is taken from a second sample of 200 farms in the same counties.[1] Data on costs also are included for 17 Lee County farmers who improved pasture in 1950.

[1] The counties include Van Buren, Davis, Monroe, Wayne, Appanoose, Lee, Decatur, Ringgold, Lucas and Clarke counties.

Information on the costs of some of the more expensive operations such as clearing of brush and timber, leveling and dirt moving was obtained from contractors in that type of work in the area. A mail questionnaire sent to the 60 contractors in the area provided 16 complete and usable schedules. A similar questionnaire was used in personal interviews with 20 of the non-respondents. The data from these 20 schedules and the 16 earlier mail schedules were weighted to allow estimates of population parameters and the clearing cost figures which follow.

Experimental data from pasture experiments at the Albia farm of the Iowa Agricultural Experiment Station were used extensively in computing the return from alternative pasture practices. In some cases where data were extremely limited, cost and return figures reflect largely the judgment of specialists who have had considerable experience with pasture management problems in the area.

FUNDAMENTAL PRINCIPLES IN PASTURE IMPROVEMENT ECONOMICS

Before analyzing the data specifically for the empirical estimates which follow, a review of the relevant basic economic or farm management principles for decisions relating to improvement of permanent pasture is in order. These principles are outlined since they (1) indicate the conditions under which different types and extents of pasture improvement should be selected, given the data which follow, by farmers with different amounts of capital and who possess different degrees of risk aversion, (2) indicate the manner in which added data, as it becomes available, can be used in arriving at decisions for the individual farm and (3) provide the framework or models indicating the types and forms of data which should be made available from pasture research and in educational programs if farmers are to be helped in making efficient choices, depending on the capital and uncertainty circumstances which surround each operator. These principles can be discussed in the five somewhat distinct categories below. (Readers uninterested in the basic principles of pasture improvement will wish to turn to the applied figures of the next section.)

Situation I: *A farmer with unlimited capital, complete information and decisions relating to a non-discounting period.*[2] This condition is the exception because farmers typically (1) are limited in capital, (2) look upon the future with uncertainty and (3) apply discounts to income because of both time *per se* and uncertainty. However, it will be discussed (1) as a step to the situations outlined below, (2) as a situation approximated by some few farmers at some few points in time and (3) because agronomic and other physical research is customarily interpreted and presented in this framework.

For this situation, supposing that the farmer is producing pasture crops alone or is concerned only with decisions in regard to pasture crops, two sets of information are necessary: (1) The ratio of the price of the improvement resource or material to the price of the product being produced for sale (normally livestock products, but forage from pasture also may be sold as pasture or as hay); (2) the ratio of the physical increase in marketable product from pasture to the physical increase in input of the improvement resource or material.[3] If we use the sign $\triangle$ to mean "change in," L to refer to the amount of livestock product produced from pasture, R to refer to the quantity of improvement resource material, P_r to refer to the price (cost) per unit of improvement resources and P_l to refer to the per-unit price of the livestock product, then the conditions under which profits can be maximized from improvement can be stated symbolically in the manner of equation (1) below:

$$\frac{\triangle L}{\triangle R} = \frac{P_r}{P_l} \qquad (1)$$

This equation states that the optimum level of pasture improvement has been attained when the ratio of (1) the "change in" (or "addition to") livestock production divided by (2) the "change in" ("addition to") improvement material is equal to the per-unit price of the improvement material divided by the per-unit price of the market product, i.e. the ratio of change in output to change in input must equal the ratio of resource price to product price. If this equation is multiplied out, it results in equation (2) below, which states that profits from pasture improvement are at a maximum when the change in output multiplied by the per-unit price of the product is just equal to the change in input of the improvement material multiplied by the price of the improvement material. (Several improvement materials such as seed, fertilizer, labor, tractor fuel, etc., can be included in the right side of the equation. The sums of these products must then equal the product or value for the output on the left of the equation.)

$$(\triangle L)\ (P_l) = (\triangle R)\ (P_r) \qquad (2)$$

While no profit would be made from this last unit of improvement, any smaller amount of improvement would always allow less profit.[4] This statement is illustrated in equations (3) and (4) which are corollaries of (1). They mean that con-

[2] In the terminology of economics the meaning of "complete information" is generally considered to be synonymous with "absence of uncertainty"; a non-discounting period is one so short that income is not discounted or reduced for time.

[3] The fundamental outline for rotations of crops also applies to choices of pasture mixtures such as grasses and legumes, or also different types of grasses and legumes when the particular vegetative make-up of a pasture is to be considered. Hence these principles will not be discussed again in respect to pasture mixture.

[4] If computed as a derivative, the ratio $\frac{\triangle L}{\triangle R}$ refers to changes in output for any infinitely small changes in improvement resource; thus any quantity of improvement smaller than that denoted by the condition $\frac{\triangle L}{\triangle R} = \frac{P_r}{P_l}$ would not maximize profits.

tinued pasture improvement will always increase profits as long as the ratio $\frac{\triangle L}{\triangle R}$ (hereafter called the transformation ratio) is greater than (as denoted by the sign >) the inverse price ratio.

$$\frac{\triangle L}{\triangle R} > \frac{P_r}{P_l} \qquad (3)$$

$$(\triangle L)\ (P_l) > (\triangle R)\ (P_r) \qquad (4)$$

Situation II : A farmer with unlimited capital, complete information and pasture improvement involving time. Ordinarily pasture improvement involves investments which extend beyond a year and therefore relate to periods long enough that the income in the future from improvement must be compared with that of alternative investments in the present. The profitable level or form of pasture improvement then is not defined by equation of the transformation ratio and the inverse price ratio but by relating the transformation ratio to the discounted price ratio. Or, a less complex system is that of discounting returns of the future back to the present and comparing them with the costs involved. If the decision of pasture relates to a single investment in improvement which will result in production of forage and meat in a future series of years, the discounted value of the return must be compared with the present costs.

For the farmer with unlimited capital, the market interest rate provides the proper discounting level; if funds were not invested in pasture improvement, they could be loaned at interest. In other words, if the market rate of interest is 5 percent, a $105-income forthcoming 1 year from now is worth no more than $100 now; if $100 were loaned out at interest now, it would amount to $105 in 1 year. Thus we can determine the present value of a future income by dividing it by the term $(1+r)^i$ where r refers to the rate of interest and i refers to the number of years in the future when it will be forthcoming. If we have a current improvement investment which will bring about incomes of $100 in each of 5 years, the present value of future incomes thus becomes that indicated in equation (5) where PV refers to the present value of the future incomes.

$$PV = \frac{100}{(1+r)} + \frac{100}{(1+r)^2} + \frac{100}{(1+r)^3} + \frac{100}{(1+r)^4} + \frac{100}{(1+r)^5} \qquad (5)$$

If r, the rate of interest, is 5 percent, the present value of the future incomes from improvement is that indicated in (6).

$$PV = \frac{100}{(1.05)} + \frac{100}{(1.05)^2} + \frac{100}{(1.05)^3} + \frac{100}{(1.05)^4} + \frac{100}{(1.05)^5} = \$446.21 \qquad (6)$$

The equation can be applied to any number of years in the general manner of equation (7) where i refers to the individual year in the future, I refers to the income of the individual year (therefore I_i refers to income in the ith year) and $\sum_{i=1}^{n}$ refers to the fact that the discounted income in each of the years 1 to n are summed.

$$PV = \sum_{i=1}^{n} \frac{I_i}{(1+r)^i} \qquad (7)$$

While the sum of incomes over 5 years is $500, the discounted value of this income is only $446.21. Hence, if the improvement investment amounts to $400, it is profitable; if it amounts to $450, it is not profitable since it is less than the undiscounted sum of $500.[5]

Quite often pasture improvement involves a large investment at an early point in time (such as in clearing trees and brush, in plowing up old pasture, in applying seed and fertilizer, etc.) and also investment in each succeeding year; repeated investment may be made in fertilizer, for example. Supposing that we have an initial investment of $1,000 in pasture improvement and $50 at the end of each of the following 5 years of pasture life while income is $290 per year (a total of $1,450 in 5 years), the discounted income quantity to be compared with the initial investment becomes that stated in (8) below.

$$PV = \left[\frac{290}{(1+r)} + \frac{290}{(1+r)^2} + \frac{290}{(1+r)^3} + \frac{290}{(1+r)^4} + \frac{290}{(1+r)^5}\right] - \left[\frac{50}{(1+r)} + \frac{50}{(1+r)^2} + \frac{50}{(1+r)^3} + \frac{50}{(1+r)^4} + \frac{50}{(1+r)^5}\right] \qquad (8)$$

The present value, which in the case of equation (8) is $1,070.90, can then be compared with the $1,000 initial investment; in the case just outlined, the investment is profitable. In this case, the costs in each future year are discounted in the manner of the income sequences. This procedure is followed since it indicates the amount which invested at compound interest will provide the cost amount of the future year. For example, if we consider the $50 cost in the third year, $44.82

[5] The procedure employed in this paragraph assumes that the product attributable to pasture in each of the future years has been isolated and that the discounted values are then compared to the single pasture investment. Where the pasture product cannot be broken down and the profitability must be figured on pasture in combination with livestock and other investments, another equation must be used.

used at compound interest of 5 percent will give the $50 for costs at the end of this period.

Situation III: A farmer with limited capital, complete information and pasture improvement involving time. When we bring in the realistic situation wherein the individual farmer has limited capital, we begin to explain why farmers on the same soil type with the same potential increases in production and income from pasture improvement may wish to invest differently. For the example above where the farmer has unlimited capital, the rate of discount used (r in the equations) was the supposed market rate of interest, or 5 percent. This was the relevant rate for discounting since the alternative or opportunity use of funds for a person with unlimited capital is the loaning out of funds at interest; profit comparisons must be made with this opportunity as the minimum return possible. However, where the operator has limited capital, he has alternative uses of funds in his own business. The proper discount rate for profit calculations for investments involving time then becomes the alternative returns rate which can be earned within the year from another investment.

Suppose that a young farmer with limited capital can earn 20 percent within a year on funds invested in brood sows, broilers, protein feed or fertilizer. In figuring the profitability of pasture investment, he will then wish to apply a discount rate of 20 percent in equation (6) above (i.e. 1.20 rather than 1.05 will be used as the denominator and raised to the power of the year indicated). When this discount rate is used, the present value of the sequence of income ($100 in each of 5 years) becomes only $297.86 rather than the $446.21 computed with interest at 5 percent. Hence, while the pasture improvement investment will be profitable for a farmer with unlimited capital who can earn only 5 percent on funds loaned or invested elsewhere, it is unprofitable (using maximum profits for the business as a criterion) for a farmer with limited capital who can use the funds elsewhere and earn 20 percent.

From these illustrations and principles, it becomes evident that recommendations on pasture improvement to individual farmers cannot be made in a blanket manner but must be conditioned to meet the capital and managerial conditions surrounding each operator; different optima exist for each farmer depending on these situations.

In this section we have considered only one level of improvement. We have analyzed the conditions under which improvement is profitable when the complete farm business and alternative investments within it are considered. The same type of analysis applies to different levels of improvement, such as those which are outlined in situation I above and which may result in production and income in a series of years into the future. The discounting can then be applied to each level or step in investment or improvement; while not all steps in improvement may be profitable when returns of the future are discounted, some will be, depending on the discount rate which is relevant. In a later section, we use these discounting systems to compute relevant pasture improvement costs for farm situations where capital is limited in different amounts. Costs alone are calculated on a discount basis since only meager information is available on returns. Farmers and farm advisers can, however, make estimates of returns and compare them with costs. Positive differences will indicate pasture improvement for the different systems is profitable. Our calculations account for alternative uses of capital where 5 and 20 percent can be realized under the price levels used.

IMPROVEMENT INVOLVING TIME AND UNCERTAINTY OF THE FUTURE

Investments made at one point in time can only anticipate the outcome of the future. Thus uncertainty is involved and discounting may be applied not only because of time but also because of "risk" itself. The amount by which incomes of the future may be discounted depends on the individual; the discount or "safety margin" by which he does, or should, lessen prospective incomes of the future will depend on the degree of uncertainty with which he views future prices, yields and techniques and his capital position and, hence, his ability to withstand setbacks in the future. Generally, incomes extending into the future will be discontinued at an increasing rate because the errors relating to anticipations typically increase with time. Thus, in the manner of equation (6), the operator with unlimited capital might want to discount incomes of the first, second, third, fourth and fifth years by 5, 7, 9, 11 and 13 percent respectively rather than by a straight 5 percent; and operators with limited capital and opportunities of current returns of 10 percent in the farm business may wish to discount incomes of the 5 years by 10, 14, 18, 22 and 26 percent; the exact rates of discount and hence the profitability of pasture investment will again depend on the individual.

