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The Outlook for Land Utilization in the United States

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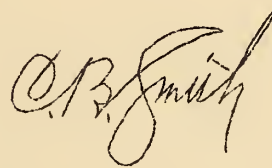
UNITED STATES DEPARTMENT OF AGRICULTURE
Extension Service.....C.W. WARBURTON *Director*
Office of Cooperative Extension Work.....C.B. SMITH *Chief*
Washington, D. C.

THE OUTLOOK FOR LAND UTILIZATION IN THE UNITED STATES*

O. E. Baker
Senior Agricultural Economist
Bureau of Agricultural Economics

F O R E W O R D

We commend to the attention of all extension directors, all supervisors, all farm-management demonstrators, and all others who have to do with the making of extension programs the material herewith presented by Dr. O. E. Baker. The material is believed to be basic in the intelligent development of any long-time Agricultural Extension program.



*Addresses presented at State leaders' conference, Fifth National Farm Boys' and Girls' 4-H Club Camp, Washington, D. C., June 17, 18, 19, and 20, 1931.

DISTRIBUTION: A copy of this circular has been sent to each State extension director; State leader in county agricultural agent, home demonstration, and club work; farm-management demonstrator; specialist in agronomy and farm crops, and farm management; agricultural-college library and experiment-station library.

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The outlook for the utilization of agricultural land in the United States is affected primarily by four groups of factors:

- I. Extent of the land resources and rate of depletion;
- II. Technical progress in utilization of these resources and trends in agricultural production;
- III. Population trends, changes in diet, exports, and other factors that affect the consumption of farm products;
- IV. Land resources of foreign countries and competition by agricultural products from these countries, both in the United States and abroad.

Each of these four groups of factors is worthy of many days' discussion, and to give the essential facts in an hour's talk requires that the statements be brief and broad, and some may seem bold. May I ask you to remember that little supporting evidence can be presented within the time limits.

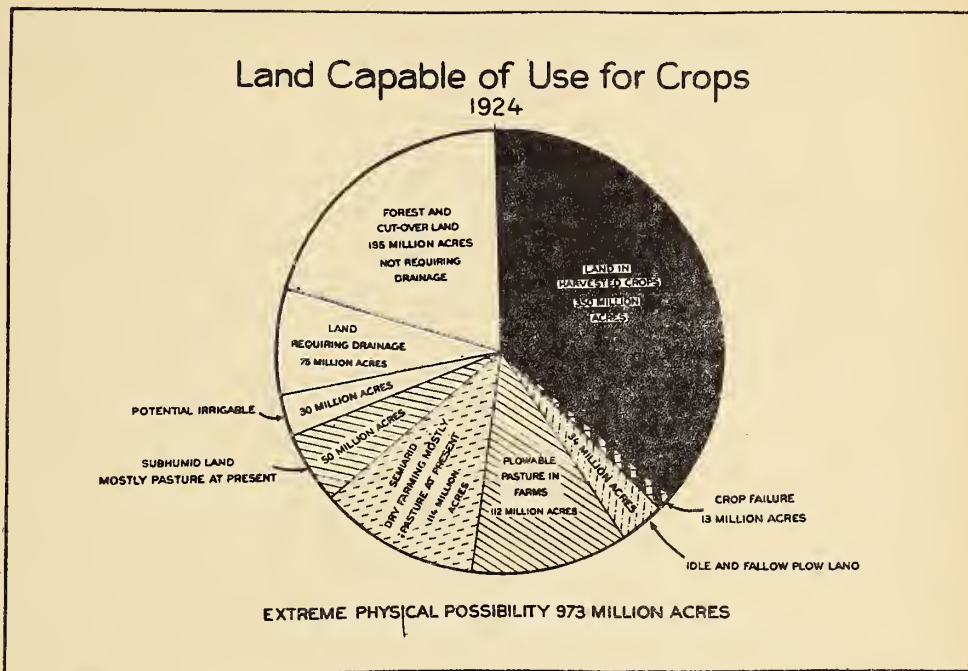
PART I. THE LAND RESOURCES OF THE UNITED STATES AND RATE OF DEPLETION

No nation in the world, except, possibly, Russia, possesses such extensive land resources as the United States; and in no other nation, except Russia, is there as much potentially arable land yet unused for crops; yet in no other nation, without exception, is depletion of the soil resources taking place so rapidly.

The Margin of Utilization for Crops

There are fully a half billion acres of land in the United States in which the climatic conditions, the lay of the land, and the fertility of the soil are no less suitable for crops than on some land now used for crops. This is more land than is in crops at present, or in pasture or fallow in alternation with crops. In other words, the utilization for crops of the potentially arable area is only half complete. But of course, the most productive land is already being cropped and that which remains unused is mostly too wet or too dry, too broken, steep, stony or infertile, or involves too heavy cost for clearing or reclamation, to justify putting it into crops at the present level of prices for farm products. However, about half of this potentially arable land, or 300 million acres, probably, is immediately available for the plow. (Fig. 1.) Nearly two-thirds of this plowable land is located in the Great Plains region.

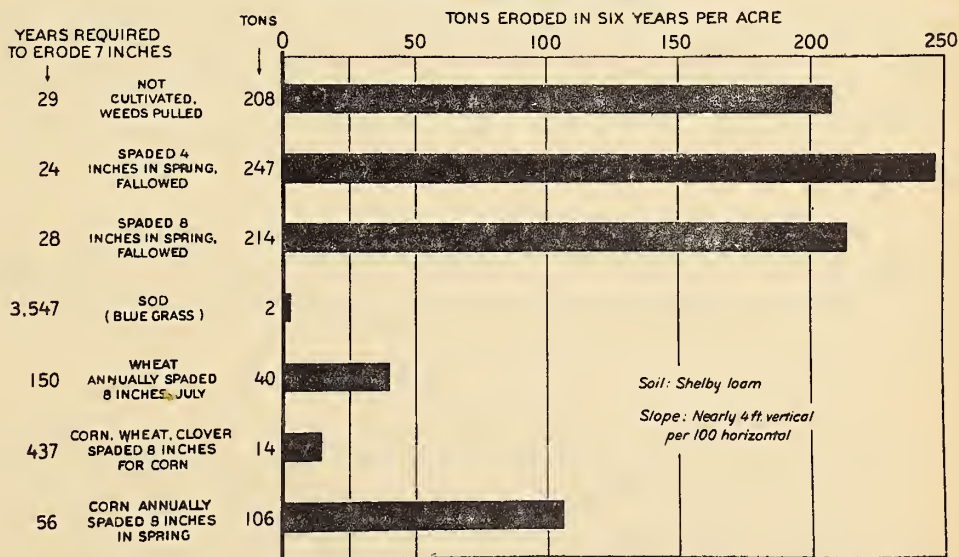
Improvements in agricultural technique, as well as changes in prices of farm products, are constantly shifting the margin of crop production. Owing to the tractor and combine, land is being used now for wheat in Montana and western Kansas which could not have been used profitably a few years ago, despite a price for wheat twice as high as now. On the other hand, land is being abandoned in the Appalachian mountain region which it was profitable to clear and cultivate a generation or more ago before the development of modern agricultural machinery. In addition, there is much land from which the forest was cleared, or on which the prairie sod was



NEG. 22087

FIGURE 1 - THE AREA OF LAND IN HARVESTED CROPS IN THE UNITED STATES IN 1924 WAS ABOUT 350,000,000 ACRES, OR LESS THAN ONE-FIFTH THE TOTAL LAND AREA; BUT IT IS ESTIMATED THAT, IN ADDITION, THERE ARE OVER 600,000,000 ACRES PHYSICALLY CAPABLE OF USE FOR CROPS, OF WHICH 300,000,000 ACRES ARE IMMEDIATELY AVAILABLE FOR THE PLOW (LIGHTLY SHADED IN THE GRAPH). MOST OF THIS PLOWABLE LAND IS IN FARMS, AND PROVIDES A MUCH LARGER RESERVE THAN IS EVER LIKELY TO BE NEEDED FOR CROPS - UNLESS EXPORTS OF FARM PRODUCTS INCREASE MANYFOLD

EROSION OF A GENTLY SLOPING FIELD NEAR COLUMBIA, MISSOURI UNDER DIFFERENT TREATMENTS



U.S. DEPARTMENT OF AGRICULTURE

BUREAU OF AGRICULTURAL ECONOMICS
NEG. 20132

FIGURE 2 - THE IMPORTANCE OF PASTURE IN RETARDING SOIL EROSION, ALSO OF A ROTATION CONTAINING A HAY CROP, IS EMPHASIZED IN THIS GRAPH. ON LAND AT THE MISSOURI AGRICULTURAL EXPERIMENT STATION SLOPING GENTLY (4 FEET VERTICAL IN 100 FEET HORIZONTAL DISTANCE), IT WILL REQUIRE ONLY 29 YEARS, AT THE PRESENT RATE OF EROSION, TO LOSE THE SURFACE SOIL FROM THE TRACT KEPT BARE OF VEGETATION, 24 YEARS FROM THE LAND SPADED 4 INCHES DEEP, 56 YEARS FROM LAND PLANTED TO CORN CONTINUOUSLY, 150 YEARS FROM LAND CONTINUOUSLY IN WHEAT, 437 YEARS FROM LAND IN A ROTATION OF CORN, WHEAT AND CLOVER, AND 3,547 YEARS FROM LAND IN BLUE-GRASS SOD

broken, 50 to 100 years ago which was good land then, some of it more productive than most arable land in the United States, but which is now being abandoned because erosion has made its use for crops unprofitable, if not impossible.

As a consequence of changes in prices of products, changes in agricultural technique, changes in the soil itself, great problems of land utilization have arisen. There are probably two million or more farmers, located mostly in the rolling or hilly lands of the Appalachian, the Piedmont and the Ozark regions, on the sandy lands of the Lakes States or elsewhere, and on the leached lands of the South, receiving an average income considerably less than that obtained by their brothers or other men of equal ability in the cities. In the past farmers in these regions and elsewhere have had the compensation of greater economic security, but this is being diminished by the increasing proportion of farms mortgaged, the mounting ratio of mortgage debt to farm value, heavier taxation, and the greater frequency of foreclosures or tax sales in recent years. In addition, it is becoming evident that the productive power of much farm land in the United States is being rapidly depleted by unwise and wasteful use of the soil, part of which is owing to the fact that this land is all the farmers have to live on, - they cannot sell it for enough to buy a better farm elsewhere, and they are too old to obtain a job in town.

Depletion of the Soil Resources

The data on soil depletion are meagre, but the estimates of well-informed persons indicate that during the brief space of 50 to 150 years, varying with the region, since the forest was cleared or the prairie sod plowed for crop production, probably a quarter, possibly a third, of the original soil resources of fully half the arable land of the nation has been lost. Moreover, it appears that the time is rapidly approaching when, owing to soil losses, the cultivation of many farms will be no longer profitable, if indeed possible, and agricultural production will decline in numerous localities.

The loss of soil resources occurs principally in three ways - (1) by removal of crops without restoring the elements of fertility thus removed, (2) by leaching of the soil, particularly the loss of the mineral salts in solution, and (3) by erosion, that is, physical removal of the soil by running water mostly.

Loss by Crop Removal. - According to J. G. Lipman, Director of the New Jersey Agricultural Experiment Station, "The cultivated crops in the United States removed in 1927 approximately 32.5 pounds of nitrogen, 12.5 pounds of phosphoric acid, 30.75 pounds of potash and 13 pounds of lime per acre. After due credit is allowed for the nitrogen returned to the land in animal manures, for that fixed by bacteria and that brought down by rain and other atmospheric precipitation, there is still a net loss of 3,000,000 to 4,000,000 tons of nitrogen annually in 300,000,000 acres of

arable land." ^{1/} The nitrogen in commercial fertilizer used replaces less than a tenth of this net loss by crop removal alone. Dr. Lipman's figures indicate a net loss through crop removal of nearly 2,000,000 tons of phosphoric acid, of which less than half is returned in fertilizer used; and a net loss of nearly 5,000,000 tons of potash from this cause, of which only one-fifteenth is returned in fertilizer.

Loss by Solution. - The loss of the elements of soil fertility by solution or leaching is much more difficult to estimate. However, analyses of the water of the Mississippi River near New Orleans indicate that 136 million tons of dissolved matter from its drainage area is passing into the Gulf of Mexico annually. The estimated loss for the entire United States is about twice this amount. Most of this matter in solution doubtless comes from cultivated fields. Apparently no analyses are available of the total nitrogen or phosphorus content of these drainage waters, nor of the potassium content separate from the sodium, but it seems probable that the amounts of these elements that flow into the ocean each year in solution are fully half as great as those lost in soil particles in suspension. ^{2/} If this be the case, there are over 250,000 tons of nitrogen, 350,000 tons of phosphoric acid, and 3,500,000 tons of potash lost annually in solution.

Loss by Erosion. - The third source of soil depletion, and much the greatest, is by erosion. H. H. Bennett, of the U. S. Bureau of Chemistry and Soils, estimates that the loss of nitrogen by soil erosion is at least 1,500,000 tons, of phosphoric acid over 2,000,000 tons, and of potash over 20,000,000 tons annually, and he says it may be many times, possibly 25 or 50 times this amount. ^{3/} Most of this erosion is taking place on the cultivated or fallow land of the Middle Atlantic, Southern, and Central States and on the over-grazed lands of the West.

The losses from all sources, therefore, appear to be at least 5,000,000 tons each year of nitrogen, 3,000,000 tons of phosphoric acid, and 28,000,000 tons of potash. The losses may be many times these amounts. In the course of time this annual loss depletes the supply of these scarcest elements of fertility in the soil. For instance, chemical analyses of soils in Southern Wisconsin which had been cropped for 50 years and of adjacent virgin soils of the same type indicate a loss of about one-third of the original nitrogen and one-fourth of the phosphorus. ^{4/}

Important as these losses of the three scarcest elements essential to plant growth may be from the standpoint of the long-time outlook for land utilization and of increasing cost of fertilizers, the significant loss from the standpoint of the immediate future is the loss of the soil itself by

^{1/} J. G. Lipman, in "The Menace of Overproduction," edited by Scoville Hamlin, pages 65-66, John Wiley and Sons, New York, 1930.

^{2/} See Clarke, Frank W., "The Composition of the River and Lake Waters of the United States, U. S. Geological Survey, Professional Paper #135.

^{3/} Bennett, H.H., and Chapline, W. R., "Soil Erosion A National Menace," U. S. Dept. of Agric. Circular #33, page 5. Provides data from which calculation was made by writer.

^{4/} A. R. Whitson, Professor of soils, University of Wisconsin, in a letter to the writer.

erosion. Nitrogen, phosphorus, potassium, and all the other mineral elements of fertility lost from the soil can be replaced by the use of fertilizers, but the humus of the surface soil, the crumb-like structure of this top layer, its water-holding capacity, bacterial content, and all the other factors that make it more fertile than the subsoil, can be replaced only very slowly, indeed, practically, never can be restored.

Based on soil survey and field studies, Mr. Bennett states that "something like 17,500,000 acres of land that were formerly cultivated in this country have been destroyed by gullying, or so severely washed that farmers cannot afford to attempt their cultivation or reclamation." ^{5/} He adds, "the estimate is considered as a minimum, because all the eroded lands have not yet been surveyed." Gullying, Mr. Bennett explains, is only a late stage of erosion, and usually does not set in severely until the surface soil is gone, and washing develops in the usually heavier subsoil with its lesser humus content.

Including erosion of surface soil, Mr. Bennett has expressed the opinion that two-thirds of the cultivated land in the United States is eroding in some degree and that a fourth to a third is eroding seriously, that is, the surface soil will be gone, unless farm practices are changed, in 35 to 100 years, varying with the character of the soil and other conditions. In other words, within 100 years gullying seems likely to be well advanced on 100,000,000 acres, or one-fourth of the nation's arable land.

In the Upper Coastal Plain of the South, for example, particularly the Susquehanna series of soils, which have a heavy clay subsoil, millions of acres of gullied land have been abandoned and are lying idle or growing up to pine forest. Similarly, in the Piedmont of Georgia, the Carolinas and Virginia, Mr. Bennett states that, - "Probably not less than 60 per cent of all the upland - has lost from 4 to 18 inches of its soil and subsoil. --- Many of the gullies have cut down to bed rock." ^{6/} Sheet erosion of the surface soil, however, is not so serious in the Piedmont as elsewhere, because the subsoil is looser and "if properly tilled and fertilized can be profitably cropped." But in the Black Prairie of Texas, the South's greatest cotton producing area, erosion is proceeding more rapidly than in the Piedmont, and the underlying chalk is much less productive. Mr. Bennett states that the dark-colored surface soil of this prairie, which is only 6 to 12 inches deep over the sloping areas, is being eroded, on the average, at the rate of something like 7 inches in 35 to 40 years". ^{7/} On some fields the surface soil is already gone and the land is lying idle.

In Oklahoma the Agricultural Experiment Station completed this year a reconnaissance erosion survey. Of the nearly 16 million acres in crops in the State, this survey shows that over 13 million acres are suffering

^{5/} Documentary Material for the Inter-American Conference on Agriculture, Forestry and Animal Husbandry, Washington, D. C., 1930, page 81.

^{6/} "The Problem of Soil Erosion", address before Association of American Geographers, Worcester, Mass., December, 1930. Probably will be published in Annals of Association of American Geographers for 1930.

^{7/} Ibid.

from the effects of severe soil washing. Of this eroding area, nearly 6 million acres have reached the stage of gullying. Of 1,700,000 acres of crop land abandoned during the last four years, 1,360,000 acres, it is estimated, were abandoned largely because of erosion. 8/

In Kansas, Professor Duley estimates that 75 per cent of the Corn Belt portion of the State is suffering severely from sheet erosion, as is also 40 per cent of the mixed farming land in the southeastern section of the State, 30 per cent of the wheat area of Central Kansas, and 10 to 20 per cent of the wheat land of Western Kansas. 9/

Quite similar conditions to those of the Corn Belt in Kansas prevail over much of the region of sloping glacial soils in Northern Missouri and Southern Iowa, that is, in the region of the Shelby soils, according to Mr. Bennett. 10/ Here some of the land has lost from one to three feet of soil, and fields that yielded from 40 to 60 bushels of corn per acre in their virgin condition now yield only 20 to 30 bushels.

