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Measuring the Productive Value of Pastures

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FOREWORD

The position which pastures occupy in the agriculture of a country changes as that country grows older. In pioneer stages when there is an abundance of land, much of it not utilized, pasture usually exists as open range without regard to the quality of the land producing that pasture. As the land becomes settled and divided up into farms, each operator is confronted with the necessity of deciding whether the various acres within his farm should be regarded as arable land or pasture and woodland. These judgments are always exercised, sometimes well and sometimes badly. As time passes and generations come and go, much of the land is farmed in arable crops and the process of soil depletion begins. In the early stages of the development of a region, farmers consider that the highest use to which the land can be put is in tilled crops which may be harvested and sold as cash crops. As time passes, more and more of the harvested crops are fed on the farm. Sometimes the management reveals a very complete regard for the factor of depletion. More often, however, crops are harvested and fed or sold without regard to the maintenance of the productivity of those lands. Thus year after year yields on the arable acres tend to decline. Finally the cost of the declining yield becomes sufficiently great that the operator concludes that his best interest lies in using the land for pasture. Then he seeds this land down and returns it to pasture uses similar to those it enjoyed before it was ever cleared or broken out of sod. There are undoubtedly times before this land is restored to pasture use when it would have been in the interest of the farmer to cease using the land for harvested crops, but his information concerning the net advantage of tilled crops as compared with pasture was insufficient to cause him to shift that land use as quickly as his long-time interest might have justified.

There are of course many instances where lands are more or less regularly shifted from intertilled crop uses to small grain and finally pasture, purely because of the farmer's recognition that rotation of crops and rest for the land which comes with pasturage is a proper use for that land. Many of the lands that have finally been restored to pasture and range use will remain in such use for a long time. The pressure of necessity eventually forces us to a classification of land more nearly in accordance with nature's intent and thus we rectify mistakes which were made by our ancestors in their assumption that land would not wear out.

More recently the development of pasture farming involving the continuous use of pasture crops or one-year rotations combining a grain or hay crop with the pasture has greatly increased the significance of pastures on all but our best lands. This development is the result chiefly of the introduction of lespedeza and the breeding of more quickly maturing crops like Missouri beardless barley. This development has been of particular significance in our medium and poor grade land areas from the standpoint of both conservation of the productivity which is still in the land and the restoration of many acres which have been depleted to the point where they could no longer provide an acceptable living for those who were forced to farm them. The net production of such lands has been increased in many instances in an almost unbelievable way. This shift on our medium and poorer lands, from a situation where the product was not paying for the effort required to one where much less effort resulted in equal or greater production at a surprisingly large margin above cost, has made very necessary some careful studies of what this change amounts to under farm conditions. Thus it is hoped that analyses like the one here reported will be used in conjunction with experimental results obtained under carefully controlled conditions to encourage the operators of our poorer or seriously exhausted lands to rapidly adopt these more conserving but also more profitable pasture farming practices.

Pasture as such has some peculiar characteristics. Unlike small grain or corn, the pasture crop is difficult to harvest in any way except with livestock. Because it must be utilized on the ground where it grew, the number of bidders for that pasture land is definitely limited, particularly in areas where farms consist of relatively small acreage. Thus a man with cattle to graze would not be interested in bidding on a 10- or 20-acre pasture field on a 160-acre farm, particularly when that farm is located at some distance from the headquarters of the owner of the cattle. Thus only the immediate neighbors are prospective buyers of the crop. The result is that in many communities in Missouri and other corn belt states pasture is hard to sell and the price compared with the real value of the feed is very low. This makes pasture cheap feed for the man on whose ground the pasture grows.

There is still another aspect. There are many fence rows, draws, and other farm areas where pasture grasses, particularly bluegrass, grow abundantly. Often these restricted areas can not be used in the growing season, but are very well utilized after the principal crop is harvested. This ground, often classed as waste land and given very little maintenance attention, becomes rather productive land if it can be grazed when crops in the adjoining fields are out of the way. This results in considerable income to the livestock producer on the farms of which the family farm is representative.

Another source of revenue from pasture is the aftermath from crops like timothy cut for hay or grasses in stubble following a small grain crop. Even though the net return may be small, this income added to that derived from the principal crop grown on that land in a particular year adds materially to the income realized from the land. There are also other crop residues which have no realizable market value but which have a real value if the farm operator is in a position to utilize them through grazing livestock.

All of these considerations are in the picture and when they are assembled and the net gain computed for a typical farm, the income thus realized adds materially to the net income gained from the operator's other activities.

On every farm where the operator is confronted with a serious decline in productivity of the crop lands, this factor becomes of greatly increased importance. It is with the idea of emphasizing this importance of pasture crops and aiding farm operators to arrive at a more accurate appraisal of the relative gain from pasture crops as compared with intertilled crops that this study has been inaugurated. Another objective which may sometimes be of great significance, particularly when production control is in the agricultural picture, is the influence of these pasture crops in contributing to the total production of animals and animal products.

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Acknowledgment is also due those members of the Advisory Committee, under which this work was conducted, for their guidance and advice throughout the period of study. This Committee included Dean M. F. Miller, Professors W. C. Etheridge, E. A. Trowbridge, A. C. Ragsdale, and O. R. Johnson.

Measuring the Productive Value of Pastures

Homer J. L'Hote

PURPOSES OF STUDY

The major objective of this research study was to develop some means whereby pasture productivity may be measured under farm conditions. As soil conservation and production control play an increasing part in the administration of our agriculture, the need for taking into account production volume resulting from pastures and pasture crops assumes greater and greater significance.

It is because of the importance of pastures in Missouri agriculture that particular emphasis has been placed on the problem of measuring pasture productivity. The solution of this problem will be of benefit not only for the service rendered in production control but specifically for the individual farmer in order that he may have a more accurate knowledge of just what he can expect from his pastures and what the production of those pastures may contribute to the value of his farm. It is thought that pasture lands well handled may have a much greater real value in the production program than is usually reflected in land values attributed to these pasture lands.

THE PLAN OF THE WORK

Under the general direction of a committee representing all livestock, soil, and crop production interests in the Experiment Station, seven representative areas were chosen as the scene where this measurement of pasture productivity would be attempted. These regions represent major soil and type of farming areas and are shown in Figure 1. Specifically the areas are as follows: Nodaway county, representing the meat producing and fattening area of Northwest Missouri; Sullivan county, with less fattening of livestock but more grazing and a rather high level of young stock production; Marion-Monroe counties, representing the Northeast Missouri small grain, hay, and pasture region; Pettis county representing the West Central Missouri livestock and grain area; Vernon-Barton counties, representing the Southwest prairie with considerable grain but also quite a lot of livestock grazing; Lawrence county, representing a more intensive livestock system of farming with emphasis on dairy and poultry products; Texas county as representing a rather high quality of livestock farming in the Ozark highlands and on lands of relatively modest production.

In each of these areas there were a number of records of a survey type from adjoining communities, but still representing that area and giving perhaps a better picture of the area than would be gleaned from just the records of the particular county or counties

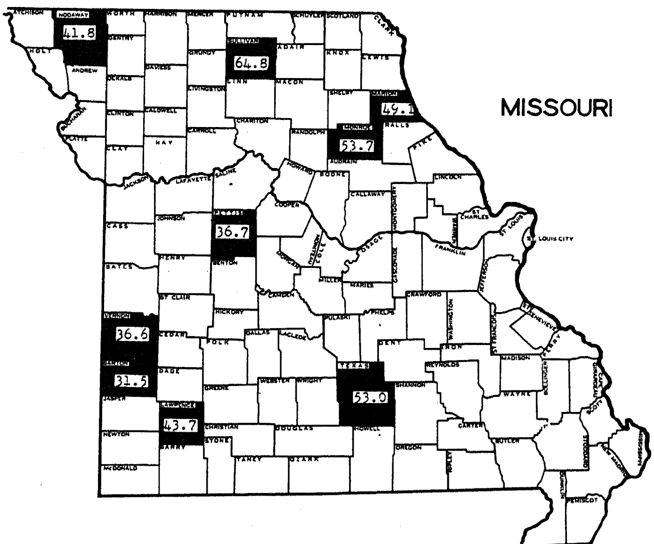

Fig. 1—Per Cent of Land in Farms in Pasture. (United States Census, 1940).

in which the work was centered. Data were collected over a three-year period, 1936-38 inclusive. Because of the season the 1936 data were of little value for measuring pasture production as the dry weather reduced significantly the production from pasture lands in that year. Consequently, the analysis presented in this report will be for the years 1937 and 1938.

