

This PDF is a selection from an out-of-print volume from the National Bureau of Economic Research

Volume Title: The Growth of Physical Capital in Agriculture, 1870-1950

Volume Author/Editor: Alvin S. Tostlebe

Volume Publisher: NBER

Volume ISBN: 0-87014-358-1

Volume URL: <http://www.nber.org/books/tost54-1>

Publication Date: 1954

Chapter Title: Plan of the Study

Chapter Author: Alvin S. Tostlebe

Chapter URL: <http://www.nber.org/chapters/c5909>

Chapter pages in book: (p. 16 - 28)

Plan of the Study

Purpose and Scope

The primary purpose of this paper is to measure and analyze the growth of physical farm capital over the eighty-year span from 1870 to 1950. The growth of physical capital was, of course, only one phase of the general expansion of agriculture in this period. Hence, several related physical developments are also discussed, including changes in the number of farms, land in farms, improved land in farms, and number of persons engaged in farming.

The paper is not concerned with the growth of farmer-owned financial assets or with the debts and equities of farmers. Its more limited objectives are (1) to portray the growth in value of the major classes of physical assets used in farming; (2) to indicate the effects of such growth on the composition and location of these assets; (3) to show to what extent changes in the value of physical assets were due to price fluctuations, and to what extent they resulted from changes in physical amount or condition; (4) to indicate trends in the amount of capital per farm and per farm worker; and (5) by relating the growth of physical farm capital to other developments of the period, to lay a foundation for fuller analysis of the forces that determined the growth of the physical means of production used in farming. This preliminary study and the fuller analysis that is to follow are designed to provide information which will be useful in any attempt to estimate the future capital requirements of agriculture.

In this study it is assumed that "real" or physical capital used in farming is represented by four major types of physical assets: (1) farm land and buildings; (2) implements and machinery, including automobiles, motor trucks, and tractors; (3) livestock; and (4) stored crops.

These four categories exclude certain items that undoubtedly are farm capital and include others about which there may at least be some question. For example, no account is taken of inventories of mill feed, insecticides, or other supplies that farmers may have on hand. They are omitted because information about such inventories is insufficient to warrant estimates for the years in question. It is believed that the amount would in any case be relatively small.

On the other hand, it may be thought that the four categories include too much. Should farm land be included in an inventory of capital? Or the farm residence? Or the automobile? In the case of land, the question is raised because of its origin; in the case of the farm residence and of the automobile, because of their use.

In economic theory land and buildings are often classified separately and, although both are durable producers' goods, only the buildings are classified as capital. The basis for the distinction lies in what are regarded as fundamental differences in the origin and supply of land and of other forms of durable producers' goods. Land has often been referred to as a gift of nature, unalterable in amount, whereas capital has been defined as a product, the supply of which responds readily to decisions regarding spending and investment. Thus a clear line is drawn between durable producers' goods that are themselves products of economic effort and responsive to economic decisions and those which are provided by nature and whose supply is therefore essentially fixed.

The differences between land and other durable producers' goods are easily exaggerated. Granted that the gross acreage of a country or region cannot be altered, it is still possible to change greatly the *productive* acreage and the productivity of the acreage already in agricultural use by means which closely resemble the methods by which buildings and equipment are increased.

To the extent that land derives its value from its usefulness in agricultural production (not from its potential use as urban real estate or in mining), its value can be raised by the investment of effort and of money to fertilize, drain, clear or irrigate it, to prevent erosion and soil depletion, or to bring it closer to markets by building roads, railroads, and the like. In short, land as well as buildings can be "increased" through the investment of current

labor and capital if the measure of growth is not area but usefulness or productivity—a more basic economic characteristic than physical dimension.

Much formerly barren land has been brought into use since 1870 by the farmers' own efforts, which included draining wet land, irrigating dry land, and clearing away brush, stumps, and stones. The productivity of acreage already in use has also been increased by such methods. The increase in "improved" land in farms and in the number of farms gives some indication of the magnitude of this gain. There is no record of the amount of time, effort, and actual cash that was invested in such improvement, but investment of this kind has nevertheless been a factor in raising land values.

A second reason for including land in the inventory of farm capital is that farm financial operations are influenced as much by the value of land as by the value of buildings or equipment. Any study that attempts to measure the investment of time and money in the physical assets necessary to farming, or to account for the farm credit outstanding during past years, can hardly ignore the changes that have occurred in so basic an agricultural asset as land.