Even in Illinois, erosion gives promise of causing contraction in the crop area. In a letter from a prominent official of the College of Agriculture it is stated, "Altho Illinois is not ordinarily considered as being subject to erosion to the same extent as many other States, erosion is one of the really serious problems facing a large group of farmers. While there are at least 9 million acres of low value land in Illinois subject to serious erosion, more than one-half of which is hardly suitable for cultivated crops, there are more than 14 million acres of high value land in the State subject to serious erosion, which is gradually approaching a stage where gullies are being formed." 11/

Effect of Depletion and Erosion on Land Utilization

The influence of soil depletion and erosion upon the utilization of land in the United States in the near future is difficult to estimate, but it appears very likely that several million acres of land will go out of use for crops within the next ten years. However, because of advances in agricultural technique and of the large area of untouched land available for crops, these few million acres that may be lost by erosion will have little effect upon the agricultural production of the Nation in the next decade or two. More important, perhaps, with reference to present influence is the slow but widespread depletion of soil fertility on land where erosion is less advanced. In view of the advances in plant breeding, the improvements in agronomic technique, and the greater control over plant diseases than in years past, it is difficult to account for the stationary or declining acre-yields of

8/ Winters, N. E. - Address before Southwestern Conference on Soil and Water Conservation, Stillwater, Okla., June, 1930. Mimeographed by Okla. Agric. Exp. Sta. Data by Counties issued by Oklahoma Extension Service.

9/ Duley, F. L. - Address before Southwestern Conference on Soil and Water Conservation, Stillwater, Okla., June, 1930.

10/ Bennett, H. H. - "The Problem of Soil Erosion," Address before Ass'n. Amer. Geographers, Worcester, Mass., December, 1930.

11/ Mumford, H. W. - in a letter to the Secretary of Agriculture.

corn, wheat, and oats during the past quarter century in most parts of the United States, except those where fertilizers are being extensively used, other than on the basis of depletion of soil fertility.

Looking beyond the next decade, it seems probable that the effects of soil depletion in its various forms will become increasingly serious, for as farmers' incomes are reduced by declining acre-yields their ability to buy fertilizers or adopt means of retarding erosion will be diminished. Undoubtedly, terracing will do much to retard erosion, and the planting of cover crops in cotton and corn fields, which crops account for fully three-fourths of the erosion losses, would also aid in holding the soil in place. Still more effective would be the use of perennial hay crops, and, most effective of all, would be keeping the land in pasture. The power of sod to hold the soil is shown in Figure 2.

Without minimizing the importance of restoring to forest the hill lands of the East and Southeast that have been cleared for crops by earlier generations, it is evidently more important from the standpoint of conserving the nation's resources to restore to grass and perennial legumes all except the level or almost level lands of the West and Southwest. This may be profitable in many cases to the individual farmer, as well as desirable from the standpoint of the nation. In general milk or meat is produced on pasture at one-half to one-fourth the cost of similar production in stall feeding. However, it is often cheaper to rent more pasture than to apply commercial fertilizer to the pasture one has in the farm. But sometimes it is inconvenient to utilize rentable pasture land, and it is probable that after a few farmers begin to fertilize their pastures, the rental on other pastures in the locality will rise.

Progress in mechanization of agriculture also is likely to improve the utilization of land with reference to erosion. The tractor will tend to stimulate the production of crops at the expense of pasture on the level lands, in order to obtain an adequate acreage for the efficient operation of the machine, and this will make competition in crop production on lands less suitable for use of large-scale machinery increasingly difficult. Such lands will tend to be used for pasture.

However, the lowering yields of the crops resulting from soil depletion or removal will tend to raise the cost of production, and the danger is that large areas of eroding lands will not go into pasture, but will go out of use entirely and soon be so severely eroded as to be almost worthless. There is urgent need for research in the control of land erosion and later for appropriate action in restoring to a condition of productivity, which should be permanent, these vast areas of eroding or badly depleted lands. Such action may require the resources of the State to supplement the efforts of individual farmers.

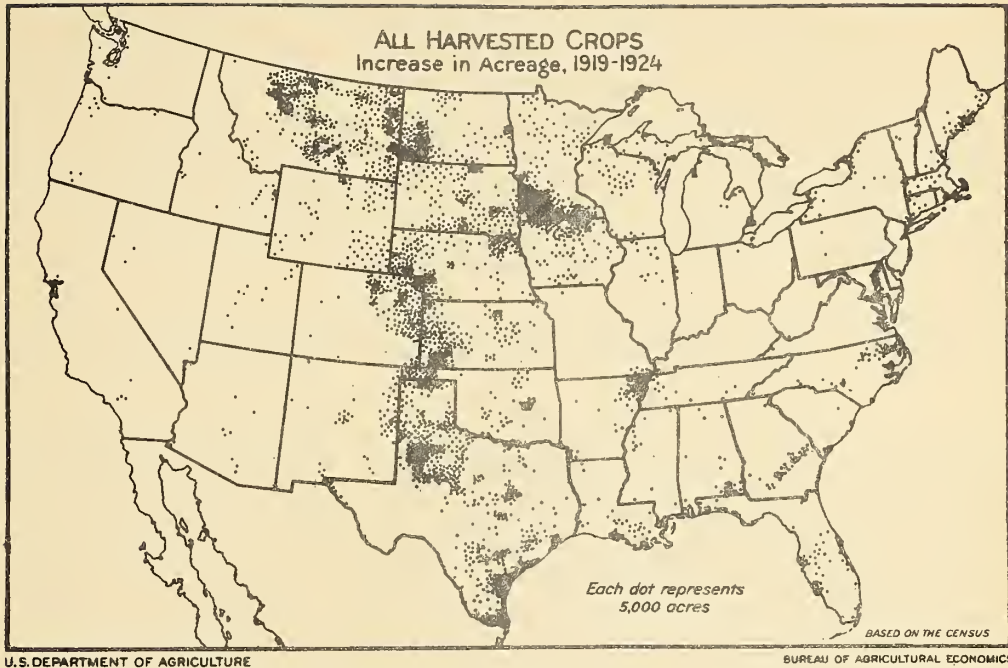
PART II. THE PROSPECT FOR AGRICULTURAL PRODUCTION.

Despite the depletion in land resources, the trend of agricultural production for the nation as a whole has been rapidly but irregularly upward, the losses in soil fertility having been more than balanced by advances in agricultural technique. As in coal mining, although the resources are less abundant, methods and machinery have improved so rapidly that a troublesome surplus of products has developed, and the less favorably situated or less efficient producers are being forced to the wall. These advances in technique that have followed the application of science to agriculture and associated industries have been myriad in number, but nearly all may be grouped with reference to the increase of production into six classes:

- (1) Those that have promoted the expansion of the agricultural area.
- (2) Those that have caused increased acre-yields of the crops.
- (3) Those that have resulted in increased efficiency in utilization of feed by farm animals.
- (4) Those that have substituted mechanical for animal power on farms and thereby conserved feed.
- (5) Those that have led to shifts from the less productive toward the more productive crops per acre.
- (6) Those that have led to shifts from the less productive toward the more productive classes of animals per unit of feed consumed.

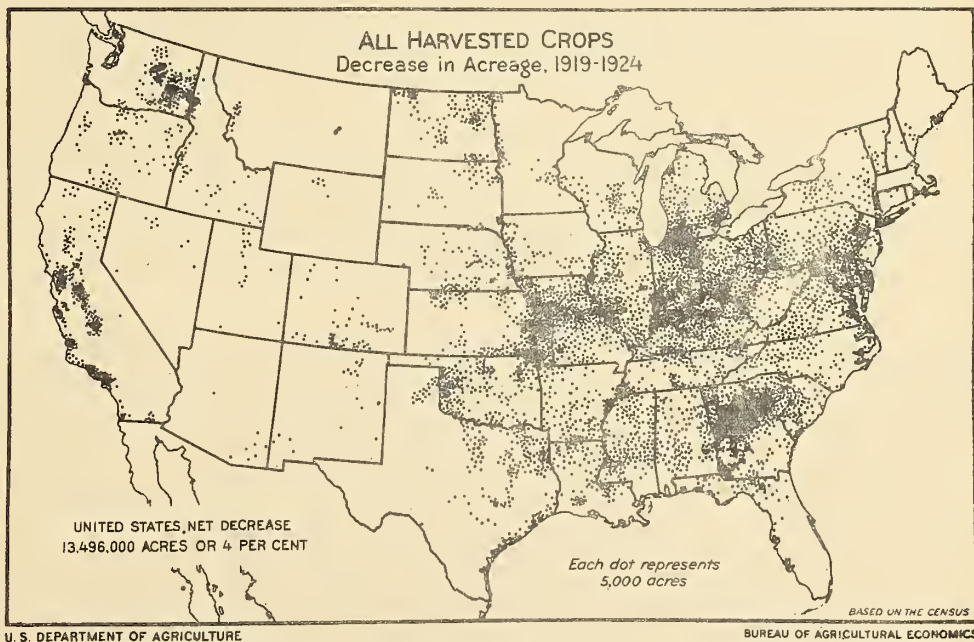
1. Expansion of the Agricultural Area. - The agricultural occupation of the world is a relatively recent development. The area brought under the plow during the past century has been as great, probably, as in all the centuries preceding; and during the past 30 years it has been two-thirds as great, apparently, as in the 70 years preceding. Prior to 1850 agriculture had developed mostly in forested regions, where streams or springs were abundant, or in desert areas reclaimed by irrigation. The vast sub-humid and semi-arid grassland areas were the grazing grounds of nomads. Most of the expansion of the crop area during the past 75 years has occurred on these grassland areas of the world, notably the prairies and plains of North America, the Russian Steppes, the Argentine Pampas, and the semi-arid lands of Australia. The utilization of such lands for crops was made possible by the invention of well-drilling appliances, which provided water for man and beast, by the railroads, which brought wood and coal to the settlers and carried their wheat and meat to market, and by the invention of grain seeding and harvesting machinery, which enabled one man to do the work of five, releasing the other four for employment in urban industries. Recently the tractor and the combine have facilitated the further expansion of grain production along the arid margin of these grassland areas. During the past decade the wheat area in our Great Plains States has increased about 8 million acres, and in the prairie provinces of Canada by about 7 million acres.

But in the United States as a whole since the World War there has been almost no increase in the crop area, expansion on the semi-arid lands of the West being balanced by contraction in the humid areas of the South and East. (Figs. 3 and 4.) The increase in agricultural production since the War must, therefore, be ascribed to other factors than expansion of the crop area.



NEG. 13043

FIGURE 3 - THE INCREASE IN CROPS HARVESTED BETWEEN 1919 AND 1924 WAS ALMOST CONFINED TO THE GREAT PLAINS REGION, WHICH IS WELL ADAPTED TO THE USE OF LARGE-SCALE MACHINERY, AND TO SOUTHERN MINNESOTA, WITH A FEW COUNTIES SHOWING AN INCREASE IN THE UPPER LAKES COUNTRY, IN SOUTHERN NEW ENGLAND, SOUTHERN GEORGIA, FLORIDA, AND THE UPPER END OF THE MISSISSIPPI DELTA. IN THE DAKOTAS AND MONTANA THE INCREASE INDICATED IS MISLEADING, AS 1919 WAS A YEAR OF UNPRECEDENTED DROUGHT AND ONLY A PART OF THE CROP WAS HARVESTED



NEG. 13042

FIGURE 4 - A DECREASE IN ACREAGE OF CROPS OCCURRED BETWEEN 1919 AND 1924 IN MOST OF THE ORIGINALLY FORESTED PORTION OF THE UNITED STATES, AND ALSO IN THE VALLEYS OF CALIFORNIA AND ON THE PLATEAUS OF EASTERN WASHINGTON. THE OUTSTANDING DECREASE WAS IN CENTRAL GEORGIA, AND IN KENTUCKY, INDIANA, AND SOUTHERN MICHIGAN, WITH A LESSER DECLINE IN OHIO, MISSOURI, AND SOUTHERN ILLINOIS. PART OF THIS LAND WAS USED FOR PASTURE AND PART LAY IDLE. THE SOILS IN THESE AREAS ARE NEITHER THE WORST NOR THE BEST IN THE UNITED STATES

2. Increased Acre-Yields of the Crops. - In parts of the United States, notably in the Atlantic States from North Carolina northward, where commercial fertilizers are extensively used, the acre-yields of the crops have been increasing rapidly. (Fig. 5.) But in most of the northern and western States acre-yields of the crops are more or less stationary, and in the South, where the boll-weevil has extended its depredations to the very edge of the Cotton Belt, acre-yields are lower than before the World War. For the nation as a whole there has been practically no change in the composite acre-yield of corn, wheat, oats, hay, and cotton since the period 1905 - 1909. (Fig. 6.)

Evidently other factors than expansion of crop acreage or increased acre-yields of the crops must account for the increase in agricultural production since the World War.

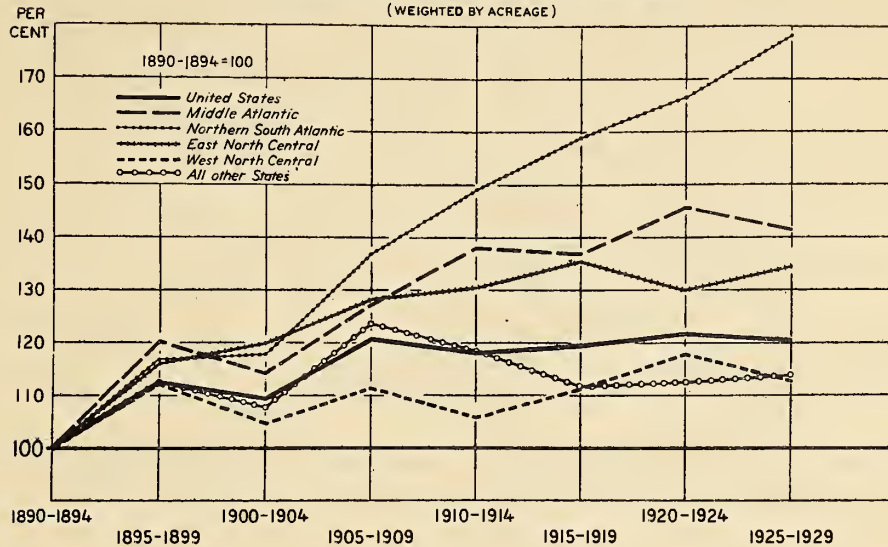
3. Increased Production of Meat and Milk per Unit of Feed Consumed. - The aggregate production of crop feed available for farm animals has increased very little since the beginning of the World War. It is probable that the total acreage in pasture has declined slightly. Nevertheless, the production of animal products, considered as a whole, has increased nearly 30 per cent. (Fig. 7.) This has been made possible by three developments:

1. The feed released by the decline in horses and mules consequent upon the increasing use of the automobile and tractor.
2. The decreasing proportion of the feed consumed by beef cattle and the increasing proportion consumed by dairy cattle, hogs and poultry, which are more efficient in transforming feed into human food.
3. The increasing production of milk and meat per unit of feed consumed, particularly of milk by dairy cows and of pork and lard by swine. Let us consider this last factor first.^{10/}

This increasing efficiency of the livestock of the nation in transforming feed into food is, in turn, owing to at least two factors. The first factor is the decreased production of pork in the South and increased production in the North and West, where the animals, in general, are of better stock and more efficient in transforming feed into food. There are,

^{10/} The increasing production of meat and milk in relation to feed consumed, and factors affecting the trends, are discussed more fully in a preliminary report (mimeographed) entitled "Regional Changes in Farm Animal Production in Relation to Land Utilization," U. S. Bureau of Agricultural Economics, Oct., 1929. In Fig. 7, which was prepared after this preliminary report was written, it will be noted that the rise in production of animal products usually follows several years (5 years in two or three instances) after the rise in crop production. For example, the large corn crops of 1920-1923 (1921-1924 in the graph) seem to be reflected better by production of animal products in 1926-1929 than do the years of small feed production, 1924-1926 (1925-1927 in the graph). This suggests a connection with the cattle cycle, despite the fact that annual changes in livestock on farms were allowed for in calculating the index of production.

