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## AGRICULTURAL IMPLICATIONS OF THE POPULATION PROSPECT IN THE U.S.A.

O. E. BAKER

*Bureau of Agricultural Economics, Washington, D.C.*

THE great problem of the Orient is how to prevent a further increase of births and, if possible, induce a decline; the great problem of the Occident is in my opinion how to prevent a further decline of births, and, in some countries, induce an increase; and the great problem of the world is how to adjust population to the natural resources and the stage of technique in their utilization, so that both the present and the future welfare of the people will be promoted.<sup>1</sup> This morning I should like to consider with you, if I may, certain aspects of this problem in the United States of America, particularly the relation of agricultural production to consumption, of future supply to demand.

### THE POPULATION PROSPECT IN THE UNITED STATES

It is clear from Professor Whelpton's address that in northern Europe and the United States the future, relative to population, so far as it is possible to envisage it with confidence, must be divided into two periods—a period of practically stationary population and a period of rapid decline. The first period, however, will lead gradually into the second, consequently any date that may be suggested as the line of separation must be considered only approximate. Moreover, during the next few years particularly, the increase of population, though slow, will have a material effect upon the demand for farm products; while the decline in population after the peak is reached will exert an influence increasing with the passage of time.

In the United States, using the lowest of the estimates made by Thompson and Whelpton, the population will continue to increase until 1956, when it will reach a maximum of about 136,500,000, which is 10,000,000 more, or 8 per cent. higher, than the 126,500,000 people in the nation to-day. By 1980 it will have declined to 126,500,000, or about the same population as to-day (Fig. 1). According to this estimate the population of the nation will remain almost stationary for fifty years to come. During the latter half of this fifty-year period

<sup>1</sup> It is just as important, of course, to adopt the technique in utilization of resources and the social and economic organization of the nation to the needs of population.

# POPULATION OF THE UNITED STATES 1850-1920 AND ESTIMATES OF POPULATION 1930-2000 A.D.

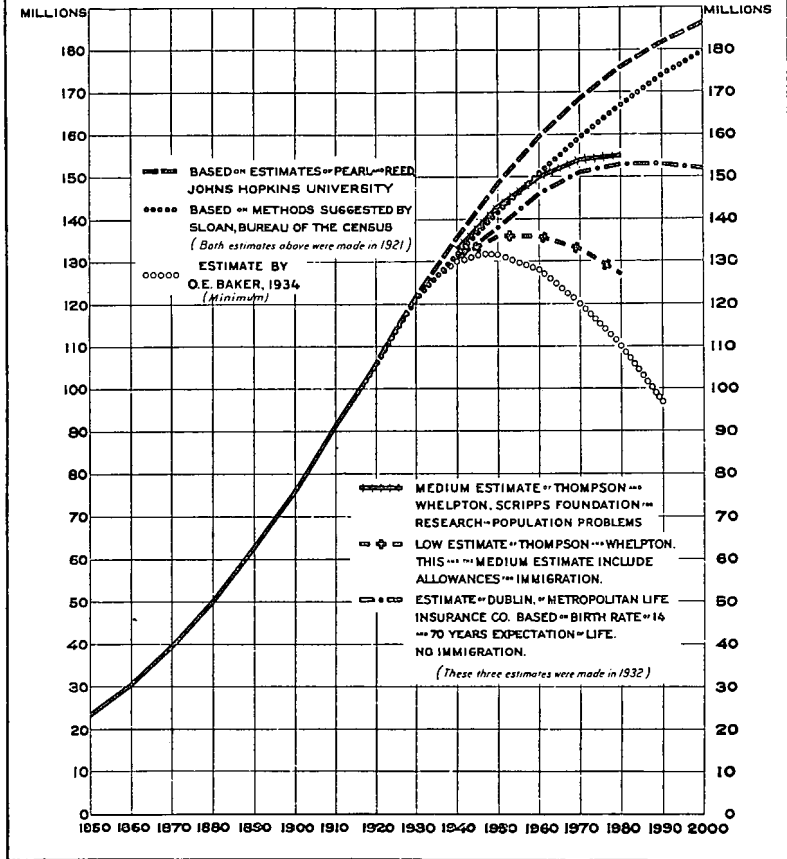


FIGURE 1. In 1921 Pearl and Reed, of Johns Hopkins University, projecting population trends on the basis of a logistic curve, estimated that the population of the United States would be about 190,000,000 by the year 2000, and would increase for several decades thereafter. But births started to decline in 1922, and by 1932 an estimate made by Dublin, also the medium estimate of Thompson and Whelpton, indicated that the population of the United States probably would never exceed 156,000,000 and that the stationary condition would be reached about 1980. The Thompson and Whelpton minimum estimate indicated a maximum population of 136,000,000, about 1957. This minimum estimate appears now the safest, although the figure for January 1, 1934, exceeds the actual population by about 300,000. Should the average decrease of 60,000 in number of births each year during the past decade continue, and should immigration be balanced by emigration, the population of the United States will reach a maximum about 1947, and then begin to decline. But the decline will be slow for a decade or more. The prospect is that the population of the Nation will not diverge 10 per cent. from the present number within the next 25, possibly 50, years.

population will be decreasing, but at a gentle rate. Although the estimate does not extend beyond 1980, it is clear that the decrease will become more rapid afterward.

This lowest estimate, made by Thompson and Whelpton two years ago, has proven slightly too high because of the extraordinary decline in births meanwhile, as Professor Whelpton has told you. Although this decline is, from the standpoint of the past, indeed extraordinary, it is not certain that, looking to the future, it will prove to be extraordinary. I was therefore constrained, while writing this paper, to improvise very hastily another estimate particularly with a view to testing out this division of the future into a stationary period followed by a period of rapidly declining population. I assumed that the number of births in the United States would continue to decrease yearly by the same average number as during the last ten years (which include six years of prosperity as well as four years of depression), namely, 60,000 less each year than in the year preceding, until births were balanced by deaths. Deaths, I assumed, would remain unchanged, although there will doubtless be a material increase in number; and immigrants, I assumed, would balance emigrants. On these assumptions I found that the population of the United States would reach a peak of about 132 millions by 1947, which is only 4 to 5 per cent. more than at present. For the period after this date of maximum population I took Miss Leybourne's estimate of the future population of Great Britain, where the population is already almost at the maximum, and applied the percentage decline each decade to the estimated population of the United States in 1947. This led to a rough estimate of 128 millions population by 1957, about 120 millions by 1967, only 110 millions by 1977, and about 96 millions by 1987 (Fig. 1). If the extreme assumption be made that births will continue to decrease until a stationary population is reached by the same number as during the depression, namely, 100,000 a year, the peak of population in the United States would be attained in 1941; but the figures just given, using Miss Leybourne's estimates for the percentage rate of decline in Great Britain, would be diminished by only a few million.

Even according to these less conservative estimates, if such they may be called, the population of the United States will remain for a quarter of a century within 5 per cent. of the present number, i.e. will be practically stationary. But a half-century hence the population would have fallen by 20 per cent., and a very rapid decline would be in progress. According to any reasonable estimate, therefore, there is a period of stationary population ahead of us, probably of a

quarter to a half-century in duration, which may be followed by a rapid decline.

AGRICULTURAL IMPLICATIONS: THE NEAR FUTURE

In considering the agricultural implications of the population prospect, it is necessary, therefore, to distinguish between the near and the remote future. What will a stationary population mean, and what will a rapidly declining population mean to American agriculture?