There is good reason also to include the farm residence as an item of farm capital. The farm residence not only provides an abode convenient to the fields and barns for the farmer and his family, main components of the agricultural labor force, but in addition frequently serves to feed and to house hired help. Moreover, such office space as a farmer may have for keeping records or transacting business will usually be found in his residence. Although it undoubtedly can also be classified as a consumers' good, it would be difficult to show that the investment in housing for a farmer, his family, and hired help is less essential to farm operation than the investment in stables for livestock or sheds for the protection of machinery. A farm residence, however modest, is likely to be among the first structures built on a new farm.

The case for including the full value of the automobile as farm capital is perhaps less clear, expediency weighing heavily in the balance. The Bureau of Agricultural Economics divides expenditures connected with the operation of farm automobiles on a 40–

60 basis (50–50 during World War II) between production and family use. Why not a similar split in the capital value of automobiles when calculating farm capital? One reason is doubt that any proportion established for the country as a whole would hold for the various states and regions. Another is the necessarily arbitrary nature of any such division. Particularly when dealing with individual states or regions, an underestimate of the proportion properly chargeable to production might easily result in as large an error as that involved in including the full value of the automobile.

Sources of Data

Published reports of the Bureau of the Census and BAE provided most of the basic data for this paper. Most of the values in current prices were taken directly from these reports; where estimates were made to obtain a wider coverage or to extend series that applied to only a part of the period under study, the data for this purpose were also chiefly drawn from these sources. Indeed, the data necessary to calculate constant-price values were also largely provided by publications of these bureaus. However, some data indispensable to these calculations were obtained from other sources (see Appendixes A and B).

Except as noted below, the values in current prices of the two major classes of physical assets—land and buildings, and implements and machinery (including automobiles, motor trucks, and tractors)—were obtained, by states, from published reports of the census. The first exception is the values of land and buildings for 1945, which are estimates of BAE. The substitution of these significantly higher values for 1945 seems justified by the information obtained from crop reporters and by the values reported by the census for both 1940 and 1950. The second exception applies to the values of implements and machinery for the years 1935 and 1950. In those years the census did not include questions on these items. However, BAE has estimated such values for the United States, and these were distributed to the states.

The values of livestock in current prices were, with a minor exception, obtained from published reports of BAE. The census has regularly reported the number and value of various classes of

livestock on farms, but as successive enumerations occurred at various times of the year, the data are not really comparable. BAE's published estimates for January 1 of each year are therefore much to be preferred. Valuations of livestock in current prices for each state beginning with 1925 consist of the published estimates of BAE for cattle, hogs, sheep, chickens, horses, and mules. The source is the same for the years before 1925 except for chickens, for which it was necessary to make our own estimate of number and value.

The values in current prices of crops stored on farms were estimated. The census has at no time enumerated the amount or the value of stored crops, while estimates by BAE are fragmentary and, in the main, are available only for recent years. The census has, however, regularly reported the amount of crops produced in the year preceding the taking of the census. Estimates of the amount of crops stored on farms were therefore made in most instances by relating production to the amount stored at the beginning of the following year, in years for which both types of data were available.

Methods of Adjusting for Price Changes

All constant-price values that appear in this study are based on new calculations. For each crop and class of livestock this meant multiplying, by states, the average price per unit on (or near) January 1 of the years 1910–1914 by the number of units in the inventory at the beginning of the census years 1870 to 1950. Except for figures on the physical volume of stored crops, which had largely to be estimated, the required data were available in publications of BAE.

For implements and machinery, constant-price values were obtained by dividing the current values by an index of prices paid by farmers for machinery. The method of preparing such an index for census years during the period 1870 to 1950 is described in Appendix B.

Neither the method of deriving constant-price values for livestock and crops nor the method of adjusting the value of implements and machinery for price changes takes account of changes in quality of the units of capital. The upbreeding of livestock and the improvement of machinery wrought physical changes that

escape our constant-price series. These are faults in the data for which there is no ready remedy, which probably result in some understatement of physical growth.

For real estate, the calculation of constant-price values was more complex. In thirty-seven states in which irrigation is relatively unimportant, use was made in one way or another of the acreage of "improved" and "unimproved" land in farms, the number of farms, and, after 1910, of BAE's estimates of expenditures on construction and depreciation of farm improvements for the United States.¹ In the eleven western states in which irrigation is relatively important account was taken of changes in the acreage of irrigated, dry farming, and grazing land. How these details and the 1910–1914 average prices of farm real estate were applied in the calculations is described in Appendix A.

