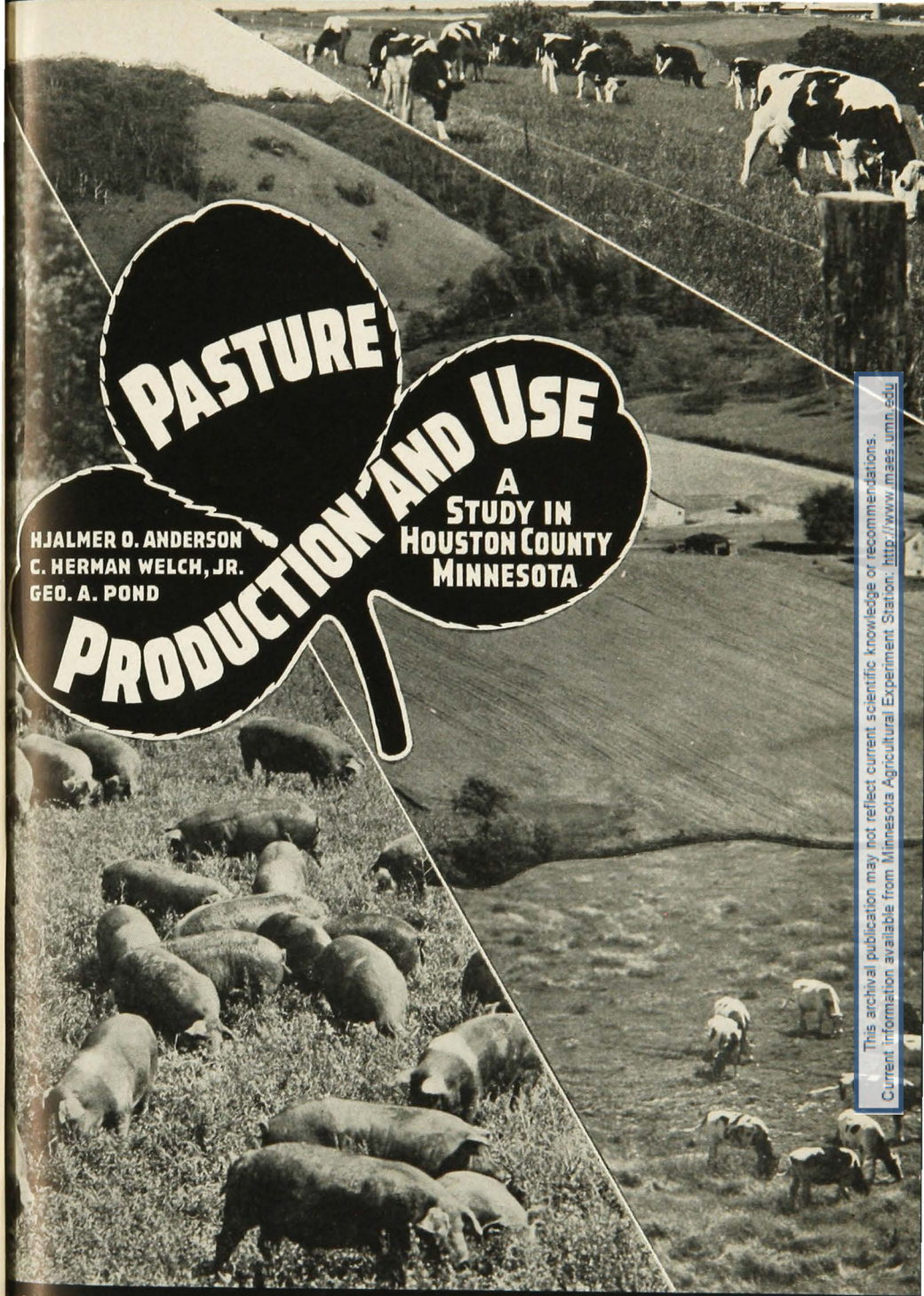

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CONTENTS

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Pasture Production and Use

A Study in Houston County, Minnesota[1]

Hjalmer O. Anderson, C. Herman Welch, Jr., and George A. Pond[2]

PASTURES comprise over 50 per cent of the acreage in farms and provide from one third to one half of the feed consumed by cattle in Houston County which is representative of a considerable area of southeastern Minnesota, including part or all of a dozen counties, as well as nearby counties in the adjoining states of Wisconsin and Iowa. The topography of this area is characterized by a succession of narrow ridges with deep, narrow valleys between. However, the southwestern part of the county consists of comparatively large areas of rolling prairie, and the land along the Root and Mississippi rivers is made up of fertile river terrace land.

Soil conservation studies indicate that vegetative cover such as is provided by good pasture growth furnishes excellent protection against soil and water losses. These studies also indicate that judicious pasturing will not impair the protective qualities of grass cover. However, in some cases, farmers feel that steep slopes and wooded areas must be used for pasture even though pasturing results in soil erosion. Overgrazing frequently leads to reduced feed production as well as to damage from erosion. These problems arise because the acreage available for pasture is limited by soil and slope conditions as well as by size of farm.

Objectives

The objectives of this study were to determine: (1) the physical characteristics of land used for pasture purposes in Houston County, (2) the productivity of various types of pasture, (3) the contribution of different types of pasture to dairy and livestock production, (4) seasonal distribution of pasturage, and (5) pasture costs.

[1] The authors acknowledge with appreciation the assistance of members of the staff of the Minnesota Agricultural Experiment Station and the Soil Conservation Service, particularly A. C. Arny, of the Division of Agronomy and Plant Genetics, who directed the part of the study dealing with the comparative yields of different slopes, and W. M. Roberts, Agronomist with the Soil Conservation Service, who also assisted in planning the study. Special credit is due H. A. Johnson and W. O. Nilsen, who were largely responsible for collecting data in the field, and to Harold Bolduan, Edwin Burtness, Martin Deters, and Ralph Krick, farmers, who cooperated in the comparative yield study. The authors also wish to acknowledge with thanks the cooperation of the 120 farmers who cooperated in the survey.