Let us consider the implications relative to the near future from the standpoint first of consumption and then of production of farm products. By near future let us refer to the period of more or less stationary population, which seems likely to last twenty-five to fifty years.

*The Outlook for Domestic Consumption.* First of all, a stationary population implies a more or less stationary domestic consumption of farm products, considered in the aggregate, provided consumption per person remains about constant, which is the prospect, judging by past experience. Although great changes have occurred in the diet of the American people, particularly after the World War, notably a large increase in use of sugar, pork, and green vegetables, a considerable increase in the use of milk, and a decrease in use of cereals and beef, the aggregate consumption *per capita* of all foodstuffs during the past third of a century has never been more than a few per cent. above or below the pre-war five-year level (Fig. 2). This is true whether foods are combined on a basis of calory value, farm price, or crop acreage required to produce them. Although the people shifted their diet from the cheaper cereals to the more expensive vegetables and pork, they also ate less of the expensive beef and more of the cheap sugar. The *per capita* consumption of milk and dairy products has increased, apparently, about 7 per cent.<sup>2</sup> Because of this approximately stable *per capita* consumption, the total consumption of foodstuffs has tended to keep step with population growth. Of the non-food products, the *per capita* consumption of cotton remained remarkably constant for a quarter of a century prior to the depression, that of tobacco more or less stationary, except for a rise during the War, while that of flax-seed increased prior to the depression, with great decrease during the depression. The consumption of farm products as a whole increased between 1920 and 1930 about the same as population, namely 16 per

<sup>2</sup> The Bureau of Agricultural Economics is revising its estimates of farm products. Fig. 2 was based on old estimates. The changes have not been great except in the case of milk, for which the revised estimates are materially lower.

cent. However, the increase in population was taking place at less than half the rate at the end of the period than at the beginning. We may look forward, apparently, to an increase in domestic consumption of farm products corresponding to the increase of

### Changes in Consumption of Food Products Per Person Total and Six Principal Products, United States, 1909-1933

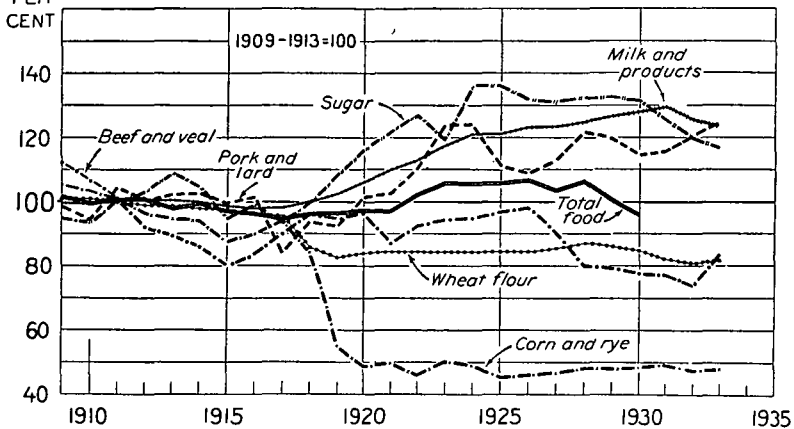


FIGURE 2. The World War worked significant changes in the diet of the American people. Perhaps of equal importance was the prohibition amendment to the Constitution, the prosperity of the urban people during and after the War, and the food education articles and advertisements in the popular magazines. The result prior to the depression was a decline of about 80 pounds per person since the pre-war years in consumption of cereal foods, and an increase of about 25 pounds per person in the consumption of sugar; also a notable increase in the consumption of pork, probably of milk also, and perhaps an equal increase in use of the leafy vegetables. During the early depression years, 1930 and 1931, the consumption of milk continued to increase, but in 1932 and 1933 a decrease occurred. The use of sugar and of vegetables has also declined, apparently, but of pork has been well maintained. Since the graph was prepared a revision of the estimates of milk production indicates an increase in *per capita* consumption of about 7 per cent. since 1909-13 instead of 25 to 30 per cent., as shown. Little change is indicated for the other foods. For total food a slight decline is indicated.<sup>3</sup>

population, that is, to a total increase of between 5 and 10 per cent., possibly 15 per cent., between now and the maximum of population, ten to twenty years, possibly thirty years, hence.

*Influence of Age Composition.* But this almost stationary population which is developing will be a different population from that in the past, having different needs relative to certain farm products. As Professor Whelpton has pointed out, there will be far fewer children

<sup>3</sup> The quantities of the various foodstuffs have been combined on the basis of the average farm price during the years 1917-26 (the decade preceding the beginning of work on the preparation of the index).

and many more old people (Fig. 3). In the United States during the four years since the census was taken, the number of births has decreased about 12 per cent., the number of children under 5 years of age has decreased about 9 per cent., and the number of children

PROPORTION OF THE POPULATION IN VARIOUS AGE GROUPS, 1850-1930, AND THOMPSON'S AND WHELPTON'S "LOW" ESTIMATE, 1930-1980\*

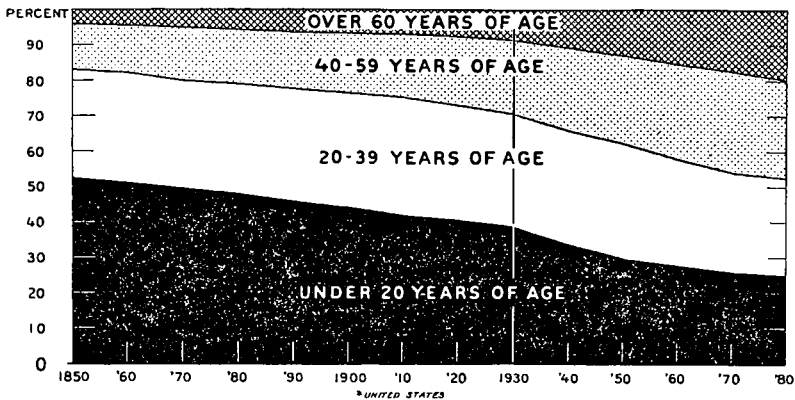


FIGURE 3. In 1870 over half the population was under 20 years of age, but in 1930 less than 40 per cent. By 1950 these children and young people probably will constitute only 30 per cent. of the population, and by 1980, or before, only 25 per cent. In 1870 about 5 per cent. of the population was over 60 years of age. By 1930 the proportion had risen to 8.6 per cent. By 1950 these old people will constitute 13 per cent. of the population, and by 1980 probably 20 per cent. In 1870 about 45 per cent. of the population was between 20 and 60 years of age, which may be considered the productive years of life, taking the people as a whole. By 1930 people in these productive ages constituted 52.6 per cent. of the total population. By 1950 they will constitute about 57 per cent., and by 1980 perhaps 55 per cent. During the next five decades, when population will be almost stationary, a larger proportion of the population will be of productive age than in the past, or, probably, in the more distant future.

5 to 10 years of age has decreased about 7 per cent. By 1940 there may be 20 per cent. fewer children under 5 years of age than in 1930, and possibly 15 per cent. fewer under 10 years of age than in 1930. By 1950 the number of children and young people under 20 years of age may have fallen 10 per cent. more. At the other extreme of life, there were 34 per cent. more people over 65 years of age in 1930 than in 1920, and approximately this rate of increase will continue for two or three decades.

