SEPTEMBER, 1935 RESEARCH BULLETIN 229

UNIVERSITY OF MISSOURI COLLEGE OF AGRICULTURE

AGRICULTURAL EXPERIMENT STATION

F. B. MUMFORD, *Director*

Factors Affecting Farm Land Values in Missouri

(From an Appraisal Viewpoint)

CONRAD H. HAMMAR

(Pubication Authorized August 29, 1935)

COLUMBIA, MISSOURI

UNIVERSITY OF MISSOURI — COLLEGE OF AGRICULTURE

Agricultural Experiment Station

TABLE OF CONTENTS

FOREWORD

The results of this study suggest that a greater emphasis be placed upon certain factors in the valuation of land, but does not carry forward the analysis to the point of giving exact directions on how to apply these results in an actual field appraisal. For this reason the study is a preliminary and provisional one and is to be so regarded. It is published in this preliminary form to make available certain factual material that it is presumed will be valuable to the appraisal profession.

ACKNOWLEDGMENTS

The study presented herein owes a particularly large debt to the work of other investigators. In this instance, the obligation is chiefly to the staff of the Department of Soils of the Missouri Agricultural Experiment Station.

Within the Department of Agricultural Economics the author has had the constant cooperation and aid of his student and colleague, Mr. Glen T. Barton, and of Professors O. R. Johnson and B. H. Frame

Throughout the study Mr. Raymond Scoville has worked with the author on the present and on a companion manuscript with the same title. This latter manuscript he will submit to the Graduate School of the University of Missouri for approval as a partial fulfilment of the requirements for the Degree of Master of Arts.

Factors Affecting Farm Land Values in Missouri

(From an Appraisal Viewpoint)

CONRAD H. HAMMAR

INTRODUCTION

So great has been the havoc of the depression in the field of farm ownership and farm mortgage lending that the need for a revision of the methods and techniques of appraising farm real estate needs no extended comment. Great acreages of land have been changing hands because of mortgage foreclosure[1] and the increase of corporate and absentee ownership of lands once held by local farm operators is all but appalling.[2] In Missouri, for instance, preliminary data indicate that approximately 18,000 farm properties, including 2,700,000 acres of land, were formally foreclosed upon and transferred into new ownership in the short period from 1930 to 1935. Faulty appraisal was, to be sure, only a contributory factor to the pressure of liquidating forces that settled upon the American farmer after 1920, and particularly after 1930, but facts seem to indicate that its part was not a small one.

There are, however, other reasons, not necessarily associated with the effects of the depression, for more extended consideration of the topic of appraising. First, farmers have, since the turn of the century and particularly during and since the war period, been making an increasing use of mortgage credit. Second, a great volume of new and pertinent data, together with suitable techniques of analysis, have been accruing in recent years. Third, the decline in land values since 1920 has left many farmers with critically small equities and future financial policies need, in part, to be reviewed in the light of problems arising in connection with farm operation upon these slender ownership margins. Finally, certain new approaches, having much of promise to the future of appraising, have appeared recently. There is, for instance, a tendency to emphasize farm earnings or land income in contrast to sales value as the proper basis for appraisal, and a growing desire to place all appraisal upon as uniform a scientific basis as is possible.

The approach of the present bulletin is not so much to emphasize either the earnings or sales value approach in the evaluation of land as it is to attempt to associate with land or real estate values an abundant and varied scope of data on physical, economic and social factors affecting these values. Whether it be sales or

1 See, for instances pages 34 to 40, U. S. D. A. Circular No. 354, "The Farm Real Estate Situation, 1933-1934," by Stauber and Regan.

2 The value of farm land owned by corporations, for instance, increased from $293,864,000 in 1930 to $770,072,000 in 1933, according to D. L. Wickens. See Agricultural Situation, June, 1935, page 12.

earnings that are accepted as the proper criterion makes little difference regarding the choice of the factors which shall be used in establishing the level of these. That is, the ultimate appraised value should be the same whether based upon earnings or sales, since it is an axiom that land has value only because it is capable of producing income or earnings.

The real difficulty with appraising has been not so much the dependence upon one criterion to the exclusion of the other, but a painful lack of facts underlyng either of the two criteria. The reporting of national, state and county average real estate values with no attempt to associate these values with suitably defined physical, economic and social characeristics of the real estate has, for a considerable period, stimulated an unwholesome tendency to regard land values more or less mechanically. Reviewing appraising has, for instance, according to Murray,[1] exerted its influence to keep fieldmen's values close to the average (usually county averages) reported for a particular section. This spurious confidence in averages has resulted in the general overvaluation of land below average in productiveness, and undervaluation of the higher quality land.

The need in appraising, therefore, is one for more abundant and accurate physical, economic, and social information so that each job of evaluation may take into account the essentially unique setting of each property under review. And perhaps beyond even this is the need for adequate analytical techniques so that this information may be accurately allied to or associated with the values of the property. Indeed, because of the more or less unique character of each property, it is almost impossible to concentrate within reasonable bounds sufficient pertinent information so that properties may be evaluated without field inspection. Actual field appraisal will, in other words, always be needed and the only contributions that studies of this kind can make are those involved in what are techniques of analysis for the purpose of relating values to the numerous factors affecting and determining values.

APPLICATION OF STUDY

Appraisals are nearly always made with some purpose in mind. Much the same facts are pertinent in the determination of value regardless of the purpose of the appraisal, however, and the scope of the present study is intended to be broad enough to cover appraisals of all kinds, be they for purchase, lending, investment, condemnation, or assessment for taxation. The attack is, furthermore, much in sympathy with that implied by the statement of the Sub-Com-

1 "The Land Appraisal Problem," Journal of Farm Economics, October 1934. See particularly page 607.

mitee on Appraisals of the National Joint Committee on Rural Credits which laid down the assumption: " . . . . . that there is but one kind of appraisal and that the value determined thereby is known as basic value."[1] They clarify their meaning of "basic" value in a succeeding paragraph by stating: "The appraisal report should show the basic value as well as the special values reported. This practice tends to clarify appraisal procedure and recognizes a common basis for all appraisals, regardless of the purpose for which they are made. Since this method gives a common objective, it will tend to give appraisers a uniform method of approach and weighting of factors."[2]

Apparently appraisal procedure needs greater clarification if it is to have this common approach and particularly if there is to be a desirable uniformity in the "weighting of the factors." The uncertainty regarding the emphasis to be laid on sales value as contrasted to that to be laid on earnings value is evidence enough that differences in opinion exist. Part of the purpose of this report is to achieve a harmony regarding this debated point.

The study is limited in scope and application in a number of respects. In the first place, an application of the methods and principles described herein to an actual field appraisal has not been made. Until such tests have been made, the study must stand as one chiefly concerned with underlying principles. Second, certain improvements that may conceivably be introduced into appraising in the light of the suggestions made cannot be utilized until further experimental work in the field of soils and field crops has been carried out. Third, the geographical limits of the applicability of the results of the study have been only partly determined. Fourth, no attention has been given to certain very important aspects of appraisal. These untouched aspects include the relationship of buildings values to land values, and the extremely important topic of the relationship of land values to certain dynamic situations such as the rise and fall of the price level, changing purchasing power of the farm dollar, and improvements in agricultural technique. Finally, a method of combining the many criteria for the valuation of land that are reported herein into a workable system of appraisal involving an appraisal report form is a task yet to be accomplished.

PHYSICAL FACTORS AFFECTING LAND VALUES

The character of the lands of Missouri is highly diverse and perspective with respect to them is more easily gained if they are viewed first in broad classes of roughly similar quality. The table following was first published in the report of the National Resources

1 Journal of the American Institute of Real Estate Appraisers, April 9, 1934, page 261.
2 Ibid, page 262.

Board and was compiled under the direction of Dr. Curtis F. Marbut of the Bureau of Chemistry and Soils of the U. S. Department of Agriculture.

TABLE 1.—LAND CLASSIFIED UPON THE BASIS OF ITS PRODUCTIVITY—MISSOURI AND ADJACENT STATES*

State	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
	Acres	*Acres*	*Acres*	*Acres*	*Acres*
Missouri	8,674,763	13,833,050	12,303,627	4,258,868	4,914,778
Nebraska	8,120,907	9,960,068	9,639,648	10,908,321	10,757,984
Iowa	25,983,110	6,906,158	1,392,680	1,007,416	344,556
Illinois	14,777,030	6,847,145	6,223,171	6,621,568	960,998
Kentucky	863,916	5,020,424	8,956,319	7,905,826	2,877,195
Tennessee	902,258	4,769,847	9,305,437	8,239,726	3,412,108
Arkansas	1,452,484	7,952,405	9,231,149	8,299,905	6,707,425
Oklahoma	1,700,604	12,795,160	15,268,765	7,825,536	6,856,079
Kansas	3,765,287	15,172,236	15,964,703	11,207,323	6,094,867
United States	101,037,573	210,934,728	345,871,800	362,559,173	881,735,414

*Arranged from Table 7, page 127, Report of the National Resources Board, U. S. Government Printing Office, 1934. The classification is based upon "the principal physical conditions influencing productivity, such as soil type, topography, rainfall, and temperature."

In general, Missouri has been favored among the states in its region in the quality of her land, as noted in the table above. Only Iowa, Illinois and Minnesota[1] have greater acreages of first grade land than does Missouri, and if the criteria be the total of first and second grade lands, only Iowa and Minnesota have larger acreages. In somewhat different terms, there are in Missouri 8.6 per cent of the total acreage of first grade lands in the United States, but only 0.6 per cent of the total acreage of fifth grade and essentially non-arable lands.

A somewhat similar classification, though from a different point of view and based more nearly wholly upon criteria of soils and topography, is given in Fig. 1 and Table 2. If classes four and five in Marbut's classification are grouped together, the acreages in the four categories of both classifications are much alike. That is, the acreages in the higher and lower classes roughly correspond.

Of the state's lands 19.3 per cent are, according to this second classification, definitely high grade agricultural land and 35.7 per cent are of moderate fertility, destined, quite surely, to be used continuously for agriculture. On the other hand, 16.7 per cent of the state's area has been counted as quite definitely unsuited to an arable agriculture and 28.3 per cent has been classified as now used in considerable part for crop production, but as having a somewhat questionable future for such production.

1 Figures for Minnesota are not included in the Table.

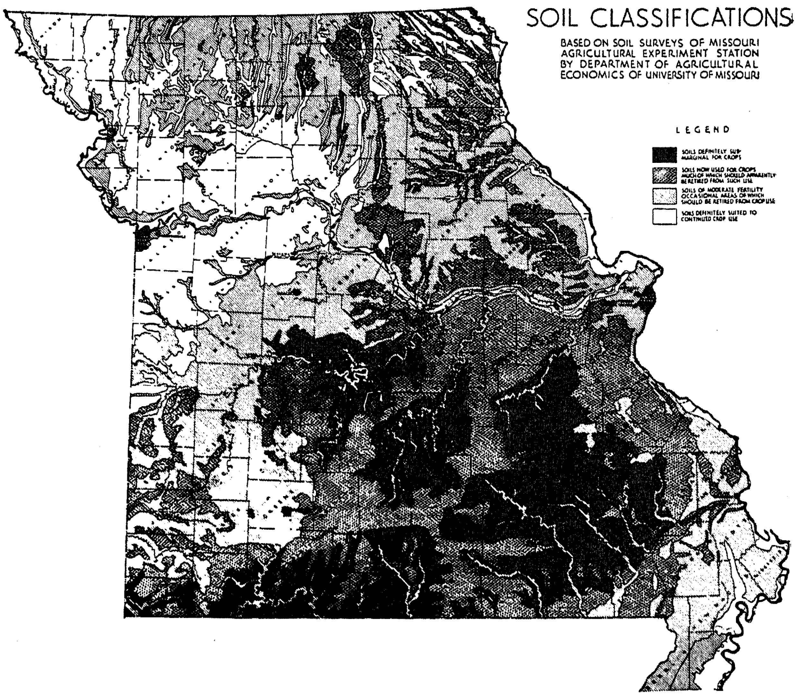


Fig. 1.—The Lands of Missouri have, in this map, been broken up into 4 major classes grading from excellent agricultural to definitely non-agricultural in characters.

The map gives the approximate location of these classes of land, but the proximate location only, since any one class, when based upon so broad a grouping, includes occasional small areas of land of a different class. That is, in areas of third class land are included occasional acreages of second or perhaps even small acreages of first grade lands that could not be separated out on a map drawn to so small a scale.

Most of the first grade lands occur in the northwestern part of the state, though there are important additional acreages along the river bottoms and in the lowlands of Southeast Missouri. Second grade lands occur chiefly in northern and northeastern Missouri, with an additional large block in the western part of the state south of the Missouri River. Third grade lands occupy the Ozark Border and Plateau areas with smaller acreages along steeper watersheds in North Missouri and still lesser acreages of flat lands in the Lowlands and in the southwestern corner of the state. The non-arable lands are located in the more dissected portions of the Ozark upland in the southern half of the State.

The acreages of various soil types included within the four major classes are given in Table 2.

TABLE 2.—GENERALIZED CLASSIFICATION OF MISSOURI LANDS ON THE BASIS OF SOIL TYPE*

(Acreage Figures are Approximations Only)

I

LANDS DEFINITELY SUITED TO CONTINUED CROP USE

Type	*Acreage*	*Per Cent*
Grundy Silt Loam	1,602,284	.036
Lintonia Loam	90,961	.002
Marshall Silt Loam	1,752,219	.040
Sarpy Fine Sandy Loam	552,946	.013
Summit Silt Loam	1,600,451	.036
Wabash Silt Loam	2,882,687	.066
	8,481,548	.193

II

LANDS OF MODERATE FERTILITY, OCCASIONAL AREAS OF WHICH SHOULD BE RETIRED FROM CROP USE

Type	*Acreage*	*Per Cent*
Bates Fine Sandy Loam	1,374,815	.031
Crawford Silt Loam	2,236,882	.051
Hagerstown Silt Loam	602,296	.014
Huntington Silt Loam	1,522,769	.035
Knox Silt Loam	1,637,893	.037
Lintonia Fine Sandy L.	474,295	.011
Osage Silt Loam	579,458	.013
Oswego Silt Loam	1,151,986	.026
Putnam Silt Loam	2,090,081	.048
Sharkey Clay	735,741	.017
Shelby Loam	3,052,573	.069
Waverly Fine Sandy Loam	227,191	.005
	15,685,980	.357

III

LANDS NOW USED FOR CROPS, MUCH OF WHICH SHOULD APPARENTLY BE RETIRED FROM SUCH USE

Type	*Acreage*	*Per Cent*
Cherokee Silt Loam	990,614	.023
Clarksville Gravelly Loam	4,484,632	.102
Hanceville Loam	272,074	.006
Lebanon Silt Loam	1,580,394	.036
Lindley Loam	2,283,308	.052
Tilsit Silt Loam	299,416	.007
Union Silt Loam	1,988,305	.045
Waverly Silt Loam	548,871	.012
	12,447,614	.283

IV

LANDS DEFINITELY SUBMARGINAL FOR CROPS

Type	*Acreage*	*Per Cent*
Ashe Stony Loam	268,684	.006
Clarksville Stony L.	7,101,454	.161
	7,370,138	.167
Total Acreage	43,985,280	

* Data compiled by Department of Agricultural Economics, University of Missouri from maps and bulletins of the Soil Survey of the Department of Soils of the Missouri Agricultural Experiment Station and the U. S. Bureau of Chemistry and Soils.

Unit Soil Factors

The above classifications are altogether too general for other than the broadest purposes in the appraisal of land and give only a beginning clue to what land values should be. The Departments of Soils and Agricultural Economics of the Missouri College of Agriculture have recently arranged a series of maps relating to various soils and land features that afford a much more detailed picture of land features for the state as a whole. It is upon the implications of these maps, each depicting a single soil or land factor, indeed, that the classification of lands in Figure 1 and Table 2 was based. These criteria constitute the individual elements of which land (or soil) is the complex. They are offered here in series for their applicability to an evaluation of the productivity and (via its productivity) the appraised value of land.

The use of these maps (of single criteria of soil productivity) has been designated as a **differential** approach to land valuation or classification. An alternative approach is that employed in the cadastre (a type of European land classification for purposes of assessment and taxation) which in essence is the assimilation of numerous criteria into a single system of classification. The mapping of soil types as it has been done in the past has been upon this basis of assimilating many criteria into a single system.

For purposes of appraisal and indeed for the planning of land use the differential system has many advantages over the cadastral system. These advantages arise chiefly because of the great flexibility of the differential system when employed in interpreting facts relating to the productivity of land. Determination of productivity is a complex matter, as is clear from the extensive quotation below which was written in part to exemplify the advantages of the differential approach to the determination of soil or land productivity.

" . . . . Productivity is always implicit rather than actual, and when encountered as a result is known as production rather than productivity. Furthermore, production is the result not of a single agent but rather of a system of cooperating agents including land, labor, capital and entrepreneur. The agents, of course, may be subdivided much more minutely. The fact remains, however, that one may not be able to arrive at an adequate classification of one of the agents upon the basis of the results obtained with a combination of agents.

"Such would not be the case if the agents were combined in uniform combinations or if these combinations were so constant that exceptions were unimportant. Unfortunately, however, the remarkable characteristic of such combinations is their unusual diversity. They vary not only in relation to the quality of the elements applied to a given acreage of land, but equally in relation to the quality or kind of agents applied. The great grist of farm management and production economic research data is testimony to the remarkable variation to be discovered in relation to these combinations.

"The suggestion that classification be based upon the results of certain optimum combinations leads nowhere. These optima in terms of physical combinations would be highest average output per unit of input or highest total output per unit of the land factor. Only under unusual circumstances and at the margin of land use, however, is land used only to the point of highest average output per unit of input and almost never is it used to the point of highest total output. Classification upon the basis of these optima would. therefore, accord only very poorly with the results under actual use. . . . .

"The diversity of combination is, however, by no means the only difficulty. Equally important is the great diversity of products and in certain cases, services that these agents in combination are employed to produce. Thus, land might be classified upon the basis of its effectiveness in the production of corn, but the results would be quite unsatisfactory for such areas as northern Minnesota, North Dakota, Montana or the Canadian Provinces, where little or no corn is produced, and about equally valueless for the cotton and fruit producing centers; in fact, valueless except where corn is an important crop. One would find the effectiveness of a classification based upon factors affecting the production of alfalfa or blue grass equally unsatisfactory where it was corn, cotton, or wheat that were the dominant crops.