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Methods

The study was made by the Division of Economic Research of the Soil Conservation Service and the Bureau of Agricultural Economics, United States Department of Agriculture, in cooperation with the Division of Agricultural Economics of the Minnesota Agricultural Experiment Station. The project included two types of study: (1) a survey of a group of 120 farms located in 11 townships of Houston County, and (2) a special study of yields on five pastures on different degrees of slope. Data obtained from the survey included: (1) physical description of pastures, (2) estimates of productivity and value of pastures, (3) description of prevailing systems of pasture management including pasture treatments, (4) amount of butterfat produced during the winter feeding and pasture seasons, (5) kinds, amounts, and costs of fences, and (6) other pasture costs.

Data from soil conservation surveys of the farms were used in determining cover conditions, slope, soil type, and degree of erosion. All pastureland on these farms was divided into tracts with similar physical characteristics in order that groupings could be made according to vegetative cover, type of pasture, slope, soil productivity, and degree of erosion rather than on the basis of fence enclosures. The proportion of tree cover and the direction of slope were determined from examination of aerial photographs and from observations by the enumerator. Pastureland soils were rated by technicians of the Soil Conservation Service as a basis for classifying the soils according to inherent productivity for pasture purposes.

Estimates of the acreage of the different types of pasture required to provide adequate grazing for one cow under different physical conditions and also of the length of pasture season

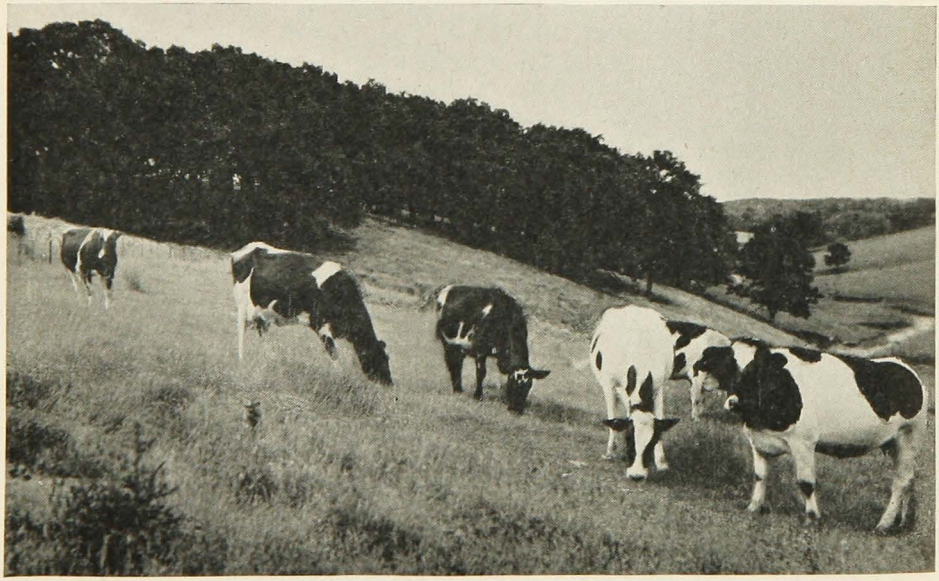

FIG. 1. Comparatively steep hillside used for permanent pasture in Houston County.

were obtained from the farmers. Since the interviews with the farmers were made mostly in June and July, information relative to pasture adequacy and supplementary feeding of cows during the fall months was obtained from mailed questionnaires.

The second part of the project consisted of a special study of the effect of slope on the yield of forage and was limited to five permanent pastures. Yield data for two years were obtained on the following slopes: 0-9 per cent, 10-19 per cent, 20-29 per cent, and 30-39 per cent. Four wire cages,[3] 4 feet square and 16 inches high, were placed within each slope range in each pasture to protect these areas from grazing.

The herbage in the caged areas was clipped, dried, and weighed each time that it reached a height of about four inches. The same number of four-foot-square areas from adjacent grazed pastures was harvested at the same time to determine the amount of available forage left ungrazed. The amount of forage consumed was determined by subtracting the amount left ungrazed at the end of the pasture season from the total production in the caged areas. During 1941 five clippings were made in one pasture and four were made in each of the other four pastures. In 1942 four clippings were made in all five pastures.

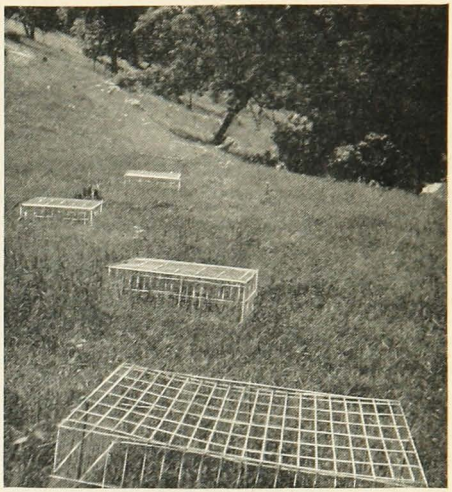

FIG. 2. Wire cages placed on slope range to protect certain areas from grazing.

DESCRIPTION OF PASTURES

Wooded Pastures Predominate

About one third of the acreage in the 499 pastures on 120 farms was classified as open pasture and two thirds as wooded pasture. About 45 per cent of the open pastures was designated as permanent upland pasture, 19 per cent as permanent bottomland pasture, 17 per cent as upland pasture which had previously been cropped, and 19 per cent as rotation pasture, most of which was on the upland soil. Nearly all of the wooded pastures were on upland soil. Open pastures ranged in productiveness from very good bottomland pasture to steep, nearly barren south slopes and rock outcrops. Similar variations in quality of land and in cover conditions existed in the wooded pastures. The wooded pastures generally were on steeper slopes and on poorer soils than the open pastures.

Steeper Slopes and Poorer Soils Pastured

Forty-one per cent of the open pastureland and 91 per cent of the wooded pastures were on slopes of more than 20 per cent. Fifty-three per cent of

[3] The Division of Agronomy and Plant Genetics provided the wire cages and made dry weight determinations.

the pasture soils were rated as poor, 17 per cent as fair, 15 per cent as good, 13 per cent as very good, and 2 per cent as the best. The pastures on the best soil were located almost entirely on bottomland with less than 10 per cent slope and were subject to frequent flooding. Most of the pastures on the poorer soils were on steep slopes which had never been broken.