Undoubtedly children consume more milk *per capita* than old people, how much more is unfortunately not known, but probably 50 to 100 per cent. more per person.<sup>4</sup> The decline in milk con-

\* Based on four studies of consumption in families classified by number of children: Waugh, Fred V., *The Consumption of Milk and Dairy Products in Metropolitan Boston*,



sumption since 1931 is owing not only to the economic depression and return of beer, but also in all likelihood to the lessening number of children. As yet, however, the effect of this decline in children is small. Likewise, the consumption of eggs is probably greater among children than among adults. The Bureau of Home Economics in the U.S. Department of Agriculture recommends twenty dozen eggs a year for children under 10 years of age in both the 'adequate diet at minimum cost' and that at 'moderate cost', whereas for adults, both male and female, whether moderately active or very active, only fifteen dozens are recommended. How far these recommendations diverge from actual consumption is not known.

On the other hand, the use of cereals by children under 10 years of age recommended by the Bureau of Home Economics is considerably less than that recommended for a moderately active woman and less than half that for a moderately active man. Although the actual consumption of bread and other cereals by children and by adults is not known, the ratio is probably not far from that in the 'adequate diet at minimum cost' described by the Bureau of Home Economics. Likewise of sugar the quantity recommended by the Bureau of Home Economics for an adult woman averages a half larger, and for an adult man twice that recommended for children 10 years of age. The ratios for consumption of lean meat and of fats (butter, lard, oils, bacon, salt pork) at varying ages are similar. Of the fruits and vegetables also adults probably eat more than children. The decrease in number of children, therefore, seems likely to produce a much greater effect on the consumption of milk and eggs than on the consumption of bread, sugar, meat and the fats, the fruits, and vegetables. Since the number of adults will continue to increase rather rapidly for a quarter of a century to come, it appears probable that the consumption of cereals, sugar, meat and the fats, and, to a less extent, of the vegetables and fruits, will continue to increase for some years after the population of the nation begins to decline. There are about 80 million people in the United States to-day 20 years of age or older, and by 1940 there will be about 87 million, by 1950 about

December 1930, published by New England Research Council, 1931, p. 13. Howe, C. B., and Waite, W. C., *The Consumption of Dairy Products in Seven Metropolitan Cities of New Jersey*, New Jersey Agricultural Experiment Station, New Brunswick, 1932, p. 70. Waite, W. C., and Howe, C. B., *The Consumption of Dairy Products in Six New Jersey Townships*, New Jersey Agricultural Experiment Station, New Brunswick, 1930, pp. 18 and 19. Cowden, T. K., and Sturges, Alexander, *Consumption of Fluid Milk and Other Dairy Products in Philadelphia, Pennsylvania, June 1934*, Pennsylvania Agricultural Experiment Station, State College, Tech. Paper No. 659, p. 20.

95 million, and by 1960 about 98 million, which will be about the peak. Any increase that may occur in the consumption of milk and eggs seems likely to depend primarily, perhaps wholly, on increasing use by persons over 20 years of age.

The probable influence of the changing age composition of the population upon the consumption of the non-food farm products is more difficult to forecast. It appears probable that children use more cotton goods than old people, who tend to use silk, rayon, and wool. On the other hand, of course, children consume almost no tobacco.

*Outlook for Exports.* In the countries of north-western Europe, except the Netherlands and Denmark, the prospect is that population will be stationary within a few years and later begin to decline, as explained by Professor Whelpton. In view of the probable continuation of progress in agricultural technique and in production of foodstuffs, it would appear likely that exports of such products from the United States to north-western Europe will not increase greatly, and of some commodities may decline. The recognition by the governments of Europe of the fact that the farmers and peasants are providing not only most of the foodstuffs, except in England, but also a large proportion of the youth, so essential to the future welfare of the nation, seems likely to result in continued protection of the agricultural interests. On the other hand, since Europe raises practically no cotton, it is possible that the imports of this commodity may increase as prosperity returns. This may prove true in the Orient also. Cotton exports from the United States have been well maintained during the depression and now constitute about three-fourths of the total exports of farm products measured in value (Fig. 4). But the production of cotton requires only about 11 per cent. of the total crop acreage in the United States. An increase in the production of cotton would exert little influence on land utilization outside the cotton belt. On the whole, the approach of a stationary and later probably declining population in north-western Europe casts a cloud over the prospect of increasing exports of farm products from the United States.

Considering the prospect for exports as well as for domestic consumption, it is my opinion that the consumption of American farm products as a whole will remain about stationary for a quarter of a century. But those products which are consumed by children in larger quantities per person than by adults are likely to experience a declining demand; while those products which adults consume more largely than children are likely to enjoy an increasing demand for two or three decades.

*Outlook for Production.* Since the early years of the twentieth century agricultural production in the United States has not kept pace with the progress of population (Fig. 5). Consumption of farm products per person has not declined, however, because more of

### Approximate Acreage Required to Produce Net Exports Major Farm Products, 1897-1932

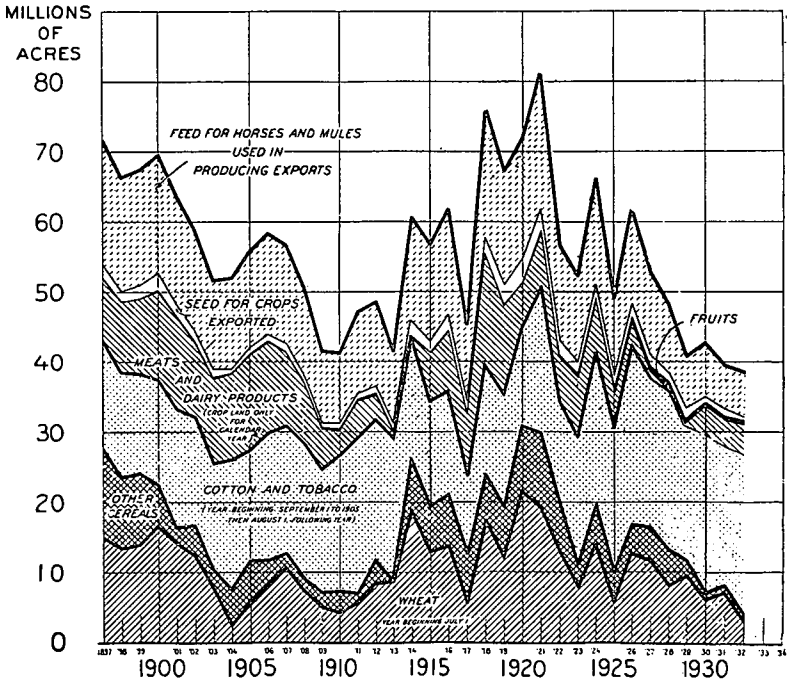


FIGURE 4. The acreage required to produce the agricultural exports from the United States has been lower during the last three years than in any previous year since the beginning of the century. The crop acreage required to produce the exports of meat, mostly pork and lard, for six years has been only a few million acres, and this is now true of wheat also. Cotton now constitutes three-fourths of the exports of farm products, and the United States is now providing almost as large a proportion as ever of the world's consumption of this crop.

the production has been consumed at home and less has been exported abroad. At the beginning of the twentieth century the exports of farm products required for their production nearly one-fourth of the total crop acreage, whereas during the last five years only about one-eighth has been required.