DESCRIPTION OF AREAS STUDIED

In selecting the areas indicated above, great importance was attached to the soil types of these areas, as soil type is probably the largest single determinant of type of farming. Figure 2 shows the type of farming areas with the particular county represented indicated with a heavy box surrounding that county's name. Table 1 shows the major soil types in each of the areas. The first four areas listed in Table 1 are in the northern more strictly meat producing region of the state. There is quite a range of soils in these regions and consequently in crop adaptations. Briefly the characteristics of the various soils are as follows:

(1) The Marshall-Wabash soils of Nodaway county constitute perhaps the most important soil type in the State from a productivity standpoint. The Marshall soil is an upland soil of gently rolling to rolling topography, and therefore inclined to erode although its water absorbing capacity is fairly high. General farming is the chief system followed in this area, with emphasis on livestock. The standard cropping system consists of corn for two or more years, followed by oats, and this by grass, usually timothy or legume generally used for meadow and pasture for two or more years. There are many permanent pastures in this region mostly on the rougher

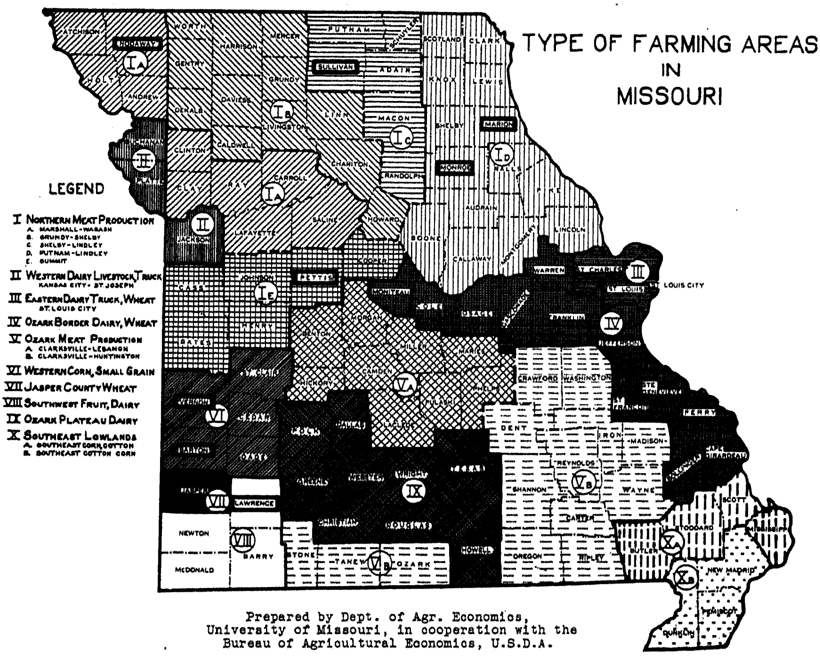

Fig. 2—Location of Areas Studied Within Type of Farming Areas.

TABLE 1. -- MAJOR TYPES IN THE AREAS STUDIED

County	Major Soil Types
Nodaway	Marshall, Wabash
Sullivan	Shelby, Lindley
Marion	Putnam, Lindley, Memphis
Monroe	Putnam, Lindley
Pettis	Summit
Vernon-Barton	Cherokee, Bates
Lawrence	Baxter, Avilla
Texas	Clarksville

ground but not exclusively so. The Wabash soil is a river bottom soil and is used mainly for the production of cash crops and rotation or supplemental pastures.

(2) The Sullivan county area is characterized mostly by Shelby soils, although the creek bottoms through this area have considerable acreages of Wabash, with some Lindley and a little Grundy soil in certain parts of the area. The country is generally rolling to moderately hilly. Shelby soil is one of the most badly eroded soils in the State. In its better phases it is highly productive corn soil and has been used excessively for corn production to the very great

detriment of the soil. There are many excellent bluegrass pastures in this area. A typical rotation found on the farms studied was corn two or three years followed by oats, seeded to timothy and clover and left in timothy and clover sod for from two to six years after the oats were harvested. Sometimes hay was cut, but most of the time the land was grazed. There are more acres of bluegrass pasture in this area than in all small grain crops combined. The spots of Lindley in this area are rough, broken tracts, very badly eroded and much less fertile than is the Shelby soil. Lindley is generally regarded as a grass soil and particularly well adapted to grazing classes of livestock.

(3) A very important section of the State is represented by Marion and Monroe counties, whose soils are predominately Putnam and Lindley. There are limited acreages of Memphis' in Marion county, and narrow strips of Wabash along the larger streams in both Marion and Monroe. The Putnam soils vary in topography from level to gently rolling. Lindley has already been described briefly. The most important crops are corn, grass, oats, and wheat. Bluegrass once covered a large portion of the area, but after being farmed for many years the land is difficult to get seeded back to bluegrass. The type of farming is very general, with more emphasis on grazing and feeding of livestock rather than the production of cash crops. Some dairying is found in the Marion county portion of this area.

(4) The Pettis county area is characterized by Summit Silt Loam as the dominant soil. Topographically this area is gently rolling, but even so it has had considerable damage from erosion. The type of crops grown is very similar to that in Area 3, except that wheat is much better adapted and will be found in more cases than in Area 3. Kentucky bluegrass grows readily in this area, and furnishes excellent pasture a large portion of the year. Because this region is rather easily accessible to the heavier corn producing areas to the north, it early developed into a very important cattle feeding area. At the present time there is less cattle feeding, but this enterprise along with the growing and fattening of hogs is still an important part of the farming plan.

(5) Examination of the Vernon-Barton county area reveals that this area is characteristically a small grain and grazing area. It is similar to the wheat lands a little farther west. The chief soils are Cherokee and Bates, the former being very level and covered with prairie grass sod in its natural state. Considerable corn, soybeans, and kafir are produced in addition to wheat, although this is not a good corn area. The Bates soil is more variable in topography. Some parts may be very level and others distinctly undulating. This area does not have as much livestock as is true of the preceding four areas described. Wheat is used exclusively for a cash crop, and

frequently the corn grown is also sold for cash. Some livestock feeding is practiced but this is not a major enterprise.

(6) Lawrence county is regarded as very representative of the Southwest Missouri fruit and dairy farming region. The soils are chiefly Baxter and Avilla soils. The Baxter soil is a rather productive soil, distinctly red in color, and topographically undulating to moderately hilly. Much of the Baxter soil is left in permanent pasture, only about one-fourth or one-third being used for tilled crops. Grass mixtures and legumes do exceptionally well on this soil, and with good pasture management will support a heavy livestock population. For the most part dairying was the major enterprise on the farms studied, although a few hogs and beef cattle were produced. The Avilla soil is closely related to Baxter but is not as rough nor as red in color, nor is it as productive as is the Baxter.

(7) The last area studied, namely that represented by Texas county, is the Ozark Plateau dairy farming region. Clarksville soils are characteristic of this area, sometimes being gravelly and other times actually stony. Most of the land is devoted to permanent pastures with a relatively small portion regarded as tillable. Row crops, small grain, and lespedeza are the chief crops harvested. As this indicates, farmers must depend on the small per cent of tillable land to produce the necessary winter roughages and they expect to buy most of the concentrates necessary to carry on dairy farming operations which represent the chief industry of this area.

METHODS OF OBTAINING INFORMATION

The same plan of work was used in all of the areas. It involved a considerable amount of detail in record keeping and in recording observations on the farms cooperating. Among other items was included a farm map showing field layout, acreage, land-use pattern, kind of fencing, water supply, type of soil, amount of erosion, per cent slope, kind of pasture grown, grasses and other plants comprising the pasture growth, kind of weeds present, etc. The records which were kept from week to week included descriptions of the kind of livestock kept and their weights, the length of time animals were on certain pastures, amount of supplemental feeds given to the stock while being pastured, the yield of livestock products—milk, cream, gain in weight, etc.—and the extent to which pasture crops were utilized and certain observations on weather and other conditions affecting pasture growth. Field men were provided to make frequent calls on cooperating farmers to check records, make additional observations, and see that all records were kept up to date. The original intention was for these field men to visit each farm approximately twice each month. Because of the large amount of detail which was required and the number of cooperators desiring to help with the study, it was found that

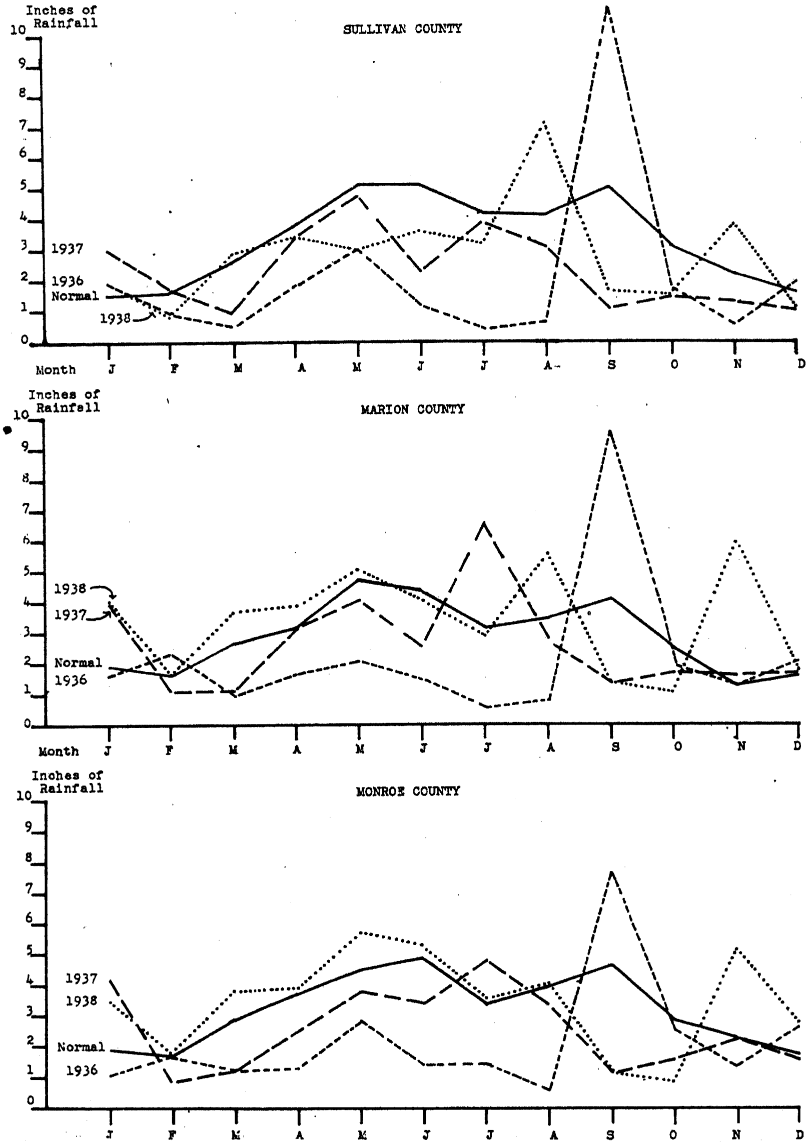

Fig. 3—Rainfall by Months in Inches.

actually only one visit a month was about as much as the field men could accomplish. However, under this system the records were kept up in fairly good shape. In addition to the observations on pastures and the production therefrom, farmers kept a fairly complete financial record.