"To get away from the effects of diversity or kind of products produced, it has been suggested that some generic measure such as energy be used as the basis for classification. Thus, one might measure the caloric value of wheat, cotton or corn, or even blue grass and other pasture crops, and classify land upon the basis of these results. The inadvisability of this method for planning purposes needs only one illustration. Cotton and corn are often rivals for land, as they are in Southeast Missouri. On the basis of caloric value, corn would undoubtedly tremendously outproduce cotton. Yet, cotton more often gets the choice than does corn. Obviously, factors other than the mere caloric output determine the effectiveness of the production of a particular crop as a form of land use. . . . . .

"One might shift to the optimum economic combination or operation at highest profit combination. But here again certain difficulties are apparent. The first of these relates to the fact that highest profit combination depends so acutely upon the prices of the products produced. These change, not only in relation to one another, but in relation to certain fixed charges as the value of money rises or falls. Each shift of prices bring about a change in the optimum economic combination and no land classification, worthy of its name, could be based upon so unstable a foundation. The suggestion that there be used an average highest profit combination based upon the average for a number of years adds little. In fact, one has what closely approximates such a classification in the case of a map of land values and, as is commonly known, cross-hatched maps of land values change under the stress and strain of economic forces much as a chamelon changes or attempts to change in crawling over a Scottish plaid.

"Perhaps, also, it is worth mentioning that technical improvements shift the highest profit combination by their effects on production and costs. In this day of rapid improvement in productive technique, this factor alone would be sufficient to rule out any classification based upon an economic optima. For instance, the movement of the Corn Belt northward, the introduction of alfalfa, soybeans and later lespedeza, and other countless illustrations might be adduced to show how fleeting are the systems of land use."[1]

Indeed, the above quotation, lengthy as it is, has by no means exhausted the complexities of analyzing the productivity of land for the purpose of arriving at its value. It does forcibly call attention to the fact, however, that land productivity depends, among other things, on how the land is used and the use to which it is put. The factors to consider in determining productivity for timber growing are different from those analyzed when the objective is the production of cotton. Separating the many contributing factors as is done in the differential system permits a concentration on the criteria that are most influential for the particular purpose or product in mind.

Before attempting to link, quantitatively, these various criteria to land values, some general comments upon the significance of each will be made.

Texture.—The soils of Missouri are dominantly silt loam in texture. Of the 28 major soil types, 15 are designated as silt loams, three as loams, one as a sandy loam, three as fine sandy loams, two as gravelly loams, two as stony loams, one as a fine sand, and one as a clay loam. The effect of soil texture on its productivity and earning appears to have received no exhaustive study. Indeed, the difficulties of making such studies are considerable. Only in a general way, therefore, can this particular land and soil quality be linked with value.

1 "Land Classification as a Basis for Land Use Planning," Conrad H. Hammar and Hans Jenny, Journal of Farm Economics, July, 1934, pages 431-433.

Medium textures, as these are noted on the scale of soil separates from coarse sand to clay particles, seem most acceptable to plant growth. That is, too high a concentration of either large (sand) or fine (clay) particles in the soil complex are, on the whole, unfavorable. However, plants appear to have so great a tolerance with respect to texture that it alone seldom is the limiting factor. Thus, if sands are adequately fertilized abundant crops may be grown upon them, as the experience of many market gardeners indicates. On the other hand, a soil made up chiefly of clay is apparently equally acceptable if fertile and if the clay particles are flocculated so that root penetration and aeration are not unduly impeded. It appears, therefore, that the effects of soil texture arise most often because of certain associated conditions that develop because of texture. Thus, sands are soon leached of their fertility, become too acid, fail to retain moisture well and, hence, are droughty and may be subject to blowing as well. The clays, on the other hand, are often retentive of fertility but are difficult to handle in that they run together or puddle when wet and bake later in drier weather. They can usually be plowed or cultivated effectively only within a narrow range of moisture conditions. Furthermore, clays are often slow to absorb or give up water, crack badly in periods of drought, warm up slowly in the spring, and are, hence, counted as slow and late soils.

The acreage of lands too sandy for optimum productiveness in Missouri is small and limited almost wholly to alluvial lands along the river bottoms and in the Southeast Lowlands. In fact, only in the lowlands are the areas large enough to be of more than minor importance. In Mississippi county the soil survey lists 49,472 acres, or 18.4 per cent, of the county's area as being a fine sand or a loamy fine sand. Adjoining this area of sand in Mississippi county is an even larger area in Scott and smaller areas in New Madrid and Stoddard counties. These sands are by no means non-agricultural and the larger share of them are include in farm ownership of one kind or another. Farming upon some of these lands has apparently been only dubiously profitable recently, and questions are now being raised regarding the most satisfactory use for them in the future.

The data in Table 3 give some idea of the effect of texture on value. Because the sample of sales of each soil type is small, however, and because it has been impossible to correct for differences in improvements (buildings and the like) as between different textures, no great reliance should be placed upon the figures. However, they show a rise in average sale value from the sands or lighter textures to the medium textures and a subsequent decline as the textures become excessively fine. Average values

TABLE 3.—EFFECT OF SOIL TEXTURE ON LAND VALUES IN DUNKLIN AND PEMISCOT COUNTIES

Sales Data for the period 1927 to 1933*

Location and Texture	Soil Type	No. Sales	Acreage	Price Per Acre
Dunklin County				
Fine Sand	Chiefly Lintonia	38	1,493	$34.86
Fine Sandy Loam	Chiefly Lintonia	182	9,370	45.87
Loam	Chiefly Lintonia	21	825	41.67
Silty Clay Loam	Lintonia & Calhoun	39	1,899	24.37
Clay	Chiefly Sharkey	27	1,946	23.54
Pemiscot County				
Sand	Chiefly Sarpy	14	915	$38.27
Fine Sandy Loam	Chiefly Sarpy	14	1,284	41.10
Loam	Chiefly Sarpy	70	3,326	41.74
Silty Clay Loam	Chiefly Sarpy	52	3,829	41.03
Clay	Chiefly Sharkey	241	30,316	30.23

*Adjusted to base period value—1932 = 100 per cent.

for fine sandy loam, loam, and silty clay loam textures in Pemiscot are remarkably uniform. In Dunklin county the silty clay loam averages lower in value than loam or fine sandy loam textures, largely, however, because many of the sales for this texture were of soils definitely lower in fertility for reasons other than texture. For all sales of clay textures in both counties, average values are depressed somewhat because of heavier drainage taxes and less certain drainage, both of which are conditions quite apart from texture.

RELATIONSHIP OF SOIL TEXTURES AND LAND VALUES IN DUNKLIN AND PEMISCOT COUNTIES

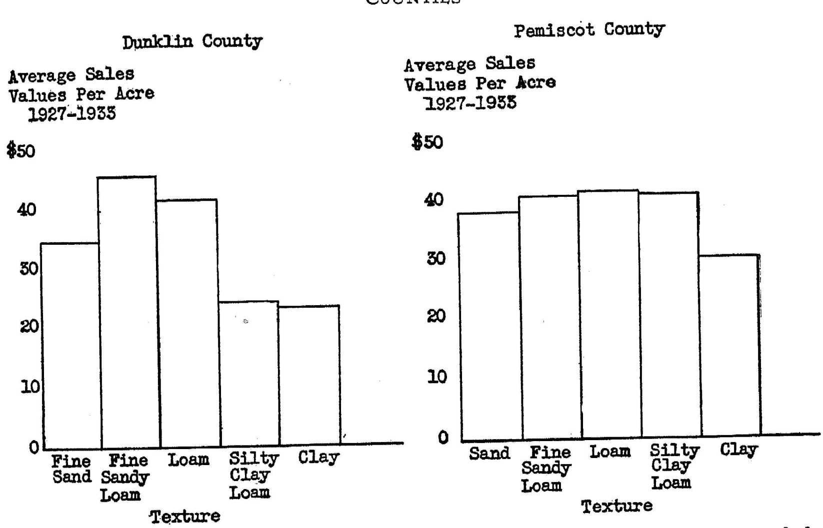


Fig. 2.—Values, according to the averages of these gross sales values uncorrected for differences in improvements, tend to be high for the soils of medium texture and lower for those with the coarser and finer textures.

Like the areas of sandy texture the surface soil[1] clays are in Missouri associated with alluvial lands. While significant areas of these heavy textured soils occur along the bottoms of nearly all the major streams in Missouri, by far the greatest acreages are located in the lowlands of Southeast Missouri. In this latter area are found approximately three-quarters of a million acres of Sharkey clay loam. Somewhat more than a third of the lowlands falls within the category of these clay soils, which occur chiefly along the lower reaches of the Little River Basin stretching from Cape Girardeau county on the north to the Arkansas state line. Another and considerable area of this same soil, about 200,000 acres, lies in eastern Mississippi county with lobes extending into eastern New Madrid and Scott counties.

These Sharkey clay loam soils are definitely lower in value than the associated and higher lying soils of the Sarpy and Lintonia series. However, the lower value results not only from texture disparities but also because the drainage on the Sharkey soils is much less adequate than is that for the other two types as noted above.

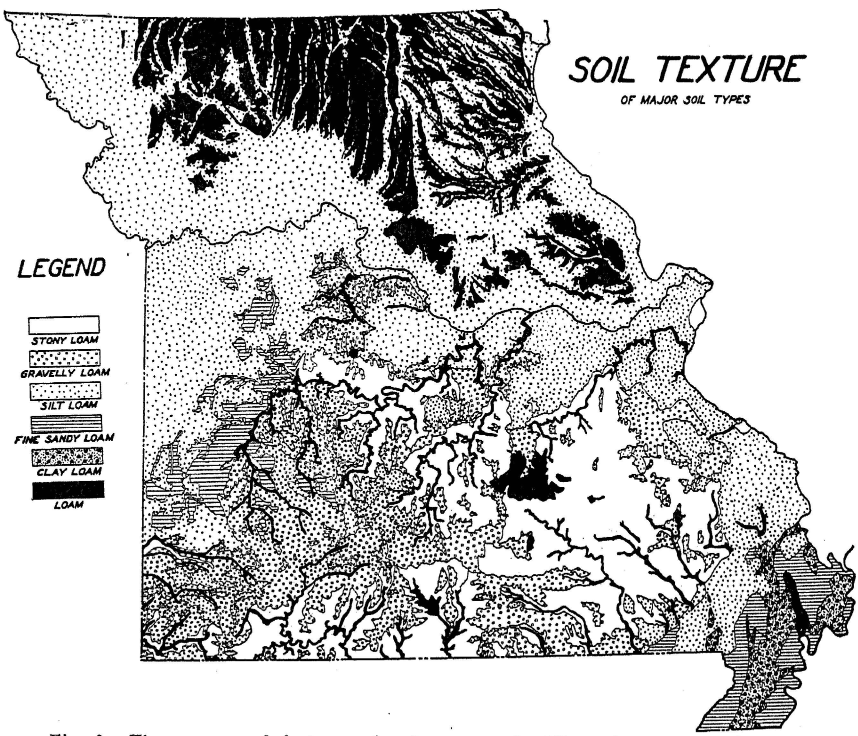


Fig. 3.—The pronounced features of soil textures in Missouri are the predominance of the silt loams and the great areas of gravelly and stony lands in the Ozarks. (Map Based on Soil Surveys of the Missouri Agricultural Experiment Station).

1 For a discussion of the effect of subsoil clays on values, see pages 24 to 28.

Of far greater importance in the total effect on the value and productivity of Missouri lands than either sand or surface soil clay as textural features is the presence of stones and gravel. For the state, as a whole, the total area of the gravelly and stony soils is about 14,000,000 acres or nearly one-third of the state's land area. These lands are located almost wholly in the Ozark Upland, together with its border. On the whole, they are associated with a topography that ranges from rolling to hilly. In general terms, the stonier lands are also the steeper lands.

To separate the effect of texture (as indicated by gravel and stone content) from that of topography on the value and productivity of these lands is infeasible. It is sufficient to say that in the main, the stony lands are non-arable and that upon the gravelly lands cultivation is more or less obstructed. A great share of these gravelly lands have been and are being farmed, however, and large acreages of the stony lands are grazed. Appraisal of these lands may, for a time, continue to be confused by the difficulty in determining the typical or proper use. Agriculture and even grazing are definitely retreating from the stony lands which are being moved into forestry, but future uses of some of the gravelly lands are problematic.

Nitrogen Content.—In states, such as Missouri, where corn is by far the leading crop, the nitrogen content of soil is a major factor in the determination of the productivity and value of land. In a recent study, the close relation between corn production and soil nitrogen has been demonstrated with the discovery that corn yields are almost perfectly correlated ($r = +.995$) with nitrogen content of soil for selected areas from Iowa south.[1] Significantly also, Wallace found a correlation of $r = +.63$ between average corn yield and average county land values for Iowa counties.[2] From the implications of these two studies, it is but a short step to the assumption that variations in soil nitrogen should be closely associated with variations in the value of land.

In Figure 4 the degree of association between surface soil nitrogen and average county land values per acre is given. The strictly linear relationship, $r = +.78$, is somewhat smaller than that determined from the curve, $\rho = .81$, but both are greatly above any figure likely to result from chance correlation.[3]

1 Jenny, Hans—"A Study of the Influence of Climate Upon the Nitrogen and Organic Matter Content of Soils," Missouri Agric. Experiment Station, Bulletin No. 152, see page 62; see also Figure 5, page 7, Mo. Agricultural Experiment Station Bulletin No. 324, "Soil Fertility Losses under Missouri Conditions" by Dr. Jenny for an initial correlation of land values and soil nitrogen.

2 Wallace, H. A., "Comparative Iowa Farm Land Values," Journal of Land and Public Utility Economics, Volume II, page 389.

3 The "r" and "ρ" would have been significant if they had been no more than .254. See page 63, "Correlation and Machine Calculation" by Wallace and Snedecor.

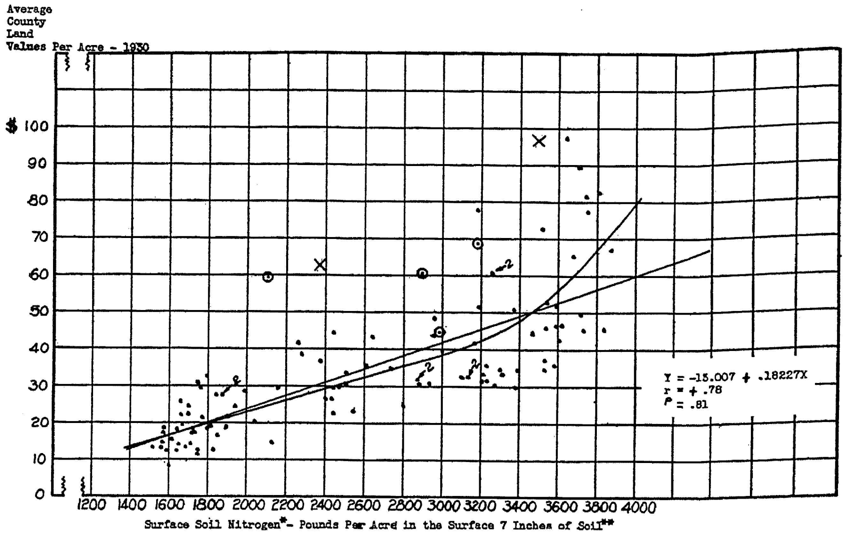


Fig. 4.—In the determination of the productivity and value of Missouri farm lands, surface soil nitrogen content is of great significance. Nitrogen is necessary to plant growth and in Missouri the higher the level of nitrogen in the soil the higher the value of the land.

*Figures for nitrogen, and available phosphorous content of soil in this and succeeding figures (Figure 7 and 11) were obtained by estimating the acreage of each soil type included in land farms in 1930. The Soils Department of the Missouri Agricultural Experiment Station made available the data for the average surface soil content of nitrogen, exchangeable bases and available phosphorus. The combination of these two types of data enabled the calculation of the average level of each of these soil factors of a composite acre or one of average productivity for the farm land for each county.

**Counties represented by circles and crosses were not used in the correlation. They are the cotton counties of Southeast Missouri and two urban counties—Greene and Buchanan. Data for Jackson and St. Louis counties are not included.

With each increase of 100 pounds in average content of nitrogen, land values increase (assuming a linear relationship) by $1.82. If, however, as seems probable, the real relationship is curvilinear, the increase is less than this amount at the lower end of the curve, and much greater at the upper end. Thus, as calculated from the curve in the chart, land values increase at a rate of about $4.00 per additional one hundred pounds of nitrogen at the upper end of the curve or between the range of 3,250 and 3,750 pounds of nitrogen per acre.

That either straight line or curve, as in Figure 4, represent accurately the full relationship between nitrogen and value is improbable. Land can be too well supplied with nitrogen,[1] and if the observations could have been extended to cover soils considerably richer in this element than those normally discovered in Missouri, a point would ultimately have been reached when additional nitrogen would have had little or no effect on value, and in ex-

1 For the influence of soil nitrogen in plant growth, see Lyon and Buckman, "The Nature and Properties of Soils," MacMillan Company, New York, 1934, pages 338 and 339.

treme cases would actually have lessened values. A curve completely expressing the relationship between nitrogen content of soil and land values would, therefore, presumably be shaped like a bell.

Neither the slope of the curve nor the exact increase in the value accompanying a given increase in nitrogen (which after all is a function pretty largely of the level of land values from which the relationships have been calculated) is of crucial importance, however. The fact of really great significance is the clear-cut association between values and nitrogen. High nitrogen lands are high value lands and vice versa, and there is reason to believe that the relationship is one of direct cause and effect.