THE VALUE OF PASTURE

On many farms opportunities exist for profitable utilization of more forage than that produced on land unsuited for other crops and the complementary forage. The pasture management problem then becomes much more complex. Decisions must then be made as to how much additional forage to produce and which of the many possible methods should be used in improving it. Intelligent decisions in each case require knowledge of the value of any additional forage output and the costs of obtaining that increase by alternative means in the manner outlined previously. The value of an increase in forage output may be measured in terms of its market value. But often forages, and especially pasture crops, have no direct market value; their values must be measured in terms of their values as livestock feed. One method of measuring the value of pastures consists of converting the pasture output to some standard feed unit measure such as total digestible nutrients (TDN) or net energy. The monetary value is then computed as the value of an equivalent number of feed units of some feed for which a market price is more clearly defined. This method assumes, unrealistically, that all feeds substitute at a constant rate. That is, it assumes that a pound of TDN in corn has the same feeding value as a pound of TDN in pasture, hay, protein supplement, etc., irrespective of the kind of livestock to which it is fed or the composition of the ration.

A more appropriate measure of the value of a unit of forage may be its substitution value, i.e. the value of the feeds it replaces as it is substituted in producing a given livestock output. If, as seems likely, forage substitutes for grain at a diminishing marginal rate in livestock rations, the substitution value of a feed declines with each increment in forage fed to an animal.[6] Additional units of livestock may be added to utilize more forage but limitations of labor, capital, skills or other resources eventually restrict the numbers which can be handled on a farm. Increased forage consumption then will result in lower marginal rates of substitution of forage for grain. It will pay to add forage until the value of the grain replaced is just equal to the cost of adding the last unit of forage. The value of forage, measured in this manner, represents its maximum value. It is never worth any more than the value of the feeds which it will replace if proper consideration is given to the labor, other capital and risks, which complement either the pasture feed or the non-pasture feed. The minimum value of pasture is its market price, i.e. the return which can be obtained from renting it to other farmers or in grazing animals at a monthly rental rate.

The two systems above provide the relevant "value of pasture" for decision-making by farmers. Where, between these two extremes, the real worth of pasture falls for the individual farm depends on its use value, i.e. its marginal value productivity, and the returns which can be had from it. However, it is never worth less than its sale value as pasture or more than its substitution value. Alternative systems of valuing pasture, such as the residual system, may lead to very great errors. The residual system used by many people involves the following steps: First the total value of livestock products from animals using some pasture is computed; the animals may be receiving a major part of their feed from other sources or they may be obtaining all of it from pasture. If other feeds are involved, their values are computed at market prices, and the computed quantities are subtracted out. The remainder then is imputed to pasture; it is taken as the amount of the total value of production forthcoming from pasture. In some few instances, labor value is also subtracted to estimate pasture returns.

[6] See Heady, E. O. and Olson, R. O., Substitution relationships, resource requirements and income variability in the utilization of forage crops, Iowa Agr. Exp. Sta. Res. Bul. 390 for details on substitution rates.

This procedure could also be used for protein feed, labor, corn or any other element going into livestock production. It has the same disadvantages in the case of pasture or any other element of production. During rising prices, the system likely overestimates the value of the element receiving the residual; during falling prices, the opposite holds true. (The system has been used to compute "pasture value" mainly during periods of rising prices and profits. Part of the return imputed to pasture may be due equally to other production elements.) One of the main difficulties in using the system is that data are not available for computing the marginal productivities which enter into production of livestock on pasture.

DATA NEEDED

The examples outlined above provide the decision-making principles upon which pasture improvement should be based. Through the procedure introduced into the formulas, they allow consideration of pasture improvement as it relates to (a) the profitability for the farm as a whole and (b) the capital position of the individual operator. Unfortunately, sufficient experimental data are not available to make full application of the principles. However, they can be applied to data now existing, to the estimates that farmers must draw together in the absence of complete experimental information and to additional information as it is made available.

In the sections which follow, initial costs have been computed for different types of pasture improvement. These are not compared on the basis of their relative profitability to individual farmers because recommendations should differ depending on the capital status of the farmer. The profit equations from the preceding section can be applied to the cost and investment data which follow, however, to suggest the relative feasibility of different methods depending on the capital available; for an individual farmer, the interest rate to be applied would be his alternative earning rate on another enterprise on the farm.

COSTS OF PASTURE IMPROVEMENT

This section deals with the costs of different levels and degrees of improvement. Two sources of estimates are used. One represents the actual renovation costs of 17 farmers in Lee county in 1950, who worked cooperatively with the Agricultural Extension Service at Iowa State College and furnished figures on their operations. The other set of data are synthesized from engineering and economic research. While the farmer-furnished data provides information on specific costs of complete renovation, or distinct pasture mixture, the synthesized costs show outlays necessary for different levels and forms of renovation computed for a 160-acre farm with the average pasture acreage of the area.

The cost figures are for both pasture renovation and for improvement by other practices. By *renovation* is meant clearing if necessary, plowing or disking to fit a seed bed, fertilizing and liming according to soil needs and planting pasture type legumes or mixtures of grasses and legumes. Pastures may be improved also by adding fertilizer, by mowing and by seeding certain legumes or grasses to an existing stand, without plowing it up.

DETAILED COST ESTIMATES

The improvement costs for the Lee County farmers are presented in table 1. They include costs of complete renovation on the 17 farms with mixtures including brome, alfalfa, red clover, orchardgrass, ladino, alsike, reed canarygrass, birdsfoot trefoil, timothy and sweetclover. Typically, the systems used included mixtures of the grasses and legumes mentioned. For these farms the machine and power costs, including depreciation and repair on machinery, were $7.33 per acre; labor costs were $4.73 per acre; and material costs were $28.33 per acre. If these farmers had imputed no costs to their machines and labor but included only power and materials costs, the total would have been $30.98 ($2.65 for power and $28.33 for materials). These costs are for initial establishments of seedings only and do not include the costs of subsequent operations such as fertilization and clipping.

Since the acreage renovated and the seed mixture used differed considerably between farms, additional cost estimates have been provided in table 2 and in later sections. The data in table 2 provided costs for the typical machine and labor operations on a 160-acre farm and include repair, fuel, depreciation and other costs in an amount which might be attributed to a renovation process when an average acreage of other crops are grown. Costs are based on machine studies at Iowa State College. If no cost is attached to labor, e.g. it might be available on the farm with no alternatives, the total machine and power costs are $5.55; if power costs alone are considered, they amount to $2.26.

The computed costs for machinery and labor are slightly higher than for the 17 Lee County farms, mainly because they are based on average performance rates for machines and labor. The Lee County farmers represent a distinct stratum of agriculture and likely are more efficient than the average of all farmers in southern Iowa. However, either set of data can be used to suggest the "neighborhood" of machine and labor costs for pasture renovation. Both sets of data have been converted to a 1950 price level base.

It is true of course, that the per-acre costs of renovation depend on the number of acres renovated. Working of a few acres requires a certain minimum of overhead expense in getting equipment ready, in moving equipment to the field and so forth. Figure 1 illustrates how these costs vary with the number of acres improved. Machine and labor operations involve some "overhead" or

TABLE 1. ITEMS OF COST IN COMPLETE PASTURE RENOVATION FOR 17 LEE COUNTY, IOWA, FARMERS, 1950.

Item	Cost per acre renovated
Tractor	$ 2.65
Plow	0.93
Disc	0.73
Harrow	0.53
Drill	1.30
Fertilizer spreader	0.04
Wagon and spreader	1.00
Roller	0.15
Total power and machine cost	7.33
Labor cost	4.73
Materials cost	28.33
Total costs	40.39
Average acres per farm	10.6

TABLE 2. COMPUTED MACHINE AND LABOR COSTS IN COMPLETE RENOVATION OF 1 ACRE, 1950 PRICE LEVELS.

Item	Acres once over	Hours used	Cost per hour	Total cost
Tractor		3.84	$0.59	$2.26
Plow	1	1.42	0.58	0.83
Disc	2	0.83	0.65	0.54
Harrow	1	0.14	0.75	0.11
Fertilizer spreader	1	0.46	0.51	0.23
Endgate seeder	2	0.22	3.62	0.80
Wagon		0.22	0.11	0.02
Roller	1	0.29	0.91	0.26
Mower	1	0.48	1.05	0.50
Labor		3.84	1.00	3.84
Total				9.39

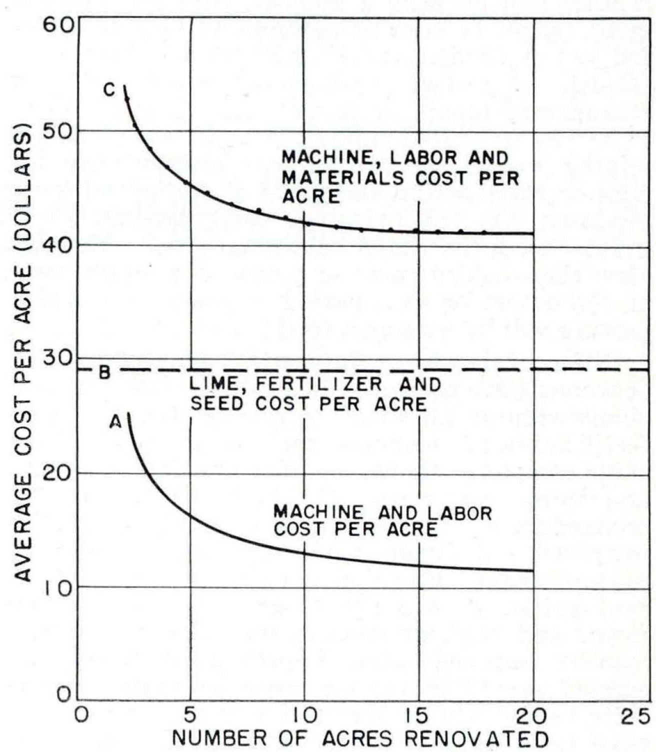

Fig. 1. Per-acre costs of improvement in relation to the number of acres improved per farm on 17 Lee County farms.

fixed costs which cause per-acre costs to decline rapidly at the outset in the manner of curve A; variable costs then become more important and the curve levels out so that gains in the form of lower costs become quite small for more than 6 to 10 acres. On the other hand, seed and materials costs (line B) tend to be constant and the curve of total costs thus is of the nature of C, where costs decline quite rapidly up to 6 to 10 acres but become quite constant for acreages beyond this level.

While declining costs occur on any farm depending on the acres covered, the remaining sections of this study will use only a single average cost figure. In other words, we will suppose renovation involving an average number of acres. Since declining average costs came about almost entirely through machine costs, farmers with various acreages can compute their constant seed, fertilizer and materials cost per acre and then read the machine costs off a curve such as A in fig. 1. The two figures will then give an estimate of the total per-acre costs of renovation (with consideration given to the number of acres to be renovated).

COSTS RELATED TO DIFFERENT LEVELS OF IMPROVEMENT

As mentioned previously, pasture improvement is not an "either-or" process in the sense that it must be done in one manner or not at all. There are many different degrees of pasture improvement which can be attained through different systems—ranging from simple renovation such as clipping weeds on bluegrass to plowing up of the pasture and planting a mixture with an expected great longevity such as seedings of birdsfoot trefoil and orchardgrass. Each of these different intensities of pasture improvement involve different amounts of inputs or costs. The farmer's task, if he has unlimited capital, then is one of determining how far he can go with improvement inputs or costs before the value of the added yield produced, i.e. the marginal value product P, is greater than the added (marginal) cost. He may view these added costs in terms of a single year at the outset or as a period of years over which pasture will be used as a feed.

Different levels or intensities of pasture improvement are compared in table 3. The first is a simple step in improvement representing nitrogen fertilization of bluegrass, the second and third involve complete renovation with (1) alfalfa, brome and ladino clover and (2) birdsfoot trefoil and orchardgrass. How far pastures can be profitably improved will depend partly on the price of beef in the manner outlined in a previous section. With beef priced at $12 per hundred pounds at the farm, and without discounting of costs in the manner outlined later, improvement cannot be carried profitably for all levels of improvement. With beef at $20 per hundred pounds, these several systems would be more profitable. The bluegrass system gives the lowest cost per $1 of investment in labor, machine services and materials

TABLE 3. COSTS AND PHYSICAL RETURNS FROM DIFFERENT LEVELS OF PASTURE IMPROVEMENT.*

Item	System		
	Fertilization of bluegrass (1 year)	Alfalfa, brome, ladino (5 years)	Birdsfoot trefoil and orchard-grass (20 years)
Initial investment	3.51	35.51	39.07
Added investment over 20 years for reseeding and fertilizer	66.69	111.21	39.39
Total investment over 20 years	70.20	141.80	58.46
Investment per year	3.51	7.09	2.92
Added pounds gain per year in yearling steers if all seasonal pasture used (over untreated bluegrass)	91	230	167
Total pounds gain in 20 years	1,820	4,600	2,340

* These improvement practices are explained in more detail along with the details of the cost items in later paragraphs and tables. The only exception is that the fertilization system for bluegrass in this table includes only 182 pounds of 33-0-0 while later tables include 150 pounds for the same system. In the cost calculations of this study, taxes and items of farm overhead are not included when these would be the same regardless of the crop or management system. Net returns or costs including these fixed costs will differ by the same absolute amount as those which exclude these overhead costs.

but also the smallest increase in production. With costs at 1950 levels, it would pay for itself with beef as low as 6 cents per pound, supposing no margin of price gain or loss on the original weight of the cattle and without considering the farmer's discount.