CHANGES IN COMPOSITE YIELD PER ACRE FOR CORN, WHEAT, OATS, AND POTATOES (WEIGHTED BY ACREAGE)



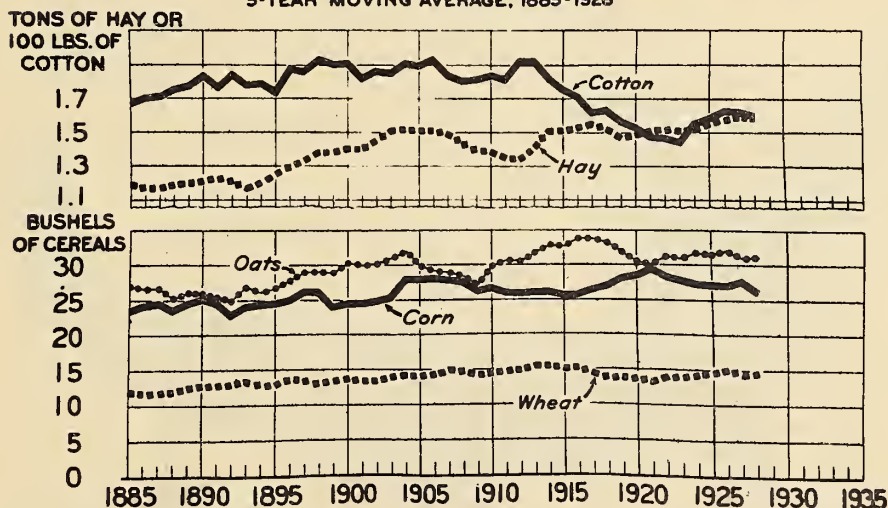
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FIGURE 5 - THE COMPOSITE ACRE-YIELD OF FOUR IMPORTANT CROPS FOR THE COUNTRY AS A WHOLE HAS NOT CHANGED GREATLY DURING THE LAST TWO DECADES. IN SOME OF THE EASTERN STATES, HOWEVER, CONSIDERABLE INCREASE HAS OCCURRED IN AVERAGE YIELDS, DUE LARGELY TO THE INCREASED USE OF FERTILIZERS AND TO THE ABANDONMENT OF LESS PRODUCTIVE ACRES. IN THE CENTRAL WEST PROGRESS IN PLANT BREEDING AND CROP PRACTICES HAS BEEN BALANCED BY SOIL EROSION AND GRAUUAL DEPLETION IN FERTILITY. IN THE OLDER PARTS OF THE COTTON BELT (INCLUDED MOSTLY IN "ALL OTHER STATES") IMPROVEMENTS IN TECHNIQUE HAVE BEEN OFFSET IN RECENT YEARS BY DEPRECIATIONS OF THE BOLL WEEVIL AND BY SOIL EROSION

Corn, Wheat, Oats, Cotton, and Hay YIELD PER ACRE FOR UNITED STATES 5-YEAR MOVING AVERAGE, 1885-1928



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FIGURE 6 - THE ACRE-YIELDS OF WHEAT ARE NOW SLIGHTLY HIGHER THAN AT THE BEGINNING OF THE CENTURY, DESPITE EXPANSION OF PRODUCTION INTO SEMI-ARID AREAS. THE ACRE-YIELDS OF CORN ARE HIGHER THAN AT THE BEGINNING OF THE CENTURY, BUT NO HIGHER THAN IN THE DECADE PRECEDING THE WORLD WAR. THE ACRE-YIELDS OF OATS HAVE NOT INCREASED MATERIALLY DURING THE LAST THIRTY YEARS. THE ACRE-YIELDS OF COTTON TENDED DOWNWARD FROM ABOUT 1906 TO 1921 OR 1923, BUT HAVE BEEN MAINTAINED SINCE AT A LOWER LEVEL THAN BEFORE THE ADVENT OF THE BOLL WEEVIL. THE AVERAGE ACRE-YIELD OF HAY HAS INCREASED LARGELY BECAUSE OF SHIFTS FROM THE LESS PRODUCTIVE GRASSES TO THE MORE PRODUCTIVE LEGUMES

Index of Total Meat, Milk, and Egg Production, Animal Units on Farms Jan. 1, and Crop Feed Consumed, 1897-1929

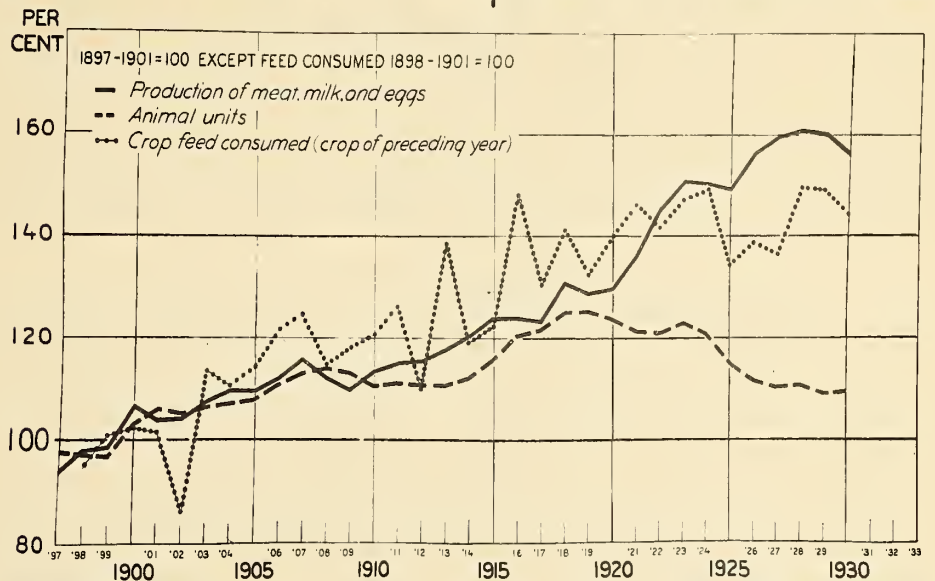


FIGURE 7 - FROM THE BEGINNING OF THE CENTURY UNTIL THE CLOSE OF THE WORLD WAR THE LINES REPRESENTING CROP FEED CONSUMED, NUMBER OF ANIMAL UNITS AND TOTAL PRODUCTION OF MEAT, MILK, AND EGGS TRENDED UPWARD FAIRLY CLOSE TOGETHER. AFTER 1919 THE NUMBER OF ANIMAL UNITS ON FARMS TRENDED DOWNWARD, THE QUANTITY OF CROP FEED CONSUMED TRENDED UPWARD SLIGHTLY, WHILE THE PRODUCTION OF MEAT, MILK, AND EGGS TRENDED UPWARD RAPIDLY UNTIL 1928. FOR 1930 THERE WAS NO MORE CROP FEED AVAILABLE THAN IN 1916, YET PRODUCTION OF ANIMAL FOODSTUFFS WAS ABOUT 26 PER CENT GREATER. FOR EXPLANATION SEE TEXT. THE FIGURES ON WHICH THIS GRAPH IS BASED ARE SUBJECT TO REVISION

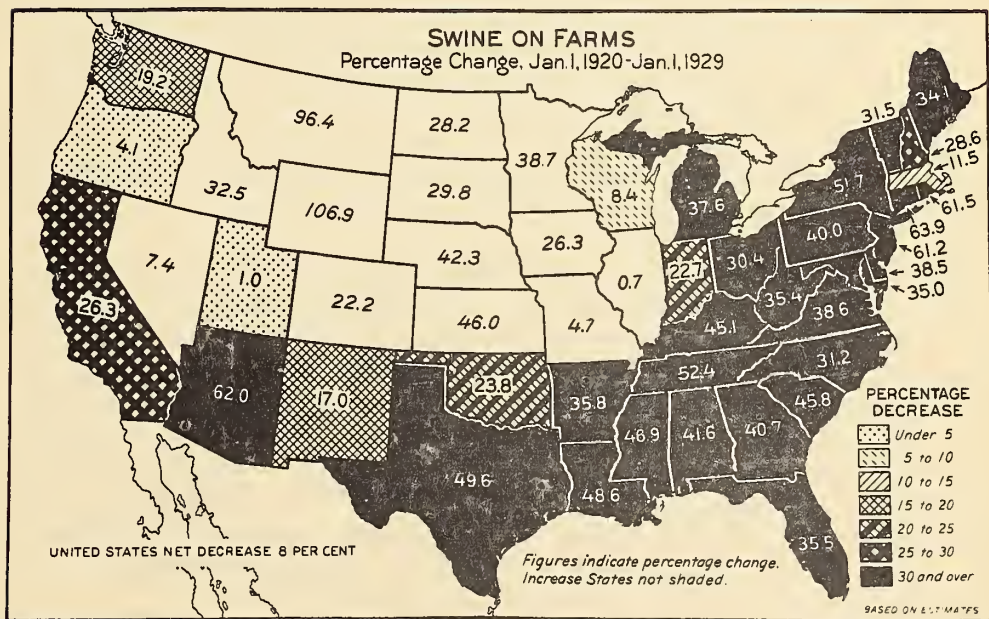


FIGURE 8 - THE PERCENTAGE CHANGE IN NUMBER OF HOGS ON FARMS BETWEEN 1920 AND 1929 BRINGS OUT PROFOUND GEOGRAPHIC SHIFTS IN THE INDUSTRY. IN THE COTTON BELT THE DECREASE IN MOST STATES EXCEEDS 40 PER CENT. THE DECREASE IS ALMOST AS GREAT IN VIRGINIA, MARYLAND, AND PENNSYLVANIA, AND IS EVEN GREATER IN NEW JERSEY AND NEW YORK. ON THE OTHER HAND, FROM MISSOURI TO COLORADO AND NORTHWARD A NOTABLE INCREASE HAS OCCURRED, EXCEEDING 40 PER CENT IN KANSAS AND NEBRASKA, AND MOUNTING TO ABOUT 100 PER CENT IN WYOMING AND MONTANA

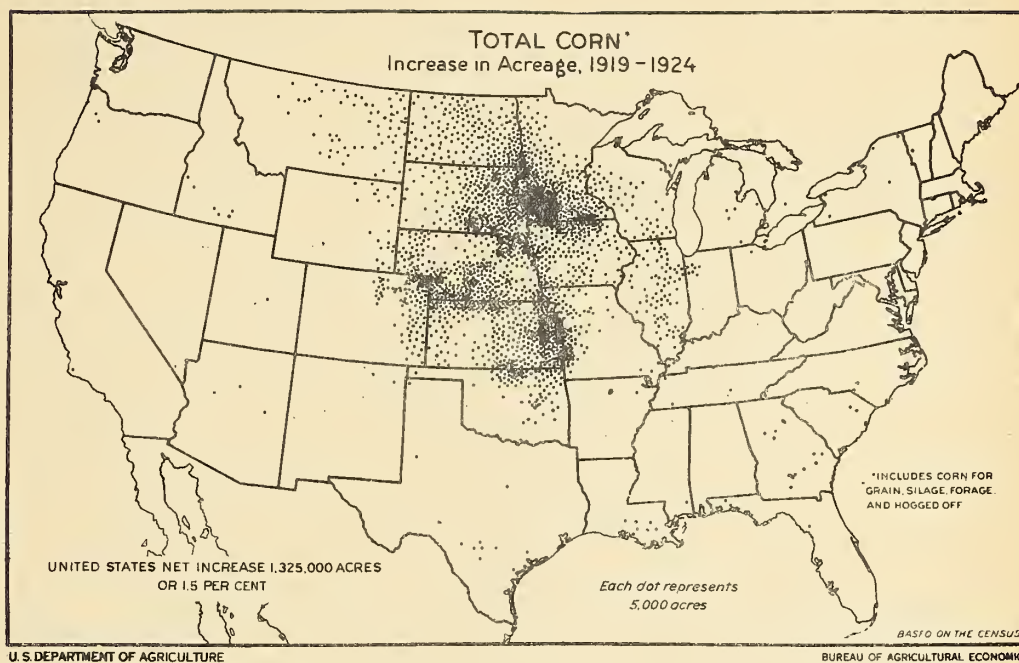
only about half as many hogs south of the Ohio and Potomac rivers as there were ten years ago. (Fig. 8.) On the other hand, there are 20 to 100 per cent more hogs in the States from Minnesota and Iowa to Kansas and westward, excluding the Pacific coast. There has been a corresponding shift in corn acreage and the yield per acre of corn is about twice as high in Iowa and Minnesota as in the South. (Figs. 9. and 10.) A large increase in production of milk likewise has occurred in the region west of Lake Michigan. (Fig. 11.) Undoubtedly, the feed released by the decline in horses and mules in the North and West has been an important cause of this increasing concentration of meat and milk production in the West North-Central States. (Fig. 12.)

A second cause of this increasing production of meat and milk per unit of feed consumed consists of the improvements in farm practice. Cow-testing associations and other agencies have promoted the selection of the larger-producing cows and the slaughter of the poorer cows. The figures indicate little increase in the number of cows during the past decade, but the production of milk has increased more rapidly than the human population, which has increased 16 per cent. Feed eaten by the cows has also increased, but not as rapidly as milk production. Likewise, there are fewer hogs on farms than a decade ago, but the production of pork and lard is, apparently, 20 per cent greater. (Fig. 13.) Better sanitation has resulted in saving more pigs per litter, and the feed that the dead pigs consumed is now saved. Also more legumes and minerals are being used and more growth is obtained on the same amount of feed. Beef cattle and sheep are being slaughtered at an earlier age, and young animals make more gain on the same amount of feed than old animals.

The significance of this increasing production of meat and milk per unit of feed consumed, becomes evident when it is realized that about 70 per cent of the crop land and all of the pasture is used to feed farm animals. Over 80 per cent of the sustenance yielded by the soil each year in the United States is eaten by farm animals. It is probable that the increased efficiency of the nation's live stock in transforming feed into food is as important a factor as the tractor and automobile in accounting for the great increase in agricultural production since the War.

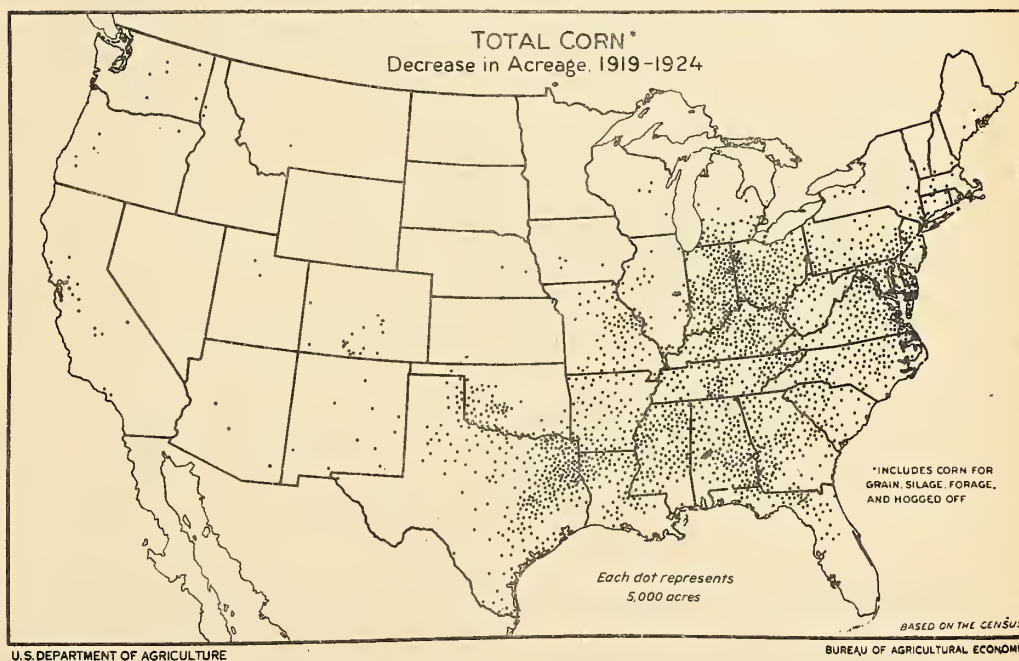
4. Substitution of Gasoline for Horse Feed. - The introduction and increasing use of the automobile and tractor has permitted a reduction in the United States of over 8,000,000 horses and mules since the War, and thereby released about 25,000,000 acres of crops, which are now used mostly to feed meat and milk animals and to grow cotton. (Fig. 12.) As about 200,000,000 acres were used for these purposes in 1919, it appears that this crop land released by the decline in horses and mules has provided an increase of about 12 per cent in 12 years in the acreage used for the production of meat, milk and cotton. This is an increase two-thirds as great as the increase in the nation's population.

5. Shifts from less productive toward more productive crops per acre. - Less important, yet a significant factor, particularly from the standpoint of the crop land requirements of the nation, has been the shift from the less productive crops per acre to the more productive; particularly, from corn toward cotton in the South, a crop which is worth much more per acre, from



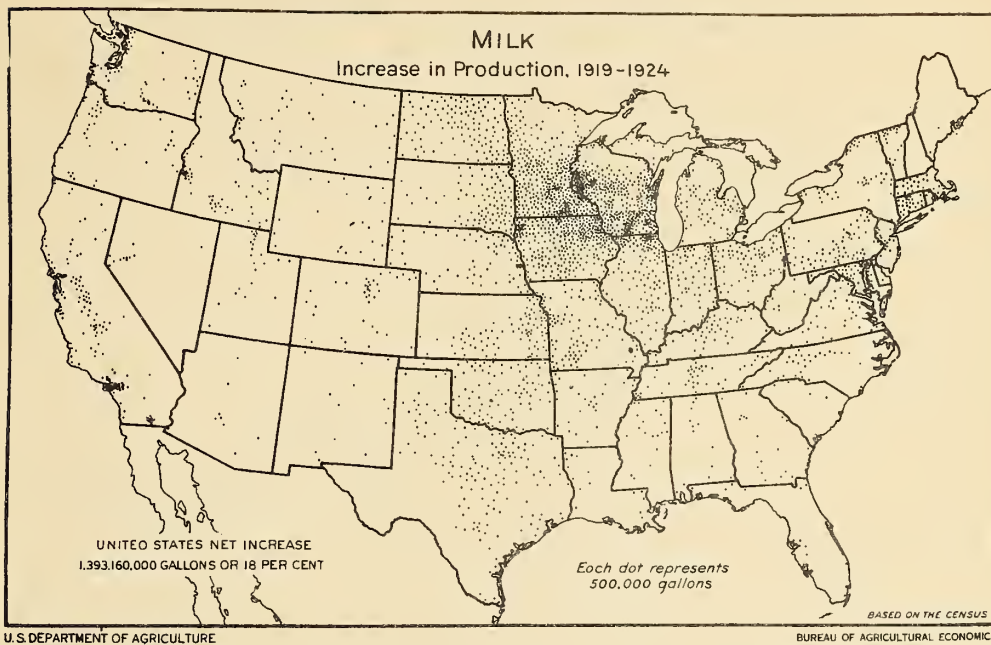
NEG. 13159

FIGURE 9 - IN MOST OF THE REGION WHERE THE ACREAGE OF CORN HARVESTED INCREASED BETWEEN 1919 AND 1924, THE ACREAGE OF WHEAT DECREASED NOTABLY, AND IN THE DAKOTAS THERE OCCURRED ALSO A CONSIDERABLE DECREASE IN HAY ACREAGE. IN SOUTHWESTERN MINNESOTA THE INCREASE IN CORN ACREAGE WAS IN PART OWING TO A DROUGHT IN 1919, AND IN PART TO DRAINAGE OF LAND BETWEEN 1919 AND 1924. PARTLY AS A CONSEQUENCE OF THE GEOGRAPHIC SHIFT IN CORN ACREAGE, THE PRODUCTION OF PORK AND LARD HAS BEEN GREATER THAN BEFORE