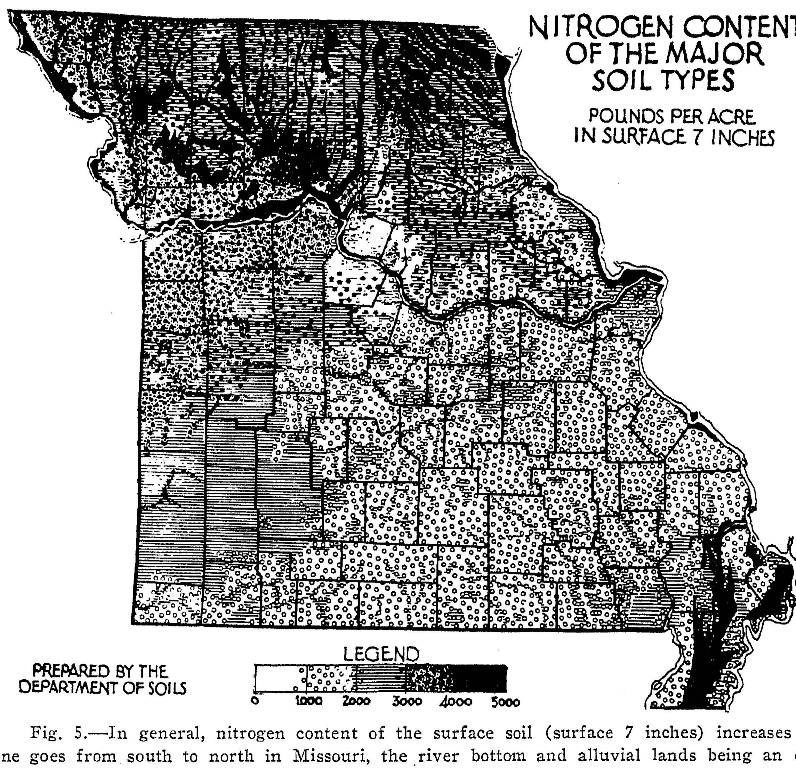


Fig. 5.—In general, nitrogen content of the surface soil (surface 7 inches) increases as one goes from south to north in Missouri, the river bottom and alluvial lands being an exception. Missouri Experiment Station Bulletin 349.

In Missouri, as indicated in Figure 5, high nitrogen soils occur primarily along the river bottoms in Southeast and Northwest Missouri. Among the soils the highest in average nitrogen content is the Sharkey clay loam with 4,360 pounds per acre, and the lowest, the gravelly and stony Clarksville soils of the Ozarks with a little more than 1,500 pounds per acre.

Lime Requirement and Potassium.—While no attempt has been made in the present study to relate either lime requirement or potassium content to land values, some general comments on the significance of these two factors in their relation to land quality may be helpful.

Figures 6 and 7 give a generalized version of the distribution of soils with varying levels of lime requirement and potassium content throughout the state.

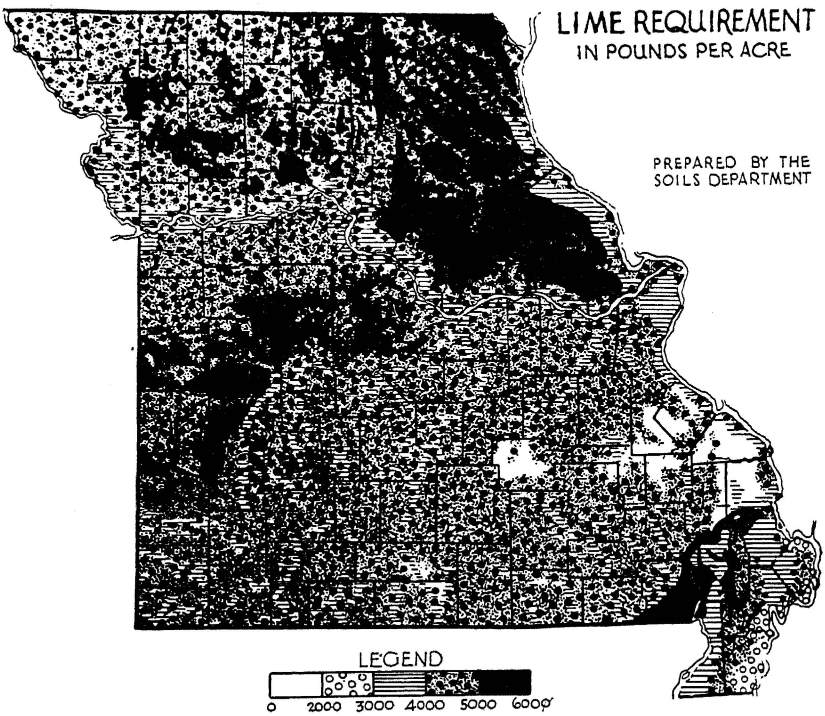


Fig. 6.—Lime requirement is, in general, greatest in Missouri for lands with clay pan subsoils extending in a belt diagonally across the State from northeast to southwest.

Lime requirement, expressed in terms of the number of pounds per acre needed to neutralize soil acids in the surface 7 inches of soil, is greatest in a belt of soils stretching diagonally across the state from northeast to southwest and following generally those soils with relatively impervious subsoils. Such crops as alfalfa, sweet and red clover are particularly sensitive to a deficiency of lime, and areas low in exchangeable bases or with high lime requirements (the two criteria are similar but not synonymous) are

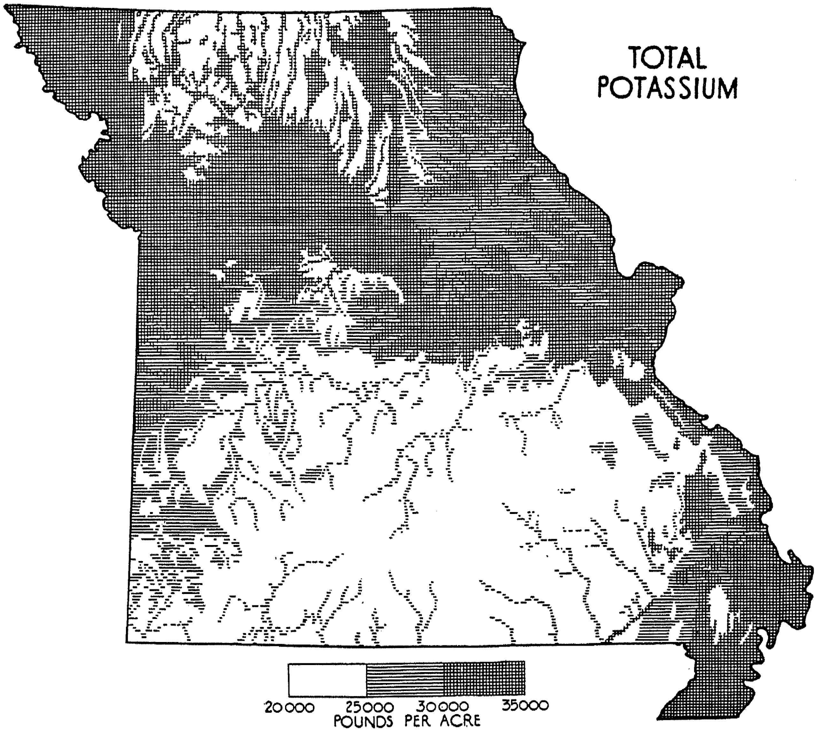


Fig. 7.—The distribution of total potassium is similar but by no means identical to that of nitrogen. Map prepared by the Department of Soils.

at a disadvantage in the production of these high protein crops. So often the establishment of a successful livestock system in Missouri is dependent upon an ability to produce proteinaceous crops. On the whole, livestock is not as abundant and livestock production not as profitable in areas low in exchangeable bases or having a high lime requirement. The greater use of acid tolerant legumes such as soybeans and lespedeza has tended to reduce this disadvantage of the more acid soils.

The distribution of potassium, as in Figure 7 corresponds closely to that of nitrogen. Loessial and alluvial soils are generally very well supplied. Relatively low levels of potassium are found throughout the Ozarks and upon the glacial Shelby loam of north central Missouri. The Lindley loam, a soil of rather low productivity, is relatively well-supplied with potassium.

Readily Soluble Phosphate.—The distribution of readily soluble phosphate, that is phosphate readily available as a plant food, is given in Figure 8. Ozark soils, including Ozark Border and Plateau areas as well as the Ozark Center are notably low in available phosphate as are also the glacial Shelby and Lindley loams of the north central part of the state. By contrast, the alluvial soils and the loess soils of Northwest Missouri are well supplied.

The relationship between variations in the soil content of readily soluble phosphorus and land values is indicated in Figure 9 and is similar to that indicated for nitrogen. The degree of association is approximately the same as for nitrogen, r = +.80, but the evidence of curvilinearity is so small that no curve was fitted. Again the range of the data is limited and the nature of the relationship between land values and readily soluble phosphate at higher and lower concentrations can only be conjectured.

Clay Pan.—One troublesome characteristic of a large area of land in Missouri and one the effect of which on productivity and value is difficult to determine, is subsoil clay content. More than 6,000,000 acres or about 14 per cent of the total area of the state

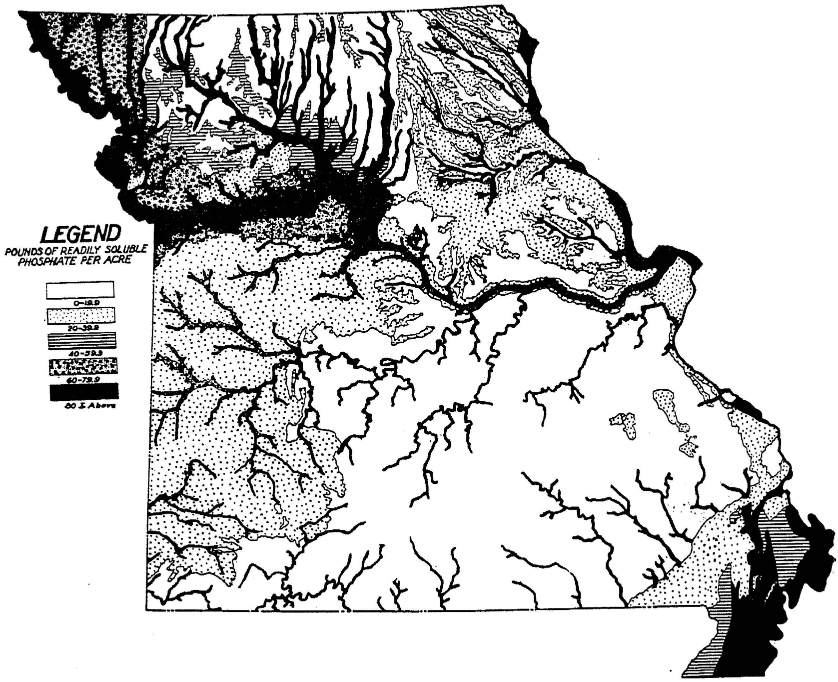


Fig. 8.—Pounds of Readily Soluble Phosphate Per Acre. The distribution over the state of readily soluble phosphate per acre is given in the map above. Phosphate in this form is apparently readily available to plants. From Missouri Experiment Station Bulletin 349, p. 23. (Map adapted from map prepared by U. S. Soil Erosion Service in cooperation with the department of soils of the Missouri College of Agriculture.)

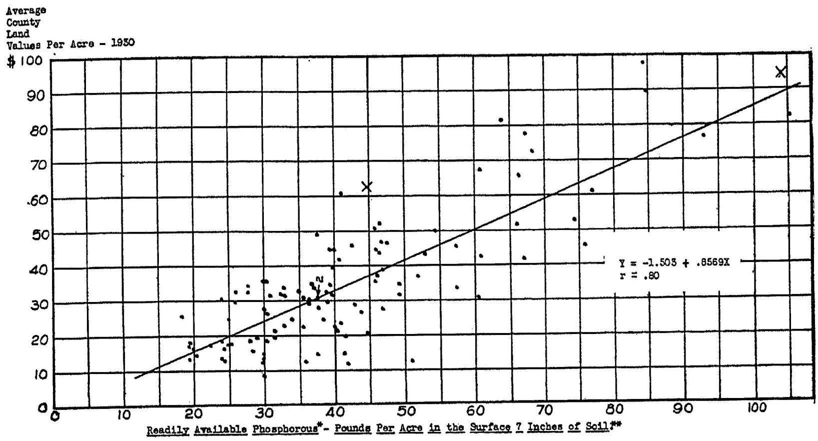


Fig. 9.—A measure of phosphorous content of soil readily available to plants and hence significantly related to land productivity and value has been difficult to determine. Dr. Baver of the Missouri Agricultural Experiment Station has supplied the data on phosphorus used in the above figure.

*See Footnote, Fig. 4.

**See Footnote, Fig. 4.

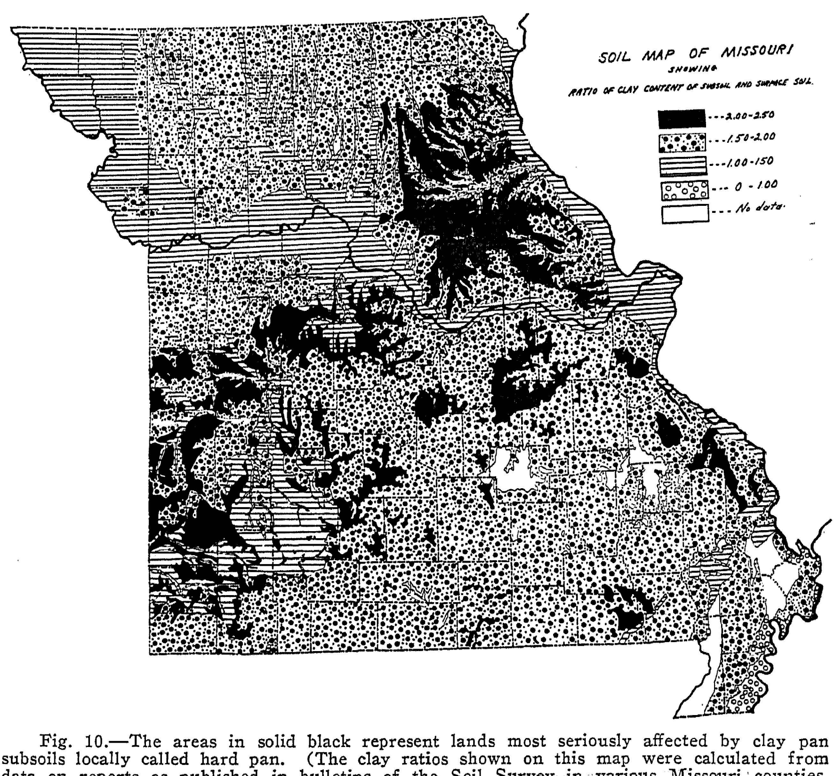


Fig. 10.—The areas in solid black represent lands most seriously affected by clay pan subsoils locally called hard pan. (The clay ratios shown on this map were calculated from data on reports as published in bulletins of the Soil Survey in various Missouri counties, and are of major soil types only. Furthermore, since the number of observations for each soil type was invariably small the ratios are only approximations of true ratios.)

may be said to be clay pan lands or as having such impervious soils as to materially reduce their productiveness. They are generally soils of relatively great geological age and often are characterized by relatively infertile surface soils in conjunction with their clay pan subsoils. In Figure 10 these clay pan soils are sketched out in solid black, and are designated as having a high ratio of clay in subsoil as contrasted to surface soil. In point of fact, the inertness and infertility of the clayey subsoil seems to be as great (or greater) a factor in explaining the low productivity of these soils as is the ratio of clay in subsurface and surface. There is a distinction, however, between clay content as a mere feature of soil texture and a clay pan as a feature of the subsoil alone. The use of the ratio is intended to bring out this difference.

The effect of these clay pans as such is generally recognized. Miller and Krusekopf in their bulletin on "The Soils of Missouri"[1] make a number of relevant comments including those listed below.

"The Lebanon silt loam probably has more unfavorable subsoil characteristics than any other Ozark soil."[2]

Of the Putman silt loam they write: "The true subsoil begins abruptly at a depth of 16 to 20 inches and is a grayish brown, stiff, impervious clay, having an effect upon the soil similar to that of a hardpan layer."[3]

Of the Cherokee silt loam they write: "The ashy gray subsurface and the brown, stiff clay subsoil are the distinguishing characteristics of the type. The subsoil when wet is gummy, but when dry is hard and intractable. Water passes through it very slowly."[4]

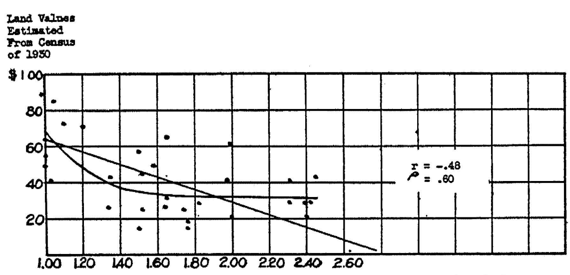


Fig. 11.—Lands with heavy clay pans have lower values, other things equal, than do those in which the clay is absent or less pronounced.

1 Missouri Agricultural Experiment Station **Bulletin 264.**
2 Ibid., page 69.
3 Ibid., page 44.
4 Ibid., page 57.

The effects of these clay pans is to hasten soil exhaustion since plants are limited to a relatively shallow layer of surface soil. The reserves of plant food are, therefore, much less than for soils upon which plants may feed to greater depths and the relative rate of exhaustion is presumably greater. Effect of erosion, where the degree of washing is the same, is also much more severe on these clay pan soils since the removal of the surface soils exposes the unproductive and intractable subsoils.

By estimating the average or typical values of lands by the major soil types a rough approach to the effect of varying clay ratios on values may be made. The Census of 1930 gives land values by townships, making the desired estimates of land values both easier and more accurate. In Figure 11 such typical values are plotted against the clay ratios for the major soil types. The coefficient of correlation (linear) is small and not highly significant, but the index of correlation, $\rho = .60$, is much higher and above a figure that would apparently have occurred by mere chance.[1]

Data for soils with clay ratios below 1.00 (viz., for soils with more clay in the surface soil than in the subsoil) are not available now. There is some reason to believe, however, that other things being equal, a ratio of essentially 1.00 approaches the ideal and that a curve indicating the complete relationhsip between clay ratios and land values would have been bell-shaped. The bases for such presumptions are much the same as those offered in the case of nitrogen in preceding pages.

After a clay ratio of about 1.80 has been reached, the effects of increasing subsoil clay upon values is small. That is, predicting from the curve, the value at a ratio of 1.80 would be about $32 per acre and that at 2.40, near the top of the ratios, about $31 per acre.

Depth of Surface Soil.—For a number of reasons the depth of surface soil is an important factor in determining productivity of land. The surface layer is the one in which the ordinary farm crops do most of their feeding. In it accumulates most of the humus, which is not only a factor in soil fertility, but an important structural feature as well.