As indicated earlier, the weather has a very marked effect on any studies of pasture crops. Thus while this work was intended to

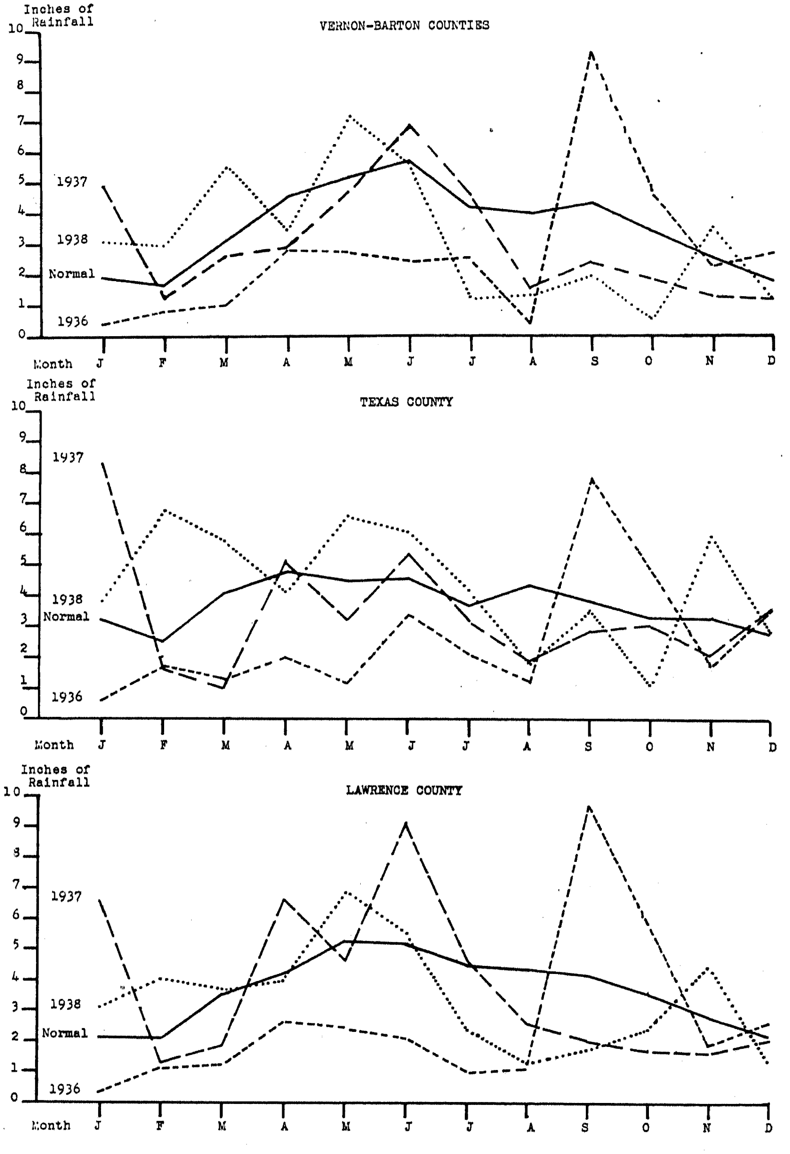

Fig. 4—Rainfall by Months in Inches.

cover one or two years, the exceedingly dry season of 1936 made pasture records for pasture crops other than spring rotation and supplemental pastures worth very little. Records for the main pasture season were particularly handicapped because of dry weather. This involved mostly permanent pastures, so that wherever permanent pastures formed a major part of the pasture system the data became more or less useless. Likewise the drouth of 1936

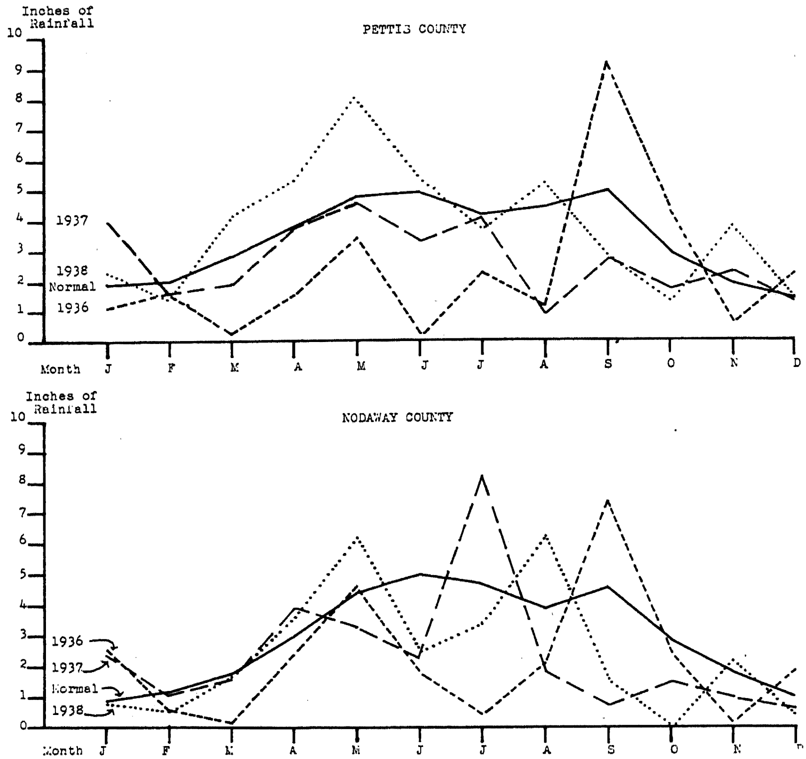

Fig. 5—Rainfall by Months in Inches.

was sufficiently severe to decrease the effectiveness of permanent pastures even in 1937. The grazing of small grain in the fall of 1936 proved of considerable help to farmers since rains began early in September of that dry year. It is felt that the 1936 records may have considerable value in showing what actually happened to farms and farm production during a serious dry season, and how farmers worked to minimize the effects of such a season. This analysis has yet to be made. For the pasture year 1937 there were several instances of rainfall below normal, but because of a practically normal rainfall in July the pasture data for 1937 has considerable merit. It is regarded as desirable that the study be carried on for additional years until seasonal difficulties are largely eliminated and the material, therefore, becomes more representative of average seasonal conditions.

There was some slight difficulty with the rainfall situation in 1938 toward the end of the year. Rainfall deficiency in the fall months undoubtedly reduced the benefits the farmers derived from fall grazing in 1938 as well as 1937. Figures 3, 4, and 5 show by months the rainfall in each of the areas for each of the three years,

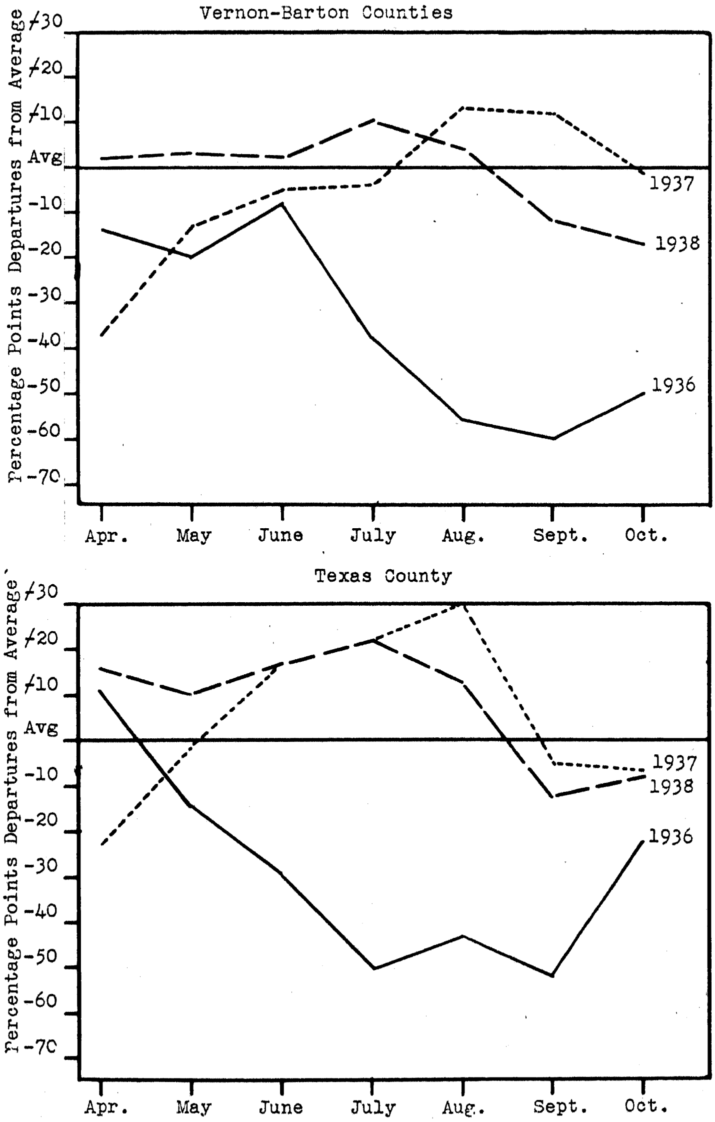

Fig. 6—Monthly Deviations in Pasture Condition from the 20-Year Average (1921-1940) for the years 1936-1938.