The course of agricultural production in the United States during the past twenty years may be divided into four periods. The first

period may be called the War period. It extended from 1914 to 1921. During this period the trend of agricultural production remained almost horizontal. With so many young farmers in training camps and with farm organization so disturbed, the farmers did well to hold production stationary. It was a period of high prices for farm

Agricultural Production, Crop Land, Farm Labour, and Population  
1897-1934

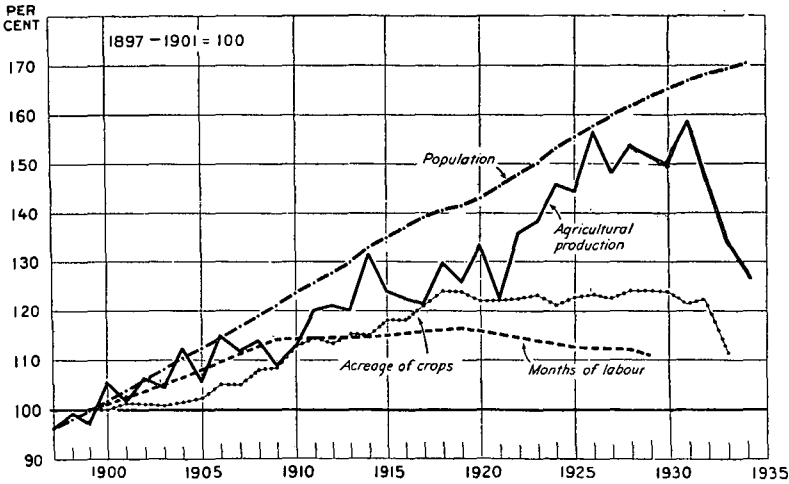


FIGURE 5. Agricultural production from 1926 to 1931 was about 50 per cent. greater than at the beginning of the twentieth century, crop acreage was nearly 25 per cent. greater, and quantity of labour employed in agriculture in 1929 was 10 to 12 per cent. greater. Production per acre therefore increased about 20 per cent., and production per man about 35 per cent. Most of this increase occurred after the War. The trend of production has been rapidly downward since 1931, owing largely to exceptional drought. The base period 1897-1901 was opulent in the relation of production to population, about one-fourth of the production being exported; as compared with one-eighth at present. Consumption *per capita* has been well maintained, except during the War years, when the decline in consumption was attributable mostly to foods, and during the depression years, when the decline is largely attributable to non-foods—cotton and flax particularly.

products. This stationary production persisted until 1921, which was a season of unusually adverse weather conditions. Production fell almost as low in 1921 as in 1917.

The second period extended from 1921 to 1926. From the low point in 1921 to the high point in 1926, agricultural production increased 27 per cent., but comparing the 1914-21 average with the 1926-31 average the increase becomes only 21 per cent. This was a rate 50 per cent. more rapid than that of population increase. In 1926 the ratio of production to population again touched the level

that existed at the beginning of the century. This period of increasing production was one of low prices for farm products, measured in purchasing power. But prices did not decline during the period, instead they rose from 1921 to 1925. Population was increasing rapidly, notably so at the beginning of the period, urban prosperity was also increasing, and consumption *per capita* was high.

The third period extends from 1926 to 1931. During these years the trend of production was again horizontal. Prices of farm products continued low until the depression and then dropped much lower.

The fourth period includes 1932, 1933, and 1934. It has been a period of rapid decline in production. Before we speculate upon the prospect of a continuation of this trend let us consider the factors that induced the increase from 1922 to 1926.

*Factors in the Increase of Production.* The great increase in production from 1921 to 1926 took place despite a stationary acreage in crops, a declining acreage in pasture, a declining quantity of labour in agriculture (including labour involved in manufacture of the machinery), a stationary or slightly declining trend in acre-yield of the crops and a notable decline in the carrying capacity of pastures. If area and acre-yield of the crops and pastures did not increase, if length and breadth and height remained constant, how could there be an increase in volume? It is because agriculture has a fourth dimension, indeed, a fifth, a sixth, and a seventh dimension.

1. Between 1921 and 1926 the number of horses and mules on farms decreased by over 3 millions, and in cities probably by over 1 million more, releasing about 13 million acres of land for other uses, mostly to feed milk and meat animals. Since the decline in horses and mules began, in some states twenty years ago, nearly 40 million acres of crop land have been released for other uses by the substitution of gasoline for horse and mule feed. The major portion of this land has been released in the most fertile portions of the country (Fig. 6).

2. The second factor that induced the rapid increase in production was a shift from the less productive to the more productive crops per acre, notably from corn toward cotton in the south (the value of the cotton crop per acre is normally twice that of corn), from wheat toward corn in Minnesota and the Dakotas particularly, and from hay and grain toward fruit and vegetables in California and elsewhere (Fig. 7). Between 1921 and 1926 this shift resulted in an increase of production equivalent to the products of at least 15 million acres of average crop land. However, comparison of these two years exaggerates the importance of this factor, for in 1921 cotton acreage was abnormally low and in 1926 abnormally high.

3. Likewise, there was a shift from the less productive classes of live stock per unit of feed consumed toward the more productive classes, i.e. from beef cattle and sheep toward dairy cattle, swine, and poultry (Fig. 7). Beef cattle and sheep require several times as much feed to produce the same amount of human food, measured in

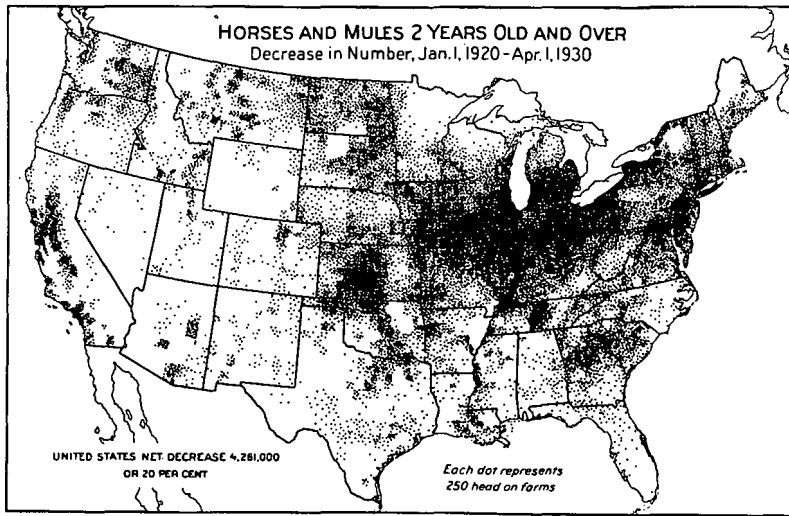


FIGURE 6. This map shows only the decrease in mature horses and mules between the Census years 1920 and 1930. The decrease was proportionately much greater—63 per cent.—in young stock. The area of crop land released by the decline in all horses and mules probably exceeded 20,000,000 acres during this decade, 1920-1930, and now amounts to about 40,000,000 acres, when calculated from the earlier peak in numbers in each State. Most of these 40,000,000 acres are now used to feed meat and milk animals.

calories, as do dairy cows, swine, and poultry. This change in relative importance of the classes of live stock resulted in an increase of production during the five years probably equivalent to that from about 5 million acres of average crop land.