Of the humus content of the soil Lyon and Buckman say: "Its importance in the regulation of nutrient supply of higher plants is of the first order. Physically, the soil humus is loose and fluffy, and low in plasticity and cohesion. It, therefore, tends to lighten a heavy soil while binding in some degree a sandy one. Besides encouraging and preserving granulation, it helps the water-

1 A value as low as ρ equal to .47 would have been significant.

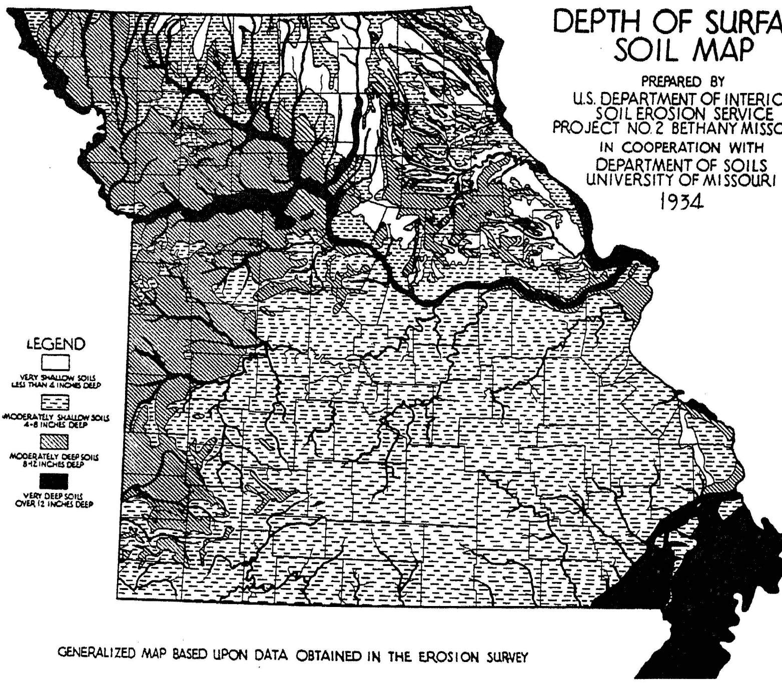


Fig. 12.—The surface soil, as designated in this map, is the surface layer of uniform color.

holding capacity of soil, sufficient reason in itself for the adequate maintenance of the organic ingredient."[1]

In an area with a continental climate where precipitation is abrupt and its erosive effects vigorous, the surface soil and its humus are a critical factor in soil conservation. Baver calls attention to the need for maintaining humus content of soil as means of combating erosion. He states:

". . . . . As the humus content and fertility of the soil is lowered, its susceptibility to erosion increases. Humus makes the soil more porous and absorptive in rainfall and by causing granulation of the soil, helps to resist the erosive action of running water."[2]

Topography

Topography, as a characteristic of land, is at once independent of and related to soils. Each soil type is limited in its topographic range. Clarksville stony loam always occupies a hilly terrain, while

1 Lyon and Buckman, "The Nature and Properties of Soils," MacMillan Company, 1934, page 84.

2 Baver, L. D., "Soil Erosion in Missouri," Missouri Agricultural Experiment Station Bulletin No. 349, page 20.

the Wabash soils have flat and never more than gently undulating surfaces. Other soil types are more tolerant of topographic differences and the terrain of the Marshall silt loam may vary from undulating to rolling and that of the Putnam silt loam from essentially flat to rolling.

Because of the inter-relation of topography and soil, it is fitting to consider together their effect on land values. In fact, it is difficult to disassociate the effects of the two.

The relationship of topography to land value is similar to that of texture. That is, a middle range of slopes; not too flat, on the one hand, and not too steep, on the other, is most satisfactory to the user of the land. Level or flat lands when coupled with the soil texture, normally encountered upon them in Missouri, commonly suffer from tardy surface drainage and are difficult to handle in rainy seasons. If this flatness is coupled with structural defects such as clay pan subsoils, the difficulty is much accentuated. On the other hand, soils on steep slopes are subject to severe run-off and,

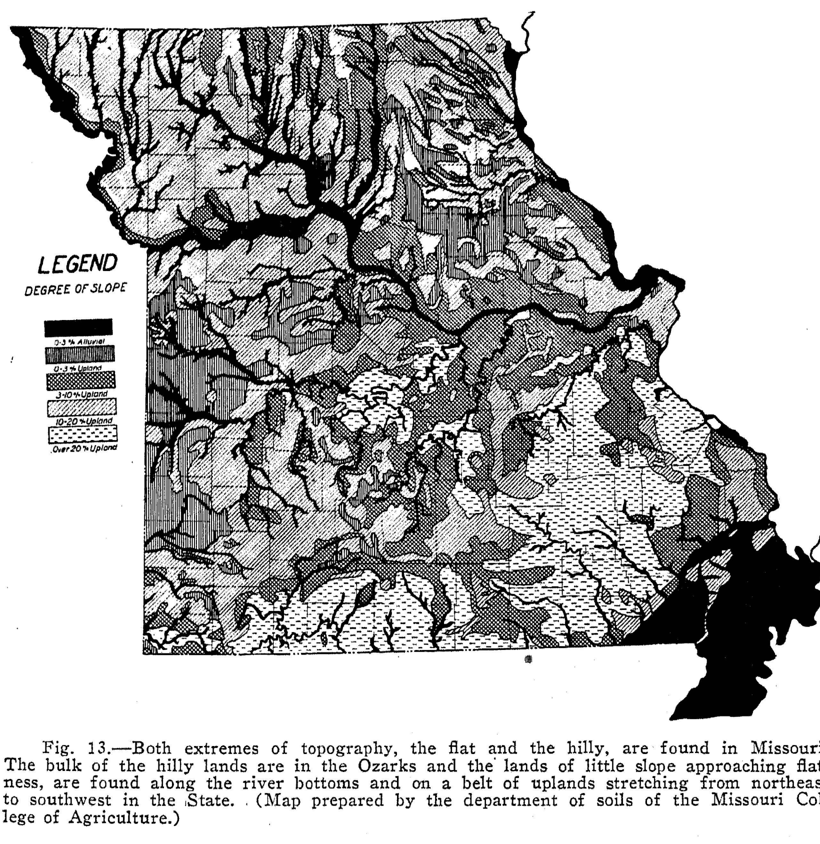


Fig. 13.—Both extremes of topography, the flat and the hilly, are found in Missouri. The bulk of the hilly lands are in the Ozarks and the lands of little slope approaching flatness, are found along the river bottoms and on a belt of uplands stretching from northeast to southwest in the State. (Map prepared by the department of soils of the Missouri College of Agriculture.)

because of this run-off, are likely to be erosive. In fact, slopes need not become very steep in Missouri until they must be kept permanently in some sort of cover crop, if erosion is to be curbed. That is: "Whenever sloping land is planted to a crop that does not provide cover for the soil, erosion takes place . . . . In fact, most of the severe erosion in the state occurs on land that has an average slope greater than 10%. Only moderate erosion has taken place in areas having slopes less than 3%."[1]

The effect of topography on values is, in Missouri, accentuated by a number of associated land factors. In the rougher and more dissected portions of the Ozarks, the most hilly terrain of the entire state is coupled with extreme stoniness. Either slopes or stones would alone be an effective bar to cultivation in this area. On the flat uplands of northeast and west south central Missouri (Putman, Cherokee and Oswego soils) a level terrain and a clay pan subsoil occur together so that slow surface and internal soil drainage are combined. Finally upon low lands, particularly in Southeast Missouri, the flat terrain is a factor, albeit a secondary one, responsible for recurrent flood damage. Internal soil drainage in this area is less of a factor in depressing land values than is the case for the tight subsoil lands alluded to above.

By using estimated land values for the major soil types (as was done in the analysis of clay pans and values, page 25) and estimates of the typical slope for each soil type, a relationship between topography and land values may be established. Numerous other associated features of land, in this case, obscure the nature and degree of association and the resulting coefficient of correlation, $r = -.38$, is close to the lower limits of significance. The more exact nature of the relationship awaits further study.

FACTORS AFFECTING THE PRODUCTIVITY OF LAND

The relationship between land income or the productivity of land and its value has been discussed in a number of studies[2] and needs no general comment here. The concern of the appraiser is how to judge accurately and expeditiously the productivity of the land as his basis for determining its value.

Murray and Meldrum[3] in a recent study on "A Production Method of Valuing Land" have suggested, as a desirable method for determining productivity, that a history of yields of crops grown in a suitable rotation and under average or typical management, be obtained. From these yields there may then be calculated

1 Baver, L. D., "Soil Erosion in Missouri," Missouri Agricultural Experiment Station Bulletin No. 349, pages 15-16.
2 See particularly Chambers, C. R., "Relation of Land Income to Land Value," U. S D. A. Department Bulletin No. 1224.
3 Murray, W. G. and Meldrum. H. R. "A Production Method of Valuing Land," Iowa Agricultural Experiment Station Bulletin No. 326, March, 1935.

the income-producing power of the land and, if the estimates or data are reliable, it is but a step from income to value. "This question of reliable yields," they comment, "is the crux of the appraisal problem as far as physical production is concerned."

For a number of reasons, obtaining reliable yields may prove difficult. First, the soil and topographic complex and the land use pattern of each farm is more or less unique so that yield data need to be those from the particular piece of land being evaluated. Second, it is the unusual rather than the usual farmer that keeps an accurate record of yields and estimates are by no means always reliable. Third, there is the ever present problem of determining whether the type of farming has been normal and whether management has been average. If these factors have been non-typical the yields are biased and their reliability is lessened. Fourth, the relationship of yields to income and value is by no means unmodified by the costs of obtaining these yields. The case is clearest where considerable quantities of fertilizer are normally employed. However, the intensity of cultivation and the efforts at combatting pests, have additional effects.

For purposes of valuing land for the production of crops not normally grown in the rotation prior to the date of evaluation, direct yield data may be of limited use. And still more limited is their use in areas where there is need to evaluate land never before cropped. Thus, for land still in cut-over stage, newly drained or leveed, or still in virgin sod, a dependence upon criteria other than yields is necessary. The acreage of such lands is and will continue to be considerable.

Finally, there is the fact that past records of yields however dependable may not accurately represent the productivity of land for the future. In fact, they will be so representative only under the presumption that the type and system of farming has been such that the past level of yields can indefinitely be maintained. Under most systems of farming, fertility losses are considerable[1] and in many situations land depreciation because of erosion is a most pressing fact. Where such depreciation has been considerable, land must be evaluated upon the basis of estimates of its future yields rather than upon any records of its yields in the past.

The basic data from which to estimate these future yields are apparently to be sought in the soil and topographic features that proved so acceptable as a basis for judging the value of land directly. In fact, if these features are the basis of value, they must also be the basis, in large part, for yields and for productivity. To test out this hypothesis or presumption is simple enough and in succeeding paragraphs the same soil and land features that were, in the preceding section, related to land values are related in much the same manner to various aspects of land productivity.

To begin with, the implications of the two following figures are unmistakable. The data on yields[1] and soil factors were neces-

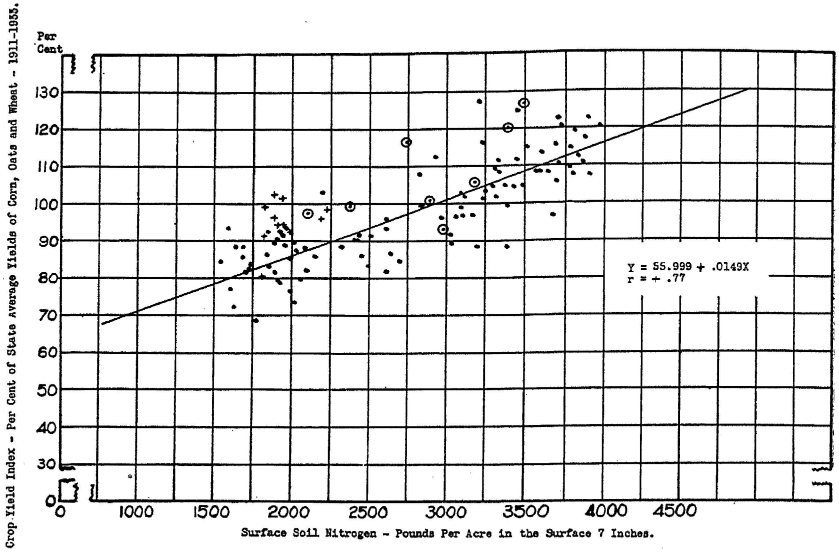


Fig. 14.—Surface Soil Nitrogen and Yield Index. The level of nitrogen in the surface soil is related to these composite yields in much the same manner as it is related to land values, as in Figure 3. That is, the gross correlation is approximately the same in both cases. Dots within the circles represent urban and Southeast cotton counties not used in determining the predicting equation. Counties represented by crosses are those of Northeast Ozark Border where the intensity of land use is known to be relatively high.

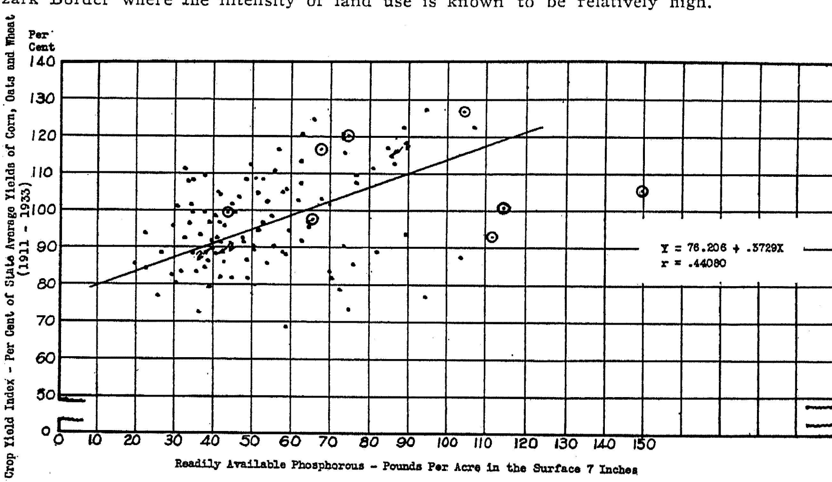


Fig. 15.—Readily Available Phosphorous and Crop Yield Index. Differences in available phosphorous are not as highly correlated with variation in composite crop yields as are differences in nitrogen or exchangeable bases. Circle counties are urban or Southeast Lowland counties and were not used in determining the relationships.

1 The index of yields was constructed from county average yields for the three crops over the period 1911 to 1933, inclusive. The yields for each county were calculated as per cents of state average yields for the same period and these combined upon an unweighted basis. The yield data for other crops were not as reliable as those for corn, oats and wheat and, hence, were not included. The specific difficulty with tame hay figures arose because of the indefinite and varying hay crops included in the composite "tame hay".

sarily estimates, at best only approximating true figures. The relationships are, however, striking.

The relationships are, furthermore, linear (only in the case of nitrogen is there a small evidence of curvilinearity) and are on a much more stable basis than those for value. That is, the average yields, based as they are on a 23-year period, can be expected to change only slowly as time goes on. The level of land values, however, has no such claim to stability and can be expected to change as the value of money or the relative prices of farm products rises or falls and indeed has changed greatly and repeatedly during the same 23-year period, 1911- 1933 inclusive, that was used in the determination of average crop yields. One could rather confidently expect, therefore, that if the soils of a particular tract analyzed about 2000 pounds of nitrogen, and 65 pounds of available phosphorous per acre of surface soil (surface 7 inches), that the yields obtained would be about equal to or a little above the average for the state.

To predict the yields for particular crops alone upon the basis of these productivity factors is more difficult than was the case for an index based upon the three major crops, because it is quite impossible to find upon what specific kind of land within the county each crop was grown. The three crops, corn, oats and wheat, occupy a major part of the crop land in most counties, but such is not the case for any of these alone. That is, oats or wheat or corn are probably grown on lands of more than average fertility, but the selection or bias almost surely differs widely as between counties. In some counties corn gets first choice and in others such as Jasper, Lawrence, Platte, and St. Charles, first choice is probably given to wheat. The acreage of each of these crops by counties can be obtained, but no information is available on the type of land upon which they are grown except in general terms.

Data are available in the case of corn yields to test the bias of county average yields that results because corn is grown not upon average crop land but, in most cases, upon land decidedly better than average. In Figure 16 average corn yields are plotted against average nitrogen content of soil for 106 Missouri counties. The yields in counties with high nitrogen soils is only moderately greater than for those with low nitrogen soils. That is, using the predicting equation,

$$Y = 16.417 + .0003425X$$ [1]

the yield in counties with an average of 1500 pounds per acre of nitrogen in its surface soil is 21.6 bushels and for a county with a

1 Where Y is the predicted yield and X is the observed level of nitrogen in the soil.

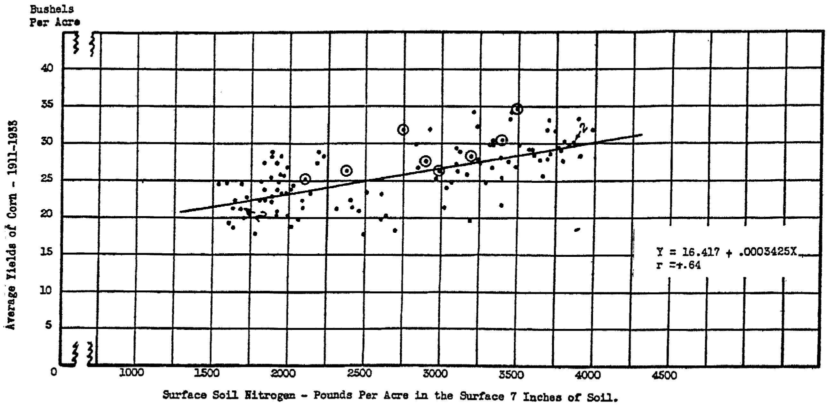


Fig. 16.—Nitrogen and Corn Yields. Average corn yields in bushels are not as closely correlated with variations in surface soil nitrogen as are the composite yields as Fig. 14. Circle counties are urban and southeast lowland counties not used in determining the relationships. (In Figure 16 as in Figures 14 and 15 the observed data do not extend over the full range of possible observation. Obviously a soil with no nitrogen would yield no corn. The curves therefore are no more than a partial representation of the complete relationships.)

nitrogen content of 4000 pounds per acre, the yield is only about 9 bushels greater or 30.1 bushels per acre.