Permanent Pastures Only Slightly Eroded

Most of the permanent pasture included in this study had not been affected appreciably by erosion. In contrast, over one fourth of the previously cropped upland pasture and nearly one third of the upland rotation pasture showed evidence of severe erosion. In many cases, pastures that had previously been cropped were converted from cropland to permanent pasture in an effort to control erosion, for convenience in cultivating cropland, or because of the need for additional pasture. Nearly one half of the acreage of this type of pasture was on slopes of over 20 per cent. Rotation pastures were slightly more eroded than the cropland retired to pasture even though they were on less steep slopes. This suggests the need for more soil-conserving crops or the use of other soil conservation methods on some of the land used for rotation pasture.

CARRYING CAPACITY

Open Pastures Most Productive

On the basis of the farmers' estimate of the number of acres required to feed one cow, one acre of rotation pasture was equal to about 1.5 acres of previously cropped and open permanent pasture, or to 2.6 acres of wooded pasture. The farmers rated open permanent pastures on the 0-9 per cent slopes, consisting chiefly of bottomland pasture, as having greater carrying capacity than the other types (see table 1).

Slope Reduces Pasture Yield

The estimated acreage of the various kinds of pasture needed per cow generally increased as the per cent of slope increased. One acre of open permanent pasture on the slopes of less than 10 per cent was equal to 2.2 acres on slopes of over 30 per cent, and one acre of wooded pasture on slopes of less than 10 per cent was equal to about 2.0 acres on slopes of over 30 per cent. Less difference in the estimates of the acreage needed per cow occurred among the different slopes of upland pastures which had been cropped. No material difference among slopes was found in estimates for rotation pasture. However, since the most productive soils were on the lesser slopes, the variations in carrying capacity may have been due as much to soil differences as to slope differences.

Table 1. Estimated Carrying Capacity of Different Types of Pastures in Houston County, Grouped According to Slope

Slope group	Open pasture				Wooded pastures
	Rotation	Previously cropped	Permanent	All open	
	Acres required to feed one cow				
0– 9 per cent	1.7	2.0	1.4	1.5	2.9
10–19 per cent	1.6	2.2	2.2	2.0	3.2
20–29 per cent	1.7	2.5	2.5	2.3	4.0
30 per cent and over	.....	2.7	3.0	2.9	6.0

Table 2. Average Pasture Production and Consumption Per Acre on Different Slopes of Five Permanent Pastures, Houston County, 1941-42

Slope group	Pasturage produced	Pasturage consumed	
	Pounds*	Pounds*	Per cent
0– 9 per cent	2,713	1,916	71
10–19 per cent	2,201	1,636	74
20–29 per cent	2,024	1,409	70
30–39 per cent	1,984	1,434	72
Average	2,231	1,599	72

* 15 per cent moisture.

Slope Reduces Cage Yields

The farmers' estimate of differences in carrying capacity corresponded, in general, with differences in yield obtained from the areas under cages. While data based on two years' results are not sufficient to warrant broad generalizations, they indicate that the highest yields of forage may be obtained from the lesser slopes. The yield on the 0-9 per cent slopes was about 20 per cent greater than on slopes of 10-19 per cent and was 27 per cent greater than on slopes of over 30 per cent. A larger amount of forage was also consumed on the lesser slopes than on the steeper slopes. There was little difference among slope groups in the per cent of forage consumed.

Renovation Increases Production

About 10 per cent of the open permanent pasture areas had been improved by applications of lime and fertilizers or by seeding legumes, most of which had been done recently as a part of the

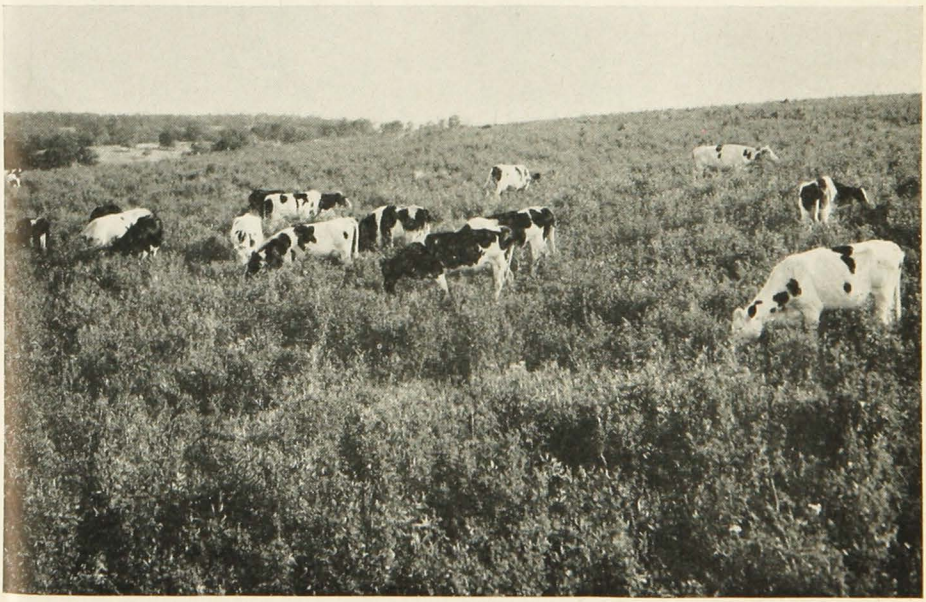

FIG. 3. Pasture renovation transformed an unproductive permanent bluegrass pasture into this productive legume pasture.