The amount of an improvement material to use will vary with its price as compared to the price of the livestock product. Usually, because of the law of diminishing returns, any single improvement material will add less and less to the total grass and livestock production as more and more of it is used. This point is illustrated in fig. 2 and table 4 with bluegrass fertilization, for weather similar to 1951, where each 10-pound increment of nitrogen adds less than the previous unit to total grass production and total beef per acre from a cow-calf herd. With beef at 10 cents per pound and nitrogen costing 12 cents per pound for application, only 10 pounds of nitrogen is profitable; the second 10-pound unit adds $1.20 to cost but only $1.10 to returns per acre. With beef at 20 cents and fertilizer at 12 cents, 50 pounds of nitrogen are profitable. With fertilizer at 15 cents and beef at 20 cents, only 40 pounds would be profitable; the fifth 10-pound unit would add $1.50 to costs but only $1.40 to return. The response for individual years will depend on the weather of the particular season, of course.

RELATIVE COST OF PASTURE MIXTURES INVOLVING DIFFERENT PERIODS OF TIME

The earlier section on decision principles indicated that one of the basic questions relative to pasture improvement, once decision has been made to improve pasture, is which system is most eco-

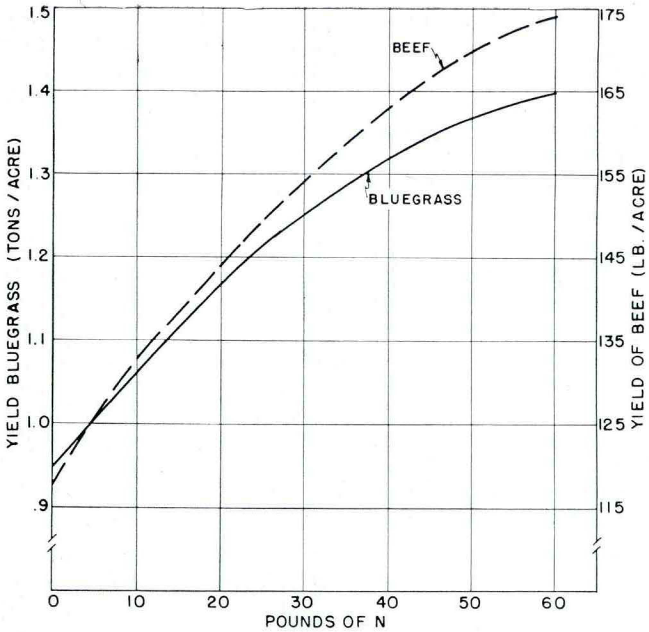

Fig. 2. Relation of level of nitrogen fertilization on forage and beef yield per acre, 1952. (Based on data of table 4.) Yields in other years will be higher or lower depending on weather.

returns from each for a sample of farms. However, the costs outlined below can be taken as "standards" applicable to many soil situations. The value of the livestock product for each kind of livestock and for each particular farm and soil situation can then be estimated and net returns can be computed accordingly. In a later section, cost-returns comparisons are made on the basis of currently available yield and production data.

The previous soil management system differs between farms and consequently different quantities of fertilizer and lime are necessary to establish a stand and obtain a yield of forage. Costs at 1950 price levels have been worked out for five levels of fertilization and liming. These data can then be applied to individual farms depending upon the category in which they fall. Table 5 shows the (undiscounted) costs for four systems where the first, second and third represent renovation starting from bluegrass while the fourth represents improvement of bluegrass pasture by seeding lespedeza. These initial costs are greatest for the birdsfoot trefoil-orchardgrass mixture and lowest for the lespedeza.

The last column under each treatment shows the initial cost of improvement when machinery and labor costs are added. Again the costs are greatest and lowest for the mixtures mentioned above. However, the two systems (birdsfoot trefoil and lespedeza) are estimated to have a life of 20 years. Therefore the relevant 20-year costs with an initial application of 3 tons of lime and 200 pounds of 0-20-0 are \$33.86 and \$19.43 for these two systems respectively. It must be remembered that the other two systems would need to be repeated as indicated; at the end of each fifth year for the alfalfa-brome-ladino and reed canarygrass-ladino mixtures, respectively. In the same order, the 20-year (undiscounted) costs for these two mixtures (where costs include repeating of the system with longevity of less than 20 years to give a period of 20 years pasture) are \$122.36, and \$110.76 for the alfalfa-brome-ladino and reed

nomical. Many pasture mixtures and many different levels of improvement can be used; these involve different seed mixtures and different quantities of fertilizer or lime that last for different periods of years. Two types of information are needed for final decision on the one which is most economic: Information must be made available (1) on the livestock returns from the alternative systems and (2) on the costs of the different systems. While data are not yet available to cover returns from all of the different improvement systems possible, costs are calculated in the tables below for different pasture mixtures. Since the level of grass and livestock production from these mixtures and practices will vary greatly from farm to farm, no attempt has been made to estimate net

TABLE 4. RELATION OF RATE OF FERTILIZER APPLICATION TO TOTAL AND MARGINAL YIELDS OF GRASS AND BEEF, AND PROFITS UNDER DIFFERENT PRICES.

Pounds nitrogen fertilizer per acre	Yield dry bluegrass forage per acre*		Marginal (added) yield grass (lbs.)	Yield beef per acre† (lbs.)	Marginal (added) beef (lbs.)	Cost of added beef with nitrogen at 12c per lb.	Value of added beef with price of	
	(tons)	(lbs.)					10c per lb.	20c per lb.
0	0.95	1,900	—	118	—	—	—	—
10	1.07	2,140	240	133	15	1.20	1.50	3.00
20	1.16	2,330	190	144	11	1.20	1.10	2.20
30	1.25	2,490	160	154	10	1.20	1.00	2.00
40	1.32	2,640	150	163	9	1.20	0.80	1.60
50	1.38	2,750	110	170	7	1.20	0.70	1.40
60	1.40	2,800	50	174	4	1.20	0.20	0.40

* Based on a function derived to fit the 1951 fertilization data in table 11, $Y = 0.95 + 0.012F - 0.000074F^2$, where Y is bluegrass yield in tons and F is pounds of nitrogen. The marginal or added yield hence is $\frac{dY}{dF} = 0.012 - 0.000144F$. (The marginal yields in the table are computed by simple arithmetic.) Small differences between columns in table are due to rounding.

† Based on a function to fit the 1951 fertilization data with the conversion of bluegrass into beef, for a cow and calf beef herd, at the rate of 16.1 pounds of grass to 1 pound of beef. The equation (of fertilizer into beef) is $B = 118.01 + 1.49F - 0.00919F^2$ where B is beef in pounds and F is pounds of nitrogen. The marginal or added yield of beef is defined as $\frac{dB}{dF} = 1.49 - 0.01838F$.

TABLE 5. A COMPARISON OF TOTAL INITIAL OUTLAYS AND ANNUAL OUTLAYS BASED ON INITIAL OUTLAY FOR VARIOUS RATES OF LIME AND FERTILIZER APPLICATION AND FOR THREE SEED MIXTURES AND LESPEDEZA.*

Varying rates of application per acre of lime and fertilizer	Cost of lime and fertilizer	Seed mixtures: Birdsfoot trefoil-orchard-grass		Alfalfa-brome-ladino		Reed canarygrass-ladino		Phosphate and lespedeza†	
		Cost of lime, seed, fertilizer per acre	Total cost per acre including machinery and labor	Cost of lime, seed, fertilizer per acre	Total cost per acre including machinery and labor	Cost of lime, seed, fertilizer per acre	Total cost per acre including machinery and labor	Cost of lime, seed, fertilizer per acre	Total cost per acre including machinery and labor
0 tons lime	$ ——	$14.25	$23.64	$ 8.90	$18.29	$ 8.00	$15.39	$ 3.00	$ 7.13
100 lbs. 0-20-0	1.98	16.23	25.62	10.88	20.27	9.98	17.37	4.98	9.11
200 lbs. 0-20-0	3.96	18.21	27.60	12.86	22.25	11.96	19.35	6.96	11.09
300 lbs. 0-20-0	5.94	20.19	29.58	14.84	24.23	13.94	21.33	8.94	13.07
400 lbs. 0-20-0	7.92	22.17	31.56	16.82	26.21	15.92	23.31	10.92	15.05
1 ton lime	2.78	17.03	26.42	11.78	21.17	10.78	18.17	5.78	9.91
100 lbs. 0-20-0	1.98	19.01	28.40	13.66	23.05	12.66	20.05	7.76	11.89
200 lbs. 0-20-0	3.96	20.19	29.58	15.64	25.03	14.74	22.13	9.74	13.87
300 lbs. 0-20-0	5.94	22.97	32.36	17.62	27.01	16.72	24.11	11.72	15.85
400 lbs. 0-20-0	7.92	24.95	34.34	19.60	28.99	18.60	25.99	13.70	17.83
2 tons lime	5.56	19.81	29.20	14.56	23.95	13.56	20.95	8.56	12.69
100 lbs. 0-20-0	1.98	21.79	31.18	16.44	25.83	15.44	22.83	10.54	14.67
200 lbs. 0-20-0	3.96	23.77	33.16	18.42	27.81	17.52	24.91	12.52	16.65
300 lbs. 0-20-0	5.94	25.75	35.14	20.40	29.79	19.50	26.89	14.50	18.63
400 lbs. 0-20-0	7.92	27.73	37.12	22.38	32.77	21.38	28.77	16.48	20.61
3 tons lime	8.34	29.71	39.10	17.34	26.73	16.34	23.73	11.34	15.47
100 lbs. 0-20-0	1.98	22.59	31.98	19.22	28.61	18.22	25.61	13.32	17.45
200 lbs. 0-20-0	3.96	24.47	33.86	21.20	30.59	20.30	27.69	15.30	19.42
300 lbs. 0-20-0	5.94	26.55	35.94	23.18	32.57	22.28	29.67	17.28	21.41
400 lbs. 0-20-0	7.92	28.53	37.92	25.16	34.55	24.16	31.55	19.26	23.39
4 tons lime	11.12	30.51	39.90	20.12	29.51	19.12	26.51	14.12	18.25
100 lbs. 0-20-0	1.98	27.35	36.74	22.00	31.39	21.00	28.39	16.10	20.23
200 lbs. 0-20-0	3.96	29.33	38.72	23.98	33.37	23.08	30.47	18.08	22.21
300 lbs. 0-20-0	5.94	31.31	40.70	25.96	35.35	25.06	32.45	20.06	24.19
400 lbs. 0-20-0	7.92	33.29	42.68	27.94	37.33	26.94	34.33	22.04	26.17

* Certain constant seed costs and machine and labor costs have been used for all fertilization rates under each improvement system. These are respectively: $14.25 and $9.39 for birdsfoot trefoil-orchardgrass; $8.90 and $9.39 for alfalfa-brome-ladino; $8.00 and $7.39 for reed canary-ladino; $3.00 and $4.13 for phosphate and lespedeza.

† In this and later tables, this treatment is termed "phosphate and lespedeza" to emphasize that the phosphate fertilization is an important part of this renovation system. The term "lespedeza" is used in the text for the purposes of brevity. Lime is not included for this treatment since it usually is not needed in Iowa.

canarygrass-ladino systems.[7] Thus the costs per year over a 20-year period for investment in this step of renovation, i.e. excluding the fertilizer required between points of renovation, is $1.95 for birdsfoot trefoil-orchardgrass, $6.12 for the alfalfa-brome-ladino, $5.54 for red clover-reed canarygrass-ladino and $0.97 for lespedeza.

In addition to these costs which occur in the practice of seeding, fertilizer also would be required in between the years of seeding. Two hundred pounds of 0-20-0 would need to be applied at each of eight different times for the systems which include the birdsfoot trefoil and the lespedeza, the two improvement practices with an "expected" longevity of 20 years; the same quantities are estimated for the mixtures including brome and reed canarygrass with the applications of 200 pounds of 0-20-0 made at four times in addition to "re-renovations" made every 5 years.

When we add costs of this nature, i.e. the original renovation costs on line 3 of table 6, the renovation costs at the end of each system's life span on line 4 and the added fertilization costs on line 7 we obtain the total 20-year costs indicated on line 8 and the per-year costs indicated on line 9, in table 6. Lowest costs are for the complete renovation system including birdsfoot trefoil and the improvement system including lespedeza; per-year costs are greatest for the brome mixture. If we include the fertilization of bluegrass (see system E, table 6) without renovation, we obtain a per-year cost for all of the operations amounting to $4.73, a cost falling midway between the other four systems. Renting of bluegrass gives the second-low cost per acre. Of course, as will be brought out later, the yield per acre and the number of acres to produce a given amount of livestock also must be considered. Our figures in table 6 are one step in this direction. (If we were interested only in lowest costs per acre without regard to production, we would grow only weeds.)