On the other hand, with the use of more closely controlled and accurate data, drawn directly from the experiment fields of the Missouri Agricultural Experiment Station, another predicting equation, presumably free from bias may be calculated. The equation is

$$Y = 6.105 + .00593X$$ [1]

Using this latter equation, the yields predicted for a level of 1500 pounds of nitrogen is 15.0 bushels per acre and for 4000 pounds of nitrogen 29.8 bushels per acre as contrasted to the 21.6 and 30.1 as forecast by equation derived from average county yields and average cropland nitrogen. The upward bias of the first equation is 6.5 bushels at the 1500 pound nitrogen level, but the two equations are in essential agreement on yields at the 4000 pound nitrogen level. The average bias at varying nitrogen levels may be judged by reference to Figure 17.

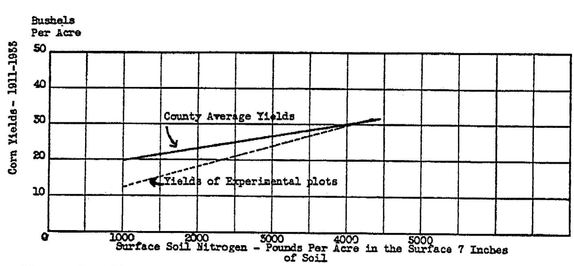


Fig. 17.—The corn yield nitrogen relationship with two types of data. The bias in yields, when county average yields are used, is measured by the distance between the two lines and is essentially zero at 4000 pounds.

1 This equation based on only twelve observations—all that were available.

In other words, as has long been thought to be the case, farmers in areas of low nitrogen choose the more fertile of their fields for corn production, while those in areas of high nitrogen soils grow their corn upon lands that are essentially average in fertility.

The bias in yields, because of the selection of land, would be as great or greater in the case of crops, other than corn, since these are grown upon a lesser total acreage that is less evenly distributed over the state as a whole. This bias constitutes an effective bar to the prediction of yields upon the basis of average (per county) crop land, content of nitrogen, and available phosphorous, though it by no means destroys the validity of the underlying presumption that these soil features do actually govern in part the fertility and productivity of land. What is needed is a far larger amount of data on these soil characteristics of specific plots of land on which yield data are available for various crops for a period long enough so that weather exigencies are averaged out. With adequate data of this latter type it should be possible to predict with a desirable accuracy the potential productivity of any piece of land for the range of crops for which it is suited.

Until such data are available, dependence will of necessity be placed upon such makeshifts as the crop index employed in Figures 4, and 9. For Missouri counties this yield index is highly correlated with county average values of land (Figure 18).

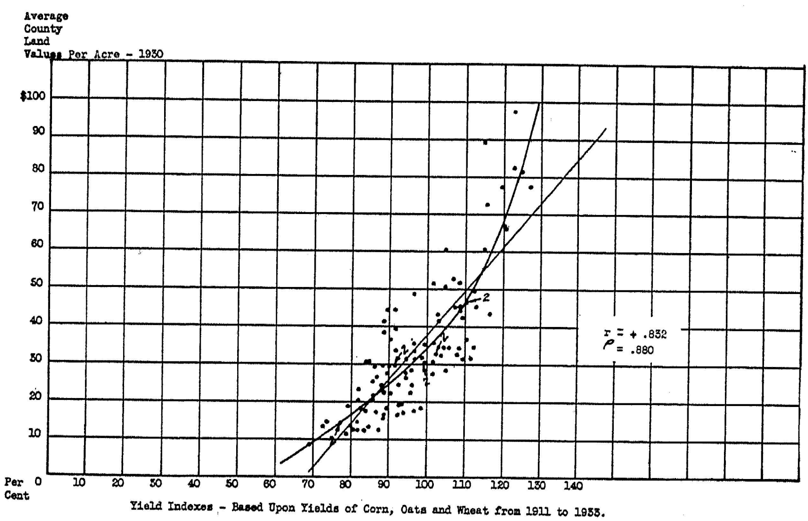


Fig. 18.—High and low composite yields reflect levels of nitrogen, and available phosphorous and are correlated with average county land values in much the same manner.

Effect of Clay Pans on Yields

Because of the unsatisfactory measures of clay pans, a different approach to the problem of their effects on yields is needed. This structural soil feature apparently affects not only the level of yields, but exerts a most pronounced effect on the stability of yields. That is, yields upon lands without this structural defect are less variable than those where the subsoil-surface soil, clay ratio is high. In the table below the average coefficients of variation ($\frac{\sigma}{M}$ x 100) for counties with low and counties with high ratios are given for corn, oats and wheat.

TABLE 4.—VARIABILITY OF YIELDS FOR CORN, OATS AND WHEAT FOR COUNTIES WITH DIFFERENT SUBSOIL—SURFACE SOIL CLAY RATIOS

Clay Ratios of Dominant Soils	Variability of Yields		
	Corn	Oats	Wheat
	$\frac{\sigma}{M} \times 100$	$\frac{\sigma}{M} \times 100$	$\frac{\sigma}{M} \times 100$
1.00-1.50*	204	225	218
1.50-2.00**	225	271	229
2.00-2.50***	311	360	270

*Atchison, Andrew, Buchanan, Clay, Holt, Nodaway, Platte and Saline counties.
**Caldwell, DeKalb, Harrison, Mercer, Putnam, Schuyler and Sullivan counties.
***Audrain, Barton, Henry, Monroe, Shelby and Vernon counties.

Missouri is located pretty well toward the southern edge of the range of spring oats and variability in yields is greatest for this crop. The variability for corn and wheat is not greatly dissimilar Corn suffers from the characteristic midsummer droughts and wheat from winter killing, winter cold and droughts. The stability of yields or its obverse, variability of yields, by counties in Missouri, is given in Figures 19, 20, and 21 for corn, oats and wheat, respectively.

The variability between crops is, however, much less pronounced than the variation between counties or groups of counties with different clay ratios. On the average, yields are nearly 50 per cent more variable in counties where the preponderant share of the soils have a clay ratio of between 2.00 and 2.50 than in those where the ratio is from 1.00 to 1.50.

One should hasten to say, however, that clay pans are by no means the only factors producing variation in yields. Other factors are insect pests, floods, drought periods, differences in total precipitation and its monthly distribution and to a lesser extent, variations in frost damage. Of all factors, however, soil differences, particularly clay pans, and rainfall distribution with the

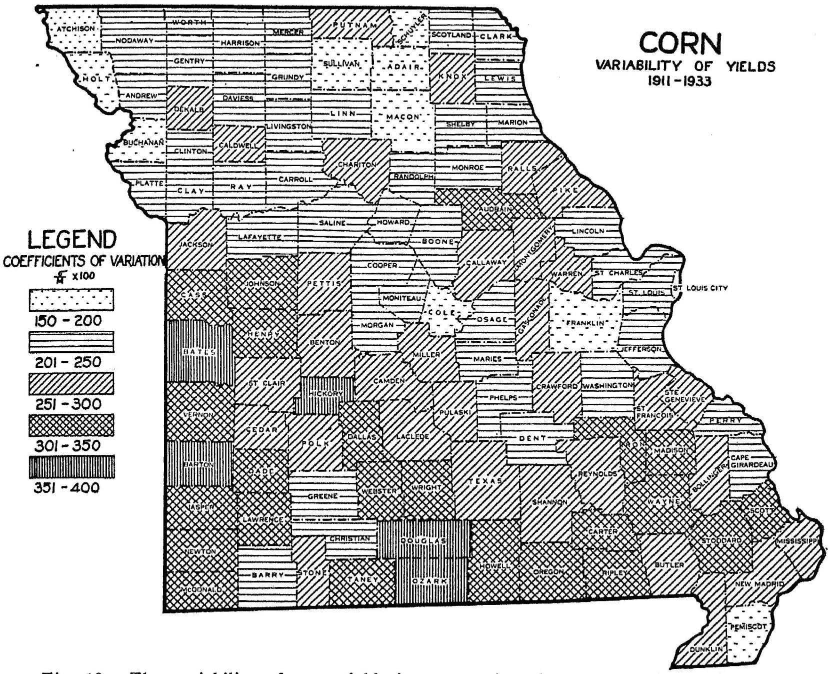


Fig. 19.—The variability of corn yields is greatest in a large group of counties in Southwest Missouri. By contrast, yields are most stable in Northwest Missouri. Map based on data from Mo. State Statistician, Bu. Agr. Econ.)

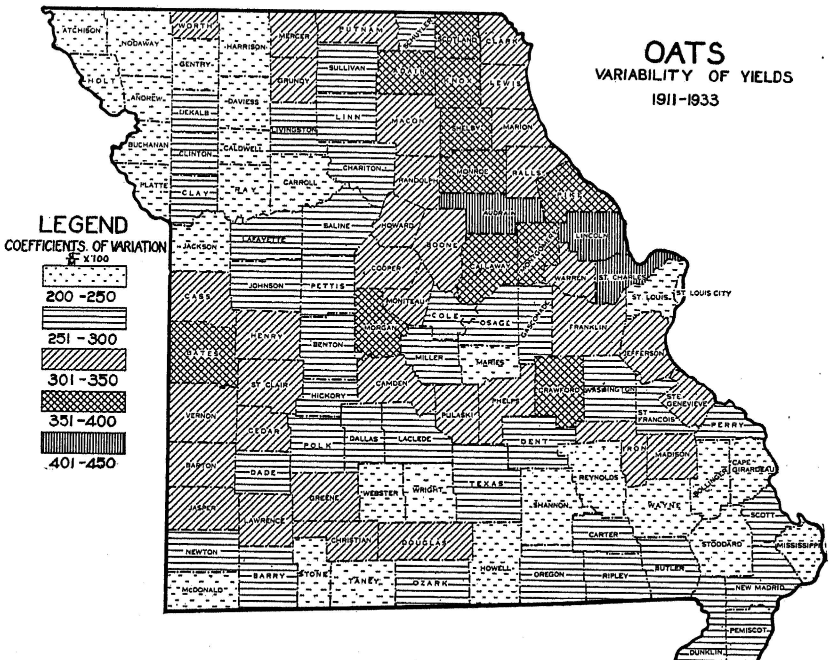


Fig. 20.—Oat yields are most variable in Northeast Missouri and particularly in Audrain County. In comparing this map with those for wheat and corn, please note the different hachure scale.) (Map based on data from Mo. State Statistician, Bu. Agr. Econ.)

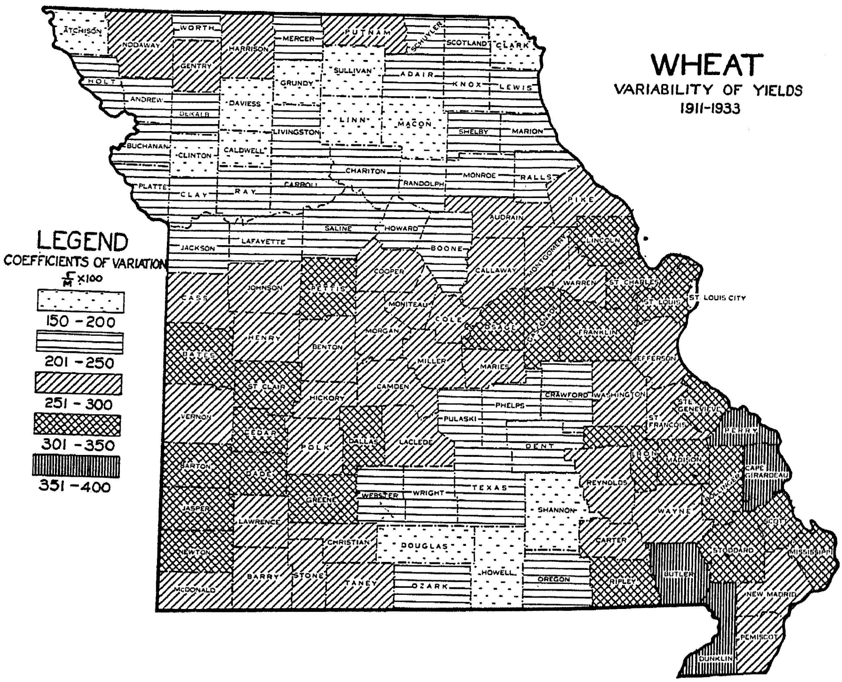


Fig. 21.—Wheat yields vary most in southern half of the state, about a dozen counties of the Ozark Plateau section excluded. (Map based on data from Mo. State Statistician, Bu. Agr. Econ.)

associated drought periods, are almost surely the most important. It happens that for two counties with widely different clay ratios, Atchison and Barton, the monthly distribution in rainfall is very similar (See Figure 22). Yet in Barton county yields for all three crops are approximately twice as variable as in Atchison.[1]

Heavy clay pans appear to accentuate the exigencies of climate, as is apparent from the table below, giving ranges in yields in Atchison and Barton counties. In Atchison county the highest yields are respectively 221%, 206% and 208% of the lowest

Table 5.—Range of Yields of Corn, Oats and Wheat During the Period 1911-1933 in Atchison and Barton Counties

County	Corn		Oats		Wheat	
	Lowest Yield	Highest Yield	Lowest Yield	Highest Yield	Lowest Yield	Highest Yield
Atchison	19	42	18	37	12	25
Barton	5	32	9	35	6	21

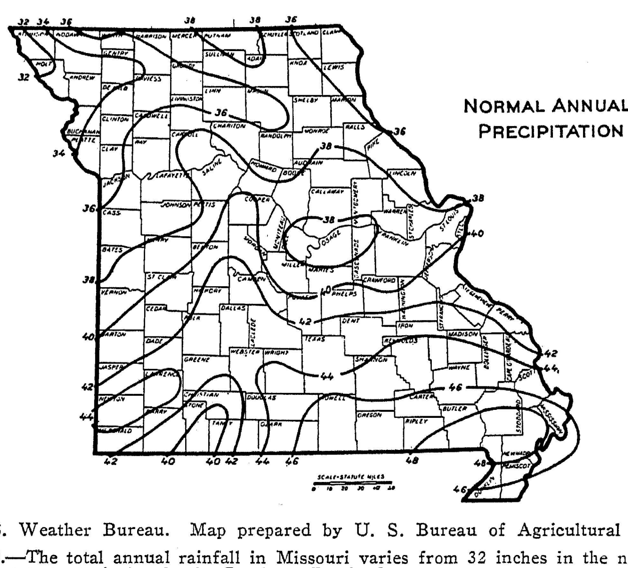
1 The coefficients of variation are: For corn—Atchison 162, Barton 375; For oats—Atchison 201, Barton 314, and for wheat—Atchison 169, and Barton 330. Oats and wheat fertilized in Barton county and not in Atchison.

yields for corn, oats and wheat. The comparative figures from Barton county are 640%, 389% and 350%. Furthermore, and quite as significantly, the differences between the highest yields in the two counties is small, while differences between the lowest yields are great. Thus, between the highest yields the differences are only 131%, 106% and 119% for corn, oats and wheat, respectively, but the differences between the lowest yields for the same crops are 380%, 200% and 200%. The tentative conclusion suggested by these data is that adverse weather conditions reduce yields more in Barton than in Atchison county. The data of Figures 22, 23, and 24 tend to substantiate such a conclusion. However, dependence upon data for two counties only, the assumption that the yield data are reliable and that other factors producing variations in yields are constant, suggest the need for further analyses before too great a dependence is placed upon the conclusions.

Effects of Climate on Yields

Before going on to the methods of using data heretofore presented for the purposes of judging the productivity and value of land, some comment on the character of the Missouri climate is in point.

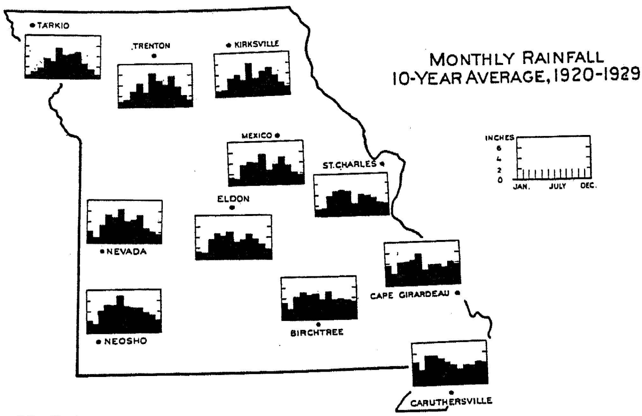
The figures presented below speak so clearly for themselves that no great comment on them is necessary. The salient features of Missouri's climate are essentially four in number. First, it is of the continental long summer variety. Second, it has, on the



From U. S. Weather Bureau. Map prepared by U. S. Bureau of Agricultural Economics.

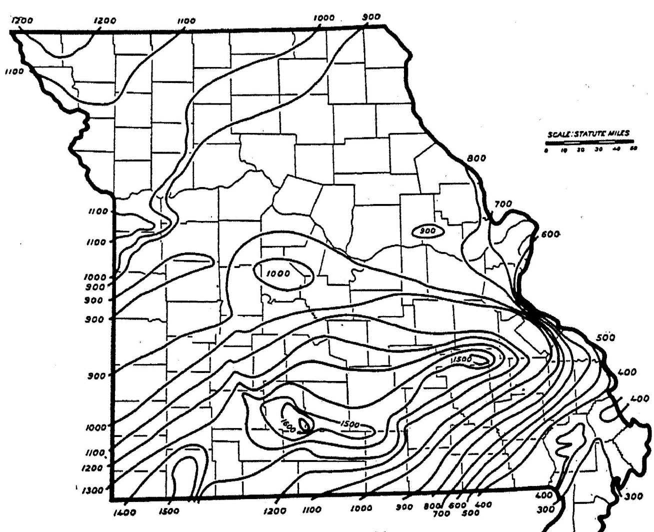
Fig. 22.—The total annual rainfall in Missouri varies from 32 inches in the northwestern part of the state to 48 inches in the Southeast Lowlands.

average, an abundant rainfall, quite sufficient for the crops commonly grown in the Midwest (Figure 22). Third, its rainfall is well distributed, most of it coming in the growing season, but there is a characteristic drought period occurring in the latter part of July and the first week of August and lasting a fortnight or more. These drought periods occur at the hottest part of the season and take a considerable toll, not only on cultivated lands but particular-



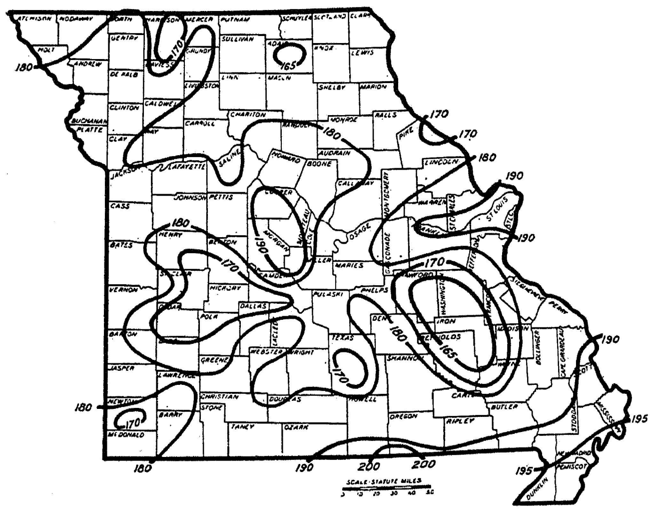
Courtesy U. S. Bureau of Agricultural Economics.