4. The fourth factor accounting for the increase of production from 1921 to 1926 was the increasing production of meat per unit of feed consumed by hogs, by sheep, and by poultry, and of milk per unit of feed consumed by dairy cows. Between January 1, 1921, and January 1, 1926, the number of hogs on farms decreased 11 per cent., but the production of pork and lard was 12 per cent. greater in 1926 than in 1921. Comparing the five years centred on 1921 with those centred on 1926 we find a decrease of 7 per cent. in number of hogs on farms, January 1, and an increase of 10 per cent. in production of pork and lard. This increase in production per hog has undoubtedly

been accompanied by increasing efficiency in utilization of feed by swine.<sup>5</sup> The increase has been in progress for at least 20 years and is due to better sanitation methods which have reduced mortality, to the hog cholera serum and other advances of science, to better feeding practices, including the use of legumes and minerals, and to other

### Less Productive Compared with More Productive Crops Per Acre and Meat and Milk Animals Per Unit of Feed Consumed, Percentage Change in Acreage or Number, 1900 to Date

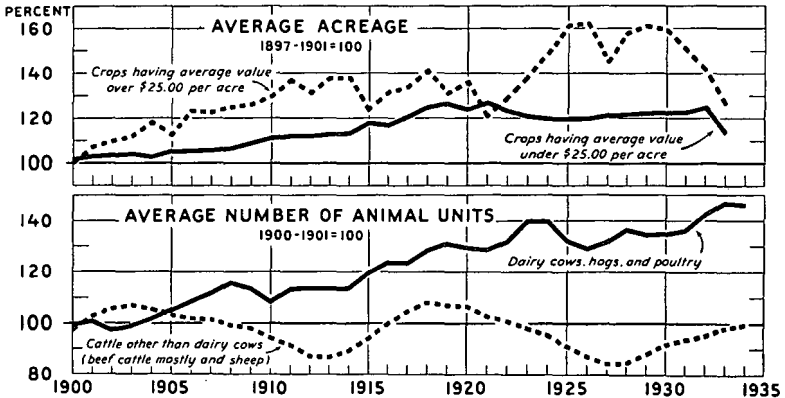


FIGURE 7. The acreage of crops having a high average value per acre (over \$25 during the period 1925-9) has increased more rapidly than that of crops having a lower average acre-value. From 1921 to 1925 the increase in acreage of the more valuable crops was notable. Since 1930 the depression has led to a decline in acreage of cotton, the most important of the high-value crops. Likewise the increase in number of dairy cows, hogs, and chickens has been much greater than of beef cattle and sheep, which produce less human food per unit of feed consumed. As a consequence, production per acre has increased.

improvements in animal husbandry. Likewise with dairy cows, the number on farms increased less than 4 per cent. between 1921 and 1926, while the production of milk increased between 10 and 20 per cent. It is doubtful if the consumption of feed increased half as rapidly as the production of milk. The cow-testing associations and other agencies promoting improved practices in dairy husbandry evidently exerted a significant influence.

These four factors apparently induced an increase of production

<sup>5</sup> The trend of crop feed production was stationary from 1915 to 1930, and after allowing for the feed released by the decline in horses and mules, the quantity remaining for meat and milk animals did not increase half as fast as the production of animal products. Estimates made of the quantity of feed consumed by beef cattle, dairy cattle, swine, sheep, and poultry indicate that this increase in efficiency in utilization of feed occurred in all these classes of farm animals, except that it was very slight among beef cattle.

between 1921 and 1926 equivalent to the average crops on fully 40 million acres of land, and during the entire decade preceding the depression equivalent to probably 65 million acres of crop land. But during the depression the influence of these factors has been much less; indeed the direction of influence of the second factor has been reversed, i.e. the trend has been from the more productive to the less productive crops per acre.

It is interesting to observe that the Agricultural Adjustment Administration programme has tended to encourage the less intensive use of the land. In the south the cotton acreage has been greatly reduced. Some of this land lies idle and some has gone into corn and forage crops. The wheat acreage in the west has been reduced also. Some of the former wheat land lies idle and some has gone into pasture and less productive uses. This year an elaborate campaign was instituted to reduce corn acreage, particularly in the Corn Belt, but it has been modified because of the very extensive and severe drought. The programme for reduction of corn acreage is associated with a programme for reduction in number of hogs. The Agricultural Adjustment Administration has endeavoured also to shift the production of animal products from the more efficient toward the less efficient classes of animals in the use of feed. Last fall several million little pigs were bought and converted into fertilizer, and educational efforts have been exerted towards reduction in the number of dairy cows. Meanwhile we are in the upward segment of the beef cattle cycle. The drought, however, may reduce greatly the number of cattle.

The land released during the depression by the continued decline in horses and mules has probably been more than counterbalanced by this shift from the more productive toward the less productive uses of land, and from the more productive toward the less productive classes of live stock, while the increasing number of colts suggests that by 1940, if not before, the number of horses and mules may be increasing again. It requires more land to feed a horse than it does a human being. Moreover, the trend toward increasing production per animal has been reversed temporarily. Milk production per cow and egg production per hen are lower this summer than in any summer during the nine years for which records are available.

*Trend in Crop Yields.* The decline in importance of these factors that explain the extraordinary increase of agricultural production from 1921 to 1926, and the reversal in the influence of at least one of the factors during the depression, has been supplemented by a notable decline recently in acre-yield of several crops (Fig. 8). The



trend in the acre-yield of corn has been downward since 1920 or 1921, while that of wheat and hay has been stationary from about 1905 until recently. Acre-yields of oats were about stationary from 1922 to 1930, following a notable decline from 1917 to 1921. In 1933 the average acre-yield of wheat was lower than in any

## Corn, Wheat, Oats, Cotton, and Hay

YIELD PER ACRE FOR UNITED STATES

5-YEAR MOVING AVERAGE, 1885-1929

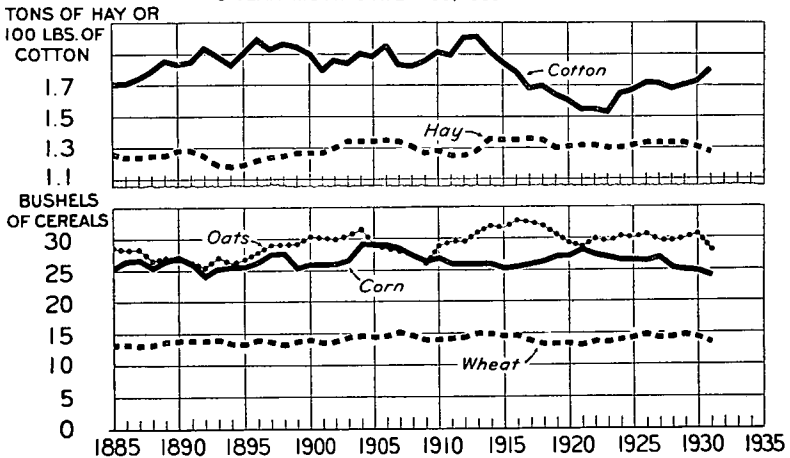


FIGURE 8. The acre-yields of wheat in the United States as a whole have changed little for 40 years, except for an occasional abnormal year. It is worth noting, however, that owing to drought in 1933 and 1934, the acre-yields were lower than in any year since 1881. The acre-yields of corn have trended downward during the last decade. During the last five years acre-yields averaged lower than in any preceding five years since the Civil War, though they were almost as low in 1890-4. The acre-yields of oats have been fairly well maintained, but in 1933 and 1934 were the lowest on record. The acre-yields of cotton trended downward as the boll weevil extended its ravages, but in 1931 and 1933 were notably high. The average acre-yield of hay has increased largely because of shifts from the less productive grasses to the more productive legumes. In 1930, 1931, 1933, and 1934, however, yields were low.

previous year since 1893, of corn than in any year since 1901, except 1913 and 1930, and of oats the acre-yield was the lowest on record. Small grain yields will be still lower in 1934. Hay yields this season are lower than ever before. The wheat and hay crops in 1934 almost certainly will be the smallest in forty years. But the acre-yields of cotton have been tending upward since 1923, after a devastating decline beginning about 1912, attributable largely to the boll-weevil. However, the amount to be ginned in 1934 is limited by law to 10 million bales, which is a smaller crop than in any year of the past decade.