Table 3. Effect of Pasture Treatment on Carrying Capacity of Open Upland Permanent Pastures

Treatment	Acres treated	No. of pastures	Slope group	
			All	10–19 per cent
		Cow-months per acre		
Untreated	1,320	98	1.8	2.3
Partial renovation	137	23	2.4	2.1
Renovated areas	14	3	4.4	4.4

soil conservation program. Most of the treatments were applied to slopes ranging from 10 to 19 per cent. Only three of the 120 farmers reported a complete pasture renovation program consisting of applications of lime and fertilizer and legume seed to permanent bluegrass pasture areas on which the sod had been worked up by disk, springtooth, or field cultivator. The average estimated carrying capacity on these pastures was 4.4 cow-months per acre as compared with 2.3 cow-months for comparable untreated pastures. Other studies of renovated pastures in this section of the state indicate similar differences in yields.[4] Partial renovation treatments consisting of applications of lime, fertilizers, or legume seed, but not all three, were made on 23 other pasture areas. The estimated carrying capacity of these areas was slightly larger than that of the untreated areas. This is an indication that partial renovation will increase yields but not as much as complete renovation (see table 3).

PASTURELAND VALUES

Assessors valued open pastureland on the lesser slopes about 300 per cent higher than similar pastureland on slopes of over 30 per cent. The spread in value per acre among slope groups was, in a general way, comparable to differences in the estimated carrying capacity. Farmers' estimates of pastureland values corresponded closely to the estimates of the assessors.

PRODUCTION FROM PASTURES

Half of Cow Pasturage from Open Permanent

Approximately 22 acres of open permanent pasture, 41 acres of wooded pasture, 6 acres of rotation pasture, and 28 acres of cropland, from which some crop had been harvested earlier in the season, were used per farm as pasture for milk cows in 1941. In addition to providing forage for milk cows, these pastures were also used for other cat-

Table 4. Assessors' Estimated Value of Various Types of Pastureland Grouped According to Slope

Slope group	Open pasture				Wooded pastures
	Rotation	Previously cropped	Permanent	All open	
0– 9 per cent	$46	$37	$24	$30	$22
10–19 per cent	38	25	23	29	19
20–29 per cent	24	17	14	17	14
30 per cent and over	.....	14	10	11	10
All slopes	37	22	19	24	13

[4] Unpublished data from pasture renovation trials of the Division of Agronomy and Plant Genetics, Agricultural Experiment Station, University of Minnesota.

Table 5. Acreage and Percentage of Each Type of Pasture Used by Milk Cows and Farmers' Estimate of Percentage of Pasturage from Each

Type of pasture	Acres per farm	Per cent of acreage	Per cent of pasturage
Open permanent	22.1	23	50
Upland open permanent	12.7	13	21
Retired cropland	4.9	5	12
Bottomland	4.5	5	17
Wooded	41.1	42	15
Rotation	5.6	6	16
Hay, grain, and corn fields*	28.2	29	19
Total	97.0	100	100

* Fields from which hay, small grain, or corn had been harvested.

tle, horses, sheep, and hogs on most of the farms. A number of farmers used separate pastures for other dairy cattle, beef cattle, hogs, sheep, or horses. The farmers estimated the proportion of pasturage obtained by the milk cows from the various types of pasture during each month of the pasture season. According to these estimates, open pastures, comprising 23 per cent of the acreage, provided 50 per cent of the pasturage, whereas wooded pastures, comprising 42 per cent of the acreage, provided only 15 per cent of the pasturage. Meadows, grain stubble, and cornstalk fields provided 19 per cent of the season's pasturage, most of which was obtained during the late summer months when permanent pasture furnished comparatively little feed. Rotation pasture was considered the most productive, comprising only 6 per cent of the acreage, but providing 16 per cent of the pasturage (table 5).

Meadows and Stubble Fields Provide Midseason Grazing

Most of the pasturage obtained during the months of August to October, inclusive, was from cropland from which a part or all of a crop had been removed. During 1941 about 2.4 acres of alfalfa meadow, 11.6 acres of clover and timothy meadow, and 9.4 acres of small grain stubble, about half of which had been seeded to grass or legumes, and 4.8 acres of corn fields were pastured per farm after the crops had been removed. Figure 4 shows the periods in which the various types of meadows and other fields were pastured.

On a few farms, alfalfa, clover, and timothy were pastured in June and July after the first cutting of hay had been harvested; however, farmers generally did not utilize meadows for pasture purposes until after August 1. The fields were pastured somewhat earlier and more intensively than usual because of the extremely poor condition of the permanent pasture in July and August. Unusually large yields from the first cutting provided an ample supply of hay thus permitting the use of the meadows for pasture purposes. Grain fields were pastured after August 1 and cows were usually turned into the corn fields after October 1. The different types of crop residues were pastured up to the latter part of November.

1941 Pastures Normal

Pastures in May and June of 1941 were rated by these farmers as "good," producing about the normal amount of forage. In July and August, pasture growth was rated "fair." The deficiency in pasturage supply was more

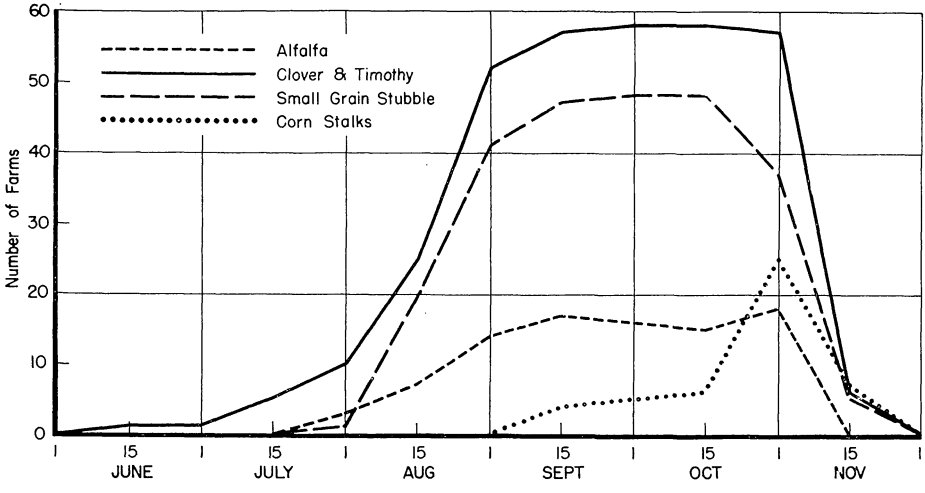

FIG. 4. Number of Houston County farmers pasturing fields after hay, small grain, or corn had been harvested, 1941.

severe than usual due to the prolonged drouth in July and August. Pastures were rated as "good" in September and October and continued to be unusually productive until late in the fall. In many cases, little or no supplementary feeding of cattle was necessary before December 1. Slightly more than half of the farmers reported net gains in weight of dairy cows for the pasture season, whereas 6 per cent reported loss in weight and 40 per cent no apparent change in weight.