After constant prices were calculated for each class of physical farm assets, the several classes were aggregated to obtain the total value of physical farm assets at 1910–1914 prices. This prompts a question: If the constant prices had been those of another year or period, say of 1929 or of 1950 instead of 1910–1914, would the rate at which total capital grew have been significantly different?

The percentages in Table 1 indicate that the difference would have been nominal before 1920, and even after that date the difference would have been of very moderate proportions. It seems unlikely therefore that any substantially different conclusions would be reached if an alternative price base were used.²

Comparability of Census Data

No attempt was made to adjust census data on number of farms, acreage, and related items to improve comparability and accuracy, as available information for this purpose is inadequate. Census

¹ For a definition of improved land, see page 71, note 1.

² The more rapid growth in total capital indicated when prices of 1929 and 1950 are used as constants is in line with expectations because prices of the components that increased in relative importance were relatively higher in the later years. The largest gain in relative importance was scored by machinery, mostly at the expense of real estate. Based on 1910–1914, the price indexes of farm machinery in 1929 and 1950 are 151 and 294 respectively, compared with 116 and 169 for real estate. Another case in point is the sharp decline in the number of horses and mules after 1920; this was accompanied by relative weakness in the price of these animals compared with the prices of other livestock.

TABLE 1
 PHYSICAL FARM ASSETS, UNITED STATES, 1870-1950
 (three constant-price values; 1910 = 100)

Year	1910-1914 Prices	1929 Prices	1950 Prices
1870	43.6	43.7	44.1
1880	61.3	61.6	62.1
1890	74.3	74.7	75.4
1900	88.8	89.2	89.4
1910	100.0	100.0	100.0
1920	109.9	110.5	111.5
1930	108.4	109.6	110.6
1940	107.1	109.1	110.9
1950	118.4	122.7	126.8

Source: Column 1 derived from Table 8. Column 2 derived from Table G-1. Column 3 values in 1950 prices were computed in the same manner as described in Appendix G, except that the appropriate increase in land and buildings for 1950 was found to be 74.1 per cent (instead of 19.7 when converting to the 1929 price base) and the index used to convert the value of machinery to the 1950 base was as follows: 1870, 46; 1880, 38; 1890, 32; 1900, 31; 1910, 34; 1920, 60; 1930, 50; 1940, 54; 1950, 100. Prices per head of livestock on January 1, 1950, and per unit of stored crops on December 15, 1949, were multiplied by the numbers of livestock and the volume of crops stored on farms on January 1 of census years.

reports as well as several studies made since 1930 indicate that, at least for certain areas and for certain years, the enumeration of farms varied in completeness to an extent that impairs comparability.³ The shortcomings are most pronounced in the enumeration of the number of farms, and the comparability of this item is believed to be less satisfactory than that of any other data appearing in the basic tables. Despite an essentially similar definition of a farm throughout the eighty-year span there was, nevertheless, enough variation in minor aspects of the definition, in instructions, in interpretation, judgment, and zeal on the part of enumerators and their supervisors so that the count of small farms probably varied considerably more than their actual number from census to census and from one region to another in the same year.

³ See, for example, *Twelfth Census of the United States: 1900*, Vol. V, Part 1, pp. xvii, xviii; also I. G. Davis, "A Discussion of the Accuracy of Agricultural Census Enumeration in the Northeast," *Journal of the American Statistical Association*, September 1933, pp. 272-285; J. D. Black, "The Coming Census Enumerations," *Journal of Farm Economics*, July 1934, pp. 451-458; and J. D. Black and R. H. Allen, "The Counting of Farms in the United States," *Journal of the American Statistical Association*, September 1937, pp. 439-447.

As most of the error was in the enumeration of the smallest farms, the effect on the comparability of acreage, value of real estate, machinery, livestock, and production was doubtless far less serious than on number of farms. Except for number of farms, the damage to comparability was perhaps not very significant, at least insofar as national and regional totals are concerned. But any conclusions involving the number of farms, if they are to be trusted, must take account of the probable errors in the census figures mentioned above. In other words, care must be exercised lest small differences between two census dates, or among regions, be thought to indicate significant agricultural changes when in fact they may have resulted entirely from differences in the completeness with which farms were enumerated. It is believed that the conclusions which follow in this paper do not depend on differences so small that they might be the results merely of faults in the basic data.