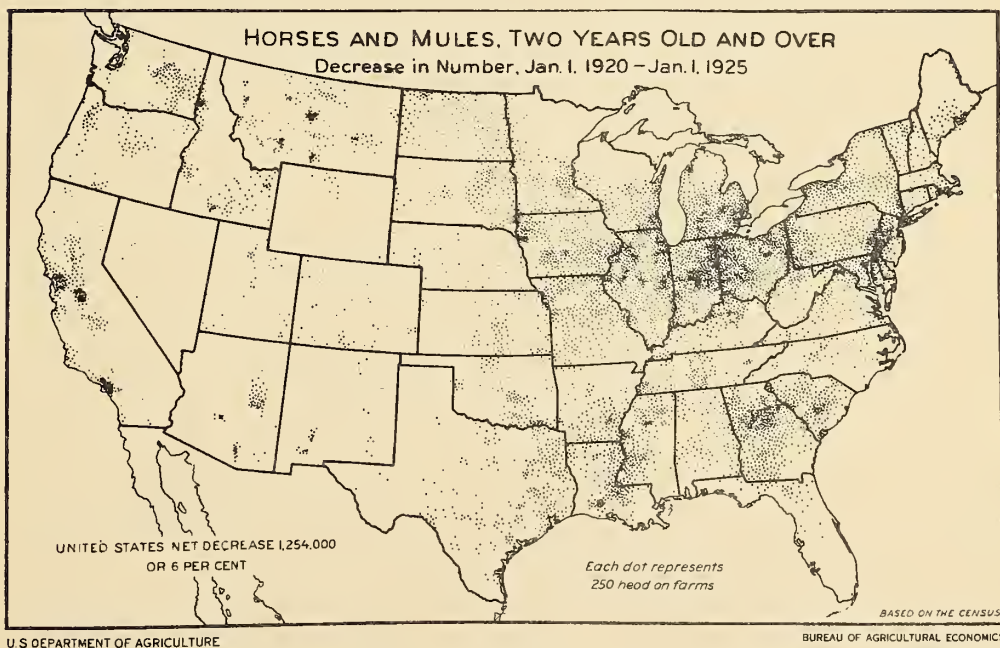
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FIGURE 10 - THE DECREASE IN CORN ACREAGE BETWEEN 1919 AND 1924 WAS PRACTICALLY CONFINED TO THE ORIGINALLY FORESTED PORTION OF THE UNITED STATES, WHERE THE SOILS ARE NATURALLY POORER THAN IN THE PRAIRIE PORTION, AND WAS GREATEST, PROPORTIONALLY, IN THE SOUTHERN STATES. IN THE INDIANA AND OHIO PORTION OF THE CORN BELT, THE DECLINE IN CORN ACREAGE WAS ONLY A PART OF THE SHIFT FROM CROPS TO PASTURE, RESULTING IN PART FROM THE HIGH WAGES OBTAINABLE IN THE NEARBY CITIES



NEG. 16666

FIGURE 11 - THE INCREASE OF MILK PRODUCTION IN THE UNITED STATES BETWEEN 1919 AND 1924 WAS ALMOST UNIVERSAL, BUT IN THE AREA WEST OF LAKE MICHIGAN THE INCREASE WAS GREATER THAN ELSEWHERE. IN THE SIX STATES, WISCONSIN, IOWA, MINNESOTA, NORTH DAKOTA, SOUTH DAKOTA, AND NEBRASKA, THE PRODUCTION OF MILK, ACCORDING TO THE CENSUS, WAS 32 PER CENT GREATER IN 1924 THAN IN 1919, BUT THE PRODUCTION OF BUTTER WAS 56 PER CENT GREATER, ACCORDING TO REPORTS MADE TO THE UNITED STATES DEPARTMENT OF AGRICULTURE



NEG. 17779

FIGURE 12 - THE GREATEST DECREASE IN NUMBER OF WORK HORSES AND MULES BETWEEN 1920 AND 1925 TOOK PLACE IN THE EASTERN AND CENTRAL CORN BELT, IN THE HAY AND DAIRY BELT, AND IN CALIFORNIA, IN BRIEF, WHERE THE INCREASE IN TRACTORS WAS GREATEST. BUT A NOTABLE DECREASE OCCURRED ALSO IN GEORGIA, SOUTH CAROLINA, AND IN OTHER SOUTHERN STATES, WHICH WAS ASSOCIATED WITH THE DECREASE IN TOTAL CROP LAND HARVESTED AND CAN BE ATTRIBUTED ONLY PARTLY AND INDIRECTLY TO THE TRACTOR AND AUTOMOBILE

SWINE ON FARMS JAN. 1, COMPARED WITH PORK AND LARD PRODUCED, AND POPULATION, 1900-1930

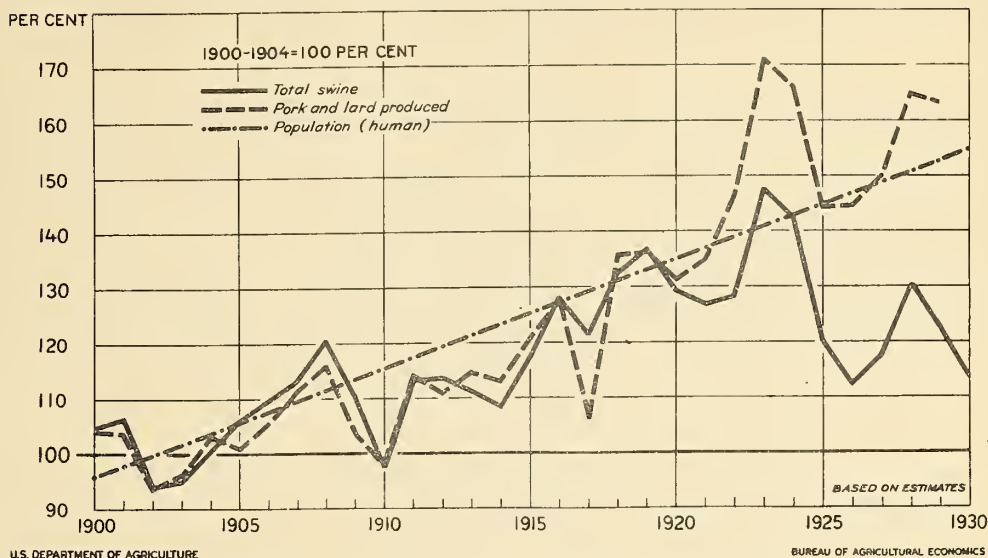


FIGURE 13 - THE PRODUCTION OF PORK AND LARD SHOWS NO DEVIATION IN TREND FROM THE NUMBER OF HOGS ON FARMS FROM 1900 TO 1920, THAT IS, PRODUCTION PER HEAD ON FARMS JANUARY 1 REMAINED PRACTICALLY CONSTANT. THEN THE TWO LINES BEGAN TO DIVERGE, AND BY 1923 PRODUCTION OF PORK AND LARD PER HOG ON FARMS WAS ABOUT 18 PER CENT GREATER THAN IN 1920, AND BY 1926 IT WAS APPARENTLY 28 PER CENT GREATER. THE PRODUCTION OF PORK AND LARD PER PERSON DURING THE PAST DECADE AVERAGED MORE THAN IT DID 25 YEARS AGO

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, 1900-1930

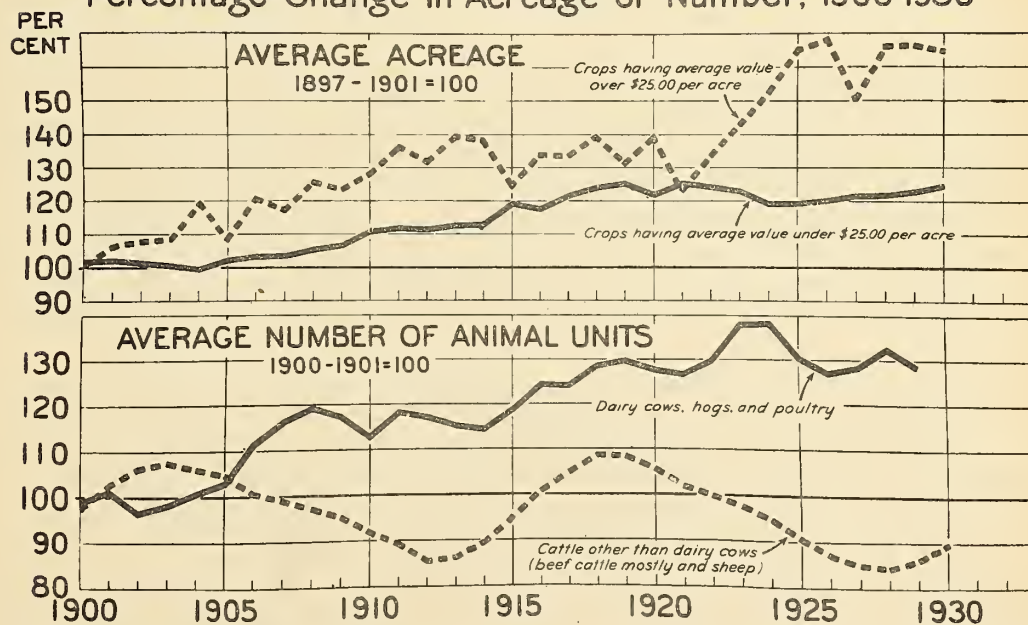


FIGURE 14 - THE ACREAGE OF CROPS HAVING A HIGH AVERAGE VALUE PER ACRE (OVER \$25 DURING THE PERIOD 1925-1929) HAS INCREASED MORE RAPIDLY THAN THAT OF CROPS HAVING A LOWER AVERAGE ACRE-VALUE. SINCE 1921 THE INCREASE IN ACREAGE OF THE MORE VALUABLE CROPS HAS BEEN NOTABLE. LIKEWISE THE INCREASE IN NUMBER 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

wheat toward corn in the North, and from grain and hay toward fruit and vegetables in several areas, notably in California. The acreage of crops having a value of less than \$25.00 an acre has remained more or less constant for 15 years, whereas the acreage of crops having a value of over \$25.00 an acre has increased over 20 per cent since the World War. (Fig. 14.)

6. Shifts from less productive toward more productive animals per unit of feed consumed. - Likewise, there has been a shift from beef cattle toward dairy cattle, hogs, and chickens, which produce much more food than beef cattle per unit of feed consumed. (Fig. 14.) The American people consume (disappearance) about 1,400,000 calories of food per person per year, and to produce this number of calories requires only two and a third acres of grain, hay, and silage fed to dairy cows and one and two-thirds acres of pasture, only three acres of corn and other products fed to hogs, but about eleven acres of grain and hay fed to beef cattle, besides several acres of pasture.

Will these Causes of Increased Production Continue?

The two most important of these four factors that have promoted the rapid increase of agricultural production since the War seem likely to persist for several years. There are less than half enough colts being raised to replace the horses and mules that die or become incapacitated yearly, consequently the replacement of horses by tractors appears inevitable for several years at least. Moreover, the use of the combine in association with the tractor seems likely to result in a continued expansion of grain production in the semi-arid areas of the West. The improvements in farm practices, particularly those that have contributed to greater production of meat and milk per unit of feed consumed, probably will continue for many years.

In addition, it is becoming evident that even at present prices of farm products, it would pay to use more fertilizer, and if prices of farm products should become higher, the use of fertilizers would be greatly encouraged. The depletion of soil fertility points to a greatly increased use of fertilizers in the future, particularly on the more level and the more fertile soils. Progress in agricultural technique, therefore, seems likely to overbalance the decline in soil resources for at least several decades to come.

There is another factor to be considered, in addition to the soil depletion, namely, labor depletion. Although the present generation of farmers will continue to farm for a much smaller compensation than that received by most other occupational groups, because there is no alternative employment for old farmers and little other for farmers of middle age, the farmers' children are migrating to the cities so rapidly that the total farm population has decreased, perhaps 10 per cent in the last ten years. It is probable that the average age of the farmers, like that of farm horses, is increasing. Moreover, the rural birth rate, though higher than the urban, is decreasing almost as rapidly. (Fig. 18.) If it declines as much in the next 8 years as in the last 8 years, it will be insufficient to maintain a stationary farm population permanently and provide any surplus for the cities.

Some light may be thrown on this question of the balance between technical progress and land and labor depletion in the near future by comparing the trend in agricultural production during the past 30 years with the trends in crop acreage and in quantity of farm labor.

Trend in Agricultural Production in the United States Compared
with Trends in Crop Acreage and Farm Labor

During the past four years the Division of Land Economics in the Bureau of Agricultural Economics has been working on an index of agricultural production since the beginning of the Twentieth Century. ^{11/} The work is not yet completed, but is sufficiently complete to show that at no time since 1900, and probably since 1890, did agricultural production increase at so rapid a rate as in the years from 1921 to 1926. Since 1926 the trend of production has been downward, or if cotton be excluded, since 1928. This trend in production is compared with the trends in population, total crop acreage, and total agricultural labor in Figure 15. Production, population, land, and labor at the beginning of the century are each considered as 100 per cent, and the chart shows the percentage change each year since compared with the base year or years at the beginning of the century.

Production and Population. - First, let us note the relation of agricultural production to population. This relation was opulent at the beginning of the century, - if we may judge by the export surplus of farm products, it was as opulent as at any time previously or since. Prices of farm products also indicate that this base period was one of relative abundance. The average farm price of corn during the 5-year period 1897 - 1901 averaged 36 cents a bushel, of wheat 64 cents, and of cotton 7 cents a pound.

This high ratio of production to population persisted until 1907, when a slight slump occurred in production, which was not regained in 1908, and was followed by another slump in 1909. Then followed a period of 5 years in which production each year was larger than in the year preceding, except 1913. In 1914 the opulent relation of production to population which existed at the beginning of the century was temporarily restored, owing principally to a very large cotton crop and a large wheat crop. In 1915, 1916 and 1917, war years, production declined again, then increased in

^{11/} The various crops and animal products (bushels, bales, pounds, etc.) are totaled on the basis of average farm price during the decade 1917-1926. This normal farm value of the crops and animal products during a series of years represents more closely than any other common denominator the aggregate amount of labor, capital, and other factors involved in production; in fact, it is the only common denominator that permits combining foodstuffs with fibers. Each crop is separated into the parts used for human food, for animal feed and for other purposes, mostly industrial. The animal feed part is then omitted and animal products substituted in the index. In the index of animal products allowance is made for the annual change in number of livestock on farms January 1. The index covers consumption also, and it is planned later to total the food-stuffs on the basis of energy value, measured in calories, in order that data may be available on changes in diet measured in this manner.

Agricultural Production, Crop Land, Farm Labor, and Population 1897-1930

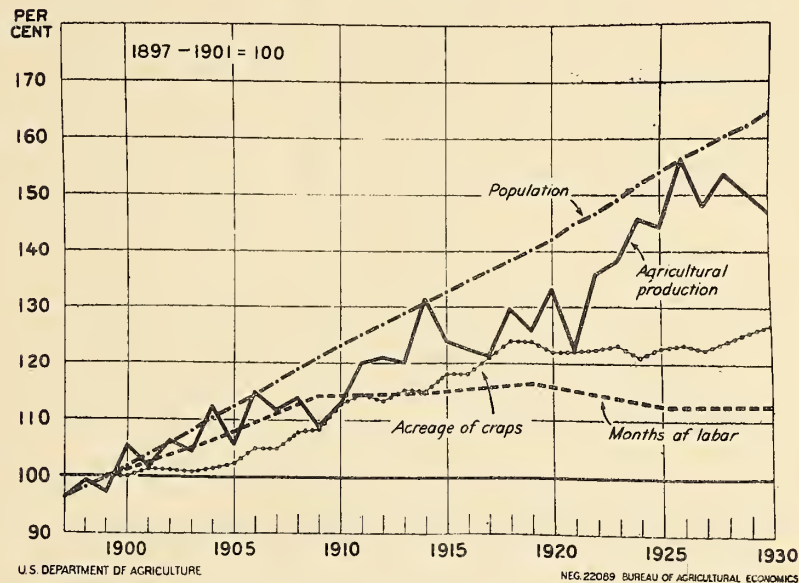


FIGURE 15 - ALTHOUGH AGRICULTURAL PRODUCTION IS NOW ABOUT 50 PER CENT GREATER THAN AT THE BEGINNING OF THE TWENTIETH CENTURY, CROP ACREAGE IS ONLY 25 PER CENT GREATER, AND QUANTITY OF LABOR EMPLOYED IN AGRICULTURE IS ONLY ABOUT 12 PER CENT GREATER. PRODUCTION PER ACRE HAS, THEREFORE, INCREASED ABOUT 20 PER CENT, AND PRODUCTION PER MAN ABOUT 34 PER CENT. MOST OF THIS INCREASE HAS OCCURRED SINCE THE WAR. THE INCREASE IN PRODUCTION PER ACRE BETWEEN 1919 AND 1929, TWO FAIRLY NORMAL YEARS, WAS ABOUT 16 PER CENT, PRACTICALLY NONE OF WHICH IS OWING TO INCREASE IN ACRE-YIELDS OF THE CROPS, WHILE THE INCREASE IN PRODUCTION PER MAN WAS ABOUT 25 PER CENT. THE FIGURES ON WHICH THIS GRAPH IS BASED ARE SUBJECT TO REVISION

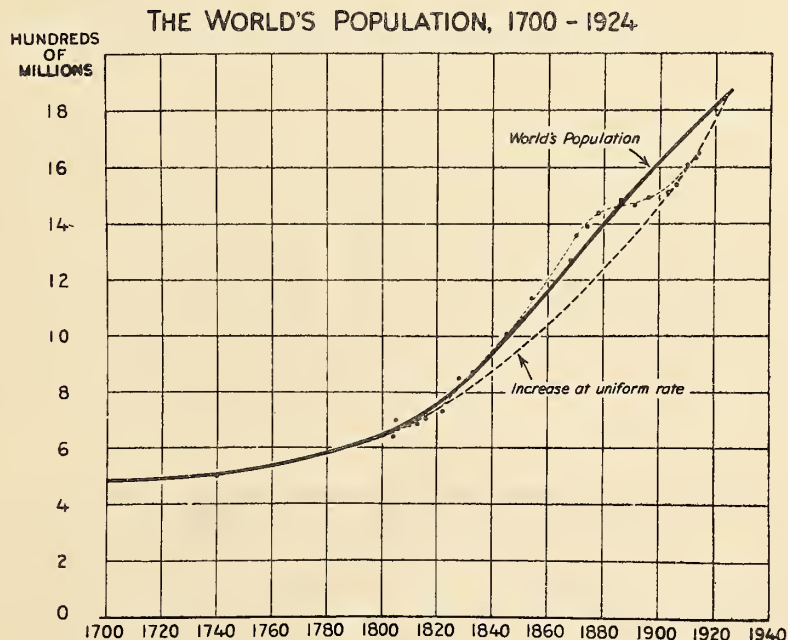


FIGURE 16 - THE INCREASE IN THE POPULATION OF THE WORLD DURING THE LAST TWO CENTURIES HAS BEEN TWICE AS GREAT AS IN ALL THE CENTURIES PRECEDING. THIS HAS BEEN MADE POSSIBLE LARGELY BY THE APPLICATION OF SCIENTIFIC KNOWLEDGE TO AGRICULTURE, TRANSPORTATION, MANUFACTURING, AND MEDICINE. THE GRAPH IS COPIED FROM G.H. KNIBBS: "THE MATHEMATICAL THEORY OF POPULATION" IN REPORT ON AUSTRALIAN CENSUS OF 1911, VOL. I, APPENDIX A. PUBLISHED IN 1916. THE CURVE IS EXTENDED ON BASIS OF LATER DATA

1918 and 1920, reaching a point in this latter year as high as in 1914. But meanwhile the nation's population had increased 10 per cent. The season of 1921 was exceptionally adverse, production being only 23 per cent above that at the beginning of the century while population had become 47 per cent greater. Then followed what was, in some respects, the most remarkable period in the history of American agriculture. For 5 years production each year was greater than in the year preceding, and by 1926 had reached as opulent a relation to population as at the beginning of the century. Between 1921 and 1926 agricultural production increased about 27 per cent, whereas population increased 9 per cent. This increase in production from 1921 to 1926 was largely in cotton, meat, and milk.