NOTE—Figures 6 to 9 inclusive are based on unpublished data, Agricultural Marketing Service, U. S. Department of Agriculture. In all cases pasture condition is reported as of first day of month. April data show deviation from 16-year average only.

as well as the normal rainfall for that area. These data were furnished by the United States Weather Bureau.

A better picture of pasture conditions in the areas for the years 1936, 1937, and 1938 is shown by Figures 6, 7, 8, and 9 which show the monthly deviations in pasture conditions from the 20-year

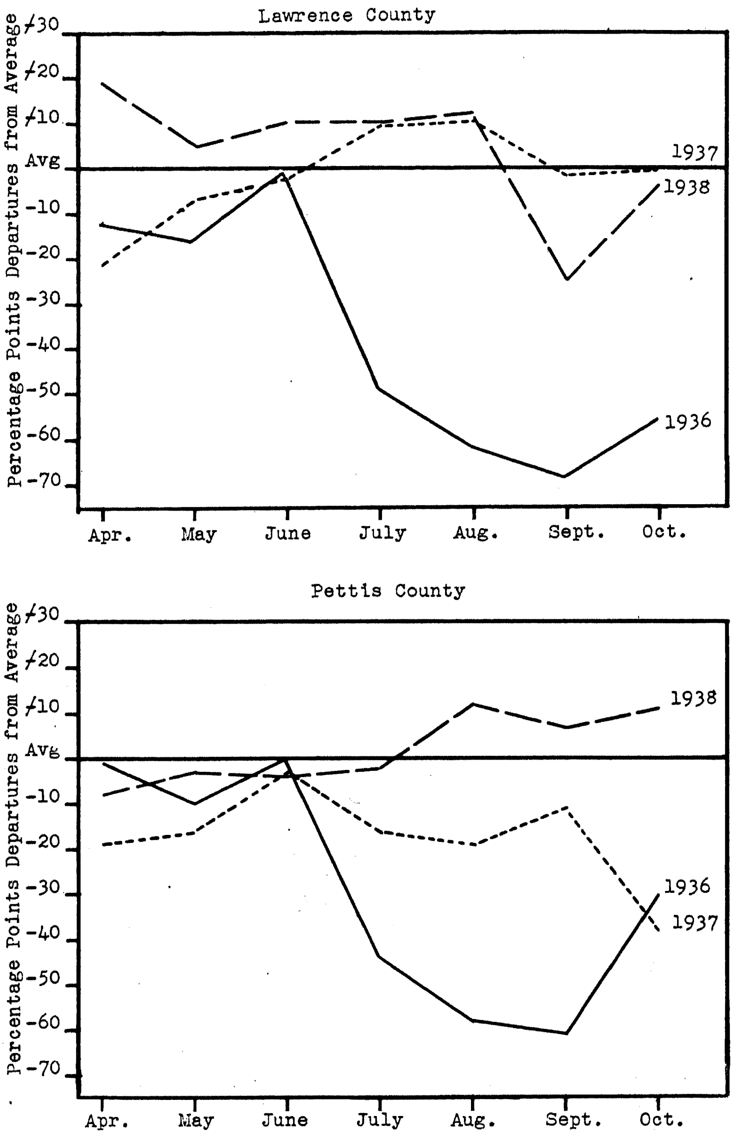

Fig. 7—Monthly Deviations in Pasture Condition from the 20-Year (1921-40 Average for the Years 1936-38).

(1921-40) average for the years 1936-38. These charts are based on unpublished data by counties furnished by the Columbia, Missouri, office of the Agricultural Marketing Service, United States Department of Agriculture.

For more than a half century the monthly crop schedules of the Agricultural Marketing Service have carried questions on pasture condition in percentage of normal during the pasture season.

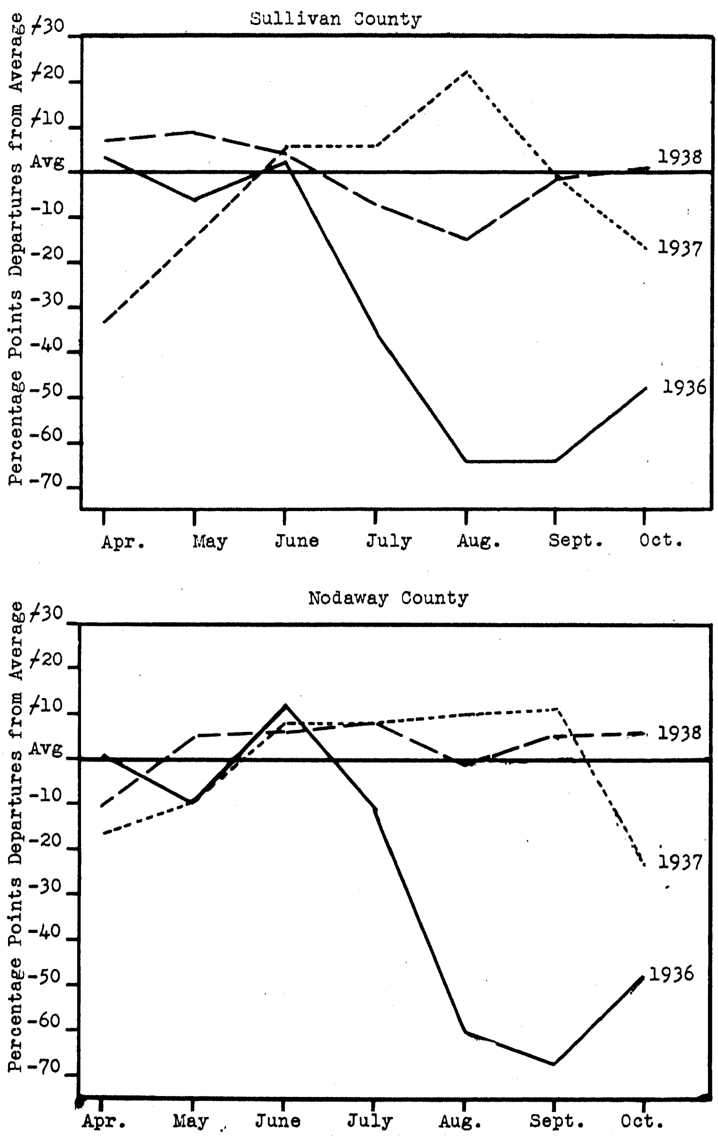

Fig. 8—Monthly Deviations in Pasture Conditions from the 20-Year (1921-40 Average for the Years 1936-38).

The condition of pastures in 1936 was decidedly below average from July 1 to October 1. Previous to July 1, the condition approximated average—in a few areas it was below, while in other areas it was above average.

In 1937 the condition of pastures on April 1 was below average in every area. In Pettis county the condition of pastures was below

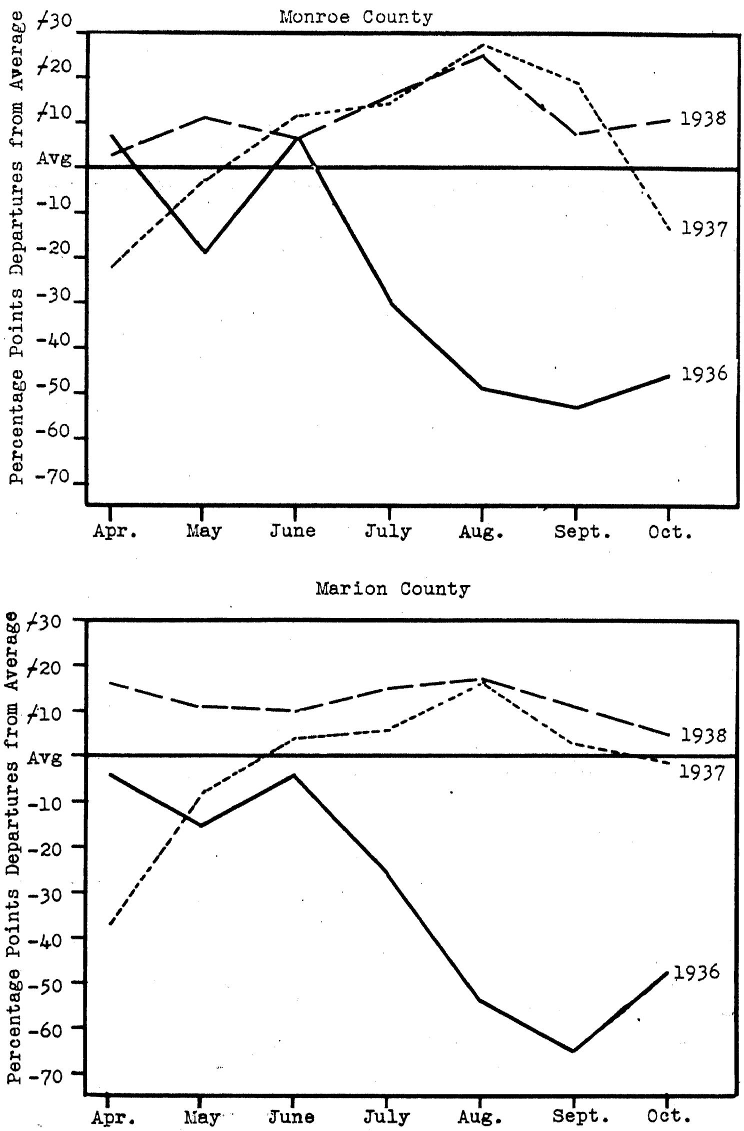

Fig. 9—Monthly Deviations in Pasture Condition from the 20-Year (1921-40 Average for the Years 1936-38).

average throughout the pasture season. In most of the areas the condition was above average from June 1 to September 1. The fall drouth began in September and on October 1 pasture conditions were again below average in every area.