Supplementary feeding—While grain feeding is usually reduced materially when cows are put on pasture, some of the farmers continue to feed small amounts of concentrates throughout the summer. Approximately 150 pounds of concentrates are normally fed per cow from May 1 to November 1 (see table 6), but considerably less than the average amount was fed during the 1941 pasture season. About 90 pounds were fed per cow on these farms from May 1 to November 1 and an additional 90 pounds were fed in November.

Less than 175 pounds of hay is normally fed per cow during the pasture season, much of which is fed during the period of pasturage shortage in July and August, and about the same amount was fed in 1941. Only about an average of 50 pounds of silage is normally fed per cow while on pasture, most of which is fed in May. In 1941 more silage was fed than usual in the late summer and early fall months.

Table 6. Estimated Amount of Concentrates, Hay, and Silage Fed Per Cow During Pasture Season, 1941 and Normal

	May–June		July–August		Sept.–Oct.		Total	
	1941	Normal	1941	Normal	1941	Normal	1941	Normal
Pounds per 60-day period:								
Concentrates	49	49	13	50	31	49	93	148
Hay	43	43	19	74	116	55	178	172
Silage	37	37	124	12	112	0	273	49

Livestock Production

Fifty-four per cent of the cows on these farms freshened in the four-month period, December to March, with the largest proportion in any month freshening in February. Only 8 per cent freshened in the months of July, August, and September, the low period for the year. "Normal" butterfat production, based on average production per month during the lactation period, indicates that the monthly production should be expected to rise gradually until in May and then fall gradually until in November when production would reach the lowest point. Actual production on these farms rose much more rapidly in May and remained higher in July and June than this "normal" production, undoubtedly because of the stimulus of milk production by succulent pasture forage.

Half of 1941 Livestock Production from Pasture

The total nutrient requirements for dairy cows were computed on an average estimated weight of 1,000 pounds per cow and the average butterfat production per month (see table 7). The amount of nutrients contained in supplementary feed was subtracted from the total required and the remainder credited to pasture. On this basis, 1,131 pounds, or 49 per cent, of the 2,315 pounds of butterfat was obtained from barn feeding, and 1,184 pounds, or 51 per cent, from pastures. The predominance of late winter freshening was responsible, in part, for the proportionally large production of butterfat during the summer. Pasture conditions during September, October, and November were also favorable for milk production.

The value of livestock production per farm for the average number of cows, young cattle, sheep, and horses on these farms was computed from farm records kept by farmers in Fillmore, Houston, and Winona counties.[5] These reports show that the average gross returns from dairy cattle for the five-year period, 1936-40, other than dairy products were about $33 per cow. Assuming that $15 of the cattle increases came from calves not on pasture and that one half of the remainder was obtained from harvested crops, the credit to pasture of cattle increases would be $9 per cow or $108 for a 12-cow herd.

These farm records also indicate that the average returns from sheep were about $5 per head. Assuming that 50 per cent of the increase in sheep production was obtained from pastures, the credit to pasture feeding would be $2.50 per head, or $20 for a flock of eight sheep.

Assuming that the value of pasture amounted to $5 per horse, the total credit to pasture for three horses would be $15. On the basis of these estimates, the total livestock returns, including butterfat production, from pastures would amount to $617 per farm.[6]

Open Permanent Pasture Chief Source of Forage

Crediting each type of pasture according to the farmers' estimate of the proportion of pasturage obtained from each, 50 per cent of the livestock production from pastures came from open

[5] Soil Conservation Farm Management Service. University of Minnesota, Division of Agricultural Economics, Reports No. 87, 101, 105, 115, and 123. 1936-40.

[6] The value of hog production obtained from pastures has not been included in this study because no adequate method for making this evaluation was available. The amount would be small because few hogs were kept on the pastures included in the study.

Table 7. Total Digestible Nutrients Required for Body Maintenance and for Milk Production Provided by Barn Feeding and by Pastures

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total and average
Milk per cow per day ..... lbs.	12.2	12.7	14.3	14.1	17.7	17.9	15.4	13.1	12.0	11.3	9.3	10.8	13.4
Total digestible nutrients:													
Required* ..... lbs.	11.1	11.3	11.8	11.7	12.9	13.0	12.2	11.4	11.0	10.8	10.1	10.6	
From barn feed* ..... lbs.	11.1	11.3	11.8	11.7	1.1	1.1	0.7	0.7	1.1	2.3	6.7	10.6	
From pasture ..... lbs.	.....	.....	.....	.....	11.8	11.9	11.5	10.7	9.9	8.5	3.4	.....	
From pasture ..... pct.	.....	.....	.....	.....	91.5	91.5	94.3	93.9	90.0	78.7	33.4	.....	
Butterfat from barn feed .. lbs.	176.4	182.5	206.0	203.0	21.7	22.0	12.6	11.5	17.3	34.6	88.4	155.6	1,131.6
Butterfat from pasture ..... lbs.	.....	.....	.....	.....	233.3	236.4	208.7	176.8	155.9	127.8	44.9	.....	1,183.8
Total butterfat production lbs.	176.4	182.5	206.0	203.0	255.0	258.4	221.3	188.3	173.2	162.4	133.3	155.6	2,315.4

* Fitch, J. B., Searles, H. R., Hanson, E. A., and Leighton, R. D., Feeding the Dairy Herd. Minn. Ext. Bul. 218. 1941.