The costs mentioned above and computed on the basis of 1949 prices are for 6 months of pasture season. Hence the per-month cost of pasture season would range from $0.49 for the lespedeza to $1.18 for the alfalfa-brome-ladino system.

TIME CONSIDERATIONS

The figures cited, putting pasture outlays on a per-year basis, do not include all cost considerations. These figures do not account for time and the fact that capital is tied up for a longer period in some of the systems than in others. In the section on principles, we indicated that time aspects of an investment must be considered through the discounting of costs and returns by the alternative income which might be earned on the same capital. If the farmer did not have an investment in pasture, he could invest his funds in other lines and, consequently, the return foregone elsewhere must be considered when a specific investment is evaluated. Hence, to account for the different periods over which investments extend under the various systems, they are discounted for time below.

Since the mixture with the greatest expected longevity extends over 20 years, we compare the cost for each system over a period extending this distant into the future; the trefoil-orchardgrass and lespedeza systems would, precluding unfavorable weather, have to be initiated only once while the reed canarygrass-ladino and alfalfa-brome systems would need to be repeated four times and the nitrogen fertilization of bluegrass would need repeating each year. Costs of renting unimproved bluegrass also would need to be paid out each year, but the cost of the 20th year of pasture under this system would not be paid out for 20 years; the biggest portion of the investment for the birdsfoot trefoil system would be paid out now to extend over 20 years.

The farmer may view the costs of pasture over a 20-year period in an entirely different manner from that outlined in the above section. While one system may have a lower per-year cost, it may not be selected because it requires a higher initial investment. As an example, suppose that one improvement system has a longevity of 20 years and a single investment of $20 to be made at the outset. (Actually the systems outlined require the addition of fertilizer within the life of a system.) The farmer can use an alternative system which costs $12 per acre and which lasts only 10 years; the total costs over 20 years are then $24 per acre. While the per-year costs of these amounts are $1.00 for the first system and $1.20 for the second system, the latter has the advantage that it does not tie up as many funds as the former.

For 100 acres of pasture, the long-lived system would require an initial outlay of $2,000 while the short-lived one would require $1,200. The money necessary to replace the short-lived system could be loaned out or used in the business to accumulate earnings over 10 years. Using the equations outlined in an earlier section and assuming the rate of return on alternative investments is 5 percent, the present discounted costs over 20 years for the second system are $\$1{,}200 + \frac{\$1{,}200}{(1.05)^{10}}$ or $\$1{,}200 + \$938 = \$2{,}138$ (i.e. $938 put away at 5 percent interest would make $1,200 available in 10 years). Under these circumstances, the long-lived system would be best since the investment of $2,000 is less than the $2,138 discounted costs over 20 years for the system which would need to be repeated in 10 years. However, if the farmer can earn 20 percent on an alternative investment in his business the present discounted

[7] These total costs for 20 years of pasture, not including fertilization and mowing costs in the interim of the life of a pasture management system, are given on lines 3 and 4 of table 6. In other words, the initial cost on line 3 would be realized but it would need to be repeated over 20 years to give the added costs indicated on line 4. Line 4 is line 3 repeated three times more for the B and C systems and 6 times more for the D system.

TABLE 6. PASTURE COSTS PER ACRE FOR DIFFERENT SYSTEMS OF PASTURE IMPROVEMENT WITH DISCOUNT RATES OF 5 AND 20 PERCENT.

Item of cost	A Birdsfoot trefoil, orchard-grass (20 years)	B Alfalfa, brome, ladino (5 years)	C Reed canarygrass, ladino (5 years)	D Phosphate and lespedeza (20 years)	E Bluegrass nitrogen fertilizer (1 year)	F Rented bluegrass pasture
1. Initial labor and machinery[a]	9.39	3.39	7.39	4.13	0.77	—
2. Initial materials[b]	24.47	21.20	20.30	15.30	3.96	—
3. Total initial[c]	33.86	30.59	27.69	19.43	4.73	3.40
4. Repeated initial at end of expected life[d]	—	91.77	83.07		89.87	64.60
5. Added labor and machine for fertilizer or partial renovation[e]	7.71	3.84	3.84	7.71	—	—
6. Added materials for fertilizer or further improvement[f]	31.68	15.60	15.60	31.68	—	—
7. Total added[g]	39.39	19.44	19.44	39.39	—	—
8. Total initial, repeated initial plus added (3 + 4 + 7)[h]	73.25	141.80	131.01	58.82	94.60	68.00
9. Total per year (8 ÷ 20 years)[i]	3.44	7.09	6.55	2.94	4.73	3.40
10. Years after which repeated initial made[j]	—	5, 10, 15	5, 10, 15	—	1 to 19 inc.	1 to 19 inc.
11. Years after which added cost made[k]	3, 6, 8, 10, 12, 14, 16, 18	3, 8, 13, 18	3, 8, 13, 18	3, 6, 8, 10, 12, 14, 16, 18	1 to 19 inc.	1 to 19 inc.
12. Discounted value of repeated initial costs[l]						
(a) at 5 percent	—	57.47	51.92	—	61.90	44.50
(b) at 20 percent	—	19.22	17.37	—	27.64	19.87
13. Discount value of additional fertilization[m]						
(a) at 5 percent	23.79	12.15	12.23	23.79	—	—
(b) at 20 percent	7.82	4.57	4.64	7.82	—	—
14. Sum of discounted value of repeated and additional costs (12 + 13)[n]						
(a) at 5 percent	23.79	69.56	64.15	23.79	61.90	44.50
(b) at 20 percent	7.82	23.79	22.01	7.82	27.64	19.87
15. Sum of initial costs, discounted repeated costs and discounted additional costs (3 + 14)						
(a) at 5 percent	62.86	101.14	91.84	43.22	61.90	46.40
(b) at 20 percent	46.89	54.38	—	27.25	27.64	23.20
16. Present cost per year of 20 pasture years in the future[o]						
(a) at 5 percent	3.10	5.57	4.59	2.16	3.10	2.32
(b) at 20 percent	2.34	2.38	2.49	1.36	1.38	1.16

[a] Includes all machine, power and expense labor.

[b] Includes fertilizer, seed and lime with lime at 3 tons per acre and fertilizer (0-20-0) at 200 pounds for the A, B, C and D systems and 150 pounds of 33-0-0 for the E system (bluegrass would be fertilized every year).

[c] Sum of lines 1 and 2.

[d] The initial investment repeated at the end of the years indicated on line 10 for systems with longevity of less than 20 years.

[e] Labor and machine costs of applying fertilizer within life span for each system (for end of years indicated on line 11). Two hundred pounds of 0-20-0 were used at each of these points of time indicated for A, B and C; D and E include 200 pounds of 0-20-0 at the end of the years indicated on line 11; F includes cost of clipping each year; fertilizer costs annually are indicated in line 4.

[f] See footnote e (footnote f is materials applied under e).

[g] Sum of lines 6 and 7.

[h] Is the sum of the initial cost, this initial cost repeated at the end of the years indicated on line 10 (for systems with less than 20 years) and the renovation costs mentioned under footnotes e and f at the times (years from beginning) mentioned on line 11.

[i] Sum of line 8 divided by 20 years.

[j] Indicates the years at the end of which the original renovation would need repeating. (This is every year for fertilization of bluegrass).

[k] Indicates the years at the end of which fertilizer would be added or clippping would be done within a system.

[l] Value of repeated investments (at times indicated on line 10 for the amount shown on line 3) discounted back to present supposing that interest rate or alternative earnings rate is that indicated.

[m] Same as footnote 1 for renovation costs within a cycle of each system.

[n] Sum of lines 12 and 13.

[o] Line 15 (sum of lines 3 and 14) divided by 20 years to give annual cost.

cost of the short-lived system is $\$1{,}200 + \frac{\$1{,}200}{(1.20)^{10}}$ or $\$1{,}200 + \$451 = \$1{,}651$ which is less than the $2,000 for the long-lived system.

Since the several systems of improvement require different amounts of investment at the outset—i.e. the birdsfoot trefoil requires more funds in the first year (line 3 of table 6) than any other mixture although it has a lower total (line 8) than three of the other systems—and require varying amounts of funds at varying times over a 20-year period, discounted costs may rank differently than the "absolute costs" (lines 8 and 9 of table 6). To include these time aspects of pasture costs, lines 12 through 15 have been computed in table 6. Line 12 shows the discounted value of the "repeated" investment for those systems with an expected longevity of less than 20 years; line 13 includes the discounted value of the fertilization costs and clipping which are in addition to the fertilizer, seed, machine and labor costs made at the time of establishing seedings. (Bluegrass fertilization and clipping would need repeating in each of the following 19 years.) The reseeding costs (equal to those on line 3) have been discounted for the periods shown on line 10; the added fertilization costs have been discounted for the periods shown on line 11. The discounted annual costs, at the outset of a future 20-year period, thus become those indicated in line 16. With a 5-percent interest rate, the discounted costs are still lowest for lespedeza and the fertilization of bluegrass falls close as the next-low system, i.e. line 16 as compared to line 9. With a 20-percent discount rate, bluegrass fertilization has about the same cost as improvement by seeding lespedeza, and rented (unimproved) bluegrass has the lowest cost. The other systems don't fall relatively so low because either (1) they require investments which must be carried many years over time or (2) the total of costs over time are so large.

The difference between systems is much less where future costs are discounted to allow for the fact that lower present investments under some methods would allow these same funds to be loaned at interest or used elsewhere in the farm business. Again the difference between the figures on line 9 and those on 16a and 16b is this: Line 9 shows the estimated costs per acre per year which would actually be paid out in getting 20 years of pasture under the different systems. Lines 16a and 16b show what costs would be, looking ahead over 20 years, when we "in effect" deduct the returns which might be had elsewhere on the funds required for these systems; we consider that not all of the funds required for some systems would be invested in pasture at the present but part could be made in the future, with the "future costs" currently invested at 5 and 20 percent respectively.

These figures are important since they provide the equivalent of the figuring (although not in exactly the same fashion) which the farmer with limited capital must use if he is interested in maximum returns for his business as a whole rather than in a single line such as pasture. In line 9 we see that bluegrass improvement (nitrogen fertilization) costs roughly twice as much per acre per year as lespedeza. When discounting is included, however, a farmer who could earn 5 percent on funds invested elsewhere would find (line 16a) bluegrass renovation to be nearly the same. If the farmer is so limited on capital, however, that he can earn 20 percent within the business, i.e. for funds invested in machinery, protein feed, livestock, etc., he will find that this "alternative costs" calculation (line 16b) causes bluegrass renovation to be no more costly than the lespedeza system and rented pasture to be less costly for each acre.

COSTS OF RENTING PASTURE

Many farmers have opportunities for increasing their pasture supply by purchasing additional bluegrass pasture land or by renting additional pasture. More than 50 percent of the farmers interviewed in the 1951 survey said that pastures were available for renting in their communities. Where this alternative exists some farmers may, depending on their capital position, find this to be the most economical way to increase their forage supply. Since pasture rental involves a small present outlay, discounted costs per acre can be lower than for pasture improvement systems, depending on the discount rate and the costs involved. On the basis of data collected from the 1951 sample in southern Iowa, the average rental rates in the area at that time were $3.60 per acre annually or $2.00 per head of mature cattle per month for unimproved bluegrass pasture.

These per-acre costs may be compared with the costs per acre for alternative improvement systems in table 6. Using a per-acre rental rate of $3.40 to more nearly conform with 1950 price levels, costs have been computed for pasture rental in table 6. These figures can be used to compare this system of feed supply with the improvement systems already enumerated. The annual rental cost corresponds to the total initial costs on line 3 of table 6. Since these costs are repeated each year, the repeated initial costs for the 20-year period (line 4) would be $64.60. Assuming that any added labor, machinery or fertilizer expenses would be borne by the landlord, there would be no added expenses corresponding to lines 5, 6 and 7 of table 6. Thus the total cost (line 8) would be $68, and total undiscounted costs per year (line 9) would be $3.40, lower than the annual costs for each of the renovation systems except lespedeza. When time aspects are considered and costs are discounted at 5 percent, the discounted costs for the 20-year period (line 15) amount to $46.40 and the present cost per year (line 16) amounts to $2.32. For a farmer with limited capital and opportunities for earning

20 percent on alternative investments on his farm, the discounted costs are $23.20 for the entire 20-year period and only $1.16 on a per-year basis.