Fig. 23.—Rainfall at most stations is heavier in summer than in winter but at times falls off badly during July.



From Report Missouri Geological Survey. Map prepared by U. S. Bureau of Agricultural Economics.

Fig. 24.—Variations in elevations in Missouri are such that the length of the growing season is much the same throughout the state.



Length of Growing Season (From U. S. Weather Bureau). Map prepared by U. S. Bureau of Agricultural Economics.

Fig. 25.—Only in the cotton growing section of the southeast lowlands is the frost-free season in Missouri much above the average of the state.

ly on pastures. They differ in intensity in different parts of the state as can be surmised by the low levels of rainfall for July for some of the stations reported in Figure 23. It is these drought periods, rather than total precipitation, that are the limiting factors as far as rainfall is concerned. Fourth, the variations in elevation, as in Figure 24, are such that the growing season (Figure 25) is of much the same length in the southern as in the northern part of the state, the exception being the southeast lowlands, which are part of the Gulf Coastal Plain and which have a season long enough for the growing of cotton.

No attempt has been made to calculate the direct effect of the various aspects of climate on value and productivity. Obviously, there are such effects, since climate affects crop yields and is an important determinant in the process of soil formation. The effects of weather on value should, therefore, be comprehended for the most part when value is associated with yield and/or soil factors. In a more intensive study, however, certain direct relationships between climate and value might easily be worth determining.

GRADING LAND FOR APPRAISAL

The most satisfactory method of employing the types of information presented in preceding pages for purposes of appraisal would be to use them as a basis for grading land. Such an approach to land grading has some advantages as contrasted to that based upon soil type. First, it centers attention upon factors known to affect productivity and value; the characteristics of land in which the appraiser is most interested. Many of the criteria used for designating soil type have no great relationship to the productivity of the land. Second, these unit soil factors or elements can be measured and put into quantitative terms. Soil type being a composite is not susceptible to such measurement. After being measured these unit factors may be related directly to such things as yields or values. Third, the gradations upon the basis of these measured characteristics can be made very fine. A wornout soil can be distinguished from one classified within the same soil type but still in a virgin condition.

On the other hand, the number of soil and land characteristics having some effect on the value of a particular piece of land is often great, and it is not always possible to secure measurements of all of them nor to try to uncover a specific relationship of each to productivity or value. Similarly, the emphasis or weighting of each factor or characteristic, even where these are measurable, differs more or less from farm to farm. One should, therefore, not expect too much from such a system of grading though it should measurably increase the appraiser's ability to judge the capacity of the land to produce crops. Perhaps, also, it is not too much to say that it would enable him to increase acceptably his ability to understand "land" since in effect this method of grading breaks the composite "land" up into much simpler and more easily comprehended elements.

There seems some possibility, also, that an appraiser who spent his time mastering the relation of these various unit soil factors to crop yields and land productivity would find his knowledge somewhat more broadly useful than one who limited his attention largely to soil types. Nitrogen, phosphorus and exchangeable bases and the like are presumably much the same from Maine to California and from Louisiana to Minnesota. Soil types often constitute a complex pattern even in a relatively small locality. The need to interpret one's knowledge of the unit soil factors in relation to varying climatic conditions and to a great variety of crops would be no greater than the similar need when dependence is upon soil type.

Furthermore, types of farming differences seem to have had only a moderate influence on the relationships between the various soil factors and land value and productivity in Missouri. The southeast lowland cotton counties constitute an exception and were left out of most analyses for that reason. Unquestionably, had the boundaries of the investigation been considerably extended, types of farming would have been found where relationships would have been significantly different and a preliminary sorting of the data would have been needed.

At present, it appears that, in Missouri, the farmer pays pretty much the same for nitrogen, exchangeable bases, phosphorus and so on whether he wants the land for grain raising, dairying or beef and hog production. Indeed, an inspection of a type of farming area map of Missouri and one giving township land values as reported in the census of 1930 reveals very little correlation between type of farming and land values. Dairying occurs on lands high in price and upon lands low in price. The same may be said of beef and hog production and even of cash grain farming. In other words, land values seem not so much to have adjusted themselves to types of farming or vice versa as both of these seem to have adjusted themselves to differences in these unit soil factors. The cotton producing counties of the southeast lowlands again constitute an exception and some interaction between land values and type of farming these unquestionably exists.

If, however, as suggested above, the amount of such interaction is moderate the usefulness of the method of land grading herein proposed is enhanced. That is, the comparability of grades would not be limited to a single type of farming area but would extend across the boundaries of several. The point, however, should not be labored until further work establishes or controverts the nature of the suggested relationships between types of farming, land values and the unit soil factors.

With these data on soil and land factors derived from such a system of grading at hand, it is possible to proceed by two methods to relate them to its value. The first method is to relate them directly as was done in the first part of this bulletin, (Pages 5 to 40). To do this, however, one must have access to data on values of land similar to those employed in the present study. Actual sales values of individual tracts are influenced by a number of factors quite apart from those pertaining to its physical complex. That is, distance to town, the size of the town, the type of road, and certain other aspecs of community and location values have added effects. Analyses using sales values of individual tracts would therefore, not reveal relationships as close as those derived from average values, though the predicting equation, assuming an adequate sample, might be quite as good.

For the individual appraiser, buyer or seller, the use of this method of relating physical factors directly to value would hardly be feasible. For central office or reviewing appraising the case would be different, since in these offices a large volume of data on value is normally accumulated. It should be noted, however, that relationships established for values at the year's level would not necessarily hold for the values of preceding or succeeding years. It would be necessary, in other words, to revise the analyses for each significant change in the level of land values. Since correlation technique is now used in most such central offices, making the analysis is only a minor difficulty as compared to that of obtaining usable and accurate data with which to work.

A second method would be to use the data obtained on these unit soil factors as a basis for predicting the productivity of the land or its yield of crops. Under present circumstances, this method is under the great disadvantage that, save perhaps in the case of nitrogen and corn yields, data accurately associating yields of particular crops with particular levels of soil constitutents are not generally available. Assuming such data to be available, however, it would be possible to forecast yields and upon the bases of these to use some such method of relating land productivity to its value as is suggested by Murray and Meldrum in their recent bulletin.[1] Indeed, because the methods herein suggested are so new and untried, they must be used in conjunction with and not in place of those suggested by Murray and Meldrum.

Furthermore, this type of grading falls far short of completeness in areas where site or location values overshadow, using an artificial distinction, those based upon earnings. Thus, average land values for Jackson and St. Louis counties fell completely off the charts (Figures 4 and 9) despite the fact that the levels of nitrogen and phosphorous in these counties are not exceptionally high.

On the other hand, differences in land use intensity in the "normal counties" apparently reflect themselves in yields rather than values and constitute no difficulty in the matter of grading. Thus, in Figures 13 and 14 yields in counties of the Northeast Ozark Border, where are concentrated an unusually large percentage of foreign born and people of foreign born and mixed parentage, run exceptionally high, as can be determined by noting the crosses used to represent the composite yields in these counties. Foreign born farmers, it is generally conceded, farm their land somewhat more intensively than do native born.

Despite the higher yields obtained by such farmers, however, land values in these Ozark Border counties are not "out of line" with those in other parts of the state and in Figures 4 and 9 fall indiscriminately above and below the line (or lines) of regression as do those of other counties. The higher yields in these counties are, in other words, translated into higher labor incomes rather than higher values for the land.

1 "A Production Method of Valuing Land," Iowa Agricultural Experiment Station Bulletin 326.

EFFECTS OF LOCATION AND HOME FEATURES ON LAND VALUES

In their recent report the Sub-Committee on Appraisals of the National Joint Committee on Rural Credits defines an appraisal as: " . . . . . . the definite written detailed opinion of a qualified individual or group of individuals of the basic value of a rural property" and they go on to define "basic value" as being " . . . . . . the worth of a property derived from such economic elements as **earnings, location and home uses.**"[1] The foregoing sections of this bulletin are at variance with the latter definition only in so far as the term "earnings" is revised to mean more specifically potential earnings or productivity rather than realized earnings of the past.

.... Differences in productivity as measured by the unit soil factors appear, unequivocally, to constitute the major explanation for variations in average land values from county to county in Missouri. Within counties, however, there is a wide range of variation in values which can be explained only partly by differences in the physical productivity of the land. And after the level of potential physical productivity has been established by reference to inherent qualities of the soil, it is necessary, to complete the analysis, to go on to the investigation of these factors of "location and home uses" that exert an additional effect.

To analyze these effects it is almost necessary to employ a case study of each property being evaluated, though certain fairly safe generalizations applying to many properties can apparently be made. The work of a number of investigators has established the facts, perhaps self-evident, that the location of a farm in relation to size of town, distance from town, type of road, and distance to the road, affect value in a fairly regular manner.[2]

Attempts have also been made to analyze the effects of distance to town and type of road by noting the differences in cost of hauling. While this latter approach has some merit, it runs into the difficulty that not only are there many ways of compensating for distance, such as shifts to the production of more concentrated or higher value products as distance increases, but determination of net or actual costs is made uncertain by reason of many conjuncture costs. That is, hauling is seldom for a single purpose but mixes up business, pleasure and indefinite objectives in an almost indescribed tangle.

No doubt the variations in these hauling costs and the associated features of location do have their effect on land values. These effects are, from a quantitative viewpoint, however, always

1 Journal of American Institute of Real Estate Appraisers, April 9, 1934, page 261.

2 See, for instance, Haas, G. C., "Sales Prices as a Basis for Farm Land Appraisal," Minn. Agric. Experiment Station Tech. Bulletin No. 9, and Ezekiel M. J. B. "Factors Affecting Farmers' Earnings in Southeastern Pennyslvania," U. S. D. A. Dept. Bulletin No. 1400.

a fact of the moment rather than of any long continuing period and change as the level of land values is altered or as types of farming shift or improvements in methods of transportation and types or qualities of roads are made. Indeed, so rapid are such shifts in periods of unsettled values (as from 1920 to 1935) that there has been a rather general tendency to leave a consideration of their effects to the judgment of the appraiser.

In periods of more stable values it would be quite possible, by holding certain other factors constant, to analyze more constructively the effect of distance to town on the values of land. Data on individual sales of land in Texas County, Missouri where towns are unusually uniform in size revealed, for instance, that land on improved state or county-maintained roads sold, on the average, for $2.12 more per acre than land on intermittently maintained dirt roads. That is, 8,630 acres, located on improved roads, sold in the years 1932 and 1933, brought $12.26 per acre, while 5,885.43 acres on dirt roads brought $10.16 per acre.

Analyses of the effect of distance to town on value made in a number of counties with similar data gave only indifferent results. That there were effects was clear, but often they were erratic; so erratic that they have not been included here. Further analysis with more complete data not at present available need to be made.

Much the same comment could be made regarding the effect of size of town or city on value of adjacent land. On the whole, it appears that only centers of population of metropolitan or semi-metropolitan status have effects, extending over any considerable area, that transcend those arising from differences in quality of land. Thus, while land values in St. Louis and Jackson county were so high that they could not be entered upon Figures 4 and 9, as these were constructed, those for Buchanan and Greene counties with the considerable cities[1] of St. Joseph and Springfield could be and were entered. They appear as crosses; the average value for Buchanan county land being $96.20 per acre and that for Greene $62.43.

While the value for Greene county is sensibly higher than others within the same range, as far as nitrogen, and phosphorous are concerned, that for Buchanan county is only moderately out of line. Yet St. Joseph is a larger city than Springfield, and Buchanan is a smaller county than Greene. For Cole county with Jefferson City; Jasper county with Joplin, Webb City and Carthage; Pettis county with Sedalia, and Marion county with Hannibal; average values were so moderately affected that their use in the correlations was quite unprejudiced.

1 St. Joseph—population in 1930—80,935. Springfield—population in 1930—57,527.

The site value influence of the smaller cities and towns extends, therefore, over short distances only and even those for St. Louis and Kansas City probably not for more than about 50 miles. In Figure 26 below, for instance average land values for townships located at varying distances from Kansas City are given. A great body of Summit silt loam near this city permitted a choice of these townships in such a manner that the productivity of land could be held essentially constant. A residual effect on values remains even at 40 miles distance, but from about 25 miles on is so small as to be easily covered up by local influences such as differences in land productivity and the like. That is, as judged by the curve (fitted free hand) the value at 25 miles was about $54 per acre, while that at 40 miles was about $47. Equally pertinent in this connection is the fact that wheat farming upon an extensive basis creeps up to within 20 miles of St. Louis, a city (with its suburbs) of more than a million population.

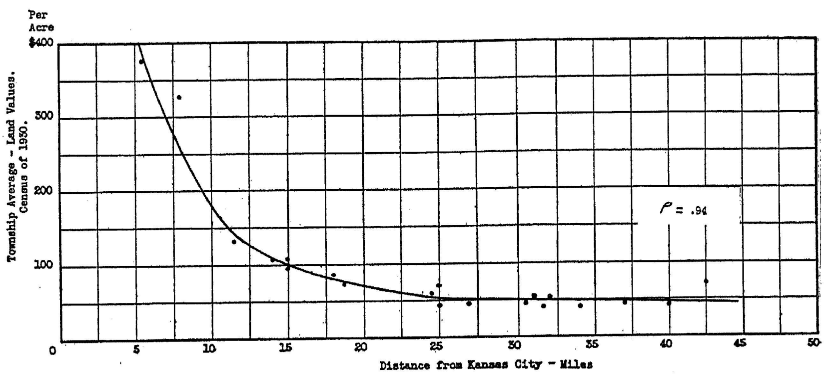


Fig. 26.—South and east of Kansas City there is a large block of quite uniform land. Effects of increasing distances from this metropolitan center on land values may, therefore, be accurately judged. After a distance of 25 miles, additional effects are small.

Other aspects of "location and home uses" having less tangible effects upon values are those directly associated with the community. Churches and schools make a difference and scenic attributes, in an era of a quite intensive search for country estates by urban people, may be of such importance as to quite outweigh all other factors combined. The market for tracts for country homes is particularly active in Jefferson and Franklin counties near St. Louis.

Springs with a regular flow of cold water that may be used for cooling market milk are known to be an occasional but important feature on some farms. The area adjacent to Hannibal, for instance, has a number of such farms.

The construction, style and arrangement of the buildings is an additional factor in determining the marketability of a farm and the selection of the site for the buildings may have a further influence. Other types of land improvements such as ponds, wells, and in many parts of the state, orchards, vineyards, asparagus beds and the like are particularly important in the case of the individual farm. In part, these defy analysis upon any broadly generalized basis; in part, they are beyond the scope of the present study. Buildings and similar improvements are a case in point. So important are these that frequently their correct appraisal is a matter of greater moment than that of the land itself. In their case, however, very different appraisal principles are involved and a separate study is needed.

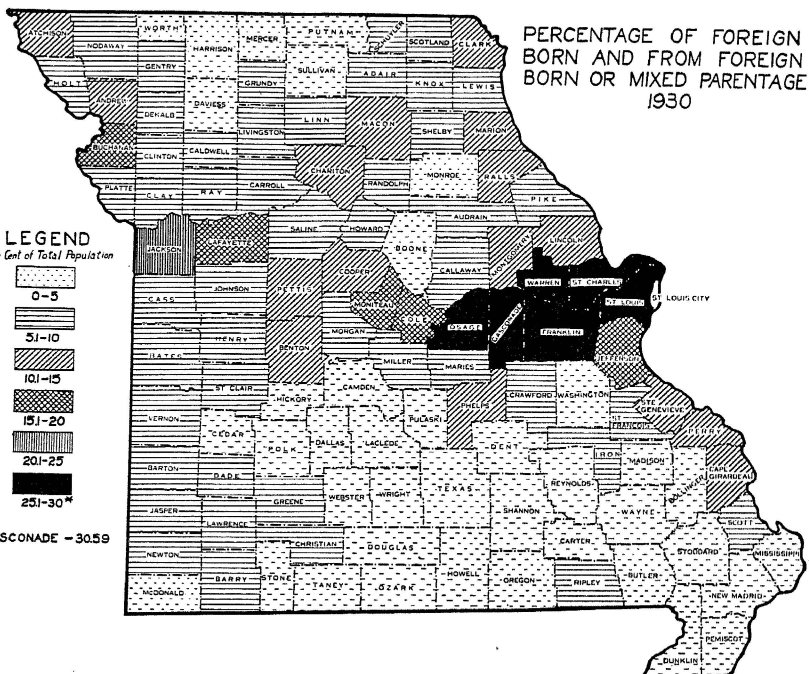


Fig. 27.—The percentage of the foreign born is largest in urban areas and in the counties of the Northeast Ozark Border. (Map from U. S. Census.)

In one case of community values a comment on generalized data is perhaps pertinent. As noted above, some counties of the state have more than a proportionate share of foreign born, and of foreign born and mixed parentage in their population. The greatest concentrations radiate out from St. Louis, but all Northeast Ozark Border counties stand out is this respect. The foreign born are, in this case, largely Germanic and are known to have built for themselves communities of a somewhat unique character. Their farming methods, particularly with respect to labor standards and soil and land conservation, are also conceded to be different. Yields for a given soil type are likely to be higher in these communities with a large percentage of foreign born and foreign born parentage.

Values of land in such areas are not, however, largely affected, on the average. In individual communities the demand for land may be unusually active but, as noted above, the effect of the intensive husbandry and land management of these people is, apparently, more to raise labor incomes than to increase land values.