In the Vernon-Barton, Texas, and Lawrence county areas pasture conditions in 1938 were above average until August, but below for the remainder of the pasture season. Pastures were about average in Nodaway but above in the Marion-Monroe area throughout the year 1938. Sullivan county pastures suffered the usual July and August setback, but were about average for spring and fall. The Pettis area was slightly below average the first part of the season, but above average the last half of the pasture year.

COMPUTING THE PRODUCTIVITY OF PASTURE

The original plan called for the direct computation of gain in weight or output of product while the animal was on pasture. If this information could be obtained from the records, it would be a simple process to convert gains in weight or production of milk or other product into some common unit, such as corn equivalents.*

For illustration, if the amount of feed required to produce 1000 pounds of beef is known and if a pasture produces that amount of beef, then the feed value of that pasture could be determined. However, conditions must be more highly controlled than those found on most farms to permit this direct computation. In most cases scales were not available, various types of animals ran on the same pasture and frequent changes in numbers occurred. While the product of the pasture in the form of gains in weight and milk produced could be determined, such products as wool and simply maintenance of the animal body as in work stock, presented another problem. Usually it is not practical for farmers to duplicate experimental grazing conditions where just one class of livestock is used on a restricted area and where grazing can be highly controlled. Farmers have further difficulties. Livestock may be fed supplemental feeds while on pasture. When a farmer's pasture gets short it may not be practical to reduce the amount of livestock or move some of the stock to another field, because he does not have the additional field or his stock may be permanent breeding stock which must not be sacrificed. Thus the problem resolves itself into one which is practical under actual farm circumstances. Therefore, the feed requirement used in this study was the amount of feed necessary to maintain the animal and produce the gain in weight or the livestock products produced by the animals while on pasture.

Morrison's feeding standards† were used in working out these requirements. After deducting the corn equivalent value of the feeds fed while on pasture from the total feed requirement, the remainder measures the contribution of the pasture to this requirement and consequently gives the value actually realized from the pasture. The limitations and imperfections of this method are fully realized; nevertheless some method adaptable to actual farm conditions had to be used and the results of the use of this method lead one to believe that it is adapted to these conditions and will give accurate results if the number of records obtained is sufficient.

*A corn equivalent is an amount of feed having a net energy value equivalent to that of one bushel of No. 2 dent corn.

†Morrison, F. B., *Feeds and Feeding*, 20th Edition, pp. 1004-1008.

TABLE 2. -- CALCULATION OF THE PRODUCTION OF A 20-ACRE PERMANENT PASTURE

	Dairy Cows	Heifers	Calves	
10 Dairy cows -- 70 days grazing each	700 da.			
2 Heifers -- 70 days grazing each		140 da.		
2 Calves -- 70 days grazing each			140 da.	
Feed requirement per day in bus. corn equivalent	.296	.178	.117	
Total feed requirement	207.2	24.9	16.4	248.5
Corn equivalent value of feed fed on pasture:				
Corn	43.8	--	--	
Wheat bran	9.4	--	--	
Cottonseed meal	5.7	--	--	
Total corn equivalent value of feed fed	58.9	--	--	58.9
Total corn equivalent value of pasture				189.6
Corn equivalent value of pasture per acre				9.5

Table 2 is an example of the use of this method in calculating production from a 20-acre permanent pasture. This 20-acre permanent pasture was completely utilized by ten dairy cows, two heifers and two calves, each animal grazing a total of 70 days. The total feed requirement for this 70-day period for the dairy cows was 207.2 bushels of corn equivalent; for the heifers, 24.9 bushels, and for the calves 16.4 bushels. The total feed requirement for all cattle amounted to 248.5 bushels of corn equivalent. Total feed fed to the dairy cows amounted to 58.9 bushels of corn equivalent. The amount obtained from pasture is the difference between the total feed requirement and the amount of feed fed while on pasture. This difference amounted to 189.6 bushels of corn equivalent or 9.5 bushels per acre. This method can be used on any type—permanent, rotation, or supplemental—or kind of pasture and with any kind of livestock. If a crop is not completely pastured out on a particular field, it is a means of measuring the production that is secured from the field in the form of pasture.

METHOD OF CONVERTING VARIOUS FEEDS TO A COMMON FEED UNIT

In order that various feeds may be readily combined it is necessary to convert all feeds to a common denominator or a feed unit. Usually the base for a feed unit is one pound of grain such as corn, barley, wheat, etc., and other feeds are given values relative to this. However, in this study the feed unit base used is one bushel of

No. 2 dent corn. A feed unit is then called a corn equivalent, and other feeds are given values relative to one bushel of corn.

The two common bases for comparing feeds (and consequently calculating corn equivalent values) are (a) total digestible nutrients, and (b) net energy value of feeds. Under the system using total digestible nutrients, feeds are valued in accordance with the amount of digestible nutrients—protein, carbohydrates, and fat—which they contain. The net energy system takes into account all losses in metabolism and is the actual and complete total—nutritive—energy value of a feed for a given body function.

Net energy values have been used in this study, since net energy values do take into account, in addition to other losses, losses of energy which occur in animals during the digestion and assimilation

TABLE 3. -- CORN EQUIVALENT VALUES OF VARIOUS FEEDS*
(On the Basis of Net Energy)

Feed	Corn equivalent value per unit
1 bu. No. 2 dent corn	1.000
1 bu. barley	.763
1 bu. feterita, hegari, kafir grain	.950
1 bu. oats	.468
1 bu. soybeans	1.146
1 bu. rye	.910
1 bu. wheat	1.146
1 ton alfalfa hay	18.715
1 ton barley hay	18.309
1 ton blue stem or prairie hay	16.640
1 ton red clover hay	19.301
1 ton sweet clover hay	19.301
1 ton clover and timothy (mixed) or mixed hay	17.317
1 ton corn stover	10.778
1 ton kafir, sorgo, cane, or hegari fodder	13.461
1 ton cowpea hay	18.399
1 ton Korean lespedeza hay	19.436
1 ton oats hay	15.648
1 ton straw	8.523
1 ton soybean hay	17.362
1 ton sudan or cane hay	15.333
1 ton timothy hay	15.874
1 ton millet hay	16.280
1 ton redtop hay	15.693
1 ton wheat hay	14.701
1 ton crimson clover hay	17.587
1 ton silage	7.824
100 lb. wheat bran	1.346
100 lb. cottonseed meal	1.630
100 lb. linseed oil meal	1.734
100 lb. cane molasses	1.254
100 lb. soybean oil meal	1.822
100 lb. meat scraps	1.635
100 lb. tankage	1.729
100 lb. wheat brown shorts	1.549

*Computed from Morrison, F. B., Feeds and Feeding, 20th Edition, Table II, p. 995.

of feed and since these values are more correct in evaluating roughages.

Using No. 2 dent corn as a base, the corn equivalent values of other feeds may be calculated as follows: There are 44.35 Therms of net energy in one bushel of No. 2 dent corn. A feed which furnishes 44.35 Therms of net energy is, therefore, equivalent to one bushel of corn. There are 20.77 Therms of net energy in one bushel of oats, therefore one bushel of oats is equivalent to .468 bushels of corn. There are 50.82 Therms of net energy in one bushel of wheat, therefore on bushel of wheat is equivalent to 1.146 bushels of corn.

The method described above was used in working out the corn equivalent values of the feeds listed in Table 3. This table includes most of the feeds in common use, both roughages and concentrates. When mixtures of two or more feeds were fed, the corn equivalent value of the mixture was calculated by determining a weighted average of the various feeds in the mixture. Feeds on which the net energy values were not obtainable and which were fed on the farm were given corn equivalent values of some feed which was similar to the feed in question. These feeds were not included in the table because usually there was only a very small volume fed in each case.

To secure a more complete evaluation of a feed, other factors than the amount of energy or total digestible nutrients furnished by the feed must be considered. The amount of digestible protein, the vitamin and mineral content, and the general suitability of each feed for that class of livestock must all be given due attention.* The imperfections of the net energy system of evaluating feeds should be appreciated; nevertheless, it should be recognized also that a method may be distinctly useful, although it may not be perfect, particularly in a field in which perfection is probably an unattainable ideal.

DETERMINATION OF THE FEED REQUIREMENTS FOR THE VARIOUS CLASSES OF LIVESTOCK

Before attempting to determine the amount of nutrients an animal may secure from pasture in a day's grazing, it is necessary to know the average feed requirement necessary to maintain the body and to produce any gain or product. Morrison's feeding standards were used as a base for determining the feed requirements for an animal in each class of livestock on an average farm. For example, in the determination of the daily feed requirements for a *family milk cow*, an average family milk cow was estimated as weighing 1,000 pounds, producing annually 4,695 pounds of milk averaging 4.26 per cent butterfat. This was the average annual production of milk cows in Missouri. A 1,000 pound family milk cow requires 6.74 Therms of net energy daily for body maintenance. An additional 4.03 Therms of net energy are required to produce 12.86 pounds of milk per day. The total daily requirement is, therefore,

*Morrison, F. B., *Feeds and Feeding*, p. 54.