When we consider that the systems requiring large present capital outlays may involve greater risks, i.e. in losing the entire amount expended for seeding if weather is unfavorable, and relate these to discounted costs, we can see how farmers may be entirely rational in their selection of pasture management systems even if they do not select the one with the greatest physical yield per acre.

There are, of course, certain limitations in the use of rented pasture. While about one-half the farmers interviewed said that they could rent pasture, not all of them could do so if they all actually went into the rental market at the same time (or, they could do so only at a higher rental cost than existed at the time). Rental also has these disadvantages: (1) It is usually further from home requiring added time for inspection of stock. (2) Difficulty with sires may exist where other persons stock are run in the same pasture. (3) Greater effort is needed to provide water and salt and in care of fences. Of course, some rented bluegrass pastures are just as productive and "safe" as those used by the owner.

TABLE 7. YIELDS FROM PASTURES IN SOUTHERN IOWA WITH VARIOUS IMPROVEMENT PRACTICES.

Kind of pasture	Yield of dry forage (tons per acre)			Animal gains (pounds per acre)
Albia, Iowa, 1951-52*	1951	1952		1951-52 average†
Unimproved bluegrass	—	—		104
Improved by renovation				
Ky. bluegrass-trefoil	—	—		291
Bromegrass-trefoil	—	—		271
Bromegrass-alfalfa-ladino	—	—		334
Beaconsfield, Iowa, 1951-52‡	1951	1952		1951-52 average§
Unimproved bluegrass	1.26	1.69		121
Improved with phosphate and lespedeza	1.60	1.78		174
Improved by renovation grass-legume mixture	3.25	2.54		301
Albia, Iowa, 1945-51**	1945	1950	1951	
Unimproved bluegrass	0.67	0.56	0.95	
Improved with:				
40 pounds N	1.13††	0.99	1.32	
60 pounds N	1.22	0.84	1.40	
30 pounds N fall, 30 pounds N spring	1.21			

* Average yield of two pastures of each treatment for 1951 and 1952 pasture seasons, Albia, Iowa.

† Hereford steers.

‡ Pasture improved by renovation received lime, a total of 100 pounds P_2O_5 in two applications, a mixture of two grasses and three legumes; other improved pasture received a total of 100 pounds P_2O_5 and a seeding of Iowa 6 lespedeza, but no land preparation. Clippings computed to 12 percent moisture (weed free).

§ Gains of Hereford cows plus their calves.

** Clippings computed to 12 percent moisture.

†† Estimated from exponential yield function.

COSTS IN PRODUCING A GIVEN INCOME

Costs represent only one side of business decisions; production and income must also be considered. While unimproved bluegrass pasture has the lowest per-year and per-acre costs discounted to the present, will it also allow the lowest costs for producing a given amount of livestock product or income? While it has a lower discounted cost per acre, it also has a lower carrying capacity per acre as is suggested in the Iowa experimental data of table 7.

The use of nitrogen fertilizer on bluegrass also gives fairly low discounted costs per acre. However, the response for nitrogen alone and the total yield has not been high. Nitrogen alone has increased yields from 40 percent to 80 percent but the increases have come in the period when surpluses already exist. In Iowa, experiments where nitrogen has been added without mineral fertilizers, on acid soils, deficient in phosphorus, 1 pound of nitrogen has produced about 20 pounds of dry bluegrass clippings. It requires about 15 pounds of these clippings to produce a pound of beef with yearling steers. It has been estimated[8] that from 30 to 50 pounds extra dry weight of forage can be produced on pastures from each extra pound of nitrogen up to at least 100 pounds in the northern states, if one starts with a soil in good physical state and in a reasonably good state of fertility.

Nitrogen usually enhances the feeding value of feeds by increasing the protein content in addition to producing higher yields. Calculating from "Feeds and Feeding" by Morrison, and starting with a 700-pound steer and assuming a daily gain of 1.8 pounds for a period of 167 days (total gain 300 pounds) and an average daily requirement of 14.7 pounds of total digestible nutrients (TDN), 2.39 tons of bluegrass clippings (12 percent moisture) would be required. This assumes 18.6 percent TDN and 31.8 percent dry matter in average green Kentucky bluegrass (from Morrison). With the average of unimproved bluegrass pasture at Albia yielding 0.73 ton of clippings, it would require 3.3 acres to supply the feed for the above steer. It is recognized, however, that bluegrass pastures do not supply nutrients at a uniform rate through the grazing season.

Using the data available on beef gains and pasture yields, we have prepared the estimates of table 8 to show the relative costs of different pasture systems open to the farm when yield and production are considered. The five systems shown are those from table 6 with the exclusion of reed canarygrass and ladino clover. Figures are for only one kind of livestock production; namely, gains from beef cows and calves. Other types of livestock might produce either more or less salable product per acre. However, the system which gives the lowest cost per acre for a given gain of beef in table 8 would generally also give the lowest cost for a given production of other livestock. The figures show the estimated number of acres which, as an average over a number of years, would produce 1,000 pounds of beef per year (20,000 pounds in 20 years). (These quantities are estimated from the data of table 7 and other experimental information.) Over 8 acres would

[8] Bear, Firman E. Looking ahead to nineteen fifty three. N. J. Agr. Exp. Sta. Victory Farm Forum. December 1952.

TABLE 8. GROSS INCOME, COSTS AND "NET INCOME ABOVE SEED AND IMPROVEMENT MATERIALS COSTS" IN PRODUCING 1,000 POUNDS OF BEEF PER YEAR FROM COW-CALF HERD.

Item	Birdsfoot trefoil, orchardgrass	Alfalfa, brome, ladino	Phosphate and lespedeza improvement on bluegrass	Bluegrass fertilized with nitrogen	Bluegrass rented (unimproved)
1. Acres to produce 1,000 pounds beef*	3.2	2.6	5.1	5.9	8.3
2. Income in 20 years with:†					
(a) Beef at 12c	$2,400	$2,400	$2,400	$2,400	$2,400
(b) Beef at 18c	3,600	3,600	3,600	3,600	3,600
3. Total non-discounted costs in 20 years‡	251.07	368.68	335.27	568.14	564.40
4. Total discounted costs in 20 years with discount rate of:§					
(a) 5 percent	201.15	262.96	246.35	365.21	370.15
(b) 20 percent	150.05	141.59	155.33	163.07	164.92
5. Non-discounted net income in 20 years with price of:**					
(a) Beef at 12c	2,149	2,031	2,065	1,832	1,836
(b) Beef at 18c	3,349	3,231	3,265	3,032	3,015
6. Discounted net income on acres in line 1 in 20 years with:††					
(a) 5 percent discount					
(1) Beef at 12c	1,369	1,307	1,324	1,205	1,200
(2) Beef at 18c	2,154	2,092	2,109	1,960	1,985
(b) 20 percent discount					
(1) Beef at 12c	551	559	556	538	536
(2) Beef at 18c	902	910	897	889	887
7. Discounted net income per acre in 20 years with:††					
(a) 5 percent discount					
(1) Beef at 12c	428	503	232	204	145
(2) Beef at 18c	673	805	370	332	239
(b) 20 percent discount					
(1) Beef at 12c	172	215	98	91	65
(2) Beef at 18c	282	350	157	151	107

* Number acres estimated to produce 1,000 pounds of beef from cow and calf herd.

† Total of 20,000 pounds beef in 20 years multiplied by price indicated. These acreages have been estimated on this basis: (1) Unimproved bluegrass is assumed to give the yields shown at Beaconsfield in 1951-52. (2) Orchardgrass and trefoil are assumed to give yields as high as trefoil and bluegrass in table 7, with a percentage increase over unimproved bluegrass as great for beef cows and calves as for steers in table 7. (3) Alfalfa-brome-ladino is assumed to give percentage increases over unimproved bluegrass as great for beef cows and calves as for steers in table 7. (4) Lespedeza is assumed the same as shown for beef cows in table 7. (5) Fertilized bluegrass with 50 pounds of nitrogen is assumed to be the same as for 1952 in table 7, based on the function of table 4 (which gives the 1952 figures in table 7).

‡ From table 6, line 8, multiplied by acres in line 1 of this table; costs are not discounted.

§ Figures from table 6, line 15, multiplied by number acres in line 1 of this table.

** Sum of non-discounted income less sum of non-discounted costs (lines 2a and 2b minus line 3).

†† Is discounted value of income all 20 years after costs of particular year have been substracted from income of particular year. Is not income per acre per year.

be required for unimproved bluegrass pasture which might be rented as one alternative in obtaining feed from pasture; only 2.6 acres would be required for an alfalfa-brome-ladino mixture.

Line 3 shows the total improvement cost over 20 years in producing 1,000 pounds of beef per year (20,000 pounds in 20 years) for the five systems. Because of the greater acreage required, the two bluegrass systems would require the much greater cost outlay, even though the cost per acre is considerably less than for some of the other systems. But again when costs are discounted, to account for the length of time funds are tied up in the different systems and for the returns that can be made from other investments, the bluegrass systems become much more favorable. This is true since under fertilization or renting of bluegrass, only a small amount is invested at the present; improvement or expenditure made for pasture in the 20th year will be made only at the end of the 19th year, or throughout the 20th year for renting. In contrast, part of the large initial outlay for the birdsfoot trefoil-orchardgrass mixture would be tied up for 20 years and could not be invested elsewhere to earn income. (The discounting system, in a sense, reduces the cost by the amount any "funds saved from pasture improvement" would earn elsewhere.) With discounting at 20 percent, fertilization of bluegrass gives present cost values nearly as low as for lespedeza and nearly as low as for trefoil. The gap between rented, unimproved pasture and trefoil is only $15 under a 20-percent rate while it is $313 before costs are discounted.

Net income, without discounting, above improvement costs, i.e. nothing has been subtracted for labor, taxes, cattle costs and other expenses, is greatest before discounting for the trefoil improvement system and smallest for the bluegrass pasture alternatives. With discounting at 5 percent, the difference is partly eliminated; with discounting at 20 percent and beef at 18 cents, bluegrass fertilization gives practically the same net return in producing 1,000 pounds of beef per year as the trefoil system; renting of bluegrass has an income only $10 less than for trefoil while the alfalfa-brome-ladino system gives, by a slight amount, the highest net return. These data show that for a high discount rate, returns in producing a given amount of livestock are quite similar for the several systems. The farmer could hardly be termed "irrational" for selecting lespedeza or birdsfoot trefoil over alfalfa-brome even though the latter may yield more forage per acre and require fewer acres to produce 1,000 pounds of livestock product. The time and capital considerations brought in through discounting can even cause the bluegrass systems to be equally attractive with the others, even though they give much lower yields per acre.

But even though one system gives the lowest cost for a given amount of production or income when expenses are discounted back to the present, farmers selecting a source of pasture feed also need to consider the capital outlay and the risks involved. The figures below show the amount necessary to invest in land and improvement, with land at $50 per acre, to produce the 1,000 pounds of beef per year shown in table 8A.[9] The first column shows the investment necessary in case seedings could be established immediately with no loss. The initial investment to produce 1,000 pounds of beef is greatest for unimproved bluegrass operated by an owner; it is smallest for unimproved bluegrass rented by the operator. While an owner would have the lowest investment with the alfalfa-brome-ladino system, a man very short on capital who wished to produce more livestock might want to rent unimproved bluegrass, if he could find a dependable pasture, so that he could invest more in livestock to consume it.

Since the risk of a seeding failure is one hazard facing the farmers, the second column below has been prepared to show the investment after one complete failure and a repetition of the improvement.[10] When the costs for one seeding failure is added, the lespedeza system requires the greatest investment, even though it has low per-acre costs in table 6 and moderate costs for producing 1,000 pounds of beef in table 8. Renting of unimproved bluegrass still allows the lowest investment, although it does not have the lowest per-acre costs in table 6 or the lowest costs for 1,000 pounds of beef in table 8. The farmer must balance the cost side against the investment side. If he has unlimited capital, he should select the system which gives the lowest cost for a stated amount of production. If his funds are limited, however, a big investment which gives lowest costs may not leave any capital to buy livestock to use the pasture. He will need to select a system which has greater costs but requires a lower initial investment and leaves some funds for purchasing livestock. A system such as lespedeza (along with bluegrass fertilization, mowing or renting) has one risk advantage in the sense that the land need not be "plowed clean"; a failure in 1 year may leave some bluegrass for pasture in the next year.

The figures of table 9 have been prepared to show the net return to labor in producing 1,000 pounds of beef when the five pasture systems of table 8 are used. In this case, costs include winter feed, building and fence charges, breeding fees, taxes and all other items. Incomes are shown both before and after they are discounted. The resulting figures indicate the return to a farmer for his labor after paying all other expenses in producing 1,000 pounds of beef per year. Costs are at 1950 levels. The incomes extend over 20 years. For example, under the lespedeza improvement, the farmer would produce 20,000 pounds of beef in 20 years and, with beef at 12 cents and discounting at 5 percent, would have $163 for the labor required in 20 years.