Table 8. Estimated Value of Livestock and Livestock Products Per Farm Obtained in 1941 from Various Types of Pastures

Type of pasture	Value of livestock increases	Value of butterfat	Total returns	Acres per farm	Returns per acre
Meadows, grain, and corn fields*	$ 30	$ 87	$117	28.2	$ 4.15
Rotation	24	72	96	5.6	17.14
Open	72	241	313	22.1	14.16
Wooded	17	74	91	41.1	2.21
Total and average	$143	$474	$617	97.0	$ 6.36

* Fields from which hay, small grain, or corn had been harvested.

permanent pasture, 19 per cent from meadows, grain stubble, and cornstalk pasture, 16 per cent from rotation pasture, and 15 per cent from wooded pastures (see table 5 and figures 5 and 6). Most of the production from open permanent pastures came in May and June and the proportion credited to this source gradually decreased as more production was obtained from meadows, grain stubble, and corn fields. Rotation pastures yielded the highest returns per acre and open permanent pasture ranked second. The gross returns per acre of permanent pastures were relatively high considering that most of this production came from land which could not be used for the production of other crops. Production from pastures also involves comparatively low labor and equipment costs.

PASTURE COSTS

Five Miles of Fence Per Farm

A total of 1,546 rods of fence per farm including only the farm share[7] of the boundary fence was in use in 1941 on the 120 farms included in this study (see table 9). This was an average of 59 rods per animal unit or about eight rods per acre of farmland. The farmers estimated the average present replacement costs of posts and wire per farm at about $521 and the labor of constructing the fence at $142 per farm or an average of 43c per rod. An average of 227 rods of contour fence was built on 47 farms as a part of the soil conservation program.

Nearly 1,400 rods of fence were used for pasture enclosures, an average of 14 rods per acre of permanent and rotation pasture, or 52 rods per animal unit. The present replacement cost of this fence, including labor, was estimated at $556 for the farm or an average of slightly less than $6 per acre of pasture.

About 30 per cent of the farm fence was woven wire averaging 28 inches in height which was usually supplemented by two strands of barbed wire. Most of the barbed wire fences was made up of three strands. The cost of the woven wire fence was estimated at about 66 cents per rod as compared with 31 cents for barbed wire fence. The life of woven wire was estimated at 25 years; barbed wire, 26 years; set posts, 10 years; driven posts or stakes, 5 years.

On the basis of the estimated cost of construction and length of life, the annual cost of all farm fence would amount to $66 per farm—about 35 cents per acre of farmland. Annual pasture fence costs were $58 per farm or 60 cents per acre of pasture.

The above costs do not include electric fences which were in use on 20

[7] Each farmer usually constructs and maintains only one half of all line fences which are a part of the fence system on two adjoining farms.

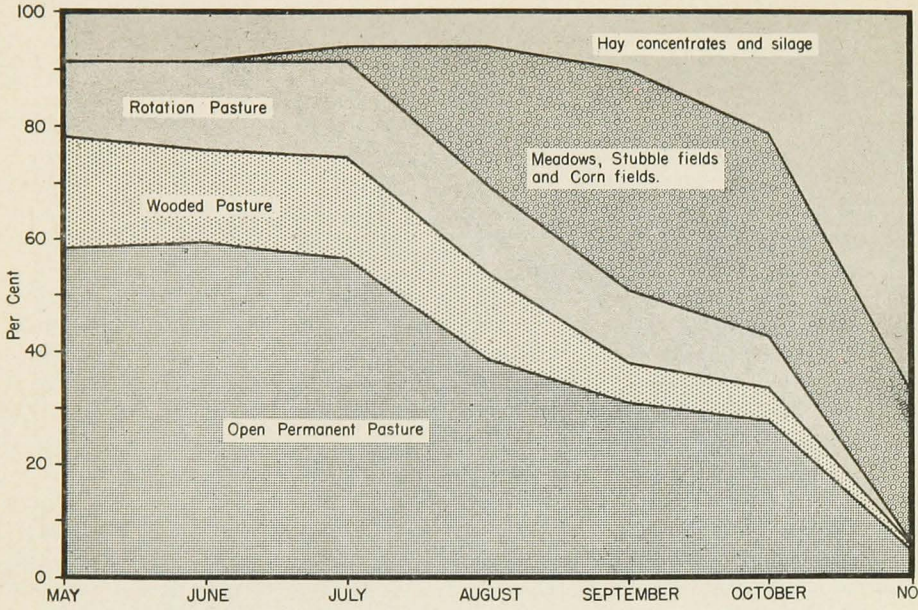

FIG. 5. Percentage of butterfat obtained per month from various types of pasture and other feed, Houston County.

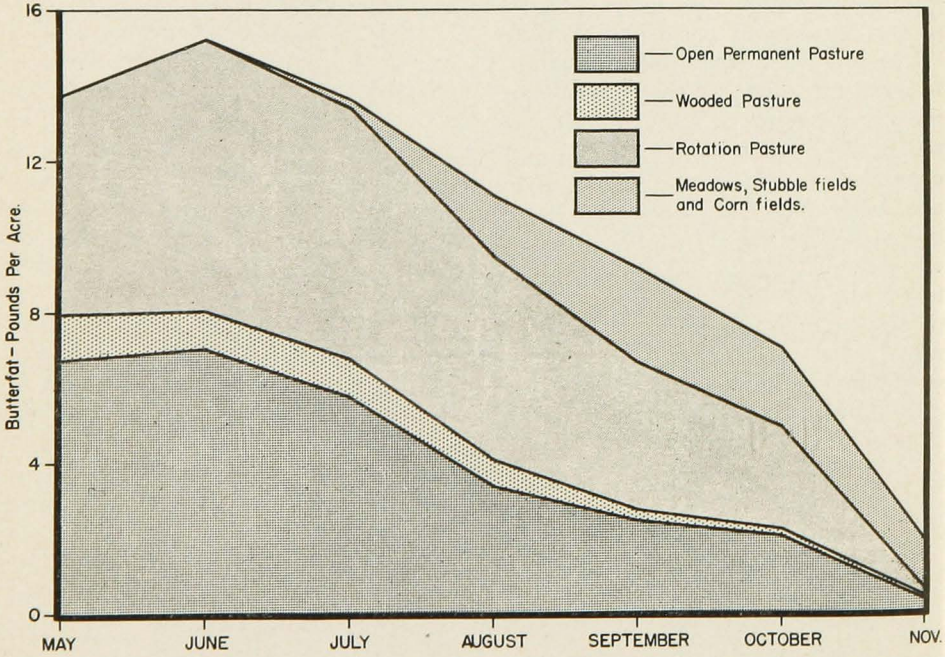

FIG. 6. Pounds of butterfat produced per acre of various types of pasture.