From an appraisal viewpoint, therefore, these communities differ chiefly in the fact that improvements, the type of land considered, are commonly superior to those found elsewhere. Once apprized of this fact, appraisers should have no difficulty in these counties.

VARIATIONS IN CAPITALIZATION RATES

Capitalization rates are coordinate with earnings as a determinant of land values, since it is only by the use of these rates that earnings may be translated into values. That is, the bridge between productivity and value is never direct but always involves three steps. The first step is that between the land and the physical income from land. In the second step this physical land income is converted into money income, and lastly, money income is translated into land values by the use of the capitalization rate. That is, one can know nothing of the value of land that produces fifteen bushels of wheat without going through the intermediary steps of translating that wheat into money or economic income and by the use of the capitalization rate, translating this income into value.

For a number of reasons, Chambers in his now classic study on **The Relation of Land Income to Land Value** regards the average mortgage rate of interest as the best practical expression of the capitalization rate in a particular community.[1] These average rates change in response to various economic forces and situations and no later data than that to be derived from the 1930 Census is available. In Figure 28 average rates by counties for 1930 are given.

There is a general tendency for rates to be low where values are high and high where values are low. Or to put the matter in somewhat different terms, rates are low where the levels of nitrogen, exchangeable bases and phosphorous are high and high where these are low. Doubtless this latter method of stating the facts put them more nearly into a causal relationship, since capital or loanable funds apparently migrate less readily to areas of low than to areas of high productivity. In fact, the coefficient of correlation

1 See pages 40-46 in U. S. D. A. Department Bulletin 1224, "Relation of Land Income to Land Value" by C. R. Chambers, for a discussion of the validity of the mortgage rate of interest as the capitalization rate.

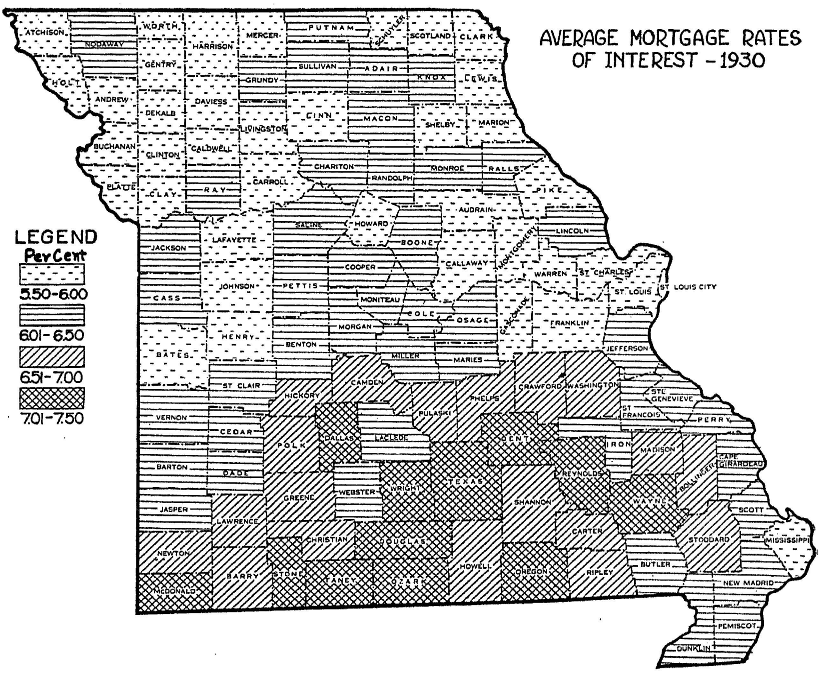


Fig. 28.—Capitalization rates are closely allied to average mortgage charges which, in Missouri, are, in general, high in areas of land of low productivity and low in areas of high productivity. Map from U. S. Census.

between land values and capitalization rates is, r=-.62, while that between these rates and nitrogen and exchangeable bases, respectively, are r=-.74 and r=-.78 respectively.

Capitalization rates, or the closely related interest rates, are, however, not simple unified concepts, but rather a composite of time preference, risk, and cost of administration. It was apparently this complex nature of the capitalization rate that the Appraisal Sub-Committee had in mind when it offered the following comments regarding the factors affecting the rate of capitalization.

> *Location.* While location influences value directly it is also recognized in the rate of capitalization, on the theory that owners are willing to accept a low rate of return in a desirable location, and expect a high rate in and undesirable location.
>
> *Interest Rates in the Community.* The mortgage loan rate typical of the community, while not necessarily the rate to use, has an influence. Bank loan interest rates also have a bearing.
>
> *Hazardous Operations.* Certain types of operation, such as fruit growing, irrigation, and dry land farming are considered especially hazardous and therefore, the capitalization rate is higher.
>
> *Supervisory Burden.* The costs of supervision or management may be reflected in the capitalization rate or may be considered as a cost of operation and deducted in arriving at net income.

Tenure of Operation. This affects rate of capitalization of farm land to some extent, although it must be recognized that the tenure of operation may change.

Capitalization on the net cash rent basis is relatively low since it is assumed that the owner of the land carries no risk of the operation of the land.

Capitalization on a net share rent basis is usually at a higher rate than that of cash rent since the owner assumes a share of the risk of the business approximately proportionate to his rental share of the products of the land.

Capitalization on the net farm income basis usually carries the highest rate since all risks of the business are assumed by the operator in arriving at net income. Whenever practicable the rental basis of capitalization is preferable to that of net income.[1]

REGIONS OF EXCEPTIONAL COSTS

Taxes have a mixed effect on value. That is, while, as the Appraisal Sub-Committee states—"they must be deducted from income before net earnings can be determined", they may also result in such improvement in earning or income-producing capacity of land that their net effect may be to increase its value. This latter effect is clearest in situations where taxes are used for the construction of roads or drainage, irrigation or levee systems, but provision for schools and even for general government must also, though less tangibly, affect similarly the value of land.

If, however, one regards the taxes and income-producing power of land separately and as largely independent of one another (and there is much reason to adopt that viewpoint) the deduction of taxes before the determination of net income is a legitimate procedure. The result of such separation is that the appreciatory effects of taxes are counted as being realized in increased income and the depreciatory effects in increased expenses.

In Missouri two types of tax situations are particularly pertinent in the appraisal of land. The first of these is that dependent upon the levies of the various local, county and state governments. All land, except a small tax exempt acreage, is subject to such levies.

In some respects the best expression of such levies, as these relate to land values, is in terms of amount of the tax per acre. There is, however, so great a variation within acres and, hence, in the assessed valuation of these acres, that only some general indication of the weight of taxes upon this basis would be feasible. An alternative method is to express these taxes in terms of average tax rates as is done in Figure 29. These rates vary from district to district and even from farm to farm in the county and, hence, are only an approximate expression of the weight of taxes on land values.

Certain broad generalizations may, however, be derived from the map. First, taxes like capitalization rates tend to be high

1 Journal of American Institute of Real Estate Appraisers, April 9, 1934, pp. 262-263.

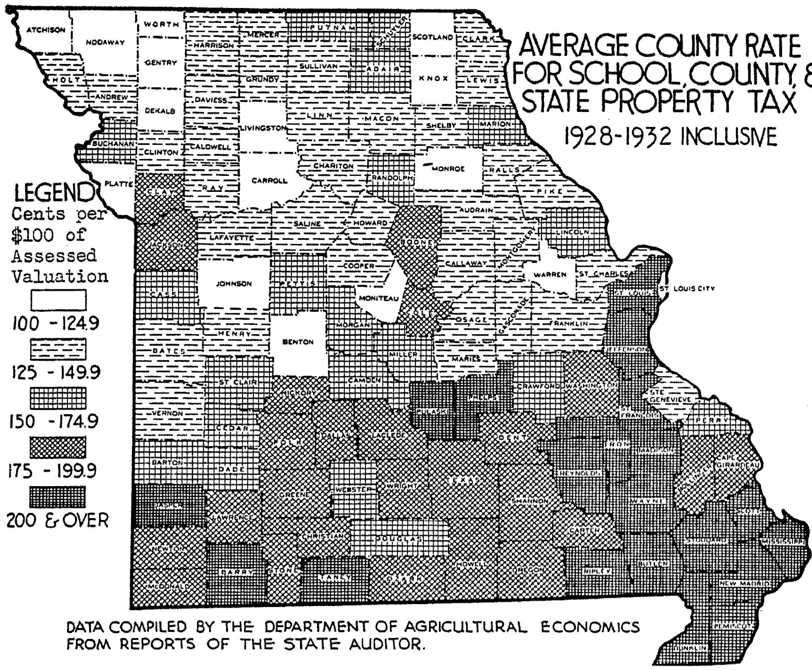


Fig. 29.—Tax rates, like capitalization rates, tend to be high where the level of nitrogen, exchangeable bases and available phosphorous are low.

where the level of nitrogen, exchangeable bases and available phosphorous are low, though urban counties and those of the Southeast Lowlands constitute, in this case, an exception. The correlation between average tax rates for state and local purposes and for the five-year period, 1928 to 1932 inclusive, by counties (the counties as in Figures 4 and 9) with nitrogen and exchangeable bases gives approximately equal coefficients, viz: r=.65 and r=.63, respectively.

In this case a low level of productivity, and hence of land values, means low total assessed valuations in areas of poor lands, since counties do not vary much in size in the various parts of the state, though many of the aspects of cost of government are approximately constant from county to county. Counties with poor lands and low total assessed valuations must, therefore, in order to maintain suitable standards of governmental service, compensate by increasing the rate.

For urban counties the case is different, since in these counties total assessed valuations are exceptionally high rather than the reverse. However, urban counties are noted for the large number and high quality of the governmental services they provide.

Under present governmental arrangements these rate differences are likely to continue and it seems a safe generalization that the appraiser of land will persistently encounter relatively high general property tax rates in areas of poor land and in those in close contact with urban centers.

The answer to one very important question relating to taxes, that is: "Will they increase or decrease?"—is always more or less uncertain. Data provided by the Bureau of Agricultural Economics has been the basis upon which the graph below has been constructed.

Property taxes in Missouri rose rapidly from 1913 to 1929 (somewhat faster than in the United States as a whole) and from 1929 to 1933 declined. Since then the change has presumably not been great.

Since 1929 the move toward a somewhat lesser dependence upon the property tax has, in Missouri, gained momentum and the 1933 General Assembly passed a general sales tax law, the rate of which (½%) was doubled by the 1935 Assembly. The repeal of the 18th Amendment has also opened up a new source of revenue in liquor excises. The major dependence of local units of government remains the property tax, however, and inasmuch as the rise of taxes on farm lands between 1913 and 1929 was almost wholly a rise in local taxes, these new tax sources (the sales and liquor taxes) which are employed solely by the state, have a lesser significance than might otherwise be the case. Furthermore, the sales tax statutes were enacted under a strong pressure of emergency and are still regarded in some quarters as temporary expedients.

The appraiser is, therefore, justified in regarding with some caution the strong downward trend of farm property taxes since 1929 and should hardly be unprepared to find the forces leading to the general rise in taxes between 1913 and 1929, again exerting

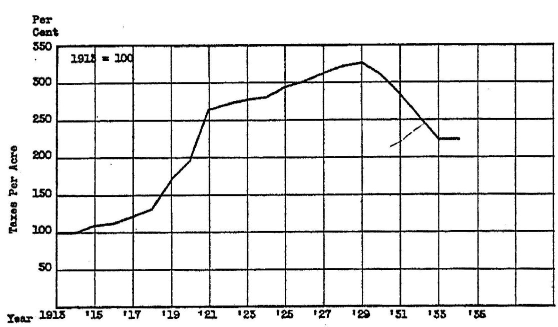


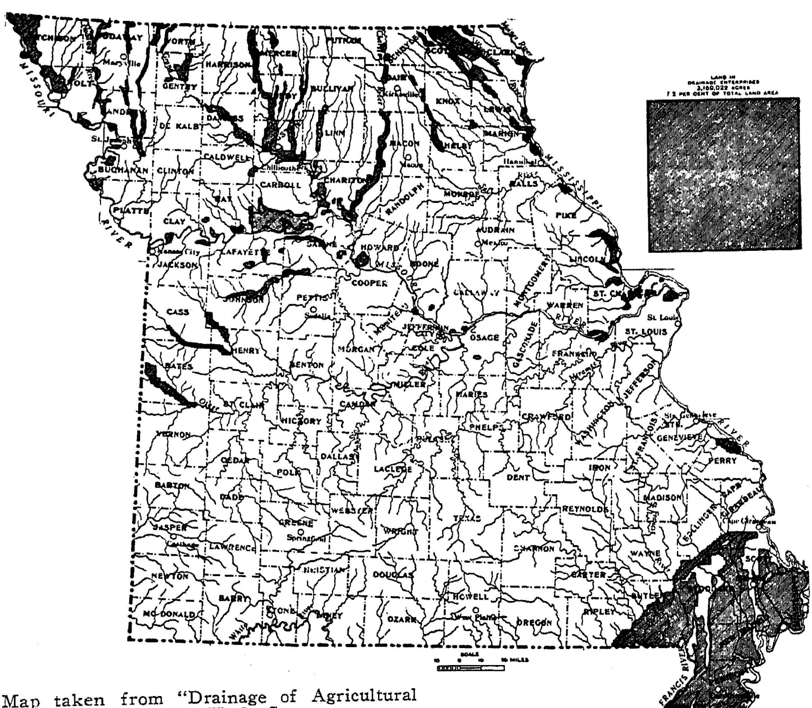
Fig. 30.—The trend in property taxes per acre in Missouri was sharply upward from 1913 to 1929 and equally sharply downward from 1929 to 1933. There was little change from 1933 to 1934. Data are from the Bureau of Agricultural Economics.

themselves as more normally prosperous years reappear. The fact that governmental costs have apparently been rising for many decades if not centuries strengthens the conclusion that an upward trend in taxes is the normal situation.

The second type of taxes pertinent to the problem of appraisal are the special assessments levied for land reconstructions such as drainage ditches and levees. A total of 3,150,022 acres or 7.2 per cent of the entire land area of the state was included within drainage enterprises in 1930, according to Census data. Not all of these enterprises had outstanding bonded indebtedness, though a large share of them did. Presumably, all of them labored under the necessity to collect revenues for maintenance and operation.

The location of these drainage enterprises in the state is given in Figure 31. Somewhat more than half the total is located in the Southeast Lowlands, 74.8 per cent of the land area of which, is included in such enterprises. As is to be expected at times following years of such drastically low prices for farm products, many of these enterprises are in financial distress at present and the weight of the special assessments is a particularly onerous burden.

So diverse are the conditions, financial and otherwise, in these special improvement districts that little more of value can be offered here other than to point out their location as in Figure 31.



Map taken from "Drainage of Agricultural Lands," Missouri 1930 U. S. Census.

Fig. 31.—About half of the land in drainage enterprises in Missouri is in the Southeast Lowlands Area.

REGIONS OF THREATENING PHYSICAL DETERIORATION

Perhaps the most serious single threat to continuing productivity of Missouri lands is soil erosion. Inasmuch as Dr. Baver[1] has only recently made a comprehensive report on the ravages of this form of land deterioration, only a minimum of comment is needed here.

In Figure 32, derived from Dr. Baver's study, the areas within the state subjected to varying degrees of erosion are shown. Generally the severity is greatest in the northern and northeastern areas of the state where considerable acreage has been almost destroyed for agricultural purposes by excessive gullying.

Fig. 32.—The areas of most serious erosion are those shaded most deeply. The map is an adaptation by Mr. E. A. Mayes, State Land Planning Consultant for Missouri from Figure 1, page 9, Missouri Agricultural Experiment Station Bulletin No. 349 by L. D. Baver.

Dr. Baver estimates that in the state, upon 10,233,000 acres erosion has been slight or negligible, upon 11,839,000 there has been only moderate sheet erosion and no gullying, upon 11,668,000 acres there has been moderate sheet erosion and some gullying, upon 1,780,000 acres erosion has been so excessive that more than 75 per cent of the surface soil is gone and gullying is so severe that arable farming is essentially precluded.[2]

1 Those interested in a more adequate discussion of Soil Erosion in Missouri are referred to Missouri Agricultural Experiment Station Bulletin 349, "Soil Erosion in Missouri," by L. D. Baver.

2 Ibid., see Table 2, page 9.

For present purposes it is perhaps sufficient to note that the most serious threat of further erosion occurs for the most part in those areas where its effects have already been most severe. A number of factors must be considered in determining the erosivity of a soil, and in the study referred to the soils of the State are grouped according to their similarities in erosion.[1]

While no attempts have been made to relate the effects of erosion to the value or productivity of land, there is abundant evidence in the case histories of many Missouri farms that the effect is there. Over most of Missouri no appraisal is complete until some estimate of present and future erosion has been made.

While wind erosion has a continuous small effect over most of the state, it is a serious factor only upon a small area of sandy soils in Scott, Mississippi, Stoddard and New Madrid counties in Southeast Missouri.

Closely akin to erosion is river cutting, but while erosion as such threatens only the uplands, river cutting attacks the bottom lands. The Missouri River is particularly unruly in this respect and some Ozark streams, because of the rapid run-off induced by the deforestation of their watersheds, are by no means sinless. For this reason, all lands with appreciable frontages on streams require more than usual care if mistakes in appraising are to be avoided.

A further type of land depreciation associated with stream beds but not erosion is that arising in the lower reaches of the Grand River and apparently a possibility on a good many of the smaller streams in northern Missouri. It results from uncoordinated drainage development. In the "Proceedings of the First Missouri Conference on Land Utilization," Mr. Hez K. Johnson, Consulting Engineer of Chilicothe, Missouri, makes the following comments.[2]

> "Grand River has its source in the prairie lands of southern Iowa, winds in a southeasterly direction through the northwestern counties of Missouri, and flows into the Missouri River near Brunswick in Chariton County. The outlet is about 260 miles above the mouth of the Missouri River and about 130 miles below Kansas City. The length of the Grand River is about 215 miles and it has an average fall of about 3.6 feet per mile. The fact that the lower 150 miles has an average fall of only 1.4 feet per mile is basis enough upon which to predict the result of straightening the more rapidly flowing tributaries of the upper end. It is no longer necessary to theorize on what would happen. It has already happened.
>
> "A very extensive program in an effort to obtain protection from damaging overflows within the Grand River Basin has been consumated. The prevailing method used was channel straightening by means of cutoffs or new channels constructed of less capacity than the origial stream, with the hope that natural erosion would enlarge the channels to carry even a greater flow than the old river bed. In only a few instances did this plan fail to fuction. These failures invariably can be attributed to unwise location impelled by local interest. While in some of the separate units that installed

1 Mo. Exp. Sta. Bul. 349, page 45.
2 Ibid., page 12.

works appreciable benefits were realized within the area, matters were commonly made worse in the downstream areas. There could hardly be a better demonstration of the futility of separate drainage districts, without coordinating their plans, to accomplish unversal benefits from their efforts to control floods, than the consumation of the works along the Grand River Basin"

Two further aspects of land deterioration, arising from subsidence in mining areas and burning in forested areas, are worthy of some passing comment. Mining, particularly of coal, lead and zinc, is important in a number of agricultural counties in Missouri. In all mining areas, therefore, there is some danger from subsidence. The great lead and zinc mines are in St. Francois, Madison, Jasper and Newton counties. Coal mining is more widely distributed.