10.77 Therms of net energy or .243 bushels of corn equivalent per day. In like manner the daily feed requirements for various animals in the different classes of livestock were determined. Table 4 gives the corn equivalent requirements per head per day for various animals in the different classes of livestock.

TABLE 4. -- CORN EQUIVALENT REQUIREMENTS PER HEAD PER DAY FOR VARIOUS ANIMALS IN THE DIFFERENT CLASSES OF LIVESTOCK

Type of livestock	Corn equiv. requirement per head per day	Type of livestock	Corn equiv. requirement per head per day
Dairy cow	.296	Colts	.204
Family milk cow	.243	Other horses	.167
Beef cow	.132	Ewes and rams	.035
Bull	.140	Lambs	.026
Cattle fattened	.310	Lambs fattened	.038
Calves	.117	Sows	.090
Other cattle*	.178	30-100 lb. hogs	.054
Work stock	.256	101-250 lb. hogs	.105

*Yearling and 2-year old heifers and steers not on feed.

THE PRODUCTIVITY OF PERMANENT PASTURES

A permanent pasture is defined as one which is covered with perennial or self-seeding annual plants, which has not been cropped within the past eight years, and which is kept indefinitely for grazing purposes.

A number of different pasture plants were found growing on the permanent pastures in Lawrence and Texas counties. About one-third of the stand on permanent pastures was Korean lespedeza. Overgrazing and the drouth of 1936 killed a large part of the stand of grass. In the spring of 1937 Korean lespedeza was seeded on a large acreage of these pastures, which accounts for the high percentage of the stand being Korean lespedeza in 1937. Other plants growing on permanent pastures in Lawrence and Texas counties were Kentucky bluegrass, low hop clover, Japanese clover, white clover, orchard grass and redtop. In Vernon and Barton counties the main permanent pasture grasses were Kentucky bluegrass, redtop, and Korean lespedeza. In Pettis, Nodaway, and Marion counties the predominant permanent pasture herbage was Kentucky bluegrass. In Sullivan and Monroe counties Kentucky bluegrass was the predominant pasture grass but considerable amounts of timothy and redtop were also found growing.

Detailed grazing records were secured on 9,837 acres of permanent pasture, representing 364 fields. The details by areas are shown in Table 5.

The areas have been listed in order of the productivity of the pasture. There is no necessary relation between the index of productivity of the major soils for each area and the pasture production, partly because these pasture yields do not cover a period of time of

TABLE 5. -- PERMANENT PASTURE PRODUCTION IN 1937

County	Number of Fields	Acres	Avg. production per acre in bus. of corn equivalent
Nodaway	43	1047	18.1
Lawrence	56	828	13.6
Pettis	41	921	13.4
Marion	27	439	11.7
Monroe	60	1543	10.2
Sullivan	43	3029	9.8
Texas	62	1069	8.8
Vernon-Barton	33	961	8.0
Total	364	9837	xx

sufficient length to prevent them being influenced by seasonal variations. Additional reasons might be the tendency in the more highly productive soil regions for permanent pastures to be on soils just as productive as the crop land on the same farm, while in the less productive areas there is the definite tendency for permanent pastures to be on the poorest soils on the farm. In some of the intermediate grade soils, permanent pastures are now on lands which once were cropped but which because of depletion have been restored to permanent pasture use. The fact that there is great variation in the productivity of a given kind of pasture on any particular soil type will be emphasized in a subsequent section of this report. (See Table 6.)

TABLE 6. -- GROSS PRODUCTION VALUE PER ACRE OF PERMANENT PASTURES IN MISSOURI (IN CORN EQUIVALENTS) 1937-38

By individual counties	Lower 1/3	Middle 1/3	Upper 1/3	20-Year (1921-40) avg. corn yield
Nodaway, (N.W.)	7.45	18.92	35.22	27.7
Sullivan, (N.C.)	5.71	12.10	24.57	27.5
Marion and Monroe Counties, (N.E.)	3.87	11.39	24.58	25.5
Pettis, (W.C.)	4.28	11.72	25.53	21.9
Vernon, (S.W.) Prarie	5.69	9.43	18.19	16.1
Lawrence, (S.W.) Ozarks	4.25	13.70	23.70	20.6
Texas, (S. Central)	3.79	8.05	16.17	18.2
Ozark Area				
Texas and Lawrence	4.01	10.88	19.94	19.4
S. W. Missouri				
Vernon and Pettis	4.99	10.58	21.84	19.0
North Missouri				
Nodaway				
Sullivan				
Marion				
Monroe	5.42	13.75	27.62	26.3
State Average	4.99	11.92	25.62	xxx

In preparing this table all the permanent pasture fields were grouped according to their production; the poorest third in one group, a middle group, and the upper third in another group. For instance, in Nodaway county the poorest one-third of the permanent pastures yielded a corn equivalent production of 7.45 bushels per acre. The average production for the best third of the permanent pastures was nearly five times this much, or 35.22 bushels per acre. In Sullivan county the average production of the poorest one-third of the pastures was a little less than 6 bushels of corn equivalent, and the average for the best one-third was slightly over 24 bushels. The least variation between the poorest and the best pastures seemed to be in the Texas and Vernon areas, and the greatest variation in the North Missouri counties. If the corn equivalent yield of the better pastures is compared with the actual corn yield on the land devoted to corn in the various regions, some very important comparisons can be made. It will be found that the best pastures produced a considerably higher yield in corn equivalents than did the average corn fields. The average pasture in Nodaway county, with its Marshall-Wabash soils, yielded about two-thirds as much as the average corn land. In Sullivan county the middle one-third of the permanent pastures produced slightly less than half the average yield of corn in that county. In this county most of the corn is grown on bottom soil, while relatively little of the pasture is found on these soils. In the Marion-Monroe and Pettis areas the middle group of pastures yielded just about half as much as the average corn yield per acre. In Lawrence and Vernon counties it was considerably more than half. These areas are evidently better for pasture production than for corn production.

If the counties are grouped and refer to the Texas and Lawrence area as the Ozark area, the Vernon and Pettis area as the Southwest Missouri area, and the three North Missouri areas as representing North Missouri, the middle group of permanent pastures produced practically half as much as the average corn yield in those regions. If one were to make allowance for the difference in cost of a corn crop as compared with a pasture crop, it would undoubtedly be found that average pasture land produces cheaper corn equivalent production than average corn land. While an accurate distribution of corn acreage according to yield is not available, it is a safe assertion that the good permanent pastures in any part of the State are returning net above cost more than the corn crop on at least three-fourths of the acreage of corn grown. One other indication that this table seems to justify is that there are enormous possibilities for improvement of the productivity of permanent pastures. Also it is evident that the poorest permanent pastures in any one of the regions hardly justify the designation of pastures from a physical production standpoint; but from the standpoint of the net return per acre, even the poorest pastures will show a rather substantial return on the average value of the land as the community values permanent pasture land.

THE PRODUCTIVITY OF ROTATION PASTURES IN 1937

Land areas cropped more or less regularly within the past eight years in which all pastured crops were entirely utilized as pasture were classified as rotation pasture. The records on rotation pastures covered 155 fields, a total acreage of 1952. The number of records in any one area was regarded as insufficient in some cases to justify presenting the results by individual areas. There is one exception to this case. The acreage of timothy pasture in the four northernmost areas was sufficiently large that the record for timothy is presented in Table 7. In this table is also given the data for timothy

TABLE 7. -- THE PRODUCTIVITY OF ROTATION AND SUPPLEMENTARY PASTURE PER ACRE PER YEAR, 1937-1938 (IN CORN EQUIVALENTS)

Kind of Pasture		AREA: North Missouri		South Missouri	
		Yield per acre	Index	Yield per acre	Index
Rotation Pasture					
Timothy alone	Nodaway	30.92	166	*	
	Sullivan	25.80	139		
	Marion-Monroe	12.93	69		
	Pettis	10.31	55		
Timothy and Lespedeza		14.07	114	10.66**	86

* Not enough cases to give indicative figure.
**From Texas County only.

and lespedeza for North and South Missouri. Timothy pasture in Nodaway County produced a yield of nearly 31 bushels of corn equivalent per acre; Sullivan county almost 26 bushels; and the Northeast Missouri area and the West Central about half that amount. If all areas of the State are combined for a given type of rotation pasture, indicative yields are obtained. These are shown in Table. 8.

In the rotation pasture data shown in Tables 7 and 8 the data for the years 1937 and '38 have been included. The most productive rotation pastures in the areas studied seem to be sudan, sweet clover, and barley. These crops produced 20 bushels or more of corn equivalent per acre. Timothy, timothy and Korean, oats and Korean, and rye would fall in the middle group, while wheat pasture and Korean pasture were of considerably lower productivity.

There are certain things which should be kept in mind in connection with rotation pastures and the value which farmers derive therefrom. In the first place, the pasture season is short and a rotation pasture crop must be utilized at the proper time. Farmers are not always able to do this. Also the shorter the pasture season the more likely the effects of unfavorable rainfall will be reflected in the production of a rotation pasture. These facts are only another

TABLE 8. -- YIELDS OF VARIOUS KINDS OF ROTATION PASTURES IN 1937 AND 1938

Kind of Pasture	Number of Fields	Acres	Avg. production per acre in bus. of corn equivalent
Oats	19	265	13.1
Korean	57	967	9.7
Timothy	55	1139	16.1
Sudan	13	116	22.0
Rye	22	170	12.1
Sweet clover	20	279	21.2
Barley	18	113	20.0
Wheat	14	222	9.9
Timothy and korean	35	596	14.8

NOTE-- The relative values of these different pasture values might have been biased by the fact that their frequency of occurrence was not evenly distributed among the various counties. For example, the acreage of timothy and Korean lespedeza seeded together was largely in Lawrence and Texas counties while the acreage of timothy alone was in the areas in north Missouri.