Since 1926, or since 1928 if cotton be excluded, as previously noted, there has been a period of declining production, like that from 1906 to 1909, and 1914 to 1917. But this declining production, apparently, is owing mostly to adversities of the weather. In 1927 there was the Mississippi flood, in 1929 the season was extraordinarily wet, and during 1930 drought of unprecedented duration covered a large portion of the country. Total crop acreage has been increasing slowly since 1927, but total crop production dropped greatly in 1929 and even more in 1930. The agricultural surplus, as measured by exports, apparently would have been greater since 1926, had not these adversities of the weather intervened.

The small corn crop of 1930 may result in a low production of meat in 1931, and bring the index of agricultural production for 1931 below that for 1930. There will then have been five years of downward trend in production, a period longer than that of 1906 to 1909, and as long or longer than that which followed the peak in 1914, if the year 1921 be excluded. This difference exists, however, that the present period of decline is owing principally to an extraordinary series of bad seasons, whereas the period 1914 - 1917 was attributable largely to war conditions.

Production and crop area.- The total acreage of crops harvested has remained steadier than agricultural production, principally because it is much less affected by weather conditions. But comparison of the curves of production and acreage indicate that during the past 30 years three cycles, if such they may be called, have occurred in the relationship, each cycle or period being characterized by a rising and then a declining production per acre, (total production, not crop yields). During the last cycle, however, which may best be dated from 1917, particularly if cotton be excluded from the production index - (it was the principal cause of the drop in 1921), production rose much higher above acreage than in the previous cycles.

This great disparity between crop acreage and total agricultural production during the past decade, amounting to about 22 per cent as compared with the relationship at the beginning of the century, undoubtedly is owing principally to the land released by the decline in horses and mules, to increasing production of meat and milk per unit of feed consumed, and to shifts toward the more productive crops and farm animals previously noted. Since replacement of horses and mules by tractors must continue, owing to few colts being raised, and since improvement in production of milk, probably also of meat, per unit of feed consumed is likely to persist, it seems almost

certain that during the next cycle the disparity between production and acreage will be greater than during the present cycle, which appears to be approaching a close. But whether the increase in production will be sufficient for the needs of the increasing population without an increase in crop acreage is not certain. Total crop acreage in the United States as a whole has remained more or less stationary since 1918, but with a tendency upward since 1924. Unless more wheat land is devoted to other crops, and perhaps a little cotton land also, with a probable consequent decline in exports of these commodities, or unless there is a series of very favorable seasons, it looks as though some expansion in crop acreage will occur during the next decade. This increase in acreage is more likely to occur in the later years of the cycle (if there be a cycle), when production is declining. It should be recalled, however, that in 1925 there were about 25 million acres of plow land lying idle, and 113 million acres of plowable pasture in farms. There is a large opportunity for expansion of crop acreage, therefore, within the present farm area.

Production and Human Labor. - The quantity of labor employed in agriculture increased between 1899 and 1909 approximately as fast as production; but between 1909 and 1919 there was very little increase in agricultural labor, and between 1919 and 1924 the census figures indicate a decrease. ^{12/} Comparing the 15 per cent increase in farm labor since the beginning of the century with the 50 per cent increase in farm production, there is indicated an increase of about 30 per cent in production per man-month. All of this increase has taken place, apparently, since 1909, and most of it since 1919. In view of the rapid progress in the mechanization of agriculture, it seems unlikely that there will be an appreciable increase in the quantity of labor employed in agriculture during the next decade at least, and the present downward trend may continue.

PART III. THE PROSPECT FOR CONSUMPTION OF FARM PRODUCTS.

Having briefly considered in Parts I and II the rapid depletion of the Nation's land resources, and the still more rapid progress in agricultural technique, there remains to be noted the third group of factors that are fundamental in estimating the future need for farm land, namely, those relating to population and per capita consumption in the United States and to exports.

^{12/} The estimates of agricultural labor, unlike the estimates of production and crop area, are based on the census, and, therefore, are available only for the years 1899, 1909, 1919 and 1924. They consist of the number of farmers multiplied by 12, assuming that farmers work all the months in the year, plus the expenditure for labor divided by the average monthly wage, by States. The estimates are not complete, because family labor is not included; but it is believed the figures are approximately comparable between the four years, and, therefore, suffice as a basis for index numbers. The 1930 census data are not yet available.

The Prospect for Population Growth

However great the increase in agricultural production during any brief period, if population continues to increase it must sooner or later press more and more severely upon the limitations of the land. This fact, which Malthus pointed out over a century ago, and which he showed was characteristic of the history of almost all civilizations prior to his time has colored the thoughts of many persons interested in the relationship of land to population even to this day.

The Significance of Science

The factor which has completely altered the outlook in Western Europe and North America, and may still alter it in the Orient, though, perhaps, it is too late in the Oriental half of the world, is science and its application to agriculture, to industry, and to man himself. The influence of science has been manifold, - it has permitted a great increase in population both by providing more food and by reducing the death rate, and has provided the basis for a much greater increase of agricultural production than of population. It is probable that the diet just before the War in Western Europe, where the consumption of meat, an expensive food, increased greatly during the Nineteenth Century, and in North America, where the working man to-day eats foods that the wealthy could not afford a few decades past, is twice as expensive as that of 100 years ago. Science also has provided amazing developments in transportation and communication -- the railroad, steamship, automobile, airplane, and radio, for instance; it has greatly increased the production of manufactured goods; and now the evidence is conclusive that the popularization of scientific knowledge, associated with the influences of modern city life, is causing a rapid decline in the birth rate. But before we consider this portentous development let us note the growth in the population of the world which science has made possible.

The Progress of Population in the World

Prior to the Eighteenth Century science had exerted little influence upon human affairs. The population of the world had been probably 400 to 500 million for several centuries, and half of these millions were in India and China. ^{13/} (Fig. 16.) The population of Europe was about 100 million in the year 1700. During the Eighteenth Century the population of Europe almost doubled and during the Nineteenth Century it was more than doubled again. Moreover, during these two centuries the continent of North America was occupied by the white race, also parts of South America, Africa, and Australia. Where the white man went with his science and political organization, population increased. The population of India probably has doubled during the last century, and the population of Japan has doubled in the last 60 years. In Java, under the rule of the Dutch, population has in-

^{13/} Willcox, Walter F. - "Increase in the Population of the Earth and the Continents," "International Migrations," Vol. II. Chap. 1. National Bureau of Economic Research, New York, 1930.

creased eight-fold within a century.

The Eighteenth and Nineteenth Centuries are unique in human history. During this brief span of time the population of the world has increased twice as much as in all centuries preceding since man appeared on the earth. Little wonder that Malthus viewed the future with foreboding, and that economics during most of the Nineteenth Century deserved the characterization of the "dismal science." Apparently all the world was going the way of the Orient and science was helpless, if, indeed, it was not hastening the process by saving the infants and prolonging life. Since the United States affords the most conspicuous example of rapid increase of population, and as it also provides one of the best examples of the changes that are in progress at present, let us consider its population trend more carefully.

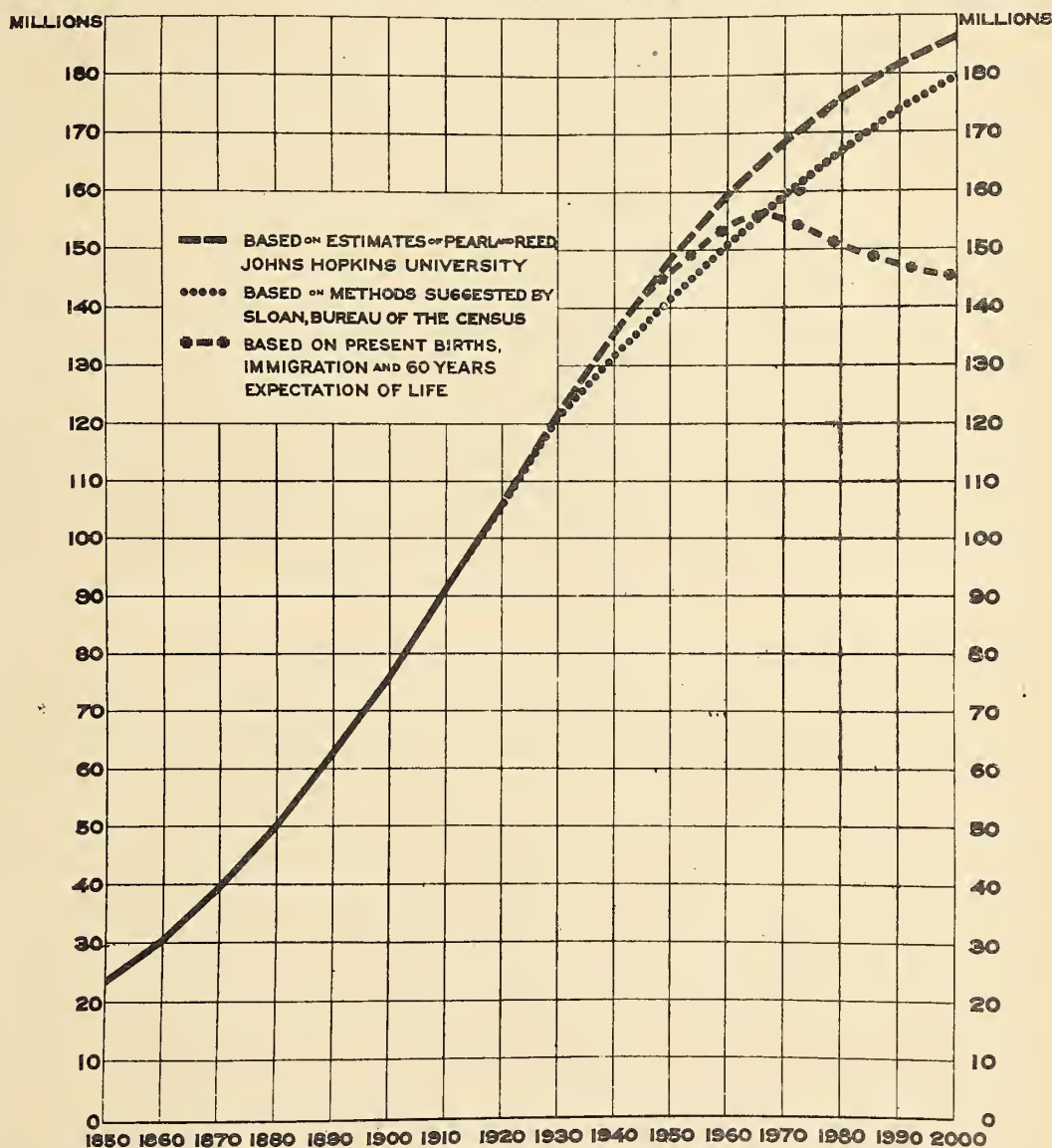
The Growth of Population in the United States

From 1790, when the first census of population was taken, until the Civil War, the American people obeyed the Biblical injunction "Be fruitful and multiply and replenish the earth," increasing about as fast as was physiologically possible. The population doubled every quarter century. In 1840 the population of the Nation was over four times as great as in 1790, and by 1860 it had almost doubled again. (Fig. 17.) Simultaneously this pioneer people subdued a virgin continent - clearing the forests, plowing the land, building houses and roads, schools and churches.

With the Civil War came a rapid expansion in the use of newly invented agricultural machinery, and a large proportion of the farm population was released for other employment. The Civil War also stimulated the development of new industries and many rural villages rapidly developed into manufacturing cities, particularly in the Northeastern States. With the coming of city industries and urban life, the birth-rate began to decline, and although the increase of population shown by the Census was greater each decade from 1870 to 1910 than in the preceding decade, this increase was owing much more than before to immigration. Moreover, despite this immigration the rate of population increase grew smaller. From 1870 to 1880 the increase of population was 30 per cent, from 1880 to 1890 it was about 25 per cent, from 1890 to 1900, and likewise from 1900 to 1910, only about 20 per cent. From 1910 to 1920 the increase was only 15 per cent.

The World War brought another great change in American life. Immigration was cut off, millions of men were in war camps, and simultaneously there arose an urgent demand for labor in city industries, in part to provide manufactured materials for the war. Just a few years previously, as was the case before the Civil War, new and more efficient agricultural machinery, notably the tractor and the automobile (which has saved probably more farm labor than the tractor), came into use, and fewer people were needed on the farms to grow the Nation's food and fibers. Because of this and other factors, an unprecedentedly rapid migration set in from the farms to the cities, and it still continues, though the net movement is, apparently, somewhat smaller during the last three years.

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



NEG. 10622

FIGURE 17 - LESS THAN TEN YEARS AGO PROFESSORS PEARL AND REED, OF JOHNS HOPKINS UNIVERSITY, ON THE BASIS OF THE POPULATION TRENDS, ESTIMATED THE UNITED STATES WAS SLOWLY APPROACHING A STATIONARY POPULATION OF NEARLY 200,000,000 ABOUT THE YEAR 2020. BUT THE RAPID DECLINE IN THE BIRTH RATE SINCE 1921, INDICATES A MAXIMUM POPULATION OF LESS THAN 165,000,000 ABOUT THE YEAR 1960, UNLESS THE IMMIGRATION LAWS ARE CHANGED. MOREOVER, UNLESS THE BIRTH RATE RISES OR IMMIGRATION INCREASES, A DECLINE IN THE NATION'S POPULATION WILL SET IN SOON AFTER 1960

The immigrants from Europe prior to the war were mostly young people, recently married or of marriageable age. Moreover, these immigrants came mostly from peasant farms where the tradition of large families persisted. The reduction in immigration, therefore, reduced not only the increase of population, but also reduced the birth-rate in the United States. Similarly, of the present migrants from the farms to the cities, probably half are young people recently married or of marriageable age, - middle aged and old people can not well learn a new occupation and make the many other adjustments necessary. Most of those past middle life who go to the cities go to retire. Since farm people have a much higher birth-rate than city people, this migration of the young to the cities has reduced the birth-rate still further.

The Trend in the Birth Rate

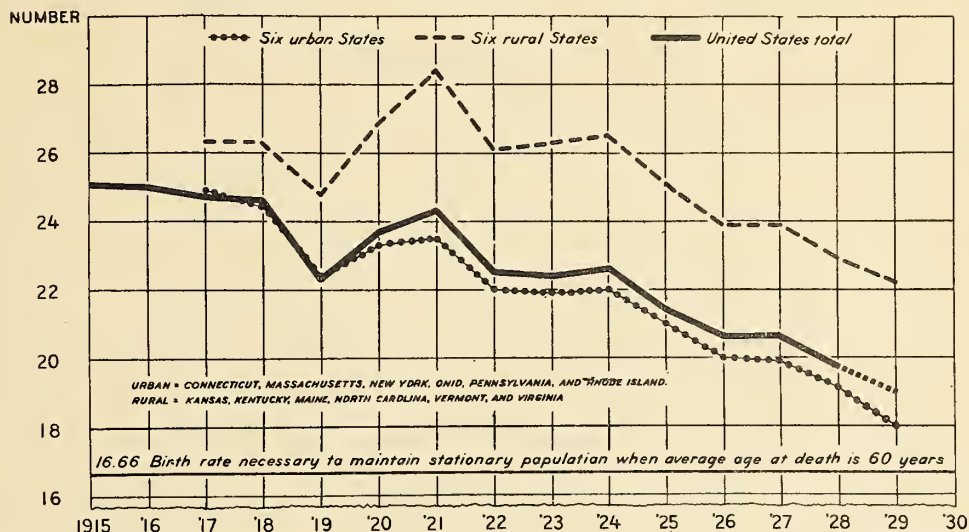
In 1921 the birth rate in the registration area, which included most of the United States, was 24.3 per thousand population; in 1929 it was only 18.8 (Fig. 18.) A birth rate of 16.7 is necessary to maintain a stationary population with our present expectation of life of 60 years, provided there is no immigration. Two or three years hence, therefore, if the present downward trend in the birth rate continues, the number of daughters born will be only enough to replace the mothers of the present day, and if the birth rate continues to fall at the present rate for two years thereafter, a net immigration of 150,000 legal entries plus, possibly 50,000 illegal entries, as estimated for recent years, will not be sufficient to prevent a declining population when the children of to-day reach middle age. ^{14/}

The best judgment of the population statisticians is that the United States will attain a stationary population of between 140,000,000 and 160,000,000 people about the year 1960, perhaps by 1950, and whether the population will decline thereafter will depend on the immigration laws and on the willingness of parents to sacrifice for the sake of children.