The figures for number of persons engaged in agriculture reported by states in the *Census of Occupations* lack much in accuracy and comparability, since among other things they suffer from recognized errors in enumeration and differences in coverage with respect to both age and type of agricultural worker. Adjustments of the figures reported for the United States for census years 1870–1930 were made by the Bureau of the Census to take account of the major discrepancies. In this paper these adjustments are carried to states and regions, along with additional minor adjustments made to improve the homogeneity of the class. The 1940 and 1950 data provided by the census were expanded to include workers in the ten- to thirteen-year age group. The adjustments are described in detail in Appendix F.

Geographic Presentation of Data

Where possible, the data have been compiled on a state basis and they have been combined by regions for discussion and analysis.

The advantage of presenting a breakdown of the data by geographic regions is that it reveals numerous diverse movements that would otherwise be submerged in all-embracing United States totals. The direction and rate of growth of farm capital have varied greatly during this period in various parts of the United States.

The segregation and study of data by regions permits the analysis of numerous special situations and makes possible a more detailed knowledge of the factors that have influenced capital growth.

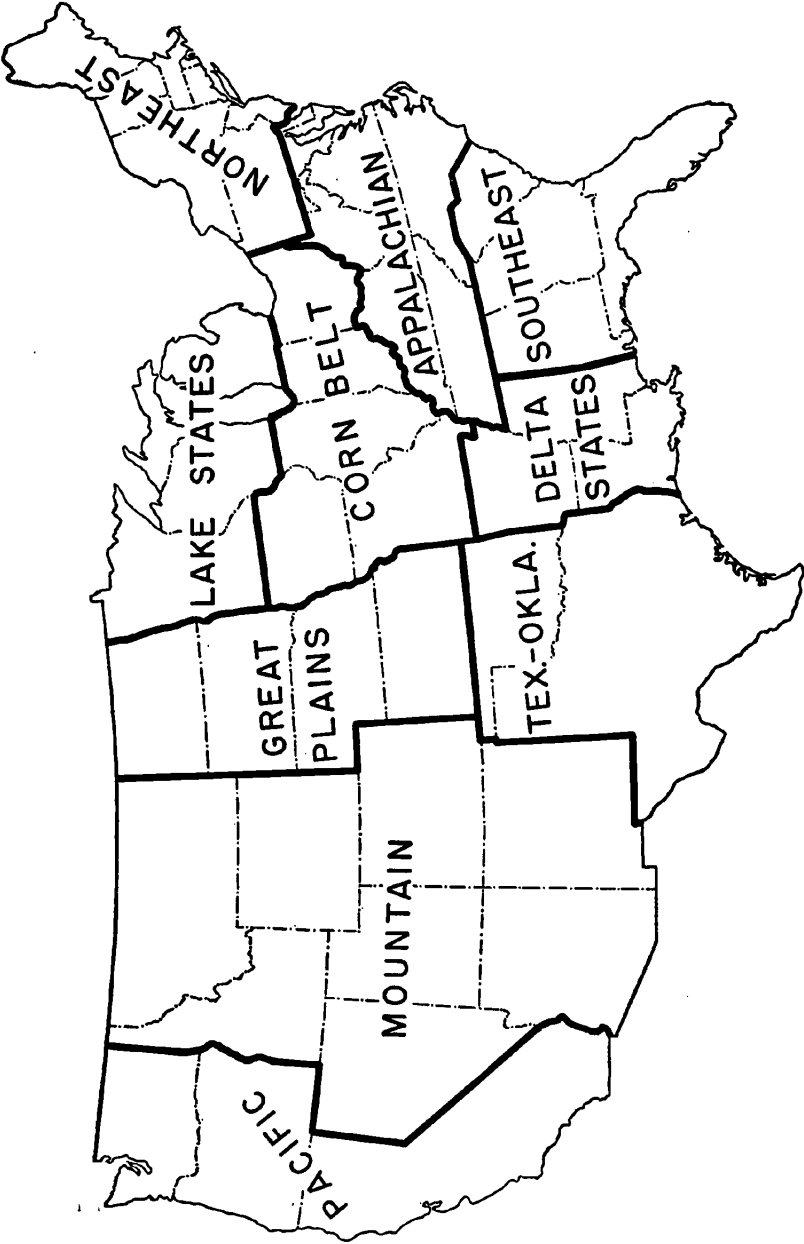
What geographic divisions best facilitate analysis of farm capital formation? The answer depends largely on what is to be emphasized, on the time span to be covered, and, most of all, on the data available for the purpose.