These low yields of grain and hay are due primarily to drought of extraordinary extent and severity, but weather conditions appear scarcely adequate to explain the downward trend in acre-yields, principally of corn, oats, rye, and the grain sorghums, during the past decade or longer.<sup>6</sup> Apparently the depletion of soil fertility by erosion and crop removal, accompanied by a decline in the organic content of the soil in many parts of the United States, has proven as potent in affecting the average crop yield for the country as a whole as all the improvements in agricultural technique, including the use of artificial fertilizers. However, the use of fertilizers has declined during the depression. The forces of the research and extension services, plus the powerful aid of the agricultural press, have only counterbalanced the forces tending toward depletion of soil fertility during the past quarter of a century.

*Depletion of Soil Resources.* Looking to the future, it is not certain that the farmers, with the aid of the various agencies, will be even as successful as in the past in counteracting the effects of soil depletion upon acre-yields of the crops, considering the nation as a whole, unless higher prices of farm products permit extensive use of fertilizers on the less erosive lands, for the depletion of soil fertility by erosion is advancing at an accelerating rate. The Secretary of Agriculture in his annual report for 1933 makes the following statement:

'Unrestrained soil erosion is rapidly building a wilderness of worn-out land in the United States. The wastage speeds up with the removal of the absorptive topsoil down to the less absorptive, more erosive subsoil. Approximately 35,000,000 acres of formerly cultivated land have been essentially destroyed for crop production; 100,000,000 acres of land now in crops have lost all or most of the topsoil; 125,000,000 acres of land now in crops are rapidly losing topsoil; and an additional area is suffering from erosion in some degree.'

These figures indicate that an area equal to nearly one-tenth the present crop area of the United States has been destroyed, so far as crop production is concerned, by erosion, about one-quarter of the present crop land has lost all or most of the topsoil, while a third is rapidly losing its topsoil. It may help to visualize the extent of the destruction to note that the 35,000,000 acres already rendered un-tiltable are equal in area to all the crop land and ploughable pasture

<sup>6</sup> It is interesting to observe that the acre-yields of wheat and cotton, the two crops which have expanded notably into the drier portions of the Great Plains, show no decline in the nation as a whole prior to 1932. Apparently the more fertile soil in the case of wheat, and both better soil and greater freedom from injury by the boll-weevil in the case of cotton, have fully counterbalanced the frequently deficient moisture in the Great Plains region.

of New England, New York, New Jersey, Maryland, and Delaware. Erosion has been most severe, however, in the south, owing in part to the fact that the two dominant crops, cotton and corn, are intertilled, which results not only in exposure of the soil to the rain and wind during most of the season, but also in lowering the organic matter in the soil, and organic matter is very important in retarding

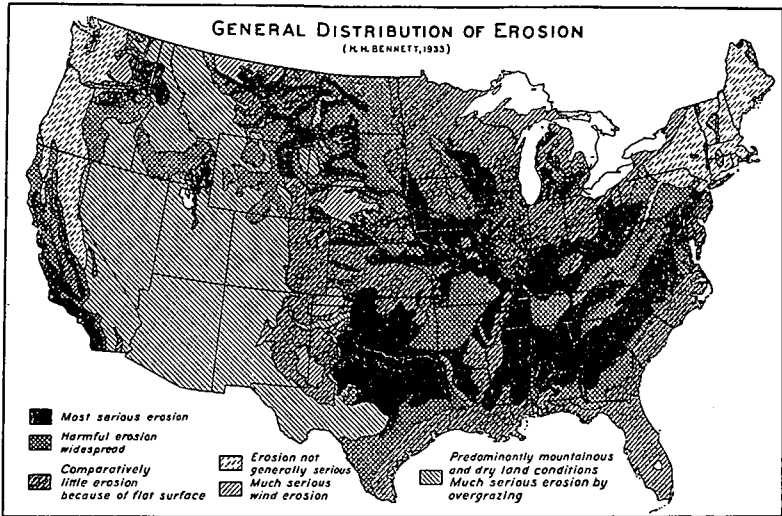


FIGURE 9. The regions of most serious erosion are the Piedmont, which extends south-westerly from New York City to central Alabama; the upper coastal plain of Alabama, Mississippi, western Tennessee and of north-eastern Texas; much of the Ohio river valley, and of the lower Mississippi and lower Missouri river valleys; the Prairies of Texas and Oklahoma, the Palouse-Walla-Walla districts in the Pacific North-west and the hill slopes in California. Erosion is also widespread in the Appalachian mountains from Pennsylvania south and in the Ozarks of Missouri and Arkansas.

erosion (Fig. 9). In addition, the rainfall is heavier in the south than in the north, and as the soil is not frozen nor covered with snow during most of the winter, erosion can occur throughout the year.

In Oklahoma a recent survey revealed that of the 16 million acres of crop land in the state (including land which was formerly in crops) nearly 6 million acres had reached the stage of gullying, and that about 1,400,000 acres had been abandoned largely because of erosion.<sup>7</sup> There was a decrease of over 10,000 farms in south central and south-eastern Oklahoma between 1920 and 1930, and of almost as many more in north central and north-eastern Texas, where erosion is also

<sup>7</sup> *Soil Erosion Survey of Oklahoma, Extension Service, Agricultural and Mechanical Arts College, Stillwater, 1929, p. 2.* The survey was made by the Experiment Station.

becoming severe. It is the opinion of the experiment station workers in Oklahoma that fully two-thirds of the erosion losses in this state have occurred during the last ten years. In the Piedmont of Georgia and the Carolinas erosion has been in progress for a much longer period. Dr. Bennett, of the Bureau of Chemistry and Soils, states that 'probably not less than 60 per cent. of the upland . . . has lost from 4 to 18 inches of its soil and subsoil . . . (and) many of the gullies have cut down to bed rock'.<sup>8</sup> In the Georgia and South Carolina portions of the Piedmont area depletion of soil fertility, in association with the advance of the boll-weevil and other factors, has exerted a devastating effect. The number of farms in the area decreased 50,000 between 1920 and 1930. In some counties nearly half the farm population migrated to the cities or to other parts of the country. Undoubtedly erosion was a factor also in inducing migration in much of North Carolina and Virginia, in Kentucky, Tennessee, and Arkansas, and even in parts of Missouri, southern Iowa, and Illinois. In Illinois there are at least 9 million acres of low value land subject to serious erosion, more than one-half of which is hardly suitable for cultivated crops, and there are more than 14 million acres of high value land in which erosion is gradually approaching a stage where gullies are being formed.<sup>9</sup>

At the Missouri Agricultural Experiment Station measurements on a gently sloping field, typical of the soil and slope of much of the northern portion of the state, show a loss of over 245 tons of soil per acre continuously in corn during the twelve years the experiment has been in progress, 111 tons from land continuously in wheat, but of only 35 tons from land in a rotation of corn, wheat, and clover, indicating that the surface soil, averaging 7 inches deep, will last for 50 to 380 years, depending upon the cropping system. If put into blue-grass pasture it would require 2,800 years to remove the top 7 inches of soil, which may be no more rapid than the process of soil development. It is estimated that 'about one-fourth of the surface area of Missouri is subject to severe erosion, that one-fourth is subject to moderate erosion, and about one-half to light or negligible erosion'.<sup>10</sup>

<sup>8</sup> Bennett, H. H., in *Documentary Material for the Inter-American Conference in Agriculture, Forestry, and Animal Husbandry*, Oct. 1930, p. 81. See also *Progress Reports of Soil Erosion and Run Off Experiments in Piedmont, North Carolina*, by F. O. Bartel, mimeographed by U.S. Bureau of Agricultural Engineering.