A recent investigation made by the Metropolitan Life Insurance Company shows that it costs in the cities about \$9,000 to raise a child to the age of 18, for a family having an income of \$2500 a year. Since it requires over three children per family to maintain even a stationary population, it appears that for a typical urban American family to raise three children will cost \$25,000 to \$30,000. This necessarily reduces the standard of living, and fewer parents, evidently, are willing to make the sacrifice. The number of births in the United States is now fewer each year than in the year preceding. There were 60,000 fewer children born in 1928 than in 1927; 80,000 less in 1929 than in 1928. Enrollment in the first grade of the public schools has been trending downward since 1918, in the second grade since 1922, and in the third grade since 1924. The rapid decline in the birth rate since 1924 has not yet had time to be reflected in the school enrollment. The increasing proportion of the population living in the cities will tend to depress the

^{14/} During the past year (1930) emigrants have almost equalled immigrants, but as this is owing largely to the economic depression, it is transitory, probably.

BIRTH RATE PER 1,000 POPULATION, REGISTRATION AREA OF UNITED STATES 1915-1928 AND SIX URBAN AND SIX RURAL STATES, 1917-1928



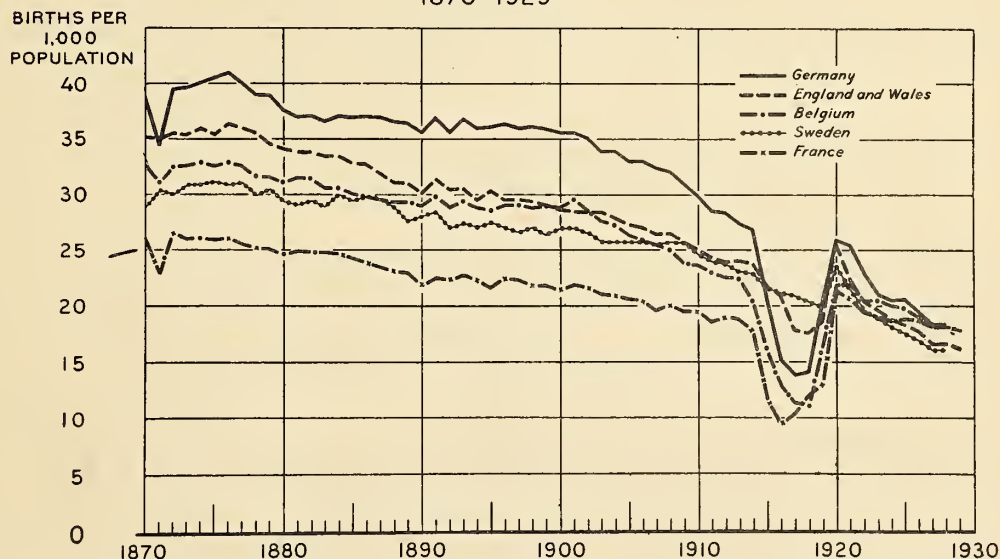
U.S. DEPARTMENT OF AGRICULTURE

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FIGURE 18 - THE BIRTH RATE BEGAN TO DECLINE SLOWLY AFTER THE CIVIL WAR, AND THIS GENTLE DECLINE CONTINUED UNTIL THE WORLD WAR. SINCE 1921 THE RATE OF DECLINE HAS BEEN MUCH MORE RAPID. (THE DROP IN 1919 WAS OWING LARGELY TO THE EPIDEMIC OF INFLUENZA IN 1918). IT WILL BE NOTED THAT THE RURAL BIRTH RATE IS TENDING DOWNWARD IN MUCH THE SAME WAY AS THE URBAN BIRTH RATE. THE FALL IN THE BIRTH RATE HAS BEEN SO RAPID RECENTLY THAT, DESPITE THE INCREASING POPULATION, THE NUMBER OF CHILDREN BORN EACH YEAR IS LESS THAN IN THE YEAR PRECEDING. THE ENROLLMENT IN THE LOWER GRADES OF THE PUBLIC SCHOOLS IS DECLINING

BIRTH RATES: FIVE COUNTRIES OF NORTHWESTERN EUROPE 1870-1929



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FIGURE 19 - BIRTH RATES ARE DECLINING ALSO IN NORTHWESTERN EUROPE, WHICH HAS HITHERTO PROVIDED THE PRINCIPAL EXPORT MARKET FOR AMERICAN FARM PRODUCTS. THE MARKED DECREASE IN THESE COUNTRIES IN THE YEARS OF THE WORLD WAR WAS MERELY AN EXAGGERATED DISLOCATION IN AN OTHERWISE STEADILY DECLINING TREND. APPARENTLY THIS TENDENCY IS OCCURRING WHEREVER INDUSTRIALISM AND URBANIZATION HAVE BECOME IMPORTANT. IF THE TREND CONTINUES, STATIONARY POPULATION IN THE MORE HIGHLY INDUSTRIALIZED COUNTRIES APPEARS VERY PROBABLE IN 20 TO 30 YEARS. DATA IN THE CHART ARE FROM THE BALANCE OF BIRTHS AND DEATHS, VOL. I, NEW YORK, MACMILLAN CO. (1928), BY ROBERT R. KUCZYNSKI, OF THE BROOKINGS INSTITUTION, WASHINGTON

birth rate still further. ^{15/} Less than a quarter of the Nation's population now lives on farms as compared with three-quarters a century ago, and it is possible that only a sixth will be living on farms a third of a century hence. ^{16/}

Rural and Urban Birth Rates

Although the birth rate everywhere is trending downward, it is much higher among farm people than city people. The number of children under 5 years old per 1000 women 15 to 45 years of age was twice as high in rural areas in 1920 as in cities of 100,000 population and over. In 1930, in only one of the 20 cities for which reports are now available, were there enough children under 5 years of age to maintain a stationary population permanently, and in half of these cities there were only about 3/4 enough children to do so. On the other hand, in the farm population of 24 States for which reports have been published to date, there are, on the average 55 per cent more children under 5 in relation to women 15 to 44 years of age than is necessary to maintain a stationary population permanently. On the farm, the child is in many cases an economic asset from 10 years of age onward, the wife is an economic necessity and a co-worker, while even the aged find plenty that they can do. Moreover, the farm is the home and the factory, and the family is both the economic and social unit. In the modern urban industrial system, on the other hand, there is little place for the child and no place for the aged, while the wife tends to become either a factory or an office worker, and the home is more and more in an apartment house or a hotel. In many, perhaps most cases, the individual, not the family, is the economic unit.

The industrial revolution has brought a social revolution in its train, and the great need is to find the golden mean between rural civilization with its tendency to excessive population and consequent poverty, as exemplified by China, or nearer home, by some parts of the Southern Appalachian region, and modern urban civilization with its tendency toward deficient population and racial decay.

Apparently there is less than a quarter century of grade ahead in which to solve the problem. Owing to the large proportions of young and

^{15/} Since this paper was written, P. K. Whelpton, of the Scripps Institute for Population Research, has shown that the increase in the Nation's population was nearly 2,000,000 a year during the early years of the last decade, but is now only about 1,000,000, and is rapidly declining. See American Journal of Sociology, May, 1931.

^{16/} There is likely to be a great increase, however, in the number of suburban homes of factory workers, professional men, and others, that have a cow and chickens, a garden, and sometimes a little hay land, and produce enough to meet the census definition of a farm, namely, 3 acres of land, or \$250 worth of products. Farms of 3 to 10 acres in the United States increased in number 35 per cent between 1920 and 1925, and farms of 10 to 20 acres increased 16 per cent. The number of farms in all larger size groups declined. Owing to a change in instructions to the census enumerators, such a comparison can not yet be made between 1925 and 1930. Apparently, the automobile has made more small farms, principally near the cities, than the tractor has made large farms.

middle aged people, few of whom will die for several decades, and owing in much smaller degree to immigration, the population of the United States, as already ^{noted} probably will continue to increase for 20 to 25 years, when there may be 20 to 30 millions more people than at present. Practically all this increase will occur, doubtless, in the cities. The agricultural census of 1925 showed a slight decrease in number of farms from that in 1920, about 1 per cent, and a greater decline in farm population, amounting to about 2,000,000 or over 6 per cent. The census of 1930 will show, probably, a decline of nearly 2,000,000 more in the farm population of the Nation, after allowance is made for the change in date of enumeration from January 1 to April 15.

A rural birth rate sufficient only to maintain a stationary farm population would reduce materially one of the greatest drains on American agriculture, namely, the drain incident to the settlement of farm estates. A large part of the farm mortgage debt is owing to the necessity of the son or daughter who remains on the farm paying the brothers and sisters who have moved to town for their share in the estate. On the other hand, when the birth rate of the farm population is only sufficient to maintain a stationary condition, the population of the cities will be declining rapidly, unless there is a great increase in immigration from abroad; and a declining domestic demand for farm products may become as difficult a situation for the farmers as the present heavy burden of debt.

Consumption of Foods and Fibres per Person

The World War caused changes in the diet of the American people as it did in many other things. The principal change in diet was a notable decline in the use of wheat bread, of corn meal, and of other cereals for food and an increase in the consumption of sugar, of milk, of pork, and probably of fresh vegetables. Apparently the higher wages and salaries of city people after the War enabled them to eat more of the expensive foods, sugar being an exception. (Fig. 20.)

The Cereals. - The average consumption of wheat flour per person, for instance, was about 211 pounds in the pre-war period 1909-1913, but after the United States entered the World War there was an abrupt drop to 176 pounds (in 1917-1918), which is 17 per cent decrease, and consumption has remained almost stationary at this point since. The use of corn for human food declined much more, doubtless owing largely to the rising standards of living during and after the War and increasing use of wheat flour and other foods by both negroes and whites in the South, where corn had been used for human food more extensively than elsewhere, and to the increasing proportion of the people who live in cities, where little corn bread is baked in homes and even less by bakers. The decline in use of rye flour has been about as great proportionately as of corn meal.

The total consumption per person of wheat, corn, oats, rye, buckwheat, and barley for human food averaged about 340 pounds a year during the pre-war period 1909-1913, whereas during the last five years it has been only about 240 pounds. This is a decrease of 100 pounds, or nearly 30 per cent. On the other hand, the average American is now eating about a third

CHANGES IN CONSUMPTION OF FOOD PRODUCTS PER PERSON. TOTAL AND SIX PRINCIPAL PRODUCTS, UNITED STATES, 1909-1929

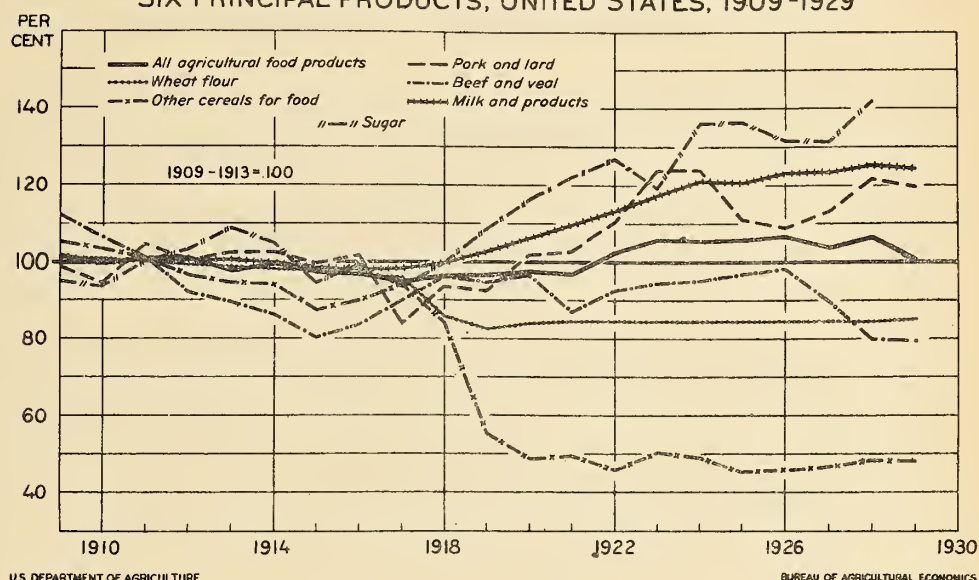


FIGURE 20 - THE WORLD WAR WORKED SIGNIFICANT CHANGES IN THE DIET OF THE AMERICAN PEOPLE. PERHAPS OF EQUAL IMPORTANCE WAS THE PROHIBITION AMENDMENT TO THE CONSTITUTION, THE PROSPERITY OF THE URBAN PEOPLE DURING AND AFTER THE WAR, AND THE FOOD EDUCATION ARTICLES AND ADVERTISEMENTS IN THE POPULAR MAGAZINES. THE RESULT HAS BEEN A DECLINE SINCE THE WAR YEARS OF ABOUT 100 POUNDS PER PERSON IN CONSUMPTION OF CEREAL FOODS, AND AN INCREASE OF ABOUT 27 POUNDS PER PERSON IN THE CONSUMPTION OF SUGAR, ALSO A NOTABLE INCREASE IN THE CONSUMPTION OF MILK AND PORK, AND PROBABLY A SMALLER INCREASE IN USE OF FRUITS AND VEGETABLES

ACRES REQUIRED TO PRODUCE 1,400,000 CALORIES OF CERTAIN FOODS

(THE YEARLY CONSUMPTION OF FOOD PER PERSON AVERAGES 1,400,000 CALORIES)
UNITED STATES, 1922-1924

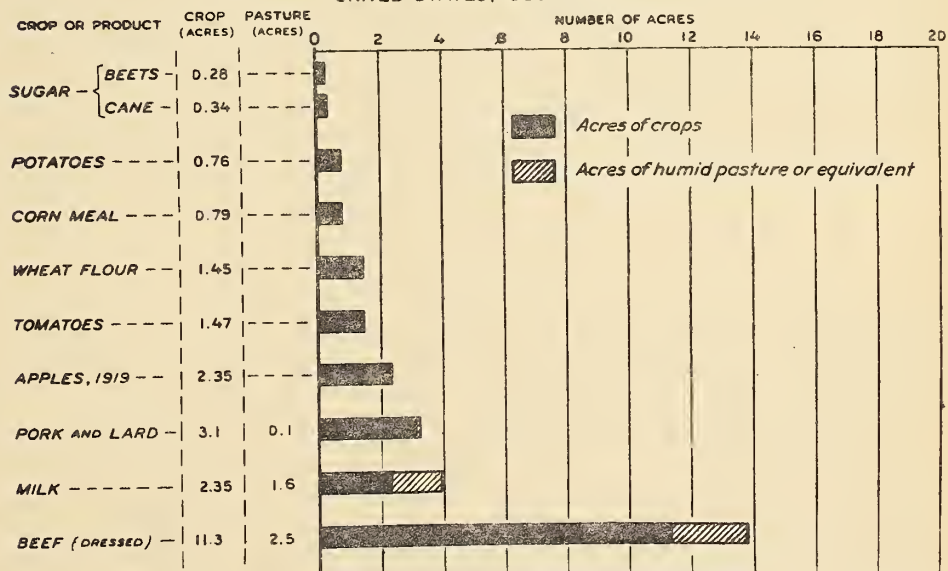


FIGURE 21 - ONE-THIRD OF AN ACRE IN SUGAR CROPS PRODUCES ABOUT AS MANY CALORIES OF FOOD AS THREE-FOURTHS ACRE OF POTATOES OR CORN, OR ONE AND A HALF ACRES OF WHEAT OR TOMATOES. BUT, LACKING PROTEIN AND FAT, A PERSON COULD NOT LIVE ON SUGAR ALONE. THE CEREAL DIET WOULD MAINTAIN HEALTH MUCH LONGER. TO MAINTAIN HEALTH PERMANENTLY MEAT, MILK, OR OTHER FOODS HIGH IN PROTEIN AND FAT SHOULD BE ADDED. THESE REQUIRE THREE TO FOUR ACRES OF CROPS AND PASTURE TO YIELD THE SAME ENERGY VALUE IN PORK OR MILK, OR ABOUT 14 ACRES DEVOTED TO BEEF PRODUCTION

more sugar than before the war, probably a fourth more milk and dairy products, possibly a fifth more vegetables, and, until recently, a little more meat.

Sugar. - The yearly consumption of sugar per person was about 80 pounds in the pre-war years, 1909-1913; and is now about 110 pounds, an increase of fully 30 per cent. Most, if not all, of this increase occurred between 1917-1918, when prohibition became nation-wide, and 1924. Sugar is a pure carbohydrate and the cereals are mostly carbohydrate. It appears that nearly a third of the decline in cereal foods has been balanced chemically by this increase in consumption of sugar.

Meat. - During the pre-war period the consumption of pork and lard per person was about 73 pounds, while during the last five years it has averaged 84 pounds, apparently. This is an increase of 15 per cent. The per capita consumption of beef and veal declined from about 82 pounds in 1909 to 59 pounds in 1915, rose during the war years to 70 pounds in 1918, remained high till 1926, but has since declined greatly. It was 57 pounds in 1930, which was lower than at any time in the last 30 years, and not unlikely is lower than at any time during the last 100 years. The total consumption of meat per person, excluding poultry, but including lard, was about 154 pounds during the pre-war period, and is now about the same, except that with the advance of the economic depression, consumption declined to 151 pounds in 1929, and to 145.5 pounds in 1930. During the period 1923 to 1926 the consumption averaged 161 pounds. The significant change has been the increased per capita consumption of pork and decreased consumption of beef.

Milk. - The increase in consumption of milk and its products per person has been even greater, apparently, than of pork. Preliminary estimates indicate that consumption per person is now considerably greater than during the pre-war period (1909-1913). The increase started in 1915 and was under full swing by 1918, when the prohibition act came into effect. The increase was associated also with the health campaigns of the war period and later, and with the prosperity of the wage-earning classes. During the recent economic depression per capita consumption has declined several per cent.