Without discounting returns and costs back to the present, calculated net returns to labor are highest for brome-alfalfa and birdsfoot trefoil (line 7). Rented bluegrass has medium returns while fertilized bluegrass and lespedeza give slightly lower returns (lines 7a and 7b). With discounting at 5 percent, rented bluegrass gives the greatest discounted net income to labor while alfalfa-brome is second and birdsfoot trefoil is third; lespedeza and fertilized bluegrass give nearly the same returns. With discounting at 20 percent, rented unimproved bluegrass gives the highest labor return while brome-alfalfa again is second, trefoil is third and lespedeza and fertilized bluegrass, in fourth and fifth places respectively, again are nearly equal. Aside from brome-alfalfa, the farmer might be indifferent as to which one of the other four systems he selects, if he has limited capital and must discount future costs and returns at a high rate.

[9] The investment is the $50 land value per acre plus the total initial improvement cost on line 3 of table 6 multiplied by the number of acres shown in table 8. (For unimproved bluegrass which is owned, it is the value of 8.3 acres only; for renting it is 8.3 acres multiplied by the $3.40 rental rate.)

[10] The figures in column 2 are those from column 1 plus the figure on line 3 of table 6 with lime costs subtracted, except for the owning of unimproved bluegrass. Here we suppose that the land would simply be available in the next year. Under renting, 2 years rent would be necessary before income is realized.

TABLE 8A.

System	Cost of land and improvement or rental with no failure	Cost of land and improvement or rental at end of second year with complete failure in first year
1. Trefoil-orchardgrass	$285	$373
2. Alfalfa-brome-ladino	230	277
3. Phosphate and lespedeza	396	459
4. Bluegrass fertilized	323	351
5. Bluegrass rented (unimproved)	28	56
6. Bluegrass owned (unimproved)	415	415

COSTS OF CLEARING TREES AND BRUSH AND RETURNS FROM POST AND LUMBER

Improvement of a large area of pasture in southern Iowa can be accomplished only if the land is cleared of brush and trees. In some cases, the clearing operations provide merchantable lumber which helps to defray the costs. Information on cost of clearing was obtained from contractors in the area who perform clearing and dirt-moving services. An initial mail questionnaire was sent to a complete list of contractors in the 10-county

TABLE 9. NET DISCOUNTED RETURN OVER 20 YEARS TO LABOR UNDER TWO PRICE LEVELS FOR BEEF AND TWO DISCOUNT RATES. (ALL INCOME AND COST ITEMS FOR 1,000 POUNDS OF BEEF PER YEAR AND NUMBER OF ACRES REQUIRED TO PRODUCE IT.)

Item	Birdsfoot trefoil, orchardgrass	Alfalfa, brome, ladino	Phosphate and lespedeza	Bluegrass, nitrogen fertilized	Bluegrass, rented
1. Number of acres	3.2	2.6	5.7	5.9	8.3
2. Non-discounted value of beef in 20 years with:					
(a) Beef at 12c	$2,400	$2,400	$2,400	$2,400	$2,400
(b) Beef at 18c	3,600	3,600	3,600	3,600	3,600
3. Discounted value of beef in 20 years:					
(a) 5 percent discount					
(1) Beef at 12c	1,570	1,570	1,570	1,570	1,570
(2) Beef at 18c	2,355	2,355	2,355	2,355	2,355
(b) 20 percent discount					
(1) Beef at 12c	701	701	701	701	701
(2) Beef at 18c	1,052	1,052	1,052	1,052	1,052
4. Non-discounted value of all costs but labor for 20 years	2,120	2,100	2,160	2,160	2,155
5. Discounted value of all costs but labor for 20 years:					
(a) 5 percent discount	1,385	1,376	1,407	1,410	1,356
(b) 20 percent discount	618	614	628	630	605
6. Discounted net return to labor:					
(a) 5 percent discount					
(1) Beef at 12c	185	194	163	160	214
(2) Beef at 18c	970	979	948	945	999
(b) 20 percent discount					
(1) Beef at 12c	83	87	73	71	96
(2) Beef at 18c	434	438	424	422	447
7. Non-discounted net return to labor in 20 years:					
(a) Beef at 12c	280	300	240	240	245
(b) Beef at 18c	1,480	1,500	1,440	1,440	1,445

area. A repeat questionnaire was sent to the non-respondents. The total number of respondents for the two mail surveys was 14. A field survey was then made of a sample of the remaining non-respondents: The two samples were then weighted in terms of their composition (in number) in the total population of contractors. The data from the total of 30 completed questionnaires were then used to give the figures in table 10. Income from merchantable timber may be available in some areas and the return will depend on the market available. Other alternatives also exist for the clearing operation itself. If the operator owns the proper equipment or can rent it, he can cut the costs at least by one-half if he need not charge for his labor. Also, spraying with chemicals can be done successfully on pastures where brush alone is concerned and the density is not too great; clearing also may be required if brush is very dense.

TABLE 10. COSTS PER ACRE FOR CLEARING LAND, SOUTHERN IOWA, 1951. RETURNS FROM LUMBER SALES AT SPECIFIED PRICES.

Tree or brush density	Cost per acre when diameter of tree in inches is		
	less than 6	6 to 9.9	10 to 14.9
Tree numbers per acre			
6	$ 6.32	$ 9.50	$ 17.20
25	21.33	31.93	59.40
50	43.92	66.71	116.30
75	68.24	100.38	180.79
100	90.68	140.85	244.61
Brush density			
light	25.75		
medium	39.59		
heavy	55.00		
Tree density	less than 6	6 to 9.9	10 to 14.9
Amount of each material in a given sized tree	1.5 posts*	3.5 posts*	100 Bd. ft. lumber†
6	$ 2.70	$ 6.30	$ 12.00
25	11.25	26.25	50.00
50	22.50	52.50	100.00
75	33.75	78.75	150.00
100	45.00	105.00	200.00

* Posts valued at 30 cents each.

† Lumber valued at $20.00 a thousand board feet.

One decision the farmer must make if he has land with tree cover which can also be used for pasture is this: Should I clear the land and put it into pasture or should I apply improved woodlot management and produce merchantable timber over a long time period? Ordinarily, a good stand of timber which is already near the production stage or will be so in 5 to 10 years will give greatest returns if it is managed as a forestry enterprise. Considering clearing costs and future returns, the operator with this opportunity usually can buy more land for pasture at a cost lower than the cost of clearing a dense tree growth; he then may have returns from both the forest enterprise and the pasture enterprise.

To determine whether a given tract will give a greater return over time if in pasture or a woodlot, in the sense of present values of incomes in the future, the discounting procedures of the previous section should be used. The present investment and future costs should be estimated for the forestry enterprise. Then the amount and the time of returns should be determined. Costs and income should then be discounted back to the present by the appropriate discount rate. Next, the future costs of putting the same land into pasture should be determined and after production and income of the future is estimated, these quantities can also be discounted back to the present; the present values of future incomes under the two alternatives can then be compared. Starting from a new or young wooded area, forestry is usually at a disadvantage with pasture or other crops which begin giving even a small return at the present; returns from trees come so far into the future that even with a 5-percent discounting rate, the present values of future incomes is relatively low. On the other hand, a wooded area which currently is or will soon come into production under improved management might well be left as a permanent woodlot enterprise. If land were to be cleared to allow establishment and improvement of pasture, however, the returns indicated in table 10 are those estimated for 1951 prices.

RETURNS FROM GRAIN IN COMPLETE RENOVATION

Since complete renovation of bluegrass generally necessitates plowing the ground, the process of pasture improvement provides the alternative of harvesting a corn crop in the year before the seeding is established. Corn yields often are quite high on pasture land broken out in this manner, especially if the land has been in pasture for a long period of time and manure has been dropped by animals fed grain or hay from other fields or in the feed lot. While high yields may be obtained with no fertilization under this condition, the use of commercial fertilizer may be desirable for plowed pasture land which has had a poor stand of grass or has been devoted mainly to weeds. On well-established pasture land which is plowed, erosion often is not a problem, if the land is planted to corn for a single year before establishment of the seeding, because of the large amount of organic matter accumulated on pasture over several years.

The possibility of a corn crop, the returns of which can be used to defray part or all of the initial pasture improvement investment, causes complete renovation systems, such as those outlined in table 6, to have a relative advantage as compared to improvement including bluegrass fertilization or lespedeza. Using typical costs for corn and a yield of 40 bushels per acre, we get the results in table 11. Here we see that after credit has been allowed for a 40-bushel corn crop, an amount easily attained on most permanent pastures, the first and second systems have net initial costs (investments for fertilizer or repeating the renovation in later years is not included) of $11.05 and $2.57 respectively while the third has a net credit over the initial cost of $0.33. The costs for the two improvement systems not renovated are the same as the initial investment in improvement since no corn crop is realized.

These figures may differ between farms where different yields are obtained for corn and where cash costs may or may not attach to the labor inputs. Many permanent pastures will yield 50 to 60 bushels of corn per acre; with yields this high under present price levels, all of the complete renovation systems will return more for a year of corn that is required for the first outlay in initially establishing the seeding. Also, with present prices and costs, the oat crop used as a nurse crop with the seeding will net $5 to $10 per acre on most soils in the area, but to help guarantee a seeding catch, it should be clipped or grazed. For mixtures such as the brome-alfalfa and others which have a short longevity, corn may be planted once in every 5 or 6 years. These returns must then be related to the costs such as those outlined in table 6. The additional returns from corn in the short-lived pasture system can give them the advantage over more permanent systems on many farms.

TABLE 11. COSTS PER ACRE OF INITIAL PASTURE IMPROVEMENT WHEN THE VALUE OF A SINGLE CORN CROP IS CREDITED TO THE RENOVATION PROCESS.

Item of cost	Birdsfoot trefoil, orchard-grass	Alfalfa, brome, ladino	Reed canary-grass, ladino	Phosphate and lespedeza	Blue-grass fertili-zation
1. Initial cost of renovation (line 3 of table 6)	39.07	30.59	27.69	19.43	8.96
2. Machine and material costs for corn	13.47	13.47	13.47	—	—
3. Labor costs for corn	8.51	8.51	8.51	—	—
4. Total costs for corn	21.98	21.98	21.98	—	—
5. Total costs for renovation and corn crop*	61.05	52.57	49.67	—	—
6. Credit from 40 bushels of corn at $1.25	50.00	50.00	50.00	—	—
7. Cost or return per acre after corn credit†	—11.05	—2.57	+0.33	—19.43	—8.96

* Sum of costs shown on lines 1 and 4. Corn costs do not include fertilizer.

† Minus sign indicates amount by which costs on line 5 exceed credit on line 6; positive sign indicates amount by which credits on line 6 exceed costs on line 5.

FARMER ADJUSTMENTS AND ATTITUDES IN USE OF PASTURE

This section deals with the pattern of use of pasture by the sample of southern Iowa farmers; it also includes a summary of their attitudes in the use of pasture. Information of the forces in the mind of the farmer which determine his use of pasture is important in gearing education to the conditions of each individual decision-making unit. The data which follow are based on the area samples explained earlier for the southern Iowa area.

SEASONAL VARIATIONS IN PRODUCTION

Production from each type of pasture varies considerably from month to month. Yields are highest in the spring and fall with the low production coming in July and August and with some recovery in the fall.

These are some of the ways in which a farmer may adjust to seasonal pasture production: (1) He may plan his livestock program on the basis of the expected average production for the year. He can put up hay or grass silage in the months of high production and feed this surplus in the months when pasture is deficient. (2) He may carry just enough livestock so that he can expect adequate pasture in the periods of lowest pasture production. Thus he will have more than enough pasture in the best months, and this excess will go unused in some cases. Usually, however, some of the excess growth in the early part of the season can be allowed to accumulate and be consumed later during the midsummer period when the herbage is more or less dormant and very little actual growth is being made. (3) He may provide supplemental pasture during the periods of poor yields. For example, he may plant sudangrass, rape or similar pastures which give good yields during the periods when other pastures are at their lowest yields. Or he may turn the livestock out on fields from which a crop of hay has been taken earlier. Also, after the nurse crop has been harvested, livestock may be turned out on stubble to graze on new seedings. (4) He may maintain production in the face of a seasonal decline in pasture supply by feeding more grain or harvested hay. (5) Livestock production may be allowed to vary with pasture yields. Thus milk cows may be permitted to decline in milk production and beef cattle allowed to lose weight during the periods of low pasture production. (6) Livestock may be bought and sold during the season to fit pasture production.

Farmers in the southern pasture area of Iowa who were asked how they adjusted their livestock program to the seasonal variability of pasture yields gave responses as shown in table 12. The majority of these farmers (75 percent) indicated that their livestock programs were based on what they expected pasture production to be during the seasonal low production period, with perhaps some dormant herbage carried over from the lush growing months to times when growth has more or less stopped. Thus for most farmers the *effective* supply, the amount significant in determining the value of pasture, was based on the yields in the lowest production period of the summer plus whatever "dormant" growth can be carried over to this period.