<sup>9</sup> Mumford, H. W., Director of Illinois Agricultural Experiment Station, in a letter to the Secretary of Agriculture.

<sup>10</sup> Miller, M. F., Professor of Soils, in a letter to the writer. See also *Missouri Agricultural Experiment Station Research Bulletin*, no. 63, p. 31.

During the past two dry seasons erosion by wind has developed amazing vigour in the Great Plains region. This erosion also has been facilitated, doubtless, by the depletion of organic matter in the soil as a result of cultivation. The surface soil, as deep as the plough furrow, has been removed, it is reported, from thousands of square miles. Fences have been completely covered with soil, while the accumulation of dust on the roads has had to be removed by snow-ploughs. One day this spring in Washington, D.C., more than a thousand miles away, the fine dust in the air obscured objects a mile distant, and blanketed the city in a yellow haze. This dust cloud covered most of the eastern United States, and despite a fair westerly wind it was more than a day before it cleared.

In the north-eastern states, crop removal and leaching have reduced the fertility of millions of acres, particularly of land that has produced timothy hay for shipment to city markets. Reduction in soil fertility doubtless has been a factor in promoting migration from farms in these states. On the other hand, the development of dairying and egg production, and the importation of large quantities of mill feed, grain, and hay from the west for the cows and chickens, has doubtless resulted in improving the soil on many dairy and poultry farms. A vast transfer of the elements of soil fertility from the wheat regions and the Corn Belt to the dairy farms of the north-eastern states is in progress. However, in the humid northern states, considered as a whole, the losses from the surface soil since settlement average possibly a third of the original sulphur, a fourth of the nitrogen, a fifth of the phosphorus, and a tenth of the potassium.<sup>11</sup> Calcium and magnesium losses have been notable in many soils. The losses by crop removal and leaching can be restored and maintained almost indefinitely, however, if it is found profitable to do so, for the known deposits of minerals containing these elements seem sufficient for centuries to come. But during the next decade, owing to erosion losses and to the probability that the extensive use of fertilizers will come slowly, it seems likely that acre-yields of the crops, taken as a whole, will not increase, as compared with the past decade, and may continue to decline.

<sup>11</sup> This is an audacious generalization. It is based, for sulphur, in part on a paper entitled 'Agricultural Aspects of Sulphur and Sulphur Compounds', by J. G. Lipman and H. G. McLean, *Chemical and Metallurgical Engineering*, vol. xxxviii, no. 7 (July 1931); for nitrogen, phosphorus, and potassium on analyses of cropped and adjacent virgin soils of the same type, supplemented by data in a paper by Dr. Lipman entitled 'The Nitrogen Outlook', *Journal of the American Society of Agronomy*, vol. xxiv, no. 3 (1932), pp. 227-37; and for potassium by lysimeter (leaching) measurements at Cornell University.

*Future Need for Farm Land.* Of all the factors that influence the future need for farm land the only one that can be estimated quite closely for one or two decades is the population of the nation. It is practically certain that between now (August 1934) and January 1, 1940, the increase of population will be 3 to 5 millions, or 3 to 4 per cent., and between 1940 and 1950 population may increase 2 to 5 millions more. At  $2\frac{1}{2}$  acres of crops harvested per person (excluding exports) this means that 8 to 12 million more acres of crops will be needed by 1940, and 12 to 25 million acres by 1950, other factors remaining equal. If crop yields per acre should decline or exports of farm products increase more land would be needed. If the diet should shift from animal products toward more cereals or sugar, or if the exports of farm products should decline further, less land would be needed. However, *per capita* consumption of farm products, considered as a whole, has changed very little during a third of a century, and it appears likely that a new level in exports of farm products has almost been reached. Considering changes in technique of production, it is inevitable that the number of horses and mules will decline for several years to come owing to insufficient number of colts to balance deaths; but the land thus released may be counterbalanced by shifts from the more productive toward the less productive crops per acre under the surplus control programme, and the reversion of some crop land to pasture. It is certain that the soil resources of the nation are being depleted rapidly, particularly by erosion, but this may be partially counterbalanced by the use of fertilizers on the less erosive lands.

On the whole, it appears probable that by 1940 several million more acres of crop land would be needed to supply the American people with their present *per capita* consumption of farm products and maintain the present exports. But the present *per capita* consumption may not be maintained, and a shift back may occur toward the more productive crops per acre, or the more productive live stock per unit of feed consumed, though this is less likely. Moreover, this estimate is a net figure for the nation as a whole. Many millions of acres of land will doubtless go out of use for crops in certain regions, and many millions of acres come into use for crops in other regions.

Between 1920 and 1930 the decrease in area of harvested crops exceeded 32 million acres in 1,940 counties reporting a decrease, located mostly in the originally forested eastern and southern portion of the United States. The outstanding decrease was in the Piedmont of Georgia and South Carolina and in a belt extending from southern

New England across New York, southern Michigan, Ohio, southern Indiana and Illinois, and most of Kentucky and Missouri, to eastern Oklahoma and central Texas (Fig. 10). Part of this land is used for pasture, part lies idle, and part is growing up to bush or forest. The soils in these areas are, in general, poor or fair, but some are good.

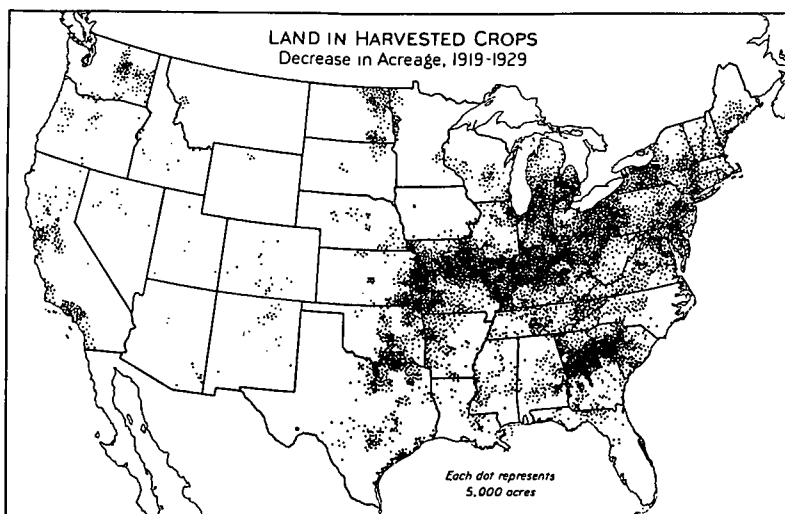


FIGURE 10. A decrease in acreage of crops occurred between 1919 and 1929 in most of the originally forested portion of the United States. The decrease in the 1,940 counties reporting a decrease exceeded 32,000,000 acres. The outstanding decrease was in the Piedmont of Georgia and South Carolina, and in a belt extending from southern New England across New York, southern Michigan, Ohio, southern Indiana, southern Illinois, and most of Kentucky and Missouri, to eastern Oklahoma and central Texas. Part of this land was used for pasture, part lay idle, and part was growing up to brush. The farms in these areas generally are small, and the soils are poor or fair, but some are good. Erosion was a large factor in the decline in crop acreage in the Piedmont, Ohio Valley, and Missouri areas.