The Effect of the Change in Diet on the Need for Land

These changes in diet have had a marked effect upon the need for farm land since the war period, but compared with the pre-war years the change is slight. If man could live on sugar alone it would require only about one-third of an acre of sugar beets (at average acre-yields in United States), or cane (average acre-yields in Louisiana) to provide the same amount of energy as that in the food the average adult American consumes each year, but it would require three-fourths of an acre of corn or potatoes, an acre and a half of wheat or tomatoes, over three acres of crops if he ate only pork and lard, about two and a third acres of crops and one and two-thirds acres of pasture if he lived on milk, and 11 acres of crops plus two and a half acres of pasture equivalent if he lived wholly on beef and veal. (Fig. 21.)

Of course, no man could live on sugar alone, for in a few weeks he would develop diabetes or other diseases; probably he could not live for a year on wheat alone; but he might be able to do so on milk, which is the most complete food. This comparison of acreage required to produce an equal quantity of food, measured in calories, shows that much more land is required to produce a diet based largely on meat than one based on wheat, corn, or the other cereals. It now requires over two acres of crops to feed the average American, but only one acre to feed the average German, one-half acre to feed a Chinese, and one-fourth an acre, a Japanese. This is owing largely to the difference in diet, except that the difference between China and Japan is owing to much higher crop yields in Japan.

The decrease in the United States since the pre-war years in consumption per person of cereal foods, principally wheat flour and cornmeal, has reduced the area of these crops needed to feed a person from about 0.34 acre to 0.26 acre, or by about one-twelfth of an acre; while the increase in consumption of milk, pork, and vegetables has increased the area per person needed to produce these products by an eighth of an acre. Nearly all the increase in sugar consumption has been supplied by Cuba, Porto Rico, Hawaii, and the Philippines, so it has not been included in the estimate. However, if this increased amount of sugar were produced within the continental United States it would require only 0.01 acre of beets per person, or 1,250,000 acres for our 123,000,000 people. The net result of the change in diet in the United States since the pre-war period has been an increase in crop land needed to feed each person of only about one-twenty-fourth of an acre, or an increase of 2 per cent.

This is a very small amount of change; and in view of the fact that the high ratio of natural resources to population in the United States will very probably persist, there seems little likelihood of such a change in diet occurring as would reduce the area of crop land required for domestic needs to any such per capita figure as that for Germany, for instance. The safest assumption, perhaps, is that the present acreage requirement per person will be subject only to such reduction as results from progress in agricultural technique, and a stationary domestic supply of beef with correspondingly increased supply of pork and milk. 17/

17/ For a population of a sixth greater than at present, this would mean a per capita consumption of foodstuffs, measured in crop area, only about 3 per cent less than at present, excluding effect of changes in agricultural technique.

There are four important non-food farm products which also need to be considered - cotton, wool, flaxseed, and tobacco. The per capita consumption of cotton has been remarkably uniform, varying between 25 and 30 pounds during most of the years since 1900. Although mill consumption of cotton has declined notably during the past year, this decline is almost certainly transitory. Wool consumption per person, on the other hand, has remained since the World War at about 10 per cent below the average at the beginning of the century. The per capita consumption of linseed oil, the principal flaxseed product, has been increasing until recently, but the increase is supplied by imports, which are now about as large as the domestic production of flaxseed. The consumption per person of tobacco has increased about a fourth during the past 30 years.

Combining all the major agricultural products consumed by the American people on the basis of crop land required to produce them, it appears that the net land requirements per person, assuming a stationary production per acre, are about the same now as 30 years ago. In view of the population and production prospects, it seems likely that the aggregate consumption of farm products in the United States will continue to increase more or less directly with the population. The outlook, therefore, provided the immigration restrictions are not relaxed, is for a consumption less than 10 per cent larger a decade hence and probably about 15 to 20 per cent larger 20 to 25 years hence, when it will become approximately stationary for a few years and then may decline. The increase in agricultural production between the low year 1921 and the peak in 1926 was about 27 per cent, and between the decade 1912-1921 and the decade 1922-1931 was about 17 per cent. In other words, the Nation's maximum domestic needs for farm products are not likely to require a greater increase in production than that which has occurred since the World War period.

Of course, if the prosperity of the American people should decline, and they should eat more bread and other cereal foods and less meat and milk, there might be less than 15 per cent increase in the domestic market for farm products from the standpoint of land required to produce them, in fact, there might be no increase whatever in the area of land needed. On the other hand, if the people should consume more meat or milk per person the area of land required to produce the food supply might be more than 15 per cent greater.

The land area required to provide for domestic consumption will also vary, of course, with progress in motorization of agriculture, with changes in acre-yields of the crops, with changes in production of meat and milk per unit of feed consumed, with changes in relative importance of the crops and of the different classes of livestock, and with other factors. The probability is that these changes will occur - for there is nothing certain in the modern world except change, - but it is uncertain to what extent these changes will counterbalance the increase of population. It seems very likely, however, that the increasing production per acre will continue, and that the percentage increase in crop area, if any, will be much less than the 15 to 20 per cent increase in population. (assuming no material change in restrictions on immigration).



Exports

In recent years from one-tenth to one-fifth of the Nation's farm products, measured in area of land required to produce them, has been exported, mostly to Europe; ^{18/} and in Northwestern Europe, where most of the exports go, as in the United States, the birth rate has been declining for 50 years. But the decline during the war years was much greater in the belligerent countries than in the United States, and the rebound in 1919 and 1920, after the soldiers had returned home, was more marked. (Fig. 19.) However, the decline since 1920 has brought the birth rate to lower points in nearly every country of Northwestern Europe than it is in the United States. From Sweden to Scotland and Switzerland the birth rate has fallen to that point where it is scarcely able to maintain population permanently, and in England, Germany, and Sweden there are not enough daughters being born to replace the mothers of the present day. In 20 to 30 years, perhaps sooner, these countries of Northwestern Europe will have a stationary population, and unless the present trend of the birth rate is reversed or they receive immigrants from abroad, the population in several of these countries will then begin to decline.

Since Northwestern Europe has been the great foreign market for American agricultural products, it is clear that American farmers cannot depend on an increasing expansion of that market, such as might be expected to accompany an increasing population. On the contrary, agricultural technique is advancing in Northern Europe as it is in North America. In Northwestern Europe the acre-yields of some of the crops are twice as high as in the United States, and after a decline during the war years, they are now advancing in several countries beyond their pre-war levels; also, as in the United States, there has been a shift from production of cattle primarily for beef toward dairying and swine, which shift, there as here, results in a notable economy in the amount of land needed to provide the people with food.

Moreover, the intensification of the nationalistic spirit which accompanied the World War, and the consequent desire for national security with respect to the food supply, brought in, like an undertow, a notable wave of tariff enactments. Italy, which imported until recently 60 to 90 million bushels of wheat annually, including flour, mostly from the United States, has now practically prohibited imports with a tariff approximating 87 cents per bushel. In Germany and France, likewise, tariff duties have become almost prohibitive. ^{19/} Of the great wheat-importing countries of Europe, only Great Britain, Belgium, and the Netherlands retain free trade in wheat.

In Southern Europe also the birth rate is declining, but less rapidly. Even in Italy, where a vigorous nationalism has retarded the decline at least temporarily, the number of births in 1929 was fewer than in 1928. But although declining in most of Southern Europe, the birth rate is still high, and the stationary state of population is more remote than in northern Europe. On the other hand, in Russia population is increasing at the tremendous rate of 2 to 3 per cent a year apparently -- 25 to 30 millions gain

^{18/} Excluding the area of land required to feed the horses and mules used in producing the products exported.

^{19/} In Germany the tariff on wheat was increased to \$1.62 a bushel.

during the past decade -- and there is no evidence of a declining birth rate, except in the cities, which include only 20 per cent of the population. In this respect Russia resembles the Orient rather than the Occident. It is not improbable that the Russians will be eating all, or nearly all, the wheat they produce before many years.

The acreage required to produce the agricultural exports from the United States was lower in the fiscal year 1929-30 than in any year since the beginning of the century, and only about half as great as in 1921-22. (Fig. 22.) The exports in 1930-31 seem likely to be still less. The crop area required to produce the exports of animal foodstuffs (mostly lard and pork) now only slightly exceeds that which would be required to produce the imports (beef, lamb, milk, and some dairy products), whereas of the cash crops, notably cotton and wheat, this is far from the case.

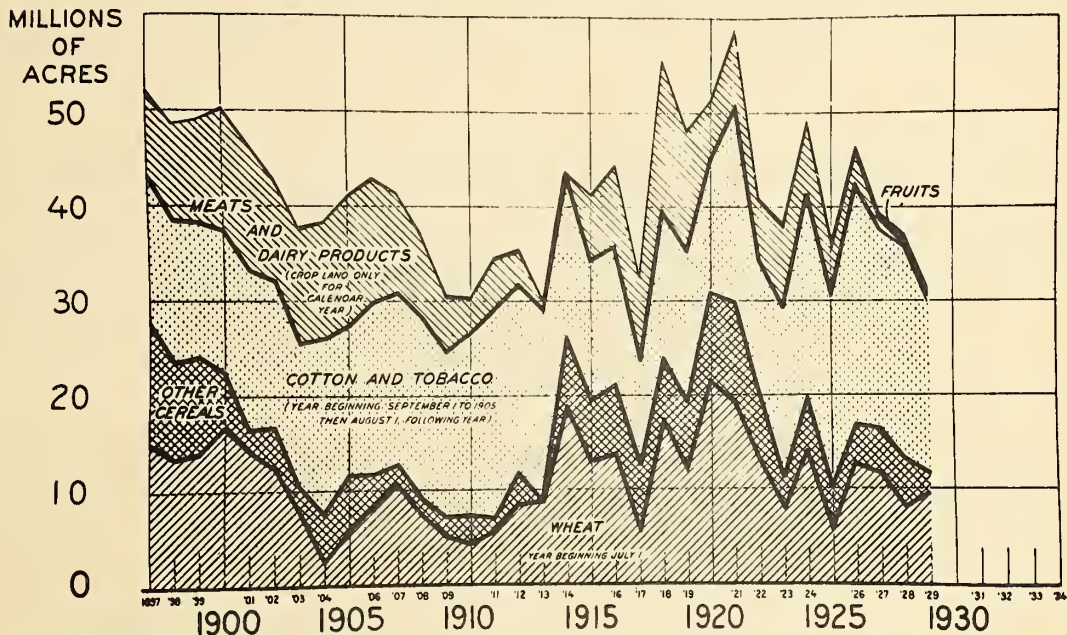
The significance of the rapid decline in agricultural exports since 1926 is not yet clear. Undoubtedly the reduction in the purchasing power of European peoples, owing to diminution of American credit and other factors, the increase in European tariffs on agricultural products, the decline in the value of silver, which has affected the purchasing power of Oriental peoples, and many other factors have exerted an influence. But it is interesting to note that this recent great decline in agricultural exports has coincided with a decline in total agricultural production just as it did from 1907 to 1910. Whether exports will increase with the increase in production which may be expected as weather conditions become more normal only the future can reveal. The situation is complex, and political as well as economic considerations are involved.

This much, however, may be said:

- (1) The imports of beef, which have exceeded the exports every year since 1921, were increasing until recently.
- (2) The imports of dairy products have slightly exceeded exports for 8 years, but are not increasing.
- (3) The exports of pork have declined, but not rapidly in the last four years, while the exports of lard have been maintained until recently.
- (4) The exports of corn and rye have almost vanished.
- (5) Unless wheat production decreases, or per capita consumption increases, exports may continue for two decades.
- (6) The exports of cotton have been greater in recent years than ever before, and there is no prospect of domestic consumption approaching production.

In brief, the export surplus of animal products, with the exception of lard and, to a less degree, of pork, no longer exists. If the production of pork and lard does not increase and per capita consumption remains at the average level of the last ten years, the exports of pork will be required for home consumption in four years, but the lard exports are sufficient to

Approximate Acreage Required to Produce Net Exports Major Farm Products, 1897-1929



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FIGURE 22 - THE ACREAGE REQUIRED TO PRODUCE THE AGRICULTURAL EXPORTS FROM THE UNITED STATES WAS LOWER IN THE FISCAL YEAR 1929 - 1930 THAN IN ANY YEAR SINCE THE BEGINNING OF THE CENTURY, AND IT MAY BE STILL LESS IN 1930 - 1931. THE CROP ACREAGE REQUIRED TO PRODUCE THE EXPORTS OF ANIMAL FOODSTUFFS NOW ONLY SLIGHTLY EXCEEDS THAT WHICH WOULD BE REQUIRED TO PRODUCE THE IMPORTS, BUT FOR COTTON AND TOBACCO, THERE IS NO PROSPECT OF IMPORTS EXCEEDING EXPORTS. FOR WHEAT EXPORTS AND IMPORTS WOULD NOW BE ABOUT EQUAL HAD PRE-WAR PER CAPITA CONSUMPTION PERSISTED

supply 50 to 60 million people at the present rate of domestic consumption, which is much more than the probable increase in the Nation's population. For lard and cotton, therefore, there is little hope of imports exceeding exports in the future. The significance of this fact to the Cotton Belt is very great, but to the Corn Belt is much less, as lard is of minor importance compared with pork or beef or dairy products. More significant to the Corn Belt, in view of the present tariff policy, is the fact that for practically all animal products, except pork and lard and condensed or evaporated milk, imports exceed exports, and that the Nation's population is still increasing about 0.9 per cent a year.

PART IV. POSSIBILITIES OF AGRICULTURAL PRODUCTION IN FOREIGN COUNTRIES

Foreign competition with American farm products in the world's markets is confined, as already noted, principally to wheat, cotton, tobacco, lard, the vegetable oils and certain fruits. In the time available this morning we will be able to consider only the principal wheat-growing regions.

Wheat

The long-time outlook for competition in marketing wheat is affected principally by the prospect for production in seven grassland regions, -- Canada, Russia, Northern China, India, Argentina, Australia and South Africa. This prospect is, in turn, dependent in part on the land resources of these countries. But as a basis for comparison let us note first the potential wheat area in the United States. 20/

United States. -- The area of land in the United States in which the climate, the soil and the topography, or lay of the land, would permit the production of wheat at a high price may be roughly estimated at 1,000,000 square miles, or 640,000,000 acres. This is an area two-thirds as great as that physically available for all crops, almost twice as great as that in harvested crops at present, and ten times as great as that in wheat at present. Obviously wheat will never occupy all this potential area, and it is best, perhaps, to apply the present proportion of crop land in wheat, 25 per cent, to this potential area figure. This gives a result of 160,000,000 acres as a very rough estimate of the area that might be put into wheat when the population pressure is such as to bring practically all the potentially arable land under crop, and provided the present relative importance of wheat compared with other crops persists. At present there are about 60,000,000 acres of wheat. Under heavy pressure it seems probable, therefore, that the acreage of wheat in the United States might become two to three times as great as at present.

20/ The reader should realize that as only about half of the agricultural area of the United States has yet been covered by the Soil Survey, the figures given must be rough estimates; while for the foreign countries, in most of which soil survey work is scarcely begun, the figures given are merely guesses by competent persons who have assembled available information, often meager. But these guesses by students of the subject suffice to reach a broad conclusion of real significance.

Canada. - The area of potentially arable land in Canada has been officially estimated at as high as 350,000,000 acres, which is almost as much as the area of crops harvested annually at present in the United States. This may be an over-estimate. In traveling through the Prairie Provinces, Ontario, Quebec and the Maritime Provinces it appeared that the crop area in Canada constitutes about the same ratio of the potentially arable area that it does in corresponding regions in the United States. But, to be generous, let us assume that settlement in Canada has advanced relatively only three-fourths as far as in the United States. On this basis Canada has a potentially arable area of, possibly, 210,000,000 acres as compared with the 975,000,000 acres estimated for the United States. Subtracting the 60,000,000 acres in crops in Canada harvested in 1930, leaves 150,000,000 acres as a rough estimate of the additional area available for crops.

About 40 per cent of the total crop acreage in Canada is in wheat. Since much of the potentially arable area not yet in crops is forest land, mostly acid in reaction and not good for wheat, it seems unlikely that should 210,000,000 acres ever be brought into use for crops, over 30 per cent, or about 60,000,000 acres will be in wheat. There are about 25,000,000 acres in wheat at present. The ratio of present acreage to potential acreage of wheat in Canada, therefore, is similar to that in the United States.

Russia. - In the European portion of the U.S.S.R. the original grass-land area is mostly under the plow. Dr. C. F. Marbut, Chief of the United States Soil Survey, who recently returned from a trip through southern Russia, estimates that there are only 10 to 12 million acres of virgin grass land, possibly a little more, still available for grain in the sub-humid "black-earth" and the semi-arid "brown-earth" regions of European Russia.^{21/} But in the Asiatic portions of these belts there is a vast area of potential grain land now used only for grazing or lying unused -- probably 150 million acres, and perhaps much more. The area of the "black-earth" soils in the entire U.S.S.R. is nearly three times the area of such soils in the United States, and the area of "chestnut-brown" soils is fully twice as great. On the other hand, there is little true prairie land in Russia, like our Corn Belt, and the forest soils that adjoin the grass-land belt on the north are not particularly fertile -- they resemble the soils in our northern Great Lakes region, according to Dr. Marbut, -- while to the south of the grass land belt lies the desert.

The data collected by Dr. Marbut as to the almost complete occupation of the "black-earth" and "brown-earth" belts in European Russia is confirmed by Dr. Shantz, formerly ecologist in the U. S. Department of Agriculture, now President of the University of Arizona, who traveled from Baku, on the Caspian Sea, to Moscow and Berlin by airplane. He reports that almost every foot of the land in this wheat-growing region of Russia, except the wet meadows grazed by geese, horses, and cattle, and the village areas, was under the plow.

^{21/} Marbut, C. F., "Russia and the United States in the World's Wheat Market," Geog. Review, January, 1931, page 15.