While coal, lead and zinc mines are of greatest importance, there is an appreciable but scattered mining of various kinds of clays and rocks. Almost without exception these are open pit or quarry developments and too obvious to constitute any appraisal pitfall. Somewhat more likely to trip up the unwary is the land disfiguration resulting from the mining of barites or tiff. Tiff occurs commonly in small pockets not far from the surface. Mining it leaves the terrain in a series of small, irregularly spaced excavations with the associated debris. Depreciation of land incident to tiff mining does not destroy the further usefulness of land, but does seriously detract from its value. Deposits of this mineral occur chiefly in Washington, St. Francois and Jefferson counties.

More insidious in effect than any of the above aspects of land depreciation is that resulting from burning. In the forested areas of the Ozarks there is a firmly rooted habit of burning over the forest floor each year on the presumption that such burning improves the pasturage. In recent years this presumption has been most vigorourly challenged. Continuous burning destroys the accumulated humus, depletes the surface of its organic matter, decreases the water absorbing capacity of the soil and increases run-off and erosion. Land burned over repeatedly is, therefore, less productive and less valuable land than that which remains unburned.

No data are available on the extent of this burning. Roughly, however, the boundaries of the most severely burned area coincides with the Class IV land in Figure 1. The great majority of the area so burned is of low agricultural value and the harm done from the agriculturalist's viewpoint is, therefore, not so great. The burden of the injury falls upon future forestry.

REGIONS OF EXCEPTIONAL RISK

Most pressingly apparent as regions of exceptional economic risk are those subject to flooding, including river bottom lands and the lowlands of Southeast Missouri. The state has a surprisingly large area of these alluvial lands, (somewhat more than 7,500,000 acres) not all of which however are subject to flood hazard in the same degree. Of this total about 2,200,000 acres are to be found in the seven counties comprising the lowlands. Great systems of levees, the total mileage of which in Southeast Missouri alone is 490 miles, protect these lands from ordinary floods, but have not thus far been so constructed as to ward off damage during years of exceptionally high water, the floods of 1935 being a case in point. A more or less constant effort, aided during recent years by Federal Governmental outlays, is being made to improve the protection.

These lands include some of the most fertile and productive farm lands in the state. A special map giving their exact location is not included here but is scarcely needed, since both bottom lands and lowlands are such prominent land features that they may hardly be overlooked. However, land in drainage enterprises, as in Figure 31, corresponds closely to that most critically subject to flooding, and this figure may, therefore, be referred to for the proximate location of flood hazard lands.

Another type of exceptional risk, both physical and economic, has been referred to above in connection with clay pan lands. There is much evidence that crop yields on such lands vary much more from season to season than they do upon lands not subject to this structural fault, other things equal.

Somewhat different are the risks that grow out of the farming of marginal agricultural lands, of which Missouri has an abundance. Upon such lands appraisal is confounded by the fact that in years of low agricultural prices the surplus of income, above that needed for the subsistence of the operator and his family, is often zero and no net income accrues to land. There is customarily and persistently a grave question whether such lands should remain in a farming use. In other words, if during future years prices and purchasing power of farm products are to be at a substantially lower relative level than during the decade 1921 to 1930, much of this marginal land should apparently be moved into such uses as forestry or grazing. Valuations based upon appraisals for such use are much lower than those made upon the presumption of a level of prices which will permit farming upon them to continue. The appraisal of such lands, therefore, runs a somewhat greater than normal risk that these lands will be moved into lower uses where valuations will be at much lower figures.

TABLE 6.—DISTRIBUTION OF FARMS BY SOIL TYPES IN MISSOURI—1930
Group I. Lands of high productivity Group III. Lands of low productivity
Group II. Lands of moderate productivity. Group IV. Lands, chiefly non-arable.

Soil Type[1]	Acreage	Per Cent in Farms	Per Cent Total Land Area	Per Cent of Total Number of Farms	Surface Soil Nitrogen Per Farm
Group I—*North. & West. Mo.*					
Grundy	1,602,284	90.7%	3.7%	3.6%	636,615
Marshall	1,752,219	93.1	4.0	4.1	588,566
Summit	1,600,451	91.4	3.6	4.7	418,075
Wabash	3,145,530	86.6	7.2	7.2	588,134
Group II—*North. & West. Mo.*					
Bates	1,374,812	82.1	3.1	3.1	339,839
Osage	579,458	85.8	1.3	1.3	483,071
Oswego	1,151,985	93.1	2.6	2.8	456,335
Putnam	2,090,081	91.5	4.7	4.2	519,038
Shelby	3,051,793	94.5	7.0	8.2	420,525
Group III—*North. & West. Mo.*					
Cherokee	990,614	92.2	2.2	2.4	339,070
Lindley	2,283,308	89.7	5.2	5.9	386,386
Group II—*Ozark Highland*					
Crawford	2,237,986	82.3	5.1	7.0	207,026
Hagerstown	602,296	86.6	1.4	1.6	210,644
Huntington	1,522,769	91.8	3.5	5.9	200,514
Knox	1,637,893	84.3	3.6	4.7	284,498
Group III—*Ozark Highland*					
Clarksville*	4,484,632	70.3	10.3	8.7	207,743
Hanceville	272,074	73.6	.6	.5	228,562
Lebanon	1,580,394	81.7	3.6	3.9	240,599
Tilsit	299,416	76.9	.7	.6	235,689
Union	1,988,305	80.0	4.5	4.2	240,790
Group IV—*Ozark Highland*					
Clarksville** and Ashe	7,369,818	40.1	16.7	7.1	241,338
Group I—*S. E. Lowlands*					
Lintonia*** and Sarpy	379,592	73.1	.9	2.3	112,200
Group II—*S. E. Lowlands*					
Lintonia****	475,767	83.2	1.1	1.9	137,214
Sharkey	735,741	48.4	1.7	2.6	231,296
Waverly****	227,191	74.0	.5	.6	197,536
Group III—*S. E. Lowlands*					
Waverly	548,871	46.1	1.2	.9	255,868
		Recapitulation by Groups			
North and West Missouri					
I	8,100,484	89.8	18.5	19.6	556,403
II	8,248,129	90.8	18.7	19.6	438,199
III	3,273,922	90.4	7.4	8.3	372,486
Ozark Highland					
II	6,000,944	85.7	13.6	19.2	224,157
III	8,624,821	74.9	19.7	17.9	224,338
IV	7,369,819	40.1	16.7	7.1	241,338
Southeast Missouri					
All	2,367,162	61.3	5.4	8.3	177,060
Total or average	43,985,280	76.7	100.0	100.0	

[1]Unlabeled soil types are silt loams.
*Gravelly loam.
**Stony loam.
***Loam.
****Fine Sandy loam.

On the approach of farm land to a marginal status a measure permitting a more accurate judgment than has heretofore been possible has recently been derived. In the last column of Table 6 the surface soil nitrogen available to farmers upon various major soil types within the state are given. The soils are grouped into broad classes in the "Recapitulation by Groups" at the bottom of the table.

The Class III lands of North and West Missouri and the Ozark Highland are those approaching a marginal status for general farming. Both for the Southeast Lowlands and for Class II lands of the Ozarks the nitrogen per farm is below that for the Class III lands, but certain adjustments in the type of farming (cotton in the lowlands and fruit, dairying and poultry on Class II Ozark lands) permit a successful agriculture upon what amounts to smaller farms upon lands of these latter types.

Only about half as much surface soil nitrogen is available to farmers upon the Class III Ozark land as is available to farmers using the Class I and II lands of North and West Missouri. Upon individual soil types, notably the Clarksville gravelly loam, the situation is even more extreme.

While there are ways of compensating for this lack of underlying land resources as measured by nitrogen (viz., intensive types of production and a self-sufficing mode of living) it remains true that it is these classes of lands that are likely to move into lower uses under a regime of low prices for agricultural products.

It is not the average farm upon such lands, however, that is most critically situated, but rather those of smaller than average size or those upon poorer than average land within the soil type. A rough measure of the proportion of farms by counties so situated[1] is afforded in Figure 33 in which the percentage of farms reporting the total value of products sold and consumed below $600 in the prosperous year 1929 is given. Roughly the percentages are high in areas of Class III and IV lands (See Figure 1) though northeast Ozark Border counties constitute an exception. It is in the counties where the percentage of farms with low gross incomes are highest that most of the marginal farm land in the state is to be found.

"One crop" areas are also not uncommonly areas of exceptional risk because of their dependence upon a single crop for the major source of their income. Missouri's agriculture is unusually diversified and in only one small corner of the state, the Southeast Lowlands, is there a genuine "one crop" agricultural section. While cotton is grown pretty largely over all the lowlands area, it appears

1 For a more complete discussion of this topic from a somewhat different viewpoint see the article "Land Use Intensity and Resettlement Problem in Missouri" by the author and J. H. Muntzel in August, 1935, number of the Journal of Farm Economics.

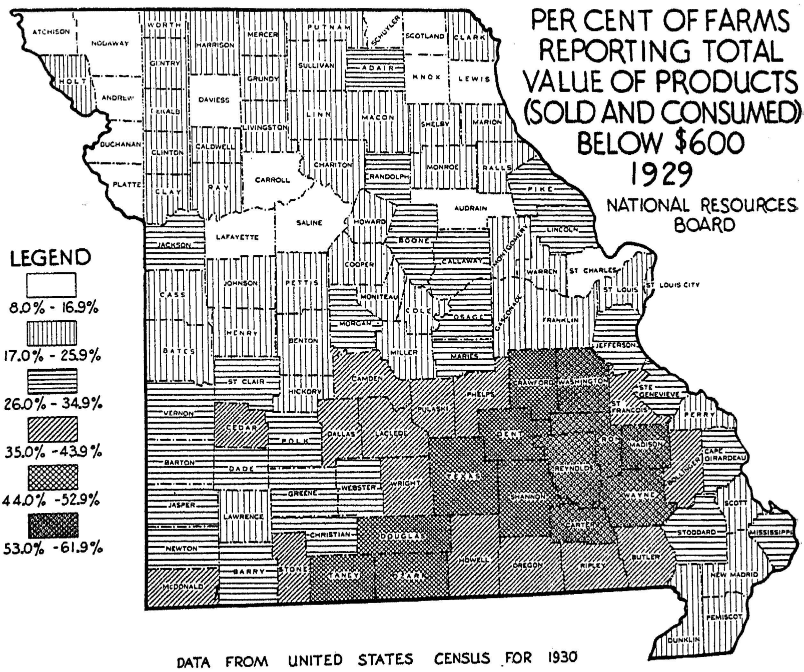


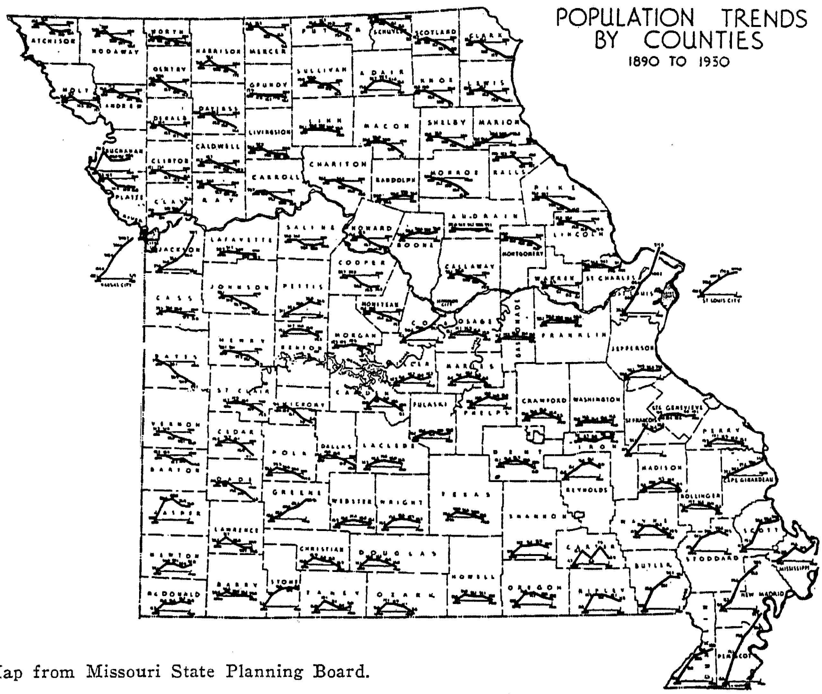
Fig. 33.—Low farm incomes and lands of low productivity are intimately associated one with the other.

under a one crop system, chiefly in the four counties—Pemiscot, Dunklin, New Madrid and Mississippi.

In diversified areas land values are insured against the collapse of prices of any one crop because of the fact that land devoted to that crop can be shifted more or less immediately to other crops. In one-crop areas such insurance is lacking.

In Southeast Missouri, for instance, the type and unit of land use suitable to production of cotton departs widely from that normally employed in the diversified areas of other parts of the state. Farms are small in these areas and the average acreage per farm in Pemiscot and Dunklin counties are, respectively, 38.2 and 58.2 acres, as contrasted to 152.5 acres in diversified Nodaway county and 131.2 acres as an average for the state as a whole. A similar comparison may be made by contrasting the nitrogen per farm figures in the last column of Table 6. Despite the relatively high nitrogen content of the soils of the lowlands the per farm nitrogen is the lowest for the state. Land tenure conditions and systems of farm operation are also peculiar to the area and different from those found elsewhere.

Because of these differences, land cannot be readily shifted to alternative types of production and its value may be and is somewhat less than that of equally productive land in a diversified farming section. It was for this reason that it was necessary to exclude the heavily specialized cotton counties as well as the urban counties from the correlations as in Figures 4 and 6.



Map from Missouri State Planning Board.

Fig. 34.—Nearly all the strictly agricultural counties in the state have shown either a declining trend of total population or a trend that remains rather constant, marked exception being found in Southeast Missouri where the trend lines indicate a rather rapid settlement of the area in recent years. This is explained by the fact that Southeast Missouri is a rather youthful agricultural area. The lands have been drained in comparatively recent years and have not as yet been fully occupied. The trend of population from the farm to the cities up to 1930 is indicated by the increase shown in those counties where large towns or cities are located.

REGIONS OF EXCEPTIONAL SPECULATIVE INTEREST

The southeast lowlands are, somewhat paradoxically, a region in which risks of evaluation (as above) and the possibility of considerable increases in value are both of considerable magnitude. Risks arise out of floods and the dependence upon a single crop—cotton. Rises in value are a possibility because of the active demand for land that has characterized the situation in these counties for some time.

In the four cotton counties—Dunklin, Pemiscot, New Madrid and Mississippi, for instance, the number of farms increased from

13,374 in 1920 to 15,139 in 1930, an increase of more than 13 per cent in the 10 years, or at the rate of one per cent a year. During the same period the number of farms in the state as a whole decreased from 263,004 to 255,940 or by somewhat less than 3 per cent. Land in farms in the four counties increased from 751,600 acres in 1920 to 874,687 in 1930, or by 16.4 per cent, and land in farms in the state decreased almost exactly 3 per cent.

Growth of population in the immediate vicinity is a fairly good criteria by which to judge the possibilities of speculative increases in value. In Figure 37, provided by the Missouri State Planning Board, the increases and decreases of population in each of the counties of the state are graphically portrayed. Decreases have occurred in almost all the highly developed agricultural counties of the state, except those in Southeast Missouri; the Ozark counties have about held their own, but in urban counties and cotton counties there have been increases.

Increases in land values apart from those brought about by generally favorable price relationships for agriculture are, therefore, most likely to occur in the Southeast cotton counties and in those containing or adjacent to the larger cities.

CONCLUSIONS

1. Land may be said to derive its value from two major sources: first, those within itself, that is, the inherent character of its physical makeup; and second, from its economic setting.

2. From the viewpoint of the valuation of farm land, the important inherent characteristics are such things as the nitrogen, and available phosphorous content of the soil, soil structure, particularly clay or hard pans and its topography.

3. When measures of these inherent physical characteristics, called unit factors, are correlated with average land values the resulting relationships as designated by coefficients and indexes of correlation are strikingly high.

4. When measures of these same unit factors are related to average yields equally striking relationships are discovered.

5. It appears, therefore, that these unit factors may be used as a basis for grading land and there is reason to believe that

such grading would correspond very closely with gradations in actual productiveness of the land.

6. In other words, such grading would afford a means of judging or appraising at once land values and land productivity.

7. Features of the external economic setting of land affecting its value are diverse and not readily susceptible of generalized analysis. They include such influences as those arising from location and special aspects of the community in which the land is found.

8. An important factor influencing land values is the capitalization rate. In Missouri, capitalization rates are, in general, high in areas of poor and low in areas of good land, as measured by varying levels of the above inherent features of land character.

9. Taxes of both the general and special assessment kind exert a further powerful influence. General property taxes, like capitalization rates, are high where land is low in productivity and lower where productivity is high. Urban communities constitute an exception. Special assessment levies are found chiefly in drainage and levee districts.

10. Erosion is a powerful land value depreciating force in Missouri and no appraisal is complete until some effort has been made to forecast the future effects of erosion on the value of the property being evaluated.

11. A large acreage of land in the state is subject to exceptional risks; the largest area being the alluvial bottom lands subject, in greater or lesser degree to flood hazards. A somewhat different type of risk is that encountered in single crop areas as in cotton counties of Southeast Missouri.

12. Regions of exceptional speculative interest are in general those with most actively increasing population.