Much of the land is hilly or steeply rolling, and erosion has taken a heavy toll. These conditions, as well as the fact that many of the farms are small, has resulted in systems of farming poorly adapted to large-scale machinery, and, where agriculture is dependent on hand labour, there is generally small production per worker.

During the same decade an increase of crop land exceeding 33 million acres occurred in 1,130 counties reporting an increase, located mostly in the Great Plains region (Fig. 11). The suitability of the land, of the crops grown, and of the large-sized farms in the Great Plains to the use of power machinery made agriculture profitable despite the frequency of drought. But the very low

prices for grain in recent years have brought acute distress to this region also, and drought has been exceptionally severe in many portions.

*Summary of Near-Time Outlook.* Looking only to the next decade or two, when population will still be increasing, it appears probable that agricultural production in the United States will increase with equal slowness, and may remain below the 1926-31 level. The

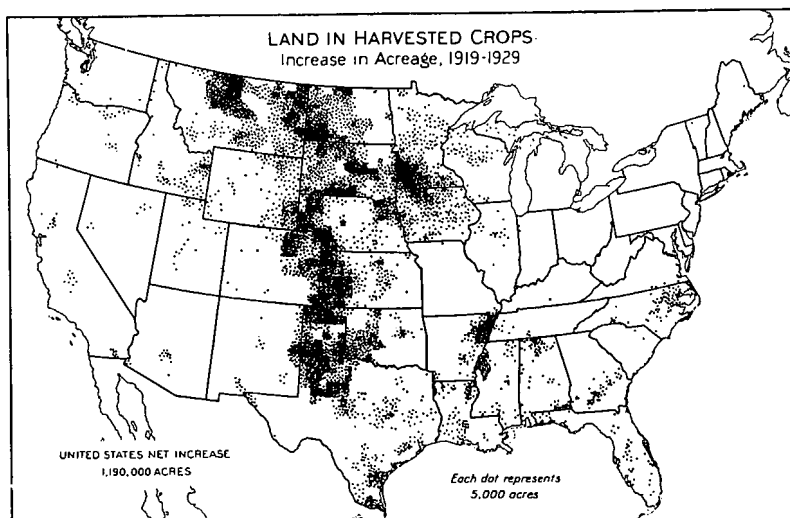


FIGURE 11. The increase in crop area between 1919 and 1929 occurred mostly in the semi-arid portion of the Great Plains Region, where the tractor, combine, and other labour-saving machinery made it possible to grow grain on the level land profitably at the prices then existing. A notable increase occurred also in south-western Minnesota and in the Mississippi River bottoms of Mississippi and north-eastern Arkansas. In both these areas much land has been drained, but most of the Minnesota gain was because of a severe drought in 1919. The increase in the 1,130 counties in the United States reporting an increase during the decade exceeded 33,000,000 acres.

divergence between the trends of population and production has become very wide (see Fig. 5). If present trends continue, there may soon be complaint in the cities of the high cost of living. Even after population begins to decline gently, it is quite possible that agricultural production may be declining more rapidly. The near-time prospect for agricultural returns in the United States, therefore, seems to me hopeful, provided the city people produce a large supply of commodities to exchange with the farmer.

They should be able to do this, since for a decade or two to come there will be a larger proportion of the population in the productive age groups (20 to 65 years old) than ever before. If heavy



migration from the farms to the cities is resumed this will be true of the cities as well as of the nation as a whole. There will be fewer children to support, while time will not yet have brought the full harvest of the aged. All may seem well with the world, and the people will doubtless eat, drink, and be merry.

#### LONG-TIME OUTLOOK

Looking beyond the near future, the outlook for the nation as well as for agriculture becomes clouded, in my opinion even ominous. The 20 per cent. decline in births during the past decade will certainly be reflected in a declining population in the future, unless the birth-rate rises or the restrictions on immigration are greatly relaxed. If the birth-rate continues to decline and the restrictions on immigration are retained, it seems almost certain that the population of the nation will be falling faster than agricultural production a half-century to a century hence, perhaps sooner. Should this occur it may involve a long period of low prices for farm products.<sup>12</sup> A rapidly declining national population appears very likely to induce rural distress; and if agriculture remains largely commercial it would result in heavy migration from farms.

If migration from the farms to the cities is resumed in numbers approaching the pre-depression level, agricultural production will tend to concentrate on the more level, more fertile, or more favourably located lands, and these may be cultivated more intensively, not necessarily by more labour but mostly by the use of more capital. The poorer lands, the hilly lands, the dry lands along the arid margin of the Great Plains would revert to forest or pasture—millions of acres are reverting already. Fields cleared from the forest with incredible labour, farm buildings that remain as memorials to the hopes and the labours of brave men and women, churches and schools empty and unneeded, will be slowly concealed by the encroaching forest, and a rural civilization as fair, perhaps, as any the world has ever known, will disappear from many parts of the United States. This process has been in progress for fifty years in portions of New England. Abandoned farms are now to be found as far west as eastern and southern Ohio and southern Indiana. Fifty to one hundred years

<sup>12</sup> Prices may tend to rise, if the decline in population be rapid (fewer 'demanders' for a slowly increasing supply of gold), but owing to the greater difficulty of adjusting the supply of agricultural products to the demand than is the case with most industrial products, prices of farm products seem likely to rise less rapidly than those of non-farm products. As to the possible rapidity of decline of population, it should be recalled that births are now declining nearly 4 per cent. a year.

hence such a condition may characterize most of the poorer agricultural areas of the nation.

The federal government has already initiated a programme to facilitate the transfer of farm families from poor lands to better lands where they can maintain a higher standard of living. The plan is to buy their present farms and loan additional money to them with which to buy better land on long-term payments and at low interest rates. In some cases large farms will be purchased and sub-divided for this purpose. For those farmers who may not wish to continue farming other arrangements will be made.

This seems a fitting and worthy programme for the government to pursue. Although in the popular mind the major objective is to reduce agricultural production, in the minds of most students of the subject the major objectives are, I believe, the welfare of these people on poor land and the conservation of natural resources, particularly the retardation of soil erosion.

Nevertheless, one cannot but wonder how far this process will go. As the population of the nation declines, will migration from the land prove persistent, progressive, and ultimately precipitous? Or will lessened opportunity for employment in the cities compel the rural youth to remain on farms, as they have been compelled to do during these years of economic depression; and thus lead, perchance, to the development of a new rural civilization with a birth-rate sufficiently high to maintain population stationary? Or will there be a spreading out of the cities, made possible by the automobile and the electric power line, and a commingling of country and city in what our Dr. Galpin has called a 'rurban' civilization?

No one can answer these questions, but we can be sure of this, that the declining birth-rate has brought European civilization to the great turning-point in its history. And may I add the further conviction, that in any civilization which is permanent the family will be the dominant economic unit, as it is in agriculture, and not the individual, as in our modern urban economic system.

Since this paper was written I have learned in a letter from Dr. Burgdörfer, Director of the Statistisches Reichsamt in Berlin, that during the first five months of 1934 the birth-rate in Germany has been about 18 per cent. greater than during the same months in 1933, in twenty large cities as a whole about 25 per cent. greater, and in Berlin about 50 per cent. greater. This is a marvellous change. So far as I know an increase of more than a few per cent. in the birth-rate has not occurred either in Europe or North America during the years since vital statistics have been available. It is the first ray

of hope in an otherwise dark prospect. You are better qualified than I to interpret the causes of this amazing increase in births and to predict the duration. But it suggests that a reversal of the downward trend of the birth-rate is possible when a people are deeply moved by a serious situation and are willing to adopt an altered philosophy of life.