But it should be recalled that agriculture in Russia still uses mostly the three-field system of the Middle Ages in western Europe, in which spring grain follows winter grain and is followed by a year of fallow. The census statistics of the U.S.S.R. for 1928 reveal the fact that about one-third of the arable land was not sown. Of such fallow land there were nearly 150 million acres in the entire U.S.S.R. In addition, there were about 90 million acres of meadows, 158 million acres of pastures, and 99 million acres of other land suitable for agriculture in its present condition, -- a total of nearly 400 million acres, most of which needs only plowing to be ready for crops. Of course, much of the fallow land is in semi-arid regions, where, owing to deficient moisture, it is found profitable to conserve the rainfall of two years for a single year's crop, but after allowance is made for this and for semi-arid pasture and for the wet meadows, there are, apparently, about 300 million acres in Russia of pasture and idle land immediately available for crops. This is about the same acreage as in the United States.

Of the forest and cut-over land in Russia there appears to be much more that could be used for agriculture after clearing than in the United States; indeed, if we have interpreted the word "suitable" in a table in the Russian official report correctly, ^{22/} there is the amazing total of about 1,500,000,000 acres, which is over five times as much as in the United States. It is well, however, to keep in mind Dr. Marbut's opinion that most of this forest area possesses poor soil; also, that the growing season is short and cool. In all likelihood very little of this forest and cut-over land would be suitable for wheat production.

The total area physically available for crop production in the U.S.S.R. is, according to the Russian estimates, over twice that in the United States; whereas the area in crops at present is considerably less than in the United States (about 300 million acres in U.S.S.R.). The total land area of the U.S.S.R. is nearly three times that of the United States. But if I may venture a personal opinion without careful investigation it is that the agricultural land resources of that vast nation are of a magnitude comparable with the combined resources of the United States and Canada. It may be, in view of the shortness of the growing season in most of the U.S.S.R., that its agricultural resources are no greater than those of the United States. As in the United States, it seems likely that agricultural production could be doubled. Probably this is true also of wheat production.

Argentina. - The land resources of Argentina have been studied more carefully by Dr. C. F. Jones, of Clark University, than by any other person with whom I am acquainted. He writes as follows:

"In reply to your letter of December 5th concerning the probable future maximum production of wheat in Argentina, I am glad to send you the estimates which I have made. In my book on South America, I have given the following statement.

^{22/} Our interpretation of this word has been confirmed by correspondence with authorities in the U.S.S.R., who warn, however, that since the decision as to what land is "suitable" for crops is left to local officials, there is doubtless wide diversity in classifying the land.

'Argentina has 225,000,000 acres physically adapted to wheat culture; with 30 per cent of this land yielding wheat at 13 bushels per acre, the country could produce 900,000,000 bushels. While the country has large possibilities, a long time will elapse before its crop mounts even to two-thirds of this figure.'

"The figure 225,000,000 acres includes, of course, much land that will be used for the production of corn, barley, oats, and even alfalfa for range land. This figure includes warm, rather moist lands on the northern margin of the Pampa which may not come under wheat production. Also there are considerable areas within the belt which have hard-pan soils and which will probably not be used for wheat culture. At present, almost 40 per cent of the cultivated land in Argentina is in wheat. As agriculture becomes more advanced, this percentage will undoubtedly decrease to between 30 and 25 per cent. Therefore, it seems to me that the probable future maximum production will be somewhere in the neighborhood of 900,000,000 bushels.

"As the rate of increase in wheat production in Argentina is slower than it has been in Canada, it may take much longer for the wheat crop of Argentina to double than it did for that of Canada. Once the production has reached 500,000,000 bushels, the increase afterward probably will be much slower.

"In making these estimates I have used all the materials available published by the Argentine government, the Department of Agriculture figures, and those of the Food Research Institute of California. I trust that they will be of some use to you."

It may be added that the average area in wheat at present in Argentina is 20,000,000 acres, and that production ranges from 150,000,000 to 300,000,000 bushels.

China. - In Manchuria, Mongolia and parts of the adjacent provinces of China, there is a large area of semi-arid grassland that might grow wheat, particularly if power machinery were used to reduce the cost of production and balance the effect of low acre-yields. But how much land there is in this region that might be used for wheat and other small grains no one has estimated. It may be as large as 25 or even 50 million acres.

India. - In India also considerable expansion of the wheat area is possible, but estimates are not at hand. In recent years India has not had much wheat to export, and as the population increases, particularly the purchasing power, more and more of India's wheat will be eaten by its people.

Australia. - The outstanding authority on agricultural resources of Australia is Prof. Griffith Taylor, formerly of the University of Sydney, New South Wales, and now of the University of Chicago. In a letter he says:

"Climatically, of course, there is a much larger area suitable for wheat in Australia than is now used.....It is impossible to say closely how much of the wheat area must be cut out for other reasons.....In Australia there are, perhaps, 700,000 square miles climatically suitable for crops, of which about 500,000 square miles are suitable for wheat.

"Let us assume one-quarter of this area available for wheat (the ratio in the United States) may eventually be put into wheat, that is, 125,000 square miles. Although 70 per cent of Australia's total crop area is in wheat, that is, about 11 million acres, or 17,000 square miles..... if the proportion of 4 to 1 for potential wheat lands to land actually in wheat in the United States should hold ultimately also for Australia (and this is a big if), then Australia can add 7 times as much wheat to its agriculture. There is no useful soil survey in Australia beyond what I have quoted."

More recently there have been 14,000,000 to 18,000,000 acres in wheat in Australia, and since this area might be increased to 80 million acres, (which is more land than is in wheat in the United States at present) it would appear that the wheat acreage in Australia could be expanded four or five-fold, -- possibly more. 23/

South Africa. - There are a few million acres of wheat in South Africa, and although the possibilities of expansion may be of a similar magnitude to those in Australia, the small development which has taken place suggests that the difficulties to be overcome in expanding the production of wheat are very great.

Western Europe. - There remain for consideration the more or less densely populated countries of western Europe, excluding the U.S.S.R. The utilization of the land resources has proceeded, of course, much farther in most of these countries than in those previously considered, except India and China, but it is probable that in nearly all of these European countries the area in crops, and of wheat likewise, could be increased between 10 and 30 per cent.

World Possibilities: - It appears, therefore, that the area in wheat could be increased under the pressure of permanently high prices two-fold, in the United States, Canada, and the U.S.S.R., and three to five-fold in Argentina and Australia. On the other hand, in Europe, excluding the U.S.S.R., the increase cannot well exceed 25 per cent. Most of this potential wheat land, however, is less productive per acre than that now in use. Moreover, in much of the wheat area in all these countries, except in western Europe and eastern North America, acre-yields are frequently limited by rainfall and not by the fertility of the soil. A large increase in acre-yields in the

23/ Unsuitable soils and hilly or rough land surface might reduce materially the estimate of 500,000 square miles climatically suitable for wheat; but, on the other hand, it is more likely that 50 per cent of the potentially arable area would go into wheat than the 25 per cent assumed on the basis of importance of wheat compared with other crops in the United States.

dry-farming portions of these countries through the use of fertilizers cannot, therefore, be expected. But mechanization of agriculture is advancing in many of these countries almost as fast as in the United States, with consequent trend toward increasing acreage, and fertilization is becoming more common in the humid parts of these countries. On the whole, it seems probable that if the price of wheat should rise and remain permanently at the war-time level, the world production would double within a few decades.

Meanwhile, most of these countries are competing with each other in the world's markets. The condition of the wheat grower in the United States is bad, but the condition of the Canadian, Australian, and Argentinian wheat grower is worse, while that of the Russian wheat grower is problematical.

Unfortunately, on the semi-arid lands in particular, there is, in large measure, no other crop to be grown than wheat. It is generally wheat or pasture, and to put wheat land back into pasture commonly means bankruptcy, and in many cases would require several years. It seems to be a matter largely of which farmers can hold out longest, and from this standpoint the farmers of the United States have several advantages.

PART V. SUMMARY

In our efforts to foresee the future need for farm land in the United States and its utilization in various parts of the country, we have four major groups of facts to guide us:

1. Land Resources of the United States

The soil resources of the United States are greater than those of any other nation, except Russia, possibly, but are being depleted rapidly. Millions of acres of land formerly cultivated are being abandoned largely because of loss of fertility or erosion. But fertilizers and crop rotations, including use of legumes, can restore the elements of fertility lost by crop removal and leaching, and there is much low-grade and medium grade land, now in pasture or forest, that can be cultivated to replace the land lost by erosion. On the other hand, there is much eroded or depleted land that will revert to pasture or forest. The depletion of resources, however, tends to increase the cost of production; and the loss of soil by erosion particularly will cause serious local and even regional declines in agricultural production and income, accompanied, doubtless, by increases in production and income in other parts of the nation. The increasing mechanization of agriculture will promote the use of the more level land for crops, and use of the hilly land for pasture, or forest, or, if depleted badly, it may lie waste.

2. Technical Progress in Agricultural Production

There has been very little increase in total crop acreage or acre-yield since the World War, and the amount of crop feed and pasturage has remained about stationary for 15 years, the "agricultural surplus" which has developed despite an increasing population being due almost wholly, from the production standpoint, to the large amount of feed released by the decline in horses and mules, to increasing production of meat and milk per unit of feed consumed,

and to shifts from the less productive crops per acre and less productive classes of farm animals per unit of feed consumed toward the more productive. All four of these factors are likely to exert an influence for at least ten years, and possibly 25 years to come; but as the saturation point in use of automobiles has, apparently, almost been reached, and shifts from the less productive toward the more productive crops and farm animals are diminishing, while soil losses are likely to increase, it seems probable that the increasing population will require a slight increase in crop area, -- unless a great increase should occur in the use of fertilizers.

3. The Prospect for Consumption of Farm Products

This has three aspects: (a) the outlook for population; (b) for consumption per capita, and (c) for exports.

The number of children born in the United States each year is declining, and unless the birth rate rises, which is improbable, or unless the immigration restrictions are relaxed, a stationary population of between 140,000,000 and 160,000,000 will be reached soon after the year 1950, possibly earlier, followed by a slow decline. Twenty years hence, therefore, assuming a stationary per-capita consumption and the present immigration restrictions, the domestic need of the Nation for agricultural products appears likely to be only about 15 to 20 per cent greater than at present. This involves much less increase in production as that which occurred in 5 years between the abnormally low year 1921 and the high year 1926, and only about as much as occurred between the decades 1910-20 and 1920-30. Such an increase would provide also for the maintenance of our present exports of farm products. The rate of increase in production will need to be more rapid in the earlier years than in the later years of this twenty-year period before a stationary population is reached, but at no time need it exceed 1 per cent a year, unless exports increase greatly, as contrasted with 2 per cent average annual increase since the World War.

Changes in Consumption per Capita. - During the last thirty years changes in diet and in consumption of the fibres have not affected the per capita requirement for farm land very materially, and seem unlikely to affect it greatly in the future.

Exports. - The approach of a stationary and possibly declining population doubtless will enhance the interest in exports of agricultural products. At present an important export surplus exists only for cotton, tobacco, wheat, lard, vegetable oils, and several fruits. Twenty years hence, if the present stationary trend in the production of wheat and in per capita consumption continues, there will be little or no export surplus; but the price of cotton, tobacco and lard at least will, very likely, then, as now, be determined largely by the world's markets. Those markets may be larger, particularly if China develops into an industrial nation and is able to ship products to the United States in payment for the cotton, tobacco, and food products.

This question as to the future foreign demand for American farm products introduces a great uncertainty into the outlook for land utilization. The agricultural land resources of the United States are greater than those of

Europe, excluding Russia, and probably are almost equal to those of the Orient; yet there are only about 125,000,000 people in the United States at present, and never likely to be over 160,000,000 unless immigration restrictions are relaxed, as compared with nearly 400,000,000 in Europe, excluding Russia, and possibly 1,000,000,000 in the Orient. Can such a disparity in ratio of resources to population persist permanently? Will it be found advantageous to export a large proportion of the nation's agricultural products to these lands of dense population, receiving in return such products as they offer?

The answers to these questions will depend upon many factors, among which the most important, probably, are the progress that may be made in agricultural technique, changes in national policies both in the United States and abroad, rate of advancement in the standard of living, particularly in the Orient, and, perhaps fully as important, the severity of foreign competition.

4. Possibilities of Production in Foreign Countries

In the production of cotton, tobacco, wheat, lard, the vegetable oils, and certain fruits, it seems probable that the American farmer must meet competition in the world's markets from farmers of other countries for many years to come. In the case of wheat, it appears that the ratio of land available to land now used for wheat is about as large in the world as a whole as in the United States, i.e., the acreage could be doubled, possibly trebled. Moreover, agricultural technique is advancing in many of these foreign countries almost as rapidly as in the United States and crop area is expanding more rapidly. Whereas production of wheat in the United States has remained more or less stationary for fifteen years, world production, excluding China, has increased about 20 per cent. Likewise, cotton production in the United States is about the same now as fifteen or twenty years ago, but production in foreign countries has increased 40 to 50 per cent.

The Outlook

The outlook for land utilization in the United States is, briefly, for an increase in crop acreage in the more level and more fertile areas, where tractors and associated machinery and increasing use of fertilizer are likely to widen the present difference in cost of crop production as compared with the less level or less fertile areas, -- particularly since depletion of fertility by soil erosion and leaching and by crop removal is certain to become increasingly serious. In other words, crop production will tend to concentrate on the more level, more fertile, or more favorably located land. For a few years the total crop acreage of the nation may remain stationary or even increase slightly, but it is then likely to decrease as population declines (assuming little relaxation in immigration restrictions and no great increase in agricultural exports). Pasture lands probably will increase as crop land decreases, but since much pasture in hilly, eroded, or infertile areas will revert to brush and eventually to forest, this increase in pasture acreage may be transitory. Such reversion to forest has been in progress for several decades in parts of the Appalachian region; and during the past decade, for the first time in the nation's history, the area of forest and brush land in the United States as a whole increased materially. The reversion of crop land to pasture and forest, therefore, will be not a new development; it seems likely to become, merely more extensive and general.

This is the outlook, but it is not a forecast. The uncertainties in the situation, such as changes that may occur in our immigration policy, changes in tariff policy, both in the United States and abroad, the possibility of rapid industrialization in the Orient, which may be counter-balanced by continued rapid increase in agricultural production abroad, are too great to permit any definite conclusion.

Of these things, however, we may be sure, -- that the soil resources are being depleted, often wasted; that there will be further progress in agricultural technique; that there will be notable regional shifts in production; that prices of several farm products will continue to be affected by world conditions and national policies; that public action will be necessary to solve some of the vast problems of land utilization; and that those farmers who keep their eyes on the future, keep in touch with the men and institutions provided for their guidance, and do not fail to do their daily work well, are very likely to succeed.

ADDENDUM

The conclusions reached in the discussion of changes in agricultural production and consumption (pages 7 to 23) are based mostly on the published estimates of the Bureau of Agricultural Economics and on the Census of Agriculture, with division of each product into the portions used for human food, for livestock feed and for other purposes made in most cases on the basis of the returns to the Census of Manufactures. There are, however, several notable exceptions.

1. The estimates of wheat production and consumption are those made by Holbrook Working of the Food Research Institute, of Stanford University and published in Wheat Studies, Vol. IV, No. 2, entitled "Statistics of American Wheat Milling and Flour Disposition Since 1879."

2. Estimates of rice production and consumption for 1922 to date are those of the Rice Millers' Association.

3. The estimates of fruit production and consumption, in addition to the estimates of the Bureau of Agricultural Economics, are based on the various research studies of the Department of Agricultural Economics, of the University of California, supplemented by railroad reports on citrus shipments from Florida and a few minor miscellaneous sources.

4. The estimates of milk production and consumption prior to 1917 were made by the writer using very meagre material, principally Bulletin 55, Bureau of Animal Industry by H. E. Alvord (1903) and Bulletin 177, Bureau of Crop Estimates, by Eugene Merritt (1915), with estimates for intervening years based largely on per-capita milk consumption data for Boston, New York and Philadelphia and on the production data in the Census of Agriculture and consumption data in the Census of Manufactures.

5. The estimate of the amount of crop feed consumed by horses and mules is based on cost records of the Bureau of Agricultural Economics and State Experiment Stations, and was calculated for each State.

The conclusions cannot be free from errors contained in the statistical data used. Several of the graphs, particularly Fig. 13, suggest that these

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errors may be material. Any precise figure given in the text, therefore, must be considered as approximate. Precise figures are given because it seems better to do so than to be satisfied with a general statement which has only qualitative value and frequently little meaning.

However, the person who uses these figures may wish to have some idea of the magnitude of the possible errors. Such estimates of error can be merely personal opinion, and the writer ventures the following judgments solely on his own responsibility.

The Census figures for population of the United States, used in calculations of consumption per person, may be as much as a few per cent too low, but are probably closely comparable from decade to decade. These are, in all likelihood, the most accurate figures used in the study. The agricultural census data contain errors of a similar or greater magnitude and mostly in the same direction. The annual estimates of crop acreage and production made by the Bureau of Agricultural Economics may for certain crops and in certain years be closer to reality than the Census statistics, but the further removed these estimates are from the Census year the greater is the probability of error. The annual estimates of numbers of animals on farms January 1 are subject to similar limitations, except that the indications afforded by changes in number of animals assessed for taxation, in receipts at over 60 markets, and in inspected slaughter are also available as a basis for revising the preliminary estimates.

Finally, with reference to the estimates of production of meat and milk, although the basic data are less satisfactory than those on number of farm animals, the trends agree more closely with the trends of human population, and when combined with other foodstuffs into an index of per-capita consumption result in totals that are remarkably constant.

In reading this discussion of production and in studying the graphs it should be kept in mind, therefore, that there are undoubtedly errors in details, possibly involving serious divergencies from reality in certain time relationships portrayed. Nevertheless, the changes indicated by the data not only are real, in the writer's opinion, but also the magnitude of the change is approximately as indicated, except, possibly, in production of pork and lard per hog on farms, noted above, and in production of milk per cow.

The estimates of acreage and production of the principal crops prior to 1909 are being revised at present, and the 1930 Census of Distribution, as well as of Agriculture, will contain valuable data on production of meat and milk in 1929. These new data may indicate changes in the index numbers for both the early and the late years of the 30-year period.