Table 9. Estimated Total Investment and Annual Cost of Farm Fence

	Expected life–years	Amount per farm	Investment cost: Total	Investment cost: Per rod	Annual charge
Woven wire fence					
Woven wire, 28 inch	25	516 rods	$189	$ .35	$ 7.56
Barbed wire, 2 strand	26	1,032 rods	42	.08	1.68
Posts	8.5	516 posts	53	.10	6.24
Labor, building		33 days*	64	.13	2.56
maintenance		4 days			8.00
Total costs		516 rods	$348	$ .66	$26.04
Annual cost per rod					.05
Barbed wire fence					
Barbed wire, 3 strand	26	3,181 rods	$130	$ .13	$ 4.81
Posts	8.5	1,035 posts	107	.10	12.59
Labor, building		39 days*	78	.08	2.89
maintenance		10 days			20.00
Total costs		1,030 rods	$315	$ .31	$40.29
Annual cost per rod					.04
All farm fence					
Total cost	10	1,546 rods	$663	$ .43	$66.33
Annual cost per rod					.04
Annual cost per acre of pasture		97 acres			.68
Annual cost per acre of farmland		193 acres			.35
All pasture fence					
Total cost	9.6	1,363 rods	$556	$ .41	$57.92
Annual cost per rod					.04
Annual cost per acre of pasture		97 acres			.60

* Based on farmers' estimate that it takes about 5 man-days to build 80 rods of woven wire fence and 3 man-days to build 80 rods of barbed wire fence.

farms. The average cost of electric units was estimated at about $13 and the annual upkeep at about $2. The electric units were comparatively new and no estimates were obtained as to how long they would last. The farmers were of the opinion that this type of fence was valuable for temporary use, particularly on meadows and stubble fields that were arranged in contour strips.

Fence Costs Higher on Poorer Pastures

Not only is soil erosion most severe where vegetation is scant, but fence costs are also apt to be higher per unit of livestock pastured. Annual fence costs ranged from less than $1.50 per animal unit on a group of farms with less than two acres of pasture per animal unit to over $2.50 on farms with

Table 10. Estimated Amount and Cost of Fence Per Farm and Per Animal Unit on Farms Grouped According to Acres of Pasture Per Animal Unit

	Acres of pasture per animal unit: 0–1.9	2.0–3.9	4.0 and over
Rods of fence	838	1,070	1,597
Number of animal units*	24.6	24.7	25.5
Rods of fence per animal unit	34	43	63
Annual cost of fence per animal unit	$1.43	$1.82	$2.63

* Exclusive of poultry.

Table 11. Estimated Annual Pasture Costs Per Acre, Per Cow, and Per Cow-pasture-day for Different Types of Pasture

Item	Rotation pasture	Open permanent	Wooded pasture
Assessor's valuation per acre	$37.32	$20.09	$12.25
Interest @ 4 per cent	1.49	.80	.49
Taxes @ 30 mills	1.12	.60	.37
Labor, pasturing cows*	.20	.20	.20
Fence cost	.68	.68	.68
Cost of seed†	.35	.....	.....
Annual cost per acre	$3.84	$2.28	$1.75
Acres needed per cow	1.6	2.2	5.5
Annual pasture cost per cow	$6.14	$5.02	$9.57
Days of pasture	165	153	140
Cost per cow-pasture-day	$0.037	$0.033	$0.068

* Driving cattle to and from pasture, 40 minutes per day.
† One fourth of cost of seeding timothy and clover.

four acres or more per animal unit. In some cases total fence costs per farm would be reduced if some of the unproductive pasture areas were protected from grazing. Where comparatively large amounts of fence are required to protect some areas from grazing, the costs may more than offset the benefits.

Land Charge a Major Cost

The principal items of pasture cost are land charges and fencing cost. While less time was spent in feeding and caring for livestock during the pasture season than during the remainder of the year, these farmers reported spending 40 minutes per day in driving cattle to and from the pasture. This totals 10 ten-hour days for the five pasture months, or a cost of about $20 per farm per year at the wage rate of 20 cents per hour. The annual cost of seed for rotation pasture was estimated at 35 cents per acre assuming that the seedings will last for four years.

The average annual cost per acre of rotation pasture was nearly $4.00 as compared with slightly over $2.00 for open permanent pasture and $1.75 for wooded pasture. Because the acreage needed per cow was larger and the pasture season was shorter, the cost per cow-pasture-day was nearly twice as high for the wooded pastures. According to these estimates the cost per cow-pasture-day of open permanent pasture was slightly lower than for rotation pasture.

APPLICATION OF DATA

Pasture Program Important

Permanent pastures in southeastern Minnesota are frequently overgrazed even though the pasture acreage per farm is relatively large. Since the acreage of permanent pasture is determined largely by soil and slope conditions, the adjustment of pasture supply to the needs of livestock is ordinarily made by varying the acreage of temporary pasture. Planning the pasture program, therefore, involves obtaining estimates of (1) the carrying capacity of permanent pastures available on the farm, (2) the pasture needs of the livestock for the farm, and (3) the acreage of rotation and emergency pastures needed to supplement permanent pastures. This procedure is equally applicable for planning pasture programs in other sections of the state even though production possibilities differ.

Table 12. Suggested Standard for Carrying Capacity of Different Types of Pasture

Type of pasture	Acres per animal unit
Rotation	1.0–1.5
Bottomland permanent	1.0–1.8
Upland permanent	2.0–3.0
Previously cropped	2.0–3.0
Wooded	5.0 acres and up

Standards of Carrying Capacity

A standard of carrying capacity for the various types of pasture based on data contained in this report has been prepared for use as a guide for pasture planning in southeastern Minnesota (see table 12). These standards are based on the assumption that meadows and small grain stubble fields will be available for pasture during the late summer and fall months. The better grades of each type of pasture obviously will support more livestock per acre than the poorer grades of the same type. In most instances a larger acreage of pasture will be needed per animal unit on the steeper slopes than on the less sloping land. The acreage of pasture should be large enough to provide an ample supply of forage for years with slightly less than normal rainfall. Good grass cover obtained in this way will prevent soil losses and decrease the rate of water runoff, particularly on the steeper slopes. Emergency pastures and supplementary feed may be needed for seasons of more serious drouth. While pasturing woodlots is not recommended, precautions should be taken to prevent overgrazing if it becomes necessary to pasture these areas.