In this study emphasis is on over-all capital formation and on the factors that have determined its growth through an eighty-year span. Many of the data required to measure and to analyze the growth of capital over so long a period had to be estimated, as in many instances the available data were meager or too general, lacked comparability, or covered only a part of the period under study. In numerous important instances the data were such that estimates based on them could be regarded as reasonably reliable only if they applied to areas comprising two or more states. Thus there was no real alternative to presentation and analysis at the regional level; a choice could be made only among a number of possible groupings of states. As it was highly desirable to observe how capital formation had proceeded in different types of farming, and as in any event this would have to be done by examining area-wide data, an arrangement of states frequently used by BAE to emphasize type of farming was chosen (see black and white map).

This map should be compared with the colored map, which indicates the location of certain types of farming. The colored map shows that no state, much less any region, has a completely homogeneous agriculture. Indeed, the second map makes farming appear more uniform than it is. The nature and organization of farming are such that not even a county has a completely homogeneous agriculture. Regional data covering two or more states must therefore be regarded as representative of developments in specific types of farming only to a limited degree.

To illustrate, it would be foolish to draw fine distinctions between the investment structure of the average farm in the Corn Belt and in the Lake States and to insist that these distinctions accurately showed differences in investment structure of corn-live-stock-feeding farms and specialized dairy farms in the Middle West. There are, for example, too many dairy farms in Iowa, the

THE UNITED STATES DIVIDED INTO TEN "TYPE-OF-FARMING" REGIONS



most homogeneous state in the Corn Belt, to permit this. But it is possible to say that, in the regions dominated by corn-growing and livestock-feeding operations on the one hand and by forage crops and dairying on the other, the capital structure of farms, on the average, showed certain likenesses and differences as indicated by the regional data. Comparison of the regional data can show what would be involved in the way of capital formation per farm if some region that hitherto has specialized in field crops such as cotton or wheat, which are directly marketed, were to change its major interest to dairying or livestock feeding.

In most of the ten regions designated in this study there is considerable uniformity in the type of farming, as shown in the second map. However, the region comprising the Pacific States defies classification. In California alone important islands of specialized agriculture, including the production of wheat, cotton, dairy products, fruits, and truck crops, are surrounded by larger areas devoted to the production of range livestock. The Great Plains and Texas-Oklahoma regions are also notable for contrasts in type of farming. In the main the Great Plains region is identified with small grain production, but a large segment of the region lies in the Corn Belt and another is in the range-livestock country. In Texas-Oklahoma large areas are devoted mainly to cotton production, but there are also large areas in which range-livestock and wheat production prevail.

Elsewhere there is more uniformity; the organization, techniques, and capital use of the dominant type are prevalent enough to give the data of the region their peculiar characteristics. For example, in the Southeast region or the Delta States, the production of cotton, although by no means an exclusive enterprise, so far overshadows the other types of farming that state and regional data on farm capital reflect the characteristics that mark the typical cotton-growing farm. Investment per farm and per person engaged in farming is very much lower in these regions than in regions in which livestock enterprises of one kind or another predominate.

The colored map indicates where various types of farming were carried on in 1949. Data reflecting farm operations near the beginning, at the middle, and at the end of the eighty-year period indicate that in most regions the changes in type of farming were not drastic (see Table 2). The notable increase in the percentage of

TABLE 2

PERCENTAGE OF IMPROVED FARM LAND DEVOTED TO SELECTED CROPS, AND VALUE OF LIVESTOCK ^a (OTHER THAN HORSES AND MULES) PER PERSON ENGAGED IN FARMING, BY REGIONS, 1879, 1909, AND 1949