Several farmers (13 percent) indicated that they attempted to level out the pasture supply by making hay or silage in the "lush" months and feeding it in the poorer months. This practice may be more common in other areas where more of the pastures are rotation pastures. Inasmuch as nearly all pastures in the area studied were permanent pastures, and largely bluegrass, one would expect this practice to be used very little; the nature of bluegrass growth and the poor

TABLE 12. ADJUSTMENTS MADE BY SOUTHERN IOWA FARMERS TO SEASONAL VARIATIONS IN PASTURE PRODUCTION.

Type of adjustment made to seasonal variation	Farmers who said this most nearly described the manner in which they took variation into account	
	Number	Percent
(a) Plan livestock program on the basis of average annual production. Carry over hay or silage from best months for feed in poor months.	16	13
(b) Carry just enough livestock that pasture is adequate in lowest production period. Surplus pasture in good months unused or dormant herbage grazed in dry months.	86	73
(c) Provide supplementary pasture for periods of low production.	8	7
(d) Substitute grain for pasture in periods of lowest pasture output.	8	7
(e) Let livestock production drop with decline in pasture output.	0	0
(f) Buy and sell livestock to fit pasture.	0	0

quality of bluegrass hay or silage ordinarily make it impractical to carry forward the surplus production of the spring months for summer feeding. Only a very few farmers (7 percent) indicated that they adjust to the seasonal variation in pasture yields by providing supplementary pastures. In this area, one explanation why pasturing the second crop meadow is not popular is that the hay is needed for winter forage feeding. Another 7 percent of the farmers indicated that they stepped up their grain feeding in the periods of low pasture yields and thereby maintained production through the periods of low pasture supply.

None of the farmers interviewed indicated that the system which they used in adjusting to seasonal yield variations was that of allowing feed intake and livestock production to drop in periods of low production. This does not mean, of course, that this practice was not followed occasionally. Several farmers indicated that, frequently, feed is inadequate for short periods and their livestock lose weight or reduce production. But apparently few farmers consciously planned to meet the seasonal declines in yield in this way.

ADJUSTING SEASONAL PRODUCTION TO NEEDS

Solving pasture problems involves considerable planning; no one type of pasture can support a high level of livestock production throughout the grazing season. The forage available for grazing is constantly changing in quantity and in feeding value. The proper combination of permanent, rotation and temporary pasture, makes possible adequate pasturage throughout most seasons. The farmer can, however, make important adjustments in his pasture program to help even out the production of forage over the season. Figure 3, with estimates based on experimental data, is an attempt to show graphically how pastures vary in

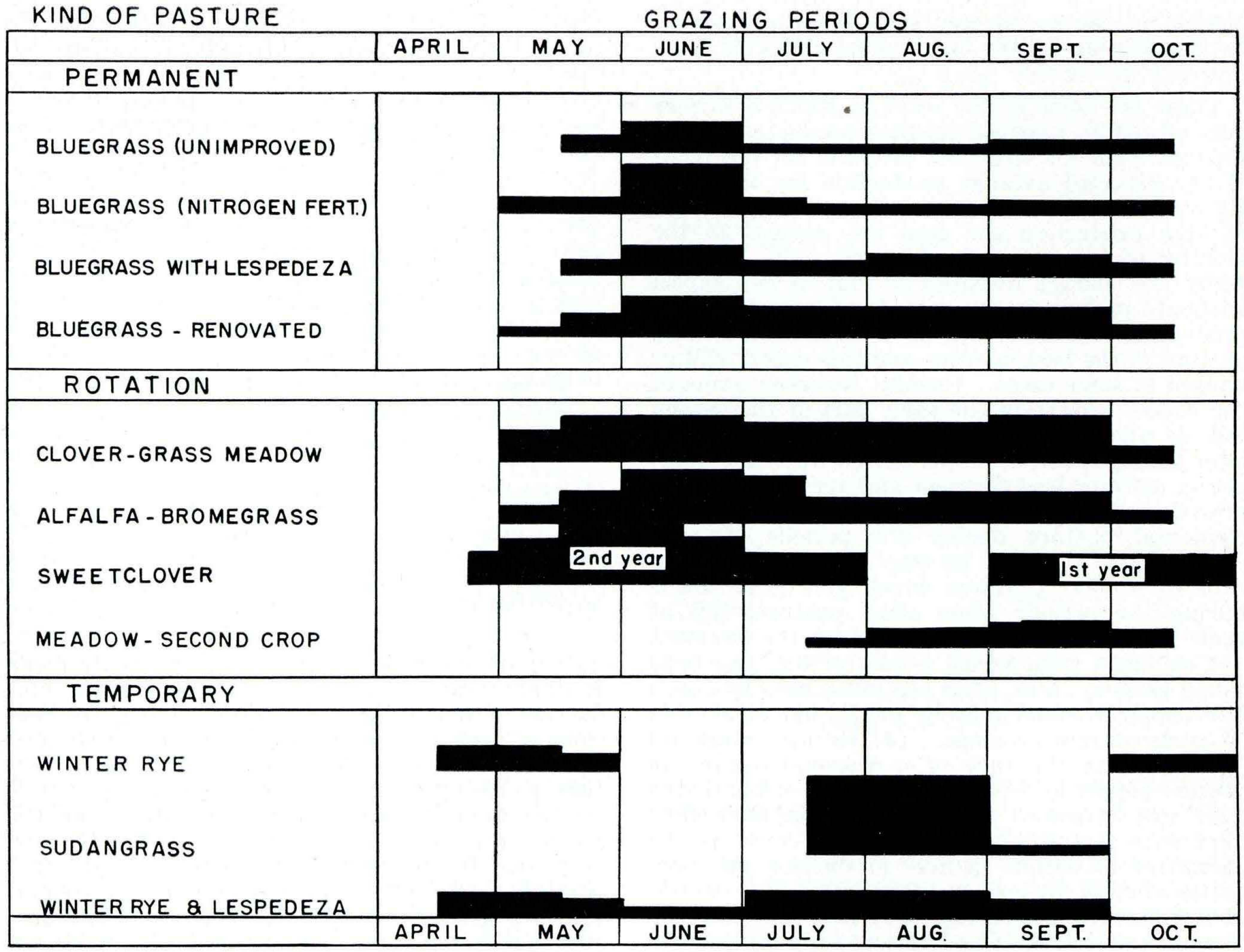

Fig. 3. A pasture calendar for Iowa.

quantity of feed produced and the seasonal distribution of this growth. Estimated carrying capacities are shown for some permanent, rotation and temporary pastures. It shows the high and low points of production characteristics of permanent pastures and indicates the need for supplementing livestock on the midsummer permanent pasture. To provide the proper distribution of feed throughout the year, it is highly desirable to provide temporary midsummer pasturage and/or to feed the surpluses which should be preserved as hay or silage.

The fact that farmers usually stock, at any time, only as much livestock as they would expect their pastures to carry in the poorest months, means poor utilization of pasturage. Even though early summer surpluses are utilized later as pasture, feed value is lost due to advancing maturity of the pasture plants and the trampling and fouling by livestock.

VARIATIONS IN ANNUAL PASTURE OUTPUT

Farmers interviewed in southern Iowa were asked how the year-to-year variability of pasture yields affected their livestock program. Their replies are summarized in table 13. Most of the farmers (61 percent) replied that they limited the size of their livestock enterprises to what they felt their pastures could handle adequately in the poorer years.[11]

Several (16 percent) of the farmers said that they plan their livestock program to fit production in the better years. In years when pasture yields are low, they plan to buy additional hay or rent additional land. Nearly as many farms (14 percent) said that their livestock programs are geared to the expected average yields over the years. In better than average years, they cut additional hay and stored it for feeding in years when yields were below average.

Only a few farmers (7 percent) said that they adjusted their livestock numbers to fit variations in production. These farmers indicated that they commonly sold some of their livestock when it ap-

[11] Generally by "poorer years" the farmers did not mean the years of such extremely low production as the drought years of 1934 and 1936, but years in which production was well below average.

TABLE 13. ADJUSTMENTS MADE BY SOUTHERN IOWA FARMERS TO YEAR-TO-YEAR VARIATIONS IN PASTURE PRODUCTION (FROM SURVEY OF 122 FARMERS IN 1952).

Type of adjustment made	Farmers who said this most nearly described the manner in which they took variation into account	
	Number	Percent
(a) Plan livestock program on basis of average yields. Store surplus as hay or silage from good years to poor years.	17	14
(b) Plan livestock program to assure enough pasture in poorer years (and thus have an unused excess most years).	73	61
(c) Plan livestock program so most of pasture is used in good years; buy hay or rent additional pasture in poor years.	19	16
(d) Adjust livestock numbers to fit pasture production.	9	7
(e) Substitute grain for forage.	2	2

peared that pasture output would be low, and bought additional feeder cattle or sheep to use the extra pasture when the pasture outlook was good. Two percent said that they adjusted to year-to-year variability in pasture production by varying the composition of the livestock rations. They indicated that in years when pasture output was high they fed rations containing high proportions of forage. In years of less favorable pasture production, they substituted grain for the deficiency in pasture.

On the basis of the surveys in southern Iowa, one of the greatest obstacles to the efficient utilization of existing pastures is that of weather uncertainty. While both are important, the between-year variability is most important in terms of uncertainty; the occurrence, extent and timing of seasonal variability is known with greater certainty than the characteristics of year-to-year variability. Since most farmers in our surveys adjusted to the between-year type of weather uncertainty by keeping just enough animals on pasture to meet production in average years or in drier years, pasture feed goes unused in years of better than average weather. As table 14 shows, for the 59 percent of the farmers in the 1949 survey who adjusted to weather variability by fitting animal numbers to low production years, the system provided enough excess forage throughout the year, as an average per farm, to support nearly 10 head of mature cows. The 1951 survey showed, similarly, that a considerable excess capacity existed on most farms in the good years. As shown in table 15, these farmers estimated that their pastures would carry over one-third more cattle than were being carried in 1951.

Because of this system of adjusting to weather uncertainty, these farmers put less emphasis on pasture improvement than would hold true in the absence of year-to-year variability of yields; since a surplus of pasture exists in most years, the attitude of these farmers is that improved pasture would only increase their surplus.

Thus, it seems that livestock numbers on many farms in the area are limited by the level of pasture production in the poorer months of the less productive years. If so, increasing the returns from pastures may hinge on either (1) finding ways of reducing the cost or inconvenience of harvesting, storing and redistributing the pasture output to provide a supply more in harmony with livestock requirements, (2) adopting pasture improvement practices which either increase pasture yields in seasons when yields are normally low or reduce the effect of drouth or other year-to-year variables on production or (3) finding economical means whereby hay can be carried forward to meet the emergencies of dry years.

As table 14 shows, the average amount of hay carried forward from 1 year to the next was small. Development of improved techniques and equipment for forage harvesting and storing have simplified the problem of evening out the pasture supply a great deal, but it is doubtful that it is yet economical to produce and store good hay and grass silage from unimproved native pastures. The fact that few of the farmers in the southern Iowa survey were attempting to level out their seasonal pasture supply by carrying over the surplus pastures from the good to the low production periods may be due to the predominance of bluegrass pastures, which are not well suited for hay or silage production. Livestock production also

TABLE 14. ADJUSTMENT OF ANIMAL NUMBERS TO VARIABILITY IN PASTURE PRODUCTION (FROM SURVEY OF 200 FARMERS, SOUTHERN IOWA, 1949).

Item	Percent
Percent of farmers who normally have pasture in excess of livestock requirements as a "risk adjustment."	58.9
Average number of mature beef cows which could be carried on excess pasture for farmers using this system.	9.8
Average number of tons of hay carried over by all farmers.	6.4 tons

TABLE 15. RATE OF STOCKING AND ESTIMATED AVERAGE UNDER-UTILIZATION OF PASTURE FOR ALL FARMS IN SAMPLE, SOUTHERN PASTURE AREA, IOWA, 1951.

Item	May	June	July	Aug.	Sept.	Oct.
Animal units* pastured per month per acre	0.278	0.278	0.277	0.278	0.283	0.279
Additional animal units estimated pasture would carry per acre	0.114	0.114	0.111	0.103	0.104	0.108
Total estimated carrying capacity per acre per month	0.392	0.392	0.388	0.381	0.387	0.387

* An animal unit is a mature cow or its equivalent.

can be increased if pastures can be developed which are more tolerant of dry weather.

Improvement of permanent bluegrass by clipping, fertilization or other methods likely can make little constribution to evening out the seasonal production of grass, or even the inter-year variation in production. As was pointed out earlier, the main effect of nitrogen fertilizer application on pasture crops is to increase the output in May and June. The effect on yields in July and August is slight. Unless the additional forage which is produced in the spring can be harvested and stored economically, the returns from the application of fertilizer is unimportant. Liming will ordinarily stimulate the growth of the legumes in bluegrass mixtures and thus improve the quality of these pastures. Application of fertilizer may increase the growth of the grass and the competition between the ungrazed bluegrass and the legume may be injurious to the legume.