Long Pasture Season Desirable

A long pasture season is desirable because pastures provide feed at relatively low cost. An ideal pasture program provides continuous as well as ample grazing throughout the entire pasture season. Permanent bluegrass pastures in southeastern Minnesota usually provide good pasturage in the spring and early summer, but they produce comparatively little forage during the months of July and August at which time many pastures are overgrazed. Under good pasture management, legumes in renovated areas of permanent pastures usually will provide forage during this period. Meadows and grain

Table 13. Acreage and Carrying Capacity of Different Types of Pasture Illustrated in Problem

Type of pasture	Acres available	Acres needed per cow	Total number of cows
Upland renovated	8	1.6	5
Upland permanent	10	2.5	4
Bottomland	3	1.5	2
Total for permanent pasture	21		11
Rotation pasture needed	6	1.5	4
Total	27		15
Supplementary summer and fall pasture			
Timothy and clover, second crop	14		
Alfalfa, second crop	20		
Small grain stubble fields	20		
Cornstalk fields	20		

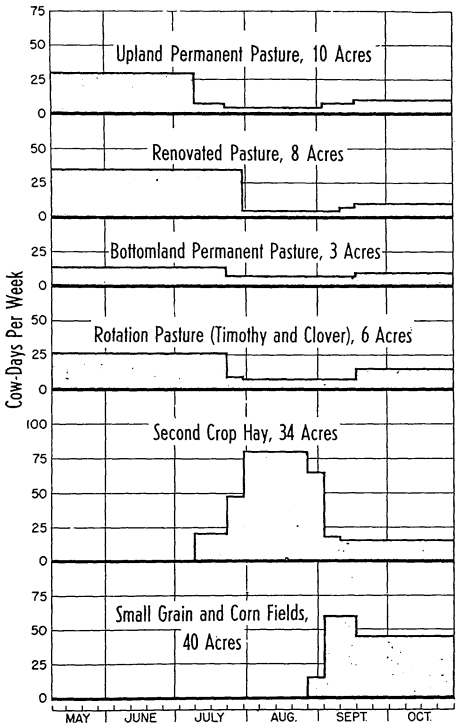

FIG. 7. Pasture program for 15 dairy cows based on assumed acreages of various types of pasture.

stubble may also be used to advantage as supplementary pastures during this period as well as later in the season.

Estimating Acreage Needed for Pasture

The pasture program on a farm should include: (1) full utilization of land best suited for permanent pasture, (2) sufficient rotation pasture to provide adequate pasturage for livestock, and (3) utilization of available meadow and crop aftermath for pasture purposes. For illustrative purposes, a pasture program has been developed for a farm on which permanent pastures are inadequate for the needs of the livestock on the farm. The acreage in pasture and the number of acres of each type required per cow is shown in table 13. In this case, 21 acres of permanent pasture, 8 acres of which have been renovated, and as much of 20 acres of timothy and clover as is needed are available for pasturing 15 dairy cows. The balance of the timothy and clover and 20 acres of alfalfa may be pastured after the first cutting of hay has been harvested. It will be possible to pasture 20 acres of small grain after harvest as well as 20 acres of cornstalks after the corn has been picked.

Estimates of the carrying capacity for the different types of pastures on the farm were obtained by dividing the total acreage by the number of acres needed per cow. According to the estimates made, permanent pastures will furnish pasturage for 11 cows (11/15 of the amount needed) and the additional pasture must be provided for the equivalent of four cows. Six acres of timothy and clover, with a carrying capacity of 1½ acres per cow, will provide the additional forage needed for the 15 cows during the early part of the season. Hay, small grain, and corn fields will provide supplementary pasturage later in the season after the crops have been removed. If the second crop of alfalfa, timothy, and clover is cut for hay, Sudan grass or spring-sown sweet clover may be used for supplementary pastures during July and August.

The seasonal grazing program for the pasture problem developed in the preceding paragraph is shown graphically in figure 7. The important place of meadows in filling the gap in pasturage supply in July, August, and September is clearly shown.

SUMMARY

THE Houston County area covered in this study typifies a sizable portion of southeastern Minnesota where the land lies mainly in steep, narrow ridges and deep, narrow valleys. Pastures occupy one half of the land in the county and provide from one third to one half of the annual feed for livestock. Nearly all the pastures studied were on steep slopes or on land that was otherwise unsuited to cultivation. About two thirds of it was wooded.

According to farmers' estimates one acre of rotation pasture was equal in carrying capacity to 1.5 acres of previously cropped and open permanent pastures, or to 2.6 acres of wooded pasture. Tests showed that both yield and the amount consumed were greater on the moderate slopes than on the steeper.

Farmers' estimates indicated that 50 per cent of the livestock production from pastures came from open permanent pastures, 19 per cent from crop aftermath, 16 per cent from rotation pasture, and 15 per cent from wooded pasture.

A total of 1,546 rods of fence, including only the farm share of boundary fence, was in use per farm in 1941. The annual cost of fence was $66 per farm or 35 cents per acre.

Not only is soil erosion most severe where vegetation is scant, but fence costs are also higher per unit of livestock pastured. Annual fence costs ranged from less than $1.50 per animal unit on farms with less than two acres of pasture per animal unit, to over $2.50 on farms with four acres or more per animal unit.

Interest on investment, taxes, and fence maintenance are the principal costs in pasture production, averaging about $4.00 per acre for rotation pasture, $2.00 for open permanent pasture, and $1.75 for wooded pasture.

To provide adequate, continuous grazing for a long season requires a well-planned pasture program consisting of available permanent pasture, renovated if possible, supplemented with rotation and emergency pastures and meadow and other crop aftermath.