Region	1879	1909	1949	Region	1879	1909	1949
United States:				Delta States:			
Corn (grain)	21.9	20.6	14.9	Corn (grain)	31.3	27.0	15.5
Wheat	12.4	9.3	14.4	Wheat	2.2	.3	^b
Hay and forage	10.8	15.1	16.0	Hay and forage	.7	3.8	10.0
Cotton	5.1	6.7	5.1	Cotton	34.7	29.1	25.1
Livestock	\$229	\$227	\$471	Livestock	\$66	\$55	\$137
Northeast:				Great Plains:			
Corn (grain)	5.9	6.4	5.8	Corn (grain)	29.0	19.4	11.5
Wheat	5.2	4.3	5.7	Wheat	19.5	22.1	28.7
Hay and forage	25.9	33.7	42.9	Hay and forage	10.6	16.3	15.3
Livestock	\$266	\$252	\$532	Livestock	\$295	\$510	\$926
Appalachian:				Texas-Oklahoma:			
Corn (grain)	27.2	23.2	18.2	Corn (grain)	19.5	24.7	6.4
Wheat	11.8	6.0	4.5	Wheat	3.0	3.4	23.2
Hay and forage	3.8	8.1	17.2	Hay and forage	.5	6.0	8.3
Cotton	3.9	3.9	3.6	Cotton	17.2	26.5	20.7
Livestock	\$112	\$92	\$190	Livestock	\$458	\$210	\$502
Southeast:				Mountain:			
Corn (grain)	31.8	27.2	24.6	Corn (grain)	3.2	3.0	1.4
Wheat	4.7	.5	1.3	Wheat	10.5	8.1	22.1
Hay and forage	.2	2.5	10.2	Hay and forage	16.8	31.7	17.0
Cotton	33.4	38.2	15.4	Livestock	\$1,390	\$923	\$1,033
Livestock	\$58	\$47	\$134	Pacific:			
Lake States:				Corn (grain)	.6	.5	^b
Corn (grain)	9.6	11.4	15.3	Wheat	17.7	15.2	16.3
Wheat	27.6	9.5	5.2	Hay and forage	7.4	19.1	14.8
Hay and forage	15.3	21.9	23.8	Cotton	^b	^b	3.7
Livestock	\$253	\$329	\$556	Livestock	\$990	\$345	\$480
Corn Belt:							
Corn (grain)	29.7	29.7	30.9				
Wheat	14.2	7.3	7.9				
Hay and forage	10.2	14.9	13.3				
Livestock	\$310	\$390	\$750				

^a Five-year average centered on census year. Values in 1910-1914 prices.

^b Negligible.

Source: Livestock, number on farms for 1878-1882 and for 1908-1912, and value per head January 1, 1910-1914, *Livestock on Farms January 1, 1867-1935*, Revised Estimates, Dept. of Agriculture, 1938. Number on farms for 1948-1950, *Livestock and Poultry on Farms and Ranches on January 1*, Revised Estimates, Dept. of Agriculture Stat. Bull. 106; for 1951-1952, *Livestock on Farms, January 1*, Dept. of Agriculture Crop Reporting Board Release, Feb. 14, 1952. The value of chickens included in the average is for census years only. For method of estimating for 1880 and 1910 see Appendix D. Persons engaged in farming from Table 4. Improved land acreage from Table 5. Acreage harvested 1879 and 1909: corn and wheat from *Census of Agriculture: 1940*, Vol. III, *General Report*, pp. 722, 736; hay and forage from *Census of Agriculture: 1910*, Vol. V, *General Report and Analysis*, p. 641; cotton, *ibid.*, p. 681. Acreage harvested in 1949, *Agricultural Statistics*, Dept. of Agriculture, 1951, pp. 9, 39, 62, 69, 288.

improved land devoted to hay and forage doubtless is partly a result of improvement of sloughs and other unimproved parts of farms from which wild hay was cut in the earlier years, and of greater reliance on seeded meadows on improved land on which crops were rotated. The increase in livestock per person engaged in farming, especially notable in 1949, reflects primarily the decline in farm workers and only secondarily the increased emphasis on livestock enterprises and increased numbers of livestock. Comparative stability has prevailed throughout the eighty-year span because climate, topography, soil, and perhaps in lesser degree, markets and other social institutions are the chief determinants of the type of farming that is carried on in any region. As a rule changes in these factors are either negligible or so slow that the type of agriculture in a given region tends to remain fundamentally the same over long periods of time.

This is not to say that important modifications in operations and in specific crops do not occur within the framework of a given type of farming. Such innovations have in fact been frequent and sometimes spectacular. For example, in some northern states, where dairying has been the dominant type of farming, and hay has been a major field crop, through the years covered by this study there has been considerable change in the type of hay which was grown, and especially in the manner in which it has been harvested and preserved. In 1870, when the hay crop was only a little less important than now, there were few, if any, silos. Certainly no part of the hay crop was ensiled. Today this and other recently developed methods of harvesting and preserving this ancient crop are increasingly used. Changes in caring for and handling the livestock are no less impressive. Thus the type of farming has changed far less than the techniques, and changes in the latter have been especially influential determinants of the use of capital in farming.