TABLE 9. -- THE PRODUCTIVITY OF ROTATION PASTURE PER ACRE PER YEAR, 1937-38 (IN CORN EQUIVALENTS)

Kind of Pasture and Area	Lower 1/3	Middle 1/3	Upper 1/3
Rotation Pasture: Korean lespedeza			
North Missouri - Nodaway, Sullivan, Marion, Monroe	2.6	4.7	16.5
South Missouri - Texas, Lawrence Vernon, Pettis	2.7	9.3	20.9
Rotation Pasture: Small grain and Korean lespedeza pastured out			
North Missouri	6.7	12.1	29.1
South Missouri	5.9	16.1	39.3

way of saying that management and weather are very important factors in determining the value of rotation pastures. Many of the farms keeping the records were understocked, particularly in 1937, because of the preceding year of almost complete crop failure. The growth of a rotation pasture if not used for grazing is not usually carried over into the winter or a subsequent year as is often true with permanent pastures. Usually the farmer could not afford to provide additional animals just for a rotation pasture season when his farm would not otherwise be able to carry this stock. Further evidence that management plays a large part in the productivity of rotation pastures is indicated in Table 9. This table indicates that the upper third of the rotation pastures were in some cases six or seven times as productive as were those pastures falling in the lower third. Korean lespedeza in the southern half of the state shows the largest variation from the poorest to the best.

This table compares two kinds of rotation pasture; first, Korean alone and small grain and Korean completely pastured out.

THE PRODUCTIVITY OF SUPPLEMENTAL PASTURES

Land areas which were pastured and from which a crop was also harvested were classified as supplemental pastures. Small grain pastured and harvested, grasses or legumes seeded in small grain and pastured after the small grain was removed, pasturing the stubble or any growth on the area after the crop was removed are examples of crops or combinations of crops that were considered as supplemental pastures.

For the years 1937 and 1938 records were secured on 5,667 acres of supplemental pastures. Again ignoring the individual areas by grouping pastures according to the kind of supplemental pasture, the acreage covered by the sample and the productivity per acre in corn equivalent are shown in Table 10. The most productive supplemental pasture was Korean following small grain which produced

TABLE 10. -- YIELDS OF VARIOUS KINDS OF SUPPLEMENTAL PASTURES FOR THE YEARS 1937 AND 1938

Kind of Pasture	Number of Fields	Acres	Avg. production per acre in bus. of corn equivalent
Barley pastured and harvested	33	351	3.8
Wheat pastured and harvested	49	1139	3.1
Korean in small grain stubble	26	472	9.8
Small grain stubble pastured**	79	1662	5.0
Corn stalks pastured	42	905	2.4
Timothy cut for hay and pastured	44	1138	4.4
Timothy and clover cut for hay and pastured	9*	217	4.7
Rye pastured and harvested	7*	85	8.0
Sweet clover in small grain stubble	6*	90	10.6

* Insufficient number of records for an adequate sample; however, the yields are indicative of what one might expect.

**There was very little actual grazing of the stubble. This production was largely secured by grazing the grass weeds growing in the stubble and the small amount of grass and legumes (when the number of plants was insufficient to call it a satisfactory stand).

The relative values of these different pasture values might have been biased by the fact that their frequency of occurrence was not evenly distributed among the various counties.

9.8 bushels of corn equivalent per acre. No other supplemental pasture (where an adequate sample was obtained) produced more than about half this amount of production. Barley pasture from a relatively small acreage sample indicated a corn equivalent value of just under four bushels. This represents the fall and spring grazing when the livestock are removed so that the crop will mature for harvesting. The highest return, with the exception of Korean lespedeza in small grain stubble, was realized by grazing small grain stubble after the crop was harvested. Most of the grazing furnished in small grain stubble was volunteer clover, lespedeza, and weeds which came after the small grain was removed. Second growth timothy after the hay has been harvested ranked next in production to the grazing furnished in small grain stubble. Grazing furnished by wheat was about three-fourths as important per acre as that furnished by barley.

In Table 10 there are three other supplemental pasture crops listed, but the sample is too small for the data to be anything more than indicative. It is quite likely that subsequent records will change these figures materially. The important factor to be kept in mind in connection with supplemental pastures is that these pastures are almost clear gain to the livestock grower. In other words, the chief use of the land was for the crop which was harvested. These supplemental crops are extra. This can be illustrated in the following manner. Suppose a farmer sows sweet clover in his wheat and receives a yield of 15 bushels of wheat per acre. In addition to the 15 bushels of wheat he would get 3.1 bushels of corn equivalent for grazing the wheat and 10.6 bushels of corn equivalent in grazing the sweet clover following the wheat. By reducing the wheat to corn equivalents it will be found that instead of getting a return of 15 bushels of wheat from the land, he actually received 30.9 corn equivalents in the total productive value of that acre of ground that year. If he planted the wheat alone without grazing, then his return would have been 15 bushels of wheat or 17.2 bushels of corn equivalent feeding value. This illustration can be applied to any of the other crops. Or, if a typical practice of barley and Korean lespedeza is used the following results by adding Korean as a supplemental pasture would be obtained. In addition to the actual grain yield of barley, four bushels of corn equivalent value by the grazing of barley itself would be secured. Grazing the Korean following the barley yields an additional 9.8 bushels in feed value. Thus in addition to the barley crop, Korean as a supplemental pasture with the barley would contribute 13.6 bushels of corn equivalent. This, it can be seen, will add 50 to 75 per cent to the value of the product from a single acre.

SIGNIFICANCE OF PASTURE PRODUCTION

It is not easy to compare pasture production per acre with crop production per acre. Nevertheless, pastures do contribute a large part of the feed supplied to livestock. Even if pasture acreage in Missouri were only one-fourth as productive as crop land, this would add an area equivalent to about 4,250,000 crop acres. This is very significant since a large part of this land could not be used for the production of feed were it not used for pasture. It is also important to note that even though the gross production per acre of pasture may be less than the gross production per crop acre, the net production is high because the cost of producing an acre of pasture is significantly less than the cost of producing an acre of harvested crops. For example, in Nodaway county the cost of producing an acre of corn on land averaging 35 bushels per acre over a period of ten years was $13.46 or 38.5 cents per bushel of corn. The cost of producing an acre of permanent pasture would have averaged approximately $2.76 per acre. If permanent pasture produced an average of 18 bushels of corn equivalent per acre (Table 5), the cost per bushel of corn equivalent would have been 15.3 cents or a difference of 23.2 cents per bushel. If these same relationships held true, the same amount of corn (35 bus.) could be produced for about 60 per cent less if it had been produced in the form of permanent pasture. If land now used in the production of corn were used for permanent pasture production, it is possible that the net production per acre would be as high or higher than when used in corn production. Permanent pastures at present usually occupy the poorest land of a given farm while corn is generally grown on the best land. If permanent pastures averaged 18 bushels of corn equivalent per acre, it is reasonable to believe that land now growing corn would certainly produce more than 18 bushels of corn equivalent per acre if it were used for permanent pasture production. It might approach in productivity the yield secured on the best one-third of Nodaway permanent pastures, or 35.22 corn equivalents per acre (Table 6).

TABLE 11. -- COST OF PRODUCING AN ACRE OF CORN AND AN ACRE OF PERMANENT PASTURE IN NODAWAY COUNTY

Cost items	Permanent pasture	Corn
Growing	$0.67	$8.02
Harvesting	--	1.55
Taxes	.35	.65
Interest at 5%	1.74	3.24
Total cost per acre	2.76	13.46
Cost per bushel of corn equivalent produced	.153	.385

Table 11 shows the major costs involved in growing an acre of corn and an acre of permanent pasture in Nodaway county. If a comparison were made of a given land area used either for permanent pasture or for corn production, the difference in the cost per bushel of corn equivalent produced would be even greater than this.

Of course, there are other reasons why farmers do not use all their land for pastures. As long as the production from harvested crops is greater than the same land would yield if devoted to pasture, and so long as prices of this production will pay farmers for the trouble of producing and marketing the product, it would not be desirable to shift this land to pasture production. Also there is the problem of providing the variety of feed needed for the livestock necessary to utilize the pastures which are already on the farm. Thus the farmer has the problem not only of getting physical production but getting the variety of production which coupled with his livestock output gives him a satisfactory farming system which enables him to sell his time and other resources to best advantage. The important point here is that there are acres now being used for crop production which if shifted to improved pasture crops would not disrupt the farming system, but it would give a greater output at a lower cost. This would be particularly true if farmers succeed in improving their pasture production so that it compares more favorably with some of the best examples of pasture production now being done in the community.

POTENTIAL PASTURE PRODUCTION IN MISSOURI

In 1939 the production of all harvested crops that could be utilized as feed amounted to approximately 262 million bushels of corn equivalent which included all grains, silage and hays. This amount does not include straw or stover since no production data were available on these products. Using the average yields determined in this study for permanent and woods pastures, the production of land areas used only for pasture amounted to approximately 148 million bushels of corn equivalent. On this basis land used exclusively for pasture production accounted for 36.1 per cent of the total feed supply on Missouri farms in 1939.