The data in table 16, based on the 1951 survey in southern Iowa, shows that the amount of livestock being carried per acre on the improved bluegrass pastures was no greater than on the unimproved bluegrass pastures. Since these differences are not statistically significant, we can only say that the amount of livestock being carried was the same for unimproved and improved bluegrass. However, it is indeed likely that the unimproved pastures were those which had been kept in a high state of productivity and with good weed-free stands through proper grazing. Improved bluegrass pastures, as many farmers indicated, were those where the pasture had been poorly managed previously but practices had been used to restore its productivity. In this sense, it might be said that improvement of poor bluegrass pasture can bring its productivity up to the level of well-managed bluegrass pasture. Most important, however, is the gain in production from improved species and rotation pasture. The rate at which farmers stocked rotation pastures was nearly double the rate on the bluegrass pastures.

FARMER ATTITUDE TOWARDS RISKS IN SEEDING MIXTURES

Very little information is available for comparing the year-to-year variability of yields for different pasture crops over extended periods of time. But farmers generally have some notion as to the hazards involved in growing different pasture crops; and whether they have any basis in fact or not, these notions are important in determining how farmers develop their pasture programs. Their notion of the risks involved for different kinds of seedings affect their choices for different improvement systems. The operator with a small amount of capital may select a grass or legume which he feels is "very safe," even though it has a lower yield than others; its use may prevent him from tying his funds up in seed and fertilizer and then losing it from drouth. For example, most southern Iowa farmers looked upon timothy of being "almost certain" and therefore many used it even though it yields less than many other grasses or legumes.

Farmers in the southern pasture area survey also were questioned about their opinions as to the riskiness of crop failure for various other grasses and legumes. Each farmer was shown a list of 11 grasses and legumes which are common in the area or are generally recommended for use in the area. He was asked to indicate which of these grasses and legumes with which he was familiar. For each grass and legume with which he was familiar, each farmer was asked whether he considered the chances of failure in any year to be very low, moderately low or very high. He was also asked to indicate what he considered to be the chief cause of failure for each of these pasture crops. The replies to these questions are summarized in table 17.

Nearly all of the farmers interviewed were familiar with red clover, timothy, alfalfa and lespedeza. A surprisingly small number, however, were familiar with some of the grasses and legumes which are recommended for pastures in the area. For example, only 6 percent of the farmers interviewed were familiar with orchardgrass, only 23 percent were familiar with birdsfoot trefoil and 26 percent with ladino clover.

The pasture crop considered "very risky" by the largest percentage of the farmers familiar with it was alfalfa. Twenty-four percent of the farmers familiar with alfalfa said that it was a "very risky" crop, 11 percent said that they considered it "moderately safe" and 55 percent said that it was a "very safe" crop. Ten percent of the farmers who were familiar with it would express no opinion on its riskiness. Red top, timothy and lespedeza were considered "very safe" by a large majority of the farmers who were familiar with them. Only 4 percent considered lespedeza a "very risky" crop, 5 percent of the farmers thought timothy was "very risky" and none of the farmers considered red top to be a "very risky" crop.

Of the small number of farmers who were familiar with birdsfoot trefoil, ladino clover and orchardgrass, large percentages of them had not yet formed an opinion as to the "riskiness" of pasture failure with these crops; 39 percent had no opinion on the "riskiness" of birdsfoot trefoil, 38 percent had no opinion on ladino clover and 25 percent had no opinion on orchardgrass. The number of farmers who considered these three crops "very safe" was much smaller than for any of the other crops; only 18 percent felt that birdsfoot trefoil was "very safe," 19 percent thought ladino clover was a "safe" crop and 25 percent thought that orchardgrass was "very safe." Lack of knowledge on these new grasses and legumes has the effect of throwing them in the "risky" or "very risky" category, however; without some firm knowledge of their outcome farmers look upon them with a high degree of uncertainty.

The large differences in opinion as to the safety

TABLE 16. RATE OF STOCKING PASTURES, BY MONTHS, SOUTHERN PASTURE AREA, IOWA, 1951.

Kind	Description of pasture			Number of pastures reported	Animal units pastured per acre per month*					
	Percent bottmland	Percent wooded	Percent virgin		May	June	July	Aug.	Sept.	Oct.
Unimproved bluegrass	4.9	24.5	54.7	72	0.298	0.298	0.301	0.289	0.277	0.278
Improved bluegrass†	8.5	19.7	56.8	42	0.274	0.274	0.271	0.277	0.277	0.272
Rotation pasture‡	—	—	—	16	0.510	0.510	0.572	0.442	0.442	0.425
Hay aftermath and new seeding	—	—	—	9	—	—	—	0.196	0.558	0.612

* An animal unit is a mature cow or its equivalent.

† Improved bluegrass category includes all permanent pastures reported which had been improved within the last 10 years. The extent and type of improvement varied considerably. The average cost of the improvements at 1951 prices was estimated at $5.84 per acre. The range in costs was from $0.40 to $30.00 per acre.

‡ Rotation pastures were mostly alfalfa-brome mixtures with a few clover-timothy pastures reported.

of each pasture crop requires some explanation. Why, for example, should 55 percent of the farmers think that alfalfa was a very safe crop while 24 percent of this group of farmers considered it a very risky crop? The divergent opinions may be explained in part by the limited experience of many of these farmers with each of the crops; their estimates of the degree of risk for each crop were often based on the "luck" they or their neighbors had had in a few attempts at growing that crop. Some of the differences in opinion may have been due to differences in definition of the terms "very risky" or "very safe." Since no attempt was made to define these terms to the farmers, it is likely that the chances of failure that one farmer associated with the term "very risky" may be far different from that of another. The way each farmer uses alfalfa also may have affected his selection in respect to degree of risk. It stands up better under haying than under pasturing. Alfalfa is not a grazing-type plant. Continuous defoliation under pasturing causes alfalfa to thin out and predisposes the plant to winter killing. Then, too, it is likely that when a farmer says he considers a venture very risky he is taking into account not only his estimate of the frequency of occurrence of an unfavorable outcome but also his own ability and willingness to bear risks.

As shown in the last five columns of table 17, a large number of farmers associated pasture failure primarily with drouth, in the case of most of the pasture crops. Failure to get a stand established was considered the main hazard by many farmers for several crops; 60 percent of them listed failure to get a new seeding catch as the major hazard in producing birdsfoot trefoil. A similar percentage gave the same reason for failure of ladino clover. Winter-kill was given as the chief hazard in alfalfa production by 23 percent of the farmers. Thirty-six percent of the farmers also thought that winter-kill was the main source of failure in red clover production. Insects and disease were considered important hazards by only a few of the farmers.

Some notion of farmer belief in respect to uncertainty of stands for three crops is reflected in table 18 for the 200-farm sample. Questions were asked in respect to clover, timothy and alfalfa, because the number of farmers who have experience with the other seeds is more limited. When uncertainty is considered, the fact that many farmers continue to grow acreages of for-

TABLE 17. ATTITUDES OF FARMERS CONCERNING THE RISK OF STAND FAILURE WITH VARIOUS PASTURE CROPS, SOUTHERN PASTURE AREA, IOWA.

Pasture crop	Percent of farmers interviewed who were familiar with crop	Percent of farmers familiar with crop who considered it				Percent of farmers responding who considered the most common cause of stand failure*				
		very risky	moderately safe	very safe	expressed no opinion on riskiness	winter kill†	seeding failure	insects and/or disease	drouth	other‡
Alfalfa	94	24	11	55	10	23	30	2	34	11
Bromegrass	63	12	28	41	19	4	47	4	43	2
Lespedeza	87	4	7	73	16	11	28	0	48	13
Birdsfoot trefoil	23	18	25	18	39	5	60	0	35	0
Sweetclover	83	7	14	55	24	11	32	11	39	7
Red clover	100	6	16	65	13	36	21	3	38	2
Ladino clover	26	9	34	19	38	0	60	0	40	0
Timothy	95	5	8	73	14	0	16	2	82	1
Sudangrass	32	2	20	62	16	0	50	0	38	12
Red top	58	0	8	72	20	0	7	0	93	0
Orchardgrass	6	0	50	25	25	0	33	0	67	0

* There may be considerable overlapping in the causes listed in that what some farmers regard as winter kill may be the effect of insects or disease, drouth, or flooding.

† The very great uncertainty and lack of knowledge in the minds of many farmers is indicated in that 11 percent looked upon lespedeza as involving the possibility of winter kill. Actually lespedeza is an annual dependent on proper grazing for reseeding itself each year. Some farmers, however, may have been thinking about failure to get a reseeding from one year to the next.

‡ Other causes mentioned included "too wet," "lime and phosphate deficiency" and "poor soil."

TABLE 18. FARMER ATTITUDES ON UNCERTAINTY OF OBTAINING STANDS.

Type of forage	Number of years out of 20 in which failure of new seeding is expected (average for all farmers)
Alfalfa	3.9
Red clover	3.5
Timothy	1.4

age which do not result in the greatest physical yield can be understood. As mentioned previously, farmers with limited capital often have as a goal the selection of "safe outcomes" to minimize the chance of losses or low returns as much or more than the selection of alternatives with high return possibilities but which also involve large chances of loss.

LIVESTOCK UNCERTAINTY AND PASTURE MANAGEMENT

To the uncertainty of forage stand must be added the uncertainty of livestock prices and production. It is entirely possible for a farmer to select a type of pasture improvement which is highly productive relative to its costs and yet to combine it with a livestock system which results in a large loss because of falling prices. In other words, the success of the pasture and livestock venture depends as much on price ratios for the livestock as on the physical efficiency of the pasture system. By careful decisions on livestock purchases, the farmer may make much more on this venture alone than through detailed selection of pasture mixtures and improvement systems; by unwise decisions, he may lose on the livestock relative to the improved pasture.

With an uncertain market for livestock and supported corn prices, it is not hard to see why a farmer would put his money into fertilizer for corn rather than to improve pastures. Pastures must be harvested by livestock—they have no other value.

As indicated in the data in table 19, based on the 200-farm sample, the majority of the farmers look upon beef cattle raising as involving less uncertainty than either cattle feeding or dairying, while dairying is viewed with less uncertainty than feeding. It is for these reasons that many farmers run a herd of grade beef stock on unimproved pasture rather than feed some choice cattle on well-improved and high-yielding pasture forages. While the latter system will likely give greater returns over a long period, it involves a greater probability of large financial sacrifices in a single year. Accordingly, many young farmers with limited funds buy one or a few grade beef cows. These are then run on unimproved pasture. Quite frequently the number of animals cannot use all of the unimproved pasture available. Under these conditions, there is little reason to improve the current pasture acreage since part of it goes unused anyway. The farmer whose capital position forces him to use this system in using available bluegrass pasture is not irrational but uses the pasture forage as a method of deferred capital accumulation; as he saves back heifers, he is carrying on a system of deferred capital accumulation using the forage which would otherwise be wasted.

The fitting together of many alternatives in livestock and pasture systems into a logical farm management arrangement is thus a difficult problem. There are no fixed recipes which can be applied to all farms; the system must be fitted to the conditions of the individual farm. Not only does the livestock system weight as heavily as the system of pasture management in determining profits but it is equally as important in determining the amount of capital necessary. Many quantities of capital can be used to consume a given amount of pasture or other forage by different classes of livestock. For capital-short farmers, these considerations are as important in farm management decisions as is pasture improvement itself.

Very large amounts of capital are necessary for utilizing a given amount of forage through the more usual cattle feeding systems; less is required for beef cows. A farmer who can produce the equivalent of 100 tons of hay from bluegrass pasture and rotation hay, but has limited funds may have no economic reason for improving his pasture. On the other hand, the farmer with ample funds may not wish to restrict his forage to 100 tons but to substitute legume-brome, lespedeza, ladino clover and other grasses for bluegrass and, by so doing, double his capacity to produce livestock; he may turn to feeding cattle on pasture, where some grain combined with forages will work to increase the volume of business which can be supported on a given acreage.

TABLE 19. COMPARISON OF ENTERPRISE RISK AND UNCERTAINTY FOR 200-FARM SAMPLE.

Enterprise comparisons	Percent of farmers believing one enterprise to be more risky than another
Risk and uncertainty greater for dairying than for beef cattle raising	56.4
Risk and uncertainty greater for beef cattle raising than for dairying	39.6
Did not know or would not answer	14.0
Risk and uncertainty greater for beef cattle raising than for beef cattle feeding	3.0
Risk and uncertainty greater for beef cattle feeding than for beef cattle raising	91.2
Did not know or would not answer	5.8
Risk and uncertainty greater for dairying than for beef cattle feeding	11.7
Risk and uncertainty greater for beef cattle feeding than for dairying	86.1
Did not know or would not answer	12.2