Total pasture on Missouri farms amounts to more than just the production from land used entirely for pasture. A large acreage of small grain was pastured to some extent and later harvested. Legumes and grasses seeded in small grain were pastured after the small grain was removed. Areas from which a hay crop had been removed were also pastured. If this acreage were taken into consideration, it is entirely possible that total pasture production on Missouri farms amounted to at least 175 million bushels of corn equivalent.

Using the same acreage of harvested crops as were produced in 1939 and seeding Korean lespedeza or other legumes and grasses in small grain, the total production obtained by pasturing could amount to a still larger portion of total feed production. If every acre of wheat, barley, and rye had been pastured to some extent, this source of pasture could have supplied approximately 7 million bushels of corn equivalent without decreasing the yield of the harvested small grain. If Korean lespedeza or some other grass or legume had been seeded in every acre of small grain and these legumes or grasses pastured after the small grain was removed, an additional 37 million bushels of corn equivalent could have been obtained. Pasturing all hay acreage after removal of a hay crop would add an additional 12 million bushels. The total pasture from these sources and from land used exclusively for pasture would amount to approximately 204 million bushels of corn equivalent.

In Missouri there is an additional source of pasture. There are approximately 9.5 million acres of land outside farms. This acreage is largely in the Ozark Region and a large part of this at present is utilized as open range. If this acreage produced on the average only one bushel of corn equivalent per acre, this would provide 9.5 million bushels of corn equivalent in the form of pasture. This would give a potential pasture production of 213.5 million bushels of corn equivalent in Missouri. If harvested crop production were always as great as in 1939, pasture production would then amount to about 45 per cent of total feed production in Missouri. This amount of pasture could be obtained with very little additional effort on the part of farmers. All that would be necessary would be to have sufficient livestock to utilize the pastures.

By making greater use of improved pasture systems, and by practicing better pasture management, the pasture production in Missouri could easily surpass total harvested crop production. An extensive pasture program would help save our soil resources and at the same time increase production from harvested crops.

VALUE OF PASTURE TO VARIOUS CLASSES OF LIVESTOCK

Farmers have always had the problem of determining the amount to charge for the various classes of livestock for the pasture used during the year. Usually the amount charged has been an arbitrary figure. It often happens that a farmer actually has no basis for estimating the charge and consequently he may charge pasture to a particular class of livestock at too high or too low a rate. If he charges pasture at too high a rate, feeding efficiency with this class would appear low, and if he continues doing this he may eventually decide to dispose of the enterprise. In reality if the correct charge for pasture were made, the enterprise may be operating on a paying basis. If pasture is charged at too low a rate, a livestock enterprise may be kept that actually is not paying for itself.

By using approximately 150 pasture records for the 1937 pasture season, the value of pasture to each class of livestock was calculated. This value was determined in bushels of corn equivalent per head for the pasture season. The value of pasture per head per day for each class of livestock was also determined. Table 12 gives the value of pasture per head per day and for the pasture season for each class of livestock.

TABLE 12. -- VALUE OF PASTURE FOR VARIOUS CLASSES OF LIVESTOCK

Class of Livestock	Avg. no. days they were on pasture	Value of pasture per head (in bus. of corn equivalent)	
		per year	per day
Workstock	133	25.0	.188
Colts (Under 3 years of age)	241	45.4	.188
Other horses*	152	24.9	.163
Family milk cows	243	45.0	.185
Dairy cows	205	39.0	.190
Beef cows	231	25.2	.109
Bulls	206	25.9	.125
Calves	213	20.7	.097
Cattle fattened	152	27.9	.183
Other cattle**	209	33.6	.161
Ewes and rams	284	8.5	.030
Lambs	220	6.2	.028
Hogs 30-100 lb.	143	3.0	.021
Hogs 101-250 lb.	114	3.7	.032
Sows	240	8.4	.035

* Any other horse not included under colts and workstock.
**Yearling and two-year old heifers and steers not on feed.

A farmer could use either of the values given in making a pasture charge to livestock. If a farmer knew the average number of head of each class of livestock carried during the pasture season, he could use the corn equivalent value of pasture per head per year. Or if he knew the number of days of pasture per head, he could use the value of pasture per head per day. Either would give him a good basis for making a pasture charge and therefore help him more accurately to determine the efficiency of each livestock enterprise.

A more convenient way to determine a charge for pasture for all livestock would be through the use of pasture animal units. Pasture animal unit values have been determined on the basis of total value of pasture per head per year and the value of pasture per head per day (Table 13). One can use these values and convert all livestock to a common denominator (pasture animal unit). If a farmer has not kept a pasture grazing record, he can determine the total value of pasture to his livestock by using the value of pasture to a Family Milk Cow (one pasture animal unit) times the total number of pasture animal units kept during the year. This will give the value of pasture to all livestock. If the farmer has kept a grazing record, he can convert the day of grazing of all livestock to a common denominator by using the pasture animal unit values based on the value of pasture per head *per day*. After securing the number of pasture unit days of grazing, the total value of pasture can then be determined by using the pasture animal unit days of grazing times the value of pasture per head day to a family milk cow. This method may be used to determine the value of pasture for the year or for a particular field.

TABLE 13. -- PASTURE ANIMAL UNIT VALUES (PER HEAD OF LIVESTOCK)

Kind of Stock	Pasture animal unit values, (based on the pasture used by one head of each class of livestock)	
	In the entire year	In one day
Family milk cow	1.00	1.00
Dairy cow	.87	1.03
Beef cow	.56	.59
Bull	.58	.68
Calf	.46	.52
Cattle fattened	.62	.99
Other cattle*	.75	.87
Workstock	.56	1.02
Colts (under 3 years of age)	1.01	1.02
Other horses	.55	.88
Ewes and rams	.19	.16
Lambs	.14	.15
Hogs 101-250 lb.	.08	.11
Hogs 30-100 lb.	.07	.17
Sows	.19	.19

*Yearling and 2-year-old heifers and steers not on feed.

It is important to note the difference in pasture animal unit values determined on a seasonal basis and on a head day basis. A difference in pasture animal unit values for some classes arises because some classes of livestock were on pasture more days during the year than were other classes and consequently total value of pasture to the classes will be different even though they secured the same amount of pasture per head day.

SUMMARY

About one-half of the land area in farms in Missouri is devoted to pasture production. Since such a large acreage is utilized for pasture, it was therefore considered important to attempt to determine the production from this acreage.

This study has been concerned mainly with the problem of working out a method of measuring the yields of various kinds of pasture. The method adopted embodies the determination of the feed requirement necessary to maintain the livestock, and to produce the gains and products on pasture. The feed fed while the animal is on pasture is deducted from this requirement and the residual is the amount contributed by the pasture and therefore measures the pasture yield.

Another phase of this study was the determination of pasture animal unit values for the various classes of livestock. Pasture animal unit values were determined on the basis of value of pasture per head per day and per head for the pasture season.

Yields of various kinds of pastures have been determined. A large number of different kinds and combinations of pastures were encountered. However, only a limited number of yields are reported because in many cases the number of records was insufficient for an adequate sample.

The average production of permanent pastures was 11.2 bushels of corn equivalent per acre. The yields secured on permanent pastures in a measure reflect differences in productivity of the soils on which they were grown. The yields of permanent pastures on the various soil types and computed from the 1937 data alone are given in Table 14.

TABLE 14.-- YIELDS OF PERMANENT PASTURES BY SOIL TYPES, 1937

Major soil types in area	Yield per acre in bushels of corn equivalent
Marshall, Wabash	18.1
Baxter, Avilla	13.6
Summit	13.4
Putnam, Lindley, Memphis	11.7
Putnam, Lindley	10.2
Shelby, Lindley	9.8
Clarksville	8.8
Cherokee, Bates	8.0

Permanent pastures on Marshall and Wabash soils produced the highest yield per acre. Baxter and Summit soils were about alike. Soils yielding under 10 bushels corn equivalent included the Shelby-Lindley, Clarksville, Cherokee, and Bates. Frequently rotation pastures will yield a considerably larger return from the land than the same land devoted to permanent pastures. The most productive rotation pastures were Sudan, second-year sweet clover, and barley pastured out. These crops may be expected on the average to give a return of 20 bushels of corn equivalent or more. A second group of medium productivity would include timothy, oats and Korean lespedeza, timothy and Korean lespedeza, rye, wheat, first-year sweet clover following small grain, and Korean lespedeza following small grain. These crops may be expected to yield between 10 and 20 bushels of corn equivalent. Crops yielding under 10 bushels of corn equivalent are mostly in the class of supplemental pastures. The more important ones in this group would be Korean lespedeza alone, rye pastured and harvested, pasture in small grain stubble, and pasture on timothy and clover meadow following the harvest of the hay crop.

The results of this study in addition to showing specific values for various pastures indicate two additional important facts. The first of these is that pasture production can be practically determined by this method of differences, or by subtracting the supplemental feed received by animals on pasture from the normal feed requirement to maintain the animal and produce the gains which are realized while on that pasture. The second important fact is that pasture production under farm conditions will be materially less than that secured under very highly controlled experimental conditions because farmers are not usually in a position to procure as nearly complete utilization without over-grazing, as is true under experimental conditions.

The values given in this report may be expected to shift more or less as additional data from further studies are added to these figures. The three-year period covered by this study is not regarded as an adequate length of time in which to procure highly stabilized results. However, these figures are thought to be of considerable value and probably do express the relative importance of the various kinds of pasture with a reasonable degree of dependability.